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Dust, Discoloration, and Distrust: Lived Experiences in Zambia's Copper Mining Communities

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Abstract

As Zambia seeks to triple its copper production to meet growing global demand for critical minerals, the environmental externalities on surrounding communities warrant attention. We conducted 16 focus group discussions across eight copper mining communities in Zambia's Copperbelt Province. Participants described pervasive dust and contaminated water as unavoidable features of daily life, linking them to poor health and declining agricultural productivity. Personal mitigation strategies, such as wearing masks against dust or chlorinating discolored water, were widely viewed as ineffective or unaffordable. Therefore, residents requested environmental sampling, communication around environmental risks, and government action. While discussions in male focus groups centered more around mobilization and calls for accountability, female focus groups expressed more resignation and reliance on God. The environmental burden experienced by the community members was accompanied by a sense of economic exclusion, stemming from limited local employment and restrictions on artisanal and small-scale mining activities. This double burden raises questions about the sector's social license to operate in the Copperbelt.

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1 Introduction

The global transition towards net-zero emissions has sharply increased demand for copper, a mineral indispensable for renewable energy infrastructure, grid expansion, and electric vehicles (EVs) (International Energy Agency, 2021). Resource-rich countries are positioning themselves to meet this demand, and Zambia, already the world’s seventh-largest copper producer (U.S. Geological Survey, 2026), has made mining-led growth a central pillar of its development strategy, aiming to triple annual copper production by 2031 (Republic of Zambia, Ministry of Mines and Minerals Development, 2024). Yet the communities that stand to bear the environmental and health costs of this expansion may not be positioned to influence the industry’s development (Arezki, 2025), or capture a large share of the economic gains. Populations living closest to mining operations face elevated exposure to potentially toxic metals (PTEs) through contaminated soils, waterways, and air, with effects that can persist long after mining activities have ceased (Muimba-Kankolongo *et al.*, 2022), while formal mining employment reaches only a small share of surrounding residents. This asymmetry between who bears the burden of extraction and who captures its benefits sits at the center of this paper.

A substantial body of research has long documented the general environmental and epidemiological consequences of large-scale copper mining: contamination levels, exposure pathways, and disease incidence (Dudka and Adriano, 1997; Chen *et al.*, 2022; Tchounwou *et al.*, 2012). Far less is known about how the communities living amid these conditions experience, interpret, and respond to them. How local residents perceive environmental risk, attribute responsibility for it, and judge the fairness of the benefit-sharing arrangement shapes their trust in mining firms and public institutions, their willingness to adopt protective behavior, and ultimately the social legitimacy on which continued and expanding extraction depends. Understanding these dynamics is particularly urgent in a setting like Zambia’s densely populated Copperbelt, where government policy explicitly depends on communities’ continued acceptance of an expanding industry.

We address this gap by drawing on 16 focus group discussions (FGDs) conducted in 2025 across eight wards in the copper-heavy districts of Kitwe, Kalulushi, and Chingola in the Copperbelt Province. Participants describe a landscape in which environmental burdens are pervasive. They report declining agricultural productivity, contaminated water, and constant airborne dust while experiencing few of the economic benefits associated with historically high copper production. Employment is scarce, casual, and often held by outsiders; personal mitigation strategies are financially or practically out of reach; and children, whose exposure is hardest to monitor or prevent, are seen as bearing the greatest risk. These accounts closely track evidence from concurrent soil sampling conducted in the same communities (Nyanza *et al.*, 2026) suggesting that residents’ concerns are grounded in measurable objective environmental conditions.

Rather than describing mining as a source of shared prosperity tempered by environmental trade-offs, as is implicit in much of the existing literature, our findings point to a double burden: environmental and health costs that are broadly shared, alongside economic benefits that are narrowly captured. We argue this distinction matters for how Zambia’s mining expansion, and mineral-led development strategies more broadly, should be evaluated and governed. The remainder of the paper proceeds as follows. Section 2 describes the study setting, data collection, and analytical approach. Section 3 presents the findings from the FGD. Section 4 discusses the results in relation to the broader literature. Section 5 concludes.

2 Methods

2.1 Study Context

2.1.1 Study Area and Population

The area under study comprises communities located across eight distinct wards in the districts of Kitwe, Kalulushi, and Chingola, in Zambia’s Copperbelt Province. According to the 2022 Census, the Copperbelt is the second most populous province in Zambia, with a population of 2.8 million, predominantly of the Bemba ethnic group. Its demographic profile is distinctly urban, with 83.2% of residents living in urban areas compared to a national average of 44.7% (Zambia Statistics Agency, 2025, p. 17). This high level of urbanization is reflected in comparatively stronger socioeconomic indicators, including a higher literacy rate among individuals aged five years and above (78.3% vs. 62.6% nationally) (Zambia Statistics Agency, 2025, p. 62) and a lower poverty rate (35.9% vs. 60.0% nationally) (Zambia Statistics Agency, 2022, p. 131-132).

These demographic patterns reflect a long history of copper mining that dates back to the pre-colonial period. Today, mining is characterized by large-scale private operations alongside a growing presence of artisanal and small-scale mining (ASM). Mining has historically generated strong agglomeration forces, with neighborhoods, towns, and cities developing around mine sites, in some cases through direct mine investment (Sikamo *et al.*, 2016). Yet despite its central role in shaping the region’s urban development, the Copperbelt records Zambia’s highest unemployment rate (15.8% vs. 11.3% nationally)¹ (Zambia Statistics Agency, 2025, p. 113). Beyond its economic imprint, mining has also left a substantial environmental legacy. A recent systematic review documents widespread contamination of soils, water sources, and food crops by potentially toxic elements (PTEs) across the Copperbelt, creating multiple pathways for chronic human exposure among nearby communities (Benshaul-Tolonen *et al.*, 2026).

