



Defying the gloom: In search of the ‘golden’ practices of small-scale mining operations

George Ofosu, David Sarpong^{*}

College of Business, Arts & Social Sciences, Brunel Business School, Brunel University London, Kingston Lane, Uxbridge UB8 3PH, United Kingdom

ARTICLE INFO

Keywords:

Artisanal and small-scale mining (ASM)
Formalised small-scale mining
Environmental degradation
Ghana
Land reclamation
Organizing practices

ABSTRACT

Dominant narratives on artisanal and small-scale mining (ASM) often portray mining regions as ‘informal’ zones that suffer massively from environmental degradation problems. Such insistence on the poor environmental performance of ASM zones has dovetailed with a lack of scholarly attention to some of the ‘golden’ environmental management practices taking place in some of these mining areas. In this paper, we explore how the operations of a formalised (registered) small-scale mining operator in Ghana, as objectified in its obligatory and ethical functions, contribute to reducing pollution and mine-degraded landscapes, which have long been viewed as the inevitable consequence of ASM. Emphasizing how the dynamic interplay between resources and environmental demands may come to support public policy, our study shows how mutually constituting demands on mining in highly differentiated contexts could translate into productive outcomes. Contrary to the popular perception that ASM operators are not good stewards of the environment, findings from our study suggest that these operators can be caretakers of the environment and local communities through land reclamation mechanisms. Localisation of labour could, however, contribute to more sustainable livelihoods in mining communities and help curb rising community tensions.

1. Introduction

Artisanal and Small-scale Mining (ASM) is a complex and diversified sector that ranges from poor informal individual miners seeking to eke out or supplement a subsistence livelihood to small-scale formal commercial mining activities that can produce minerals in a responsible way, respecting local laws (IGF, 2017b).¹ In many resource-rich countries, the ASM sector continues to witness exponential growth, with ASM-generated revenues serving as a precursor to socio-economic growth (Ofosu et al., 2020; Okoh and Hilson, 2011; Geenen, 2012; Arthur-Holmes and Busia, 2022). However, although the sector continues to serve as an engine of employment for a vast majority of inhabitants in mineral-rich areas (Banchirigah, 2008; Arthur-Holmes et al., 2022), these operations are often viewed in a negative light by government officials due to its association with informality and the related environmental problems (Ofosu et al., 2020; Kinyondo and Huggins, 2021). When the mainstream media, especially, throws the spotlight on ASM, it is often by highlighting one of its publicly-decried problems, such as land degradation, river and mercury pollution, and

deforestation (Hilson, 2017). In large part, the dominant narratives that script ASM production portray it as informal, which chimes with tropes of environmental degradation (Ofosu et al., 2020; Hilson and Maco-nachie, 2017). Echoes of these scripts also strongly permeate the policy-prescriptive circles (Siwale and Siwale, 2017; Geenen, 2012). (Fig. 1).

This is, however, not surprising, given that most small-scale mineral extraction activities take place in peripheral and sometimes conflict-ridden areas (see, for example, Geenen, 2012). According to studies, over 90% of ASM operations in Africa are found – many of them embedded – in the informal economy, carried out by individuals and groups who are not in possession of a licence (IGF, 2017a; Hilson, 2016). Hence, for most governments in developing countries, ASM represents an embarrassing situation; a strong contrast with the concept of modernity and efficiency pursued by the dominant society (Veiga, 1997). Thus, many governments feel reluctant to consider ASM as a viable source of employment for millions of people. Their reluctance stems, in part, from the problems arising from the environmental degradation usually associated with ASM (Hilson, 2017; Kitula, 2006).

^{*} Corresponding author.

E-mail addresses: george.ofosu@brunel.ac.uk (G. Ofosu), David.Sarpong@Brunel.ac.uk (D. Sarpong).

¹ This study focuses on the latter definition (formal mining operations). However, since many of the operators are found in the former, coupled with the fact that the burgeoning literature also focuses on the former, the study highlights both definitions throughout.

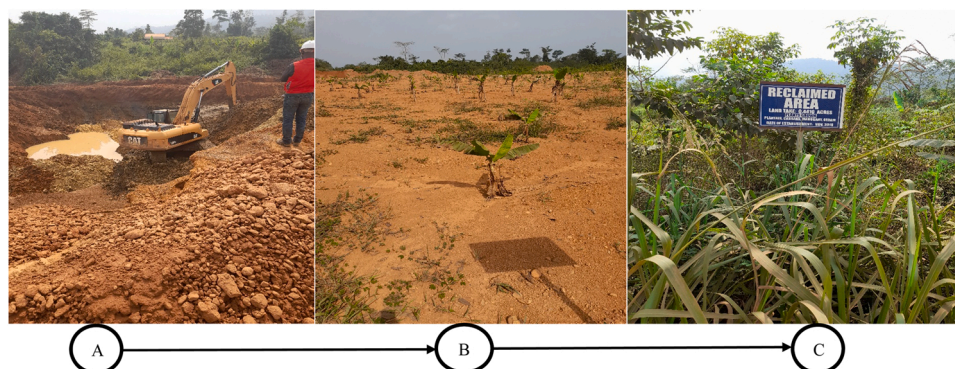


Fig. 1. From Excavation to reclamation.

Government mining policies have, however, contributed to this environmental degradation phenomenon in many mining communities around the mineral-rich world. In this storyline, the ASM sector is but a particularly powerful illustration of the disorder, corruption, and institutional weakness that characterise mineral and mining governance as a whole (Siwale and Siwale, 2017; Teschner, 2012; Geenen, 2012).

In environmental terms, mining of mineral resources, being an extractive activity, results in extensive soil damage, altering microbial communities and affecting vegetation, leading to the destruction of vast amounts of land (Sheoran et al., 2010; Dampney et al., 2020). However, the formalisation and legal regularisation of the large-scale mining industry in many countries has largely ensured agreement over the remediation of environmental pollution issues (Jacka, 2018). In contrast, the clandestine and illegal nature of ASM in most developing countries has engendered consequential environmental catastrophes (Kitula, 2006; Ofosu et al., 2020). In Ghana, for example, the detrimental environmental performance of the ASM sector (commonly referred to as *galamsey*) led to a governmental ban of all small-scale related mining activities in 2017 (Osei et al., 2021; Hilson, 2017).

Against this backdrop of neglect and degradation, which portray small-scale miners as either victims or environmental criminals, do pockets of responsible small-scale mining practices revealing sustainable environmental management exist? In terms of the minimisation of the environmental impact of resource extraction, and the rehabilitation of land to ensure continuous use, can some small-scale mining operators be regarded as models in the industry? The scores of reports and documents that various organisations have produced on the ASM topic fail to throw the spotlight on this question. The wider academic literature also offers minimal guidance on this front. One reason for this is the relatively limited focus of academic research on the operations of formalised small-scale mining operators. However, as observed by Verbrugge (2015), images of an exclusively informal ASM segment do not always correspond to realities on the ground. Instead, in countries with a long-standing tradition of ASM regulation, such as Ghana (Hilson, 2002) and the Philippines, the sector is gradually evolving into a highly intertwined group of formal sectors operating with substantial degrees of legal registrations (Verbrugge, 2015). In addition, the injection of capital, by both external and internal financiers, has led to a growing differentiation among ASM operations in terms of their levels of capitalization and professionalization (Verbrugge, 2015).

