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A conceptual framework for reframing artisanal and small-scale mining: understanding characterization of artisanal and small-scale mining in South Africa

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Abstract

The categorization of artisanal and small-scale mining has a significant impact on perception and understanding of the sector, particularly from a livelihood perspective. Several developing countries classify different types of artisanal and small-scale mining based on legal status. Given the nature such activities, the tragedy of the commons theory has been applied to understand the inevitable environmental, economic, sociocultural, safety, and health negative externalities – which are products of informality and illegality. Consequently, formalization is a panacea to sustainability. This article aims to offer a conceptual organization and foundational knowledge for characterization of artisanal and small-scale mining. It seeks to identify existing literature on the subject to avoid replication and acknowledge other scholars. Moreover, the article aims to place the study within the context of existing literature, establishing relationships with other studies and why the research is necessary. This paper pinpoints gaps left from other studies in so far as the characterization of artisanal and small-scale mining is concerned. Thus, reviewing literature abetted in finding similarities and differences on how artisanal and small-scale mining is defined from a scholarly and legal basis. The paper ascertains major claims made by earlier research on this topic, such as environmental impacts, the lack of adequate regulatory framework, and presents querying and probing questions lacking from other studies.

Keywords

scholarly definition, legal definition, legal status, negative narratives, tragedy of the commons

Introduction

Artisanal and small-scale mining (ASM) is defined as subsistence-type mining conducted by individuals or groups of people, often characterized by informality and illegality.

ASM has experienced growth in past years due to the escalating value of mineral prices and rising challenges resulting from loss of income (IGF, 2017). It is estimated that over 40 million people, particularly in developing countries, are directly involved in ASM (World Bank, 2019). This paper presents dominant characterizations of ASM, drawing on scholarly, advocacy, and legal sources. Characterization also includes a focus on negative environmental and socioeconomic externalities of ASM, drawing on theory of the tragedy of the commons. As the discussion shows, the meaning given to ASM is multi-dimensional and country-specific. Nevertheless, it is important to derive a core understanding of ASM to reflect the South African context and provide a common understanding of terms to inform ASM interventions towards the management of challenges and opportunities presented by the sector.

Scholarly and legal definitions of artisanal and small-scale mining

Quite different definitions of ASM exist in scholarly and advocacy literature. The Mining and Sustainable Development report entitled Breaking *New Ground* (2002, p. 348) characterizes ASM as operations that 'exploit marginal or small deposits, lack capital, are labour intensive, have poor access to markets and support services, low standards of health and safety and a significant impact on the environment'. Hentschel et al. (2002 p. 18) add that ASM is 'mining by individuals, groups, families or cooperatives with minimal or no mechanization, often in the informal (illegal) sector of the market'. Hinton and Hollestelle (2012, p. 5) highlight the survivalist and subsistence character of ASM as an undertaking ordinarily conducted on a subsistence basis by individuals or small groups with simple tools. Goreux (2001, p. 10) contends that ASM is mainly 'a poverty driven activity, typically practiced in the poorest and most remote areas of

a country by a largely itinerant, poorly educated populace with little other employment alternatives'. Dreschler's (2001) definition captures most themes of the apparent dominant scholarly discourse on ASM (informality, poverty, subsistence, labour intensity, low levels of capital investment, and detrimental social, health, and environmental impacts). Ledwaba and Nhlengetwa (2016, p. 27) maintain that:

> 'ASM mining operations are unregulated; they range from activities conducted by individuals to junior operations; the majority of activities are poverty-driven, with a few business orientated; they can be permanent or seasonal in nature; they are technologically backwards using very little, if any, mechanization; the sub-sector is informal and carried out illegally; it is mainly unauthorized and undercapitalized; and it is known for the low standards of health, safety and environment.'

