Beyond Resource Extraction: The Adverse Socio-Environmental Impacts of Mining Operations in Host Communities of Goromonzi and Mazowe Districts, Zimbabwe

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***Abstract*—The extraction of valuable geological materials from the earth's crust, mining, is considered a major driver of economic growth across the globe. However, mining operations are associated with environmental problems worldwide. Mining makes a significant contribution to Southern African economic development; however, its environmental impacts offset the benefits. Due to mining's dominance as an economic driver in Zimbabwe, its effects on environmental sustainability are overlooked and inadequately addressed. This research fills the gap by examining the environmental impacts of mining on host communities, with a focus on the Goromonzi and Mazowe districts, which are known for their significant extraction operations. The study adopted a qualitative case study research design. Data was collected using interviews, observations, focus group discussions, and from secondary data sources. Analysis of the data was highly centred on a thematic approach. Results from the study demonstrated the impact of mining operations on land and water resource degradation, biodiversity loss, and social ills, which adversely affect people's health, livelihoods, societal integration, and the overall resilience of host communities. Various initiatives have been implemented to suppress the dire impacts of mining, but socio-economic and political challenges have limited their effectiveness. Hence, addressing the negative effects of mining operations on host communities requires a transparent, multi-stakeholder approach that balances policies, resource conservation, community resilience, gender, and intersectional justice with the economic development brought about by mining.**

***Keywords*—land degradation, mining, resource extraction, host communities, biodiversity loss, pollution, livelihood loss**

I. Introduction

Mining is regarded as the lifeblood of socio-economic development across the globe [1]; therefore, the extraction of mineral resources is perpetuating at an alarming rate. Worldwide, raw material utilisation is projected to reach 1.670 tonnes by 2060, and metallic minerals are expected to reach 200 billion tonnes, with non-metallic rising to 860 billion tonnes, according to the Organisation for Economic Co-operation and Development (OECD) [2]. Exponential increase in resource consumption, including minerals, exacerbates challenges to environmental integrity, sustainability, and social equity. Earliest global traces of mining's environmental effects date back to around 6500 BC, and the earliest record was assigned to the Roman period owing to smelting activities. Consideration of mining as a double-edged sword from a sustainability perspective is an old phenomenon. In developed and developing nations, mining is known to trigger contamination of air, water, and soil [1, 3]. Mining operations to extract gold, coal, granite, lithium, sand, and chrome adversely impact the landscape and vegetation and encroach on agricultural land. Mining has played a significant developmental role in countries like Canada and Australia, and, though not sparing Peru, has resulted in a 15% increase in exports and a 2.1% increase in Gross Domestic Product (GDP); however, it also presents various adverse impacts [3, 4]. This led to the emergence of notions such as "mineral resource: a curse or a blessing" and "Dutch disease" in the field of mining.

After recognising that the availability of minerals is linked to social, economic, political, and environmental challenges, other countries adopted sustainable mining strategies [1, 5]. Several mining companies in developed nations have taken steps to implement green mining practices that aim to reduce environmental impacts, promote social responsibility, and conserve resources [1]. However, implementing green mining methods requires adequate resources, knowledge, sustainable practices, and a supportive legal framework [6], a situation that is often lacking in developing regions such as Africa. The mining industry is a significant contributor to Africa's economy [7], accounting for about 20% of Gross Domestic Product (GDP) in countries such as Zambia, Botswana, and South Africa. Nevertheless, mining also presents both positives and negatives that warrant attention. Mineral wealth has driven economic growth by generating roughly 20% of formal employment and supporting infrastructure development, such as schools, roads, and hospitals, in nations like Ghana [7]. Mining companies create essential jobs; for example, in Ghana, large-scale mines employ approximately 20,000 people and contribute to the national economy, yet they receive mixed reactions across Africa [7, 8]. Despite the existence of legal and environmental management frameworks, many mines in Africa continue to operate with less sustainable methods [8, 9]. Open-pit mining of minerals such as limestone, fluorspar, diatomite, gypsum, iron, and gold in Kenya results in environmental degradation and water pollution [9]. Instead of fostering development, mineral resources often lead to widespread poverty, loss of lives, displacement of

communities, and environmental harm in Nigeria [8].

In Ghana, land use changes and deforestation triggered by mining account for 24% of the nation's total greenhouse gas emissions [10]. The impacts of mining operations extend beyond disturbing forest cover and wildlife to exacerbate climate change. Mining is causing extensive land degradation, water contamination, and biodiversity loss in West Africa, including Mali, Niger, and Burkina Faso [11, 12]. Environmental problems associated with mining have reached a crisis point in Africa, particularly in Southern Africa, which hosts the Rand-Great Dyke-Copper Belt-Katanga mineral axis. Southern Africa is among the world's mineral-rich regions, but its communities face untold socio-economic and environmental problems caused by mining operations. This is among other factors, worsened by less sustainable mining operations and the enclave nature of the mining industries. In South Africa, sand mining has resulted in 54.76% of land degradation in Mentz village [13]. In countries like Botswana, Zambia, South Africa, and the Democratic Republic of Congo, mining operations cause noise, water, air, and soil contamination, deforestation, displacement of people, occupational hazards, social evils, and destruction of agricultural land [14].

