



Filling or widening ‘circular’ voids? On institutional imaginaries and barriers to circular economy transitions in artisanal and small-scale mining

Francis Arthur-Holmes^{a,*}, Godfred Amankwaa^{b,c}

^a Faculty of Business and Law, University of Portsmouth, Portsmouth, United Kingdom

^b UK Centre for Ecology and Hydrology, Wallingford, United Kingdom

^c School of Environment, Education and Development, University of Manchester, Manchester, United Kingdom

ARTICLE INFO

Keywords:

Artisanal and small-scale mining
Circular economy
Tailings
Institutional voids
Circular voids
Ghana

ABSTRACT

In this paper, we employed a qualitative approach to investigate the barriers that impede circular economy (CE) transitions in artisanal and small-scale mining (ASM) enclaves in Ghana. Drawing on institutional voids and imaginary thinking, we identified five interrelated barriers to CE transitions in ASM: (i) limited to no regulation for tailings governance, (ii) competing imaginaries fragmenting collective action, (iii) exploitative and restrictive market-making dynamics, (iv) technological barriers, and (v) partial social acceptance. Collectively, these barriers exist in mutually reinforcing relationships, where voids and imaginaries operate as co-constitutive forces that shape tailings circularity across communities. Our analysis also discusses how institutional voids and related barriers to tailings circularity act as *socio-politically constructed* configurations shaped by asymmetric practices and governance arrangements, with uneven outcomes between formal and informal actors. Based on our findings, we demonstrate how *circular voids* – spatial and institutional traps where exclusion perpetuates itself – fundamentally reshape value chains and the lived and material geographies of tailings operations. We conclude that effective governance interventions must rethink conventional formalisation frameworks to embed collaborative and hybridised governance structures that centre informal actors’ imaginaries, networks and lived geographies in designing equitable pathways for sustainable tailings management.

1. Introduction

Mining is one of the largest and most resource-intensive sectors globally, generating substantial volumes of tailings – the residual materials left after ore extraction and processing – that create significant environmental and health challenges (Franks et al., 2011; Hudson-Edwards et al., 2011; Lottermoser, 2011; Kossoff et al., 2014; Cotrina-Teatino and Marquina-Araujo, 2025). Worldwide, an estimated 14 billion tonnes of mine tailings are produced annually, with accumulation creating long-term environmental and socio-economic consequences (Ojeda-Pereira and Campos-Medina, 2021). The increasing pressure to minimise waste and enhance environmental sustainability has led to the (re)emergence of the circular economy (CE) as a promising model for transforming linear mining systems and related risks into regenerative frameworks (Kahupi et al., 2024; Vujović et al., 2025).

Across different sectors and businesses, the circular economy paradigm challenges the traditional ‘take-make-dispose’ linear model by extending resource lifecycles and keeping materials in active use

through closing loops and promoting reuse, recycling, and recovery (Geissdoerfer et al., 2017; Kirchherr et al., 2017; Kirchherr et al., 2018). Emerging evidence from the mining sector demonstrates these potentialities, including the use of seawater and desalinated water in ore processing to reduce freshwater consumption, mine waste management, and the reuse of liquid effluents (Lèbre et al., 2017; Kahupi et al., 2023; Born, 2025). However, despite this documented promise, the practical implementation of circular strategies in the mining and manufacturing sectors remains inconsistent, poorly managed, and fragmented, particularly in ASM and, more generally, within formal-informal governance in the global South (Gedam et al., 2021; Korsunova et al., 2022). In response, there have been increasing calls for contextual circular economy adoption and implementation in ASM to address these challenges (Arthur-Holmes and Vazquez-Brust, 2026).

Although these calls for action have also prompted growing scholarly attention to the circular economy’s potential to address mining-related sustainability challenges, critical gaps remain in the circularity transition literature. Most existing scholarship has predominantly focused on

* Corresponding author.

E-mail addresses: francis.arthur-holmes@port.ac.uk, frarthur88@gmail.com (F. Arthur-Holmes).

<https://doi.org/10.1016/j.geoforum.2026.104757>

Received 25 March 2026; Received in revised form 29 June 2026; Accepted 30 June 2026

Available online 8 July 2026

0016-7185/© 2026 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

large-scale industrial mining in formal contexts (Lèbre et al., 2017; Kahupi et al., 2023; Osei et al., 2023; Born, 2025; Cotrina-Teatino and Marquina-Araujo, 2025), with limited research examining how CE transitions unfold and operate – or are systematically impeded – in informal ASM settings, despite this being the sector where reprocessed ASM tailings pose serious environmental and health threats through mercury use and trade (Veiga et al., 2009; Bansah et al., 2018; Velásquez et al., 2022; Arthur-Holmes and Ofori, 2024). Others have also questioned the tensions associated with CE transitions in the mining industry (de Palacios and Rodríguez, 2022; Nuur et al., 2025), which remains largely understudied as a distinct phenomenon, particularly within the ASM sector. Within the global South specifically, existing literature has largely implicitly addressed circularity through discussions of waste management, environmental remediation, toxicity assessment, tailings trading, tailings valorisation, and formalisation strategies, yet remains disconnected from explicit CE frameworks in informal mining and ASM contexts, resulting in limited examination of CE-informed tailings governance in these settings (Kossoff et al., 2014; Bansah et al., 2018; Osei et al., 2023; Arthur-Holmes and Vazquez-Brust, 2026). Relatedly, empirical research examining practical barriers to CE from multi-stakeholder perspectives in informal mining remains relatively sparse (Velásquez et al., 2022; Kahupi et al., 2024).

These analytical and empirical gaps are further complicated by inherent paradoxes embedded in informal and formal ASM mining development contexts. Arthur-Holmes and Vazquez-Brust (2026), for instance, identified four critical paradoxes that complicate CE transitions in ASM: (i) tensions between achieving positive impacts (livelihood generation, resource recovery) and reducing negative impacts (environmental degradation, health risks); (ii) tensions between informal and formal governance structures with competing legitimacies and enforcement mechanisms; (iii) tensions between local sustainability priorities and global environmental imperatives; and (iv) large-scale mining (LSM)-artisanal and small-scale mining (ASM) tensions regarding land struggles and mineral access. In addition to these paradoxes and tensions, however, existing CE frameworks, whilst valuable for formal contexts, lack contextually appropriate conceptual characteristics to address the unique and inherent specificities of informal mining sectors (Born, 2025; Arthur-Holmes and Vazquez-Brust, 2026).

In this paper, we address these gaps by investigating barriers to CE transitions in Ghana's ASM tailings sector. Drawing on institutional voids and imaginary thinking, we ask two key questions: (1) *How are voids in the tailings circularity sector created, maintained, and shaped by institutional imaginaries?* and (2) *What barriers emerge from these voids and/or impede circular economy transitions in ASM?* In doing so, we make three interrelated contributions to the sustainability and development scholarship. First, we add a critical theoretical contribution to imaginary thinking in the sustainability transitions literature (e.g. Benner, 2025) by demonstrating how CE barriers are fundamentally rooted in competing institutional imaginaries – different ontological understandings of what tailings are (commodities, commons, or waste), different moral claims about entitlement, and different visions of legitimate economic relationships. Second, we add to existing (re)conceptualisations of institutional voids by characterising (informal) voids as not neutral absences but active spaces of contestation – socio-politically constructed configurations (Hasan and Bondy, 2025) that advantage some actors over others and also reveal whose interests benefit from their absence and how voids are actively maintained. Beyond these conventional notions, we also add to this scholarship by advancing 'circular voids' as an analytical lens for understanding how institutional traps for exclusionary dynamics in CE transitions become locked in through mutually reinforcing mechanisms and perpetuate the conditions for continued exclusion, particularly among informal actors and communities. Finally, we empirically expand the circular economy and informal mining scholarship by revealing that transitions in informal economies face distinctive barriers largely absent from mainstream literature that focuses on formal contexts. Using these empirical

cases, we argue that effective CE transitions in informal mining contexts depend not only on technologies, markets, and regulations but also fundamentally on addressing competing imaginaries and negotiating the political and ontological conflicts that underpin persistent barriers to inclusion and sustainability.

The remainder of this paper is organised as follows: Section 2 reviews the literature and provides a theoretical guide to this paper. Section 3 provides context on Ghana's ASM sector and tailings landscape; Section 4 outlines the research design and methods; Section 5 presents the empirical findings; and Section 6 discusses the significance of our findings and provides conclusions.

2. Institutional voids and imaginary thinking in sustainability transitions

In this study, we build on critical scholarship on institutional voids and imaginary thinking (Jasanoff and Kim, 2009; Mair et al., 2012; Heeks et al., 2021; Benner, 2025) that departs from linear framings to recognise these as deeply political, socio-material and institutionalised arrangements shaping transition practices and futures. Within the management and business literature, institutional voids have traditionally been understood as market failures requiring intervention and filling. Defined as the absence or weakness of institutions that support market activities and connect buyers to sellers (Khanna and Palepu, 1997; Mair and Marti, 2009; Mair et al., 2012), institutional voids have been conceptualised as gaps to be remedied through institutional development. The dominant narrative suggests that businesses gain a competitive advantage by filling voids through the internalisation of missing market functions (Khanna and Palepu, 2010; Doh et al., 2017).

However, more critical scholarship departs from this benign view of void-filling and recognises institutional plurality, viewing institutional voids as 'the intermediate outcome of conflict and contradiction among different institutional logics' constantly negotiated through everyday interactions between differently positioned actors, producing contested institutional landscapes where certain absences serve some actors' interests while disadvantaging others (Mair et al., 2012; Dieleman et al., 2022). Recent work across the social sciences demonstrates that actors may not only fill voids but also strategically maintain, expand, or create new voids when doing so serves their interests (Yep, 2015; Heeks et al., 2021; Daou et al., 2024). Related to this, and often overlooked, are informal institutional voids, which have been argued to emerge as distinctive spaces where established rules and norms face fundamental challenge, and responsibility for 'solving' emerging problems becomes dispersed among a broad range of actors rather than concentrated in discrete institutions (Hajer, 2003; Hasan and Bondy, 2025). These informal void frameworks have begun to challenge core assumptions of voids presented in the institutional voids literature, such as the assumption that voids create strategic opportunities for firms and intermediaries that are best realised through market-based approaches. Rather, they constitute 'active social spaces, rising out of existing and often conflicting institutions, where the logics, their supporting structures and actors traditionally associated with the institutions, face persistent challenges to their ability to devise meaningful solutions to issues at the nexus of these institutions' (Hasan and Bondy, 2025, p. 207). We, therefore, adopt this dialectical and relational understanding of institutional voids, recognising that actors simultaneously respond to voids whilst also shaping them (Heeks et al., 2021). This is particularly salient in contexts characterised by formal-informal economic divides, where sustainability transitions must navigate competing institutional logics.