These themes are echoed and expanded upon in legal definitions of ASM from the mining laws of many jurisdictions where ASM takes place, including South Africa. As Table I and the discussion below show, the most common factors used to define ASM include the level of capital investment, level of technology, type of mineral, level of production, and the size and depth of mining. A contrast between scholarly and legal definitions indicates that the former refer more frequently to poverty, informality or survival, and

Table I

Definitions of artisanal and small-scale mining by country

Country	Criteria
Algeria	The Algeria Mining Code (2014) makes provision for an artisanal licence, which is issued for mining exploitation for a period of five years.
Burkina Faso	The Burkina Faso Mining Code (2015, a.5) states that artisanal mining (AM) includes 'all of the operations which consist in extracting and concentrating mineral substances such as gold, diamonds and other gems, coming from primary and secondary outcrops or outcropping and recovering the products merchants using manual and traditional methods and procedures'. Use of mercury, cyanide, and child labour is prohibited. The AM licence holder is mandated to enter into an agreement with landowners. They must compensate the landowner in the case of destroying cultivated fields.
Chad	The law defines AM as 'exploitation using manual or traditional methods and procedures or both at the same time, and which is not based on the prior identification of a deposit or a deposit' (Chad Mining Code 2018, s .1). The terms AM and small-scale mining (SSM) are used in combination. The same licence is valid for both. AM is legally restricted to alluvial deposits and alluvial mining.
Colombia	Colombian Mining Law (2013, d. 933) 'limits the size of ASM concessions to 150 ha for individuals and 500 ha for groups or associations of traditional miners, and only one concession each'. Communities undertake ASM activities on demarcated land as a livelihood. The law limits ASM activities to the aerial extent determined by the concession agreement.
Cote d'Ivoire	Cote d'Ivoire Mining Code (2014, a. 68) defines AM as undertaking of the extraction and concentration of mineral substances and recovery of marketable products using manual and traditional methods that do not use chemicals or explosives.
Democratic Republic of Congo (DRC)	AM is a level of mining undertaken by citizens in a specific designated area. An Exploration Card is issued to permit AM activities to be undertaken (DRC Mining Code, 2018). AM is permitted on an aerial extent determined by the Provincial Head of Mining, for not more than one year and at a depth of up to 30 m.
Ecuador	The Mining Law of Ecuador (2009) defines AM as 'mining activities carried out by an individual, a family or an association characterized by the use of hand tools and simple and portable machines to obtain minerals, the sale of which covers only the basic needs of the person or family involved and does not require an investment of more than 150 basic unified salaries (US $39,600)'. Permit holders can possess one permit for 10 years for a determined location, renewable for equal periods.
Ethiopia	Ethiopia Mining Operations Proclamation (2013) indicates that AM is manual in nature, with an anticipated annual production, and does not involve the engagement of employed workers. AM is considered a subsistence activity.
Ghana	A licence for SSM is issued upon submission by Ghanaians of a capital investment of not less than USD 100,000, including an indication of the number of participants (Ghana Minerals and Mining Act 2006, s. 82). The licence covers all ASM activities and licence holders can mine any area licenced for a period of not more than five years. SSM operations are permissible on an aerial extent of 21 ha. The licence can be transferable and leased. The activity is linked to citizenship, investment, the number of participants, area, and time.
Guinea	The Guinea Mining Code (2006) defines artisanal operations as 'means an activity which consists of small-scale operation using traditional or no mechanized methods'. Artisanal operations refer to precious metals, such as gold and diamonds. Artisanal operations are permissible to persons of Guinean nationality. Artisanal operation permits limit the depths to 30 m and 15 m in cases of operation by lifters and digging, respectively (Guinea Mining Code 2006, a. 93). Areas reserved for artisanal operations and the perimeter thereof are designated by the responsible Minister.
Kenya	The Kenya Mining Act (2016) defines AM as 'traditional and customary mining operations using traditional or customary ways'. The Act defines four permits for the ASM sector to determine duration, area or size, mechanization, and investment level. These four permits are for AM, small-scale reconnaissance, small-scale prospecting, and SSM.
Mali	An AM licence is issued to Malian citizens based on capital investment, mechanization, and depth of mining (Mali Mining Code 2012).