It is also noteworthy that efforts to minimise the environmental degradation problems associated with the expansion of the ASM sector have led many governments to look for ways to better regulate the operations of the sector through formalisation (Hilson et al., 2018; Martinez et al., 2021). The formalisation process has been aimed at advancing the sector from its transient, inefficient, and ecologically harmful ways to a settled, sustainable business path (Siegel and Veiga, 2009; Martinez et al., 2021). To derive maximum benefits as well as to effectively regulate ASM activities, a number of countries have legalised

ASM by providing a regulatory framework through which individuals and companies can secure a licence and operating permits to operate legally (Hilson et al., 2018).

In general terms, formalisation entails the legalisation of artisanal mining and the observance of all the provisions and requirements set forth in the mining code (Geenen, 2012). Although formalisation has proved challenging, with its bureaucracy and high costs spawning illegal mining activities, recent reports are beginning to show that a number of individuals and companies do overcome the formalisation barriers and have secured titles to mine using more advanced technology (Hilson and Maconachie, 2020; Hilson et al., 2018; Ofosu and Sarpong, 2022). The formalisation principles are not only bestowing benefits on miners; legal recognition is also imposing obligations to conform to environmental standards (Siegel and Veiga, 2009; Martinez et al., 2021). This is crucial considering the widespread environmental problems associated with the extractive industry in general, and ASM in particular, with its deleterious effects on ecosystems and human health.

Hence, in the context of rising concerns about the issues of land disturbances, caused mostly by illegal small-scale mining operations, it is critical to unpack the sustainable land reclamation and environmental management processes of an overlooked segment of the ASM sector – formalised ASM operations. This study contributes to this effort by employing a case study approach to highlight the sustainable environmental management practices of a formalised small-scale mine located in Ghana. Particularly, we explore how the demands of the formalisation canon as reflected in the obligatory (legal) and ethical (social responsibility) functions contribute to the reduction in pollution and mine-degraded landscapes. In addition, emphasising how the interplay between resources and environmental demands may come to support public policy, our study shows how mutually constituting demands on mining – that is, payment of compensation – in differentiated contexts could translate into productive outcomes for inhabitants of local mining communities. In sum, findings from the study suggest that small-scale miners, contrary to popular perception, can be good stewards of the environment and caretakers of local communities through land reclamation mechanisms. On the downside, however, we find that a low rate of ‘localisation’² of labour could lead to rising community tensions, and also engender a situation where mining practices miss opportunities to contribute to more sustainable livelihoods in mining communities.

Examining the practices of formalised ASM operations is important, considering that the sector’s negative image – often engendered by the illegal mining practices of most of the operators – serves as a hindrance to positive change in policy and practice (Ofosu and Sarpong, 2022; Zavala, 2017). With little to no official and public awareness of what responsible ASM looks like, and even less of the benefits it can bring to

² Here localisation refers principally to the landowners and farmers whose lands have been leased to mining companies for extractive operations.

local communities and the environment, it is difficult to harness the support ASM needs to attract investments (Zavala, 2017; Ofosu and Sarpong, 2022). Equally importantly, a prime motivator for undertaking this study is to inform discussions about how to replicate good environmental practices (land reclamation) elsewhere in other ASM sites, and the implications for local mining development.

2. Land reclamation

Reclamation is the process of restoring the ecological integrity of disturbed mine land areas (Sheoran et al., 2010). It includes the management of all types of physical, chemical and biological disturbances of soils, such as soil pH, fertility, the microbial community, and various soil nutrient cycles that assist the recovery of soil productivity in mine areas (Sheoran et al., 2010). According to Lima et al. (2016), reclamation is aimed at the recovery of key ecosystem services and biogeochemical functions within a replacement ecosystem or rehabilitation, which implies a repurposing of the landscape. According to Asiedu (2013), the basic objective of reclamation is the re-establishment of vegetation cover, the stabilisation of soil and water conditions at the site, and the restoration of the ecosystem services (see also Bradshaw, 1996; Dampney et al., 2021).

Reclamation exercises are very important because the topsoil gets heavily damaged during mineral extraction activities (Dampney et al., 2020; Sheoran et al., 2010). Extractive activities remove the surface and underground soil, leading to the formation of wastelands and mine spoils (Sheoran et al., 2010). Mine spoils possess very poor conditions for both plants and the microorganism culture. Along with the biological functionality, the nutrient cycle is disturbed, resulting in a non-functional soil system (Singh and Singh, 1999, 2006). The consequences of manual disturbance to the topsoil during stripping and excavation cause unusually large nitrogen transformations and movements with substantial nutrient loss (Sheoran et al., 2010; Davies et al., 1995). In this regard, proper management of the topsoil is essential for reclamation plans in order to minimise nitrogen losses and to increase soil nutrients and microbes (Sheoran et al., 2010; Davies et al., 1995).

Re-vegetation after soil amendments constitutes the most widely accepted and purposeful way to reduce erosion and protect soils against degradation during reclamation. Reclamation efforts have focused on nitrogen-fixing species of legumes, grasses, herbs, and trees (Davies et al., 1995). Metal-tolerant plants are also known to be effective for acidic and heavy-metal-bearing soils (Sheoran et al., 2010). In addition, soil productivity can be increased by the addition of various natural amendments such as sawdust, wood residues, sewage sludge, animal manures, and other biological geotextiles constructed from readily available local plants such as *Pennisetum purpureum* (Sheoran et al., 2010; Nsiah and Schaaf, 2019). These amendments are very effective in the stimulation of microbial activity, which provides nutrients (nitrogen and phosphorus) and organic carbon to the soil (Singh and Singh, 2006).

3. Why reclamation?

3.1. Reclamation as an obligation under the law

As indicated earlier, legal recognition and formalisation processes impose obligations on mining operators to conform to environmental standards. According to Ghana's Minerals and Mining Act (2006) Act 703:

A person licensed under section 82 may win, mine and produce minerals by an effective and efficient method and shall observe good mining practices, health and safety rules and pay due regard to the protection of the environment during mining operations (Article 93).

Although not explicitly stated in the Act, 'protection of the environment' includes the submission of quality reclamation plans that specify how progressive reclamation, including re-vegetation of mine-

out lands, will be carried out.³ Concessioners are also expected to present pre-mining financial assurances to cover the cost of environmental damage, including reclamation (Asiedu, 2013). Failure to abide by the above-cited provision could result in the revocation of a mining licence. The Act states:

The Minister may revoke a licence granted under section 82 (1) where, (a) the minister is satisfied that the licensee has contravened or failed to comply with a term or condition of the licence or a requirement applicable to the licensee (Article 87).