¹Mineral extraction is highly capital-intensive and generates relatively little direct employment. Instead, resource rents drive growth in non-tradable services, producing what Gollin *et al.* (2016) term “consumption cities”, in contrast to manufacturing-led “production cities”.

2.1.2 Study Timing

Copper mining has long been associated with environmental risks in the Copperbelt (The New Humanitarian, 2008; Mukumba *et al.*, 2026). The fieldwork was conducted in August 2025, six months after the collapse of the Sino-Metals Leach tailings dam in Chambishi, Kalulushi district, operated by a subsidiary of a Chinese state-owned mining company, although the study protocol had been set before the accident. The accident released approximately 50 million liters of toxic slurry into the Mwambashi River, a tributary of the Kafue River, compromising water quality downstream (Chama *et al.*, 2026). Given the Kafue River’s importance for domestic water supply, agriculture, and fisheries (WWF, 2012, p.14), the disaster formed an important backdrop to this study. The research protocol was subsequently adapted to examine its effects.

2.2 Ethical Approval

The research is nested within the broader Environmental-Health (E-H) study *Measuring and Mitigating Exposure to Toxic Metals in Copper Mining Areas in Zambia*, funded by the International Growth Centre (IGC). Alongside the focus group discussions, the broader study included concurrent environmental sampling in the same communities², the results of which are reported separately in Nyanza *et al.* (2026).

The E-H study received ethical approval from Barnard College and ERES Converge, as well as a research license from the National Health Research Authority³. In addition, approvals were obtained from the Ministries of Health⁴, Mines and Mineral Development, and Local Government and Rural Development⁵. Formal approval from customary authorities was not required because the study was conducted on state land, although local leaders were consulted where appropriate. All participants provided oral consent and were compensated for their participation in kind in accordance with the approved protocol.

2.3 Recruitment and Participants

FGDs were conducted in nine wards selected through a two-step process in collaboration with local authorities, specifically the Office of the Town Clerk. First, the research team identified areas of interest based on proximity to large-scale mining operations, capturing variation in both activity (e.g., mining, smelting, refining, waste disposal) and ownership (e.g., Chinese, state-owned, Indian).

²To avoid influencing participants’ responses, the soil sampling was conducted independently, and focus group participants were not informed of the sampling activities.

³Barnard College, Columbia University, United States; approval no. 24251110092. ERES converge, Zambia, approval no. 2025-08-08. National Health Research Authority, Zambia, approval no. NHRA-2491/18/07/2025)

⁴Following national-level approval, the research team obtained authorization from the provincial office in Ndola and the district offices in Kitwe, Kalulushi, and Chingola.

⁵Authorization was obtained from the Town Clerk’s Office in each study district.

Government representatives then proposed specific wards and corresponding local contacts, typically Ward Development Committee (WDC) chairpersons⁶.

The research team subsequently contacted these individuals, who identified suitable meeting locations (including schools, clinics, private homes, outdoor benches, and market offices) and informed community members about the upcoming discussions, typically scheduled between 9:00 and 17:00. Eligibility was restricted to locally resident adults aged 18 years and above. No language requirement was imposed, and participants were free to use Bemba, English, or another language of their choosing.

The target was 10 participants per focus group. In several locations, more than 10 individuals turned up and were accommodated. In one case, multiple members of the same household presented for participation, and the research team asked them to select a single representative. Two men's groups had only 7 and 8 participants, respectively, likely reflecting constraints associated with scheduling discussions during working hours.

One focus group discussion was postponed due to logistical challenges and ultimately conducted as a mixed-gender group of 10 participants. In that session, the WDC chairperson also participated directly. Given these deviations from the study protocol, this discussion was excluded from the analysis, resulting in a sample of 16 FGDs across 8 wards.

2.4 Focus Group Approach

All 16 FGDs were facilitated by same-sex moderators, both graduate students from the University of Zambia (UNZA) who were fluent in English and Bemba. Discussions were conducted primarily in Bemba, and each session lasted approximately one hour. At each session, a researcher from Barnard College was present and observed at least part of the discussion.

To ensure consistency across groups and locations, a semi-structured focus group guide was developed and piloted prior to data collection. The guide covered key domains, including living standards, water access, food security, experiences with the local copper mining industry, health and environmental issues, mitigation behaviors related to environmental exposure, and the Sino-Metals Leach mining accident.

All discussions were audio-recorded with participants' consent and supplemented by contemporaneous field notes by a local senior researcher capturing contextual details. Recordings were translated directly into English by their respective moderator and underwent independent quality review by

⁶WDC members are not paid government employees and do not hold formal legal authority. However, they serve as intermediaries between government authorities and local communities and are therefore well placed to mobilize community members.

a senior researcher fluent in both English and Bemba. Verbatim transcription in Bemba was not conducted, given its predominantly oral use.

2.5 Data Analysis

Following transcription and translation into English, the transcripts were analyzed thematically. The principal investigator (PI) and junior researcher reviewed all 16 focus group discussions (FGDs) to identify recurring themes and develop an initial coding framework based on the FGD guide, while allowing additional themes to emerge inductively.

The fieldwork coordinator and a research assistant (RA) subsequently coded all transcripts and refined the coding framework where necessary. Coding decisions were discussed throughout the process to ensure consistency and coherence in the application of codes. The PI and a senior researcher then reviewed the coded material and developed the final analytical narrative.

As a third step, all transcripts were imported into NVivo and coded to triangulate the manual analysis and facilitate the thematic frequency counts. NVivo was used to support the systematic organization of coded data and to quantify the frequency with which themes occurred across the transcripts.

3 Results

The 16 FGDs offer detailed insight into how communities living in copper mining areas experience daily life. Participants were encouraged to reflect broadly, allowing both men and women to highlight the issues they perceived as most salient. This approach surfaced several recurring topics presented below.

