Mineral exhaustion, livelihoods, and persistence of vulnerabilities in ASM settings

Abstract

Formalization of the artisanal and small-scale mining (ASM) sector has come to dominate discourse on mineral exhaustion, livelihoods, and persistence of vulnerabilities in ASM settings. Often touted as a panacea to curbing the excesses of informal mining operations, the call for the formalization of ASM operations continue unabated. In this paper, we explore how the operations and management practices in the growing formal ASM sector get formulated and (re)negotiated in practice. We develop our contribution in the context of a formalised small-scale mining operator in Ghana, focusing on its organizing practices and operational outcomes within the contingencies of organizing to explicate how livelihoods and vulnerabilities persisting in ASM settings gets identified and labelled in practice. Data for our inquiry comes from ethnographic interviews with management and staff. Our findings in emphasizing, but also nuancing, what has come to be known as the 'mineral-exhaustion-vulnerabilities', provides insights into how the organizing practices induced by formalization cohere to support socio-economic and environmental mitigation efforts. We note that the persistence of vulnerabilities, rather than the lack of mitigation mechanisms, is largely influenced by profligacy and the incipient lack of investment culture. We conclude by highlighting the need for sustainability mechanisms, based on exit strategies for ASM operators, to tie in with comprehensive policies and lessons on income diversification and investment.

Keywords: Artisanal and Small-scale Mining (ASM); formalisation; mitigation mechanisms; sustainable development goals

1. Introduction

The artisanal and small-scale mining (ASM) sector continues to experience a phenomenal expansion in most areas, especially rural communities, in the mineral-rich world (IGF, 2017a). ASM is commonly defined as the extraction and processing of minerals through intensive labour and low levels of technology (Hilson, 2017, 2016). According to IGF (2017b), the ASM sector includes poverty-stricken informal individual miners and groups 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[1]. Due to the high rates of informality associated with the sector, however, estimates of the number of people engaged in ASM vary

[1] The empirical findings focus on the latter group of miners.

widely. According to the World Bank (2013), ASM operations are undertaken in about 80 countries worldwide involving about 100 million miners. Despite its low productivity, the sector continues to be a valuable source of minerals and metals; it accounts for about 20% of the global gold supply, 80% of the global sapphire supply and 20% of the global diamond supply (IGF, 2017a).

Notwithstanding the enormous socio-economic benefits derived from the sector, employment and labour relations, occupational health and safety issues, and workers welfare in relation to ASM operations have come to represent a conundrum (Verbrugge, 2015). The benefits of ASM are sometimes overshadowed by the considerable negative impacts on the physical environment and the health and safety of mine workers (Mantey et al., 2016; Ofosu et al., 2020). Although these phenomena are largely attributed to the informal and migratory nature of most operations, studies have shown that even in formalised settings, these exploitative practices abound (Verbrugge, 2015). This has led many scholars and international organisations to question the sustainable development potential of ASM operations (ACET, 2017).

Sustainability is defined as meeting the socio-economic and environmental needs of the present generation without compromising the ability of future generations to meet their own needs (Scoones, 1998). Thus, sustainable ASM refers to activities that promote and balance such economic, social, and environmental dimensions. These include, for example, the reclamation of mining degraded lands and the protection of water bodies (Damptey et al., 2020; Worlanyo and Jiangfeng, 2020), and good ASM labour management practices. The United Nations (UN), drawing on the definition of 'sustainability', introduced, in 2015, the Sustainable Development Goals (SDGs) as a way of ensuring a peaceful and prosperous future (Morton et al., 2019). Underpinned by the three facets of economic, social and environmental sustainability (Schmidt-Traub et al., 2017), many of the of the SDGs (in)directly relates to mining (Hilson and Maconachie, 2020a). However, as noted by scholars, little to no attention has been paid to how ASM can be incorporated in, contribute to, and benefit from the SDGs (Hilson and Maconachie, 2020a). Yet improvements in the sector can significantly contribute to, for example, the alleviation of poverty (SDG1), improvement of food availability (SDG2), and creation of better work environments and economic growth (SDG8) (Hilson and Maconachie, 2020a).

Indeed ASM can contribute to the attainment of the SDGs because the sector is associated with positive socio-economic impacts (Barreto et al., 2018). The economic impacts of ASM are evident especially in rural regions where they contribute to poverty alleviation by constituting a response to the crucial problem of survival of a large number of poverty-stricken people; contributing to the improvement of their living conditions; and stimulating, to a large extent, trade and economic activities (Traore, 1997; Hilson, 2016). The social impact has to do with: the creation of employment opportunities; the reduction of the rural-urban migration; and the establishment of some basic social amenities (Traore, 1997; Hilson and Maconachie, 2020b, 2020a). Small-scale mines also tend to support ancillary industries in rural areas. Such mines require traditional unsophisticated equipment which can be catered by local village workshops, giving the latter a chance to flourish (Traore, 1997). This increases and spreads the economic activity, with accompanying income generation and distribution (Geenen, 2012; Traore, 1997).

One major problem however is that ASM, like other activities in the extractive industry, relies on non-renewable resources which are highly depletable. In the broader sense, resource depletion is contextualised as emanating from an excess of resource consumption over its reproduction (physical depletion) (Ponomarenko et al., 2021; Santopietro, 1998). For non-renewable resources (e.g gold ores), depletion entails a quantitative and qualitative deterioration of mineral deposits, resulting in their scarcity (Ponomarenko et al., 2021; Santopietro, 1998). Hence, a livelihood based on ASM will inevitably fail to 'maintain or enhance its capabilities and assets, while not undermining the natural resource base' (Scoones, 1998).

ASM has also been described as a 'do-or-die' enterprise (Stoop and Verpoorten, 2020) and a high-risk financial-gamble activity. With regards to the latter 'risk', for example, it has been established that depending on the location where operators start exploring for minerals, they may amass substantial wealth or plunge into poverty (Geenen, 2014; Stoop and Verpoorten, 2020). As a consequence, ASM becomes precarious as a sustainable economic activity practiced over a long time (Ofosu et al., 2020). Livelihood diversification works focused on the ASM sector have shown how many miners simultaneously engage in other economic activities funded by mining-generated income (Cartier and Bürge, 2011; Chigumira, 2018). Declining mineral deposits therefore present some of the largest sustainability threats related to ASM, impacting those who

are directly and indirectly dependent on the sector (Maconachie and Conteh, 2021; Pedersen et al., 2021).

The issue of 'mineral exhaustion' and its livelihood implications on informal ASM operators has been the focus of many studies, see for example (Pedersen et al., 2021; Bryceson and Jønsson, 2010). This present study seeks to complement these studies. Our point of departure, however, is that our study is focused on an overlooked segment of the ASM sector - formalised ASM operations. Focussing on formal ASM is important because the immense scholarly focus on informal ASM has meant that our understanding of how formalised ASM impacts livelihoods, and how mineral depletion affects the operators in formalised settings have remained incomplete. In Ghana, for example, although reports indicate that, prior to the mining ban in 2017 (Hilson, 2017; Zolnikov, 2020), there were about 1200 active small-scale mining licensed operators (Hilson and Maconachie, 2020a, p.133), the activities of these operators have remained a marginalia in the scholarly literature.