Thus, a clear and obvious reason why mining companies undertake reclamation exercises is to ensure that they are on the right side of the law. They undertake reclamation exercises because of the legal obligation to comply with the law regarding the environment to ensure the award and renewal of licences for new and future mining operations. Another facet of environment remediation, however, is the intention of companies to be on the right side of society – what is commonly termed 'corporate social responsibility' (CSR) – which we examine below.

3.2. Reclamation as a form of corporate social responsibility

CSR may be defined as a comprehensive business model designed to meet the requirements and expectations of the various stakeholders in a company, as well as to care for and protect the environment (Vintró and Comajuncosa, 2010). CSR can also be understood to be a set of actions undertaken by a company in order to accept the responsibilities arising from the impact of its operations on society and the physical environment (Vintró et al., 2012; Jenkins and Yakovleva, 2006). According to Wheeler et al. (2002), CSR is a helpful conceptual framework for exploring the corporate attitude of companies towards stakeholders.

In recent times, CSR as a strategic business phenomenon has become increasingly important due to the fact that consumers make purchasing decisions which are based on the company's image and degree of responsibility, on the respect it has for its natural surroundings, and on its standards of occupational safety (Jenkins, 2004; Jenkins and Yakovleva, 2006; Vintró and Comajuncosa, 2010). This fact has grown in relevance, mainly in a market defined by information transparency, and CSR has become an almost obligatory practice in competitive terms (Vintró and Comajuncosa, 2010). Issues regarding the environment, quality, and ethics are some of the aspects that are incorporated in the composition of CSR management (Vintró and Comajuncosa, 2010). According to Hamann (2003), CSR demands that a company respond not only to its shareholders, but also to other stakeholders, including employees, customers, affected communities and the general public, on issues such as human rights, employee welfare and climate change. As a result, the main facets of any business strategy may be defined from various standpoints. Two main facets can be identified: internal and external responsibility (Vintró and Comajuncosa, 2010). Internal responsibility chiefly affects issues that are related to the welfare of workers (occupational and health safety, job security, etc.), and to shareholders (profitability and economic results) (Vintró and Comajuncosa, 2010). Meanwhile, external responsibility connects the company with suppliers, governments, and society, and includes aspects that highlight respect for natural surroundings (responsible and sustainable exploitation of mineral resources, and conservation of ecosystems), and the establishment of fruitful relations with the community (integration into related social groups and promotion of the local economy) (Vintró and Comajuncosa, 2010).

For the mining industry specifically, CSR is seen as a way of balancing the diverse demands of communities and the imperative to protect the environment with the ever-present need to make a profit (Jenkins, 2004). In this regard, it can be argued that mining companies undertake reclamation projects as a way of seeking to minimise the

³ Interview with officials of the Minerals Commission, Ghana

Table 1

Overview of research participants.

| | | | | | | | | | | | |
|--|-----------------|--------------|-----------|------------------|------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Number of years employed by OMCL | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 |
| Number years of industry experience | 20 | 22 | 7 | 3 | 6 | 10 | 7 | 7 | 6 | 6 | 5 |
| Interviewees | Project manager | Mine Captain | Geologist | Safety Officer 1 | Safety Officer 2 | Machine mechanic 1 | Machine mechanic 2 | Machine mechanic 3 | Machine mechanic 4 | Machine mechanic 5 | Machine mechanic 6 |

negative environmental impacts of their extractive activities in order to be on the right side of the general society. Thus, companies integrate environmental elements (i.e., reclamation), which, although they may sometimes not be considered in legislation, respond to the expectations of society with respect to the company (Lesser et al., 2021).

It is worth reiterating that the legal and ethical issues regarding the restoration of mining-degraded lands and land integrity are extremely important because land is one of the most important resources on which human beings and indeed all living things depend. However, the mineral exploitation activities of ASM operators, mostly illegal, have resulted in very serious land and environment degradation problems in mineral-rich Ghana. We now turn our attention to discussing this issue.

4. ASM in Ghana: the state of the environmental quagmire

4.1. ASM-induced land degradation

We develop our contribution in the context of Ghana – an old mining economy that is enjoying substantial growth since the turn of the decade (ICCM, 2015). However, having weak institutions means that the majority of small-scale mining operators in Ghana extract illegally (Patel et al., 2016), and the licensed operators do not heed environmental regulations (Teschner, 2012). In this regard, small-scale mining has subjected Ghana to deleterious environmental effects by degrading land and polluting major river bodies. This has led to the erosion of the foundations of livelihood, especially in rural Ghana (Schueler et al., 2011; Ofosu et al., 2020). This is because land serves as a prime means of rural livelihood, since it is usually exploited to enhance agricultural production (Moomen and Dewan, 2016; Sheoran et al., 2010).

Notably, Aryee et al. (2003) observed that land degradation is a common phenomenon at many uncontrolled, unmonitored small-scale mining sites. Small-scale underground openings are commonly not backfilled after mining. The mining operators usually abandon sites and pits after carrying out their operations. These openings have the tendency to collapse and trap or kill farmers, hunters and animals (Bansah et al., 2016). In reporting findings from a field study, Mensah et al. (2015) reveal that gold-mining operations have caused disproportionate damage to the lands in Prestea, one of the towns in the Prestea Huni-Valley District of the Western Region. In the Atiwa district, major scales of desertification and land degradation are prevalent, with about 50 ha of land taken from cocoa farmers by illegal mining operators (Boateng et al., 2014). Several landscapes in 11 districts in the Western Region have not been spared the devastating effects of illegal mining operations, leaving in their wake abandoned and devastated lands, uncovered pits and ungraded waste dumps (Mantey et al., 2016). Also, evidence from the study by Owusu and Dwomoh (2012) shows the destruction of farmlands by illegal miners in seven mining communities in the Kwaebibirem district. The evidence shows that the prospect of gold and diamonds in the towns of Akwatia, Kade, Wenchi, Topremang, Apinamang, Takrowase, Adankrono and Soabe has led farmlands to be heavily degraded.

Widespread ASM activities have been one of the contributing factors to serious land degradation in the Akyem Abuakwa district. Asiedu-Amoako et al. (2016) report that most of the fertile lands and rich forests in the area have been destroyed. In places of intensive mining activities

such as Nananko, Dadieso and Japa in the Wassa Amenfi East District in the Western Region, the landscape has been completely transformed into a degraded area of pits and waste materials (Opoku-Antwi, 2010). Similar scales of land degradation are observed in Nangodi in the Talensi-Nabdam District of the Upper East Region (Tom-Dery et al., 2012).