3.1 The Mine in the Background, Livelihoods Under Threat

All communities are located in areas where mining activities dominate the landscape, with visible nearby mines, tailings dams, and waste deposits. However, this proximity does not translate into meaningful employment opportunities for most local residents. Across discussions, participants consistently described limited access to formal jobs, which were perceived as scarce, temporary, and often allocated to individuals from outside the community.

“They [mining companies] only create casual jobs, no permanent jobs.” (Luapula, Kalulushi – Men FGD)

“You will just find Nyanjas and Tongas employed, but this place is for Lambas. There is not even one of us [Lambas] in the mines, there are just people from other places.”

(Luangwa, Kitwe – Men FGD)

This reflects a broader sense of exclusion from the economic benefits of mining, despite its physical presence. Rather than serving as a source of economic opportunity, the mines are seen as largely decoupled from surrounding communities.

“People just see the mine as a structure which exists in the community but provides no value to them.” (Wusakile, Kitwe – Men FGD)

This disconnection is further reinforced by the decline of informal mining activities, particularly copper scavenging following recent government enforcement measures introduced in response to fatal accidents and efforts to strengthen mining licensing and regulatory compliance (Kabuswe, 2025).

“We used to survive by going to the mining dump site and getting any meaningful materials we could to sell and make ends meet, but they stopped us, so things are hard.” (Maiteneke, Chingola – Men FGD)

These effects are felt across local economies.

“The jerabos⁷ are the ones we considered as miners because they brought in the money. When they sell, then there will be money. Not anymore.” (Chiwempala, Chingola – Women FGD)

In some cases, participants used charged language to express potential unrest and collective resistance should informal mining be further restricted, underscoring the extent to which communities depend on informal mining for survival.

“The government should not make the mistake of trying to get this pit. (...) If they even try to get or confiscate it, I think there will be war in Zambia. (...) It is our source of living.” (Maiteneke, Chingola – Men FGD)

As a result of limited formal employment in large-scale mining and the increasing restriction of informal mining activities, everyday economic life is shaped predominantly by small-scale, informal, and non-mining activities.

“I sell different things, whatever I find. I don’t even know what I sell. Anything as long as it’s business.” (Luangwa, Kitwe – Women FGD)

Within this context, incomes are low, irregular, and insufficient to meet basic living standards, including the ability to secure daily meals.

⁷ “Jerabo” (sg.) and “Jerabos” (pl.) are local terms used in Zambia’s Copperbelt to refer to artisanal miners and their organized groups, predominantly made up of youth.

“When you compare the businesses and the feeding needs, money is too little. It does not suffice. You eat using whatever you can find.” (Luapula, Kalulushi – Women FGD)

Across discussions, men more often emphasized declining income opportunities, particularly in relation to mining-related activities, while women focused on the day-to-day management of scarcity and household survival. Overall, livelihoods were characterized by high effort but low return, shaped by unstable informal activities, rising costs, and limited economic integration with the mining sector.

3.2 Environmental Externalities and Agricultural Productivity

In addition to the limited role of large-scale mining in supporting local employment and livelihoods, discussants further emphasized its negative effects on agricultural activity. Agriculture remains a central component of the Zambian economy, employing approximately 70% of the population (Zambia Development Agency, 2024), and plays an important role in both income generation and food consumption.

Rather than pointing to a discrete shock (e.g., a mining accident), participants described a gradual decline in agricultural productivity, often attributing these changes to nearby mining operations. Across discussions, they reported visible changes in crop quality, including discoloration and stunted growth.

“They [crops] just grow and suddenly turn black.” (Wusakile, Kitwe – Men FGD)

“Lumanda [Sabbdariffa gossypifolia] is sturdy, but it’s also stunting and failing to shoot. Previously, it used to shoot even when exposed to the cold, but not anymore. (...) The rape has become yellow. I have lost two fields.” (Musakashi, Kalulushi – Women FGD)

Participants frequently linked these changes to perceived deterioration in the quality of the land and stream.

“The mines which are nearby have affected the yield of the fields. The soil has changed (...)” (Ichimpe, Kalulushi – Men FGD)

“When you cultivate vegetables, they turn purple due to the acid from the mines that was poured into the stream” (Maiteneke, Chingola – Men FGD)

Consistent with these observations, participants also described declining yields, even where inputs such as fertilizer were applied:

“Ever since the mines came, when I grow rape, I only harvest twice and it changes color despite putting fertilizer.” (Musakashi, Kalulushi – Men FGD)

In some communities, this challenge was linked to water access, particularly where mining activities were seen to divert water sources:

“Us who have gardens are crying (...) they [mining companies] closed off the water.”
(Ichimpe, Kalulushi – Women FGD)

The reported decline in agricultural productivity affects both food availability and income opportunities, reinforcing broader patterns of economic vulnerability.

3.3 Water Contamination and Constrained Mitigation

Concerns about water quality were among the most immediate and strongly expressed among participants across multiple locations. They described water sources, including shallow wells, boreholes, and in some cases, piped supplies, as contaminated and unsafe.

In several communities, respondents pointed to visible changes in water quality, including the presence of residues and shifts in color:

“After fetching water and keeping it overnight, you will observe some particles at the bottom. We drink the water from the top.” (Kabundi, Chingola – Men FGD)

“Piped water is not okay. You can’t drink it directly from the tap (...) it’s brownish.”
(Kabundi, Chingola – Women FGD)

“Buckets and plates change color. No matter how much you scrub them, you will find that the bucket has changed color after two days. It starts looking orange-brown on the inside.” (Maiteneke, Chingola – Women FGD)

Participants frequently attributed these changes to mining-related processes, particularly acid discharge:

“I think those things [acid] are mobile; they [acid] will be moving underground, coming to mix with water in our wells.” (Musakashi, Kalulushi – Women FGD)

In the absence of reliable access to clean, piped water, households pointed to basic mitigation strategies, including boiling and chlorine treatment⁸. However, these strategies were widely perceived as time-consuming and financially out of reach.

