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ORIGINAL ARTICLE

Girls' Work in Artisanal Cobalt Mines in the Democratic Republic of Congo

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Abstract

The energy transition is causing a sharp increase in the global demand for cobalt. The Democratic Republic of the Congo (DRC) holds more than half of the world's cobalt reserves, with up to 30% of production coming from the artisanal sector. Whilst this sector provides a livelihood for tens of thousands of Congolese families, it is also a site of widespread child labour, which the ILO recognises as one of the worst forms of exploitation. Drawing on field data collected in Kolwezi (Lualaba Province), this study focuses on the experiences of girls in artisanal cobalt mining. This aspect is often overlooked in research that treats child labourers as a homogeneous group. Using intersectionality and feminist political ecology as analytical lenses, the study examines how the intersection of gender, age, and orphan status shapes children's participation in mining. The findings reveal that girls combine paid and unpaid labour, moving between care work and mineral extraction in order to support their households. Although poverty drives both girls and boys to work, girls face additional constraints related to gendered expectations, school exclusion, and vulnerability to abuse. Situating these experiences within the political and ecological realities of extraction reveals that child labour is a gendered survival strategy embedded in structural inequality.

Keywords Artisanal mining · Child labour · Girls · DR Congo

Introduction

Thousands of children are employed in the cobalt artisanal mining in the Democratic Republic of the Congo (DRC) (Lawson, 2021). Their labour sustains global supply chains for batteries and electric vehicles, yet their lives remain invisible in policy and scholarship. Although research on child labour in artisanal mining has increased in recent years (see, for example, Bonnet & Schlemmer (2009); Hilson (2008, 2010); Nieuwenhuys (1996); Okyere (2013)), most studies have treated children as a homogeneous group (Abebe & Bessell, 2011), paying little attention to gendered differences in their experiences. This paper addresses this gap by examining how the participation of girls in artisanal cobalt mining is shaped by intersecting forms of vulnerability, social expectations, and care responsibilities.

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Cobalt is an essential strategic mineral for producing rechargeable lithium-ion batteries, which are used in electric vehicles, digital devices, and renewable energy storage systems. This makes cobalt a critical component of the global energy transition. The Democratic Republic of the Congo (DRC) supplies over two-thirds of the world's cobalt, and a significant proportion of this comes from artisanal and small-scale mining (ASM). ASM involves low-tech, labour-intensive extraction methods (Mining Code, 2018) that operate outside or on the margins of formal regulatory frameworks. ASM differs from industrial mining, which relies on mechanised extraction, corporate governance structures, and more formalised labour standards. In the DRC, ASM is characterised by high informality, poor working conditions, and volatile market conditions, creating precarious working environments where miners—including children—assume considerable physical and economic risks. Understanding these dynamics is crucial for grasping how and why girls enter this sector and the vulnerabilities that influence their labour trajectories.

The DRC's mining history has been shaped by the rise and fall of Gécamines (formerly the Union Minière du Haut Katanga), which was founded in 1906 for the

extraction of copper and cobalt (Rubbers, 2015, 2017). Following its decline in the 1990 s due to mismanagement and structural reforms, thousands of workers lost their stable employment and access to the company's social services (Al Barazi et al., 2017; Mazalto, 2005, 2008). Many families turned to artisanal and small-scale mining (ASM) as a survival strategy (Dibwe Dia Mwembu, 2001). However, although the Mining Code sought to regulate such activities within designated artisanal mining zones (ZEA[1], these remain limited. This pushes miners, including children, into informal and hazardous sites (Calvão et al., 2021; Mazalto, 2005; Mining Code, 2018).

Child labour in the DRC's cobalt sector is often discussed in humanitarian and regulatory terms, as a moral crisis that needs to be solved by formalising the sector and increasing supply chain transparency. However, these approaches rarely consider the gendered social organisation of work and care that determines how children become involved in mining economies and navigate them. Girls are not only workers, but also caregivers, siblings, and sometimes household heads. Their involvement in mining is therefore intertwined with wider social expectations regarding femininity, dependency, and survival. To understand these dynamics, we must go beyond the language of 'hazardous work' and explore how gender, age, and family status intersect to shape vulnerability and agency.

This study draws on qualitative fieldwork conducted in Kolwezi, Lualaba Province. Twenty-six semi-structured interviews were conducted with girls and boys involved in artisanal mining, as well as with their parents and local experts. Through these narratives, the paper analyses how girls and boys perceive, perform, and negotiate their roles within mining sites and households. Particular focus is given to orphaned girls, whose lack of parental protection often makes them more dependent on informal guardians and more vulnerable to exploitation and abuse.

This research is grounded in the theories of intersectionality (Brünig et al., 2024; Crenshaw, 1989; Hill Collins & Bilge, 2020; Keuchenius & Mügge, 2021; Nash, 2008) and feminist political ecology (Elmhirst, 2011; Nightingale, 2017; Rocheleau et al., 1996; Rocheleau & Nirmal, 2014). Together, these theories offer valuable insights into how gender, age, and orphan status influence access to labour and environmental risk. These frameworks demonstrate that vulnerability is not a static state, but rather a relational concept formed through the interplay of social hierarchies and material circumstances. Applying this perspective to child labour in artisanal cobalt mining enables a more nuanced analysis of how children's daily practices both perpetuate and sometimes challenge the structures of inequality inherent in global mineral economies.