Moreover, dredging and advanced excavators have also been introduced to the ‘mining-degradation’ mix on the ASM landscape. The rush for Ghana’s gold has attracted numerous foreigners into the *galamsey* business (Mantey et al., 2016). In the span of only a few years, Ghana attracted thousands of Chinese miners, the majority of whom dispersed and mostly resided in rural communities, engaged in illegal ASM (Burrows and Bird, 2017). Unlike the Ghanaian miners, who used rudimentary equipment in their illegal mining exploits, the technology the Chinese introduced – specifically the aforementioned dredging and advanced excavators – has destroyed vast sections of Ghana’s landscape (Bach, 2014). Bach (2014) shows that an estimated 30–50% of the farmland in the Amansie West district was lost due to the Chinese *galamsey*. The study further observed that the use of heavy machinery like excavators and bulldozers in the operations of illegal mining had mechanized the small-scale mining business, sparking very serious land degradation issues. We conclude this section by highlighting that the ASM-induced degraded lands and excavated soils impose massive costs on agriculture production. This is because the excavated lands and soil – the negative legacy of mining – render previously fertile lands unfit for agricultural purpose. This can entrench a cycle of poverty in the agrarian economy through the loss of farming-generated income and a reduction of food, cash crop and livestock production (Ofosu et al., 2020). The agriculture sector becomes doubly hit in the sense that the expansion in the mining sector equates to more environmental externalities like land degradation and the destruction of existing agricultural products (Ofosu et al., 2020). For example, in the Offin Shelter belt, Boadi et al. (2016) report that ASM-induced land degradation has led to a drop in crop production.

5. Method

We adopted an exploratory qualitative research approach for our inquiry, owing to the paucity of research that goes beyond the environmental gloom to examine potential ‘golden’ practices of small-scale mining operations. Following the logics of a single case-based approach (Siggelkow, 2007), we selected a formalised small-scale mining firm to help us generate concrete, in-depth, context-specific knowledge on how the operations and salient organizing practices of these small-scale mining organizational forms may contribute to extending our understanding of general environmental management and the land reclamation policy priorities of the State.

Our case organization, herein referred to as Mayfair Fields (MF), has secured a large concession site in the Eastern region of Ghana. However, since MF has been unable to exploit the mineral resources, and with the fear of losing the mineral wealth to the exploitative activities of illegal mining operators, a section of the concession has been given to Obuodade Mining Company Limited (hereafter OMCL). The company, at the time of data collection, had ninety-eight (98) employees. OMCL, which has a long history in small-scale mining activities, is tasked to provide

| | | | | | | | | | | | | | |
|---------------|---------------|---------------|-------------------------|-------------------------|-------------------------|----------------------------|----------------------------|---------------------|---------------------|--------------------------------|--------------------------------|------------------------------|-------------------------------|
| 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | – | – | – | – | – | – |
| 11 | 9 | 9 | 7 | 6 | 5 | 22 | 22 | 10 | 15 | 7 | 9 | – | – |
| Engineer 1 | Engineer 2 | Engineer 3 | Excavator operator 1 | Excavator operator 2 | Excavator operator 3 | Processing supervisor 1 | Processing supervisor 2 | EPA officer 1 | EPA Officer 1 | Minerals Comms officer 1 | Minerals Comms officer 2 | Five (5) Local farmers | Two (2) Local Residents |

mining support services on the concession. This comprises the exclusive right to extract, process and sell the mineral wealth of the concession. The two companies have sharing arrangements in relation to the proceeds from the sale of gold from the concession. While OMCL is responsible for the recruitment of their own workforce and the sourcing of all mining equipment, MF is answerable to the Minerals Commission (MC) and takes the ultimate responsibility in the environment management processes.

The field research was conducted from December 2020 to May 2021 inside the mining compound of OMCL. During the research period, the first author visited the mining site to observe the day-to-day work and mining activities in the compound. Data for the empirical inquiry was collected using interviews with a total of 30 employees (see Table 1). In addition, the project manager of OMCL, a senior employee of MF, and a selected number of local famers and residents and officers of the Minerals Commission (MC) and Environmental Protection Agency (EPA) were interviewed. The author observed all the reclaimed sites under the supervision and guidance of the safety and environmental officer of OMCL. Documents detailing the reclaimed concessions of the mine site were also made available to the author and detailed explanation was provided by the safety and environmental officer. The interviews, which typically lasted 30–40 min each, were tape-recorded and transcribed within 24 h of collection. The interview data collected from the observation of the mine site, which were in the form of detailed field notes and mental notes, were triangulated into a whole.

Our data analysis followed three main stages. First the audiotapes were carefully listened to several times to reflect on the transcribed data and personal notes taken at the time of the interview to make sure they reflected what was heard in the field. Next was the identification of common themes across the data. At this stage, judgements about the meanings of contextual statements were made so that the relevance and importance of issues and implicit connections between them could be made (Hardy and Bryman, 2009). Here, we also made cross-references between the transcribed data, mental notes and field notes, and in some cases, the original audio file, to get a better understanding of the recurrent and conspicuous themes.

In the second stage of our analysis, the field issues and challenges raised by the research participants were used to further probe the data to match the various accounts of their ‘doings’ and ‘sayings’ in their situated practice to see how well they fitted in with our initial themes. This involved the active recycling of the emerging concepts and perspectives and refining of some early insights and ideas that appeared inconsistent or contradictory to the empirical evidence. Finally, the thematic frameworks identified were then applied to the entire dataset by annotating them with numerical codes, which were also supported with short descriptors that elaborate the headings (Ridder, 2014; Ritchie and Spencer, 1993). This helped us to develop a meaningful and more robust understanding of the data that enabled subsequent interpretation and the verification of meanings (Miles and Huberman, 1994). Following this, we engaged in what we consider to be a systematic and rigorous comparison of our indexed themes with the existing literature to build up understanding of the organizing practices of the organization in order to develop greater insight into how they contribute to land reclamation in practice. We present the fine details of our research findings in the next section.

6. Research findings

6.1. OMCL as champions of reclamation and environmental management

The researcher observed that the mining operations at the OMCL site were highly mechanised, with excavators, trucks and processing plants as the main equipment used for the operations. The method of mining, as described by the mine captain, is the extraction of shallow alluvial gold deposits. During the excavation phase, the excavators dig a pit of about 10 m deep to extract the ore. The mineral-bearing soil is then loaded into trucks and transported to the processing site for further processing.

After excavation and processing are completed, the pits are carefully covered. During several of the visits, the author observed the reclamation process with the safety and environmental officer providing guidance and explanations. The officer explained that management of OMCL is very keen on the reclamation process. Hence, the project manager makes sure that the pits are covered and the lands are reclaimed as soon as excavation is over. In the words of the environmental and safety officer:

This is what we refer to as progressive reclamation: i.e., reclamation at one section of the concession goes hand-in-hand with excavation at another section of the concession. We don’t wait till we’ve mined all the land before we start the reclamation process.

According to the officer, the progressive reclamation exercise is important because when materials are required for reclamation, they can easily be sourced from the newly excavated area; this mode of reclamation is also important because the mine is located in the tropics and thus experiences heavy rainfall. The rains can wash away the topsoil and hamper the preservation of soil quality. However, the topsoil would need to be redeployed to cover the poor substrate; the topsoil is also needed because it provides improved growth conditions – nutrients and moisture – for the growth of plants.