Thus, moving beyond the 'doom' and 'gloom' narratives usually associated with the saturated, informal ASM operations (popularly known as *galamsey* in Ghana), this study unpacks the operational outcomes of a formalised small-scale mining setting, indicating how operations and management practices are formulated and re(negotiated) in the formal sector. Drawing on fieldwork carried out on in Ghana in 2020 and 2021 and complemented by semi-structured interviews undertaken mainly with 40 employees, 10 ex-employees (retrenched workers) and management of a formalised mining company**,** our findings confirm that indeed mineral exhaustion has negative consequences on the livelihoods of miners. Nevertheless, the negative implications could be mitigated, mediated through compensation funds to help miners diversify their incomes during and after the life of the mine. Our findings further suggest that even in the midst of mitigation mechanisms, economic vulnerabilities, engendered, largely, by profligacy/lack of investment culture, persist. With reference to the SDGs, our findings bring evidence to show that with the right policies to remove the impediments to ASM formalisation, the sector can help in the attainment of the SDGs. However broader discussions on the attainment of the SDGs in relation to ASM must incorporate the need for sustainability mechanisms, based

on exit strategies for ASM operators, to tie in with comprehensive policies and lessons on income diversification and investment.

2. ASM, livelihoods and vulnerabilities

Previous studies

Much literature has examined the 'push' and 'pull' factors associated with ASM (Hasibuan et al., 2020; Banchirigah, 2006). A plethora of papers have highlighted economic or financial cum subsistence needs as the underlying reason for engaging in ASM (Hilson and Garforth, 2012; Geenen, 2012; Pijpers, 2014; Banchirigah, 2006). Poverty and lack of access to formal employment opportunities is a major problem in most rural areas in the developing world. This is connected with lack of education that limits employment opportunities (Banchirigah, 2008, 2006). Thus, most people migrate into ASM areas to look for employment opportunities. Also, most of the rural poor who could not farm because their fertile lands have been taken over by industrial mining companies turn to ASM activities (Hilson and Garforth, 2012, 2013; Nyame and Blocher, 2010; Teschner, 2012). Some prominent studies focus on challenges associated with traditional agricultural production, e.g. in most parts in sub-Saharan Africa, where suitable farmland is progressively decreasing as the population increases (Okoh and Hilson, 2011; Mkodzongi and Spiegel, 2019), which is weakening agriculture and food production as a reliable source of livelihood. These problems are exacerbated by the lack of livelihood options in rural areas (Teschner, 2012; Banchirigah and Hilson, 2010).

Other studies have explored the psychosocial factors behind ASM operations. In this vein, scholars have argued that in areas where ASM have long traditions, the advent of industrial, large-scale mining activities have often been interpreted as a deprivation of traditional community land rights (Crawford and Botchwey, 2017; Andrews, 2015; Verbrugge et al., 2015). Autochthones consider no need for permits in order to engage in ASM; for them, the land is natural entitlements; therefore, ASM is a way of taking back what belongs to them (Andrews, 2015; Aubynn, 2009). Some research findings show that not all artisanal and small-scale miners are impoverished or lack financial means to survive (IGF, 2017a, 2017b). Some of the miners are prominent entrepreneurs who seek to exploit the enormous financial gains that ASM operations

can offer (Thornton, 2014; Verbrugge, 2015). Verbrugge (2016) adds that although the initial engagement in ASM is driven by poverty, ASM is increasingly recognized as a means to accumulate wealth.

Funds from ASM have lubricated smallholder agricultural activities. A strand of literature casts the spotlight on the mining-farming complementarities that are shaping rural labour trajectories (Pijpers, 2014; Teschner, 2014; Chigumira, 2018). The literature generally argues that agriculture has become an unviable livelihood option particularly due to interrelated processes of structural adjustment and de-agrarianisation and that for many people, especially in Africa, ASM has become an important element of their livelihood portfolios (Banchirigah, 2008; Persaud et al., 2017; Fisher et al., 2019; Kamlongera, 2011). In practice, the working of small-scale mines and agriculture activities are seasonal in nature. ASM activities are usually undertaken in the dry season while agriculture activities usually occur in the rainy season (Ofosu et al., 2020; Hilson and Van Bockstael, 2011). The reality therefore is that ASM activities can provide additional employment opportunities for agro-based labourers during their idle season (Ofosu et al., 2020; Chigumira, 2018). This phenomenon also helps to curtail rural-urban migration.

Despite these positive attributes however, the ASM landscape is replete with environmental and socio-economic challenges which increase vulnerabilities in many communities. One of the major operational problems in ASM is the lack of access to credit. According to Hilson and Maconachie (2020) a greater majority of small-scale mineral operators have no access to credit. The lack of capital is a barrier to mechanization and improving efficiency. These in turn engender low productivity, low revenues and low wages (Hilson and Maconachie, 2020c; Hilson and Ackah-Baidoo, 2011). Because of low revenues, the miners tend to ignore health, safety and environmental procedures (Mantey et al., 2016). Mining entrepreneurs and labourers, generally, have few assets that banks and other financial institutions would accept as collateral (Hilson and Maconachie, 2020c; Hilson and Ackah-Baidoo, 2011). Financial institutions are not readily prepared, even when mining rights exist, to take them as security because of the geological risk of unmined deposits, the high rate of mobility among many ASM operators and the widespread weak enforcement of mining laws and regulations (Siwale and Siwale, 2017; Pedersen et al., 2021; Hilson et al., 2014). Moreover, banks traditionally require borrowers to

provide some security from their own resources, which is a gargantuan obligation for many ASM operators (Hilson and Maconachie, 2020c). Small-scale miners, according to studies, therefore find themselves in a vicious cycle: low productivity, low returns, low revenue from mining, low savings, potential inability to invest in tools and equipment (Hilson and Ackah-Baidoo, 2011; Banchirigah, 2006).

Vulnerabilities are also evident in the ASM sector because the operators have a poor reputation for occupational safety and industrial relations. Health and safety issues receive very little attention at most ASM sites as precautionary measures are neglected and no training on health and safety issues is provided (Mantey et al., 2016; Stemn et al., 2021). Most miners are not well vexed in work safety regulations with observations showing that workers do not use personal protective equipment such as helmet, earplug, mask, or gloves. Rock falls, cave-ins, perpetual dampness and inadequate ventilation result in severe mine accidents (Stemn et al., 2021). In addition, the close proximity of mine pits to one another increases the risk of cave-ins (Appiah, 1998; Bansah et al., 2016).

Moreover, much attention has been paid to vulnerabilities emanating from the negative environmental impacts of ASM, particularly the issue of mercury use (Tarras-Wahlberg et al., 2001; Arifin et al., 2015). Studies have shown that ASM activities engender land degradation problems and deforestation (Macháček, 2019; Ofosu et al., 2020; Kitula, 2006) and negatively impact groundwater and soil quality (Shoko, 2002). Pollution and mercury contamination, along with poor and unsafe working conditions in many ASM areas have a negative impact on the health of both miners and adjacent communities (Mantey et al., 2016; Ofosu et al., 2020; Wagner, 2016). These environmental problems, for example, lead to a mining ban in Ghana in 2017 with consequential negative economic impacts on livelihoods (Zolnikov, 2020; Osei et al., 2021; Eduful et al., 2020; Bansah, 2019).

