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A REVIEW OF KEY NUMBERS AND ISSUES

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Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues

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SUMMARY

Artisanal and small-scale mining (ASM) has experienced explosive growth in recent years due to the rising value of mineral prices and the increasing difficulty of earning a living from agriculture and other rural activities. An estimated 40.5 million people were directly engaged in ASM in 2017, up from 30 million in 2014, 13 million in 1999 and 6 million in 1993. That compares with only 7 million people working in industrial mining in 2013.

ASM is generally pursued as a route out of poverty or as an activity to complement insufficient income, especially in communities where alternative employment is hard to come by. ASM is also a very diverse sector. Its main challenges vary from region to region—and often from site to site.

There is a perception that ASM is a "get-rich-quick" activity. This has misinformed legislation and extension programs and led to the application of one-size-fits-all policies. However, people working in ASM are far from the same. They range from those whose livelihoods rely on subsistence farming to skilled workers who migrated from urban areas in search of work.

Despite its low productivity, ASM is an important source of minerals and metals. It accounts for about 20 per cent of the global gold supply, 80 per cent of the global sapphire supply and 20 per cent of the global diamond supply. ASM is also a major producer of minerals indispensable for manufacturing popular electronic products, such as laptops and phones. For example, 26 per cent of global tantalum production and 25 per cent of tin comes from ASM.

ENVIRONMENT AND HEALTH AND SAFETY

ASM relies on a mostly unskilled workforce using rudimentary tools and techniques. Unsurprisingly, its environmental and health and safety practices tend to be very poor. For example, dust and fine particles resulting from blasting and drilling cause respiratory illnesses. It also degrades crops and farmlands, resulting in lost food production. Streams and rivers often become polluted near ASM sites, which makes water unsafe for drinking and can also affect fish stocks previously relied upon for food.

Artisanal and small-scale mining is also the source of the largest releases of mercury, estimated at 1,400 tonnes per year in 2011 according to the Minamata Convention.

Exposure to mercury can have serious health impacts, including irreversible brain damage. Mercury is also difficult to contain and can be toxic at even very small doses. It can be transported long distances by air or water, poisoning the soil and waterways, and eventually making its way into the food chain. In sub-Saharan Africa, most of these risks are borne by women.

ASM AND LARGE-SCALE MINING (LSM)

In many parts of the world, ASM and LSM operate in neighbouring—and sometimes on the same—concessions. As mineral governance frameworks tend to favour foreign direct investment by multinational companies over ASM, there are significant power imbalances and clashes over claims. However, their coexistence opens the potential for cooperation.

Current practices and debates about ASM–LSM relations include:

- Removing ASM from LSM concessions, which is unlikely to solve clashes over land in the long run
- Separating ASM and LSM by creating "ASM zones," with proven geological reserves
- Fostering cooperation between LSM and ASM operators through buy-back arrangements, technical assistance and support for formalization
- Promoting continued dialogue and communication between ASM and LSM, facilitated by governments

ALTERNATIVE LIVELIHOODS

Moving people straight out of ASM into other sectors is not a realistic strategy, as there are typically few other employment opportunities. Programs aiming to encourage more income-generating activities along the ASM supply chain——such as gemstone cutting and polishing—have shown positive results.

Agriculture and ASM need to be seen as complementary, as opposed to two activities that are fundamentally at odds. Many families turn to ASM to supplement their farming earnings and invest in farming and farm inputs.

CERTIFICATION SCHEMES

In recent years, ethical certification schemes and standards have been used to support formalization and to improve social and environmental practices in the sector.

Standards such as Fairmined and Fairtrade Gold aim to foster responsible ASM cooperatives, provide assurance of minimum standards of production, and support the sector's formalization and professionalization. In addition, "chain of custody" initiatives aim to ensure traceable supply chains from mine to market that are free from conflict and human rights abuses. They respond to the need of companies seeking to meet international regulations and/or voluntary codes and to ensure good business practices.

Despite signs of progress, there are concerns about these initiatives. Some argue they are not reaching the most marginalized communities in need of greatest support. Instead, they are believed to be empowering already licensed and relatively affluent cooperatives able to meet the requirements and costs of certification. There are also concerns about longer-term sustainability due to their reliance on Western markets and ethical consumption trends.

FORMALIZATION

In many countries, 70 to 80 per cent of small-scale miners are informal.

Informality brings along damaging socioeconomic, health and environmental impacts, which trap the majority of miners and communities in cycles of poverty and exclude them from legal protection and support.

Formalization has to be inclusive of miners' views and effective in monitoring and enforcing regulation. It needs:

- Legal frameworks that remove barriers to formalization and are supportive and accessible rather than punitive
- Streamlined licensing processes that make it easy, cost-effective and rewarding to obtain a licence
- Access to finance for miners, potentially using geological information as collateral for loans
- Technical and financial support to meet the licensing requirements and, once licensed, to continue to improve performance

TOWARDS SUSTAINABLE ASM: WHAT DO WE NEED TO GET THERE?

- Know-how: Building capacity through local institutional partnerships
- Organization: Encouraging miners to form cooperatives and associations
- Collaboration: Encouraging large-scale mining companies to support capacity building
- Capital: Using microcredits to lend to organized groups of miners and communities, supported by donors
- Technology and equipment: Improving miners' access to efficient and cleaner technologies

IN NUMBERS:

- 40 million people working in ASM in 2017
- 150 million depend on ASM across 80 countries in the global south
- 20 per cent of the global gold supply is produced by the ASM sector
- 80 per cent of the global sapphire supply and 20 per cent of the global diamond supply come from ASM
- 26 per cent of global tantalum production and 25 per cent of global tin production come from ASM
- 40–50 per cent of the ASM workforce in Africa are women
- 70–80 per cent of small-scale miners are informal

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ACRONYMS AND ABBREVIATIONS

ARM	Alliance for Responsible Mining
ASGM	artisanal and small-scale gold mining
ASM	artisanal and small-scale mining
Au	gold
CSR	corporate social responsibility
DDI	Diamond Development Initiative
DFID	Department for International Development
EHS	environment, health and safety
FLO	Fairtrade International
GCDL	Great Consolidated Diamond Limited
GEF	Global Environment Facility
GIS	Geographical information system
GTZ	German Technical Cooperation
Hg	mercury
ICMM	International Council on Mining and Metals
IGF	Intergovernmental Forum on Mining, Minerals and Sustainable Development
ILO	International Labour Organization
ITRI	International Tin Research Institute
ITSCi	ITRI Tin Supply Chain Initiative
KPCS	Kimberley Process Certification Scheme
KT	kilotonnes
LBMA	London Bullion Market Association
LSM	large-scale mining
MDS	Maendeleo Diamond Standards
Mlb	million pounds
MT	megatonnes
NAP	National Action Plan
NGO	non-governmental organization
OECD	Organisation for Economic Co-operation and Development
OHS	occupational health and safety
PACT	Partnership for Capacity Building in Africa
PML	primary mining licence
SAESSCAM	Services d'Assistance et d'Encadrement du Small-Scale Mining
SMMRP	Sustainable Management of Mineral Resources Project
SSM	small-scale mining
SSMMC	San Simón Mategua Mining Company
UN Environment	UN Environment Programme
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization
WOA	whole ore amalgamation
µg	microgram

INTRODUCTION

Artisanal and small-scale mining (ASM) has benefited from a body of research spanning decades, despite an ongoing lack of understanding and statistical data for the sector. The existing literature, both academic and grey, has brought some consensus on key issues surrounding the sector, in many cases repeating similar findings and at times updating facts. This research paper reviews the existing literature on key thematic areas, bringing various findings together and providing updated information. Although secondary data collection is used as the main research method, the paper also benefited from the authors' field experiences. Factual numbers for key aspects of the ASM sector are still limited, but this paper demonstrates some of the knowledge gaps in the sector and pulls together important data on selected thematic areas. It is expected to provide a platform for future new research.

The immediate aim of the paper was to serve as background material for the annual general meeting of the Intergovernmental Forum on Mining, Minerals and Sustainable Development (IGF) in Geneva in October 2017. It is structured to first give a global (as well as regional) update on key ASM numbers and trends, followed by discussions of key ASM themes. These are: environment, health and safety impacts and remedial efforts; the ASM interface with large-scale mining (LSM); alternative livelihoods and diversification; ASM formalization and the global policy debate; and mineral certification schemes for ASM. The paper concludes with a discussion on initiatives and strategies for sustainable ASM.

Photo: IIED/Steve Aanu

1.0 GLOBAL TRENDS AND UPDATES ON KEY ASM NUMBERS

Artisanal and small-scale mining is recognized as a considerable source of revenue for millions of people in about 80 countries worldwide (World Gold Council, 2017; World Bank, 2013). ASM takes place in diverse regions of the world, mostly in the global South—sub-Saharan Africa, Asia, Oceania, Central and South America. The term "artisanal and small-scale" has been defined in various ways, often characterized in terms of the number of miners, the production capacity of a mine, the level of mechanization or size of capital investments (International Labour Organization (ILO), 1999; World Gold Council, 2017).

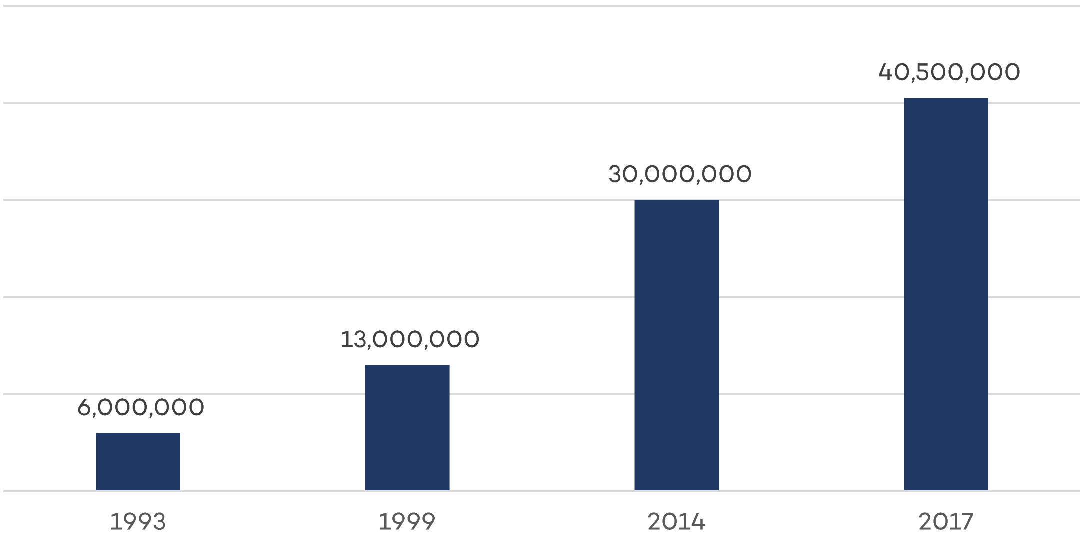


FIGURE 1. NUMBER OF ASM OPERATORS WORLDWIDE SHOWS THE GROWTH IN THE NUMBER OF ASM OPERATORS WORLDWIDE BETWEEN 1993 AND 2017.