[1] Zone d'Exploitation artisanale.

By foregrounding girls' perspectives, the paper contributes to ongoing debates on the formalisation of artisanal mining in the DRC. Current formalisation projects (see, for example, De Silva et al. (2019); Lenfant & Morisho (2019)) often assume gender neutrality, focusing on technical regulation whilst neglecting the social realities that sustain informal economies. This research argues that integrating girls' experiences into these efforts is crucial for designing effective and equitable policies. The paper concludes by proposing practical mechanisms for gender-responsive mining reform, including targeted education and health programmes, gender-sensitive monitoring, and the participatory inclusion of children's voices in local decision-making processes.

In doing so, the study contextualises the phenomenon of girls' labour in artisanal cobalt mining within broader questions of care, inequality, and the global demand for "clean" energy. It demonstrates that gendered childhoods in the mines are not merely a consequence of poverty, but are part of a wider socio-ecological system in which global technological transitions are sustained through localised forms of exploitation. Recognising and addressing these gendered dynamics are essential for ethical sourcing initiatives and social justice in resource governance.

Theoretical Framework

Intersectionality: Understanding Overlapping Vulnerabilities

This study uses intersectionality theory (Crenshaw, 1989; Hill Collins & Bilge, 2020) to understand how gender, age, class, and family status interact to influence the experiences of children working in artisanal cobalt mining. Intersectionality provides a lens through which to analyse the simultaneity of social inequalities, considering how different axes of marginalisation interact rather than operating in isolation.

In the context of Lualaba ASM, the position of children cannot be explained by "childhood" or "gender" alone. The experiences of girls are shaped by the interplay of patriarchal norms, economic necessity, and social care expectations. Many girls work not only to supplement household income, but also to provide everyday care, such as cooking, fetching water, and looking after younger siblings, whilst also engaging in mining activities. These overlapping roles blur the boundaries between domestic and productive work, revealing how gendered social reproduction sustains both family survival and the artisanal mining economy.

Intersectionality also draws attention to orphan status, a dimension that is rarely considered in the literature on child labour. Orphaned girls face particular vulnerabilities: the

loss of parental protection reduces their bargaining power, making them more dependent on peers or informal guardians and more vulnerable to exploitation or sexual abuse. Analysing orphanhood through an intersectional lens reveals how the absence of care structures exacerbates other forms of inequality, determining who is visible and who is not within the mining landscape.

Feminist Political Ecology: Linking Gender, Labour, and Environment

Although intersectionality helps to capture the multidimensionality of inequality, feminist political ecology (FPE) (Elmhirst, 2011; Nightingale, 2017; Rocheleau et al., 1996; Rocheleau & Nirmal, 2014) contextualises these inequalities within ecological and economic relations. FPE emphasises that gender is not a fixed social category, but rather a relational process embedded in material environments and political economies. It therefore bridges the social and environmental dimensions of artisanal mining.

FPE offers three key insights that are relevant to this study. The first is gendered access to resources and labour: Girls and boys occupy distinct niches in the artisanal mining economy. Girls are more often involved in lower-paid, informal tasks such as sorting, washing, and carrying ore—activities that are physically demanding yet considered 'worthless' and often performed without protection. These divisions reflect broader gender hierarchies that determine what kinds of work are considered appropriate or acceptable for girls.

The second insight concerns social reproduction and care work within the mining economy. FPE challenges the distinction between "productive" and "reproductive" labour. In Kolwezi, for example, girls' work in the mines is inseparable from their care duties at home. This dual workload reveals that global demand for cobalt depends not only on extractive labour, but also on the hidden infrastructure of care that sustains it.

The third insight relates to power structures, the environment, and health. FPE links environmental degradation to social power relations. In artisanal mining, girls' exposure to dust and toxic cobalt compounds is not random, but is shaped by gendered labour divisions and a lack of access to protective resources. The fatigue, illness, and anxiety they experience are thus political and ecological outcomes of global extraction networks.

By combining intersectionality and feminist political ecology, the study constructs a framework that recognises both social complexity and material embeddedness. Intersectionality highlights *who* is affected and through which overlapping identities; FPE explains *how* these inequalities are produced and sustained through economic and ecological systems. Together, they provide a conceptual bridge between children's narratives and structural processes. This allows the analysis to move from individual experience to institutional and global contexts by showing how girls' everyday struggles in Lualaba's mines reflect wider patterns of gendered dispossession and environmental injustice in global mineral supply chains.

Operationalising the Framework

This combined framework informs both the collection and analysis of data. The design of the interviews focused on capturing multiple dimensions of girls' lives, including labour, education, family background, and health, in order to identify the intersections of vulnerability and agency. Coding and interpretation were guided by the following analytical categories:

1. The gendered division of labour in the mines;
2. Care responsibilities;
3. Experiences of orphanhood and increased vulnerability;
4. Health risks and environmental exposure.

This operationalisation ensures that theory and data inform each other. Girls' voices reveal how macro-level structures, such as gender norms, poverty, and global demand, are experienced and dealt with in everyday life.