Table I

Definitions of artisanal and small-scale mining by country ***(continued)***

Country	Criteria
Philippines	AM is based on the type of mineral mined. For example, a guano extraction permit is issued for 5 ha for one year (renewable); gemstone and gold panning and sluicing permit 0.2 ha for three months (renewable) (Philippines Mining Act 1995).
Rwanda	The SSM licence makes provision for ASM activities but does not make mention of the term ASM. ASM operations can be undertaken within 50 ha of any licenced area for a duration not exceeding 15 years. The mining licence is not restricted to nationals and the holder can relinquish part of the mining area (Rwanda Law on Mining and Quarry Operations 2018).
Senegal	Article 39 of the Senegal Mining Code of 2003 states that the permission for artisanal activities of extracting minerals using manual and traditional methods is within an aerial extent of 5 km^2 and a depth of 15 m (Senegal Mines and Mineral Development 2015, s. 29(3)).
Sierra Leone	The Sierra Leone Mines and Minerals Act (2008) restricts AM to nationals only. AM licences are issued for areas only in specific designated areas for a period of one year, renewable three times, on an area of 0.5 ha and depth of 10 m.
South Africa	The mining permit makes provision for ASM activities, though it does not mention the term ASM. ASM operations can be undertaken within 5 ha in any licenced area for a duration of two years, renewable three times (Mineral and Petroleum Resources Development Act 2002, s.27). The mining permit is not restricted to nationals but cannot be transferred or leased.
Tanzania	SSM is indirectly defined in the Mining Act of 2010 as a type of operation for which capital investment, including labour and technology, is less than USD 100,000; this entitles one to acquire a Primary Mining Licence (PML), which is valid for a period of seven years and renewable three times. It covers all ASM activities.
Uganda	The Uganda Mining Act (2003) defines a licence for ASM activities by a Ugandan citizen with no use of specialized technology or expenditure more than USD 3,000. The licence is issued for a period of two years and can be upgraded and transferred. Licence holders have the right to prospect, mine, and trade. The mining area depends on the type of deposit; for example, the mining area for precious stones is 500 m × 300 m.
Zambia	The Zambia Mines and Mineral Development Act (2015, s.29 (3)) defines AM based on the 'area of land (size of the concession) over which an application for a licence is lodged will be a minimum of one cadaster unit.' It is also based on technical and financial capacity.

subsistence, while legal definitions highlight the mining method, level of investment, area, depth, and duration: subsistence and poverty are almost never mentioned. Both scholarly and legal definitions suggest that ASM is a less-sophisticated livelihood.

The most common ways of characterizing ASM within the legal perspective are requirements such as the mining method, level of investment, area, depth, and duration. Legal sources characterize ASM according to rights, responsibilities, and obligations. Characterizing ASM by citizenship is common in countries such as Ghana, Uganda, and Mali, where ASM activities are reserved for citizens. In South Africa, the perception is that ASM is largely conducted by foreign migrants.

Most ASM activities are not allowed to operate with high capital investment or mechanization. Countries that have adopted the concept of limited capital investment include Uganda (USD 3,000) and Ecuador (USD 39,600). Use of mechanized equipment is restricted in Ghana. Countries such as Ecuador, Colombia, and Chad characterize ASM as an activity that uses traditional methods; however, use of traditional and/or manual tools may limit production levels and hinder development.

DRC and Tanzania have established zones for ASM exploitation and exploration. Relevant district or provincial mining offices must demarcate areas for artisanal operations. Countries such as Sierra Leone, Senegal, Rwanda, and Colombia characterize ASM based on the size of the mining area. Of these countries, Sierra Leone has the smallest size of 0.5 ha, while Colombia limits an individual concession to 150 ha. Several benefits are associated with this categorization concerning job creation for locals and development of local businesses (Bugnosen, 2003). For this reason, aerial size grants miners the ability to estimate the amount of investment needed, such as for infrastructure and labour.

The zoning approach used in DRC and Tanzania removes the need for application and processing procedures. It generally occurs in the form of a pronouncement or provisions incorporated into the relevant mining legislation to accommodate specific groups, particularly indigenous members of the community. Landowners in Papua New Guinea are allowed to extract gold from their lands without formal licensing, provided that only panning or other primitive methods are used (Bugnosen, 2003). The principle of free digging is embraced by countries such as Zambia, Uganda, and Philippines to legalize extraction of minerals by landowners or any lawful occupier (Bugnosen, 2003).

This demarcation system provides mining rights over a certain vertical extent or depth of a mineral deposit or given area. Countries that have adopted this concept include Ethiopia, Indonesia, and Papua New Guinea. The depths set by Ethiopia and Philippines, for instance, are 15 m and 50 m, respectively.

There are extremes in the legal definitions concerning time periods of licence validity. Philippines has the shortest time of three months; Tanzania provides the longest time for an ASM licence of seven years. Most countries permit ASM operation for periods between one and five years. These data show that, although there may be consensus on certain key themes in ASM, there is no consensus on the specifications considered when characterizing the activity.