Mining is among the dominant economic drivers in Zimbabwe, as in 2023 it contributed 12% to GDP and 80% of national exports [15, 16]. Owing to these derived benefits, it is considered a necessary evil; therefore, the adverse environmental impacts of mining operations are given little attention [16, 17]. However, the United Zimbabwe Alliance (UZA) report of 2024 indicated that approximately 200,000 hectares of forest cover are lost annually due to mining activities, a condition that affects people's livelihoods. The report further asserted that the Ministry of Mines and Mining development reported that 75% of the mining affects arable land while creating open pits, which threaten wildlife and livestock. UZA reported that the Ministry of Health and Child Care disclosed that mining host communities had a 50% higher prevalence of respiratory diseases than communities without mining in 2024. In the UZA report of 2024, Zimbabwe's Environmental Management Agency noted that about 70% of rivers in mining host communities are contaminated, a situation that endangers human life. Aspects of mining and the environment are documented, but the depth of these studies remains limited in their examination of how the environmental effects of mining are interconnected with social impacts, given the sharp increase in mining operations [1, 3, 13, 16]. This widens the gap toward sustainability, since achieving sustainable mining operations requires data that accurately reflects the contemporary effects of mining [18].

Despite this notion, there is a paucity of studies addressing questions arising from mining operations in Zimbabwe's Goromonzi and Mazowe districts, yet mining impacts are dynamic and vary from place to place [19]. As a result, there has been an increase in written petitions, including reports and complaints, coupled with attempts to protest socio-environmental problems caused by mining operations in Mazowe and Goromonzi. Also, their unique characteristics, which include their location in relation to the mineral-rich great dyke, which attracts miners as well as their livelihood, which is highly linked to land, soil, water, and forest, increase the vulnerability of people to the impacts of mining. The continuous outcry and appeals of local people are ascribed to the limited attention given by responsible authorities, including policymakers, to community feedback. This warrants research that brings the problem to the forefront and influences community practices and the implementation of policies to address mining operations-induced socio-environmental problems. Hence, this study aims to investigate the adverse impacts of mining operations on host communities in Zimbabwe, focusing on Goromonzi and Mazowe districts. This is significant because this research illustrated how the collective environmental impacts of mining operations undermine the resilience, livelihoods, and health of community members. It also strikes a balance among mining operations, development, and environmental sustainability while providing recommendations rooted in the perspectives of local people, whose voices are often given little attention. This is essential in the 21st century, as environmental protection and safeguarding human well-being from natural resource extraction are also at the core of sustainable discourse.

II. The Ecological Distribution Conflicts Theory

Ecological Distribution Conflicts (EDC) is a concept of environmental injustice derived from ecological economics [20]. The term EDC was coined by Martinez-Alier and O' Connor to describe social conflicts arising from unequal distribution of environmental benefits, such as access to natural resources and ecosystem services, as well as unequal allocations of environmental burdens, such as waste and pollution [20, 21]. The growth of ecological distribution conflicts worldwide is attributed to the changing metabolism of the economy, with increasing flows of materials and energy [20, 22]. According to [22], EDC noted that conflicts are caused by unjust access to natural resources, unfair burdens of pollution, and the distribution of environmental losses and gains. In EDC theory, social conflicts include clashes of interests, values, and norms among individuals or groups that lead to antagonism and power struggles. According to the EDC theory, conflicts involve struggles over the valuation process regarding which values are relevant in a particular project: livelihood values, market and monetary values, ecological values, and indigenous territorial rights [20, 22]. In political ecology, EDC indicated that unequal distribution of environmental bads and bads is not always coterminous with economic distribution [20, 23].

EDC theory asserts that mining industries and government entities leave the burden of environmental problems onto local communities with limited political power to resist or request equal benefits [24]. Power imbalance is illustrated by inadequate compensation of displaced people, inadequate participation of local stakeholders, and mining-induced environmental degradation in Zimbabwe [25, 26]. In Zimbabwe, mining often provides profits to mining industries and national governments, while local communities endure environmental and socio-economic problems [25, 26]. This condition reflects the uneven distribution of environmental goods and bads between mining industries and host communities. In the Goromonzi and Mazowe districts, local communities complain of an unequal distribution of burdens and benefits from mining operations. Additionally, the study aims to unearth the adverse environmental impacts of mining

operations, which are "environmental burdens or bads" and are also at the centre of Ecological Distribution Conflicts Theory. Therefore, applying the EDC theory enables the research to understand the power relations behind the distribution of goods and bads associated with mining operations in Mazowe and Goromonzi. Linking EDC theory to this study helps frame the detrimental impacts of mining from an ecological perspective alone, but also encompasses justice issues such as who gains, who loses, and how the burdens are distributed.