Source: Based on ILO, 1999; Seccatore et al., 2014; Levin, 2014; Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017

In 1993, about six million people were believed to be working in ASM; in 1999 the International Labour Organization (ILO) revised this number to 13 million miners (including women and children) and estimated that about 80–100 million people depended on this activity at that time (ILO, 1999). In recent years, the number of people directly involved in ASM has more than doubled, reaching about 30 million people in 2014 as a result of such things as rising mineral prices and the increasing difficulty of earning a living from alternative activities like agriculture (García et al., 2015; Seccatore et al., 2014). This implies that more than 150 million people are indirectly dependent on ASM (Levin, 2014). As shown in Figure 2, the number of people involved in ASM differs across countries in Africa, Latin America and Asia. In most African countries, 5–20 per cent of the population directly depended on ASM in 2009; in Latin America 0.1–5 per cent; and Asia 0.1–1 per cent.

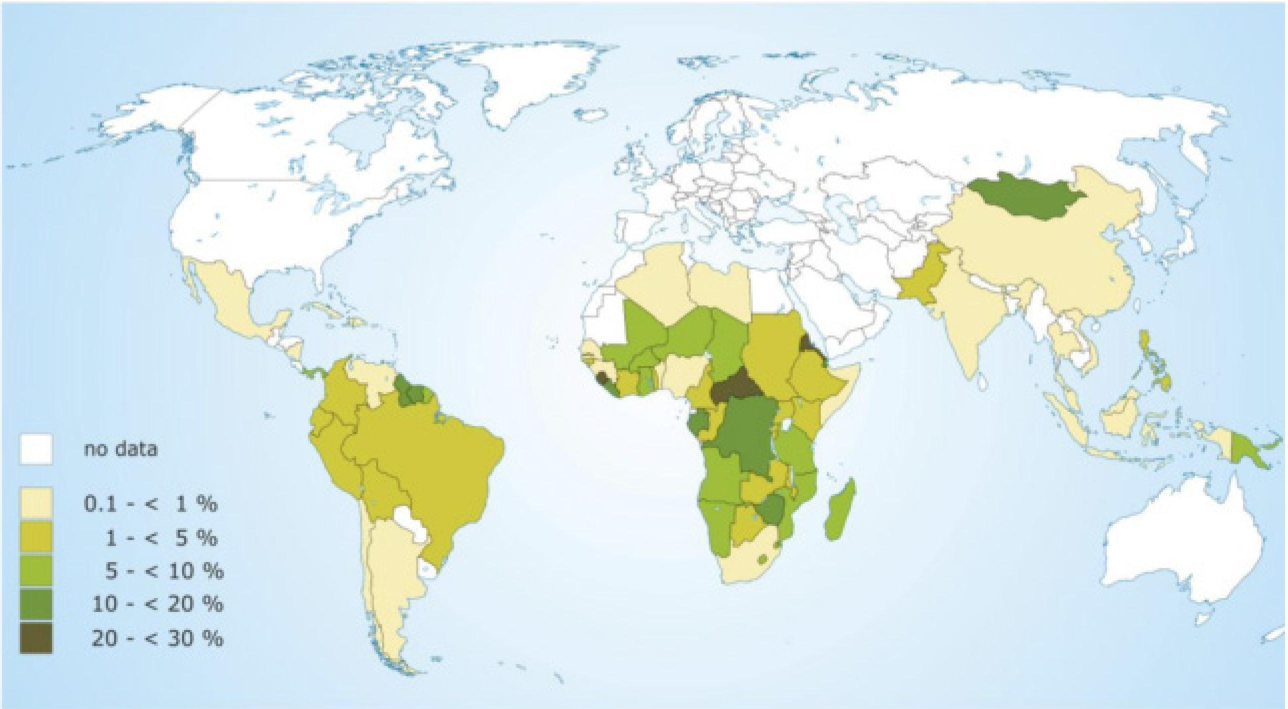


FIGURE 2. PERCENTAGE OF THE POPULATION THAT DEPENDS ON ASM

Source: Dorner et al., 2012

According to current data from the Artisanal and Small-scale Mining Knowledge Sharing Archive website (2017), direct ASM numbers might have reached 40.5 million in 2017. Some sources estimate a much higher number—up to 100 million ASM operators—compared to seven million people working in industrial mining (World Bank, 2013). However, we emphasize the need to improve national data benchmarking and consistency, to disaggregate numbers by gender, and to establish a criteria-based census of ASM operators. New databases on ASM numbers are expected in the coming months, based on a collaborative effort by several stakeholders to gather data: the DVELVE platform developed by the World Bank Group and the Partnership for Capacity Building in Africa (PACT) (World Bank Group and PACT, n.d.), and the Services d'Assistance et d'Encadrement du Small-Scale Mining (SAESSCAM) platform developed by International Peace Information Service (IPIS), focusing on the Democratic Republic of the Congo (DRC) (SAESSCAM, n.d.).

ASM is an important source of revenue for miners, their communities and local governments, especially when the activity is focused on mining high-value minerals like gold, silver and gemstones (ILO, 1999). About 50 per cent of the total number of ASM operators work on gold extraction, contributing to 90 per cent of total employment in gold mining (the remaining 10 per cent is mainly large-scale gold mining) (Levin, 2014). Estimates of the contribution of ASM to global gold production vary from between 12 and 15 per cent (Levin, 2014) to up to 20 per cent (World Bank, 2013). According to the World Bank (2013), ASM also accounts for 80 per cent of global sapphire supply, and 20 per cent of global diamond supply. The activity is, however, not limited to these minerals; according to Veiga et al. (2014), ASM operators work on more than 30 different types of minerals.

Perceptions of ASM activity vary from country to country. Stakeholders often tend to vilify ASM because of its informal nature and hazardous characteristics, with significant health and safety risks as well as susceptibility to social conflict and human rights violations (World Gold Council, 2017). ASM is further criticized due to rising awareness of "conflict minerals," which has detrimental effects on the reputation and activities of ASM communities and countries (OECD, 2017) despite only being relevant to some countries (World Gold Council, 2017).

In the last two decades, several international organizations have been working towards better integrating ASM into global economies, developing more responsible extraction and sourcing practices to support more sustainable development. These include Fairtrade Mining Standards, the Alliance for Responsible Mining (ARM)'s Fairmined Standards, the Organisation for Economic Co-operation and Development (OECD) Responsible Sourcing Guidance, and the Global Mercury Partnership. To reduce the negative impacts of the activity, however, all stakeholders (such as donors, national policy-makers) must work collaboratively, take bottom-up approaches (i.e., directly involving miners and their communities), and propose gender-based solutions (e.g., through microfinance). It is also necessary to replace negative terms such as "conflict mineral areas" that stereotype and negatively affect ASM activities, since firms tend to avoid sourcing from such countries in order to protect their reputations (OECD, 2017).

2.0 REGIONAL TRENDS AND UPDATES ON KEY ASM NUMBERS

This section highlights trends in the number of ASM operators in Africa, Asia and Latin America (i.e., Central and South America). Unlike the global estimates, literature focusing on ASM numbers in each of these three regions is scarce. Most studies, reports and scientific papers focus on only one or a few countries in these regions. Details on the estimated number of ASM operators per region and per country is available in the Appendix, based on the Artisanal and Small-scale Mining Knowledge Sharing Archive (2017) database.

The data collected shows a rising number of ASM operators since 1999 in each region, but not in every country (for example, there was a decrease of 14 per cent in Argentina between 1999 and 2014). These numbers must be used with care since 1) many countries that are likely to have ASM activities do not have estimates; 2) estimates available in the years presented here do not always cover the same countries; and 3) estimates are based on averages between the minimum and maximum number of ASM operators per country.

The data presented in the Appendix shows that most ASM operators are located in Asia, with a total average of at least 10.6 million in 2014, mainly due to the extremely high number in China (9 million). This is followed by Africa, with a total average of at least 9.9 million ASM operators in 2014, and Latin America with a total average of at least 1.4 million in 2014 (see Tables 11, 12 and 13 in the Appendix).

There were two countries with an average of more than 1 million miners in Africa in 2014 (DRC and Sudan) compared to one country in Asia (China) and none in Latin America.

There were four countries with an average of 500,000 to 1 million miners in Africa in 2014 (Ghana, Ivory Coast, Mali, and Tanzania), but none in Asia and Latin America.

Other countries where ASM activity involved at least 200,000 miners in 2014 are shown below.

TABLE 1. COUNTRIES WITH 200,000–500,000 ASM OPERATORS, 2014

Brazil	467,500	Philippines	325,000
Ethiopia	450,000	Sierra Leone	300,000
Pakistan	450,000	Guinea	250,000
Madagascar	450,000	Mozambique	200,000
Zimbabwe	450,000	Uganda	200,000
Colombia	385,500	Angola	200,000
Niger	365,000		

Most studies that provide numbers of ASM operators and people dependent on the activity are using estimates that are 5 to 20 years old. Studies of African countries with ASM are the most complete; there are estimates on almost all countries that are known to have ASM operations except four (see Table A1 in the Appendix). In Asia, 15 countries do not have estimates despite being likely to have ASM activities (see Table A2); the same is true of five countries in Latin America (see Table A3 in the Appendix). So, compared to Africa, the ASM population in Asia and Latin America remain relatively understudied.

The three regions have commonalities in terms of the poverty-driven nature of ASM and the way in which communities may combine ASM with other livelihood activities, such as agriculture, to supplement their incomes. There are also regional differences between the three continents (Hentschel, 2003, p. 20): “in Africa, AIDS and sustainable community development are the key issues;

in the Asia/Pacific region, multicultural aspects and cultural rights predominate; while in the Latin American/Caribbean region, environment, indigenous rights and legal aspects are the key issues." There are also differences in terms of women's participation in ASM. According to Hinton et al. (2003a), less than 10 per cent of women directly participate in ASM in Asia; between 10 and 20 per cent in Latin America; and between 40 and 50 per cent in Africa. In some regions, female miners can even represent 60 to 100 per cent of the ASM mining force; for example, the proportion in Guinea is as high as 75 per cent (Hentschel, 2003; Hinton et al., 2003a).

The reasons for child labour in ASM also vary depending on the region. According to Buxton (2013), children are commonly involved in Latin America as part of a "long ASM tradition"; whereas in Asia, there is less child labour due to private sector involvement in ASM. However, the number might not be clear in South Asia, where child labour is often seen as part of women's marginalization. In Africa, as in Latin America, children are also commonly involved in ASM, but more because of the socioeconomic context characterized by civil war, conflicts, weak social institutions and government, and forced labour (Buxton, 2013). It is therefore essential to understand the specifics of ASM in each site and country.

ASM IN AFRICA

The most recent publications agree that there are about 9 million ASM operators in Africa and about 54 million people whose livelihoods depend on the sector (Ledwaba & Nhlengetwa, 2016 Persaud et al., 2017). The Africa Minerals Development Centre (AMDC) considers this a "conservative estimate," citing an important lack of data on ASM, as the activity is often informal and mostly operates illegally in several African countries (AMDC, 2015). The research acknowledges that ASM is both complex and highly important for the economies of at least 23 countries in sub-Saharan Africa, especially in rural contexts.

Estimates of the total number of ASM operators for the African region are as follows:

TABLE 2. ESTIMATES OF TOTAL ASM OPERATORS IN AFRICA

PERIOD	NUMBER OF ASM OPERATORS	NUMBER OF COUNTRIES
1999	1,998,350	24
2011	8,210,000	23
2014	9,878,500	40

Note: See Table A1 for a detailed list with sources.