Several mining laws distinguish between artisanal mining (AM) and small-scale mining (SSM). Countries such as Sierra Leone, DRC, Guinea, and Mali have a separate artisanal licence category.

This distinction allows different levels and needs of mining to be appropriately regulated. Countries such as Tanzania, Ghana, and South Africa (mining permit) have a single licence category for the entire range of operations, from AM to SSM. For example, the Mineral and Petroleum Resources Development Act (MPRDA) does not clearly state that a mining permit is for SSM; however, an assumption is created that a mining permit is for this activity because the mineral in question can be optimally mined within two years on an area not exceeding 5 ha.

There are wide-ranging positions on the actors, technologies, practices, and established capital provisions that distinguish SSM from ASM in scholarly literature. Barney (2018, p. 367) practically differentiated three broad groups in ASM: 'a) micro-scale, informal, artisanal; b) small-scale, illegal, semi-mechanized; and c) medium-scale, illegal, mechanized'. Barney pointed out that;

> 'globally, the micro artisanal part of ASM encompasses comparatively independent miners working marginally productive gold tracts, experiencing high levels of vulnerability and holding subordinate livelihood positions, but who also find support through non-market access to gold and other market or subsistence-based ecological resources'.

Specific minerals, such as gold, diamonds, and gemstones, are separately licenced by some countries and are the most common minerals targeted for small-scale licensing. In Guinea, Philippines, and Mongolia, ASM licences are issued within a specific category, such as strategic (including precious metals, gemstones, oil, and coal) and specific (ores and some non-metallic minerals) resources.

The informality and illegality of ASM are highlighted in the scholarly definitions, but only implicit in the legal definitions. ASM is formal when the needs of actors in the sector are fully catered for. Formalization entails that the activity is legal, viable, safe, and environmentally responsible (Mutemeri et al., 2016). If the activity is informal within a legal context, a transition from informal to formality is possible where the regulatory framework is supportive, such as in DRC and Sierra Leone. Sustainable livelihoods are then achieved and enhanced through supportive structures, such as access to markets, financial support, and education and training, especially in environmental management, health, and safety.

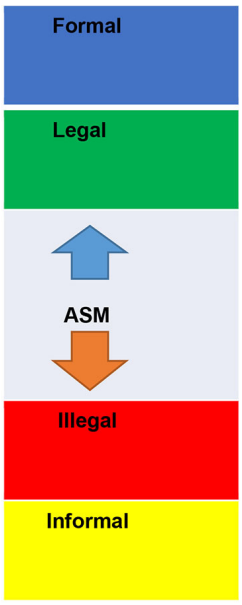

Figure 1—Types of artisanal and small-scale mining based on legal status

None of the legal definitions highlight the lack of these features as characteristic of ASM. Illegal ASM operates outside of the law, informally, and, in some instances, criminally. Within the South African context, ASM is mostly conducted under precarious conditions in disused mines. Ledwaba and Mutemeri (2017, p.18) comment on informal ASM as 'illegal, but that it is tolerated because of legitimacy inferred by socioeconomic and political imperatives'. This can be seen when the local or traditional authorities who own the land permit the activity to be undertaken as a livelihood for the poor. Figure 1 illustrates the relationship between types of ASM based on legal status.

The categories of formal/informal and legal/illegal can be used as the basis for a typology of ASM:

- *Formal/legal:* In some jurisdictions, ASM is formal (access to markets, financial support, education and training, payment of taxes, responsible environmental, health, and safety conduct) and legal (in compliance with a specific regulatory framework). This, for example, is the case in Tanzania.
- *Informal/illegal:* South Africa is an example where most ASM activity is both informal and illegal, not supported, conducted outside of the law, and criminalized. There is normally a high degree of irresponsibility because the miners are not registered and therefore not accountable.
- *Informal/legal:* In countries such as Ecuador, Ghana, and Peru, formality is only de jure and not de facto. This is linked with failure to enforce the legal requirements.
- *Formal/illegal:* In certain jurisdictions, such as in Ghana and Philippines, ASM may receive some formal support (possibly through traditional structures) yet operate outside a formal regulatory frame.

The overwhelming categorization of ASM in scholarly literature is that it is an informal and illegal economic activity. The characterization of ASM as illegal persists, because the activities violate the mining permit requirements, health and safety duties, and other mining-related laws. However, the illegality of ASM may be exacerbated by inadequate legal provisions, rather than obvious criminal intent on the part of those undertaking the work (Legal Resource Centre, 2016).