Alongside institutional voids, we draw on the concept of imaginaries to understand why certain voids persist and why stakeholders' competing visions and meaning-making fragment sustainability transitions. Imaginaries are known 'as the collectively held, ideationally created and discursively shaped representations about economic, technological, cultural and/or political developments' (Benner, 2025, p.

269). As argued within the literature, these imaginaries operate simultaneously across temporal dimensions (imagined histories and futures) and spatial dimensions (imagined places and spaces), shaping how actors understand, frame, and ascribe meaning to resources, relationships, and practices (Jasanoff and Kim, 2009; Adams et al., 2015; Benner, 2025). In sustainability transitions, imaginaries fundamentally shape what futures actors envision and how they imagine solutions should unfold. Hermann et al. (2022), for instance, identified competing CE imaginaries organised around two key tensions, namely: 'international drivers versus regional and local transition arenas' and 'ecological modernisation versus sectoral transformation'. These competing imaginaries shape not only what actors believe transitions should accomplish, but critically, which spatial and institutional arrangements they perceive as legitimate. This is particularly important for grasping why competing visions often prevent coordinated action.

The interaction between voids and imaginaries is particularly consequential for sustainability transitions (Cardascia et al., 2021; Daou et al., 2024). Whilst sustainability transitions require institutional frameworks to coordinate actors, guide change, and ensure equitable distribution of costs and benefits (Geels and Schot, 2007) in settings characterised by (informal) institutional voids, such established frameworks are largely absent.

Drawing on these two theoretical dialogues, we situate our analysis within the sustainability transitions scholarship to challenge dominant framings that treat institutional voids and competing imaginaries as separate analytical concerns. Whilst each framing offers significant analytical value when used independently, combining these two lenses provides additional value, particularly for understanding CE transitions within informal economic settings such as ASM, where value chains exist in institutional grey zones with limited regulations and where market structures are informal or emergent. In such contexts, CE transitions depend fundamentally on how these voids and imaginaries shape or are shaped by actors' shared understanding and competing visions of sustainability.

3. Formalisation, politics and state governance of ASM operations in Ghana

In Africa, the formalisation of ASM operations is a top-down, regularisation approach to bring informal artisanal or small-scale mining into the formal economy. In the context of Ghana, the ASM formalisation in the 1980s was not a deliberate government policy, but rather a component of economic restructuring and of loan conditionalities imposed by international organisations such as the World Bank and the International Monetary Fund. This was aimed at privatising state-led enterprises and small-scale mining operations. Indigenous mining groups were required to obtain small-scale mining licences so that they could operate within the formal economy (Tsikata, 1997). Here, we could argue that the formalisation of ASM operations in Ghana was purely top-down and externally driven, without consideration of customary land tenure systems, indigenous knowledge systems, and the complexity of mining enclaves, as manifested by the large-scale mining (LSM)-ASM cohabitation conflict. More broadly, this situation created further informalities, as the impact of structural adjustment programmes increased the involvement of rural inhabitants, farmers, and retrenched miners in ASM operations (Hilson and Potter, 2005).

In 1989, the Small-Scale Gold Mining Law, 1989 (PNDCL 218) was enacted to regulate and legalise the ASM (Tsikata, 1997). This legal framework provided the basis for classifying ASM into two types: legal/registered small-scale mining and illegal/unregistered small-scale mining. However, Arthur-Holmes et al. (2026) consider this classification problematic because it does not address the LSM-ASM cohabitation conflict in mining communities where residents either struggle to access or lack access to mineral-rich lands for ASM operations. Although the law requires Ghanaians aged 18 or older to participate in ASM and obtain a mining licence and operating permits for gold or diamond ASM

operations (Aryee et al., 2003; Tychsen et al., 2017), foreign nationals, including Chinese nationals and Burkinabes, have been found to participate in the sector (see Crawford and Botchwey, 2017). Past works have documented how local miners, community residents and traditional authorities connived with foreigners, particularly Chinese nationals, to provide them with documentation for operations or to work in disguise for them (Crawford and Botchwey, 2017; Kumah, 2023).

ASM formalisation thus far has achieved little to no success due to ongoing environmental degradation, water pollution, and heavy metal contamination. Several scholars have contended that the rigid licensing application system and weak institutional capacity for enforcing environmental regulations have contributed to the increasing pervasiveness of informal ASM operations (Banchirigah, 2008; Hilson et al., 2017; Kumah, 2022a; Yankson and Gough, 2019; Balag'kutu, 2024; Arthur-Holmes and Ofori, 2024).

In more recent narratives, some scholars have attributed the informality in ASM to political elites who act as kingpins and financiers for illegal operations (Bob-Milliar and Agyekum, 2025). Such political figures are linked to corruption and bribery within the sector (Crawford and Botchwey, 2017). These factors fuelling informality and illegality in the sector contribute to the ASM politics of participation and blame-shifting for the negative environmental ramifications of ASM operations. Indeed, corruption has been noted to be embedded in the everyday activities of informal gold mining across many global South countries, including state actors' involvement (Damonte, 2018). Other scholars have also argued that the lack of institutional acknowledgement of the heterogeneity of ASM operations contributes to the reluctance of unlicensed indigenous mining groups to obtain mining licences and operating permits (Kumah, 2022b; Arthur-Holmes and Ofori, 2024; Donkor et al., 2025). As noted in other countries, including the Democratic Republic of Congo (DRC) and Bangladesh, ASM operations and labour dynamics are diverse (Geenen and Bikubanya, 2024; Suykens et al., 2025). On this crucial issue, Arthur-Holmes et al. (2026) stressed that the lack of discourse on operating permits has shaped narratives in the Ghanaian policy and media milieus, where the public and informal/illegal miners regard a small-scale mining licence as the sole requirement for commencing ASM operations and as an indication of operating within an environmentally sustainable mining code and conduct.

A burgeoning body of studies has highlighted government-imposed sanctions on informal/illegal ASM operations, coupled with militarised conservation interventions, to clamp down on these operations and sanitise the sector (Hilson, 2017; Eduful et al., 2020; Ofori et al., 2024; Aziabah and Ayelazuno, 2024). Yet, the government has consistently failed to achieve those objectives. In fact, these interventions have resulted in human rights violations and injustices (Faanu and Asamoah-Gyadu, 2026) as miners are considered criminals and bandits (Tschakert, 2009; Crawford and Botchwey, 2018; Tuokuu et al., 2020) who are sometimes beaten during military raids. Scholars have weighed in on the view that the government's failure to address informality/illegality in the ASM sector, and even to promote circular business models, stems from a large-scale mining 'bias'. The bias occurs when the government favours industrial mining through tax reliefs and technical support to allure foreign investment and expand the LSM industry (Hilson, 2019; Arthur-Holmes et al., 2022). Alongside these issues, there is currently limited to no conscious CE approach to ensure responsible production and improved environmental performance. Despite the ASM regulatory and policy framework undergoing a series of reforms (in 2006, 2019), and the current one in 2025), registered small-scale miners are not trained in circular mining practices. This circumstance has created informal economy-based interactions among rural actors who consider ASM waste valuable for reprocessing or recycling into building materials (Arthur-Holmes and Vazquez-Brust, 2026). However, as required by the ASM governance framework, licensed operators must ensure that the mine tailings and waste disposal strategies set out in their Mining Operation Plan are implemented

(Tychsen et al., 2017). Also, regarding environmental degradation, heavy metal contamination and mine waste management, research scholarship highlights that informal ASM operators should continue to adopt informal social and environmental responsibility (ISER) practices by applying indigenous environmental knowledge systems embedded in African philosophies, particularly Akan philosophical perspectives, to address these challenges (Vazquez-Brust et al., 2024).

4. Sites and methods

Informed by interpretative phenomenological research (Sayer, 1992), this paper draws on findings from a qualitative case study conducted from July 2024 to September 2024 on barriers to the circularity of ASM tailings in the Talensi Mining Area (TMA) and the Prestea-Bondaye Mining Area (PBMA) in Ghana. The focus of ASM operations in these mining areas is on gold extraction and processing. TMA comprises the Obuasi, Tarkwa, and Kejetia mining sites in the Talensi District of the Upper East Region of Ghana (see Fig. 1). Obuasi and Tarkwa mining sites were named as such because they reflect the characteristics of the historical mining towns of Obuasi and Tarkwa in Southern Ghana (Koomson-Yalley and Kyei, 2022; Mengba et al., 2022). Other TMA sites were also named after Kejetia and Accra because the continuous influx of people into the area for mining operations reflects the characteristics of the Kejetia market in Kumasi and the large movement of migrants into Ghana's capital, Accra, in Southern Ghana (Koomson-Yalley and Kyei, 2022). However, the emergence of Cardinal Mining Limited in the mining enclave as a large-scale gold mining company resulted in the takeover of the Accra site, leaving the other three sites for ASM gold extraction (Arthur-Holmes and Mengba, 2024). In the Talensi district, agriculture is the primary economic activity, employing 78.3% of the population, followed by mining (5.2%) (Ghana Statistical Service, 2014). Given the high poverty incidence in northern Ghana, including in the district, the ASM operations provide economic pathways for many families, both locally and from afar, to earn a living and alleviate economic hardship (Arthur-Holmes and Mengba, 2025).