In 2011, according to the data provided by Hilson and McQuilken (2014), the number of people dependent on ASM activity in Africa was between four and 12 times the number of ASM operators, but mostly around six times the ASM miner population (e.g., in the Central African Republic, Chad, Côte d'Ivoire, DRC). In 2003, women represented between 5 per cent (in South Africa) and 50 per cent (in Mali) of the total mining population, and up to 75 per cent in Guinea (Hentschel, 2003; Hinton et al., 2003a). In most cases men and women have different tasks along the mineral processing chain, with men being more present in the extraction phase, and women in mineral processing and the delivery of auxiliary services (Armah et al., 2016).

At least four countries are known or likely to have ASM activities, but no estimates are available (see Table A1 in Appendix).[1] As Hilson (2009) noted, there is an issue of the currency of data in African ASM—however, this should not mask the sector's fast-growing livelihood significance in rural sub-Saharan Africa, including Burkina Faso, Mali, Sierra Leone and Tanzania. While gold is the focus of most of these ASM operators, other commodities (mainly gemstones and diamonds) also engage a significant number of people in countries like the DRC, Madagascar and Sierra Leone.

[1] Egypt, Republic of the Congo, Somaliland Somalia and Western Sahara.

ASM in sub-Saharan Africa is often believed to be a "rush-type" activity, characterized as chaotic and entrepreneurial-driven, where miners are "fortune-seekers" (Hilson, 2009). It is also often seen as a "distress-push" type of activity where miners are looking to alleviate their poverty and work in ASM to complement revenues from farming (Hilson, 2009). However, it is impossible to generalize since mining activities in Africa are very diverse, with varying commodities, linkages with other activities, seasonality, migration, level of engagement and so on. For example, Hilson (2016) shows the seasonal nature of ASM and farming–ASM linkages in selected sub-Saharan countries such as Ghana, Liberia, Malawi, Mali, Mozambique, Sierra Leone and Zimbabwe. Persaud et al. (2017) use the case of Senegal to highlight the importance of understanding the dynamics between agriculture and ASM, as these activities are significantly impacted by season.

Various minerals are extracted in Africa. In Tanzania, where there are more than one million ASM operators, two thirds are gold miners (Bryceson & Geenen, 2016). In the DRC, where about two million people directly depend on ASM, miners work mainly on gold, cassiterite, coltan and diamond extraction (Bryceson & Geenen, 2016). In DRC, cobalt mining is increasingly important due to market demand for electronics and electric vehicles batteries (RCS Global, 2017). Table 3 shows African countries where various minerals are mined and the number of people indirectly dependent on ASM activity.

TABLE 3. ESTIMATES OF ASM EMPLOYMENT IN SELECTED COUNTRIES IN SUB-SAHARAN AFRICA AND CORRESPONDING MINERALS

COUNTRY	DIRECTLY WORKING IN ASM	ESTIMATED NUMBER OF DEPENDENTS	MAIN MINERALS MINED BY ASM
ANGOLA	150,000	900,000	Diamonds
BURKINA FASO	200,000	1,000,000	Gold
CENTRAL AFRICAN REPUBLIC	400,000	2,400,000	Gold, diamonds
CHAD	100,000	600,000	Gold
CÔTE D'IVOIRE	100,000	600,000	Gold, diamonds
DRC	200,000	1,200,000	Diamonds, gold, coltan
ERITREA	400,000	2,400,000	Gold
ETHIOPIA	500,000	3,000,000	Gold
GHANA	1,100,000	4,400,000	Gold, diamonds, sand
GUINEA	300,000	1,500,000	Gold, diamonds
LIBERIA	100,000	600,000	Gold, diamonds
MADAGASCAR	500,000	2,500,000	Coloured gemstones, gold
MALAWI	40,000	-	Coloured gemstones, gold
MALI	400,000	2,400,000	Gold
MOZAMBIQUE	100,000	1,200,000	Coloured gemstones, gold
NIGER	450,000	2,700,000	Gold
NIGERIA	500,000	2,500,000	Gold
SOUTH AFRICA	20,000	-	Gold
SIERRA LEONE	300,000	1,800,000	Gold, diamonds
SOUTH SUDAN	200,000	1,200,000	Gold
TANZANIA	1,500,000	9,000,000	Gold
UGANDA	150,000	900,000	Gold
ZIMBABWE	500,000	3,000,000	Gold, diamonds, coloured gemstones

Source: Hilson, 2016.

Significant migration of the workforce—within countries and between neighbouring or other countries—is an aspect of ASM that makes it difficult to generate more accurate estimates. For instance, the ASM population in Tanzania is characterized by migrating from one site to another; in Geita, for example, Aizawa (2016) observed that 12 per cent of the mining population comes from outside Geita. According to the author, the miners who work as diggers are more mobile than those who are primary mining licence (PML) holders, who operate their licensed areas for years. In Bryceson and Jønsson's (2010) study of Londoni and Matundasi, Tanzania, pit owners are more mobile than either PML holders or diggers. Uganda has seen a mass migration of people looking for gold (Nabaasa, 2016). Since 2005, an estimated 50,000 Chinese people have left their country to pursue mining activities in Ghana, mostly illegally (Hilson et al., 2014).

In sub-Saharan Africa, ASM has traditionally been administered by policies designed for large-scale mining (LSM) and considered a subset of LSM (O'Faircheallaigh & Corbett, 2016). In Ghana, for instance, policies tend to be incentive-based—ASM is regulated to avoid child labour and to support miners in getting a fair price for the minerals they sell, equipment and so on (O'Faircheallaigh & Corbett, 2016). Ad hoc ASM policies are made at both the national and local levels. Currently, the Ghanaian government has taken drastic action to eradicate illegal mining, banning a significant number of ASM operators.

ASM IN ASIA

For Asia, in 1999 a total of 1,978,100 artisanal miners across 10 countries was estimated, and in 2014, 10,610,000 artisanal miners in 15 countries (ILO, 1999; Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017). The largest number of miners are found in China, Pakistan and the Philippines (see Table A2 in the Appendix). In addition, at least 15 countries are known or are likely to have ASM activities in Asia today, but no estimates are available (Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017).[2] The share of women involved also varies in this region (e.g., 10 per cent in Indonesia and 22 per cent in Papua New Guinea) (Hentschel, 2003).

As in Africa, ASM activity is sometimes combined with agriculture (rice farming), for instance in Cisitu, Indonesia; and the common use of mercury can lead to significant risks to human health and the environment (Bose-O'Reilly et al., 2016).

ASM in Asia also involves a significant number of people migrating to areas where new deposits have been found, further complicating the makeup of the sector. For instance, in Bombona, Indonesia, the number of miners rose by 40 per cent between 2007 and 2008 due to the discovery of new gold ores, attracting miners from neighbouring areas (Basri et al., 2017).

ASM policies in Asia differ from those in Africa, where ASM policies are more national; in the Philippines, for instance, local and regional policies and practices can differ greatly between the 30 provinces where ASM occurs (O'Faircheallaigh & Corbett, 2016). National legislation regulates ASM but has limited and/or variable impacts on the ground, as there are no livelihood alternatives for miners and many regions have their own local legislation (O'Faircheallaigh and Corbett, 2016). In addition, the authors note that several regions are against LSM and have declared themselves "mining-free" or "LSM-free" in opposition to national mining policies that favour LSM.

ASM IN LATIN AMERICA

In Latin America, in 1999 a total of 641,875 ASM operators was estimated across 17 countries, and in 2014, 1,442,700 ASM operators in 19 countries (ILO, 1999; Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017). In addition, at least five countries are known or likely to have ASM activities, but no estimates are available (Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017).[3]

[2] Armenia, Azerbaijan, Bangladesh, Bhutan, Cambodia (gold, ruby), Georgia, Iran, Iraq, Kazakhstan, Russia (gold, amber), Tajikistan, Turkey (coal), Turkmenistan, Uzbekistan and Yemen

[3] Belize, Costa Rica, El Salvador, Guatemala (gold), and Paraguay (gold, clay).

The largest number of ASM operators can be found in Brazil and Colombia (see Table 14 in the Appendix). ASM activity in Colombia is significant, representing 72 per cent of the country's total gold production in 2013 (Güiza, 2013). The Latin America ASM sector has strict regulations on informal operators and the use of certain substances, but has limited capacity to implement these regulations. It is particularly difficult to control informal mining where there are large numbers of miners; such as in Colombia, where about 87 per cent of 4,134 Colombian gold mining operations are illegal and 95 per cent of all the gold mines have no environmental permit (García et al., 2015).

As in Africa and Asia, migration is an important aspect of ASM in Latin America, such as in Serra Pelada (Brazil) and Nambija (Ecuador), where thousands of people migrated in the 2000s in search of gold and sapphires (Hentschel, 2003).

Policies concerning ASM differ from country to country. For instance, in Peru the government has been swinging between coercive policies involving military force on the one hand (e.g., in the Madre de Dios region) and incentive-based initiatives to support miners in creating cooperatives and providing them with financial support on the other (O'Faircheallaigh & Corbett, 2016). The government seems to have now opted for coercive interventions, as the incentives have failed. This is mainly due to a lack of organization and the financial means to support miners on site, due to the growth of ASM activities over the last 30 years (O'Faircheallaigh & Corbett, 2016).

ASM NUMBERS PER MINERAL

ASM is particularly important in locations where there are high-value minerals such as gold, silver and gemstones. According to the Center for International Forestry Research (CIFOR, 2009), gold and diamond mining account for more than half of the mineral exploitation globally and involve between six and nine million artisanal miners, i.e., about 60 per cent of all ASM activities in 2009.

According to the African Mining Vision (AMV), between 15 and 20 per cent of the world's non-fuel minerals, 18 per cent of Africa's gold and almost all African gemstones (except diamonds) are produced by ASM, and the activity could greatly contribute to national and local African economies (African Union, 2009).

For metals only, ASM operators in 2009 were estimated to account for about 26 per cent of global tantalum production, 25 per cent of the global tin production, 6 per cent of tungsten, 4 per cent of iron ore, 3 per cent of lead, 1 per cent of zinc and 0.5 per cent of copper, as shown in Figure 3.

Photo: IIED/Magali Rochat

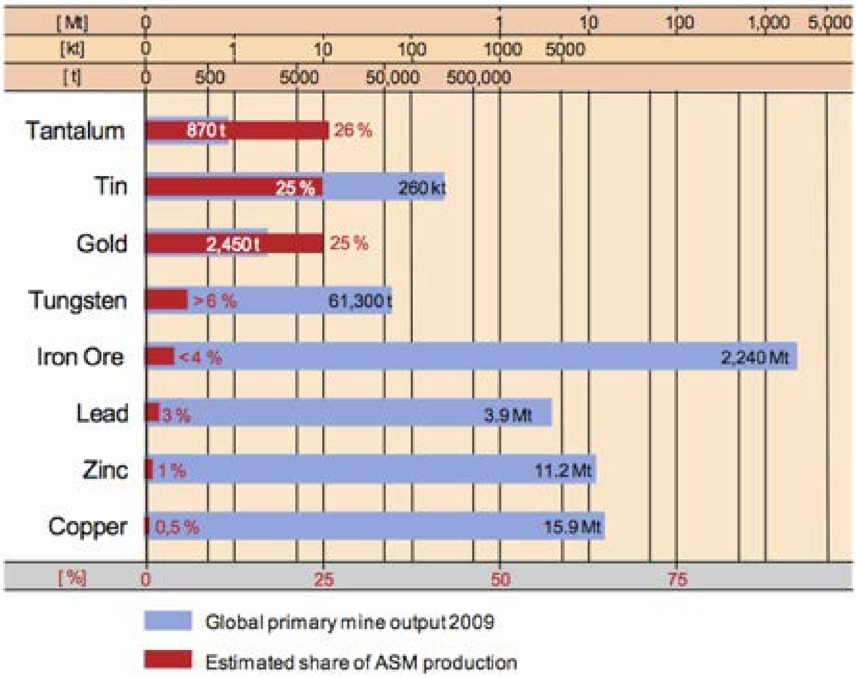


FIGURE 3. SHARE OF ASM IN GLOBAL MINE PRODUCTION OF SELECTED METALS IN 2009

Source: Dorner et al., 2012

Note: t = tonnes; kt = kilotonnes; Mt = megatonnes

TANTALUM

According to the Tantalum-Niobium International Study Center (TIC, 2017), tantalum originates from both primary industrial mining and artisanal mining, as a secondary mineral or as a by-product. Tantalum is used in the electronics industry and dental instruments and implants. Brazil is the largest producer, while important quantities are also produced in Australia, China, the DRC, Russia and Rwanda. There is low or irregular tantalum production in Burundi, France, Malaysia, Mozambique, Namibia, Nigeria, Thailand and Zimbabwe (TIC, 2017).