“We fail to boil because we don’t have enough time to do so, even for us to put chlorine in shallow wells.” (Musakashi, Kalulushi – Men FGD)

⁸Boiling and chlorination are effective for reducing microbial contamination but do not remove dissolved heavy metals from drinking water.

“You fail to have two meals a day, then you add chlorine? [laughter]” (Wusakile, Kitwe – Men FGD)

A small number of participants from the same community noted that boiling or chlorination may be ineffective in addressing contamination from toxic metals, in contrast to their effectiveness in reducing bacterial contamination:

“Even when you boil this water, you will see, I don’t know if it is silica settled at the bottom. The brown color is evident.” (Maiteneke, Chingola – Women FGD)

“Adding chlorine to the water doesn’t change anything, it only makes water have a taste of chlorine, but the color won’t change and everything will be the same, as chlorine can’t kill or remove the copper metals in the water.” (Maiteneke, Chingola – Men FGD)

The limited availability of effective and feasible mitigation strategies contributed to a broader sense of resignation:

“We cannot stop using that water, whether or not it is safe because that is all we have to drink.” (Luangwa, Kitwe – Women FGD)

“You said it may mix with the acid, what will you do?” (Moderator, Musakashi, Kalulushi – Women FGD) *“P1: Nothing. P2: Nothing. P3: We will be drinking. P4: Until we die. P5: God will keep us, because we have nowhere to go.”* (Musakashi, Kalulushi – Women FGD)

3.4 Air Pollution as a Non-Excludable Risk

Alongside water contamination, air pollution was described as a constant and unavoidable condition. Participants emphasized that dust is present daily and affects both indoor and outdoor environments:

“There is a lot of dust (...) even at the school, the dust comes and fills the classrooms. You cannot even see the sun.” (Ichimpe, Kalulushi – Men FGD)

Participants identified multiple sources of exposure, including *senta*, the local term for sulphur dioxide fumes from copper smelters, as well as dust generated by heavy mining haulage trucks traveling through residential areas:

“[The mine] releases senta, which makes you feel like your throat is burning.” (Musakashi, Kalulushi – Women FGD)

“People here have coughs due to dust from the roads, not from the mines.” (Luangwa, Kitwe – Men FGD)

“That waste they [mines] throw, they put it in a vehicle, an open truck. (...) it [the truck] moves fast, the dust starts flying around.” (Kabundi, Chingola – Women FGD)

Poor air quality was in turn associated with a range of health concerns, including persistent coughing, chest pain, headaches, and eye irritation:

“You see fumes start coming out [of the mine] at 6:00 AM. Then where does it go? It will come to the community, causing coughs and chest congestion. People have to be taken to the hospital.” (Luapula, Kalulushi – Women FGD)

“The rising dust does not bring peace to the community (...) we suffer from continuous coughs and eye problems. The dust is causing us grief as a community.” (Ichimpe, Kalulushi – Women FGD)

In some discussions, prolonged exposure was linked to more serious conditions, including what participants described as silicosis-induced tuberculosis (TB). In one focus group, a woman likened community exposure to that experienced by mine workers:

“We are also scared that we may catch it [TB] because we are breathing it [silica]. It’s the same as those people who are going into the pit; we are not different because we breathe the dust. We are miners working with silica.” (Kabundi, Chingola – Women FGD)

Participants clearly recognized air pollution as a non-excludable public bad from which individuals cannot effectively shield themselves. Individual-level mitigation strategies were viewed as largely ineffective, and responsibility was seen as lying with mining firms or the state:

“Wind pollution is beyond our means, it’s something we cannot control. You can’t sleep under a mosquito net to avoid wind, it will pass through. This is the big issue and it concerns big companies or the state; the government must come to our aid, because we can talk but if there is no action, the problem will remain the same.” (Ichimpe, Kalulushi – Men FGD)

Until effective mitigation measures are implemented, community members reported having little capacity to protect themselves:

“There are no mitigation measures. We just breathe.” (Chiwempala, Chingola – Women FGD)

3.5 Children’s Exposure and Health Risks

Water and air pollution affect the broader community, including those not engaged in mining. However, across discussions, particularly among mothers, participants emphasized that children

are the most vulnerable:

“If those things [dust] continue, we will not be healthy, especially the children. Children’s chests are not so tough.” (Ichimpe, Kalulushi – Women FGD)

Participants attributed this heightened vulnerability, in part, to children’s inability to heed warnings.

“We try to sensitize our children and warn them against going to certain areas. ‘Don’t play there, bad things pass there’ but you know the nature of children.” (Wusakile, Kitwe – Men FGD)

“Children? They don’t listen.” (Musakashi, Kalulushi – Women FGD)

Participants described a range of challenges in limiting children’s exposure, including keeping them away from dump sites and indoors during periods of high air pollution, ensuring mask use, and preventing the consumption of unboiled water.

“The children go and glean after they [the mines] dump the waste. They don’t even wear shoes.” (Chiwempala, Chingola – Women FGD)

“When you see smoke [fumes](...) we forbid the children from going there. (...) You lock them up in the house. The younger ones, not the older ones. You cannot control them [the older children].” (Maiteneke, Chingola – Women FGD)

“We cannot protect them [children] from dust. You can see, they are outside playing and when those things [dust] come out, they just breathe. You cannot make this one wear a mask; they will not accept.” (Musakashi, Kalulushi – Women FGD)

“Children, they will not pay attention to which one was boiled and which one was not boiled. They will just get and drink any water, whether boiled or not.” (Kabundi, Chingola – Women FGD)

Participants linked these challenges to adverse health outcomes among children.