The officer further explained the reclamation process to the effect that once washing has been done, segregation takes place. The boulders (the bigger rocks) which are larger than 20 mm, the smaller rocks and the fine sand are carefully separated; the boulders and the fine sand are put into the pit first. Then the overburden, which is the subsoil, is placed on top; then the topsoil comes last. The topsoil is carefully separated during excavation. According to him, once the subsoil is placed, they wait for the material to compact; but first they must level the subsoil. However, when it rains, this helps the subsoil to settle quickly. Once the topsoil is placed, the land is left fallow for the topsoil to settle for a period of about two months. The process as described above constitutes what is referred to as the primary reclamation, according to the officer.

After the primary reclamation process comes the secondary reclamation, which is basically the re-vegetation of the reclaimed land. Here the researcher noticed that trees had been planted at various sections of the reclaimed lands. Exotic and indigenous tree species like Mahogany (*Khaya ivorensis*), Ofram (*Terminalia superba*) and Emire (*Terminalia ivorensis*) could be seen on some strategic portions of the reclaimed lands. Plants like cassava and plantain had also been planted on the entire section of the reclaimed lands. When asked why they chose these plants, the officer stated:

...the reason is that cassava – as a tuber crop – does well even in loose soil. We also plant plantain with the special purpose of providing

shade for the cassava. The plantain also helps restore the lost nutrients, and its leaves are employed for mulching. Leguminous plants are also planted at various sections of the land to restore lost nitrogen to the soil. The workers volunteer to cultivate the cassava for consumption. However, as a way of restoring the lost nutrients, the first cassava plants to be cultivated on any plot of our land are not harvested during the maturity period. The tubers are left to rot beneath the soil to restore nutrients. Sometimes we also cultivate vegetables for consumption.

According to the officer, before consumption, samples of the harvested food are taken to the laboratory of the Ghana Standards Authority (GSA) for checks. The tests usually comprise the determination of the presence of heavy metals – lead, mercury, cadmium, and arsenic. Since operations started, all the food harvested on the reclaimed sites have been deemed fit for consumption by the officers of the GSA partly because the company does not employ the use of mercury or other chemicals in the mineral processing stage.

6.2. The manifest and latent reasons behind the reclamation exercise by OMCL

As previously discussed, MF and OMCL under the Minerals and Mining Act have an obligation, post-mining, to remediate the concessions allocated to them. The MC legally insists on the reclamation practice; thus, the companies have no other choice than to remediate the land. Indeed, during the research period, the researcher witnessed that officials of the MC visited the mine site on three different occasions. An officer of the MC revealed to the researcher that they regularly monitor companies' activities to make sure that their management systems are up to standard, and that the mining companies, under the Minerals and Mining Act, stand the risk of losing their licence if they fail to remediate the land. This was succinctly expressed by the project manager of OMCL thus:

Before we officially began our operations, we were made aware of the environmental remediation processes under the mining laws of Ghana. Besides, we've been in this mining business for a long time, and we know our obligatory duties. We also made sure that we put the remediation processes high on our agenda. We can only renew our licences once the Ministry is satisfied that our environmental activities are good. Thus, we have no choice. We must satisfy the reclamation requirement to continue to be in this business. As you are aware, we have especially set up the environmental and safety division to take care of these aspects.

When quizzed on the ethical considerations of land reclamation, which borders on the issue of CSR, the project manager continued:

We have a duty towards the betterment of the community lands on which we mine. But if we can't make the land better, we should not make it worse. The least we can do is to leave it as we found it. We are only here to mine the minerals. We did not find the land pit-holed, so we can't leave it pit-holed. The last thing we want to hear is that we have violated the environmental rights of the local community.

These findings basically reflect the manifest/obvious reasons that underpin OMCL's reclamation efforts. The motivation of the company in undertaking the reclamation exercises is to be on the right side of the law, and to be on the right side of society – what is commonly referred to as the 'social license to operate' (Lesser et al., 2021) – in order to ensure successive mining operations. The company has an obligation towards the law and society, and must fulfil these obligations. This brings to the fore the agency of mining laws and societal responsibilities. It suggests that for remediation and other environmentally-friendly extractive activities to be successful, stringent law enforcement and 'public acceptance' procedures ought to be upheld. However, the company is motivated in other ways to undertake the reclamation process – the issue

of seeking to cut cost and motivate workers – which we examine below.

6.2.1. Reclamation as a food cost cutting measure

Discussions with the project manager revealed a third and interesting reason why OMCL undertakes the reclamation activities. According to him, a latent reason is to produce food for the workers and to subsidise the cost of food (the company provides food for the workers during working hours). Hence, to subsidise the purchase of food, some of the food harvested on the reclaimed lands is prepared for the workers. The food is usually harvested during the second harvest season before the lands are restored to the landowners (as noted earlier, the matured food during the first harvest season is usually deployed to enrich the fertility of the land). In quantitative terms, the manager estimated that they save as much as Ghs 2500⁴ on food purchase during the harvest season. Also, the workers who volunteer to cultivate the tuber crops and the plantain are usually given a share of the harvested crops. This arrangement received a lot of praise from the workers. One security officer remarked:

I usually get two full sacks of cassava and a bunch of plantains during the harvest season. This saves me a lot of money on food purchase. In so many ways I feel motivated to work for this company.

Here our data evidence suggests that the reclamation process with its concomitant food production activities engenders twin benefits for the company under examination. Much as it helps the company to save cost on food, it also helps to motivate the workers to work for the company. This helps the company to retain the experienced staff as a way of seeking to enhance productivity and to ensure commitment on the part of workers.

6.3. Restoration and the joy of landowners

Findings revealed that the interplay between resources and environmentally-constituting demands on mining – that is, payment of compensation to landowners in different contexts – translates into mutually productive outcomes for inhabitants of local mining communities. The interplay between compensation and reclamation engenders immense benefits to the landowners and the larger community in general. To demonstrate this, let us take a look at three testimonials from three individuals who have had positive experiences with the mining company. Let us first consider the story of Mr Asante:

He owned about one-acre cocoa farm on the concession site. He inherited the farm from his father about 15 years ago. Since he started cultivating the farm, his annual earnings from cocoa sales had been around Ghs 5000. However, about four years ago, he was informed that his farm was mineral-rich and therefore had been leased to a mining company. Initially he resisted the plan to lease out his land and contemplated a court action. However, after receiving some education on the laws governing mineral extraction as enshrined in the Minerals and Mining Act, he agreed to the lease agreement and was compensated with a sum of Ghs 9000. The payment of the compensation was in line with a provision in the Minerals and Mining Act (2006) Act 703, which states that:

Where a licence is granted in a designated area to a person other than the owner of the land, the licensee shall pay compensation for the use of the land and destruction of crops to the owner of the land that the Minister in consultation with the Commission and the Government agency with responsibility for valuation of public lands may prescribe (Article 94).