Table 4 shows the most likely sources of tantalum.

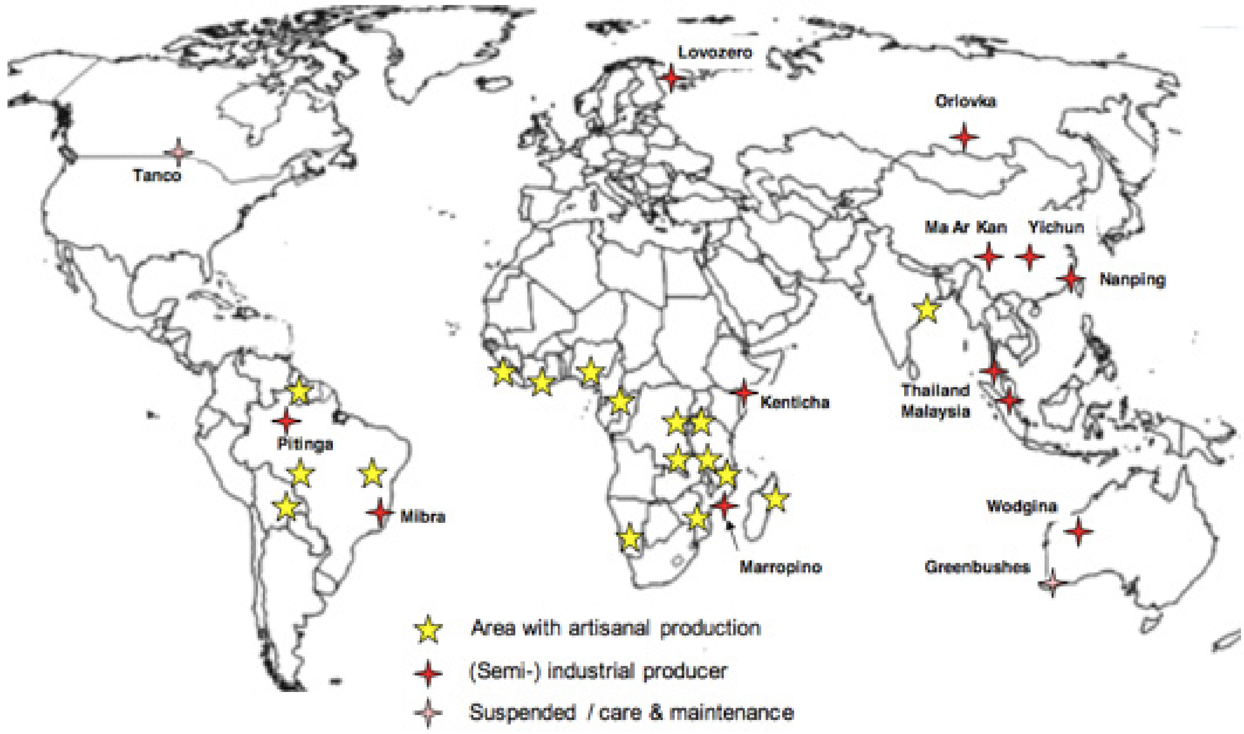
TABLE 4. GLOBAL SOURCES OF TANTALUM

SOURCE	MT	PERCENTAGE
SOUTH AMERICA	129.27	40%
AUSTRALIA	65.77	21%
CHINA AND SOUTHEAST ASIA	33.11	10%
RUSSIA AND MIDDLE EAST	31.30	10%
CENTRAL AFRICA	28.58	9%
AFRICA, OTHER	21.32	7%
NORTH AMERICA	5.44	2%
EUROPE	2.27	1%
TOTAL	**317.06**	

Source: TIC, 2017.

Most ASM tantalum production is in Africa, particularly Central Africa, where it is obtained from alluvial and soft rock deposits (TIC, 2017). Between 1995 and 2008, tantalum production in Africa accounted for 12–34 per cent of global production (Dorner et al., 2012). African production of tantalum mostly originates from ASM, except in Mozambique and Ethiopia, and rose in 2009 to reach 50 per cent of global production after Australian and Canadian production stopped (Dorner et al., 2012). Known ASM production sites are shown in Figure 4.

FIGURE 4. WORLD TANTALUM PRODUCERS



Source: Dorner et al., 2012.

ASM produces approximately 330 tonnes of gold per year in about 70 countries, corresponding to 12 per cent of global gold production (Telmer, 2011). Updated estimates vary depending on the type of data considered and are sometimes around 20–30 per cent of global gold production (Telmer, 2011); see similar estimates in Chapter 1 above.

Estimates of the ASM population involved in gold mining in Africa, South America, Asia and Oceania are shown in Figure 5.

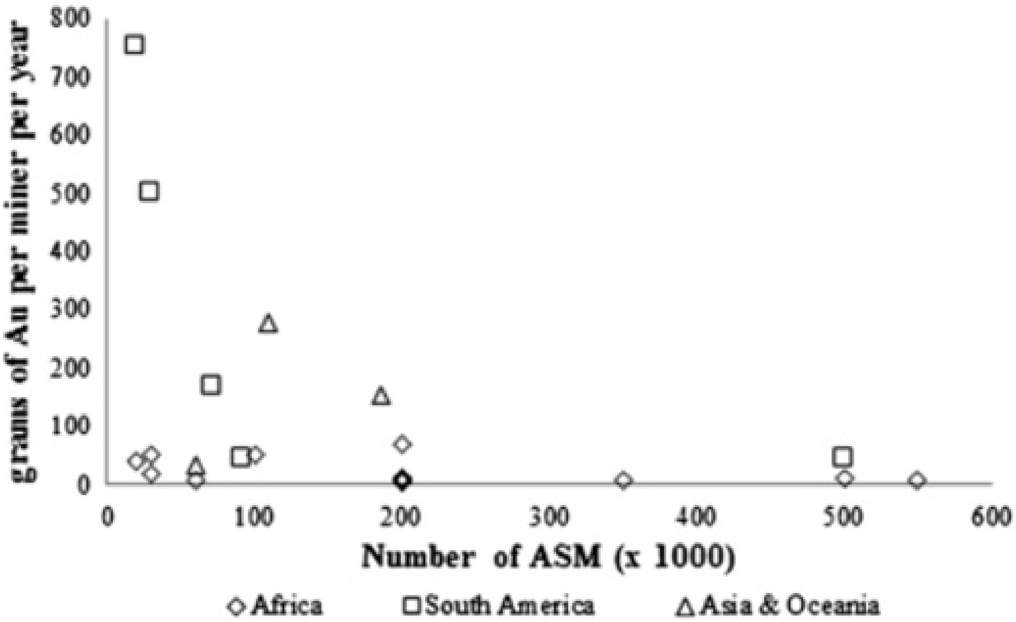


FIGURE 5. NUMBER OF ASM POPULATION WORKING ON GOLD EXTRACTION VERSUS GOLD PRODUCED PER CONTINENT

Source: Seccatore et al., 2014 *Note: Au = gold.*

According to Figure 5, the higher the ASM population, the lower the productivity (grams of gold) per capita. The reverse is also true, mainly because a lower number of ASM operators usually means that they have better technologies for gold extraction (Seccatore et al., 2014). Each continent presents different trends: South America has the highest values, then Asia, followed by Africa (Seccatore et al., 2014).

GEMSTONES

Gemstones are diverse, consisting of, for instance sapphires, rubies and diamonds. About 20 per cent of global diamond production and 80 per cent of sapphire production comes from ASM (Diamond Development Initiative [DDI], 2017; World Bank, 2013). This activity is particularly important in Africa and South America, involving about 1.5 million ASM operators in 18 different countries, often including families and children (DDI, 2017; World Bank, 2013). Diamond ASM takes place for instance in Brazil, the DRC, Ghana, Guinea, Guyana, Sierra Leone and Zambia (DDI, 2010; Siwale & Siwale, 2017).

About 65 per cent of the world's diamond reserves are found in Africa (CIFOR, 2009). Madagascar is one of the largest sapphire producers, with about 50 per cent of the global supply in 2002. Sapphire production relies heavily on artisanal mining, with about 500,000 people involved on a full- or part-time basis (Tilghman et al., 2007). Blue sapphire mining has led to a rush in Nigeria recently, being traded at a high price to Thailand and Sri Lanka (Oruonye, 2015).

3.0 ENVIRONMENT, HEALTH AND SAFETY IMPACTS AND REMEDIAL EFFORTS

GENERAL ENVIRONMENT, HEALTH AND SAFETY IMPACTS OF ASM ACTIVITY

Observers note that in some countries, while ASM is contributing to the economy (e.g., 34 per cent of Ghana's gold production in 2013) and rural employment (e.g., about 1 million rural Ghanaians), it has a significant negative impact on the environment. Environment, health and safety (EHS) conditions are poor; crops and farmland are degraded, affecting food production; and streams and rivers are polluted, resulting in costly water treatment to make it safe to drink (UN Environment, 2017, p. 28). Although each ASM site has specific characteristics, some common factors can accentuate the general EHS impacts of ASM activities. These include lack of mechanization, use of rudimentary techniques, low levels of occupational health and safety (OHS) practices, lack of a skilled workforce, lack of social security and lack of awareness about EHS issues.

The use of hazardous substances for mining puts the health of miners and their communities at risk—they are exposed, for example, to mercury, zinc vapour, cyanide, or other acids (Obiri et al., 2010). This is a particular concern in gold mining, where mercury is frequently deployed and cyanide use is growing. Mercury can be inhaled, swallowed or absorbed through the skin, but the health consequences are usually not immediate (Armah et al., 2016). Inhaling dust and fine particles from blasting and drilling processes can cause respiratory diseases such as silicosis or pneumoconiosis in men and women, and in the children who often accompany their parents (Armah et al., 2016). According to the authors, a lack of ear protection to filter noise from equipment like drills or crushers can cause temporary or permanent hearing loss and speech interference. Most OHS risks in sub-Saharan Africa are borne by women, due to the division of tasks between male and female miners.

Since research on chemical use in ASM is focused on gold mining, this section mainly addresses the use of mercury and cyanide in artisanal and small-scale gold mining (ASGM). As underlined by Spiegel et al. (in press), ASGM usually consists of two types: hard rock gold mining (primary ore) and alluvial gold mining (secondary ore). Both mining types involve different types and grades of ore, different technologies, different mercury uses and different socioeconomic characteristics. Mercury is more frequently used in hard rock gold mining than in alluvial gold mining, but in both cases resulting in serious environmental pollution and human diseases (Spiegel et al., in press).