“We are worried about the children; there is an outbreak of stomach problems. They are in and out [of the hospital]. We have a huge problem because the water we fetch from the well is not okay.” (Maiteneke, Chingola – Women FGD)

The risks faced by children are compounded by limited access to healthcare. In several discussions, participants noted that even when illness occurs, obtaining treatment is not always feasible:

“Drugs are difficult to find sometimes. Sometimes, you can bring the child [to the hospital], but there are no drugs. (...) you will sit and pray to the ancestors.” (Kabundi, Chingola – Women FGD)

Participants emphasized that meaningful improvements in children’s safety would require reductions in mining-related environmental risks. One participant highlighted the role of the Zambian Environmental Management Agency (ZEMA):

“The only way is if the mines reduce the pollution, and this is where ZEMA comes in (...) it’s up to the authorities to put pressure on the mines to ensure that this pollution can be at least reduced to a level where people can survive.” (Luapula, Kalulushi – Men FGD)

3.6 Environmental Testing and Mitigation Strategies

Beyond calls to reduce pollution, participants in several communities emphasized the need for environmental testing.

“No government, company or NGO has ever come here to monitor the air, water or land.” (Maiteneke, Chingola – Men FGD)

“The mines only measure and monitor in their own offices.” (Chiwempala, Chingola – Men FGD)

Participants further emphasized that the issue extends beyond the need for environmental testing to the dissemination of results. Several focus groups, both with men and women, reported that environmental testing had previously been conducted, but that findings were not shared with the communities.

“I found [the Mine] measuring the water but they have never shared the results.” (Luangwa, Kitwe – Men FGD)

“They tested a sample of water [in 2015] from Musakashi [stream]. They tested and went without telling us anything. There was no feedback about the goodness of the water we drink.” (Musakashi, Kalulushi – Women FGD)

One channel for disseminating information to communities was through local radio and television stations. However, participants noted that, in practice, these channels are often ineffective due to frequent power outages resulting from load shedding.

Participants noted that, in the absence of reliable and accessible information, households are unable to adjust their behavior or adopt appropriate measures to reduce health risks.

“They have not told us about protective measures. How will you protect yourself from what you don’t know? You just look to God, ‘God, you are the one who will protect me’.” (Musakashi, Kalulushi – Women FGD)

At the same time, a tension emerged in how participants interpreted these constraints. While many emphasized structural barriers to reducing exposure and maintaining protective practices, others attributed non-compliance to individual behavior:

“It’s laziness which makes it difficult [to follow protective practices].” (Kabundi, Chingola – Men FGD)

“We are all aware [of hygienic practices], it’s just laziness.” (Musakashi, Kalulushi – Women FGD)

Taken together, these responses suggest that while community members recognize the presence of pollution and express a strong demand for information, constraints in both information access and follow-through limit the adoption of mitigation strategies.

3.7 The Sino-Metals Incident

In light of the recent Sino-Metals Leach tailings dam collapse in Chambishi, Kalulushi district, at a Chinese state-owned mine, enumerators concluded discussions by inviting participants to reflect on the event and its widespread impacts.

Across all locations, participants reported learning about the accident within a few days to a week after its occurrence, primarily through radio, and to a lesser extent through television and social media. These reports were often reinforced by direct or indirect observation, including sightings of dead fish in the Mwambashi and Kafue Rivers, damaged crops, or images circulating within social networks. Participants expressed little doubt about the severity of the event.

“We heard from the radio. We confirmed when we saw fish dying on their own.” (Luangwa, Kitwe – Men FGD)

“I heard from an in-law on that side. All their fields were destroyed. All the maize dried. Swept through the field.” (Musakashi, Kalulushi – Women FGD)

The delay in information dissemination was sufficient for many households to have already unknowingly consumed contaminated water or fish, causing sickness.

“Those who drank the water before knowing [of the accident] and those who ate the fish became sick. Many of them. They suffered from diarrhoea. Things were not okay.” (Maiteneke, Chingola – Women FGD)

Participants often emphasized uncertainty about the timing and manifestation of health effects, particularly the possibility of long-term consequences:

“Whether or not someone got sick, one can have a problem in their body; you can get sick little-by-little over time.” (Luangwa, Kitwe – Women FGD)

This concern ultimately translated into a sense of resignation, with participants emphasizing that exposure had already occurred through pathways beyond their knowledge or control. They noted that banned fish could already have entered the food chain through vendors seeking cheaper supplies, while contaminated water may already have been pumped through public water systems. Consequently, participants felt they had little to no agency over preventing future exposure or influencing subsequent outcomes:

“Even when you are told not to buy fish [from the affected stream], restaurants have a cheap source of fish which they can’t resist to buy.” (Luapula, Kalulushi – Men FGD)

“I am sure they [water utility company] already pumped water from Chambeshi and we already drank it here in Kitwe. The tailing dam which collapsed discharged into the Kafue River. They [the USA government] told their people this is a long-term issue, and people will die a slow death. We drank that water.” (Wusakile, Kitwe – Men FGD)

The Sino-Metals incident, however, should not be interpreted as an isolated crisis ⁹. Participants frequently raised recurring concerns about environmental accidents, particularly those involving Chinese-owned mining companies.

“You find that a person sells a farm to the Chinese and they turn that land into a mine, without the community agreeing to such. Those are farm lands, and there will be the same [environmental] accidents which are happening now in the future.” (Kabundi, Chingola – Men FGD)

3.8 Agency and Trust in God

While both male and female participants across locations described similar conditions of life in mining communities, a notable difference emerged in their sense of agency.