Mr Asante was also assured that the land would be reclaimed and that he would be able to put it back to productive use after the mine's closure and the reclamation exercise. After consultations with a friend

⁴ At the time of the research, US\$1 was equivalent to about Ghs 5.76. Thus, the company is able to save approximately US\$434

who worked in poultry production, Mr Asante decided to start a small poultry farm. He invested about Ghc 4000 of the compensation fund on the farm. The farm prospered and he now owns about 400 birds (mostly layers). He is now a supplier of eggs to most of the food sellers in the community. He estimates that he makes about Ghc 6000 annually from the sale of the birds and their eggs. Fortunately, he also got his leased land back after a year and a half. The land had been reclaimed and so he was able to resume the cultivation of cocoa. Although he has not yet harvested the produce from the new cocoa farm, he estimates that he can make about Ghc 7000 from his first harvest alone. He says gleefully:

If I had another farm and I was asked to lease it again to this mining company, I would gladly do it.

The story of Mr Antwi also makes for interesting reading:

Mr Antwi owned a plantain and cassava farm on the concession site, spanning about half an acre, and had to give it up for mineral extraction to be undertaken by OMCL. He was compensated with a sum of about Ghc 4000. After directly contacting the project manager of the company concerning job opportunities, his son was employed as a driver for the company. Mr Antwi partnered with a family member and invested the compensation funds in the motorcycle business (transportation). He now owns one motorcycle and plans to buy another one in the next few months.

Fortunately, also, he got his land back in a reclaimed state and decided to go into vegetable production (since his land was reclaimed with vegetables by OMCL). He estimates that in the first harvest period, he made about Ghc 2500, which he used to finance his daughter's tertiary education. He was full of praise for the mining company and the MC. In his words:

I only considered miners as environmental criminals and the officers of the MC and the EPA as cheats and good for nothing. However, with the experience I've had now, I'm forever grateful to them. They've vastly improved my socio-economic life in the least. I thank them.

One other landowner also had a life-changing story to tell:

Madam Adwoa, a 72-year-old woman, is a landowner at the concession site. She used to cultivate maize, cassava, and cocoyam on the land, mainly on a subsistence basis. However, ill health prevented her from engaging in these subsistence farming activities. She therefore rented the land to another farmer for cultivation. The produce from the farm was to be shared on an equal basis. However, the other farmer cheated Madam Adwoa out of her share of the farm produce. For almost two years, she did not receive anything from the farmer. She therefore thought of selling the land outright. This became more pertinent because she sorely needed money to take care of a serious knee condition. Then came news that a mining company was to begin extraction activities on her land and that she was entitled to compensation. She received nearly Ghc 4000. She used part of the money to finance her medical bills. Now she also has her land back, reclaimed to a productive state.

At this point, however, it should be noted that although OMCL is doing 'great' things, as exemplified by the testimonials above, we also observed some potential pitfalls, details of which are provided below.

7. The downsides

Despite the fact that the majority of the interviewees (local residents and farmers) had positive experiences regarding the reclamation and operational outcomes of OMCL, some of them expressed opinions to the effect that the practices of OMCL and officials of the local district assembly missed certain opportunities to contribute to more sustainable livelihoods in the locality. The problem, in part, relates to the restoration of reclaimed lands to the landowners. According to the management of OMCL, the process of restoration entails, among other things, certification by the EPA and GSA that the lands are fit for cultivation. After the certification process, the documents are forwarded to the local district assembly, which has the responsibility to contact the landowners for

further verification in order for the lands to be given back to them. However, to some of the landowners, this process was slow and sometimes procedurally bureaucratic. One landowner expressed her frustration thus:

When they needed the land from me, I did not have to visit the office several times. They sometimes even came to my home to negotiate with me. However, when I saw that the land had been reclaimed and I needed it back, I had to visit the district office numerous times, for months. One official even demanded a bribe from me before he would certify some documents because he said he did not get anything from the compensation I received.

The researcher could not verify the bribery allegation levelled against the official of the district assembly. However, other interviewees also expressed negative opinions with regard to job acquisition in the company and hinted that the 'localisation'⁵ of labour by OMCL was far below expectation. The interviewees noted that they had expressed these concerns to the local 'chief', the district assembly, and indeed to the management of OMCL, but were yet to receive any positive response from these entities. One local resident expressed his frustration and that of his colleagues in this way:

The company (referring to OMCL) works on our lands, and although they have paid us compensation, we think we're still disadvantaged because they could have given some of us the chance to work for them. Some of us used to do small-scale mining, and so we have experience in mining operations. We explained this to the management of the company, but they said they had already recruited their workers from elsewhere but that they would look into the matter. It's been more than two years and myself or none of my colleagues have heard from them.

Indeed, management of OMCL admitted that 'localisation' of labour was low, and they had no structured plan to increase the rate of localisation in the foreseeable future. However, they referred to the issue of efficiency of labour and hinted that most of their workers had worked for them for many years and were therefore more familiar with their operations and processes. The project manager also commented that most of these experienced workers were required for the training of new workers and therefore found it extremely difficult to replace them.

8. Discussion and conclusion

Dominant media narratives on ASM have often portrayed mining regions as 'informal' zones that suffer massively from environmental degradation problems. Pollution and degraded landscapes have long been viewed as the inevitable consequence of artisanal and small-scale mining. In this context of popular narratives about the environmentally-disruptive nature of small-scale mining operations, the present study sought to examine the sustainable environmental management performance of an overlooked segment of the ASM sector – formalised (legalised) ASM operations. This task is important, considering that although the ASM sector in general comprises both artisanal (mostly illegal operators) and formalised small-scale commercial miners, scholarly works have mostly focused on the activities of the former operators, to the neglect of the latter. This should, however, not come as a surprise, considering that in Africa, for example, over 90% of ASM operations are undertaken by individuals and groups who are not in possession of a licence and thus operate illegally (IGF, 2017a). However, as observed by Verbrugge (2015), ASM is a complex and diversified sector. Thus, images of an exclusively informal ASM segment do not always correspond to realities on the ground (Verbrugge, 2015). Formalisation processes and the injection of capital, by both external

⁵ As indicated earlier, localisation refers principally to the landowners and farmers whose lands have been leased to OMCL for extractive operations.

and internal financiers, for example, have led to a growing differentiation among ASM operations in terms of their levels of capitalization and professionalization (Verbrugge, 2015; Martinez et al., 2021).

In this regard, findings from this study demonstrate that, contrary to popular perception, formalised small-scale mining operators can be 'golden miners' – good stewards of the environment and caretakers of local communities through land reclamation mechanisms. The dynamic interplay between the payment of compensation funds to landowners during the pre-mining stage and the restoration of reclaimed lands to landowners for successive use at the post-mining stage engenders immense mutual benefits to inhabitants of local mining communities. Further, the land reclamation efforts can also engender beneficial consequences to the mining operators through the production of food for employees prior to the restoration of land to former landowners.