In the mining enclave, the land ownership structure is usufruct-based, which influences access to land. Unlike the TMA, the PBMA started gold mining during the colonial period and has continued till the present. PBMA is located in Prestea-Huni Valley Municipal District in the Western Region. In this study, PBMA is defined as the area stretching from Prestea to Bondaye, including mineral extraction and processing areas along the Bondaye-Nsuta and Bondaye-Gambia roads (Vazquez-Brust et al., 2024). The PBMA communities studied were Prestea and Bondaye (see Fig. 1). Mining sites along the Bondaye-Nsuta and Bondaye-Gambia roads were also considered in this study. A large number of individuals involved in ASM operations in the area are migrants from both urban and rural areas across the country (Arthur-Holmes and Abrefa Busia, 2022; Hilson and Hu, 2022). In the PBMA, ethnic dynamics are diverse, comprising different Akan groups and ethnic groups from Northern Ghana, including those from Talensi District. Such ethnic diversity makes PBMA a unique ASM hub with a range of mining operations, including open-pit, alluvial, and underground 'ghetto' mining (see Arthur-Holmes et al., 2022). Although reports indicate that agriculture is the primary economic occupation in PBMA, the proliferation of ASM operations and farmers' transition to this type of mining activity over the years have altered the area's economic characteristics. In these two mining enclaves, a common characteristic is that they host large-scale mining operations, and most ASM operations are conducted informally, without land tenure security and mineral rights.

In collecting our data, we drew on multiple sampling techniques, specifically purposive and snowball sampling, supported by social networks and community contacts. This strategy was adopted because a few actors, including informal mining concessionaires, ASM operators and intermediaries, are involved in ASM circularity and its supply chain. To recruit these actors for semi-structured in-depth interviews and personal

conversations (informal interviews), these sampling techniques provided access and subsequently helped us obtain referrals to individuals within the tailings recycling and reuse supply chain. Given the first author's familiarity with the PBMA enclave and subsequent research on CE practices and processes of ASM tailings, digital interviewing via phone and WhatsApp was conducted from 05 July to 8 September 2024. For the PBMA research, 13 ASM operators (including 1 tailings collector/caretaker), 2 middlemen, 6 residents who utilised ASM tailings for construction purposes, and 2 workers from mining companies were interviewed.

In addition, informal interviews were held with 4 underground operators and 1 alluvial miner during the first author's visit to Prestea and Bondaye on 31 July 2024. For the TMA research, 2 face-to-face interviews and 4 informal interviews were conducted with underground operators on 7 August 2025, of whom 2 operators doubled in their capacity as informal pit claim holders and sponsors.¹ In total, 34 interviews (both semi-structured and informal) were conducted (see Table 1). We included diverse actors in our research because CE applications often involve a range of stakeholders, practices and processes.

Field observations and targeted discussions on the quality of ASM tailings and CE transitions were also conducted during site visits to the two mining enclaves. In accordance with research ethics, informed consent was obtained orally prior to both face-to-face and digital interviews. Interviewed actors were assured of the confidentiality and anonymity of their responses. More crucially, information and interviewees' personal characteristics were de-identified, and consequently, pseudonyms were used to represent the interviewees. The interview recording was made non-compulsory, and those who consented were audio-recorded. Nonetheless, the face-to-face interviews in the TMA were not audio-recorded. In the TMA, where 2 participants could not speak Twi, a native speaker was hired to translate the questions asked by the first author and the participants' responses.

Following the completion of semi-structured in-depth interviews, the first author transcribed the audio recordings verbatim from the local languages used (Fante, Wassa and Twi) into English. To ensure the accuracy of the transcript, the second author verified that the transcriptions reflected the actual responses of interviewees from the PBMA. Next, all written interview responses, audio-transcribed interviews, field observation notes, and personal conversation notes were combined to form the data transcript for analysis. The data transcript was then analysed by applying the six stages of thematic analysis (Braun and Clarke, 2006): familiarisation, coding, generating themes, reviewing themes, defining and naming, and reporting (writing up). Coding was carried out manually and textually. Upon completing all stages of thematic analysis, we deliberated again on the themes generated and on whether we could theorise or conceptualise our findings. This additional analytical strategy, which delved deeper into similarities and differences in patterns across the two case studies, offered a pathway for theorisation and concept development to explain the barriers to and the maintenance of ASM tailings circularity.

5. Findings

Here, we organise the findings around five interconnected themes that reveal the complex dynamics of barriers to the creation and maintenance of ASM tailings circularity, and their consequences for CE transitions. First, we examine how limited regulation creates spaces for informal governance whilst enabling exploitation in ways that impede CE transitions. Second, we analyse competing imaginaries and clientelistic networks that fragment collective action. Third, we explore how market-making dynamics fill commercial gaps but concentrate power among large-scale miners. Fourth, we investigate technological deficits that create health hazards whilst reinforcing dependence.

¹ These are mainly the financiers of the (underground) mining operations.

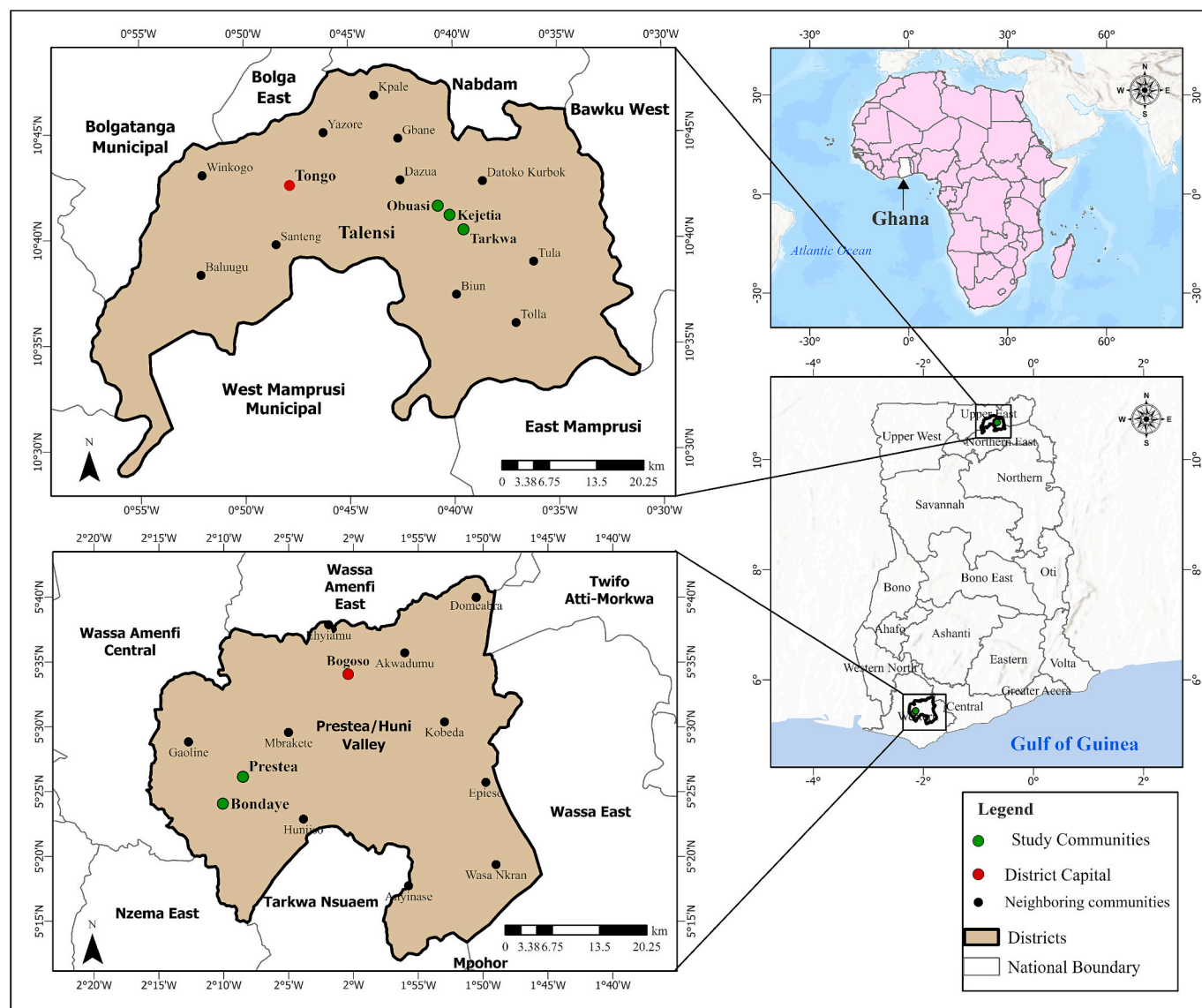


Fig. 1. Maps showing the study communities and their respective districts in Ghana Source: Authors' construct.

Table 1

List of interviewees across study sites.

Interviews groups		Number of Interviews (Semi-structured and informal) n = 34	
		PBMA sites (Bondaye and Prestea)	TMA sites (Tarkwa, Obuasi and Kejetia)
ASM operators	Underground miners	10	4
	Alluvial miners (Chang Fa operators)	5	—
	Open pit miners	2	—
	Tailings collector/caretaker	1	—
Tailings middlemen		2	—
Community residents		6	—
Mining company workers		2	—
Informal pit claimholders/ASM sponsors		—	2
Total		28	6

Finally, we examine how partial social acceptance creates legitimacy voids and concerns. Together, we demonstrate how institutional voids in Ghana's ASM tailings sector are not merely gaps to be filled but are

actively shaped by socio-economic interests and competing visions that create barriers to the equitable development of the circular economy.

5.1. Limited regulation, and the complicated creation and maintaining of CE voids

The tailings management landscape in Ghana's ASM sector is characterised by a profound regulatory absence, operating within formal-informal systems. Whilst large-scale mining companies operate within formal regulatory frameworks – holding mining leases, environmental permits, and legal recognition from the Minerals Commission – the ASM sector operates largely informally (or illegally), with minimal regulatory oversight. Across our study sites, we found that these regulatory gaps and asymmetries between formal and informal mining actors created barriers to CE transitions on how tailings were managed and recycled in several ways.