III. Research Methodology

A. Description of Study Area

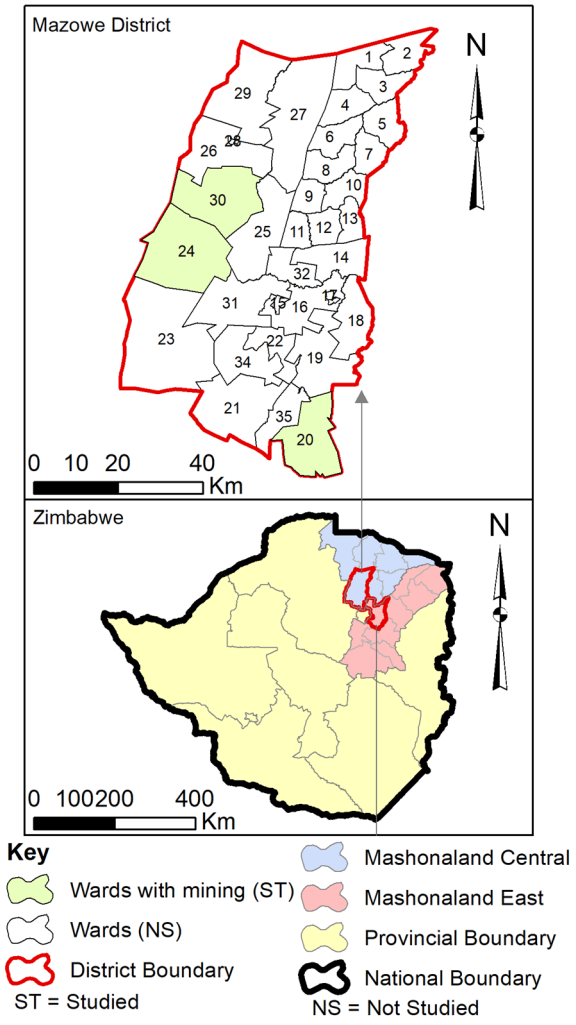

Fig. 1. The location of the Mazowe district and its wards in Zimbabwe.
Source: Authors

The study was conducted in Mazowe District (Fig. 1) and Goromonzi District (Fig. 2), located in Mashonaland Central and Mashonaland East provinces, respectively. The two districts are divided into wards, which are third-level local administrative units in Zimbabwe, below provinces and districts. In Zimbabwe, wards are numbered uniquely within each district. Mazowe District, with 35 wards, is situated about 58 km northwest of Harare and has a population of approximately 293,362 people [27]. The main sources of livelihood in the area include agriculture, mining, and vending. The geology of the area is associated with the Great Dyke, characterised by minerals such as chromium, nickel, copper, platinum, titanium, and iron, as well as vanadium, gold, and tin. Soils in Mazowe District are mostly derived from granite rock and support vegetation such as Brachystegia, Julbernadia, Terminalia, and Isoberlinia. Mazowe and Goromonzi districts are located in region 2, which receives about 720-1000 mm of rainfall annually.

Goromonzi, with 25 wards covering approximately 9100 square kilometres, is located in the southeast of Harare city. The livelihoods of about 386,199 people in Goromonzi district are mainly based on agriculture [27]; however, mining is also important. The vegetation in the Goromonzi district is mostly savanna woodland, consisting largely of grass and scattered trees. Like residents of Mazowe district, those in Goromonzi rely on both underground and surface water sources.

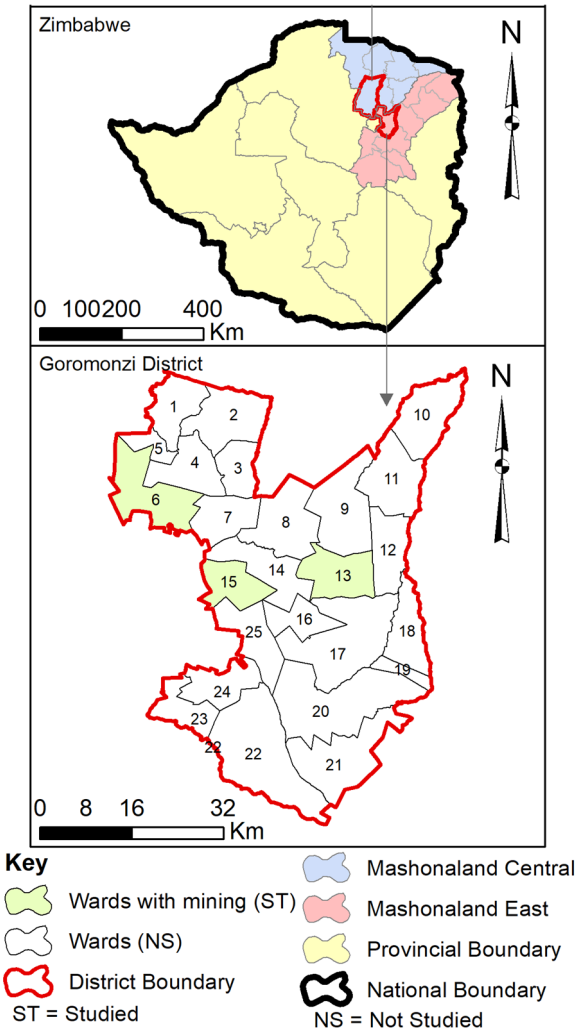

Fig. 2. The location of Goromonzi district and its wards in Zimbabwe.
Source: Authors

B. Research Design

Little is known about the full extent of the environmental consequences of mining operations in the Mazowe and Goromonzi districts [19], a scenario that requires an approach to explore the situation. Goromonzi and Mazowe are currently characterised by hostile relationships between mining industries and host communities due to mining operations that are impacting the well-being and livelihood of people [19, 28]. Owing to environmental problems triggered by mining operations, communities are appealing to

responsible authorities, institutions, and even donors seeking environmental justice in their areas. Hence, to develop area-specific practices and policies to address mining operations-induced problems in Mazowe and Goromonzi, case study results are essential. Therefore, a case study research design, which allows exploration of contextualised insights about the topic under study, was adopted. A case study provides an opportunity to explore the various environmental impacts of mining activities and their effects on the community, enabling researchers to connect the dots across different impacts. A case study enables researchers to focus on the experiences of people in the Goromonzi and Mazowe districts, thus helping them understand how mining impacts these two districts in a deeply informative way and develop context-specific solutions. The words "beyond resource extraction" suggest a broad scope for the research; therefore, a case study research design, which supports the utilisation of qualitative methods, lessens the burden of understanding people's experiences of the effects of mining on community livelihoods, resilience, health, and integration. Research directed to the districts is scarce; therefore, a case study research design, with the potential to provide important data that creates a baseline for future studies, was adopted. The adoption of a qualitative research design facilitated the collection of in-depth data regarding people's opinions, experiences, and their understanding of the environmental problems caused by mining operations.