However, we note that underpinning these 'golden' mining practices examined in this study is the prime issue of formalisation of small-scale mining operations. Obviously, the two companies examined in this case study were able to raise the required funds to cater for the cost of formalisation, the sourcing of mechanised equipment and the cost of labour. However, as has been noted elsewhere, most ASM operators have been unable to formalise their operations in order to practise responsible mining due to the fact that for most mining operators, the costs of formalization are generally high (Hilson, 2017; Siwale and Siwale, 2017). Most miners also face ineffective policies and bureaucratic inefficiency, large quantities of paperwork, long waiting periods and extensive travel to secure licences, high costs for obtaining different kinds of official documents, bribes, limited availability of land on which they can legally work, and concerns about the ensuing high investment costs in a formal exploitation project (Geenen, 2012; Hilson, 2017; Siwale and Siwale, 2017). As such, most miners have few incentives to join a formalised sector. In sum, informality is largely a product of the high entry barriers and political obstacles that exclude the informal workforce in general, and ASM operators, from the formal economic system (Geenen, 2012). In this vein, we agree with scholars such as Geenen (2012), Hilson et al. (2018) and Pijpers (2014) that mining authorities would need to make their formalization processes more flexible in order to stem the tide of illegal mining with its consequential environmentally-destructive habits.

Also of importance to the findings in this study is the issue of access to mineralised lands for ASM operators. Here we note that both MF and OMCL were able to formalise their operations because MF has been able to secure mineralised concessions which are amenable for small-scale mining (the geologist employed by OMCL indicated that the concession site has a history of small-scale mining activities). It could be surmised that even if the two companies were cash-strapped, they could deploy the land as collateral to secure funds from the capital market to finance their operations. However, for most ASM operators, access to mineralised lands is a problem (Nyame and Blocher, 2010; Hilson, 2017). The intentional construct on the part of policymakers to prioritize large-scale mining over ASM has meant the release of vast concessions to large-scale mining companies, denying local people access to mineral-rich areas suitable for small-scale mining (Hilson, 2017). In this regard we also agree with scholars such as Hilson (2017) that mining authorities would need to address the thorny issue of access to mineralised lands for ASM operators.

To sum up, we reiterate that reclamation of mining-degraded lands is crucial in the effort to achieve sustainable mining practices that cater for the needs of both mining communities and the physical environment. Reclamation of degraded mine lands is very important if mineral-rich communities in Ghana are to benefit from both their surface and sub-surface land resources. However, the relevance of our findings transcends Ghana's mining landscape. The principles involved in OMCL's land reclamation efforts, examined in this study, could serve as a useful guide for other mining operators and mining authorities in other mineral-rich countries. Further, we suggest that in cases where mining entrepreneurs are financially constrained in the payment of

compensation funds to mining communities, governmental authorities should assist them to help pay this compensation. In no case should payment of compensation to landowners be deferred. Despite the huge financial contribution of the extractive industry to the national economies of mineral-rich countries, mining communities have been known to suffer major infrastructural and developmental deficits. They should, however, not be denied the twin benefits that come with compensation and land reclamation. In addition, mining companies would need to find structured ways to integrate local landowners into their employment portfolio; government mining officials should also expedite the process of restoration of reclaimed lands to landowners. These mechanisms would help contribute to more sustainable local livelihoods that extend beyond the life of the mine.

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.

Data Availability

Data will be made available on request.

References

- Arthur-Holmes, F., et al., 2022. Graduate unemployment, artisanal and small-scale mining, and rural transformation in Ghana: what does the 'educated' youth involvement offer? *J. Rural Stud.* 95125–95139.
- Arthur-Holmes, F., Busia, K.A., 2022. Women, North-South migration and artisanal and small-scale mining in Ghana: motivations, drivers and socio-economic implications. *Extr. Ind. Soc.*, 101076.
- Aryee, B.N., et al., 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.
- Asiedu, J.B.K., 2013. Technical report on reclamation of small scale surface mined lands in Ghana: a landscape perspective. *Am. J. Environ. Prot.* 1 (2), 28–33.
- Asiedu-Amoako, S., et al., 2016. Environmental degradation: a challenge to traditional leadership at Akyem Abuakwa in the eastern region of Ghana. *Am. J. Indig. Stud.* 1A1–13A1.
- Bach, J.S. (2014) Illegal Chinese gold mining in Amansie West, Ghana-an assesment of its impact and implications. Master's Thesis thesis. Universitet i Agder/University of Agder.
- 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., et al., 2016. The hazardous nature of small scale underground mining in Ghana. *J. Sustain. Min.* 15 (1), 8–25.
- Boadi, S., et al., 2016. An analysis of illegal mining on the Offin shelterbelt forest reserve, Ghana: implications on community livelihood. *J. Sustain. Min.* 15 (3), 115–119.
- Boateng, D.O., et al., 2014. Impact of illegal small scale mining (Galamsey) on cocoa production in Atiwa district of Ghana. *Int. J. Adv. Agric. Res.* 289–299.
- Bradshaw, A.D., 1996. Underlying principles of restoration. *Can. J. Fish. Aquat. Sci.* 53 (S1), 3–9.
- Burrows, E., Bird, L., 2017. Gold, guns and China: Ghana's fight to end galamsey. *Afr. Argum.* 30.
- Damptey, F.G., et al., 2020. Soil properties and biomass attributes in a former gravel mine area after two decades of forest restoration. *Land* 9 (6), 209.
- Damptey, F.G., et al., 2021. Trade-offs and synergies between food and fodder production and other ecosystem services in an actively restored forest, natural forest and an agroforestry system in Ghana. *Front. For. Glob. Change* 447.
- Davies, R. et al. (1995) Nitrogen loss from a soil restored after surface mining.
- Geenen, S., 2012. A dangerous bet: the challenges of formalizing artisanal mining in the Democratic Republic of Congo. *Resour. Policy* 37 (3), 322–330.
- Hamann, R., 2003. Mining companies' role in sustainable development: the 'why' and 'how' of corporate social responsibility from a business perspective. *Dev. South. Afr.* 20 (2), 237–254.
- Hilson, G., 2002. Harvesting mineral riches: 1000 years of gold mining in Ghana. *Resour. Policy* 28 (1–2), 13–26.
- Hilson, G., 2016. Farming, small-scale mining and rural livelihoods in Sub-Saharan Africa. *A Crit. Overv. Extr. Ind. Soc.* 3 (2), 547–563.
- Hilson, G., 2017. Shootings and burning excavators: some rapid reflections on the government of Ghana handling of the informal galamsey mining 'menace'. *Resour. Policy* 54, 109–116.
- Hilson, G., et al., 2018. Formalizing artisanal gold mining under the Minamata convention: previewing the challenge in Sub-Saharan Africa. *Environ. Sci. Policy* 85, 123–131.
- Hilson, G., Maconachie, R., 2017. Formalising artisanal and small-scale mining: insights, contestations and clarifications. *Area* 49 (4), 443–451.