First, in stakeholders' narratives, it was noted that regulatory absence or gaps not only allow divergent practices among actors but also enable 'dangerous' informal practices that affect the transition to CE in relative terms. The most severe consequence is evident in areas such as Abosso, where small-scale miners have begun recycling tailings for their own benefit rather than selling them to large-scale miners. At most

mining sites, particularly among ASM operators and tailings collectors, there are no safety practices to guide tailings collection or even the local processing of tailings, unless they are sold to mining companies whose gold recovery operations have standard environmental and safety regulations.² Operating outside any regulatory framework, therefore, these informal recycling operators use cyanide to recover gold from ASM tailings, which has become a problematic practice in some mining enclaves. For instance, in Talensi, we found that, due to the absence of regulations on tailings recovery, informal ASM operators engage in tailings reprocessing through cyanidation, which is considered to pose widespread health risks to ASM-induced community ecosystems. In these communities, such as Tarkwa and Kejetia in TMA, it was observed that informal pit owners and sponsors³ process tailings (milled ore) through oven basins, which have also been argued to be used for processing tailings (mainly leftovers from washed milled ore). This unregulated reprocessing of tailings to recover gold has increasingly been recognised as a highly hazardous practice, where toxic fumes can cause explosions if containment is not properly implemented.⁴ This problem extends beyond the informal sector. Even among those who operate legally under mining rights and permits, cyanidation is not carried out professionally, which undermines safer mining practices. Here, the formal-informal divide creates legal precarity for ASM operators. Whilst LSM companies operate with full legal recognition, ASM operators work in what they describe as the so-called illegal [category], which contains harmful chemicals. This status exposes them to potential health risks.

Theoretically, whilst formalisation and professional regulation might rectify these institutional asymmetries and reduce hazardous practices across both sectors, they do not necessarily ensure equitable outcomes for affected communities. However, despite formalisation appearing to address this regulatory gap, community respondents expressed significant resistance. They feared that if tailings reuse is regulated and formalised, those who rely on it for livelihoods will lose access to resources they currently depend on, including shares that traditionally benefit local authorities and community members. Additionally, a tailings collector expressed concern that formalisation would eliminate collectors' ability to earn income from tailings processing. In PBMA, for example, as one community resident asserted:

Regularising the reuse of tailings for construction [and related purposes] to mitigate community risks would make it challenging for them to obtain free or cheaper tailings as sand. [This will be] because there would be strict environmental regulations that will impede recycling of tailings into the community for building [related activities].⁵

This resistance, therefore, also exemplifies a critical tension across different actor interests. Following the literature on formalisation processes (Arthur-Holmes and Ofosu, 2024), for instance, it can be argued that the barrier to circular economy development is not merely the absence of regulation but rather the configuration of regulations themselves, which intentionally or unintentionally (dis)empower different actors.

Additionally, whilst permitting and regulatory frameworks are considered to have clear effects as bottlenecks to informal ASM circularity, which is consistent with previous studies (Kinnunen and Kaksonen, 2019), we also found that enforcement gaps and practices within these informal mining enclaves compound these challenges. Ghana's militarised conservation approach exemplifies these enforcement barriers. Between 2016 and 2025, for instance, the Ghanaian government deployed military and police task forces against informal

ASM operations – Operations Vanguard, Halt I, and Halt II. These military operations, intended to combat illegal mining (galamsey), frequently disrupt indigenous ASM operators' access to mining sites. In PBMA and Talensi, stakeholders noted that the militarised conservation approach, which is frequent in these areas, prevents indigenous mining groups from carrying out their usual informal hard-rock and alluvial operations. When LSM companies hold exclusive concessions, they further exclude indigenous ASM operators from accessing mineral-rich lands, denying them the resource base needed to generate tailings for CE transitions. Together, these enforcement actions and land access barriers create unpredictability that makes tailings availability unstable. Stakeholders across our study sites also increasingly noted that without reliable access to mining sites and protection from enforcement action, informal ASM operators cannot consistently generate or collect tailings, rendering CE adoption an uncertain livelihood strategy. Although young people may take up temporary employment in tailings collection and reprocessing for income, the lack of institutional security and access to resources undermines sustainable CE business models.

5.2. Tailings as commodity, commons or waste: competing imaginaries and fragmentation as barrier

Perhaps the most fundamental and cross-cutting barrier to the development of CE in Ghana's ASM tailings sector lies in the radically different ways in which various stakeholders understand and frame what tailings are, who should have access to them, who should benefit from them, and what the CE should mean. Across our study sites, we found that whilst formal mining companies must comply with environmental regulations for tailings disposal, the overall regulatory gaps and informality among other key actors within the tailings value chain for recycling and reuse – whether ASM operators, collectors, or communities – have enabled them to develop their own practices and governance arrangements as well as differential and competing visions for CE transitions. These imaginaries most often create irreconcilable conflicts or ontological differences that prevent or slow the shared visions or coordinated action across the different stages of circularity among various stakeholders, as noted below.

For tailings collectors and some ASM operators, tailings represent a business commodity that requires investment and technology. From this perspective, recycling tailings is viewed as a business enterprise where technology and funds need to be mobilised to improve it. An ASM tailings collector argued that the collectors should be compensated for the labour and risk involved in gathering and transporting tailings, and that they require appropriate technology to treat these tailings and neutralise toxic chemicals to secure better prices. In line with these visions, many ASM operators and collectors have developed their own collection and processing methods, often without safety oversight or environmental monitoring due to the lack of 'formal procedures for tailings collections'.⁶ In Prestea, for example, one middleman noted:

...[The] environmental monitoring for tailings processing by pit owners/sponsors was conducted by themselves, not by any established institutions responsible for best mining and [tailings reprocessing]. But one thing is clear: operators participate in this [tailings trading] to generate income, [but] not to ensure responsible mining to protect the environment and to consciously reduce waste accumulation [or to participate in the adoption of the circular economy in ASM].⁷

This commodity framing justifies charging for access and concentrating on profitable use or practices. An alluvial miner in Prestea indicated these dynamics, noting that some youths have begun to see

² Interview with Changfa operator, Male, Prestea, 08 July 2024.

³ Sponsors are the financiers of underground ASM operations by providing funds to locco boys (helpers) and chiselers for food and mining inputs.

⁴ Interview with pit owner in Talensi mining area (Tarkwa), 7 August 2024.

⁵ Interview with female resident, Prestea, 8 September 2024.

⁶ Interview with a Chang Fa operator, Male, Prestea, 08 July 2024.

⁷ Interview with an intermediary (middleman), Male, Prestea, 5 August 2024.

value in tailings and in recycling discarded material to generate income. Similarly, large and medium-scale mining companies share this imaginary, viewing some tailings as *profitable* resources over which they reprocess tailings 'legally' using their mineral rights/permits. In line with this noted vision, for instance, these companies, operating formally, have established internal systems for tailings grading, pricing, and sale that serve their commercial interests. They prefer the underground extracted tailings compared to the alluvial mining tailings because of their [tailings] ore value (profitability), composition and gradation⁸.

Other actors, such as traditional leaders and community members, perceive tailings as community property or commons. Tailings, especially those deemed waste, are viewed as common resources available to everyone that can facilitate reuse for building activities. For example, as a female community resident in Bondaye indicated: 'tailings waste sometimes are recycled for free when *left there* [discarded], but other times not for free, especially if the operators or some individuals want to sell them'.⁹ Other residents interviewed argued that tailings should be freely accessible to community members, since informal miners have already extracted the ore. Nonetheless, underground miners/operators stressed that they extracted only 40% or 30% of the gold from the ore, with the remainder left in the tailings. However, central to this imaginary was the notion that tailings fall under customary land rights, owned by traditional authorities, entitling them to shares in any commercial transactions. Such customary claims also meant that even as a 'commons', access to tailings remained governed (partly) by traditional authority, particularly regarding tailings on customary lands, outsider access, and/or access mediated through social networks and rights, more evidently in the case of alluvial mine tailings.

In a related but distinct framing, in some areas, many community members view tailings as *abundant waste* that should be freely accessible, particularly to those with limited financial means. From these actors, tailings are seen as materials that mining companies have discarded, and communities should be allowed to use them as sand for construction works and for flood protection measures such as filling low-lying areas, strengthening riverbanks, and raising ground levels in flood-prone zones, without payment. Across some communities, the emphasis here was on survival needs, 'universal' access and the pragmatic reuse of tailings, unconstrained by customary rights or commercial transactions.

Overlaying these imaginaries and visions are clientelistic relationships and networks that facilitate, but also further fragment interests. For instance, we found that some communities align with specific companies based on employment and corporate social responsibility benefits rather than sector-wide interests. In Prestea, for instance, communities prefer that Prestea Sankofa Gold Limited purchase their tailings because it benefits the community, and, conversely, Sankofa Gold Limited benefits from the community by employing some community members.

'...the leaders [traditional authorities] have advised us to sell our tailings to the mining company in Prestea rather than companies outside the area. In this case, the community can benefit directly from the mining company in the area [particularly Sankofa Gold Limited]'.¹⁰

From the above sentiments, visions and collective sense-making dynamics, these clientelistic ties and fragmented configurations create self-interested local arrangements where communities support settlements that benefit them locally, even as these same arrangements exploit ASM operators or exclude other companies operating in different communities and mining enclaves. For example, an alluvial mining

operator explained how external mining companies are more comfortable trading with communities with which they have established a relationship: 'Adamus Mining Company in the Nzema area used to purchase (smooth) tailings from the crushing and processing unit operators in Prestea, but they had recently stopped coming to Prestea'.¹¹ It was also argued that other mining companies [are] using [profits] to develop other communities as part of their social responsibilities. These clientelistic ties, competing loyalties, and differing or fragmented visions, or goals and configurations seemingly prevent or impede collective action toward conscious CE adoption or transition in the ASM sector.

5.3. Market-making (dynamics) fills commercial voids but remains a key barrier

Despite the existence of a ready market and symbiotic networks that enable the trade and purchase of tailings, these dynamics are not neutral. Across study sites of PBMA, for instance, the informal ASM tailings market structures are characterised by parasitic relations and exploitative dynamics shaped by LSM companies' control over pricing, grading, and terms of exchanges which deepen inequality, create systematically poor pricing, and marginalise ASM operators and tailings collectors. Within the informal-formal tailings value chain, these dynamics operate through multiple market mechanisms that create barriers to circularity in ASM.

First, in their narratives, interviewees explained that LSM companies determine prices indirectly for their own benefit by using processing and grading mechanisms as bargaining tools of exploitation. The fundamental issue is that LSM companies monopolise and determine the value of tailings by conducting grading assessments and ore assays internally, using methods and equipment that ASM operators cannot access, understand, or verify. This creates information asymmetries that systematically disadvantage sellers. Several ASM operators and a tailings collector/caretaker interviewed described being powerless in price negotiations because they simply have to accept whatever assessment the mining companies provided. They often do not know if they are receiving fair value for their tailings or whether the price is deliberately kept low through undervaluation. Linking the exploitation dynamics in tailings trading more broadly to ASM operations, there are other forms of exploitation evident through ASM labour control and organisation (Fisher, 2007; Kwao, 2024; Arthur-Holmes and Matey, 2025).