Negative externalities of artisanal and small-scale mining

The characterization of ASM can be further enriched by elaborating on negative externalities associated with the sector, a typology of which is presented in Table II.

First, ASM triggers a variety of environment-related impacts. Gunson and Jian (2001) argue that mined land is changed, reducing its utility for other purposes, such as farming. Significant landscape destruction results from operation of AM because the open pits often cause death of both humans and animals, particularly when filled with water. They also serve as breeding grounds for mosquitoes. AM activities may disturb the water table, geological stability, and surrounding ecosystems. Lombe (2003, p. 96) argued that 'activities such as gold panning along rivers may alter riverbeds and cause siltation which would affect the river flow'. For instance, gold panning on the Zambezi River's riverbeds in Southern Africa causes heavy siltation, making the river shallower each year. In addition, heavy metals and chemicals like mercury and cyanide also end up in water bodies, causing serious damage to both aquatic life forms and humans (Lombe, 2003). Environmental degradation is the most visible of the negative impacts associated with AM. It may also be difficult to manage environmental impacts, given that the practice is elusive and illegal.

Table II

Negative externalities of artisanal and small-scale mining (adapted from Zvarivadza, 2018)

Environmental	Safety and health	Social	Economic
Pollution of water sources	Spread of diseases	Substance abuse	Corruption
Land degradation	Lack of protective clothing	Child labour	Mineral-rush effect
Mercury and cyanide pollution	Poor lighting	Prostitution	Lack of planning
Soil erosion	Exposure to dust and toxic gases	Conflicts (turf wars)	Lack of education
Dust pollution	Unsafe working tools	Destruction of cultural values and sites	Money laundering
Waste, including faecal matter	Poorly supported working conditions	Gender discrimination	Hindrance to economic growth

Second, socio-cultural disturbances are an effect of ASM. Several problems arise as a result of the discovery of mineral deposits. For instance, one might submit that migration related to ASM attracts people from diverse socio-cultural backgrounds and with different sets of cultural beliefs and norms. With a reputation for rapid wealth generation, ASM also attracts unlawful and immoral activities like money laundering, substance abuse, theft, and prostitution (Dreschler, 2001). Gyan-Baffour (2003, p. 4) adds that 'because of breakdown in law and order in most of these mining areas those who have some savings tend to spend most of their savings on alcohol, prostitution, and gambling at the expense of productive investment'. Thus, high rates of prostitution, crime, and sexually transmitted diseases, like HIV/AIDS, have been reported in mining communities (Fisher, 2008). The decay in socio-cultural values and increase in criminality in mining areas require clear policy guidelines and administration of AM activities to avert serious negative consequences that may result.

Third, the status of occupational health and safety (OHS) in AM is deplorable. The Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) (2017, p. 22) states that 'most OHS risks in sub-Saharan Africa (SSA) are borne by women, due to the division of tasks between male and female miners'. Mine accidents range from rock falls, mine cave-ins, to flooding; health hazards include mercury poisoning and silicosis (Hentschel et al., 2002). A study conducted in Tanzania by the World Bank Group (2015) on mercury levels in the breast milk of mothers living at ASM sites found that 22 of the 46 children from these mothers had high levels exceeding the World Health Organization (WHO) limit for public exposure of 1.0 μg/m^3. Accidents arise from the absence of knowledge about mining, poor education, and ignorance of risks and dangers. ASM miners also lack guidance on the usage and handling of explosives and deadly chemicals like mercury and cyanide (Hentschel et al., 2002). As a result, they tend to misuse chemicals and explosives, thereby exposing themselves and their communities to many dangers. Another major hazard on ASM sites is poor sanitation: the transitory nature of AM discourages building of sanitation facilities, leading to widespread occurrence of contagious waterborne illnesses like bilharzia and diarrhea (Fisher, 2008).

OHS is not given much priority in AM. Unless operators have formerly worked in large mining companies, artisanal miners are ignorant of the associated risks (MMSD Project Report, 2002); thus, they do not take safety measures like wearing helmets and safety shoes. In addition, the conditions in which they work are appalling, exacerbating the potential for accidents and disease outbreaks. Labour standards are also poor. Yakovleva (2007, p. 36) argued that working conditions, especially wages, are not standardized. She cites the example of women who are generally paid less than their male colleagues. Although women are not involved in heavy duties like digging, their wages are not equal to the amount of work they do; however, because of high levels of poverty, numerous people are forced to work in these hazardous conditions for very minimal incomes to enable their survival.