Anchoring the study in intersectionality and FPE provides a deeper understanding of child labour as a gendered socio-ecological process rather than merely an economic phenomenon. It recognises that girls are not merely victims of poverty, but also actors who must navigate constrained choices within unequal systems. This framework therefore supports the paper's broader argument that policies for formalising artisanal mining must address economic, legal, gendered, social, and environmental aspects to ensure the fair treatment of children. This theoretical approach transforms the study from a descriptive gender analysis into a critical socio-ecological investigation. It places girls' experiences at the intersection of global cobalt economies, local care systems, and environmental exposure, providing a basis for analytical depth and practical reform.

Approaching Girls' Lives in Mining Contexts: Methods and Analytical Choices

Research Design

This study takes a qualitative, interpretive approach to explore how girls and boys experience and negotiate their participation in artisanal cobalt mining in Kolwezi, Democratic Republic of the Congo (DRC). This approach is based on the principles of feminist political ecology and intersectional analysis, emphasising reflexivity and consideration of power dynamics during

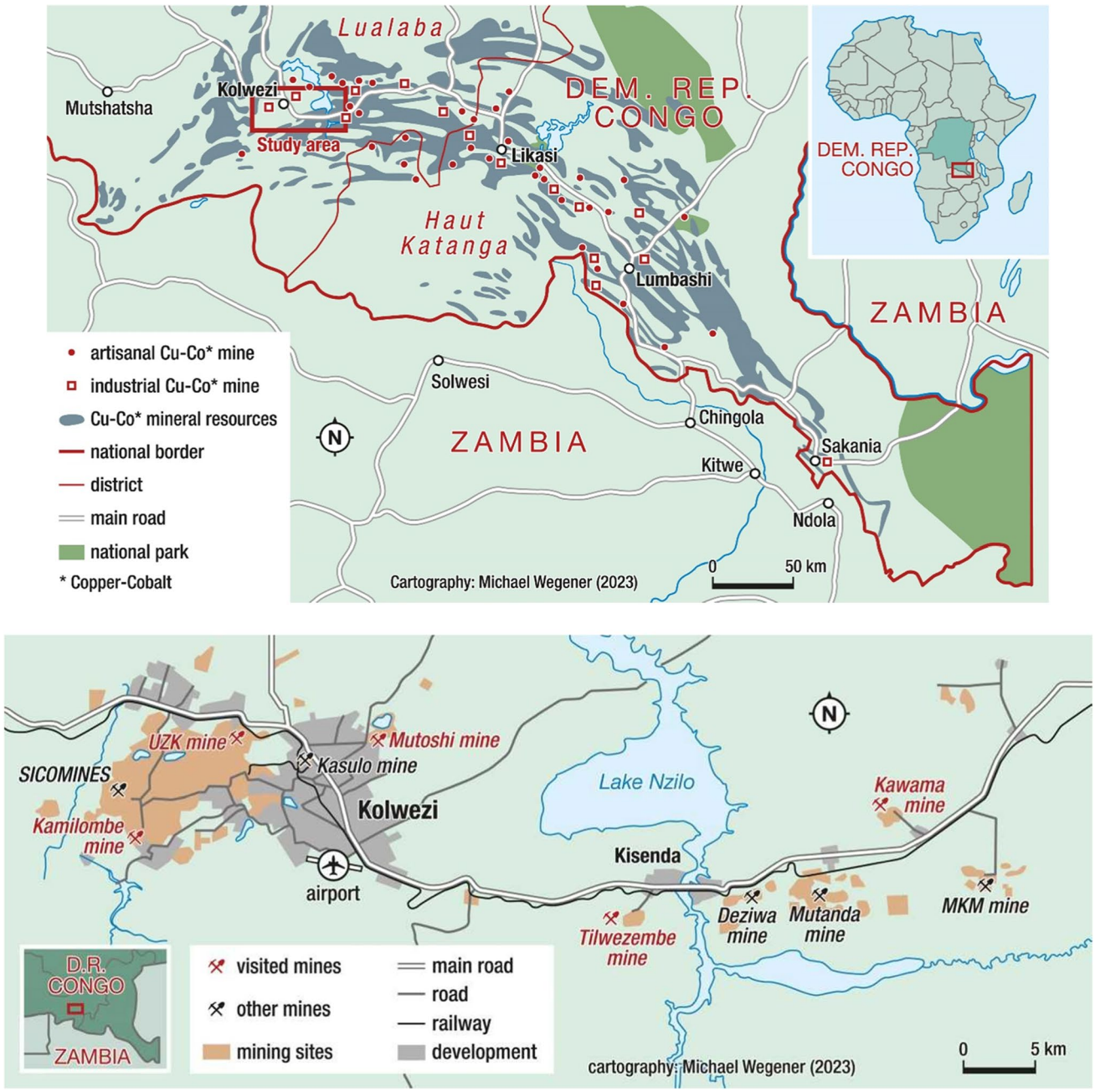


Fig. 1 Map of the study area (source: author's work inspired by BGR (2019, 2021))

fieldwork. Conducted between January and April 2023, the research combined semi-structured interviews with observational field notes and informal conversations. This approach enabled an in-depth understanding to be gained of how children, parents, and local stakeholders perceive the risks, meanings, and moral economies of children's mining work.