C. Target Population and Sample Size Determination

The research targeted the mine host communities in the Goromonzi and Mazowe districts, which are rich in various types of minerals. Targeted key informants who would participate in interviews were selected purposively and assigned pseudonym codes to maintain anonymity (Table 1). Purposive sampling was considered appropriate because it allows the selection of individuals with the potential to provide rich, relevant, and diverse insights into the study. The key informants encompass RAC-01, ARD-02, MH-03, LAO-04, EM-05 and RDA-06 (Table 1). To carry out purposive sampling, a criterion-based strategy was applied. Interviewees included individuals who worked for government agencies and institutions involved in managing mining operations and their impacts, as well as community members who held leadership positions. The justification for selecting the key informants and for how they were contacted is illustrated in Table 1. Households in the Goromonzi and Mazowe districts participated in focus group discussions because they know how mining operations are impacting their communities. A focus group is a group of people, usually 6–12, who meet to discuss a topic set by a researcher [29]. Therefore, to include a large number of people with diverse views on the topic under study, each focus group consists of 12 participants. To achieve meaningful saturation in focus group discussions, 7 groups participated in Goromonzi and Mazowe.

Table 1. Targeted key informants

Key informants	Number	Justification for selection	How were they contacted
RAC-01	1	The representative of the residents has the community's interests in environmental issues.	An appointment was secured through phone calls to arrange a face-to-face interview.
ARD-02	1	The official has information on the mining operations-induced environmental problems in agriculture.	A visit was made to the district office to access contact information for the ward-based official. Phone calls were made to set face-to-face interview appointments.
MH-03	1	Knows the health problems associated with environmental problems caused by mining operations.	Visits to health centres were made to arrange dates of face-to-face interviews with the official.
LAO-04	1	The local authority official is knowledgeable about developmental issues in the area.	Phone calls were made to secure appointments for face-to-face interviews.
EM-05	1	The official knows the environmental issues surrounding mining operations.	A visit to the district office was made, and an appointment for a face-to-face interview was made.
RDA-06	1	The official served as the entry point into the infrastructural development programs, hence was selected to share views on mining and the environment.	A visit to the district office was made to secure an appointment, which was followed by an interview with the official.

Source: Authors (2025)

D. Data Collection, Analysis, and Presentation Methods

Data were collected from interviewees using semi-structured interview guides, a structured observation checklist used during field observations and focus group discussions, and secondary data sources. English semi-structured interview guides were utilised to collect data from interviewees. The researchers arrange face-to-face meetings with interviewees at locations chosen by the participants. The interviewees' responses were written in a notebook. Results from interviews were complemented by findings from observations, focus group discussions, and secondary data sources, which provide data on the environmental impacts of mining and how mining activities affect socio-economic aspects in host communities. Secondary sources, including community feedback mechanisms and mining and water monitoring reports, were utilised. Focus group discussions (FGD) were utilised to collect data from households. A set of questions to guide the discussion was written down. A discussion was held for up to 2 hours at a location convenient to the participants. During the FGD, participant dominance and groupthink were significant challenges. To ensure equal participation and diverse ideas, the researchers posed a question, and participants took turns contributing. Applied data collection methods were used to gather information on the mineral profile and mining operations, environmental and socio-economic impacts on host communities, and measures adopted to address these impacts.

To analyse the collected data, thematic analysis was adopted; hence, processes such as data cleaning, identification of relevant data, grouping by meaning, checking for coherence, and a clear definition of each theme were undertaken. During the analysis of qualitative data, including interviews and FGD, the researchers familiarise themselves with the data by reviewing it several times, noting

keywords, ideas, and recurring issues. This was followed by assigning codes in the form of short phrases to aspects relevant to the study, grouping similar codes to form more meaningful themes, and checking whether the themes accurately reflect the data. The final stage was to provide a clear explanation of how each theme related to the research goals, and the data were presented in descriptive narratives. Triangulation of data sources to cross-verify findings, prolonged engagement to build rapport with participants and experts, and debriefing with participants to confirm the accuracy of the results were used to ensure the trustworthiness of the findings. Moreover, validation of themes was conducted using the inter-coder reliability technique, in which each of the involved authors independently coded the data, and the coded data were then compared to ensure tallying of the emerging themes. To ensure data saturation during the research, an iterative process was applied during data collection and analysis until theme redundancy was observed.

E. Research Ethics

Regarding consent to participate, the purpose, procedures, and benefits of the research were clearly explained to the participants, and they voluntarily chose to participate or decline. The research adhered to the principle of anonymity by naming participants with pseudonyms, such as RAC-01 in the study. Confidentiality was guaranteed by storing the data in securely locked drawers. Validity and reliability of the research were established through triangulation of data sources, expert and participant debriefing, and the utilisation of inter-coder reliability techniques to validate themes.