Use of hazardous substances puts the health of miners at risk. Artisanal miners and their communities are exposed to mercury, zinc vapour, cyanide, and other acids (Obiri et al., 2010). Mercury is frequently deployed in artisanal gold mining and cyanide use is growing. Mercury can be inhaled, swallowed, or absorbed through the skin, but the health consequences are usually not immediate (Agency for Toxic Substances and Disease Registry, 2024). Inhaling dust and fine particles from blasting and drilling processes can cause respiratory diseases, such as silicosis or pneumoconiosis in adults, and in children who often accompany their parents (Vanka et al., 2022). The Minamata Convention, a legally binding instrument, was initiated in 2013 by the United Nations Environment Programme to reduce trade, supply, and use of mercury and to promote mercury-free technologies in ASM (Minamata Convention on Mercury, 2013). The convention identified ASM as one of the largest anthropogenic sources of mercury pollution, with some 1400 t/a emitted (IGF, 2017). According to the United Nations Environment (2017, p. 27), 51 countries have ratified and 120 have shown interest in signing this convention. Practical efforts to control and reduce the use of mercury include the establishment of National Action Plans in all countries where ASM is undertaken. However, Spiegel (2018, p. 2) criticized the Minamata Convention in that it fails to consider the socioeconomic context of mining sites where power relations of different stakeholders influence the trade and use of mercury.

Although many countries, having endorsed International Labour Organisation (ILO) Convention 182, have abolished the worst forms of child labour, this practice seems to be the norm in many countries where artisanal mining takes place (Hentschel et al., 2002). A huge number of children are involved in ASM in SSA and in other developing countries (Bodenheimer, 2014). Although the exact number is not known, it is estimated that more than two million children worldwide are directly and indirectly involved in mining (ILO, 2004). The poverty associated with AM means that every family member, including children, must participate for survival. It has been observed that each member has a role in the AM family (Lungu, 2007). Lack of money to send children to school and the dearth of nearby schools are some of the claims that parents put forward to explain the involvement of their children

in mining (Hentschel et al., 2002); however, one can argue that the participation of minors in AM places them in hazardous working environments and leads to neglect of their education.

The *Global Report on Artisanal and Small-Scale Mining* held that children as young as three were being used in ASM (Hentschel et al., 2002). The participation of minors in ASM exposes them to severe and hazardous working conditions, and creates risks to their health (ILO, 2004). Moreover, children may be deprived of their right to education, thus denying them a future, with no employment choices other than following the ways of their forefathers in AM. As a result, formalizing AM would enable an environment that allows for better living and working conditions, comprises decent wages, and eradicates improper work practices. Miners will be obligated to observe and highly regard OHS standards, which would also ensure that just and fair working conditions are put in place and that child labour is eliminated.

Economic negative externalities associated with ASM can be disastrous for individuals, and the community at large, because the activity is primarily informal and illegal. Hence, Zvarivadza (2018, p. 3) states that the sector is difficult to regulate or implement approaches to manage socioeconomic challenges. Irresponsible exploitation of minerals may inevitably result in economic disasters, such as corruption, the tragedy of the commons, shortsighted planning, and lack of collateral security (Buxton, 2013). Thus, the economic implications of ASM can result in localized inflation, destruction of infrastructure, exploitation of labour, discrimination, failure to adapt to technology, and xenophobia due to increase in-migration of people. However, ASM can play an important role in economic growth if governments can absorb this sector as a mainstream activity (Zvarivadza, 2018).

Tragedy of the Commons Theory

A commonly applied theory to the kinds of negative environmental, social, and economic problems outlined above is the tragedy of the commons, popularized by Garrett Hardin (1968) in his seminal essay. The commons is a 'natural resource shared by many individuals' (Hardin, 1968). Governance tools to deal with the tragedy of the commons are relevant to a discussion of the formalization of ASM. In this section, we briefly discuss how the tragedy of the commons applies to the negative externalities of ASM.