Second and relatedly, this knowledge disadvantage is further reinforced and intensified when combined with monopoly or oligopoly market conditions within the tailings value chain. In stakeholders' accounts across both study sites, the market structure itself eliminates alternatives that might allow operators to escape unfair pricing. In many areas, only one or two LSM companies purchase tailings, giving them monopoly power. For instance, an underground miner explained that mining companies were previously competing among themselves [to buy tailings] but the growing and recent involvement of traditional authorities has defused such competition, [and thus] empowering the mining companies within their enclave.¹² Such monopolistic structures have also created entry barriers. Because processing tailings at scale requires capital, technology, and permits that mining companies predominantly possess, informal ASM operators lack these resources or funding. In the PBMA enclave, some ASM operators were concerned that granting monopoly status to mining companies such as Prestea Sankofa Gold Limited would lead to lower prices and a competitive disadvantage, which, in turn, would reduce their bargaining power and pricing capacity. Although the alleged favour to Sankofa Gold Limited, which promotes community-level or local mining enclave sourcing of tailings,

⁸ Informal conversation with underground/ ghetto miner, Male, Prestea, 31 July 2024.

⁹ Interview with a female community resident, Bondaye, 01 September 2024.

¹⁰ Interview with tailings collector/caretaker, Male, Prestea, 23 August 2024.

¹¹ Interview with an alluvial mining operator, Male, Prestea, 05 August 2024.

¹² Interview with an underground pit helper (locco boy), Prestea, 06 July 2024.

is regarded by some as a laudable initiative supporting local development, operators emphasised that it ‘disadvantages ASM operators and tailings actors by restricting their ability to negotiate higher prices, given other companies’ interest in buying the waste’.¹³ In the absence of alternatives and with limited bargaining power, market dynamics create a ‘take it or leave it’ situation in which large-scale miners set the terms unilaterally, controlling what gets reprocessed. This was starkly highlighted in an interview where an operator candidly explained their dilemma:

Currently, market prices for tailings sold to mining companies are low and they [the mining companies] exploit us of our hard work in gathering them. ...In Prestea, we will stop selling tailings to mining companies if we can conduct cyanidation. We do not know how to reprocess tailings using that [cyanidation], as practised by galamsey operators in Abooso. But if the government regulates the tailings collection market [Minerals Commission and Ministry of Lands and Natural Resources], we will get a fair [and competitive] price.¹⁴

More importantly, this statement and the preceding discussions reveal deeper profitability barriers affecting operators. When operators cannot verify prices and suspect they are being exploited through deliberately low assessments, selling tailings becomes economically irrational. Rather than participate in a market they perceive as systematically unfair, some operators (particularly alluvial miners) rationally choose to abandon tailings on mining sites or sell them to other actors for alternative uses, such as plastering or construction fill. This withdrawal from participation directly undermines tailings circularity, which is a core requirement for CE adoption. In Prestea, interviewed miners perceived that market dynamics in tailings collection and trading impose severe constraints on the earning potential of ASM operators, including community crushing space, unit owners, and alluvial operators. Unlike other areas such as Abooso and Talensi areas who are knowledgeable of cyanide and arsenic-based tailings recovery, many local operators in PBMA are constrained by their lack of advanced knowledge of arsenic and cyanide-based tailings recovery and are trapped between impossible choices and dilemmas such as (i) selling the ASM tailings at exploitative prices determined by knowledge and market monopolies, (ii) process unsafely without proper knowledge or equipment, or (iii) a scenario where they abandon tailings entirely or replace with more profitable news ones, which overall affect or stalls the circularity processes.¹⁵

So, in relative terms, market informality perpetuates inequality in the tailings value chain in ways that directly delay circularity and prevent CE adoption. The informal nature of these markets also means they operate without the protections that formal markets might provide, such as price transparency, dispute resolution mechanisms, and regulatory oversight of trading practices. Despite this, several respondents, including both ASM operators and intermediaries, noted that some LSM companies have subtly resisted regulation that would equalise bargaining power because the current arrangement serves their interests. In effect, market-making by LSM companies fills the commercial void but paradoxically widens the *circular economy void*. The market exists, yet when operators choose to reduce or refrain from selling tailings due to exploitative market conditions, rather than participate in unfair exchanges or dispose of them to other users, the actual circulation of materials necessary for CE is delayed with significant impacts.

Thirdly, interviewees, specifically the miners and pit owners, also reported how the limited *financial capacity* of tailings collectors and intermediaries seeking to create entrepreneurial opportunities and

generate a steady income stream has impacted their actual participation in CE markets. It was noted that these actors often lack the funds to fully participate in ASM circularity and operate at a scale capable of driving meaningful market dynamics, and as a result, they view ASM tailings circularity as small-scale economic operations, incapable of increasing monetary benefits for CE actors within the value chain. Certainly, adequate financial resources are seen as a key enabler of technologically inclined CE transitions in the ASM sector. In explaining this, some miners argued that with sufficient funds, CE actors could increase the scale of their tailings circularity operations by employing more personnel and deploying technological resources and machinery, particularly through the purchase of excavators and trucks to collect and transport tailings from ASM sites. However, this is [largely] not the case currently. For actors who treat tailings collection as either employment creation or a profit venture, financial barriers not only shape market dynamics and the scale of operations for profit but also influence the extent of environmental benefits. Indeed, some ASM miners stressed that actors with greater financial resources could excavate several heaps of tailings left abandoned at ASM sites, which, in turn, provides an opportunity to prevent flooding, especially where tailings block drainage pathways (see Arthur-Holmes and Vazquez-Brust, 2026). For instance, a recent visit to PBMA shows that a large amount of tailings considered valuable only for building applications remains unremoved and it was feared that if these tailings are not properly managed, flooding would become a common natural disaster in mining enclaves. In contrast, in the TMA, ASM operations are embedded locally within communities, with underground pits and processing centres located between people's houses. In this context, limited finances are not currently necessarily seen as a barrier to tailings circularity. This is because owners of washing/processing centres have ceased selling tailings to other individuals, preferring to reprocess them directly. However, some interviewees suggested that as ASM operations continue to expand, tailings generation will increase and eventually exceed TMA communities' capacity to accommodate tailings storage for reprocessing, resulting in the shifting and reconfiguration of ore processing within community spaces over time. In some of these areas, early signs of this are already visible. Similar community-based processing dynamics are also found in parts of PBMA, such as along the Prestea-Bondaye road stretch and in Prestea-Asompa, though without the underground hard-rock mining dimension. While a full exploration of spatial dimensions is beyond the scope of this study, we found that spatial contextual configurations or differences across mining sites reveal divergent views on limited financial resources as a barrier to ASM tailings circularity. Nonetheless, financial support from the government was suggested across sites as a requirement to promote effective circular economy implementation for better tailings management that balances addressing environmental issues and creating economic opportunities for youth in rural communities.

5.4. Technological barriers

The CE literature recognises that technological barriers constitute key obstacles to CE adoption (De Jesus and Mendonça, 2018; Souza Piao et al., 2024). Within informal ASM contexts, technological barriers manifest and interact with institutional voids distinctively. Across our study sites, we identified technological deficits, which stakeholders discussed in two ways. One clear barrier noted was the absence of appropriate, accessible technology for safe tailings treatment before tailings collectors and ASM operators recycle them into community spaces. Within the ASM circular value chain, chemicals such as lime (calcium hydroxide), sodium hydroxide, and other alkaline substances can reduce the mobility of heavy metals and neutralise acidic compounds. However, these technologies remain largely inaccessible to

¹³ Interview with an intermediary (former middleman) in Prestea, 06 September 2024.

¹⁴ Interview with a tailings caretaker, Male, Prestea, 23 August 2024.

¹⁵ Recent field observations as of March 2026 show emerging cyanidation of ASM tailings by young Burkinabes in PBMA, specifically Bondaye.

informal ASM operators and community members due to *techno-structural barriers* like ‘limited access to use chemicals’,¹⁶ costs, and unregulated ‘safe’ supply chains at the community level. These techno-structural barriers reinforce dependence by creating additional health risks for key actors, particularly operators, collectors and residents. For instance, as noted by residents, children inhale chemicals from tailings whilst playing on them (Arthur-Holmes and Vazquez-Brust, 2026). Another example frequently mentioned by household heads was that when chemicals in tailings are used in residential buildings and not neutralised, such residents inhale them at home, with ‘heat from toxic chemical compounds diffusing in the afternoon or night’.¹⁷

The second barrier concerns access to mercury-free gold-recovery technologies. Informal ASM operators do not employ mercury-free technologies, creating tailings that contain mercury, arsenic, and other toxic compounds, posing severe health risks during recycling activities. In discussing this barrier, whilst operators acknowledged that mercury-free technologies would require government support and affordable supply chains, they simultaneously and frankly admitted that the government will not support such informal operations. As one alluvial miner stated: ‘even the government is looking to arrest gamamsey operators, and how much more to support [them] with mercury-free processing technologies’,¹⁸ unless the mining operations are legal. This is because informal ASM operators exist outside formal regulatory frameworks, making government assistance incompatible with enforcement priorities that criminalise unlicensed mining activities.

Thus, the technological barrier reflects deeper institutional voids around knowledge transfer, affordability, and legal status. Whilst informal ASM operators cannot access technologies because they lack legal status, they simultaneously cannot gain legal status without demonstrating same safe practices required for those very technologies. Hence, beyond such practices reflecting a *tailings paradox* as argued by Arthur-Holmes and Vazquez-Brust (2026), it also creates a *circular void* where ‘disadvantaged’ actors are seemingly caught in cycles of adverse incorporation. For instance, under Ghana’s Environmental Protection Agency Act (Act 490) and Minerals and Mining Act (Act 703), only licensed miners with approved environmental management plans can legally purchase industrial chemicals for tailings treatment (Ofosu and Arthur-Holmes, 2025). As a result, informal operators who most need neutralising technologies are ‘legally’ barred from accessing them due to their unlicensed status. Such circular voids create additional barriers and traps, where informal operators and community members who most need access to safe technologies remain systematically excluded. In mining areas such as Abooso and TMA, as indicated, some operators have employed illicit means to obtain chemicals for reprocessing tailings.