South America is the region where the most environmentally friendly techniques are used in ASGM, and other examples of good practices can be found in Central Asia and Central America (Seccatore et al., 2014; Basu et al., 2015; Malehase et al., 2016). The practices that cause most damage to the environment are more common in Africa, with sub-Saharan Africa leading on mercury emissions, as well as East Asia (Basu et al. 2015; Malehase et al., 2016).

MERCURY

Mercury is often used in ASGM, as it provides a relatively cheap and fast technique to capture fine gold from the ore. The amount of mercury used and its emissions are influenced by many different factors; such as the scale of the operation, geological characteristics of the mining site, economic dynamics, policies concerning land use and the formalization of artisanal miners (Spiegel et al., in press).

The gold mining process using mercury can be split into seven steps (UN Environment, 2012, p. 10–11): 1) the rocks or sediments containing gold are mined; 2) the ore is crushed (if necessary) to liberate gold particles; 3) the mass of the ore is usually concentrated; 4) mercury is added to the ore to form an amalgam (a mixture of mercury and gold); 5) the amalgam is heated to evaporate the mercury and obtain a porous "sponge gold" product; 6) this is melted to produce the "gold doré"; 7) the doré is refined in gold processing shops and sold on the global market.

There are two main ways to use mercury in ASGM: whole ore amalgamation (WOA) and concentrate amalgamation (UNE Environment, 2012, p. 14). In WOA, mercury is mixed with 100 per cent of the ore. This technique makes much less efficient use of mercury, usually capturing no more than 30 per cent of the gold, and releasing large quantities of mercury into the tailings. Contaminated tailings are difficult to clean up.

Concentrate amalgamation is a better practice. This first concentrates the ore, enabling the miner to recover the same amount of gold or more than WOA while using much less mercury, or none at all. The ore can be concentrated by methods such as gravity concentration or sluices (UN Environment, 2012, p. 18–19). Concentration releases less mercury into the environment, but the amalgam heating stage can still be a source of mercury poisoning if miners do not use protective equipment, such as retorts or fume hoods, which can recover up to 95 per cent of mercury vapours (UN Environment, 2012, p. 42).

Amalgam burning can take place on site and in processing centres, but also in villages—for instance in miners' kitchens, houses or backyards, putting their health and the health of their families and community at risk of mercury poisoning when no protective equipment is used (Global Alliance on Health and Pollution [GAHP], 2014; Spiegel et al., in press). According to UN Environment (2013a, 2013b), ASM activities emit about 1,400 tonnes of mercury per year on land, air, and water and are the largest source of anthropogenic mercury emissions worldwide, at about 727 tonnes per year. Among the countries where mercury is used in ASGM, Indonesia has seen the fastest rise in the number of polluted sites in the past 20 years, with an increase of about 50 per cent between 2010 and 2015 (Balifokus, 2015). The country hosts some of the most mercury-polluted sites in the world (Spiegel et al., in press).

According to Mercury Watch (2017), four countries are the main contributors to mercury emissions from ASGM activities based on the available estimates: Bolivia (120 tonnes/year), Brazil (105 tonnes/year), China (100 tonnes/year), and Burkina Faso (35 tonnes/year). However, it must be underlined that no estimates are available for many other countries (see Figure 6).

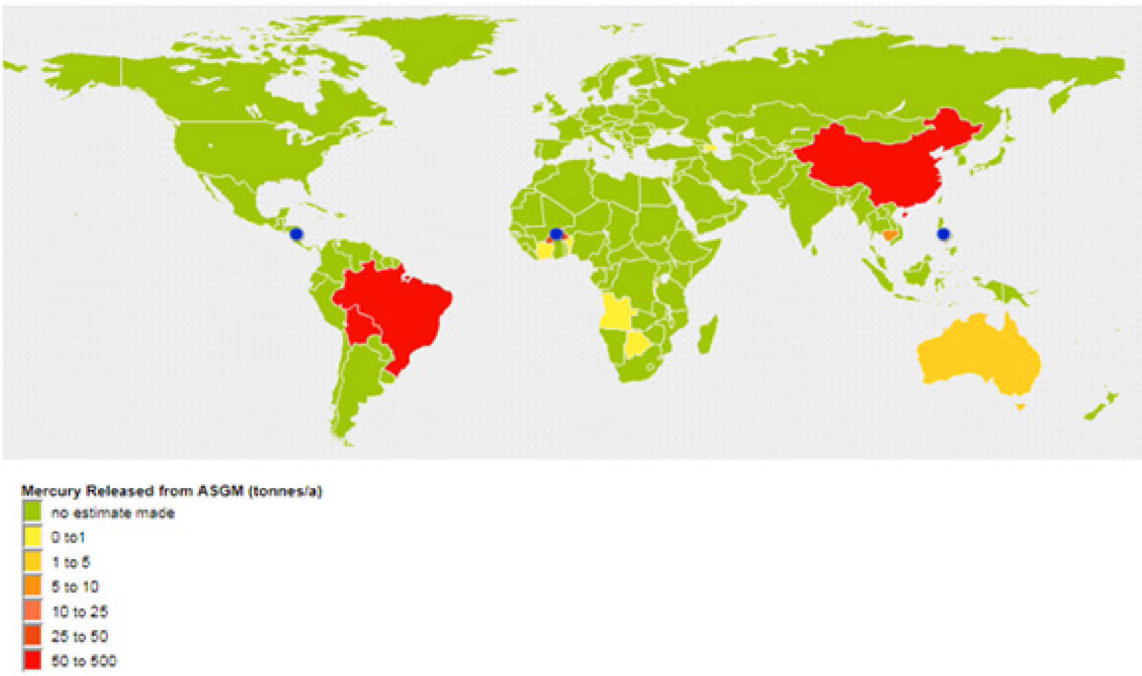


FIGURE 6. AVERAGE MERCURY RELEASED FROM ASGM

Source: Mercury Watch, 2017. *Note: Blue dot = ongoing mercury reduction projects*

Pure Earth (2017) has identified 69 countries as major sources of mercury pollution from ASGM activities in 2011 and estimated the corresponding population at risk (see Figure 7). While Figure 6 highlights the important mercury releases from ASGM in China and Brazil, these countries are not depicted as having the most population at risk in Figure 7. Indonesia stands out as one of the countries with the greatest mercury-related health issues, along with Ecuador, Mongolia and Peru, with 70,001–150,000 people exposed to mercury contamination in each.

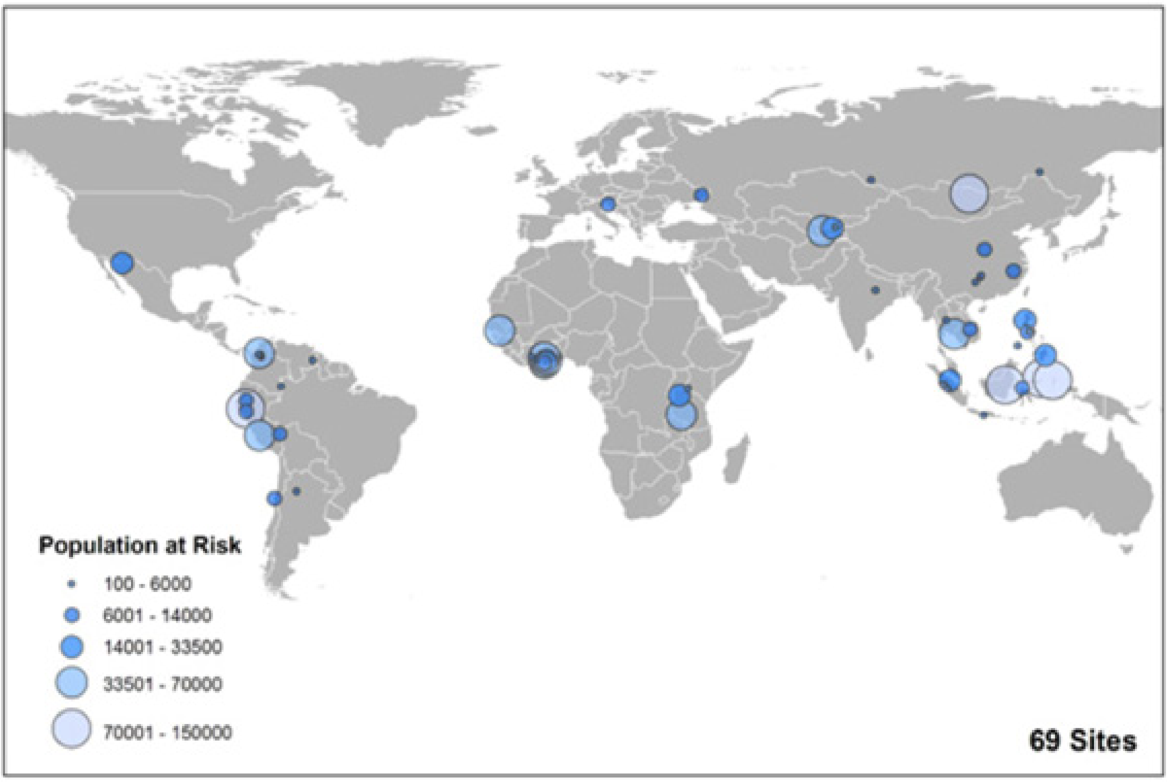


FIGURE 7. MERCURY POLLUTION FROM GOLD PROCESSING

Source: Pure Earth, 2017.

The differences between the mercury hotspots identified in Figures 6 and 7 may be explained by a lack of data and different calculation methods, boundaries, focus and data sources.

Pure Earth (2017) has found 132 ASGM sites that cause mercury contamination, affecting more than 3.5 million people, particularly in Africa and Southeast Asia (see Table 5).

TABLE 5. REGIONS MOST IMPACTED BY MERCURY POLLUTION FROM ASGM

REGION	NUMBER OF SITES	ESTIMATED IMPACTED POPULATION
AFRICA	75	2,401,200
SOUTHEAST ASIA	37	907,300
SOUTH AMERICA	19	195,000
CENTRAL AMERICA	1	3,100

Source: Pure Earth, 2017.

Seccatore et al. (2014) based their analysis on the Mercury Watch database, including additional countries when comparing the ratio of mercury consumed versus the amount of gold produced per country and per continent. This does not highlight the largest mercury releases but the least efficient mercury practices (see Figure 8).