In addition, socio-economic vulnerabilities in mining communities increase because the environmentally destructive effects of ASM such as bush burning and deforestation reduces the availability of grazing areas for livestock (Kitula, 2006). This can entrench a cycle of poverty in the agrarian economy through loss of farming-generated income and a reduction in food and cash crop and livestock production (Kitula, 2006; Boadi et al., 2016). Of equal concern to the

inhabitants of mining communities is that the harmful effects of mercury do not only deprive farming communities of safe water for irrigation and other domestic purposes, but also labour-hours for farming and production levels (Ofosu et al., 2020; Tomicic et al., 2011).

Further, research have shown that ASM operators have become more vulnerable to economic hardships due to the depletion of mineral resources (Maconachie, 2011; Walsh, 2003; Maconachie and Conteh, 2021). In Sierra Leone, for example, mineral busts, due to mineral depletion have been observed (Maconachie, 2011). Likewise in the Geita region in Tanzania, ASM activities have declined due to overworked sites and the depletion of key deposits (Pedersen et al., 2021). Mineral depletion and its consequential economic vulnerabilities have also been observed in Madagascar (Walsh, 2003, 2012).

Another worrying trend that also increases vulnerabilities in ASM communities is the phenomenon of profligate spending or lack of investment culture (Walsh, 2003; Cuvelier, 2014). On the micro level (i.e., individual spending habits), although earnings in the ASM sector are considerably higher than the average income of comparable economic activities, it has been reported that small-scale mineral operators are unable to translate their incomes into savings and investments - two essential economic ingredients required for the sustained improvement of livelihoods (Walsh, 2003; Werthmann, 2003). Walsh (2003) refers to these transient high earnings as "hot money" that fuels 'daring consumption' in mining towns.

A reading of these studies however reveals a certain particularity – a focus on informal ASM. As such, our understanding of how formalised ASM impacts livelihoods, and how mineral depletion affects ASM operators in formalised settings have remained incomplete. Little to no knowledge has emerged on how vulnerabilities emerge, the mitigation mechanisms, exit strategies and how vulnerabilities are dealt with in formalised ASM settings. We address this issue by turning towards the operations of a formalised small-scale mining operator in Ghana.

3. ASM in a formalised environment

One of the mining companies under focus in this study is MoMo Fields (hereafter MF). This company has been in the extractive business for close to a decade and has secured mining

concessions 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 Optica Mining Company Limited (hereafter OMCL) - a small-scale mining company. In this regard, the concessions have been divided into not more than 25 acres. OMCL is tasked to provide small-scale mining support services on the concessions. This comprises the exclusive right to extract, process and sell the mineral wealth of the concessions. 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) – the agency responsible for the regulation of the mining sector in Ghana - and takes the ultimate responsibility in the management processes.

3.1 OMCL – on the formalisation path

Interviews with the project manager of OMCL showed that the company had operated as an illegal mining operator previously. Not that they had not registered their operations with the MC, but their license had expired, and they had failed to renew it. Thus, obviously in the face of the law, they were operating illegally. Operating illegally meant that they were under constant threat of being apprehended by the mining authorities. Although the project manager admits that they made a financial fortune at a certain point in time from operating illegally, this came with its own problems. They could not secure loans from the financial market to boost their operations. They had even suffered an armed robbery attack at a point in time.

A mine accident had also claimed a life during their operations. Strangely though, according to the project manager, the family of the deceased accused the company of employing spiritual forces at the site leading to the death of their relative. This confirms the findings of, for example, Stoop and Verpoorten (2020) that accusations of the deployment of spiritual forces (witchcraft) in ASM operations is prevalent. The family of the deceased had threatened court action. However, the fear, on the part of OMCL, of suffering a court fine and even the fact that they were operating illegally, meant they had to settle a compensation issue out of court. Also,

according to the project manager, workers had no work contracts and security of employment. They were paid as and when they worked on a weekly basis. Worker apathy had crept in at a point in time. Due to the fact that mineral-rich concessions were becoming scarce, the company had to lay some of the workers off and reduce the salaries of some of the retained workers. The manager even suspects that some of the retrenched workers were behind the robbery attack.

The company lost a substantial amount of money and gold to the robbery attack. At a point, the lack of concession had also meant that the company was running into bankruptcy. Fortunately, though, their contacts with MF revealed that they could secure access to mineralised lands and therefore had little apprehensions transitioning into the formal domain i.e. registering their operations with the MC again and conforming to high employment and safety standards. In the words of the manager:

> I must admit that we operated as an illegal mining-operating company at a point in time. However, we gradually had to transform and become a formalised mining company because concessions were becoming hard to come by. Once we knew that we could secure concessions from MF but only through the formalised arena we had no problem renewing our operating license.

3.2 Access to capital

Interviews with the project manager of OMCL showed that the company was able to deploy the concession granted them as collateral in order to secure funds from the capital market. He expressed it thus:

> Because we have been in this mining business for quite some time, some of our equipment had become obsolete at the time this concession was allocated to us. We therefore needed money badly in order to purchase some of the equipment. One of the banks decided to give us a loan after a thorough examination of our documents concerning the mineral-rich nature of the concession. They even had to bring in an external geologist to confirm the richness of the concession. Luckily the concession was rich enough, so they granted us the loan.

The project manager further indicated that the process involved certification from the offices of the MC to the effect that the mining company had satisfied all requirement relating to the

licensing procedures as laid down in the Minerals and Mining Act of 2006 (Act 703). Also, in order to secure the concession, MF insisted that OMCL had to conform to labour legislations. This included the obligation to issue work contracts to employees, payment of fixed salaries and payment of insurance benefits among others. The obligation to conform to labour legislations ensured good employment practices and efficiency. Unfortunately, the exhaustive nature of the concessions and the depleting mineral wealth has engendered vulnerabilities in the operations, a discussion we turn our attention to.

4. Mineral exhaustion and the negative implications

Retrenchment

The mining project of OMCL generates high levels of employment. As of the time of the research, a total of 98 Ghanaians were employed. A very low rate of female employees was however observed; out of the total number of employees, only 5 were females, constituting about 5% (we touch on this in our discussion section). According to management, about 150 workers were employed during the peak period when the mining project started. However, due to dwindling levels of production, about 50 of the workers had been retrenched. There were plans to further cut down on the number of employees because they were running out of concessions. In the words of the project manager:

> We plan to retrench some of the employees in the near future. When we started our operations, we were allocated about 25 acres. The second phase involved the allocation of about 20 acres. The third phase which comprised the allocation of about 23 acres was not as rich as initially anticipated. We are still negotiating with MF for our last two allocations. Since minerals are not renewable, we cannot go back to the old concessions, you know. So, the obvious thing to do is to cut down on the number of employees. However, we have plans to re-employ them when new concessions are secured.

This confirms the findings, for example, by Pedersen et al. (2021) that loss of employment opportunities become the first and, probably, the major casualty when mineral deposits near exhaustion. However, in this formalised setting, mitigation mechanisms are put in place to cushion workers from the economic hardships. We will look at this shortly in a section below.

Mineral exhaustion had also affected remuneration of workers, and capacity building programmes, a phenomenon we examine below.