- Hilson, G., Maconachie, R., 2020. Entrepreneurship and innovation in Africa's artisanal and small-scale mining sector: Developments and trajectories. *J. Rural Stud.* 78149–78162.
- ICCM (2015) Report - Mining in Ghana - What future can we expect? The Ghana Chamber of Mines, Accra.
- IGF (2017a) Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. Winnipeg: IISD.
- IGF (2017b) IGF Guidance for Governments: Managing artisanal and small-scale mining. Winnipeg: IISD.
- Jacka, J.K., 2018. The anthropology of mining: the social and environmental impacts of resource extraction in the mineral age. *Annu. Rev. Anthropol.* 47, 61–77.
- Jenkins, H., 2004. Corporate social responsibility and the mining industry: conflicts and constructs. *Corp. Soc. Responsib. Environ. Manag.* 11 (1), 23–34.
- Jenkins, H., Yakovleva, N., 2006. Corporate social responsibility in the mining industry: exploring trends in social and environmental disclosure. *J. Clean. Prod.* 14 (3–4), 271–284.
- Kinyondo, A., Huggins, C., 2021. State-led efforts to reduce environmental impacts of artisanal and small-scale mining in Tanzania: Implications for fulfilment of the sustainable development goals. *Environ. Sci. Policy* 120157–120164.
- Kitula, A.G.N., 2006. The environmental and socio-economic impacts of mining on local livelihoods in Tanzania: a case study of Geita District. *J. Clean. Prod.* 14 (3–4), 405–414.
- Lesser, P., et al., 2021. European mining and the social license to operate. *Extr. Ind. Soc.* 8 (2), 100787.
- Mantey, J. et al. (2016) Costed reclamation and decommissioning strategy for galamsey operations in 11 selected MDAs of. International Growth Centre.
- Martinez, G., et al., 2021. Formalization is just the beginning: analyzing post-formalization successes and challenges in Peru's small-scale gold mining sector. *Resour. Policy* 74102390.
- Mensah, A.K., et al., 2015. Environmental impacts of mining: a study of mining communities in Ghana. *Appl. Ecol. Environ. Sci.* 3 (3), 81–94.
- Moomey, A.-W. & Dewan, A. (2016) Assessing the spatial relationships between mining and land degradation: evidence from Ghana. *International Journal of Mining, Reclamation and Environment*.
- Nsiah, P.K., Schaaf, W., 2019. The potentials of biological geotextiles in erosion and sediment control during gold mine reclamation in Ghana. *J. Soils Sediment.* 19 (4), 1995–2006.
- Nyame, F.K., Blocher, J., 2010. Influence of land tenure practices on artisanal mining activity in Ghana. *Resour. Policy* 35 (1), 47–53.
- Oforu, G., et al., 2020. Socio-economic and environmental implications of Artisanal and Small-scale Mining (ASM) on agriculture and livelihoods. *Environ. Sci. Policy* 106210–106220.
- Oforu, G., Sarpong, D., 2022. Mineral exhaustion, livelihoods and persistence of vulnerabilities in ASM settings. *J. Rural Stud.* 92154–92163.
- Okoh, G., Hilson, G., 2011. Poverty and livelihood diversification: exploring the linkages between smallholder farming and artisanal mining in rural Ghana. *J. Int. Dev.* 23 (8), 1100–1114.
- Opoku-Antwi, G.L. (2010) Three essays on small-scale gold mining operations in Ghana: An integrated approach to benefit-cost analysis. KNUST, Ghana.
- Osei, L., et al., 2021. Government's ban on Artisanal and Small-Scale Mining, youth livelihoods and imagined futures in Ghana. *Resour. Policy* 71102008.
- Owusu, E.E., Dwomoh, G., 2012. The impact of illegal mining on the Ghanaian youth: evidence from Kwaebibirem District in Ghana. *Res. Humanit. Soc. Sci.* 2 (6), 86–93.
- Patel, K., et al., 2016. Evaluating conflict surrounding mineral extraction in Ghana: assessing the spatial interactions of large and small-scale mining. *Extr. Ind. Soc.* 3 (2), 450–463.
- Pijpers, R., 2014. Crops and carats: Exploring the interconnectedness of mining and agriculture in Sub-Saharan Africa. *Futures* 62, 32–39.
- Schueler, V., et al., 2011. Impacts of surface gold mining on land use systems in Western Ghana. *Ambio* 40 (5), 528–539.
- Sheoran, V., et al., 2010. Soil reclamation of abandoned mine land by revegetation: a review. *Int. J. Soil, Sediment Water* 3 (2), 13.
- Siegel, S., Veiga, M.M., 2009. Artisanal and small-scale mining as an extralegal economy: de Soto and the redefinition of "formalization". *Resour. Policy* 34 (1–2), 51–56.
- Siggelkow, N., 2007. Persuasion with case studies. *Acad. Manag. J.* 50 (1), 20–24.
- Singh, A.N., Singh, J.S., 1999. Biomass, net primary production and impact of bamboo plantation on soil redevelopment in a dry tropical region. *For. Ecol. Manag.* 119 (1–3), 195–207.
- Singh, A.N. & Singh, J.S. (2006) Experiments on ecological restoration of coal mine spoil using native trees in a dry tropical environment, India: a synthesis. *New forests.* 31 (1), 25–39.
- Siwale, A., Siwale, T., 2017. Has the promise of formalizing artisanal and small-scale mining (ASM) failed? The case of Zambia. *Extr. Ind. Soc.* 4 (1), 191–201.
- Teschner, B.A., 2012. Small-scale mining in Ghana: the government and the galamsey. *Resour. Policy* 37 (3), 308–314.
- Tom-Dery, D., et al., 2012. Effect of illegal small-scale mining operations on vegetation cover of arid northern Ghana. *Res. J. Environ. earth Sci.* 4 (6), 674–679.
- Veiga, M.M. (1997) Introducing new technologies for abatement of global mercury pollution in Latin America. UNIDO; UBC; CETEM.
- Verbrugge, B., 2015. The economic logic of persistent informality: artisanal and small-scale mining in the southern Philippines. *Dev. Change* 46 (5), 1023–1046.
- Vintró, C., et al., 2012. Is corporate social responsibility possible in the mining sector? Evidence from Catalan companies. *Resour. Policy* 37 (1), 118–125.
- Vintró, C.S., Comajuncosa, J.C., 2010. Corporate social responsibility in the mining industry: criteria and indicators. *Dyna* 161, 31–41.
- Wheeler, D., et al., 2002. Paradoxes and dilemmas for stakeholder responsive firms in the extractive sector: lessons from the case of Shell and the Ogoni. *J. Bus. Ethics* 39 (3), 297–318.
- Zavala, G.F. (2017) The golden practices that defy gloom. International Institute for Environment and Development.