IV. Results and Discussion

A. Mineral Profile and Mining Operations in Goromonzi and Mazowe Districts

Results from key informants, namely RAC-01, ARD-02, and MH-03, as well as focus group discussions, indicated that these two districts are rich in mineral resources of different types, as indicated in Table 2. In the Mazowe district, wards 20, 24, and 30 have been identified as active mining sites. The involvement of Goromonzi district in the extractive mining industry was evident in wards 6, 13, and 15. Underground and surface mining methods highly characterise the mining operations in these two districts. Open-cast mining was used for surface deposit extraction, while room-and-pillar mining was used for underground deposits. Reports and focus group discussions demonstrated that large-scale mining operations in Mazowe and Goromonzi are owned by various companies, including multinationals, a situation also supported by [19] and [30]. Among other characteristics, large-scale mines in the area are multi-owned, highly mechanised, and use open excavation and underground mining methods. Inadequate resources, labour-intensive operations, and unsafe practices with the potential to harm were highlighted. Most workers in the mining sector lack access to appropriate personal protective equipment/clothing, including essentials such as helmets, gloves, goggles, and boots [10, 11, 12]. In Mazowe and Goromonzi districts, mining activities co-exist with residential settlements, essential water sources, and agricultural zones. This scenario raises questions about livelihoods, environmental integrity, and the well-being of people in host communities who, according to [27, 28], depend heavily on agriculture and natural ecosystems.

Table 2. Mineral profile of Goromonzi and Mazowe districts

District	Key minerals
Goromonzi	Lithium, Gold, Granite, and Tantalite
Mazowe	Chrome, Gold, Lithium, and Granite

Source: Field data (2025)

B. Impacts of Mining Operations on Agriculture and Terrestrial Ecosystem

Key informant interviews and environmental monitoring reports suggested that mining was leaving a mark on Goromonzi and Mazowe districts. Key informant interviews estimated that approximately 75% of the mining methods applied in these two districts have the potential to leave the land unsuitable for agriculture. ARD-02 added that the effects of mining on farming are threatening the lives of approximately 924 households in Goromonzi Ward 13. The expansion and development of mines result in massive land clearance, the formation of open pits, and pollution of the land from disposed solid waste, leaving the land unsuitable for farming and grazing [3, 8, 12]. Loss of productive agricultural land reduces yields, thereby limiting the ability of community members to sustain their livelihoods while contributing to food insecurity, a scenario that hinders the ability to achieve Sustainable Development Goal (SDG) 2. In developing regions, such as Africa, mining-induced land degradation undermines agricultural productivity, leading to higher food prices, food insecurity, and income losses [7, 11, 31]. This suggests that mining is worsening hardships and poverty in Goromonzi and Mazowe, yet eradicating poverty is among the global targets, as highlighted by SDG 1 (No Poverty).

Focus group discussions noted that crops and vegetation were withering and drying up due to dust from the mining operations, a condition observed during the field visit. Particulate matter like thick dust from mining generally disturbs the photosynthetic capacity of vegetation; nevertheless, Li *et al.* [32] noted the significance of photosynthesis in the development of mature fruits. Observations indicate that mining operations in the 2 districts intensify deforestation, resulting in extensive soil disturbance and alteration of the indigenous flora and fauna of the community, findings that align with [11] and [12]'s studies. This implies that in Goromonzi and Mazowe, protection and promotion of the sustainable use of terrestrial ecosystems and the management of forests remain a challenge due to mining operations. Key informant interviews, secondary sources, and focus group discussions indicated that mining is associated with undesirable environmental impacts, particularly on mountains, land, and forests. Additionally, environmental reports illustrated that contaminants from mining operations were causing soil pollution. Sampled soil demonstrated the presence of Cadmium (Cd) at 0.8 milligrams per kilogram (mg/kg) and Mercury (Hg) at 1.22 mg/kg, which were above Environmental Protection Agency standards of 7.1/0.6 and 1.1/02, respectively. This aligns with [4, 6, 10], which state that mining operations are sources of heavy metals that negatively affect soil quality, ecosystems, and human health.

C. Impacts of Mining Operations on Water Quality and Availability

Mines operating in the Goromonzi and Mazowe districts have drilled deeper water boreholes and are extracting large volumes of water, causing groundwater depletion and the drying up of shallow wells in host communities. Groundwater dewatering attributed to mining operations is exacerbating the decline in open water bodies, for instance, from 2.3% in 2007 to 1.08% in 2017, as shown by the Goromonzi master plan report of 2024. The impacts of groundwater extraction are evident in Goromonzi, where 6.46% of wetlands were lost, as indicated by the Goromonzi master plan for 2024. This results in a shortage of clean, reliable water for domestic uses, such as drinking, washing, and cooking, as well as for agriculture [10, 12, 13]. This affects the achievement of Zimbabwe's Vision 2030, since mining operations are slowing the attainment of the target of making human settlements inclusive, safe, resilient, and sustainable. Farmers and mining companies are extracting water from the same sources and competing for the scarce resource, creating a hostile relationship between local people and mining companies. These findings align with those in Peru, where 60% of socio-environmental conflicts between mines and communities were attributed to mining-induced water contamination and competition [33]. This problem is more acute for women who, according to [34], are often responsible for providing basic necessities, such as water, for their families. Similarly, focus group discussions indicated that females and children in the Goromonzi and Mazowe districts were highly affected by the water shortage, as they had to walk long distances. This suggests that environmental problems caused by mining operations in Mazowe and Goromonzi districts need thoughtful responses to realise gender issues in the African Agenda 2063.

Findings highlighted that elements such as mercury, cyanide, and lead used in mining processes have the potential to poison water sources if improperly disposed of, yet [35] consider water a scarce resource in Zimbabwean communities. Results showed that mining companies sometimes dispose of wastewater containing heavy metals haphazardly, which can find their way into water sources. Water contamination was affecting aquatic creatures, such as fish, which were dying and developing sores, according to focus group discussions. The protection of water sources from mining-induced pollution is still at a nascent stage, as debris from mining operations finds its way into water sources [3, 12, 14]. Nevertheless, addressing this situation is crucial to achieving sustainable mining, which requires protecting, conserving, and sustainably using water sources. Contamination of water sources results in the loss of livelihoods for fishermen and people who consider fish part of their diet. Similarly, the consequences of water pollution were attributed to mining activities following the widespread death of fish in the Migori and Kuja rivers in the Migori district of Kenya [3].