4.1 Wages and benefits

The pay level seems to be the biggest motivator for all the employees of OMCL. No worker is paid below the official minimum wage. Hence the prevailing wage is highly satisfactory when measured against the expectations of the workers. When the researcher inspected the payslip of some skilled employees, it was found that they earned between Ghc 2,500 – 3000[2] (ca. US$400 – 500) per month. According to the employees and management, the minimum basic pay for the unskilled staff ranged between Ghc 1,000 - 2,000 (ca. US$165 – 330). The financial secretary says:

> We pay our workers by the middle of the month (on time). The monies are disbursed into their bank accounts on time and their pay slips are also prepared regularly. Since we started our operations, we've not had a single complain of workers not receiving their salaries. You can ask the workers...

However, although management had no plans of reducing the salaries of the employees, a decision had been reached those salaries were not going to be increased throughout the year 2021 although inflation was on the rise. According to management, this decision had clearly been communicated to the workers. The last salary increments the workers enjoyed had happened in the last quarter of 2020. The problem was that two of their experienced workers had left the company. It was however not difficult to replace them. Some of the workers expressed concerns of economic hardship due to the lack of salary increment in the face of high cost of inflation. One worker expressed:

> You know, the prices of goods and other services keep rising by the day. Transportation fares this year are not the same as last year, food prices are not the same as last (2020). It's therefore a bad decision not to increase our salaries.

4.2 Apprenticeship

[2] As of the time of this research $1=Ghc 6

OMCL engages in a comprehensive apprenticeship programme at the mine site. The apprenticeship involves the recruitment of young men (between the ages of 17 and 20) into the mining firm to learn the skills of mining. Two of the workers (senior high school leavers) interviewed for this study started as apprentices but were later employed permanently after the apprenticeship period was over. The apprenticeship period took a year. The following statements came from these two former apprentices:

> When I completed school, my passes were not good enough so I could not enter any tertiary institution. Then my uncle contacted one of the managers of the company and they agreed to take me as an apprentice. I'm happy that I was retained after the apprenticeship. I earn good money too. But I plan to attend the School of Mines (a tertiary institution) somewhere in the future.
>
> I used to work at a *galamsey* site during my school days. So, I have prior experience in mining. One of the workers I used to work with at the *galamsey* site later got a job in this company. I therefore contacted him to help me secure a job in this company. The company was only willing to take me as an apprentice, perhaps because of my age then (17 years).

This apprenticeship phenomenon at this mining site is worth remarking. In the study by Bryceson and Jønsson (2010), the low entry barriers into ASM are extolled thus:

> Those attracted to small-scale mining generally enter without specialized mining skills. In effect, a miner's first work site is an apprenticeship where he earns as he learns.

Also as indicated, most findings on ASM practices suggest that most people engage in ASM because the tasks are easy, low-skilled, requiring low education. However, discussions with the management revealed that they contest this lack of apprenticeship phenomenon in ASM. The apprenticeship programme at OMCL is anchored in the logic that just as other artisans are trained before undertaking their operations, artisanal miners would also need to undergo formal training regarding mining operations. The programme is also meant to offer skills and employment opportunities to young men living in the rural areas around the mine site. Worryingly though, due to the dwindling mineral fortunes, management had no plans of bringing in new apprentices to the mine site. The project manager remarked:

> We believe in the specialisation of mining skills, so we instituted an apprenticeship programme to help young men in this community gain some skills and employment. We believe that just as tailors, carpenters and other artisans are trained before undertaking

> their operations, artisanal miners would also need to undergo formal training regarding mining operations. However, we have no plans of extending this programme because, as I already indicated, we are running out of concessions.

This quote suggests that it is not only experienced miners who suffer the financial repercussions of mineral exhaustion, but would-be miners also suffer the brunt of this phenomenon.

4.3 Hours of work

All workers of OMCL are engaged for a minimum of 8 hours a day from Monday to Friday. There are no work schedules for Saturdays and Sundays. Strictly, there is no work on public holidays. However, when required, workers who agree to work on the weekends are paid additional monies. Interviews with the workers showed that they had no problems working on the weekends, the extra money been the motivation. Confirming the 'mining-farming' complementarities, see for example (Okoh and Hilson, 2011; Persaud et al., 2017; Ofosu et al., 2020), one of the workers expressed:

> I like to work on weekends when I am required to do so. Obviously, money is the motivating factor. Working on weekends gives me extra money which I invest in my poultry farm business.

However, the weekend jobs had also been scrapped. Workers who used to work on weekends to earn extra money to supplement their incomes have thus been affected. One worker expressed the negative effect in the following words:

> I secured a loan from the bank in order to start a building project for myself and the family. I was using the money secured from working on weekends to pay off this loan monthly. The weekend jobs are now no more, and I have to pay from my normal monthly salary. I have about one more year to pay off this loan and this is really giving me headaches.

4.4 Skills and training

In the small-scale mining business, mineworkers do not usually have any formal mining training and skills. Thus, mining regulations in Ghana stipulate that semi-formal training and skills should be provided to small-scale miners by the Inspectorate Division of the Ghana Minerals

Commission and the Ministry of Lands, Forestry and Mines. Discussions with the project manager of OMCL revealed that indeed the Inspectorate Division of the MC visited them twice, when the operations started, in order to provide some form of training to the workers. However, with the training not forthcoming from the regulatory institution, management decided to offer training and refresher courses for their employees. The training was usually undertaken every 4 months. It involved the hiring of resource personnel to offer mining-related training. Workers usually were incentivised with a sum of Ghc 200 (ca. US$ 33) for partaking in the training programme. However due to the dwindling fortunes, management had decided to scrap the programme. No training programme was offered in the second half of 2020 and no training had been planned for 2021. A senior officer of OMCL explained it thus:

> We have decided to scrap the training programmes. Although training mine workers frequently is a good idea considering the high rates of occupational hazards associated with this job, we can no longer afford the monetary expenditure

This hints that the vulnerabilities that emerge due to mineral exhaustion are not only in financial terms. Even the capacity building programmes for miners become affected (in)directly. Fortunately, as earlier indicated, management of the company had put in place mitigation mechanisms to cushion the workers from the socio-economic hardships engendered, (in)directly, by the exhaustion of minerals. We take a look at these mechanisms.

5. Mitigation mechanisms

Payment of compensation

As pointed out earlier, some of the workers had been retrenched. However, management was able to put exit strategies and mitigation mechanisms in place for these ex-employees. The retrenched workers had all been paid compensations in accordance with the labour regulations. Compensations packages ranged between Ghc 5,000 – 10,000 (ca. US$ 830 – 1,665) depending on the length of service. To confirm the compensation issue, 10 of the retrenched workers were contacted and they all confirmed receipt of their compensation packages. One of them had this to say:

> I received my compensation money last year, 3 months after the retrenchment had taken place. Unlike my previous job, I was confident that compensation would be paid because here I had a permanent contract and thus felt a sense of security.

Another worker, although very much disappointed for been retrenched, praised management for paying him a compensation package. He told the researcher that he had invested part of the money in a grocery business:

> I was informed by the project manager that my services were no longer required due to the dwindling mineral wealth of the site, and the rising levels of the cost of production. I was paid a compensation for my service (about Ghc 7,500 (ca. US$ 1,250)). I have been able to use part of the money in setting up a grocery business. This is what sustains me and my nuclear family. Although I still feel disappointed for facing retrenchment, at least I'm happy that I got something substantial to set up this business

Management plans to contact and recruit these former workers once new concessions had been acquired and new workers are required. When the researcher asked some of the retrenched workers whether they would be willing to return to the company in case their services were required, one of them said:

> Yes, my brother. I am always willing to return. I am praying for that day when they will ask me to come back to the mining site. Who doesn't want a good job?