Male focus groups more frequently attributed responsibility to external actors, particularly mining companies:

“Pollution, it’s not our fault, it’s their fault. We are not the ones who are supposed to fix the pollution, it’s them.” (Maiteneke, Chingola – Men FGD)

In contrast, discussions involving women, particularly around food security and exposure to pollution, more often expressed a sense of resignation and reliance on faith, with similar references appearing across other sections (Section 3.3 and 3.6).

⁹In April 2026, a separate tailings dam (33C) collapsed in Kitwe, marking a second major environmental incident within a 14-month period.

“You wake up and start worrying, ‘What will we eat today?’. By the end of the day, God blesses. You eat.” (Luapula, Kalulushi – Women FGD)

“What can you do? We survive by the grace of God.” (Chiwempala, Chingola – Women FGD) *“That is poverty [laughs]”* (Chiwempala, Chingola – Women FGD)

4 Discussion

This study explored how communities living near large-scale copper mining operations perceive the balance between the economic benefits of mining and its environmental and health costs. Across the focus groups, participants consistently described bearing the environmental and health burdens of mining while receiving few of its economic benefits. Our findings are consistent with evidence from other mining contexts, where communities living near large-scale mining operations have reported limited local employment opportunities, environmental degradation, adverse health impacts, and insecure livelihoods despite the wealth generated by mining activities (Leuenberger *et al.*, 2021b,a).

The thematic frequency count (Table 1) shows a high level of concern across communities, although the intensity and nature of these concerns vary. Dust was a particularly prominent concern, with 89 mentions across the focus groups, including 27 mentions in a single community. References to smoke and fumes, including *senta*, were concentrated in particular communities, reflecting their proximity to refineries and smelters. Acid-related damage, including acid rain, was mentioned spontaneously in all communities, despite these terms not being included in the FGD guide. This unprompted and widespread concern highlights the salience of perceived water-quality impacts associated with mining and processing activities.

Importantly, however, these concerns were not expressed simply as opposition to mining or its environmental impacts. Rather, they were embedded in a broader perception that communities bear the costs of mining without receiving a commensurate share of its benefits. This perception reflects a historical relationship between mining and community welfare on the Copperbelt, in which mining companies were once more directly associated with employment, social services, and local development.

The Copperbelt’s contemporary grievances therefore need to be understood against this historical context. During the colonial period, mining companies increasingly invested in housing, education, and social services to secure and stabilize the workforce. Following independence, these investments expanded under nationalization, supported by high global copper prices. However, from the 1970s onward, declining copper prices, together with privatization, increasing mechanization, and more diverse ownership structures introduced through the Structural Adjustment Programs of the 1990s, substantially reduced the mining sector’s direct contribution to local employment and community

Table 1: Thematic Frequency Counts and Heavy Metal Contamination by Study Site

Ward / District	Keyword mention	Metals exceeding UCC
Maiteneke Chingola	Acid damage	Cu, Co, Pb
	Poor & low yield	
	Dust	
	Smoke & fumes	
	Discoloration & sediments	
	Scarcity	
	Effluent contamination	
Chiwempala Chingola	Acid damage	Cu, Co, Pb, Zn
	Poor & low yield	
	Dust	
	Smoke & fumes	
	Discoloration & sediments	
	Scarcity	
	Effluent contamination	
Kabundi Chingola	Acid damage	Cu, Co, Pb, Zn
	Poor & low yield	
	Dust	
	Smoke & fumes	
	Discoloration & sediments	
	Scarcity	
	Effluent contamination	
Musakashi Kalulushi	Acid damage	Cu
	Poor & low yield	
	Dust	
	Smoke & fumes	
	Discoloration & sediments	
	Scarcity	
	Effluent contamination	
Ichimpe Kalulushi	Acid damage	Cu, Co
	Poor & low yield	
	Dust	
	Smoke & fumes	
	Discoloration & sediments	
	Scarcity	
	Effluent contamination	
Luapula Kalulushi	Acid damage	Cu, Co, Pb, Zn
	Poor & low yield	
	Dust	
	Smoke & fumes	
	Discoloration & sediments	
	Scarcity	
	Effluent contamination	
Wusakile Kitwe	Acid damage	Cu, Co, Pb, Zn, As
	Poor & low yield	
	Dust	
	Smoke & fumes	
	Discoloration & sediments	
	Scarcity	
	Effluent contamination	
Luangwa Kitwe	Acid damage	Cu, Co, Zn
	Poor & low yield	
	Dust	
	Smoke & fumes	
	Discoloration & sediments	
	Scarcity	
	Effluent contamination	

Notes: Threshold = Upper Continental Crust (UCC) background concentration. **Bold** = ward's median concentration exceeds UCC (majority of samples elevated); plain = at least one sample exceeds UCC but the median does not.

welfare (Juif and Frankema, 2018). Against this backdrop, participants contrasted the copper sector’s historical role as a driver of broad-based development with contemporary experiences of exclusion, in which the benefits of mining were perceived to accrue elsewhere. As one participant remarked, “*That copper that we have in Zambia is developing other countries where it goes, why not here?*”

4.1 Agrarian Livelihoods and Environmental Contamination

Despite ranking as Zambia’s second most industrialized and urbanized province after Lusaka (Zambia Statistics Agency, 2025, p. 17), the Copperbelt retains a substantial agrarian base. Census data classify 51.1% of households as agricultural¹⁰, up from 39.4% in 2010 (Zambia Statistics Agency, 2025, p.182). This increase partly reflects the expansion of urban agriculture as households increasingly rely on self-provisioning amid economic pressure (Smart *et al.*, 2015). In this context, the impacts of mining on agricultural productivity emerged as a salient theme: as mining provides fewer livelihood opportunities, households have become increasingly reliant on agriculture while remaining exposed to mining-related environmental contamination.