In 'The tragedy of the commons', Hardin pronounced on the fate of a common pasture that was unowned and available to all. Adler (2012, p. 4) pointed out that, in such situations, 'it is each herder's self-regard to maximize his use of the commons at the expense of the community at large.' Assuming logical self-centered pastoralists, Hardin (1968) concluded that each herder would add as many animals as possible to his herd, with the unavoidable result of overgrazing and devastation of the common pasture. Yet the costs of overgrazing the pasture are distributed amongst every user. When all herders respond to these incentives, the pasture is over-grazed and destroyed; hence, the tragedy.

Elinor Ostrom (1992) tackled the governance of common-pool resources in her work, *Governing the Commons*. She realized that governance of common-pool resources must overcome two obstacles; namely, excludability, which entails that it is difficult to exclude others using or depleting the same resource; and subtractability, which is the tendency for one person's use to subtract from the value of the common-pool resource (Ostrom, 1992).

ASM involves the extraction of common-pool resources: the environmental resources include land, water, and air, and the mineral in the ground that has been rendered a common-pool resource by previous formal mining (Saldarriaga Isaza, 2013). ASM may or may not take place under a regulatory framework. If the undertaking is illegal, or if regulations are weakly enforced, the resource is open access and almost any person can dig up the value. Saldarriaga Isaza (2013) point out that when the action is lawful, 'the mere fact that a miner holds a licence to exploit the resource does not necessarily imply a complete exclusion of other potential miners'. However, a common-pool resource in ASM is normally dependent on social prearrangement amongst operators; in this case, between legitimate and illegitimate miners and between unlawful miners and local authorities (Department of Mineral Resources, 2016).

Hardin (1968) submitted that greater dependence on property rights could avert the tragedy of the commons. As Adler (2012, p. 3) explains, 'where property rights are well-defined and secure, the tragedy of the commons is less likely since each owner has ample incentive to act as a steward.' Owners want to preserve essential resources and prevent overuse, both for themselves and for others who value the underlying resource. Adler (2012, p. 2) argues that what Hardin labelled the "common" is more accurately described as an open-access common. He points out that 'some resources that are owned or managed in common…do not suffer the tragedy of the commons because of community management of some form or another'. Multiple-rights regimes may also be present for the same object; for example, where the state owned the private-property rights to land, then gave demarcated parcels of land to different communities as common property (Challen, 2000). Four general classifications of management regimes are therefore explained in the literature on common-pool resource management: state property, private property, common property, and non-property or open access (Campbell et al., 2001) Hardin was further criticized for his assumption of a selfish motive on the part of users of the commons (Ostrom and Hess, 2000).

Ostrom (1992, p. 416) mentions that individuals in proximity could manage common and shared resources; thus, users have the capability to create institutions to manage and govern their own resources. She also identified that self-governance and self-organization could be enhanced by new sets of rules for collective problems (Ostrom, 1992). This assertion has been reinforced by field research conducted in Nepal, Indonesia, Kenya, and Maine (USA) on the management of common-pool resources (Ostrom and Hess 2000, p. 342). Hoadley and Limpitlaw (2004, p. 4) argued that ASM miners have the capacity to create sets of rules and self-govern because formal and informal co-operatives and associations that have internal self-regulation already exist.

Lack of specific and effective legislation and rules for ASM to govern property regimes for the open-access resources that ASM miners use facilitates unsustainability in the sector. Effective legislation should promote institutions that help communities utilize their social capital to build livelihood assets. This conviction is in line with the argument of Davies (1997) that 'institutions are the social cement which link stakeholders to access to capitals of different kinds, to means of exercising power and so define the gateways through which they pass on the route to positive livelihood adaptation'.

Conclusion

Characterization of ASM identifies that the legal definitions differ from country to country; however, scholarly definitions have established that the activity is poverty-driven, conducted by

individuals, family, or groups of people using traditional or manual tools. The ASM sector is based on different legal statuses: formal, informal, legal, or illegal. The reviewed literature confirms that negative impacts of ASM that have been exacerbated by illegality due to inadequate and inappropriate regulatory frameworks, result in the tragedy of the commons, causing excludability and subtractability. The article highlights that most ASM undertakings, especially in Sub-Saharan Africa, are informal and illegal due to several challenges. The sector is marred by myriad negative environmental, social, and economic externalities, such as accidents, pollution, social ills, and corruption. Suitable formalization and regulatory frameworks could be a viable intervention to the respective challenges bedeviling ASM sustainability.

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