Contamination of water sources by mining operations was confirmed by water quality test results in one of the environmental monitoring reports (Table 3). The level of Lead (Pb) in water samples collected from water sources in mining areas was high; for instance, the Pb level in sample ID PLZ 1 was 0.07, which was above the World Health Organisation permissible limit of 0.01mg/L. The levels of Cadmium (Cd)-0.42 mg/L, Arsenic (As)-0.08mg/L, and Mercury (Hg)-0.003mg/L were high and above World Health Organisation (WHO) limits for drinking water (Table 3). Findings are supported by [36], which states that mining operations are sources of chemicals and heavy metals with the potential to cause acute and chronic diseases in people. The presence of these heavy metal pollutants in water exposes people who consume it to various ailments, as shown in Table 4.

Table 3. Results of water sample analysis

	Water Sample ID	As mg/L	Cd mg/L	Pb mg/kg	Hg mg/L
WHO Maximum Permissible Limits		**0.01**	**0.003**	**0.01**	**0.006**
	PLZ-1	<0.01	<0.01	0.07	<0.01
	PLZ-2	<0.01	<0.01	0.05	<0.01
	PLZ-3	<0.01	<0.01	0.02	<0.01
	SLG	3.7	0.42	13.58	0.04
	STR 1	0.08	0.42	7.58	0.07
	IMPD	<0.01	0.03	<0.01	0.03

Source: Environmental report (2025)

Table 4. Potential human health impacts of contaminants in Table 3

Contaminant	Health effects
Arsenic	Cancer, Skin lesions, Cardiovascular diseases
Cadmium	Kidney damage, Bone diseases, Carcinogenic
Lead	Neurodevelopment delays, Anemia, Hypertension
Mercury	Neurotoxicity, Kidney failure

Source: Environmental report (2025)

D. Impacts of Mining Operations on Community's Education System and Sexual Behaviour

The results of the focus group discussions indicated that disruption of the education system in the area was largely attributed to the need to generate quick income from mining. As a result, Zimbabwe's efforts to equip young people with relevant education and development skills remain in vain, failing to meet the targets of SADC Vision 2050. School dropouts and the decline in moral standards were a significant concern for parents and traditional leaders, who sought to safeguard their children's cultural integrity and future. This is a troubling issue in Zimbabwe, where about 895,000 children are out of school, according to the United Nations International Children's Emergency Fund's 2022 report. The Zimbabwe National Statistics Agency's 2022 report stated that 16.6% of people are out of school. Furthermore, not sparing school dropouts, people in mining host communities engage in vices such as prostitution to earn a living [5, 7, 9]. This accelerated the spread of sexually transmitted diseases in Goromonzi and Mazowe, districts in Zimbabwe where

about 1,310,438 people are living with HIV, as indicated by the United Nations Development Programme report of 2022. Mining operations are worsening the spread of HIV/AIDS in Mazowe district, where its prevalence by age group is 11.93% (15–49 all adults), 4.01% (15–24 years old males) and 5.15% (15–24 years old) in 2020, as indicated by the National AIDS Council. HIV/AIDS is also already a burden in Goromonzi district, where, in terms of chronic illnesses, 28.2% of households have a member with HIV/AIDS, as illustrated by the Zimbabwe Vulnerability Assessment Committee report of 2022. The spread of HIV/AIDS has increased prevalence and has caused several fatalities, encompassing deaths of breadwinners, causing miserable situations in Goromonzi and Mazowe districts. A view asserted by [37] that the opening of extraction industries is associated with a high prevalence of HIV and AIDS, which brought undesired effects to mining communities in Sub-Saharan Africa. Key informant interviews and focus group discussions revealed the emergence of social divisions and conflicts brought by cultural dilution and anti-social behaviour. This implies that although mining heightens infrastructure development in these areas, it also fragments societies that were once integrated, a condition also noted in Ghana [7] and South Africa [12].

E. Impacts of Noise and Dust from Mining Operations on Community's Tranquility and Human Health

Mining activities, exemplified by blasting, drilling, truck and earth-machinery movement, are sources of noise and thick dust [38]. From the findings, it was clear that mining operations were severely impacting communities, as evidenced by disruptions to sleeping patterns, increased stress, and a potential for hearing loss. RAC-01 argued that, "*Persistent noise from mining operations, mostly at night, leads to sleep deficiency, leading to fatigue and tiredness during the day.* Exposure to dust can lead to respiratory problems, including chest pain, tuberculosis, and asthma, among people in host communities [8, 10, 11]. MH-03 asserted that*, "Adults and children from mining host communities visit hospitals complaining about persistent coughing, chest pains, severe pneumonia, and tuberculosis due to dust.* Through field observations, it was noted that most miners were working in confined shafts and pits, sharing poor-quality air due to limited ventilation. This was a matter of concern since miners are exposed to substances like dust, fumes, and gases, translating to the occurrence of obstructive pulmonary diseases, pneumoconiosis, and pulmonary tuberculosis. This aligns with [39]'s studies, which indicate that air laden with dust from mining operations poses health hazards to mine workers and people in nearby communities. To aggravate the situation, due to resource shortages, local people in the mining industry were exposed to extremely poor working conditions. Creating decent working environments for people in the mining sector is significant in Zimbabwe, since it is a key route for achieving the social and human capital development pillar outlined in the Southern African Development Community (SADC) Vision 2050 blueprint.