Participants consistently described declining crop health, mentioning stunted growth, leaf discoloration, and low yields (Section 3.2). They often attributed these changes to acid spills from nearby mines, although the observed impacts are also consistent with chronic exposure to metal-rich dust from smelters and tailings facilities (Křibek *et al.*, 2011)¹¹. These observations align with the documented effects of heavy metal contamination on plants, including chlorosis, necrosis, stunting, and reduced growth (Mir *et al.*, 2021). Previous studies from the Copperbelt have likewise reported crop copper concentrations exceeding World Health Organization (WHO) food safety limits in Chingola, Chambishi, and Kitwe (Benshaul-Tolonen *et al.*, 2026).

These community perceptions are supported by findings from the environmental component of the E-H study. Surface soil samples collected from the same study communities (N = 58) revealed substantial spatial heterogeneity in contamination, with copper showing the greatest enrichment (approximately 18-fold above Upper Continental Crust background values) (Nyanza *et al.*, 2026). All sites had copper concentrations above the upper continental crust (UCC) reference level (Table 1), and copper concentrations exceeded agricultural soil quality guidelines at 93% of sampled locations. In addition, nearly one-third of all sites exceeded thresholds for overall multi-element pollution with more than 50% of samples for cobalt (Co) and/or lead (Pb) exceeding the UCC reference level in five wards. The highest contamination was observed in Wusakile, Kitwe, where

¹⁰An agricultural household is one in which at least one member is directly involved in agricultural or horticultural production.

¹¹Copper is relatively mobile in soils, allowing it to migrate from tailings dams and open pits into surrounding areas (Mulenga, 2022).

elevated concentrations of copper, cobalt, zinc, lead and arsenic clustered around residential areas (Table 1).

4.2 Environment and Health

Across discussions, participants described two broad clusters of health concerns: (1) respiratory and related symptoms (e.g., persistent coughing, chest congestion, throat irritation, headaches, and eye problems) attributed to dust and sulfur dioxide fumes (*senta*) from mining and smelting activity (Section 3.4) and (2) gastrointestinal illness, including diarrhea, attributed to contaminated water, crops and fish (Section 3.3, 3.7). These complaints are consistent with the established health effects of heavy metal contamination (Benshaul-Tolonen *et al.*, 2026), though the most serious conditions, such as silicosis and tuberculosis, are more commonly found among miners and ex-miners than in the broader community (Ngosa and Naidoo, 2016).

For communities in the immediate proximity of large-scale mining operations, the health impact we document appears to be primarily negative. This contrasts with findings from non-causal research in communities surrounding the Trident Copper Mine¹² in the nearby Northwestern Province, which documented improvements over time in indicators including reduced child stunting, lower prevalence of parasitic infection in children, and an increase in facility-based deliveries (Knoblauch *et al.*, 2020, 2018)¹³. This divergence likely reflects differences in the health outcomes examined, corporate social responsibility (CSR) practices, and the maturity of the mining operations.

4.3 Knowledge and Behavior

The knowledge of participants regarding pollution and the health effects of copper mining varied widely. Most recognized the obvious (dust as a pollutant, coughing as a consequence) but few identified its specific hazardous constituents (silica), and few could substantiate their observations with evidence beyond direct experience. This gap is unsurprising, given that community members stated environmental testing and monitoring, where conducted, were never disseminated (Section 3.6).

Even where participants did recognize risks, mitigation was constrained. Some cited financial constraints, prioritizing necessities such as food and water over chlorine or charcoal for boiling the water; this is plausible given that the Copperbelt’s 2022 poverty rate was 35.9% (Zambia Statistics Agency, 2022, p. 132). Many participants also claimed to be uncertain about safer behaviors, or described some hazards, such as dust, as effectively unavoidable since protective measures, such as requiring children to wear masks or remain indoors, were neither feasible nor realistic. More broadly,

¹²A greenfield development in Northwestern Province operated by Canadian mining firm First Quantum Metals.

¹³Consistent with these findings, quantitative evidence from large-scale gold mining elsewhere in Africa found reductions in local infant mortality following mine openings, alongside rapid local economic growth (Benshaul-Tolonen, 2019).

this pattern is consistent with the behavioral literature showing that knowledge of health-promoting behaviors does not necessarily translate into adoption, particularly where financial constraints, competing priorities, and the limited perceived effectiveness of individual actions reduce incentives to act (Hussam *et al.*, 2022). Respondents expressed all three of these constraints: money, time, and efficacy.

For Zambia, these results point to three complementary priorities. The first is strengthening the monitoring of pollutants in soil, water, and air by both private mining firms and the public regulator (ZEMA), while ensuring that the results are disseminated to affected communities (Benshaul-Tolonen *et al.*, 2026). Evidence from Mufulira in the Copperbelt Province suggests that such investments can improve public health: the installation of an air quality monitoring station, alongside upgrades to smelter operations, was associated with lower asthma incidence in an area where respiratory illnesses accounted for 75% of health complications (Chihana *et al.*, 2024). The second priority is improving risk communication by providing households with clear, practical, and low-cost mitigation strategies. However, communication strategies should account for existing inequalities in access to information, as commonly used channels (i.e., radio programs, university debates, and social media platforms) tend to reach more affluent community members while excluding many women (Jayasinghe *et al.*, 2019). The third priority is evaluating the effectiveness of personal exposure-mitigation strategies. Communities cannot reasonably be expected to adopt measures such as water filtration or mask use unless these strategies are shown to be effective against the multiple, and partly unknown, sources of environmental contamination they face.