Kolwezi is one of the main cobalt-extraction hubs in the DRC. Numerous artisanal mining sites operate semi-informally around the city alongside large-scale industrial mines. These sites are characterised by intense labour, precarious working conditions, and a blurring of the boundaries between household economies and mining activities. The city is also home to a network of NGOs, local cooperatives, and state agencies involved in child protection and the formalisation of mining. This context provides a diverse social setting in which to examine gendered childhoods within extractive economies. Figure 1 shows the study area and the visited mines.

Participants were selected using purposive and snowball sampling methods to capture a range of gendered and

social positions within the mining economy. Initial contact was established through two local NGOs working on child protection and community development in Kolwezi, who facilitated introductions to families and mining cooperatives.

The final sample consisted of:

- Fourteen children (seven girls and seven boys), aged between 10 and 17, who were all directly involved in artisanal mining activities
- Five parents or guardians, to provide context on household decision-making and perceptions of child labour
- Seven local experts, including two NGO representatives, three administrative officials and two community leaders, to provide institutional perspectives

The selection criteria for children included:

1. Active or recent participation in artisanal cobalt mining activities (e.g. ore collection, washing, or transportation).
2. Residency in Kolwezi or its peri-urban mining zones.
3. Willingness to participate, with informed consent from parents or guardians where applicable.
4. A gender-balanced sample of orphans to reflect intersectional differences in vulnerability.

Boys and adults were included primarily for comparison and triangulation purposes, to ensure that the analysis of girls' experiences was situated within broader community dynamics.

Data Collection and Analysis

Semi-structured interviews were conducted in Swahili and French, lasting between 45 and 90 min. To reduce power imbalances and avoid exposing children to hazardous environments, interviews with them were held in safe and familiar settings, such as NGO offices or shaded outdoor areas. The interview guides were structured around four thematic areas derived from the study's conceptual framework: (1) everyday work routines and division of labour, (2) educational aspirations and family background, (3) care responsibilities and household roles, and (4) perceptions of risk, safety, and health. Complementary field observations focused on the spatial organisation of work, gendered interactions, and visible health or safety risks. Field notes were used to record non-verbal cues, local idioms, and contextual elements that enriched the analysis.

As child labour in mining is officially prohibited in the DRC (Mining Code, 2018), some initial reluctance or refusal to participate was encountered. Some respondents feared that the study was linked to government efforts to identify individuals contravening official regulations. To address these concerns, time was taken to clearly present the study's objectives, provide information sheets to literate participants, and explain that the data collection was confidential and strictly for academic purposes. These steps helped reassure participants that their anonymity would be preserved throughout the study.

The research adhered to the ethical guidelines for social research involving minors (BERA, 2018; Graham et al., 2013).

- Approval was obtained from the ethical review board of the *Université Catholique de Bukavu* with the reference number UCB/CIES/NC/002/2023.
- Participation was voluntary, and informed consent was obtained from all adult participants and the guardians, along with assent from the children themselves.
- Pseudonyms were used and identifying details (such as mine names or neighbourhoods) were anonymised.
- Interviews were conducted sensitively, bearing in mind participants' emotional well-being, and participants were given the option to pause or withdraw at any time.

Reflexivity was integral to the fieldwork process. As an external researcher working in a context marked by poverty and inequality, I continuously reflected on how my positionality—including my gender, language, and institutional affiliation—shaped trust, access, and interpretation. I engaged with local collaborators and translators to cross-check meanings and ensure contextual accuracy.

All interviews were audio-recorded with consent and transcribed verbatim. The transcripts and field notes were coded using NVivo 12 software. The thematic and intersectional analysis moved through three stages:

One. Open coding: Identification of recurring themes related to gendered work, vulnerability, and health.
Two. Axial coding: Linking these themes to broader analytical categories (e.g. care, orphanhood and environmental exposure).
Three. Interpretive synthesis: Connecting the empirical findings to the theoretical frameworks of intersectionality and feminist political ecology.

Triangulation of children's, parents', and experts' accounts helped to validate interpretations and highlight contradictions. Particular attention was paid to girls' voices, emphasising how they articulated their own agency, fear, and aspirations within the constraints of mining life.

Intersecting Vulnerabilities in Girls' Lives: Findings and Critical Commentaries

Low Incomes and Similarities in the Experiences of Girls and Boys in Artisanal Mines

The results suggest that poverty is still the main reason why children are involved in artisanal mining. As one 14-year-old girl explained, "My sister and I come here, and so do the boys. We collect minerals to sell in Musompo and give the money to our mother to buy food".[2] A community leader stated: "There are very vulnerable families at this artisanal mining site. If you forbid their children from going to the mine, they would not survive the famine".[3] He added that the collapse of the Gécamines company left many families in a precarious situation. Parents had no choice but to turn to artisanal mining with their children. The bankruptcy of Gécamines created widespread unemployment and normalised child labour as a survival strategy, as described by Dibwe Dia Mwembu (2001) and Rubbers (2006, 2015, 2017).