F. Measures to Address Impacts of Mining on Host Communities

The study's results highlighted that mines, particularly large-scale mines, are attempting to mitigate their impacts and are employing various approaches to address the impacts of mining operations. Signs reading "Do Not Drink the Water" were observed posted at water sources with potentially contaminated water. Water samples were collected from water sources near mines to test whether the water was suitable for human consumption. Large-scale mines treat their wastewater to neutralise toxicity before disposal, a situation supported by [40]'s studies in South Africa. Wastewater treatment minimises the release of hazardous pollutants into water sources, thus operating within the boundaries of SDG 6, which calls for reducing water pollution to improve its quality. To address water pollution in an integrated approach, government agencies, community members, and mining industries worked together in the Goromonzi and Mazowe districts. Their combined efforts aimed to assess the problem of water pollution, document the findings, and act accordingly. Ensuring the availability and sustainable management of water sources requires integrated efforts, as noted by [41]. Key informant interviews indicated that there are practices that advocate for all stakeholders' involvement and the utilisation of awareness campaigns to control alluvial mining in the Mazowe district. However, authorities responsible for monitoring mining-induced water contamination asserted that it was difficult to monitor and frequently visit large-scale mines due to limited resources. Community members were reported to avoid eating fish from contaminated water sources to protect themselves from disease; however, this affects their diet and rights. Water was used to suppress dust, but community members suggested constructing tarred roads for long-term benefits.

Mine workers and people from host communities who presented symptoms of dust infections were treated at the nearest clinic. Results demonstrated that, to ensure the sustainability of the communities, the mines drilled boreholes for local people and supported agriculture by providing irrigation systems. This indicates that mines operating in the Goromonzi and Mazowe districts play a vital role in ensuring attainment of goals that support the availability and access to safe water for all, a situation supported by [41]. The existence of tailing dams also indicated measures implemented by the mines to curb the environmental impacts of residues produced during ore processing. Reduction of mine and community conflicts was guaranteed through community engagement. Key informant interviews indicated that conducting an Environmental and Social Impact Assessment (ESIA) before commencing the mining project was a recommended measure. ESIA is significant for ensuring that mining operations are sustainable by identifying environmental and social impacts while enhancing positive impacts [42]. Mining companies are urged to operate in accordance with recommended environmental standards throughout their operations, but compliance was limited. Curbing of school dropouts was done through avoiding employing minors; however, they resorted to anti-social behaviour like prostitution. Large-scale mines have adopted backfilling of excavated areas, a practice which is considered in land reclamation by [43].

Taking the above into account, responses to problems experienced by host communities exist, but are hindered by weak enforcement, limited resources, and a lack of

stakeholder inclusion. This is why [43] argued that dealing with environmental problems associated with the extraction of rare earth elements requires management programs that support an integrated approach. The proposed framework (Fig. 3) illustrates measures that can be integrated to achieve the sustainable mining concept, mitigating the negative socio-economic and environmental impacts of mining while enhancing the positive outcomes of mining operations to foster thriving host communities. To make the framework contextually relevant, its development was primarily informed by research findings and literature. Fig. 3 shows that mining has both positive and negative impacts, underscoring the extractive industries as a double-edged sword for host communities. This aligns with [44], which argues that mining operations bring vices and virtues that affect the socio-economic and environmental characteristics of host communities. Mining host communities depend heavily on natural resources (Fig. 3); therefore, the adverse impacts of mining activities on forests, land, and water resources undermine their livelihoods and well-being. A view supported by [45] and [46] that most of the Zimbabwean communities, particularly rural communities, relied on naturally occurring resources for survival. Undesired impacts of mining can be mitigated and desired outcomes enhanced through transparency, consideration of gender issues, a multi-stakeholder approach, and balancing extraction activities with biodiversity conservation. Ultimately, Fig. 3 advocates for inclusive and environmentally responsible mining approaches that balance economic development with environmental integrity and social justice. This leads to sustainable mining operations that uphold the protection of ecosystems and human safety while safeguarding the environment, creating thriving mining host communities [47, 48].