5.5. Partial acceptance as a barrier

In Ghana’s ASM sector, as in other informal mining contexts, the adoption of tailings for CE purposes depends heavily on social acceptance. Beyond the competing imaginaries and fragmented narratives discussed earlier, we found that partial social acceptance¹⁹ of tailings reuse creates a distinct legitimacy crisis. This partial acceptance becomes a barrier through two key mechanisms, namely through (i)

perceived tailings quality and (ii) information voids that undermine trust and broader acceptance.

Across most sites, particularly in PBMA, ASM operators and community residents discussed how quality voids create selective acceptance and hinder universal adoption of tailings as construction materials. The fundamental issue is that in most of these areas, many community members have not accepted tailings from alluvial mining operations as appropriate substitutes for extracted sand for construction. This rejection stems from significant quality variations and physical impurities that render tailings unreliable and inferior to conventional sand. Often these tailings contain tree branches, gravel, diesel [oils], and metal objects. As one community resident explained:

Some tailings are not good and unsuitable for use in plastering. The quality is low. You can see sticks, unwanted stones, and oil [diesel] traces in it. Only the ‘somp’ [smooth tailings] from milled and processed hard rocks is often accepted by the community members, but somp boys or owners will not sell to you unless you know someone at the crushing. Even with this, unless the somp is considered [an absolute] waste, not needed... and becoming a burden at the [washing] site.²⁰

In order to use tailings, these impurities need to be removed. However, because quality varies so significantly and many tailings are demonstrably low-quality or low-priced materials, only some people, primarily those who prioritise affordability over quality, accept and use them. Those with means, resources, or choice reject low-quality tailings entirely. This quality void creates a two-tier system where only those with limited financial means accept low-quality (inferior) or low-priced materials. As one ASM operator stated: ‘the poor residents who preferred these low-quality tailings because of their lower price’.²¹ These tailings are therefore not widely accepted or recognised as appropriate construction materials, when they are seen as second-class substitutes suitable only for those who cannot afford better alternatives.

On the other hand, both operators and community members across multiple sites also noted how *information voids* on the quality and chemical composition of materials create distrust and uncertainty that impede informed consent and broad social acceptance. These chemical safety issues in the tailings, which according to some, also reflected the lived experience of environmental contamination and health impacts in mining communities. According to our discussions with the operators and observations in TMA, the barrier extends beyond safety concerns alone. It was explained that communities and users had limited or no access to reliable information on which tailings contain which chemicals, at what concentrations, and with what risks.²² For instance, within these informal mining settings, there is no independent testing, no certification system, no trusted third party that can verify safety claims, hence there is also no proper mechanism to treat tailings to remove chemical compounds, and even if communities wanted to use tailings, they have no way to ensure adequate treatment has occurred. As one community member explained, concern about the possibility of chemical contamination creates uncertainty that no stakeholder can definitively resolve. Without trusted information systems and verified treatment mechanisms, communities cannot provide informed consent to the reuse of tailings. In light of this, some ASM operators stated that the lack of information on tailings, whether they contain chemicals or not, hinders community acceptance, as they cannot be regarded as equally important raw materials as extracted sand.²³

These interconnected *information-safety voids* (i.e. the absence of testing systems or trusted verification), overall, create what several

¹⁶ Interview with underground operator, Male, Talensi mining area (Kejetia), 07 August 2024.

¹⁷ Interview with male resident in Prestea, 06 September 2024.

¹⁸ Interview with one alluvial miner, male, Prestea, 21 July 2024.

¹⁹ Tailings social acceptance in CE contexts refers to the degree to which communities, construction workers, and other stakeholders recognise and accept tailings as legitimate, safe, and appropriate materials for reuse in construction and other applications in the governance and management of tailings treatment and reuse.

²⁰ Interview with a community resident, male, Prestea, 04 August 2024.

²¹ Interview with alluvial operator, Male, Prestea, 03 August 2024.

²² Informal discussion with underground operator, Male, Bondaye, 10 August 2024.

²³ Interview with community member, Male, Prestea, 06 September 2024.

respondents described and what we term as legitimacy concerns, as most of these actors could not determine what is safe, which often creates or results in fundamental distrust that undermines or impedes coordinated action for different tailings reuse and reprocessing. By virtue of their use of tailings, community members are [automatically] the actors who bear the health risk.²⁴

6. Concluding discussion

This paper investigates barriers to CE transitions in Ghana's ASM sector by drawing on the concepts of institutional voids and imaginary thinking. In doing this, we add to the circular economy and mining literatures (Upadhyay et al., 2021; Kahupi et al., 2023; Osei et al., 2023; Born, 2025; Nuur et al., 2025), by responding to critical calls for repositioning and decentring how CE approaches and adoptions are theorised, understood and operationalised within the *informalised* ASM sectors (Arthur-Holmes and Vazquez-Brust, 2026). Based on a qualitative approach in two ASM mining enclaves, our analysis identified five interconnected barriers to CE transitions: (i) limited regulation creating fragmented governance, (ii) competing imaginaries fragmenting collective action, (iii) exploitative and restrictive market-making dynamics, (iv) technological deficits reinforcing dependence, and (v) partial social acceptance that generates tailings legitimacy concerns. Importantly, CE adoption in ASM communities often began as a livelihood necessity to diversify income sources or increase earnings rather than as a well-designed, conscious waste management practice to reduce mine waste, including tailings, to promote a responsible or green mining agenda in the global South. This livelihood-driven context amplifies the five barriers identified by (re)producing or perpetuating informality and exclusion, perhaps due to operators' normalisation of informal practices or lack of resources and willingness to support the regulation and transparency that legitimate CE requires.

In line with the reconceptualised *voids-filling* literature (Mair et al., 2012; Heeks et al., 2021; Hasan and Bondy, 2025), our findings illustrate that institutional voids in the ASM tailings sector are actively constructed through political and economic dynamics shaped by competing imaginaries. Among our stakeholder groups, for instance, we identified three competing visions of what tailings are and who should benefit from them, whether they are seen as a commodity, as commons or waste. Relatedly, these competing imaginaries directly shape *social acceptance* and market dynamics of tailings reuse. Whilst past studies have identified technical, regulatory, and market-based barriers to CE adoption in the industrial large-scale mining industry (Upadhyay et al., 2021; Born, 2025) and in waste management systems (Souza Piao et al., 2024), we demonstrate that in addition to these, competing institutional imaginaries fundamentally also shape social acceptance in ways that impact the (re)creation, widening, or filling of voids and barriers to CE transitions.

Through this analysis, we make two key theoretical contributions to the scholarship and offer some policy implications. First, we add to the imaginary thinking in the sustainability transitions literature by demonstrating that barriers to CE in informal mining are fundamentally rooted in competing institutional imaginaries rather than discrete technical deficiencies. Existing CE barriers literature has focused on formal mining contexts (see for example, Upadhyay et al., 2021; Born, 2025), but our findings reveal that in informal ASM contexts, these technical barriers are secondary manifestations of deeper ontological conflicts. The incompatibility of imaginaries means that no single policy intervention can resolve barriers without creating new exclusions. This aligns with broader transitions scholarship, which shows that competing imaginaries function as powerful drivers constraining what becomes politically and institutionally viable (Trencher and van der Heijden,

2019).

Finally, throughout this paper, we add to the institutional voids literature by advancing and conceptualising circular voids as an analytical lens to better situate CE and sustainability transitions, which operate through mechanisms of *structural entrapment*, in which competing imaginaries actively construct and perpetuate self-reinforcing configurations that cannot be resolved through technical and formalisation interventions alone. In cyanidation for gold recovery, for instance, informal operators cannot legally purchase the necessary chemicals without permits, and they cannot obtain permits without demonstrating safe chemical handling practices. This supports our argument that barriers to ASM tailings circularity are not merely absences or impediments, but active configurations that systematically entrench informal actors in cycles of exclusion shaped by power asymmetries and ontological conflicts. This notion of *circular void* helps reveal how seemingly disparate barriers interconnect through competing imaginaries to produce structural entrapment. Whilst this lens emerges from ASM contexts in Ghana, its relevance to other informal extractive economies requires comparative testing. Future studies can employ it to examine analogous entrapment mechanisms in other informal extractive and economic contexts, such as waste management and agriculture, where similar self-reinforcing dynamics are likely to constrain sustainable transitions. Also, in understanding these voids and entrapment, another key area of investigation could build on prior studies that have examined cyanidation of ASM tailings (e.g. Velásquez-López et al., 2011; Verbrugge et al., 2021; Knoblauch et al., 2020; Pedersen, 2025), by applying this framing to interrogate the paradoxical nature of such transition technologies and how they shape human-nature interactions and socio-ecological risks across different geographies.

From a policy and practice perspective, these findings suggest that rather than imposing singular regulatory frameworks, governments should support multi-stakeholder dialogues that explicitly consider and negotiate competing visions of what the CE should mean. This finding suggests that hybrid governance arrangements combining formal and customary systems may be more effective than conventional formalisation. Specifically, policies should support: (i) collaborative platforms where large-scale miners, ASM operators, and traditional authorities jointly set pricing mechanisms and quality standards; (ii) capacity-building programmes enabling ASM operators to conduct independent tailings assays, reducing information asymmetries; and (iii) benefit-sharing frameworks that recognise traditional authorities' customary claims whilst ensuring ASM operators and marginalised communities receive fair compensation. Such support should be coupled with transitional pathways toward formalisation that account for operators' existing capabilities and livelihood needs (see Arthur-Holmes and Vazquez-Brust, 2026).