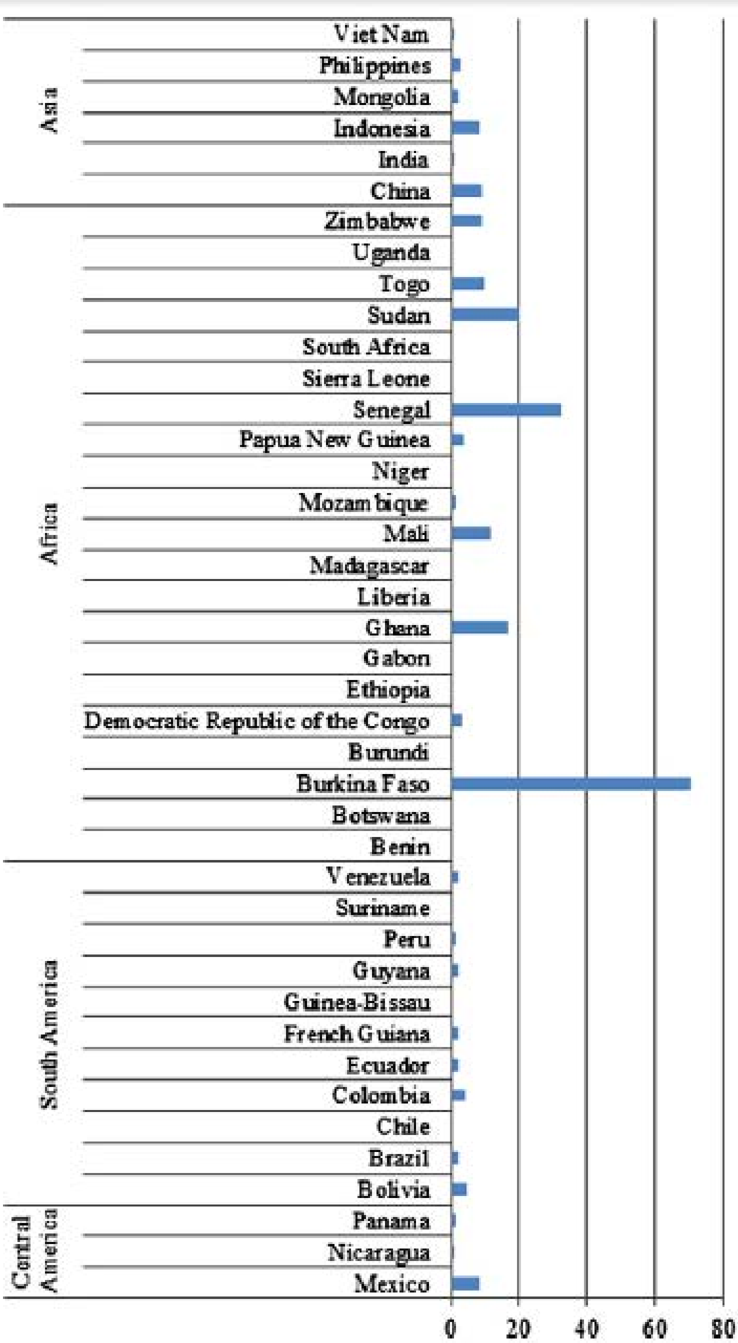


FIGURE 8. RATIO OF MERCURY CONSUMED VERSUS GOLD PRODUCED, BY COUNTRY PER CONTINENT

Source: Seccatore et al., 2014

The least effective practices can be observed in Africa: Burkina Faso (with a ratio of about 70), Senegal (a ratio of about 35), Sudan (a ratio of about 20) and Ghana (a ratio of about 17). Better practices can be found in Asia and Central America (Indonesia, China and Mexico all have a ratio of about 10). The most effective practices are in South America, where Colombia and Brazil still have a ratio of about 5, but all other countries fall below this ratio. Seccatore et al. (2014) also underline that geological differences between the different areas could have an impact on these results, but they were not able to take this into account in their analysis. They encourage further research such as field research and census to elaborate on their findings.

Mercury hotspots. Although there is no consolidated database so far on ASM, there are some well-known ASGM mercury "hotspots." Hotspots are determined by measuring the level of elemental mercury or methylmercury in humans and the environment. The level of elemental mercury in humans is measured by blood or urine sampling, showing recent or current exposures to mercury (World Health Organization [WHO], 2008). The level of methylmercury in humans is commonly measured from the hair to show the ingestion of mercury from fish consumption (WHO, 2008; Gibb & O'Leary, 2014).

Mercury contamination is far worse in some countries than others. For instance, Tanzania and Indonesia are defined as hotspots by Evers et al. (2014, p. 10–11). In the Matundasi and Makongolosi regions of Tanzania the amalgamation process is conducted in the open air without any safety or mercury recovery systems. Most of the contaminated water from sluicing and amalgamation is poured directly into the Lupa River and has environmental and health impacts on Lake Rukwa in South Tanzania, and on the people living in this area. In Indonesia, several sites are of concern, as shown in Figure 9. In both countries, the level of mercury in human hair largely exceeded the US Environmental Protection Agency reference dose of 1.0 parts per million.

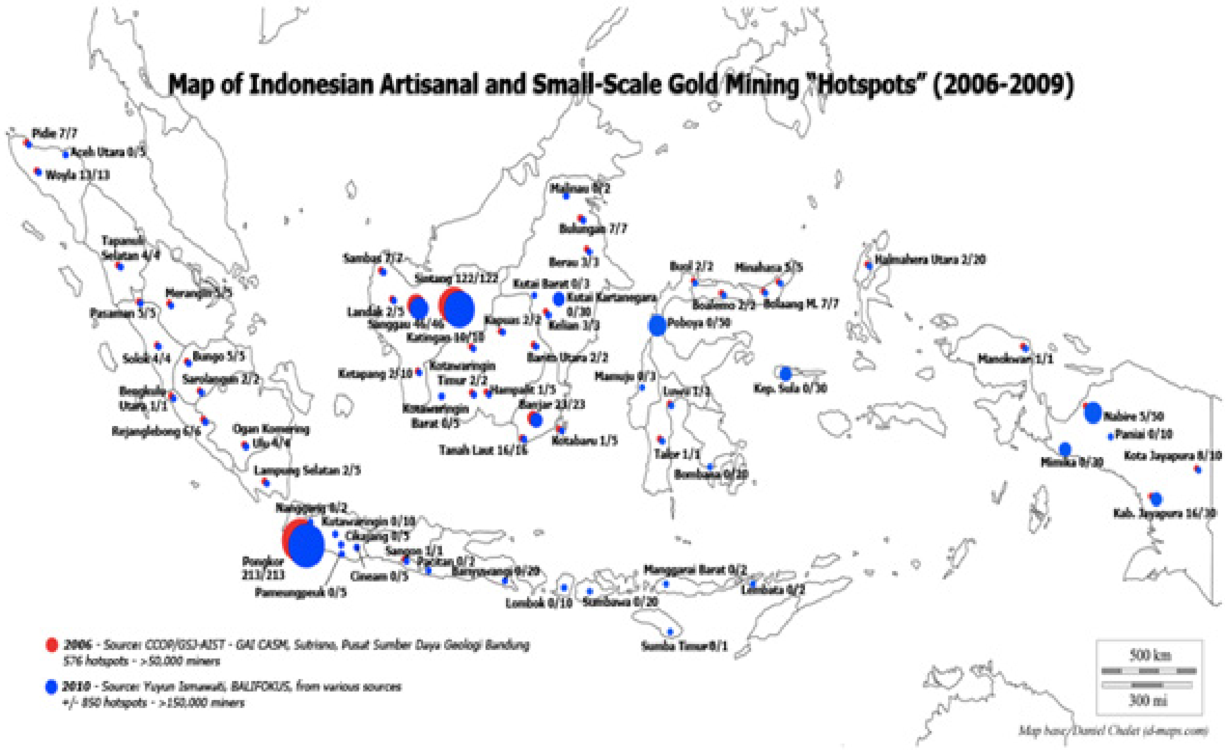


FIGURE 9. MAP OF ASGM MERCURY HOTSPOTS IN INDONESIA

Source: Ismawati, 2010.

As noted by Evers et al. (2014, p. 10-11) and Ismawati et al. (2013), almost all households in Sekotong, Indonesia, operate a "ball-mit" unit (a processing plant to recover gold) in their backyard or close to rice fields without any EHS equipment. The mercury-contaminated tailings are then further processed with cyanide or poured into rivers.

Figure 10 shows some examples of mercury measurements in human hair in Tanzania and Indonesia.

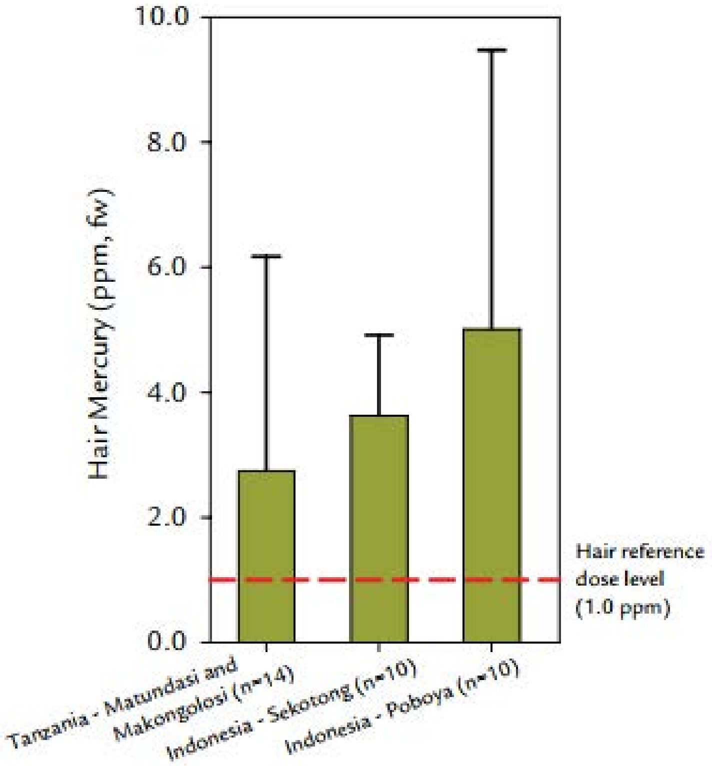


FIGURE 10. MERCURY CONCENTRATIONS IN HUMAN HAIR FROM ASGM SITES IN TANZANIA AND INDONESIA

Source: Evers et al., 2014, p. 10–11

Note: ppm = parts per million; fw = fresh weight; the black line T represents standard deviation—an estimate of the variation in the sample data set

In general, Indonesia's ASGM sites are more polluted than those of other countries (Ismawati et al., 2013).

A number of studies around the world have found mercury concentrations in human urine well above 100 micrograms of mercury per gram of creatinine (µg Hg/g-creatinine). The World Health Organization says that there is a high probability of developing classical neurological signs of mercury poisoning if this level is exceeded (see Figure 11). These limits are exceeded in various ASGM sites, such as in Burkina Faso (Black et al., 2017).