In addition to being driven by poverty, girls and boys have one more thing in common: they are subject to abuse by security guards at the mining site. As child labour is officially prohibited, the children flee when law enforcement officers make their rounds. During their escape, some of them may be injured. If a child is caught, their parents are summoned and may have to pay fines. One girl said, "If the police come here, we all run away. Children are not allowed to be here".[4] An agent of the mining police confirmed that her institution's role includes removing all young girls and boys, as well as pregnant women, from artisanal mines.[5] She added that some parents become aggressive when the police ask them to hand over their child, claiming that "Nilikuya na mutoto wangu kutafuta maisha", which translates as "I came with my child to find ways to make a living".

From a feminist political ecology perspective, these findings demonstrate that children's involvement in artisanal mining is not solely a consequence of poverty, but also stems from structural changes in the local political economy. The collapse of Gécamines reshaped livelihoods and pushed households toward environmentally risky, informal extraction. Poverty, insecurity, and exposure to violence are therefore not individual misfortunes, but rather the result of unequal access to resources and power within this post-industrial landscape. FPE reveals how global demand for cobalt and the breakdown of state support have created conditions in which children's labour is essential to household survival, linking everyday vulnerability to broader ecological and economic processes.

Gendered Division of Labour and the Invisibility of Girls' Work

In all the interviews, the girls described tasks that were physically demanding but socially devalued. Whilst boys often worked in visible roles such as digging or transporting ore, girls were more commonly engaged in activities such as sorting, washing, carrying smaller loads, and looking after younger children on site whilst their mothers worked. These activities were performed at the margins of the mining zone. These roles were often referred to as "helping" rather than "working", a distinction that normalises girls' labour as an extension of domestic duties. As one 13-year-old girl explained: "When my brother goes to dig, everyone sees him. I stay near the water and wash the stones. People say I am helping, but it is still work".[6]

This invisibility of girls' labour highlights the hidden infrastructures of care (Duffy, 2011; Rocheleau et al., 1996; Tronto, 2008; Tronto & Fisher, 1990) that support extractive economies. The dual involvement of girls in domestic and mining work reflects the co-dependency of social reproduction and material extraction. This dependency is exacerbated by the fact that some girls, particularly those from migrant families and orphans, live near mining sites. Within the framework of feminist political ecology, these findings emphasise that the boundary between the "productive" and the "reproductive" is permeable and gendered: girls' contributions sustain both household survival and the flow of cobalt to global markets.

Orphan Status and the Multiplication of Vulnerabilities

Orphanhood emerged as a key factor in shaping girls' entry into and experience of mining work. Of the seven girls interviewed, three identified as orphans, whilst two others lived with extended family members who relied heavily on their labour for income.

Firstly, the absence of parental care among orphaned girls generated distinct patterns of dependency, responsibility, and risk. Without guardians to mediate their relationships with adult miners or small-scale mining traders (known as négociants), these girls often entered mining sites through peer networks or informal sponsorship arrangements, which exposed them to greater risk of exploitation. A 15-year-old orphan explained: "I washed ten bags of ore for a miner who said he would pay me after he sold it. But when he

[2] Child interview, Kolwezi, January 23, 2023.

[3] Expert interview, Kolwezi, February 9, 2023.

[4] Child interview, Kolwezi, January 27, 2023.

[5] Expert interview, Kolwezi, January 28, 2023.

[6] Child interview, Kolwezi, March 30, 2023.

took the ore to the depot, the buyers said it had no value and refused to buy it. After that, the miner told me not to ask him for money or he would hurt me. I started crying, but no one helped me; they knew I was an orphan".[7] Dependence on male patrons or peers often blurs the line between work and vulnerability, exposing girls to transactional relationships combining labour, emotional dependency, and, in some cases, sexual coercion. Intersectionality theory helps to explain this dynamic: the intersection of gender, age, and orphan status creates compound forms of precarity that cannot be captured by the single variable of "poverty".

Secondly, this form of economic pressure in the mining industry intersects with gendered expectations that position girls as household caregivers. Participants who were orphaned and living with elderly or sick grandparents described daily routines in which mining work coexisted with heavy domestic responsibilities. In the near absence of formal social protection mechanisms, girls' labour becomes central to household survival, reproducing the interwoven dimensions of care (material, economic, and emotional) conceptualised by Letablier (2001). In this sense, orphaned girls occupy a paradoxical position: they bear the burden of care responsibilities within the household whilst simultaneously being highly vulnerable at mining sites. As the literature on care emphasises (Dussuet, 2017; Letablier, 2001; Tronto, 2008), their involvement in mining is not separate from, but an extension of, the domestic labour through which they support their families. The situation of these girls in the mines is further exacerbated by the fact that women and girls are prohibited from accessing certain productive areas of artisanal mines. Consequently, they are often relegated to marginal and low-paid tasks such as washing, carrying stones, or providing childcare on site for working mothers.