Whilst our paper draws its findings from qualitative fieldwork across two ASM mining enclaves in Ghana, our analysis points to questions that require investigation across other informal mining contexts and geographies, particularly regarding circularity practices on mine waste management, ecological harm and environmental degradation, and links to livelihood criticality and formalisation approaches. Although we have initiated this latter effort in other publications from the research project, targeting practice-based and lived geographies-specific policy insights and recommendations (Arthur-Holmes and Vazquez-Brust, 2026), future research must assess whether circular economy strategies that centre on informal actors' imaginaries and lived realities could more effectively support both sustainability transitions and livelihood security in informal mining contexts, particularly in addressing tailings paradoxes. Overall, our analysis thus demonstrates that in informal mining contexts, the question is not simply whether voids can be filled and generate barriers to CE transitions, but rather through whose imaginaries and by whom they are filled, and fundamentally, the need to understand the *soft* institutional structures that shape what (circularity) becomes possible.

²⁴ Interview with a former tailings middleman, Male, Prestea, 06 September 2024.

CRediT authorship contribution statement

Francis Arthur-Holmes: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Godfred Amankwaa:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Formal analysis, Data curation, Conceptualization, Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors thank their research translator (Emmanuel, a native in the Talensi mining area) and community contacts in the research sites for their help during data collection. Special thanks to the research participants who took time off to participate in the face-to-face and digital interviews. Also, we thank the editor and the two anonymous reviewers for their comments on the earlier drafts.

Data availability

Data will be made available on request.

References

- Adams, S., Blokker, P., Doyle, N.J., Krummel, J.W., Smith, J.C., 2015. Social Imaginaries in Debate. *Social Imaginaries* 1 (1), 15–52.
- Arthur-Holmes, F., Vazquez-Brust, D.A., 2026. Emerging circular economy practices, environmental health risks, and the “tailings paradox” in Africa’s artisanal and small-scale mining: evidence from Ghana. *Environ Sci Policy* 176 (104305), 1–18.
- Arthur-Holmes, F., Matey, P.D., 2025. Gender as an entangled force: Gendered mining entanglements, labor organization and leadership structure in artisanal and small-scale mining. *J. Rural. Stud.* 115 (103594), 1–16.
- Arthur-Holmes, F., Mengba, J.D., 2024. Conceptualizing collective action and informal women cooperatives in Africa’s artisanal and small-scale mining sector: The case of Northern Ghana. *The Extractive Industries and Society* 20, 101558.
- Arthur-Holmes, F., Mengba, J.D., 2025. Hidden mining capitalism, mineral transportation chain, and gendering livelihoods in Africa’s artisanal and small-scale mining: evidence from northern Ghana. *Resour. Policy* 107, 105608.
- Arthur-Holmes, F., Tomude, E.S., Damtar, D., 2026. Is a licence for small-scale mining a means, an end, or both? Politics of ASM formalisation and environmentally-responsible mining in Ghana. *Environ Sci Policy* 175, 104290.
- Arthur-Holmes, F., Ofosu, G., 2024. Rethinking state-led formalisation of artisanal and small-scale mining (ASM): Towards mining licence categorisation, women empowerment and environmental sustainability. *Resour. Policy* 93, 105058.
- Arthur-Holmes, F., Abrefa Busia, K., 2022. Women, North-South migration and artisanal and small-scale mining in Ghana: Motivations, drivers and socio-economic implications. *The Extractive Industries and Society* 10, 101076.
- Arthur-Holmes, F., Abrefa Busia, K., Yakovleva, N., Vazquez-Brust, D.A., 2022. Artisanal and small-scale mining methods and the Sustainable Development Goal 6: Perceived implications for clean water supply. *Environ Sci Policy* 137, 205–215.
- Aryee, B.N., Ntibery, B.K., Atorkui, E., 2003. Trends in the small-scale mining of precious minerals in Ghana: a perspective on its environmental impact. *J. Clean. Prod.* 11 (2), 131–140.
- Aziabab, M.A., Aylazuno, J.A., 2024. The failure of the militarised fight against ‘Galamsey’ in Ghana: A critical overview of the class and political dynamics. *J. Planning Land Manag.* 3 (2), 38–51.
- Balag’kutu, T.A., 2024. Governance fragmentation and agency of miners in Ghana’s artisanal mining sector. *Geoforum* 156 (104148), 1–11.
- Banchirigah, S.M., 2008. Challenges with eradicating illegal mining in Ghana: a perspective from the grassroots. *Resour. Policy* 33 (1), 29–38.
- Bansah, K.J., Dumakor-Dupey, N.K., Stemm, E., Galecki, G., 2018. Mutualism, commensalism or parasitism? Perspectives on tailings trade between large-scale and artisanal and small-scale gold mining in Ghana. *Resour. Policy* 57, 246–254.
- Benner, M., 2025. Imaginaries: The Ideational Foundation of Sustainability Transitions. *Tijdschrift voor economische en sociale geografie*.
- Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. *Qual. Res. Psychol.* 3 (2), 77–101.
- Bob-Milliar, G.M., Agyekum, H.A., 2025. State incapacitation for partisan political interest: Assessing government’s responses to the neo-galamsey crisis in Ghana. *The Extractive Industries and Society* 24, 101762.
- Born, K., 2025. Adoption of circular economy practices in the mining sector: evidence from Chile. *Resour. Policy* 102, 105514.
- Cardascia, S., Fischer, C., Amankwaa, G., 2021. Drivers of water system eco-innovation in Ethiopia: the case of Hawassa Industrial Park. *Water Science Policy Brief*. 1.
- Cotrina-Teatino, M.A., Marquina-Araujo, J.J., 2025. Circular economy in the mining industry: a bibliometric and systematic literature review. *Resour. Policy* 102, 105513.
- Crawford, G., Botchwey, G., 2017. Conflict, collusion and corruption in small-scale gold mining: chinese miners and the state in Ghana. *Commonwealth & Comparative Politics* 55 (4), 444–470.
- Crawford, G., Botchwey, G., 2018. Militarisation and criminalisation of artisanal and small-scale gold mining. *Rev. Afr. Polit. Econ.* 45 (156), 321–334.
- Damonte, G.H., 2018. Mining formalisation at the margins of the State: Small-scale miners and state governance in the Peruvian Amazon. *Dev. Chang.* 49 (5), 1314–1335.
- Daou, A., Salamoun, R., Abdallah, C., 2024. Institutional voids and business model convergence in the recycling industry. *Environ. Innov. Soc. Trans.* 52, 100882.
- De Jesus, A., Mendonça, S., 2018. Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecol. Econ.* 145, 75–89.
- de Palacios, L.D.L.T., Rodríguez, J.A.E., 2022. In mining, not everything is a circular economy: Case studies from recent mining projects in Iberia. *Resour. Policy* 78, 102798.
- Doh, J., Rodrigues, S., Saka-Helmhout, A., Makhija, M., 2017. International business responses to institutional voids. *J. Int. Bus. Stud.* 48 (3), 293–307.
- Dieleman, M., Markus, S., Rajwani, T., White III, G.O., 2022. Revisiting institutional voids: advancing the international business literature by leveraging social sciences. *J. Int. Manag.* 28 (3), 100935.
- Donkor, P., Siabi, E.K., Mensah, S.K., Frimpong, K., Vuu, C., Nyantakyi, E.K., Siabi, E.S., Boachie-Ameyaw, A., 2025. Informal artisanal and small-scale mining in sub-saharan Africa: Policy evolution, sector formalization, and future trajectories. *Resour. Policy* 109, 105698.
- Eduful, M., Alsharif, K., Eduful, A., Acheampong, M., Eduful, J., Mazumder, L., 2020. The illegal artisanal and small-scale mining (galamsey) ‘menace’ in Ghana: is military-style approach the answer? *Resour. Policy* 68, 101732.
- Faanu, P., Asamoah-Gyadu, G., 2026. The social costs and injustices of militarized approaches to illegal artisanal small-scale mining governance in Ghana. *Canadian Journal of African Studies/Revue canadienne des études africaines* 60 (1), 21–44.
- Fisher, E., 2007. Occupying the margins: labour integration and social exclusion in artisanal mining in Tanzania. *Development and change* 38 (4), 735–760.
- Franks, D.M., Boger, D.V., Côte, C.M., Mulligan, D.R., 2011. Sustainable development principles for the disposal of mining and mineral processing wastes. *Resour. Policy* 36 (2), 114–122.
- Gedam, V.V., Raut, R.D., de Sousa Jabbour, A.B.L., Agrawal, N., 2021. Moving the circular economy forward in the mining industry: challenges to closed-loop in an emerging economy. *Resour. Policy* 74, 102279.
- Geels, F.W., Schot, J., 2007. Typology of sociotechnical transition pathways. *Res. Policy* 36 (3), 399–417.
- Geenen, S., Bikubanya, D.L., 2024. Heterogeneity and labour agency in artisanal and small-scale gold mining in the Democratic Republic of Congo. *Dev. Chang.* 55 (1), 123–156.
- Hasan, M.N., Bondy, K., 2025. Reframing informal institutional voids as the attempted remaking of contested social spaces: evidence from England. *J. Manag. Inq.* 34 (2), 203–221.
- Geissdoerfer, M., Savaget, P., Bocken, N.M., Hultink, E.J., 2017. The Circular Economy—A new sustainability paradigm? *J. Clean. Prod.* 143, 757–768.
- Ghana Statistical Service, 2014. 2010 Housing and population census. District analytical report. Talensi District. Available at: https://www2.statsghana.gov.gh/do_cfiles/2010_District_Report/Upper%20East/TALENSI.pdf.
- Hajer, M., 2003. Policy without polity? Policy analysis and the institutional void. *Policy Sci.* 36 (2), 175–195.
- Heeks, R., Gomez-Morantes, J.E., Graham, M., Howson, K., Mungai, P., Nicholson, B., Van Belle, J.P., 2021. Digital platforms and institutional voids in developing countries: the case of ride-hailing markets. *World Dev.* 145, 105528.
- Hermann, R.R., Pantera, M., Nogueira, L.A., Monteiro, M., 2022. Socio-technical imaginaries of a circular economy in governmental discourse and among science, technology, and innovation actors: a norwegian case study. *Technol. Forecast. Soc. Chang.* 183, 121903.
- Hilson, G., Hilson, A., Maconachie, R., McQuilken, J., Goumandakoye, H., 2017. Artisanal and small-scale mining (ASM) in sub-Saharan Africa: Re-conceptualizing formalisation and ‘illegal’ activity. *Geoforum* 83, 80–90.
- Hilson, G., Hu, Y., 2022. Changing priorities, shifting narratives: remapping rural livelihoods in Africa’s artisanal and small-scale mining sector. *J. Rural. Stud.* 92, 93–108.
- Hilson, G., Potter, C., 2005. Structural adjustment and subsistence industry: artisanal gold mining in Ghana. *Dev. Chang.* 36 (1), 103–131.
- Hilson, G., 2017. Shootings and burning excavators: Some rapid reflections on the Government of Ghana’s handling of the informal Galamsey mining ‘menace’. *Resour. Policy* 54, 109–116.
- Hilson, G., 2019. Why is there a large-scale mining ‘bias’ in sub-Saharan Africa? *Land Use Policy* 81, 852–861.
- Hudson-Edwards, K.A., Jamieson, H.E., Lottermoser, B.G., 2011. Mine wastes: past, present, future. *Elements* 7 (6), 375–380.
- Koomson-Yalley, E., Kyei, J.R.K.O., 2022. ‘We are mine workers’: Feminists’ political economy in artisanal and small scale gold mining in the Talensi District, Ghana. *J. Rural. Stud.* 95, 140–147.