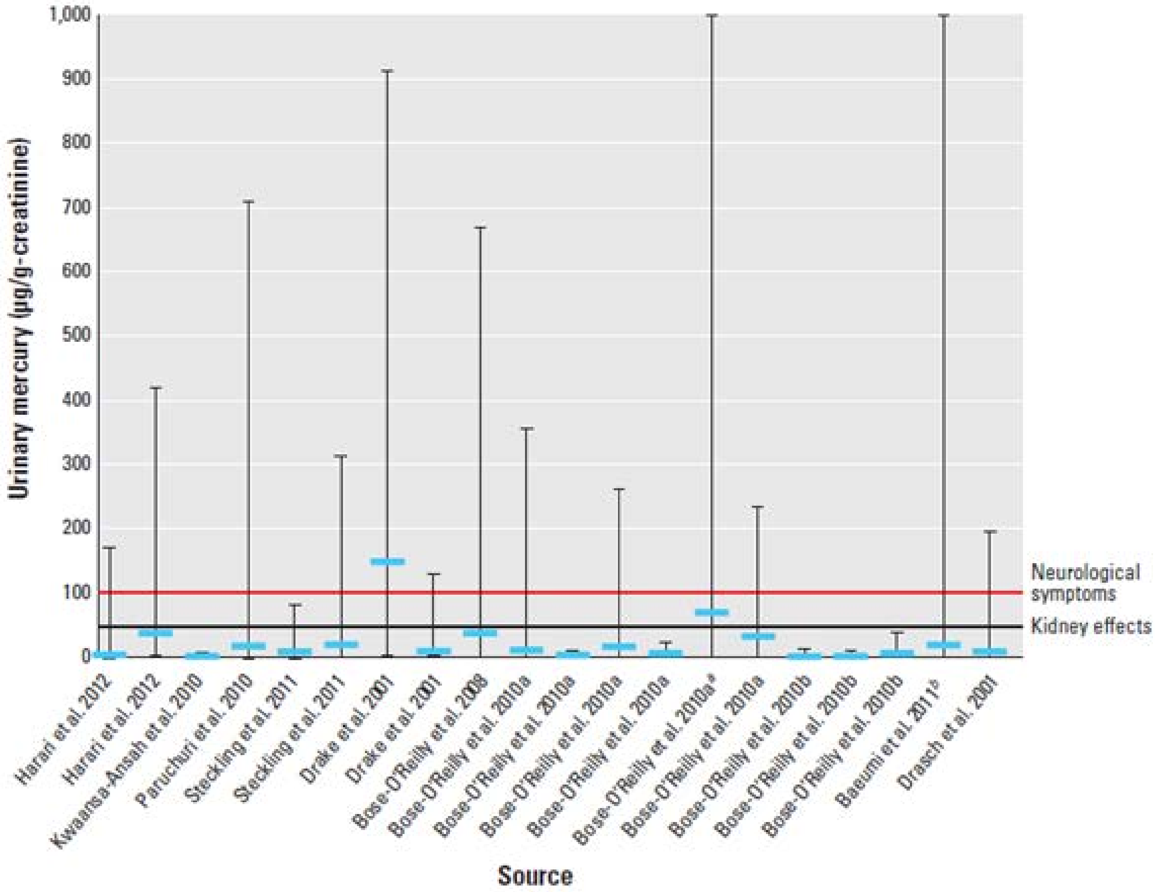


FIGURE 11. URINARY MERCURY FOUND IN ASGM POPULATIONS

Source: Gibb & O'Leary, 2014.

Notes: horizontal blue lines = means; vertical lines = ranges; horizontal red line = 100µg/g-creatinine value for neurological effects identified by WHO; horizontal black line = 50µg/g-creatinine concentration at which renal tubular effects are expected to occur.

Mercury is a neurotoxin that can cause harm to people, especially pregnant women (putting the development of the fetus at risk) and children (UN Environment, 2012, p. 8). The bioaccumulation of methylmercury (an organic compound of mercury produced by bacteria) in aquatic food chains affects rivers, fish and crops like rice; degrades biodiversity; and puts billions of people at risk of mercury poisoning (GAHP, 2014; UN Environment, 2012:8). According to the WHO, inhaling elemental mercury vapours and consuming fish or shellfish where mercury has bioaccumulated constitute the main cases of exposure to methylmercury, which is highly neurotoxic (WHO, 2017; GAHP, 2014).

Mercury is among the top 10 chemicals of major public concern according to WHO. Mercury poisoning affects the brain and the nervous, digestive and immune systems, as well as lungs, kidneys, skin and eyes (UN Environment, 2012; WHO, 2017). The symptoms of mercury poisoning include tremors, insomnia, memory loss, headaches, cognitive and motor dysfunction, respiratory failures, psychotic reactions, and eventually death in the case of severe poisoning (WHO, 2017; GAHP, 2014). People working in ASM and using mercury are the most directly and seriously affected since they are exposed to both occupational mercury poisoning and methylmercury poisoning through the food chain.

CYANIDE

Cyanide is usually used in LSM operations but is increasingly used in ASGM because it can recover more gold than mercury amalgamation (EPA, 2017). In some cases, it is more effective and cost-efficient, as shown in Ecuador (Veiga et al., 2009). However, cyanidation is still generally costlier than mercury amalgamation for most ASGM sites, and requires more knowledge and technical training (Veiga et al., 2009). While highly toxic itself, a further danger of introducing cyanide to ASGM is the risk that it gets mixed with mercury, in which case impacts on EHS are considerable (Spiegel & Veiga, 2010).

Cyanidation is often used to process the residual gold from tailings after mercury has been used first (Spiegel et al., in press; Drace et al., 2016). Mixed together, mercury-cyanide can bioaccumulate in aquatic organisms, resulting in fish with high levels of mercury contamination, as observed for instance in Ecuador (Veiga et al., 2014; Guimaraes, 2011); this mercury-cyanide complex can also carry mercury further than it would go on its own (EPA, 2017). The use of cyanide to process tailings is commonly observed in countries including Brazil, China, Colombia, Ecuador, Mozambique, Nicaragua, Peru, the Philippines, Tanzania, Venezuela and Zimbabwe (Veiga et al., 2014; Hilson & Van der Vorst, 2002).

Cyanide can be used instead of mercury as a "direct cyanidation process" (Spiegel et al., in press); the safest way to use it is after the ore has been concentrated (EPA, 2017). However, cyanide is also a toxic hazardous substance, although it does not persist in the environment, like mercury (GAHP, 2014; EPA, 2017). Unlike mercury, cyanide can decompose into less toxic forms and has immediate and acute effects, while mercury has long-term effects on EHS (Veiga et al., 2014).

The use of cyanide is not as widespread in ASGM as mercury since it requires more capital investment and skills, different business models, and its management is more complex (Spiegel et al., in press). However, the number of processing plants that use cyanide is rising in reaction to international pressure to phase out mercury use (Spiegel et al., in press).

CLEANER TECHNOLOGICAL ALTERNATIVES AND PRACTICES

Technological alternatives and environmentally friendly practices are critical to tackling chemical usage in ASM. However, while technical alternatives exist, they are not always applicable due to geological, socioeconomic, cultural and other site-specific factors. One barrier to adopting cleaner technologies for mining communities is cost effectiveness; the technology must increase the amount of minerals recovered and/or reduce efforts (GAHP, 2014). Also, ASM operators are usually risk-averse and will not change their practices until the benefits have been clearly demonstrated to them (GAHP, 2014).

There are a variety of mercury-free methods for extracting gold, and some have shown potential. UN Environment's (2012) *Practical Guide to Reducing Mercury Use in Artisanal and Small-scale Gold Mining*, aimed at policy-makers, miners and civil society, describes in detail a number of technologies and approaches for reducing and eliminating mercury use in ASM. The Artisanal Gold Council is currently compiling a bibliography of existing literature on technical approaches to reducing mercury use in ASM.[4]

Among the most common technological alternatives to chemical usage in ASM, retorts and mercury-free concentration methods have been subject to many studies and pilot projects, with varying levels of success.

[4] See http://goxi.org/forum/topics/need-your-input-building-an-asgm-technical-solutions-bibliography

RETORTS

Retorts are devices made from metal or glass used to recover mercury emissions from burning the mercury/gold amalgam, thus reducing mercury contamination and use. Figure 12 shows two different types of retorts, the first made from metal and the second made with a glass kitchen bowl, which can be made easily with domestic materials.

Retort using metal

Retort using kitchen bowl

FIGURE 12. EXAMPLE OF RETORTS MADE OF METAL AND GLASS KITCHEN BOWL

Source: Artisanal Gold Council (AGC), 2013; Erlich, 2014.

A retort is a relatively simple and effective method for capturing mercury emissions in the burning process—if used correctly. Specifically, retorts should be closed properly, used outdoors, with a sufficiently high temperature, and they should not be opened during the burning process. However, some projects in which retorts were distributed among mining communities failed, since metal retorts do not allow miners to see the process of amalgamation. To counter the negative perceptions of retorts that miners developed as a result, retorts made of glass were developed and tested, as shown in Figure 12. Other reasons for miners not using retorts are summarized in Table 6.

TABLE 6. MINERS' REASONS FOR NOT USING A RETORT

ARGUMENTS	REASONS
Mercury is harmless.	Miners do not see immediate health issues when exposed to mercury vapours.
Retorts are expensive.	Miners do not know inexpensive options.
It takes too long (sometimes miners are exposed to bandits).	Retorting temperature is too low.
Inexperience in operating a retort.	Lack of assistance in operation.
Gold is lost during retorting.	With iron retorts, the amalgam is not visible, so miners believe it has been lost.
Gold sticks to the retort crucible.	Occurs when the temperature is too high or when crucible is not lined with a thin layer of clay, talc or soot.
Recovered mercury loses coalescence.	Sometimes condensed mercury disperses into fine droplets.
Gold comes out brown from steel retorts.	Cause is unknown; it is probably due to a superficial reaction with iron.

Source: Veiga et al., 2014.

Some successful examples of retort use were observed in Munhena, Mozambique, where some miners stopped open amalgam burning altogether and used retorts instead; although not in a completely safe way (Shandro et al., 2009). In Matundasi and Londoni, Tanzania, some miners adopted the retort, especially for big amalgam balls—smaller ones still being burned in the open air (Jønsson et al., 2009). The latest literature does not support recovering mercury with retorts as the best option; it argues that the more successful approaches to reducing mercury use and introducing mercury-free alternatives take into account the socioeconomic environment, show the benefits to miners, and contribute to educating and training miners (Black et al., 2017).

MERCURY-FREE CONCENTRATION METHODS

The US Environmental Protection Agency (EPA, 2017) describes several mercury-free techniques to concentrate ore—i.e., to increase the amount of gold in the ore to be processed by removing lighter particles. These are safer and economically feasible, and could support miners to get a higher price for their gold on the market (EPA, 2017). If used appropriately, these concentration-based techniques can significantly reduce the use of mercury or even eliminate it totally. The ore is crushed/milled to extract the gold and decrease its particle size, until the most suitable size is obtained via screening or sieving. The most effective method from those described below depends on the type of ore processed, the different minerals present in the ore, the size of gold particles and whether or not water and electricity can be used.

GRAVITY CONCENTRATION METHODS

Gravity concentration methods are the most commonly used, and are based on the density of gold compared to other minerals. Common gravity concentration methods are panning, sluicing, the use of shaking tables, or spiral concentrators.

Panning: Panning requires water and a pan to separate gold from other particles. Gold particles are heavier and stay at the bottom of the pan, while lighter particles are ejected by the process. The gold particles processed in this way can then be further recovered by smelting, but this is not always necessary.

FIGURE 13. PANNING

Source: Gold Fever Prospecting, 2017a.

Panning is a cheap but time-consuming method, requires experience to be effective, and only processes small amounts. Therefore, miners often carry out panning after other gravity concentration methods, such as sluicing, have been used.

Sluicing: Sluice installations require water to wash the ore. Water flows through the ore along the sluice, set up at an incline of 5 to 15 degrees, and as the gold particles are heavier than the other minerals they get trapped in the material on the sluice (often carpets). The carpets can then be washed to obtain the captured minerals.

FIGURE 14. SLUICING

Source: Sutherland, 2014.

Sluicing can be a fast, effective method to process large amounts of ore, capturing greater amounts of heavy minerals by causing the water to flow slowly (e.g., using a sluice built in a zigzag shape or with two sluice surfaces). Sluices are one of the most common mercury-free alternatives in the sector (Davies, 2014). The price for buying or building a sluice varies depending on how they are designed. Sluices require a substantial amount of water to process the ore, preferably with a constant flow, and may therefore require other equipment such as piping, drums and buckets; they are also not suitable for water-scarce areas. Moreover, the concentrate obtained in this way does not usually contain a significant amount of gold and thus needs further concentration, such as by panning.