4.4 Differences Across Gender

Although male and female participants raised similar concerns (declining employment, declining agricultural productivity, and deteriorating health), they diverged sharply in how they interpreted these conditions. Men appeared more knowledgeable about the environmental and health impacts of copper mining, plausibly reflecting greater first-hand exposure through current or former mining work. They framed pollution as a public bad requiring government intervention, called on ZEMA to respond, and appeared more willing to organize and confront mining firms, at times invoking the possibility of unrest. Women, who expressed particular concern for their children’s health, were less likely to frame the issue in terms of public action. Instead, they more often invoked divine providence in the face of hardship (Section 3.8). This difference may reflect broader gender norms governing participation in public decision-making around mining. Key informant interviews conducted in Zambia found that prevailing gender norms often discouraged women from speaking publicly (Jayasinghe *et al.*, 2019).

These contrasting responses are consistent with different manifestations of external health locus of

control (EHLOC), whereby health outcomes are attributed to factors outside one’s control¹⁴. Men primarily attributed responsibility to “powerful others” (the government and/or mining companies), whereas women more often invoked God. While EHLOC is generally associated with poorer health outcomes and lower engagement in health-promoting behaviors (Mozafari *et al.*, 2024), in this context such responses may be rational, as the environmental conditions and exposure fall largely outside of community members’ control. Future research should pay particular attention to the gendered dynamics of health behavior, access to health information, and the accessibility and effectiveness of personal mitigation strategies.

4.5 Social License to Operate

The concept of Social License to Operate (SLO) provides a useful lens through which to interpret the findings. SLO emphasizes that extractive industries depend on legitimacy and trust among surrounding communities, with environmental degradation, limited community participation, and distrust of firms and government identified as key drivers of community resistance (Conde and Le Billon, 2017). Our findings suggest that the social license of Zambia’s mining sector may be fragile. Participants consistently described limited employment opportunities (Section 3.1), widespread environmental degradation (Sections 3.2, 3.3, and 3.4), and low levels of trust in both mining companies and public institutions, particularly regarding environmental monitoring and information sharing (Section 3.6). Although grievances were widespread, we found little evidence of organized collective action, suggesting that community concerns may not readily translate into pressure on mining firms or the state, in contrast to settings where organized mobilization has reshaped the terms of extraction (Bebbington *et al.*, 2008).

Negative perceptions were especially pronounced for Chinese-owned mining operations. However, these findings should be interpreted cautiously; they may reflect differences in community experiences (Benshaul-Tolonen and Fernandez Musso, 2026), but also broader anti-Chinese political discourse in Zambia (Hairong and Sautman, 2013; Shi and Seim, 2021). In addition, the recent Sino-Metals Leach accident may have amplified negative perceptions during the period of data collection. Our findings therefore support a narrower conclusion: community trust is not uniform across mining operators, a distinction with important implications for community–firm relations and the long-term sustainability of the sector.

4.6 Study Limitations

FGD findings should be interpreted in light of several limitations. First, communities were purposively selected based on their proximity to large-scale mining operations. While appropriate for

¹⁴In contrast to internal health locus of control (IHLOC), in which health is viewed as being one’s own responsibility and as being affected by one’s behavior (Wallston *et al.*, 1978).

understanding the experiences of those most exposed to mining-related pollution, this approach may overrepresent areas with greater environmental burdens. If the economic benefits of mining extend over a wider geographic area than pollution exposure, the perceived imbalance between environmental costs and economic benefits may be less pronounced in the broader Copperbelt population.

Second, participants were not sampled by employment status or other socioeconomic characteristics, and focus groups were conducted during regular working hours. This may have reduced participation among formally employed individuals, potentially biasing perceptions. In addition, the study was limited to communities surrounding eight mining operations and did not include more remote mining areas. The findings should therefore not be generalized to all mining communities in the Copperbelt or neighboring Northwestern Province.

Finally, the focus groups captured community perceptions rather than directly measuring environmental exposure or establishing causal relationships with health outcomes. Although concurrent soil sampling provided complementary evidence of contamination, a more comprehensive assessment would require additional environmental monitoring, including air and water quality, together with biomonitoring of exposed populations.

5 Conclusions

As Zambia positions itself to triple copper production by 2031 to meet growing global demand, understanding how mining is experienced by the communities living closest to extraction becomes increasingly important. Drawing on focus group discussions across Zambia’s Copperbelt, this study examined how residents perceive the balance between mining’s environmental costs and its economic benefits.

Participants consistently described declining environmental quality, including concerns about agricultural productivity, contaminated water, and persistent airborne dust, alongside widespread unease about the health consequences of pollution, particularly for children. At the same time, they reported limited access to the economic benefits of mining, describing formal employment as scarce, insecure, and often inaccessible to local residents.

These perceptions emerged in communities where concurrent environmental sampling independently documented elevated mining-related contamination of residential and agricultural soils. Analysis of 58 soil samples collected from the same study communities found widespread enrichment of copper and localized hotspots of multiple potentially toxic elements, demonstrating that participants’ concerns arose in settings with objectively elevated environmental contamination, even though the soil measurements did not directly assess air or water quality.

More broadly, our findings challenge the common framing of mining as a local health–wealth trade-off. For many participants, mining was not experienced as an exchange between these outcomes. Instead, they described what we characterize as a double burden: environmental and health costs that are broadly shared alongside economic benefits that are perceived to accrue elsewhere. In addition, our results contradict hypotheses that community members may simply not be aware of the environmental burden and health risks they are exposed to while living close to copper mining operations. On the contrary, several focus group discussions centered on demands for greater environmental monitoring and for direct feedback on study findings. Participants demonstrated an awareness of environmental risks and expressed a clear desire for evidence about the conditions in which they live.

These findings point to a need for more systematic and transparent environmental monitoring in communities surrounding mining operations, accompanied by meaningful communication of results and responsive government action. As copper production expands, monitoring should not only assess environmental conditions but also ensure that affected communities have access to the information generated about their environments.

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