- Kwao, B., 2024. Labour control through risk and profit-sharing: Social inequalities and exploitation through artisanal and small-scale mining in Ghana. *Geoforum* 154, 104070.
- Knoblauch, A.M., Farnham, A., Ouoba, J., Zanetti, J., Müller, S., Jean-Richard, V., Utzinger, J., Wehrli, B., Brugger, F., Diabougba, S., Winkler, M.S., 2020. Potential health effects of cyanide use in artisanal and small-scale gold mining in Burkina Faso. *J. Clean. Prod.* 252, 119689.
- Jasanoff, S., Kim, S.H., 2009. Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea. *Minerva* 47 (2), 119–146.
- Kahupi, I., Yakovleva, N., Hull, C.E., Okorie, O., 2024. Factors affecting the adoption of circular economy in mining companies of developing economies—A Namibian stakeholder perspective. *J. Environ. Manage.* 361, 121214.
- Kahupi, I., Yakovleva, N., Chen, S., 2023. The significance of SDG16 “strong institutions” toward the adoption of circular economy approaches for artisanal and small-scale mining sector in sub-Saharan Africa. In: *The Social Dimensions of the Circular Economy*. Springer International Publishing, Cham, pp. 171–200.
- Khanna, T., Palepu, K., 1997. Why focused strategies may be wrong for emerging markets. *Harv. Bus. Rev.* 75 (4), 41–51.
- Khanna, T., Palepu, K.G., 2010. *Winning in Emerging Markets: A Road Map for Strategy and Execution*. Harvard Business Press.
- Kinnunen, P.H.M., Kaksonen, A.H., 2019. Towards circular economy in mining: Opportunities and bottlenecks for tailings valorization. *J. Clean. Prod.* 228, 153–160.
- Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huijbregtse-Truijens, A., Hekkert, M., 2018. Barriers to the circular economy: evidence from the European Union (EU). *Ecol. Econ.* 150, 264–272.
- Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. *Resour. Conserv. Recycl.* 127, 221–232.
- Korsunova, A., Halme, M., Kourula, A., Levänen, J., Lima-Toivanen, M., 2022. Necessity-driven circular economy in low-income contexts: how informal sector practices retain value for circularity. *Glob. Environ. Chang.* 76, 102573.
- Kossoff, D., Dubbin, W.E., Alfredsson, M., Edwards, S.J., Macklin, M.G., Hudson-Edwards, K.A., 2014. Mine tailings dams: Characteristics, failure, environmental impacts, and remediation. *Appl. Geochem.* 51, 229–245.
- Kumah, R.K., 2022a. The License is just a Piece of Paper”: Local Perceptions on Artisanal and Small-Scale Mining Formalisation in Ghana. *International Journal of Sustainable Development & Planning* 17 (3).
- Kumah, R., 2022b. Artisanal and small-scale mining formalization challenges in Ghana: Explaining grassroots perspectives. *Resources Policy* 79, 102978.
- Kumah, R., 2023. Chinese participation in Ghana's illegal small-scale gold mining: linking local pull factors to distributional inequities. *The Extractive Industries and Society* 16, 101356.
- Lèbre, É., Corder, G., Golev, A., 2017. The role of the mining industry in a circular economy: a framework for resource management at the mine site level. *J. Ind. Ecol.* 21 (3), 662–672.
- Lottermoser, B.G., 2011. Recycling, reuse and rehabilitation of mine wastes. *Elements* 7 (6), 405–410.
- Mair, J., Marti, I., Ventresca, M.J., 2012. Building inclusive markets in rural Bangladesh: how intermediaries work institutional voids. *Acad. Manag. J.* 55 (4), 819–850.
- Mair, J., Marti, I., 2009. Entrepreneurship in and around institutional voids: a case study from Bangladesh. *J. Bus. Ventur.* 24 (5), 419–435.
- Mengba, J.D., Atanga, R.A., Akurugu, C.A., 2022. Small-scale gold mining and gender roles: critical reflections on socio-cultural dynamics in north-eastern Ghana. *SN Social Sciences* 3 (1), 4.
- Nuur, C., Karabag, S.F., Feldmann, A., 2025. Circular economy in the extractive frontier: Tensions and pathways for transformative change in mining. *The Extractive Industries and Society* 25, 101764.
- Ofori, G., Arthur-Holmes, F., 2025. Becoming a friend of the foe: the evolving perspectives on the ‘cohabitation’ strategies of large-scale and artisanal and small-scale mining operations. *World Dev.* 195, 107137.
- Ofori, G., Siaw, D., Sarpong, D., Danquah, S., 2024. Ban mining, ban dining? Re (examining) the policy and practice of ‘militarised conservationism’ on ASM operations. *The Extractive Industries and Society* 17, 101432.
- Ojeda-Pereira, I., Campos-Medina, F., 2021. International trends in mining tailings publications: a descriptive bibliometric study. *Resour. Policy* 74, 102272.
- Osei, V., Bai, C., Asante-Darko, D., Quayson, M., 2023. Evaluating the barriers and drivers of adopting circular economy for improving sustainability in the mining industry. *Resour. Policy* 86, 104168.
- Pedersen, A.F., 2025. Gold and geo-uncertainty in the making: the introduction of cyanide in Tanzania's artisanal and small-scale mining sector. *Geoforum* 162, 104276.
- Sayer, R.A., 1992. *Method in social science: A realist approach*. Psychology Press.
- Souza Piao, R., Vincenzi, T.B.D., Vazquez-Brust, D.A., Yakovleva, N., Bonsu, S., Carvalho, M.M.D., 2024. Barriers toward circular economy transition: Exploring different stakeholders' perspectives. *Corp. Soc. Respon. Environ. Manag.* 31 (1), 153–168.
- Suykens, B., Rahman, A., Khan, S.R., Dhali, S.A., 2025. Governing artisanal and small-scale sand mining in Bangladesh. *Dev. Chang.* 56 (1), 111–136.
- Trencher, G., van der Heijden, J., 2019. Contradictory but also complementary: National and local imaginaries in Japan and Fukushima around transitions to hydrogen and renewables. *Energy Res. Soc. Sci.* 49, 209–218.
- Tschakert, P., 2009. Digging deep for justice: A radical re-imagining of the artisanal gold mining sector in Ghana. *Antipode* 41 (4), 706–740.
- Tsikata, F.S., 1997. The Vicissitudes of Mineral Policy in Ghana. *Resour. Policy* 23 (1–2), 9–14.
- Tychsen, J., Boamah, D., Ahadjie, J., Sandow Ali, M., Alidu, S., Awuah, P., Quaicoo, I., Amankwah, R., Fobil, J., Nyame, F., Davis, E., 2017. *ASM Handbook for Ghana*. Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark, 160 pp. Available at <https://www.delve-database.org/uploads/resources/Artisanal-and-Small-Scale-Mining-Handbook-for-Ghana-with-a-regional-perspective.pdf>.
- Tuokuu, F.X.D., Idemudia, U., Bawelle, E.B.G., Baguri Sumani, J.B., 2020. February. Criminalization of “galamsey” and livelihoods in Ghana: Limits and consequences. *Natural resources forum* 44 (1), 52–65.
- Upadhyay, A., Laing, T., Kumar, V., Dora, M., 2021. Exploring barriers and drivers to the implementation of circular economy practices in the mining industry. *Resour. Policy* 72, 102037.
- Vazquez-Brust, D.A., Arthur-Holmes, F., Yakovleva, N., 2024. The social and environmental responsibility of informal artisanal and small-scale mining in Ghana: an Akan philosophical perspective. *J. Environ. Manage.* 360, 121131.
- Velasquez, J.R., Schwartz, M., Phipps, L.M., Restrepo-Baena, O.J., Lucena, J., Smits, K. M., 2022. A review of the environmental and health implications of recycling mine tailings for construction purposes in artisanal and small-scale mining communities. *The Extractive Industries and Society* 9, 101019.
- Velasquez-López, P.C., Veiga, M.M., Klein, B., Shandro, J.A., Hall, K., 2011. Cyanidation of mercury-rich tailings in artisanal and small-scale gold mining: identifying strategies to manage environmental risks in Southern Ecuador. *J. Clean. Prod.* 19 (9–10), 1125–1133.
- Veiga, M.M., Nunes, D., Klein, B., Shandro, J.A., Velasquez, P.C., Sousa, R.N., 2009. Mill leaching: a viable substitute for mercury amalgamation in the artisanal gold mining sector? *J. Clean. Prod.* 17 (15), 1373–1381.
- Verbrugge, B., Lanzano, C., Libassi, M., 2021. The cyanide revolution: Efficiency gains and exclusion in artisanal and small-scale gold mining. *Geoforum* 126, 267–276.
- Vujović, N., Alivjović, V., Radovanović, D., Štulović, M., Sokić, M., Kokalj, F., 2025. Towards circularity in Serbian mining: Unlocking the potential of flotation tailings and fly ash. *Minerals* 15 (3), 254.
- Yankson, P.W., Gough, K.V., 2019. Gold in Ghana: the effects of changes in large-scale mining on artisanal and small-scale mining (ASM). *The Extractive Industries and Society* 6 (1), 120–128.
- Yep, R., 2015. Filling the institutional void in rural land markets in southern China: is there room for spontaneous change from below? *Dev. Chang.* 46 (3), 534–561.