One community leader said: "Girls are vulnerable as they do not go down into the pits due to a customary prohibition. Whereas in the mines of Haut-Katanga and Lualaba, if you don't go down into the pits, you will only earn crumbs".[8]

Furthermore, the exclusion of women from most decision-making structures reinforces their limited bargaining power and cements their precarious position within the artisanal mining economy. The intersection of gender, age, orphan status, and care responsibilities magnifies girls' susceptibility to exploitation. These dynamics reflect how gendered care obligations shape girls' involvement in exploitative labour regimes, echoing feminist political economy analyses that emphasise the role of social reproduction in structuring labour relations (see Elson (1998)). However, despite these structural constraints, orphaned girls also demonstrate moments of agency. For example, some have formed collective washing groups with other girls to share workloads or coordinate safety measures. These micro-strategies reveal that vulnerability and resilience coexist, and demonstrate how girls navigate, resist, and adapt to the overlapping inequalities that shape their lives. Taken together, these findings demonstrate that orphanhood does not operate in isolation, but rather interacts with gendered norms, care responsibilities, and power imbalances within the artisanal mining sector. Recognising these layered vulnerabilities is crucial for designing interventions that acknowledge children's complex subjectivities, rather than casting them solely as passive victims.

Embodied Health Risks and Environmental Exposure

Although health concerns were a prominent theme in both the children's narratives and the expert interviews, they were often framed as "part of life" rather than as violations of rights. The girls described experiencing recurrent coughing, anxiety, fatigue, and skin irritation as a result of prolonged exposure to cobalt dust and contaminated water. Their duties, which involved washing ore and handling muddy sediment without gloves, placed them in direct contact with toxic residues. One NGO worker observed: "Girls spend long hours in water mixed with ore dust. They don't protect themselves, and no one provides them with equipment. They also inhale dust from the nearby open-pit mines and have no masks. Some develop rashes and others talk about genital infections, but they continue because they need to earn money".[9] The girls' testimonies also echoed these embodied risks. One participant referred to her neighbour's 12-year-old daughter, who worked daily at an artisanal site: "She spends the whole day washing minerals. When she came back home, she couldn't breathe properly. Her mother took her to hospital, and they said she had bronchitis. We all breathe in the dust; sometimes you cough for weeks".[10]

From a feminist political ecology perspective, health outcomes like these are not just biomedical problems, but also expressions of social inequality. Girls' exposure to cobalt toxicity stems from their marginal position in household and mining hierarchies. They are assigned "light" work, but this conceals chronic environmental hazards. Furthermore, the limited availability of reproductive health services in Kolwezi exacerbates long-term risks such as infertility and prenatal complications. Orphaned girls and those from recent migrant families are at an even greater risk because they have fewer alternatives to mining when it comes to contributing to their family's income, and they have less access to healthcare. Their embodied experiences of toxicity stem

[7] Child interview, Kolwezi, February 24, 2023.
[8] Expert interview, Kolwezi, January 25, 2023.
[9] Expert interview, Kolwezi, January 26, 2023.
[10] Parent interview, Kolwezi, February 2, 2023.

from overlapping structures of inequality that place certain girls in a more precarious position within artisanal cobalt mining. By linking girls' bodily experiences to the material conditions of extraction, this section highlights how the politics of the body and the politics of the environment intersect. Thus, the global demand for 'clean' energy technologies relies on localised, gendered exposure to environmental harm, a reality that is largely invisible in corporate supply chain narratives. This resonates with Deberdt's (2025, p. 27) argument that "the consumption of low-carbon products thus entails a necropolitics in which both humans and ecosystems are sacrificed for the greater good".

Differentiated Access to Education and Gendered Inequalities

Children involved in mining tend to come from disadvantaged social backgrounds and often lack the financial means to access education. The main barrier is economic: parents are unable to pay school fees or associated costs such as stationery, lessons, or running costs. Consequently, many children either drop out of school or split their time between classes and working in the mines to cover educational expenses. Thus, education and mining work function as either substitutes or, in some cases, complements (Batano et al., 2023).

Quantitative data from an earlier phase of the study indicated that around 40% of children involved in mining activities were not attending school, but this is a more complex picture as some children may start the school year and then drop out. Although poverty limits schooling for both girls and boys, girls are disproportionately affected. School enrolment statistics in Lualaba Province consistently show lower rates for girls than for boys, except in 2017 (see Fig. 2).

A female miner explained: "I work here with my two daughters. They help me wash minerals to sell in Musompo. Their older brother is at school, but I can't afford to support them all through education. In the coming years, I hope my daughters can return to their studies".[11] In this survey area, when a family's financial situation deteriorates, it is typically the daughters who are withdrawn from school first, whilst the sons continue their education. This pattern reflects persistent patriarchal norms that prioritise boys' schooling as a more valuable investment. One orphan girl shared her experience: "After my father died, my mother, who sold vegetables at the market, was no longer able to provide for the family. There are eight of us children, four boys and four girls. She asked our uncle, my late father's brother, to pay the school fees for the boys, and he agreed. I therefore stopped studying and started working in a mine, where I have been ever since".[12] This testimony is a prime example of how gendered norms and family hierarchies can lead to educational exclusion.