5.1 Mitigation derived from land reclamation

Here, it is worth remarking that OMCL undertakes massive reclamation exercises after excavation activities have been completed. The boulders (bigger rocks), the subsoil and the topsoil are used to refill the pits after excavation activities are completed. This is what is referred to as a *primary reclamation* exercise. A second exercise known as *secondary reclamation* involves the re-vegetation and cultivation of the reclaimed lands. As a way of supporting the retrenched workers economically, they are offered the opportunity to cultivate some of the reclaimed sites in order to produce food to supplement their retrenchment benefits. Some of the ex-employees decided to take advantage of this opportunity. One of them expressed the benefits in this way:

> Management decided that we could work on the reclaimed sites for almost a year before the lands were returned to the landowners. I took advantage of this opportunity and was

> able to cultivate a lot of vegetables for sale. I made not less than Ghc 2,500 (ca. US$ 417) during the harvest season.

To ensure that the land is environmentally safe for crop cultivation, and to prevent the transfer of mining-related heavy metals and pollutants to the food chain, interviews with the project manager of OMCL and officers of the EPA revealed that samples of the harvested food are regularly 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, acinic etc. 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 OMCL does not employ the use of mercury or other chemicals in the mining, and mineral processing stage.

The reclamation phenomenon and its beneficial consequences show that contrary to popular perception that ASM activities border on environmental criminality, for example, land degradation, leading to reduction in the production of food and cash crops, small-scale miners can be good stewards of the environment. The beneficial consequences of land reclamation also highlights the need to pay much attention to the reclamation of mining-degraded lands in most mining communities as a way of helping rural mining communities especially benefit from 'the-above-and-below-the-ground resources' (Slack, 2013).

5.2 Mitigation in relation to occupational health and safety

Health and safety

As earlier noted, occupational health and safety issues, and workers welfare in relation to ASM operations have come to represent a conundrum, see for example (Verbrugge, 2015). This was however not the case with the operations of OMCL. Management of OMCL, aware of the high level of occupational risks involved in mining projects, see for example (Kyerematen-Amoah and Clarke, 2015; Stemn et al., 2021), with its significantly negative impacts on productivity, has put in place facilities at the mine site both for prevention and management of occupational injuries. The researcher observed that all workers wore protective clothing, which includes uniforms, masks, boots, and helmets. A health post managed by a nurse has also been established

at the mine site to provide health services to the workers. Furthermore, in conjunction with health officials of the nearby hospital, management have put in place emergency response and evacuation plans at the mine site. In addition, all the employees are insured against occupational accidents and injuries. Discussions with the workers showed that they are aware that they are insured.

With regards to issues concerning the provision of shelter for the employees, a permanent structure which serves as shelter has been provided for workers. Besides, a toilet facility, and a borehole which provides water are available at the mine site. The mine manager however revealed that some of the workers who had had previous working experiences with illegal mining complained that they were not comfortable with the boots and helmets. They felt the boots, especially, were heavy for their feet. The mine manager however makes sure that all workers always wear their protective equipment. He said:

> Initially we had problems with some of the workers concerning the use of the personal protective equipment. Some of them were not particularly willing to wear the boots. We however insisted that they wear this equipment at all times once they are in our premises. Gradually they accepted the practice to wear them.

5.3 Security at the workplace

Due to the valuable nature of most minerals, mine sites can be very dangerous places as they can easily be targets of armed robbers and other criminals. Hence management of OMCL takes the issue of the security of the workers and that of the workplace very seriously. Thus, various security measures have been put in place. First, there is a security post placed at the entrance to the main mine site. This post is usually manned by not less than 2 security personnel. These personnel are responsible for scrutinising all the people and materials that enter the mine site. In addition, another security post has been stationed at the main permanent structure inside the mining yard. This post is controlled by the chief security officer together with 2 other security men. Management also has a direct arrangement with the nearby police staff who they can call upon when emergency response is required. In addition, security cameras (CCTVs) have been installed in the main administrative building in the mining yard. Especially during the times

when the processed gold is to be transported from the site, security is reinforced with additional security provided by staff of the Ghana Police Service and other private security personnel.

In this regard, the researcher sought to find out from the workers the extent to which they feel secure when undertaking their various duties inside the mining compound. Almost all the workers expressed satisfaction at the level of security provided. This was captured vividly by one of the female workers:

> As a woman, I know mine work can be very dangerous for me. Women are generally vulnerable to criminal attacks, and this can be no different on mine sites. However, I feel very safe working in this compound. The level of security provided is very good and so far, no criminal incidents have been witnessed here

Contents of the woman's last sentence was confirmed by the mine captain who explained to the researcher that since operations started, no criminal attacks or incidents have been reported on the site. In addition, the police officers in the nearby town pay them regular security visits to ensure the work site is safe.

Although management of OMCL had put in place these mitigation mechanisms in order to cushion the workers from economic hardships arising out of the retrenchment programme in particular however, elements of vulnerabilities were discovered. We examine this in the paragraphs that follow.

6. The issue of profligacy/lack of investment culture

The thorny issue of profligacy or lack of investment culture in ASM, see for example (Walsh, 2003; Cuvelier, 2014), also surfaced in interviews with some of the employees and the retrenched workers. Although some of the current and retrenched workers had diversified and invested their monies in other businesses, confirming findings by, for example, Hilson and Garforth (2013) and Mkodzongi and Spiegel (2019) that miners put their monies to good use, interviews with some of the retrenched workers indicated that their monies were not put to good use, to put it mildly. The following revelations emerged from interviews with the ex-employees: one of them said:

> I received a compensation of about Ghc 7,500 (ca. US$ 1,250). However, to tell you the truth, I never thought of investing the money in any business operation. Although I had

> plans of using the money to travel abroad, I ended up using the money to furnish my room. I bought a flat screen TV and other gadgets. Now I don't have any business or money. I eventually had to sell the TV. Life is hard.

Another had this to say:

> My compensation money amounted to about Ghc 7,000 (ca. US$ 1,167). I had initially thought of investing the money in the transportation business, but I ended up spending it on some consumables. On hindsight I think I should have seriously invested the money. Now money is hard to come by and I'm just praying that I'll find a job with one of the mining companies around this area.

One had a somehow unfortunate story to tell:

> I have worked in the *galamsey* business for a long time, and I used to make a lot of money. Eventually, I was employed by OMCL and my salary was good too. But it is sad to say, and I am shy to say it, but I cannot point to one specific property or business I invested in. My wife died and I still live in her family house. Now I am over 60 years, and it is my daughters who sometimes send me money to cater for myself. Perhaps the gods of gold were not favourable to me, and they came for their money.

Although the last interviewee admits that he lacked investment plans, his last sentence relates to the observation of the 'bitter money' phenomenon in ASM where it is believed that gold is imbued with spiritual powers and that sometimes the powers direct which way the money is to be spent, usually in profligate manner (Werthmann, 2003).