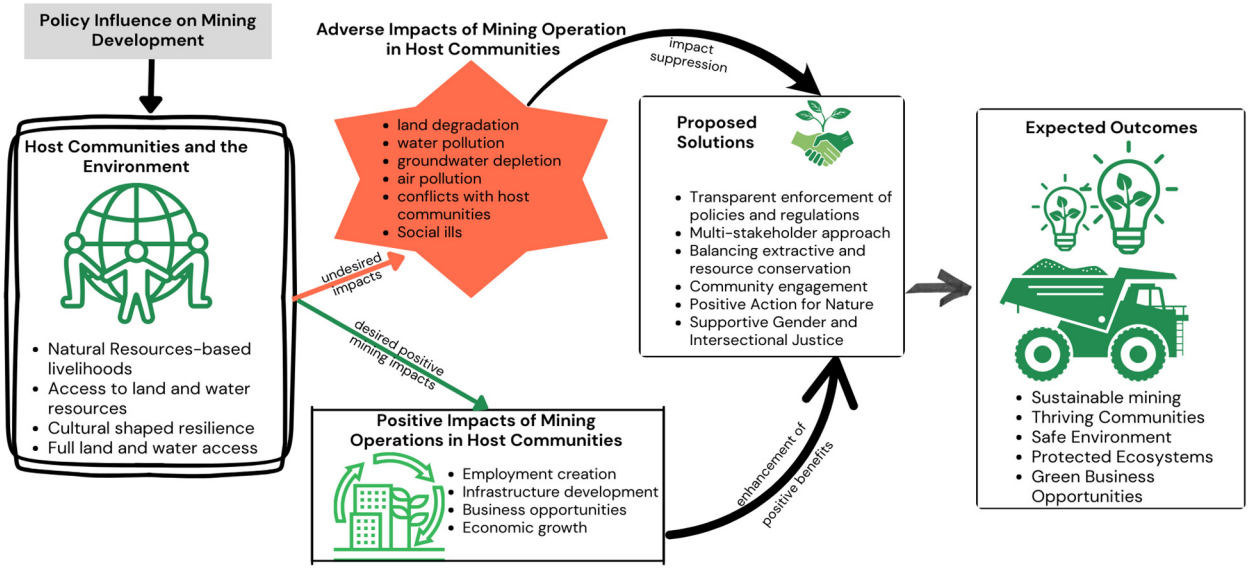

Fig. 3. Schematic mining operational impacts and sustainability measures.
Source: Authors (2025)

V. Conclusion and Recommendations

The study concludes that extraction industries are two-sided, as they bring both benefits and drawbacks to host communities worldwide. The research demonstrates that mining was causing multifaceted adverse impacts on host communities in Goromonzi and Mazowe districts. Results revealed pervasive land degradation, illustrated by open pits, extensive deforestation, soil erosion, and piles of waste that alter the natural landscape. Mining operations and development were encroaching on agricultural land, thereby disrupting crop farming and animal rearing, which are significant livelihoods for many people. Mining operations, including ore processing, cause contamination and drying up of water sources, which are critical for irrigation, human, and livestock consumption. Moreover, findings pointed to significant air contamination, respiratory problems, withering of crops and vegetation caused by dust generated from blasting, transportation, drilling, and crushing activities. Noise pollution from numerous mining operations, exemplified by blasting, the operation of heavy machinery, and truck movement, disrupts the daily lives of local people. Mining operations are posing adverse impacts on flora and fauna, with profound implications for rural people's livelihoods. Considering host communities' social aspect, mining has worsened the occurrence of school dropouts, crimes, prostitution, and the disintegration of families, coupled with cultural erosion and the high prevalence of sexually transmitted diseases. The scramble for available water resources was causing conflicts between mining companies and local communities.

Taking the findings into account, it is clear that the impacts of mining are not merely pollution but are also characterised by land-use shifts, loss of food sovereignty, injustice, and a gendered distribution of mining impacts in Mazowe and Goromomzi districts. In these two districts, the socio-environmental effects of mining are interconnected, as environmental problems reshape social systems while social structures influence the distribution of mining's adverse impacts. The study's findings are novel because they address social and environmental effects concurrently, a less common approach in other studies. Analysis of the results was based on Ecological Distribution Conflicts theory, thereby shifting from a cost-benefit economic view to a justice-and-power analysis that reveals a governance gap. Additionally, the study provides results that are essential for proposing solutions to the socio-environmental effects of mining in

districts that are not only major mining hubs but also agro-economy-based and characterised by high poverty prevalence and limited infrastructure. Furthermore, the results differ from other studies because they are presented through an integrated socio-environmental lens, which facilitates the development of a context-specific framework that advocates a transparent, multi-stakeholder approach balancing economic development with environmental integrity, justice, and community resilience.

The mines are trying to suppress the highlighted dire consequences, but the problem perpetuates, increasing poverty and undermining community resilience. However, mining-induced socio-environmental impacts persist continuously due to a lack of integrated Environmental Social Impact Assessments, good governance, cross-sectoral rehabilitation programs, and the marginalised community voice. Also, despite national policies, local enforcement of environmental regulations is limited due to political-economic pressures and resource constraints, which affect responsible authorities. Considering the adverse impacts of mining operations and how and why they manifest, addressing them in isolation is ineffective; hence, an integrated approach is imperative to recognise their systemic linkages. Consequently, the study recommends that responsible authorities implement more stringent policies and environmental governance strategies, clearly and transparently enforced through a multi-stakeholder approach. Implemented policies should ensure that government bodies, mining industries, people in host communities, and local authorities have an equal voice, prioritising resilient communities over short-term economic gains. Local government may strengthen environmental monitoring and enforcement by advocating for frequent, transparent inspections conducted by multi-stakeholder committees, including local leaders, community representatives, and environmental officers.

The local government could create an updated land-use plan that shows the boundaries of mines to prevent mining encroachment into settlements and agricultural zones. Mining companies can invest in strategies that support the utilisation of advanced water treatment and dust suppression systems, as well as circular-economy waste-management systems. Companies involved in extraction activities need to develop clear, detailed land rehabilitation and biodiversity conservation plans with measurable objectives and timelines, supported by financial plans. Local people should engage in other alternative livelihoods that are not directly affected by the lethal impacts of mining operations. Host communities can formulate their independent community-based organisations that advocate for responsible mining operations. Traditional leaders and community representatives could actively represent the general public in mining host communities without compromising their financial ties to mining companies. People in host communities should be educated and supported by mines and government agencies with essential infrastructure to invest in long-lasting livelihood alternatives, rather than relying solely on mining. In terms of future studies, the research recommends adopting a mixed-methods design that integrates qualitative and quantitative approaches to capture a more comprehensive picture of the adverse impacts of mining operations.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

P.S: Conceptualisation, data collection, writing, and editing. S.J: Reviewing and editing. H.M: Data collection and editing. T.S: Data analysis and Writing. T.S: Reviewing and editing.

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