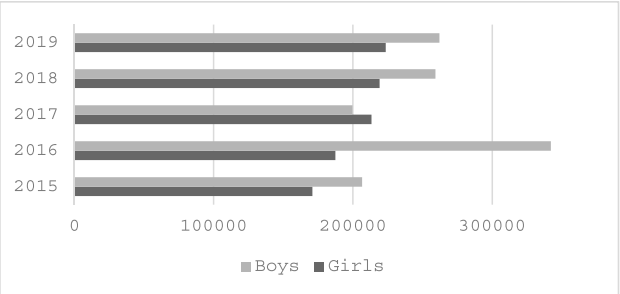


Fig. 2 Number of pupils enrolled in Lualaba for nursery, primary, and secondary education (based on data from the Ministry of Primary and Secondary Education of the DRC)

Existing research shows that girls face particular barriers to education in the DRC (Angotako Mawanzo, 2022; De Herdt et al., 2015; Kiambu Di Tuema, 2018), and the findings above confirm that these challenges intensify in mining areas. An intersectional analysis of the data reveals that exclusion from schooling is not solely driven by poverty, but by the cumulative impact of gender, age, orphan status, and the proximity of mining sites to residential areas. Whilst economic hardship restricts access for all children, girls are disproportionately affected due to patriarchal norms that prioritise boys' education and assign girls greater domestic and caregiving responsibilities. For orphaned girls in particular, the absence of parental protection exacerbates these inequalities, making school attendance challenging and often forcing them to combine schooling with mining work. Thus, educational exclusion is produced at the intersection of household precarity and extractive economies.

Gendered Risks and Agency

Some mining sites operate on the border between legality and illegality. These include recently discovered areas that attract miners before government formalisation, and zones where an industrial company holds exclusive rights, but artisanal miners encroach on the surrounding land. As artisanal mining remains largely unregulated, moral depravity flourishes here, disadvantaging both girls and boys. Several boys reported injuries sustained whilst fleeing police raids, whilst both boys and girls working independently receive derisory payments from traders who exploit their informal status.

At the same time, the blurred boundaries between legality and illegality create social vulnerabilities that are deeply gendered. Some sites have reported cases of girls being abandoned by their partners. One respondent shared: "I had a friend who I would always go to the artisanal mines with.

[11] Parent interview, Kolwezi, January 27, 2023.
[12] Child interview, Kolwezi, March 6, 2023.

She became pregnant, however, and now we can no longer see each other. She stopped her studies, and her parents took her to live with the man who got her pregnant. Unfortunately, he had fled".[13] Such cases are common due to the transient nature of artisanal work and the lack of an official registry of miners. Another respondent explained that, when a girl becomes pregnant, families often seek to avoid social shame by arranging a marriage between the two parties, regardless of her age.

In more severe cases, sexual violence is also managed informally. As one community leader explained, when a girl is raped, her parents will often reach "amicable agreements" with the perpetrator's family in order to protect their daughter's reputation. However, he added that such practices are increasingly being condemned. Another expert confirmed that distrust in the judicial system discourages formal reporting. "The judicial system offers no guarantee that the perpetrator will actually be prosecuted. Sometimes he may corrupt and be released".[14] Gender-based violence thus interacts with poverty and institutional weakness, exacerbating girls' vulnerability in both mining and community spaces.

However, girls are not merely victims of these intersecting pressures. Some demonstrate agency in navigating these constrained environments. One girl recounted: "I stayed in the neighbourhood because I needed money to buy soap and shoes, as my mother couldn't provide for all my needs. An older boy in the neighbourhood offered to give me money in exchange for sex. I refused and decided to start washing ore near the artisanal site to earn my own money".[15] Her statement highlights that although working in the mines exposes women and girls to a greater risk of violence (Rustad et al., 2016), similar threats also exist within the home and local community. For some, participating in artisanal mining becomes a means of addressing immediate financial needs and escaping other forms of dependency or abuse. Previous studies confirm that access to mines can provide women with a limited form of empowerment, enabling them to improve their livelihoods (Bashwira et al., 2014); the same appears to be true for certain children. Thus, the same extractive spaces that expose girls to harm also become arenas for negotiating dignity, livelihood, and limited agency. When viewed through an intersectional lens, these dynamics reveal how poverty, gender, and age combine to shape children's differential exposure to risk and opportunity.

Discussion: Revisiting Theory Through the Data

The findings reaffirm that child labour in artisanal mining is not a single issue, but rather an intersection of gender, social, and ecological inequalities. Intersectionality clarifies how overlapping identities—such as being a girl, a worker, or an orphan—compound vulnerability and shape different experiences of labour. Feminist political ecology explains how these social dynamics are embedded in environmental and economic processes, rendering health risks and bodily harm political issues. Together, these frameworks illuminate the fact that the lives of girls working in Kolwezi's mines are situated at the intersection of care, extraction, and survival. This demonstrates that social reproduction and environmental degradation are co-constituted. Recognising this interdependence is essential for designing mining formalisation policies that are efficient and socially just.

Beyond labour and care, the data also demonstrate how limited access to education, chronic health risks, and orphanhood reinforce the structural conditions that draw girls into mining. School dropout is often not a discrete event, but rather the cumulative result of poverty, caregiving responsibilities, and the proximity of mining sites to residential areas. Health-related problems, such as respiratory issues, skin infections, genital infections, and chronic fatigue, are not merely individual ailments, but manifestations of what feminist political ecology identifies as uneven exposure to environmental harm. Orphanhood further amplifies these dynamics: without parental protection or financial support, girls must take on greater responsibilities and have less bargaining power, making mining appear both necessary and risky. Taken together, these factors demonstrate that education, health, and orphanhood are not separate challenges, but rather interconnected vulnerabilities shaped by gender and ecological inequalities.