Interviews with some of the apprentices who had received permanent employment revealed that they too had no savings culture, perhaps unaware of the transient nature of their jobs due to the depletable nature of resources. Although they had witnessed some of the workers retrenched and had clearly been communicated to regarding further retrenchment exercises, two of the apprentices who had been permanently employed indicated that they had no savings. As indicated earlier, one of the apprentices said he received good money and planned to attend the School of Mines. However, he had not saved any money towards this ambition. When quizzed on how much he had saved from his job, he replied:

> I know it is important but why should I do that now. You think that is important than wearing good clothes and expensive shoes especially when I have to go to church on Sundays? This company will pay me every month, won't they?

This hints that rather than the lack of resources, it is the lack of utilisation of resources that usually render most miners vulnerable. One of the apprentices also had no plans of investment, he told the researcher:

> I have saved some money, but I plan to buy a car next year for my personal use. At least my mates and family members would know that I'm working and I'm somebody.

These revelations clearly show that these young men are completely unaware of the depletion phenomenon, thus the need to save and invest their monies. They lack basic understanding of the transient nature of the job they are engaged in, thus the need to diversify their income portfolios. For example, although buying a car for personal use is not a bad idea, the irrelevance of the interviewee's decision could be viewed in the context that OMCL provides buses that convey the workers to and from the mine site. Considering the transient nature of the job therefore, a much better decision would be to buy a car to provide, for example, 'Taxi' services than for personal use. This hints that measures to address sustainability and reduction of vulnerabilities in ASM settings should seriously encompass lessons on investment, savings, and income diversification, which leads us to our concluding thoughts and discussions.

7. Discussion and conclusion

This empirical study seeks to reignite the debates on mineral exhaustion and its livelihood implications. Although the ASM sector has experienced a phenomenal expansion in most rural areas, contributing enormously to employment generation, the depletion of resources, based on the fact that the sector is hinged on the availability of non-renewable resources, has rendered many miners, especially in the informal sector, socio-economically vulnerable. Miners also face economic vulnerability because their earnings can be extremely volatile. Mining entrepreneurs take big financial risks by investing huge sums of money in the preparation of mining pits without any guarantee of finding minerals. Ordinary, usually poverty-stricken miners take a small financial gamble, but they put their life and health at risk due to poor and exploitative labour conditions. Much of the existing literature and media reports have highlighted these facts.

However, a critical point worth noting is that these vulnerabilities and exploitative labour practices are semblances of the informal nature of most ASM operations.

If so, relevant questions worth asking are: how do vulnerabilities emerge in formalised ASM settings, what are the mitigation mechanisms and exit strategies and how are vulnerabilities dealt with in these formalised settings? In this regard, evidence from our case study suggests that indeed mineral exhaustion has negative consequences on the livelihood of miners. However, the negative implications could be mitigated, mediated through financial packages to help miners diversify their incomes during and after the life of the mine. The persistence of vulnerabilities therefore is engendered, largely, by the profligate spending phenomenon and lack of investment culture. Focussing on the SDGs, this study has provided evidence to the effect that small-scale mining operations can indeed contribute to the attainment of, for example, poverty alleviation (SDG1) through employment generation and good labour management practices, and the attainment of sustainable environmental practices (SDG15) through land reclamation mechanisms.

The findings of this study which also indicate that, contrary to popular perception, small-scale miners can be stewards of good labour management practices, bring to the fore, once again, the issue of formalisation of small-scale business operations in general, and ASM operations in particular. The particularly poor and exploitative labour practices evident in informal ASM settings are functions of the expansive bureaucratic procedures and high license fees that hinder ASM entrepreneurs from formalising their business operations (Hilson, 2017; Geenen, 2012; Siwale and Siwale, 2017). If mining authorities have the welfare of the large number of poverty-stricken workers populating the ASM sector at heart, then efforts should be made to ease the existing bureaucratic and costly licensing procedures (Hilson and Maconachie, 2020a).

In addition, of importance to the findings in this study is the issue of access to mineralised lands for ASM operators. Here, it is worth reiterating that both MF and OMCL were able to formalise their operations because both companies had been able to secure mineralised concessions which were amenable for small-scale mining. Moreover, as indicated, OMCL was able to 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 (Hilson,

2017). Thus in addressing policies to help in the attainment of the SDGs, policymakers would need to address the thorny issue of access to mineralised lands for ASM operators, see for example (Hilson and Maconachie, 2020a).

Moving forward, one very important point, which was highlighted by a reviewer of this paper, is the issue of 'mineral exhaustion/depletion'. Understandably, mineral resources are non-renewable, and that eventually, the ores (gold-laden soils) get mined out. What has been missing in the discussions is that due to the high rates of informality that characterise the ASM industry, the ground or mineral concessions are not properly prospected, and exploration conducted to determine the volume and tonnage of the underground mineral riches. In the end, the mining operators often exploit the land haphazardly without any professional guidance or input and assume that the mineral resource is exhausted. In Ghana, for example, where this study was undertaken, there are many large, formalised mining companies (for example GoldFields Ghana, Kibi Goldfields, AngloGold Ashanti Iduapriem) that have been working on the same concession for several decades. These companies are able to mine these concessions and discover new areas of mineralisation because they invest in technological improvements in exploration in order maximise the rate of discovery of mineral ores and also minimise discovery costs.

In seeking to formalise, and promote ASM as a sustainable livelihood activity therefore, mining governance regimes would need to address the issue of provision of technology for mineral exploration in ASM in order to improve the length of time ASM operators can mine a particular concession. Large –scale mining companies can also help ASM owners in this regard. With regards to this, we also indicate that as with the arrangement between MF and OMCL, large-scale mining companies could lease some of their concessions amenable for small-scale mining to small-scale mining operators. Mining governance regimes should also prioritise the availability of mineral-rich lands to small-scale mining operators (Hilson, 2017). In cases where small-scale amenable lands have already been allocated to large-scale mining companies, there should be arrangements to give these lands to small-scale mining operators. This has widely been noted by scholars such as Aubynn (2009), Hilson (2017) etc. However, we add that to help attain, for example, SDG8 relating to the creation of better work environments, the land arrangement should come with the condition that the small-scale mining entrepreneurs conform to good employment

regulations. This should include, for example, the issuance of work contracts, payment of insurance and health benefits and negotiated fixed salaries.

Equally importantly, compensation packages must be included in the working conditions of labourers. This would help achieve more sustainable livelihoods that extend beyond the life of the mine. In addition, before the life of the mine, training programmes should be organised for inexperienced workers to help reduce the high rates of occupational hazards like mine accidents usually associated with ASM operations, see (Stemn et al., 2021).

From a gender equality dimension, the researchers found that the number of female employees at the case organisation was very small (out of the 98 employees, only 5 were females). The women were engaged in roles as health assistant (1), cleaner (1), production member (1), receptionist (1) and secretary (1). However, research (e.g. Bashwira and Cuvelier, 2019; Maclin et al., 2017; Arthur-Holmes, 2021) has shown that in mainly informal ASM places, women constitute a substantial portion of the labour force. When the researcher of this present study quizzed the project manager of the case organisation why there were so few female employees, he explained it this way:

> The work is intensive and mechanised, so women are not needed. It also depends on the qualification of the women. In my long history in this mining business, I have hardly come across women as engineers and machine operators.

If the statement above is to be considered a truism, it would be a threat to the attainment of, for example, gender equality (SDG5). And this is where ASM scholars can be useful. Further studies are needed that examine whether the low rate of female employees is a wider feature of formalised and mechanised ASM settings. If so, which policies could be enacted to address the gender imbalance?

To conclude, we reiterate that in designing policies for the attainment of the SDGs, for example, mining governance regimes must encourage diversification and income investment. Formalisation and sustainable management of ASM must include lessons on income diversification and investment. Formal lessons on ASM operations should also tie in with lessons on income diversification and investment. This is important considering the finite nature of minerals, and the 'hot money' and 'profligate spending' syndrome sometimes associated with

ASM operators, see (Walsh, 2003). The finite and depletable nature of minerals means that, even in the best of circumstances, miners would be rendered jobless in the short and medium term. Much has been written about the need to formalise and support ASM operators in the informal zones. However, to 'leave no-one behind', attention also needs to be paid to those operators already in the formal zones. Comprehensive policy programmes should be designed that include educating miners on the need to take advantage of the potential economic multiplier effects of ASM. This includes the need to save their incomes in order to invest in more sustainable economic ventures such as property, transport, agriculture, and commerce.

References

ACET (2017) The Impact of Expanding Artisanal and Small-scale Mining on Small Holder Agriculture in West Africa. A Case Study of Burkina Faso, Ghana and Sierra Leone. African Center for Economic Transformation. Ford Foundation.

Andrews, N. (2015) Digging for survival and/or justice? The drivers of illegal mining activities in Western Ghana. Africa Today. 62 (2), 3–24.

Appiah, H. (1998) Organization of small scale mining activities in Ghana. Journal of the Southern African Institute of Mining and Metallurgy. 98 (7), 307–310.

Arifin, Y. et al. (2015) Impacts of artisanal and Small-Scale Gold Mining (ASGM) on environment and human health of gorontalo utara regency, Gorontalo Province, Indonesia. Geosciences. 5 (2), 160–176.

Arthur-Holmes, F. (2021) Gendered division of labour and "sympathy" in artisanal and small-scale gold mining in Prestea-Huni Valley Municipality, Ghana. Journal of Rural Studies. 81358–362.

Aubynn, A. (2009) Sustainable solution or a marriage of inconvenience? The coexistence of large-scale mining and artisanal and small-scale mining on the Abosso Goldfields concession in Western Ghana. Resources Policy. 34 (1–2), 64–70.

Banchirigah, S. M. (2008) Challenges with eradicating illegal mining in Ghana: A perspective from the grassroots. Resources policy. 33 (1), 29–38.

Banchirigah, S. M. (2006) How have reforms fuelled the expansion of artisanal mining? Evidence from sub-Saharan Africa. Resources Policy. 31 (3), 165–171.

Banchirigah, S. M. & Hilson, G. (2010) De-agrarianization, re-agrarianization and local economic development: Re-orientating livelihoods in African artisanal mining communities. Policy Sciences. 43 (2), 157–180.

Bansah, K. J. (2019) From diurnal to nocturnal: Surviving in a chaotic artisanal and small-scale mining sector. Resources Policy. 64101475.

Bansah, K. J. et al. (2016) The hazardous nature of small scale underground mining in Ghana. Journal of Sustainable Mining. 15 (1), 8–25.

Barreto, M. L. et al. (2018) The Impact of small-scale mining operations on economies and livelihoods in Low-to Middle-Income Countries. UK Department for International Development, London.

Bashwira, M.-R. & Cuvelier, J. (2019) Women, mining and power in southeastern Democratic Republic of Congo: The case of Kisengo. The Extractive Industries and Society. 6 (3), 960–967.

Boadi, S. et al. (2016) An analysis of illegal mining on the Offin shelterbelt forest reserve, Ghana: Implications on community livelihood. Journal of Sustainable Mining. 15 (3), 115–119.

Bryceson, D. F. & Jønsson, J. B. (2010) Gold digging careers in rural East Africa: Small-scale miners' livelihood choices. World Development. 38 (3), 379–392.

Cartier, L. E. & Bürge, M. (2011) Agriculture and artisanal gold mining in Sierra Leone: alternatives or complements? Journal of International Development. 23 (8), 1080–1099.

Chigumira, E. (2018) Political ecology of agrarian transformation: The nexus of mining and agriculture in Sanyati District, Zimbabwe. Journal of rural studies. 61265–276.

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.

Cuvelier, J. (2014) Work and masculinity in Katanga's artisanal mines. Africa Spectrum. 49 (2), 3–26.

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.

Eduful, M. et al. (2020) The Illegal Artisanal and Small-scale mining (Galamsey)'Menace'in Ghana: Is Military-Style Approach the Answer? Resources Policy. 68101732.

Fisher, R. et al. (2019) Artisanal and small-scale mining and rural livelihood diversification: The case of manganese extraction in West Timor, Indonesia. The Extractive Industries and Society. 6 (1), 229–240.

Geenen, S. (2012) A dangerous bet: The challenges of formalizing artisanal mining in the Democratic Republic of Congo. Resources Policy. 37 (3), 322–330.

Geenen, S. (2014) Dispossession, displacement and resistance: Artisanal miners in a gold concession in South-Kivu, Democratic Republic of Congo. Resources Policy. 4090–99.

Hasibuan, O. P. et al. (2020) Illegal gold mining in Indonesia: structure and causes. International Journal of Emerging Markets.

Hilson, G. et al. (2014) Chinese participation in Ghana's informal gold mining economy: Drivers, implications and clarifications. Journal of Rural Studies. 34,292–303.

Hilson, G. (2016) Farming, small-scale mining and rural livelihoods in Sub-Saharan Africa: A critical overview. The Extractive Industries and Society. 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'. Resources Policy. 54,109–116.

Hilson, G. & Ackah-Baidoo, A. (2011) Can microcredit services alleviate hardship in African small-scale mining communities? World Development. 39 (7), 1191–1203.

Hilson, G. & Garforth, C. (2012) 'Agricultural poverty'and the expansion of artisanal mining in Sub-Saharan Africa: experiences from Southwest Mali and Southeast Ghana. Population research and policy review. 31 (3), 435–464.

Hilson, G. & Garforth, C. (2013) 'Everyone now is concentrating on the mining': drivers and implications of rural economic transition in the eastern region of Ghana. The Journal of Development Studies. 49 (3), 348–364.

Hilson, G. & Maconachie, R. (2020a) Artisanal and small-scale mining and the Sustainable Development Goals: Opportunities and new directions for sub-Saharan Africa. Geoforum.

Hilson, G. & Maconachie, R. (2020b) Entrepreneurship and innovation in Africa's artisanal and small-scale mining sector: Developments and trajectories. Journal of Rural Studies. 78149–162.

Hilson, G. & Maconachie, R. (2020c) Entrepreneurship and innovation in Africa's artisanal and small-scale mining sector: Developments and trajectories. Journal of Rural Studies. 78149–162.

Hilson, G. & Van Bockstael, S. (2011) Diamond mining, rice farming and a 'maggi cube': a viable survival strategy in rural Liberia? Journal of International Development. 23 (8), 1042–1053.

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.

Kamlongera, P. J. (2011) Making the poor 'poorer'or alleviating poverty? Artisanal mining livelihoods in rural Malawi. Journal of International Development. 23 (8), 1128–1139.