Conclusion and Policy Recommendations

This study examined how girls experience and negotiate their participation in artisanal cobalt mining in Kolwezi in the Democratic Republic of the Congo. The study revealed that girls' involvement in the mining economy is not solely a consequence of poverty or parental neglect, but rather the result of various overlapping factors, including gender norms, orphanhood, societal care expectations, and environmental exposure. These factors produce multiple forms of vulnerability.

Using intersectionality theory and feminist political ecology as a basis for analysis, it is demonstrated that child labour in the cobalt sector is a social, economic, and ecological phenomenon. The boundaries between productive labour and reproductive care work are blurred; for example, washing ore and caring for siblings are both facets of the same survival strategy for girls. Understanding these entanglements challenges the conventional policy approach of treating child labour as a discrete violation to be eradicated rather

[13] Child interview, Kolwezi, March 6, 2023.
[14] Expert interview, Kolwezi, January 25, 2023.
[15] Child interview, Kolwezi, February 20, 2023.

than as a symptom of the broader inequalities embedded in extractive capitalism and global supply chains.

The research makes three conceptual contributions to the study of child labour and gender in resource economies. Firstly, it advances an intersectional understanding of vulnerability by demonstrating how the interaction between gender, age, and orphan status determines children's positions within mining hierarchies. Secondly, it extends the scope of feminist political ecology to artisanal mining, revealing how the global demand for "green" energy relies on gendered forms of social reproduction and environmental degradation. Thirdly, it redefines agency within constraints: girls are not passive victims, but strategic actors whose everyday choices reflect moral reasoning and relational belonging, even in coercive situations. These insights enrich debates on gendered labour, care, and extraction by connecting local survival strategies to the global structures that sustain them.

Policy Implications: Toward a Gender-Just Formalisation Agenda

In terms of policy and practice, the findings highlight the importance of basing formalisation and child protection interventions on girls' lived experiences. Reforms that focus solely on legal prohibitions or supply-chain audits will remain ineffective unless they address the social and environmental contexts that perpetuate child labour. Hence, recognising girls as key players in the artisanal mining economy requires a shift toward empowerment and social justice, focusing on improving the structural conditions that make their labour necessary. Therefore, formalisation must move beyond technical regulation and engage with the social reproduction of mining economies, considering who provides care, who performs labour, who suffers, and who benefits. These findings inform the following policy recommendations:

1. Gender-sensitive formalisation frameworks:
    - Integrate gender and age indicators into baseline assessments of artisanal mining zones.
    - Require cooperatives and concession holders to conduct social audits that document the presence and type of child labour, paying specific attention to the tasks performed by girls, such as washing and sorting ore.
    - Establish community monitoring mechanisms that include women and young people.
    - Actively involve mining cooperatives in efforts to improve the working and living conditions of artisanal miners, with particular attention to women. This should include strengthening miners' collective bargaining power to ensure that small-scale miners benefit more equitably from value generation along the cobalt supply chain. Improvements in miners' livelihoods are likely to translate into better living conditions for children.
2. Education and care infrastructure:
    - Partner with local NGOs to offer skills training and transition programmes for former female miners.
    - Develop accessible childcare facilities in and around mining areas to reduce the unpaid care burden placed on older girls.
    - Implement conditional cash transfer programmes combined with school attendance and children's health initiatives.
3. Health and safety protection:
    - Incorporate gendered health surveillance into mining formalisation schemes, including screening for respiratory, dermatological, and reproductive health problems associated with cobalt exposure.
    - Implement additional artisanal mining zones (called ZEA) and provide protective equipment to women involved in washing minerals.
    - Support clinics and community health workers to track the long-term effects of environmental contamination on girls and women.
4. Social protection for orphaned children
    - Expand conditional cash transfer schemes and community foster care programmes for orphaned girls, ensuring that assistance reaches mining-affected families.
    - Provide psychosocial support and mentorship networks for former female miners.
5. Participatory inclusion and governance:
    - Ensure that the voices and experiences of girls inform decision-making in local cooperatives, NGO projects, and government policy consultations.
    - Involve former child miners as peer educators and community advocates in awareness campaigns, enabling them to turn their experiential knowledge into agency.

A gender-just formalisation agenda would treat care work, education, and health as integral components of mining governance. It would recognise that the pursuit of global clean energy hinges on addressing the dirty and gendered realities of extraction in places like Kolwezi. Only by integrating social and environmental justice can reform initiatives ensure that the transition to sustainable technologies does

not continue to rely on the invisible labour of the most vulnerable people.

The stories of girls from Kolwezi remind us that the politics of cobalt are also the politics of care. Their stories reveal how vulnerability and strength can coexist within the same individuals who support their families, communities, and the global supply chain. Recognising this complexity is an ethical and practical necessity for creating effective and humane policies. By placing girls at the centre of analysis and reform, this study contributes to the growing movement to hold resource governance accountable for the greatest costs borne by local communities. It urges policymakers, corporations, and researchers to recognise that the future of "clean" energy must consider the rights and dignity of local communities' children.

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Declarations

Ethics Approval and Consent to Participate Informed consent was obtained from all study participants.

Competing interests The author states that there is no conflict of interest.

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