Kitula, A. G. N. (2006) The environmental and socio-economic impacts of mining on local livelihoods in Tanzania: A case study of Geita District. Journal of cleaner production. 14 (3–4), 405–414.

Kyerematen-Amoah, E. & Clarke, E. E. (2015) Injuries among artisanal and small-scale gold miners in Ghana. International journal of environmental research and public health. 12 (9), 10886–10896.

Macháček, J. (2019) Typology of Environmental Impacts of Artisanal and Small-Scale Mining in African Great Lakes Region. Sustainability. 11 (11), 3027.

Maclin, B. J. et al. (2017) Moving to the mines: Motivations of men and women for migration to artisanal and small-scale mining sites in Eastern Democratic Republic of the Congo. Resources Policy. 51,115–122.

Maconachie, R. (2011) Re-agrarianising livelihoods in post-conflict Sierra Leone? Mineral wealth and rural change in artisanal and small-scale mining communities. Journal of International Development. 23 (8), 1054–1067.

Maconachie, R. & Conteh, F. (2021) Artisanal mining policy reforms, informality and challenges to the Sustainable Development Goals in Sierra Leone. Environmental Science & Policy. 11638–46.

Mantey, J. et al. (2016) Costed reclamation and decommissioning strategy for galamsey operations in 11 selected MDAs of. International Growth Centre.

Mkodzongi, G. & Spiegel, S. (2019) Artisanal gold mining and farming: Livelihood linkages and labour dynamics after land reforms in Zimbabwe. The Journal of Development Studies. 55 (10), 2145–2161.

Morton, S. et al. (2019) The sustainable development goals provide an important framework for addressing dangerous climate change and achieving wider public health benefits. Public Health. 17465–68.

Nyame, F. K. & Blocher, J. (2010) Influence of land tenure practices on artisanal mining activity in Ghana. Resources Policy. 35 (1), 47–53.

Ofosu, G. et al. (2020) Socio-economic and environmental implications of Artisanal and Small-scale Mining (ASM) on agriculture and livelihoods. Environmental Science & Policy. 106210–220.

Okoh, G. & Hilson, G. (2011) Poverty and livelihood diversification: Exploring the linkages between smallholder farming and artisanal mining in rural Ghana. Journal of International Development. 23 (8), 1100–1114.

Osei, L. et al. (2021) Government's ban on Artisanal and Small-Scale Mining, youth livelihoods and imagined futures in Ghana. Resources Policy. 71102008.

Pedersen, A. F. et al. (2021) Mineral exhaustion and its livelihood implications for artisanal and small-scale miners. Environmental Science & Policy. 11934–43.

Persaud, A. W. et al. (2017) Artisanal and small-scale gold mining in Senegal: livelihoods, customary authority, and formalization. Society & natural resources. 30 (8), 980–993.

Pijpers, R. (2014) Crops and carats: Exploring the interconnectedness of mining and agriculture in Sub-Saharan Africa. Futures. 62,32–39.

Ponomarenko, T. et al. (2021) Mineral resource depletion assessment: Alternatives, problems, results. Sustainability. 13 (2), 862.

Santopietro, G. D. (1998) Alternative methods for estimating resource rent and depletion cost: the case of Argentina's YPF. Resources Policy. 24 (1), 39–48.

Schmidt-Traub, G. et al. (2017) National baselines for the Sustainable Development Goals assessed in the SDG Index and Dashboards. Nature geoscience. 10 (8), 547–555.

Scoones, I. (1998) Sustainable rural livelihoods: a framework for analysis.

Shoko, D., SM (2002) Small-scale mining and alluvial gold panning within the Zambezi Basin: an ecological time bomb and tinderbox for future conflicts among riparian states. Managing Common Property in an Age of Globalisation: Zimbabwean Experiences. 67,85.

Siwale, A. & Siwale, T. (2017) Has the promise of formalizing artisanal and small-scale mining (ASM) failed? The case of Zambia. The Extractive Industries and Society. 4 (1), 191–201.

Slack, K. (2013) The growing battle between mining and agriculture. Oxfam. [online]. Available from: https://politicsofpoverty.oxfamamerica.org/2013/04/the-growing-battle-between-mining-and-agriculture/ (Accessed 19 September 2019).

Stemn, E. et al. (2021) Analysis of artisanal and small-scale gold mining accidents and fatalities in Ghana. Resources Policy. 74102295.

Stoop, N. & Verpoorten, M. (2020) Risk, Envy and Magic in the Artisanal Mining Sector of South Kivu, Democratic Republic of Congo. Development and Change.

Tarras-Wahlberg, N. H. et al. (2001) Environmental impacts and metal exposure of aquatic ecosystems in rivers contaminated by small scale gold mining: the Puyango River basin, southern Ecuador. Science of the Total Environment. 278 (1–3), 239–261.

Teschner, B. A. (2014) “Orpaillage pays for everything”: How artisanal mining supported rural institutions following Mali’s coup d’état. Futures. 62140–150.

Teschner, B. A. (2012) Small-scale mining in Ghana: The government and the galamsey. Resources Policy. 37 (3), 308–314.

Thornton, R. (2014) Zamazama,“illegal” artisanal miners, misrepresented by the South African Press and Government. The Extractive Industries and Society. 1 (2), 127–129.

Tomicic, C. et al. (2011) Human mercury exposure associated with small-scale gold mining in Burkina Faso. Int Arch Occup Environ Health. 84 (5), 539–546.

Traore, Adama. P. (1997) Introducing new technologies for abatement of global mercury pollution deriving from artisanal gold mining. UNIDO; ECA.

Verbrugge, B. et al. (2015) Min (d) ing the land: The relationship between artisanal and small-scale mining and surface land arrangements in the southern Philippines, eastern DRC and Liberia. Journal of Rural Studies. 3750–60.

Verbrugge, B. (2015) The economic logic of persistent informality: artisanal and small-scale mining in the southern Philippines. Development and Change. 46 (5), 1023–1046.

Verbrugge, B. (2016) Voices from below: artisanal-and small-scale mining as a product and catalyst of rural transformation. Journal of rural studies. 47108–116.

Wagner, L. (2016) Organized Crime and Illegally Mined Gold in Latin America. Global Initiative.

Walsh, A. (2003) ' Hot money' and daring consumption in a northern Malagasy sapphire-mining town. American Ethnologist. 30 (2), 290–305.

Walsh, A. (2012) After the rush: Living with uncertainty in a Malagasy mining town. Africa. 82 (2), 235–251.

Werthmann, K. (2003) Cowries, gold and 'bitter money'. Gold-mining and notions of ill-gotten wealth in Burkina Faso. Paideuma. 49105–124.

Worlanyo, A. S. & Jiangfeng, L. (2020) Evaluating the environmental and economic impact of mining for post-mined land restoration and land-use: A review. Journal of Environmental Management. 111623.

World Bank (2013) Artisanal and Small-Scale Mining. IBRD-IDA [online]. Available from: http://www.worldbank.org/en/topic/extractiveindustries/brief/artisanal-and-small-scale-mining.

Zolnikov, T. R. (2020) Effects of the government's ban in Ghana on women in artisanal and small-scale gold mining. Resources Policy. 65101561.