Shaking tables: These tables are also sloped, with the mineral to be processed released together with water at the top end of the table. While the water washes the mineral feed down the table, the table is continuously shaken to separate the gold from other particles. The gold gets trapped in special grooves and is directed to the side of the table where it is collected, while the lighter materials are washed away.

This technique is effective for processing significant amounts of ore to a high standard, but is quite expensive and users need to have some experience and skill to operate it. Shaking tables are common in some countries like French Guiana, but they are not suitable everywhere, especially in areas where water is scarce (Davies, 2014).

FIGURE 15. A SHAKING TABLE

Source: AGC, 2017a.

Spiral concentrators: Spiral concentrators consist of a pan with spiralled grooves rotated continuously by a motor. The heavier material in the ore (including gold) falls through a hole at the centre of the pan and into a container. An operator feeds concentrate material containing gold ore into it and a pipe fixed horizontally to the concentrator sprays water over the pan, washing away lighter particles. The process is repeated several times until the operator obtains a high-grade concentrate of liberated gold. While these devices are easy to operate, they are more costly than panning or sluicing methods.

FIGURE 16. SPIRAL WHEEL GOLD CONCENTRATOR

Source: 911 metallurgist, 2017.

There are additional mercury-free alternatives (vortex concentrators and centrifuges)[5] which are generally effective but more expensive and thus less applicable for ASM sites. Table 5 summarizes the costs of the various technologies that are most likely to be applied or applicable in ASM.

Table 7. Relative cost of technical intervention for a single miner

TECHNICAL INTERVENTION	APPROXIMATE COSTS (IN USD)	BARRIERS
PAN	3 – 30	Requires time
RETORT	5 – 50	Requires additional time and knowledge
IMPROVED SLUICE	10 – 100	Requires water, access to supplies
SPIRAL CONCENTRATOR	200 – 600	Requires water, energy
SHAKING TABLE	1,000 – 10,000	High initial costs, requires energy, water, technical knowledge

Source: Based on UN Environment, 2012; Gold Rush Trading Post, n.d.; Gold Fever Prospecting, 2017b.

OTHER CONCENTRATION METHODS

Other concentration methods rely on the magnetic or chemical properties of the minerals. Magnets can be used on the concentrated and dry material to remove metallic materials. Flotation can also be used in ASM, although it is typically used in large-scale mining. It is a useful process when gravity concentration methods do not work well due to the complexity of the ore type. It is highly effective at capturing gold, including fine particles, but it is also an expensive investment. Additionally, flotation uses frothing agents that can also cause EHS issues.

After the concentration process, the gold can be smelted to separate it from any remaining minerals. This is done by either a miner or by a gold buyer, often at a gold shop. Mercury vapours may still be emitted when the gold concentrate is smelted. For this reason, some gold shops are equipped with fume hoods, but some are not, in which case people living above the gold shop or in the surrounding area are exposed to mercury emissions.

During the smelting process a chemical (borax) can be used to lower the melting point of the concentrate, which is better suited to ASM capacities and equipment for smelting—i.e., the "borax

[5] See https://www.epa.gov/international-cooperation/artisanal-and-small-scale-gold-mining-without-mercury.

method" (GAHP, 2014). Borax is environmentally benign, is similar in price to mercury, and can recover up to three times more gold than mercury amalgamation processes (Appel & Na-Oy, 2012). The borax method was developed in the Philippines about 30 years ago, where it is very popular, and is now being introduced in Tanzania (Davies, 2014). A direct smelting kit that uses the borax method, referred to as sika bukyia by miners, is now produced in Ghana (Abbey et al., 2014; UN Environment, 2012). This technology, like many others, has not been widely distributed due to a lack of funding for education outreach (Abbey et al., 2014; UN Environment, 2012).

Another mercury-free method of extracting gold, known as "iGoli," has been developed by the South African research and development organization Mintek. The method leaches gold concentrate with dilute hydrochloric acid and bleach, and precipitates the gold with sodium metabisulphite (Mintek, 2011). The method has been incorporated into a small plant in South Africa suitable for groups of artisanal miners or small-scale commercial operators (Mintek, 2011). In Nigeria, following the deaths of over 400 children from lead poisoning in Zamfara state in 2010 (Ugeh 2013), the government's Safer Mining Programme introduced the iGoli and wet milling machines to miners in the state. While this method holds promise (small plants have also been set up in Tanzania), the fact that the iGoli is not produced locally but in South Africa makes it too expensive for some miners to access.

Table 8 shows examples of where mercury-free concentration methods have been tested successfully in ASGM sites and/or adopted by ASGM operators.

TABLE 8. SUCCESSFUL CASES OF MERCURY-FREE CONCENTRATION METHODS IN ASGM

CASE	METHOD	REFERENCE
Clean Tech Mine, Manica, Mozambique	Magnets. The need for mercury is eliminated, since the heavy minerals concentrated by gravity separation have a high concentration of magnetite.	Drace et al. (2012)
Ghana; Geocenter Denmark project, Tanzania	Borax. Used as an alternative to mercury. Results proved that borax was more effective with an average recovery rate of 98.3% (compared to 88% with mercury). The process took a similar amount of time and effort as amalgamation.	Amankwah et al. (2010); Appel and Jønsson (2010)
Diwalwal village, Philippines	Cleangold sluice. Sluicing followed by cyanidation proved to be more effective than amalgamation.	Hylander et al., 2007

POLICIES AND PROGRAMS TO REDUCE THE EHS IMPACTS OF ASM

Governments have been working for several decades to reduce the EHS impacts of ASM, particularly the use of mercury. Some governments have banned mercury use in ASGM or ASGM itself (GAHP, 2014). But due to the large share of gold produced by ASGM, some approaches focus instead on formalizing and regulating the sector to enable ASGM operators to contribute to the country's wealth via taxes while ensuring more environmentally friendly practices (GAHP, 2014). Such approaches, however, need more involvement from stakeholders on site and investment in efficient technologies that are suitable for the local context. Even though technologies are known, the challenges lie in identifying the most appropriate ones for a given mining site and demonstrating to miners the added value of using them (GAHP, 2014).

With the rising number of ASM operators and related EHS impacts, correlated with the rise in prices for minerals like gold, several national and international initiatives have been introduced. The following sheds light on the Minamata Convention on Mercury; the various approaches taken by different countries through national legislation; and other organization-specific activities.

THE MINAMATA CONVENTION ON MERCURY

Various organizations over the past 15 years have focused on the use of mercury in ASGM. The Global Environment Facility (GEF), the United Nations Development Programme (UNDP) and the United Nations Industrial Development Organization (UNIDO) began various projects in 2002 to reduce the environmental impact of mercury use in ASGM (GAHP, 2014). Following that, the United Nations Environment Programme (now UN Environment) established the Mercury Partnership for ASGM.[6] This contributed to projects and programs to reduce mercury use and promote mercury-free techniques in ASGM.

Until the late 2000s, strategies to tackle chemical usage in ASM focused on voluntary actions to reduce the negative impacts of chemicals like mercury, and the ban of mercury exports from the United States and the European Union. According to the Zero Mercury Working Group (Zero Hg, 2016, p. 7) and the UN Comtrade database, following the US and EU export ban on mercury, new mercury trading centres emerged in Hong Kong. Mercury was exported to ASGM countries like Togo, Sudan, Brazil and South Africa (with South Africa serving as a hub for other African countries). Singapore was also identified as a hub importing large quantities of mercury from the United States and the European Union before the export ban came into force. This led to the establishment of a global legally binding instrument, the Minamata Convention on Mercury, initiated by UNE Environment (AGC, 2017b).

The Minamata Convention on Mercury was enacted in January 2013. It is a legally binding global instrument meant to support the reduction of mercury trade, supply and use in ASM and several other sectors. A strong focus is placed on ASGM since it is defined as the largest anthropogenic source of mercury emissions worldwide (UN Environment, 2013b). To date, the Convention has been ratified by 51 countries and more than 120 countries have shown interest in signing it (UN Environment, 2017, p. 27).

It stipulates that all countries where ASGM is "more than insignificant" must develop a National Action Plan (NAP) to take steps to control and reduce trade in mercury and where feasible, eliminate its use. These NAPs must be developed at the latest three years after the convention has been ratified by the country, and must include measures for capacity building and awareness raising on EHS risks. These measures need to promote the adoption of cleaner and mercury-free technologies by ASGM communities and the formalization of the sector, and provide technical and financial assistance in accordance with Annex C of the Convention. Annex C has a particular focus on public health and safety, along with strategies to prevent EHS risks, especially for vulnerable groups, and to eliminate the worst mining practices (such as WOA) and reduce mercury emissions (UN Environment, 2017, p. 26). Governments are encouraged to eradicate WOA, the burning of amalgam in the open and in residential areas, and cyanide leaching of ore or tailings where mercury has already been used (Spiegel et al., in press).

Two main documents support countries in developing their NAPs.

- A guide to developing National Action Plans (NRDC, 2015)[7]
- Draft guidance from UN Environment[8]

The UN Environment Global Mercury Partnership is also active in implementing NAP projects, especially the "global component" of NAPs, funded by the GEF. This global component focuses on information exchange at the national level, capacity building and training on developing baseline estimates, generating knowledge and regional collaboration between the countries developing NAPs. They also introduce tools and methodologies to guide the development of NAPs (UN Environment 2017). It should be highlighted that deadlines set by Convention signatories to meet their objectives

[6] See www.unep.org/chemicalsandwaste/global-mercury-partnership/reducing-mercury-artisanal-and-small-scale-gold-mining-asgm.
[7] See https://www.nrdc.org/sites/default/files/int_15101401a.pdf.
[8] See https://wedocs.unep.org/bitstream/handle/20.500.11822/11371/National_Action_Plan_draft_guidance_v12.pdf?sequence=1&isAllowed=y.

are set for themselves, and hence there are no sanctions if these are not reached (UN Environment, 2017:27).

The Minamata Convention is seen by some as a significant improvement in global regulations on mercury trade and supply. Others have doubts about its effectiveness on the ground (Spiegel et al., in press). By cutting the mercury market supply, it was expected that mercury prices would rise and make the substance too expensive for use, thus reducing negative environmental impacts on ASGM and other sectors (Spiegel et al., 2005; Hylander, 2001). At the same time, experts warned of the related risks of new illegal trade practices for supplying mercury and highlighted the need to take socioeconomic dynamics into account (Clifford, 2014).

Recently, such risks have been confirmed by several field studies, including in Indonesia. Despite the country having ratified the Minamata Convention and developed a NAP, the supply of mercury has actually increased in Indonesia through the domestic production of mercury from cinnabar mining (Spiegel et al., in press). This new source has made the substance even cheaper for ASGM operators all over the country (Spiegel et al., in press). In addition, significant informal mercury imports have been reported in Indonesia (Ismawati, 2014). Mexico has also been identified as a new mercury export source, with 134.3 megatonnes (MT) of mercury exported in 2011, 268 MT in 2013, 300 MT in 2014 and over 245 MT in 2015. The importers are countries in South America with ASGM activities, namely Colombia, Peru and Bolivia (Camacho, Van Brussel, Carrizales et al., 2016); but there is no proof that the mercury is indeed used for ASGM.

Hence one criticism of the implementation of the Minamata Convention is the lack of consideration of mining sites' socioeconomic contexts, where different stakeholders and power relations influence the trade and use of mercury in ASGM (Spiegel et al., in press). Another criticism is the lack of stakeholder involvement in developing NAPs and their implementation, such as in Indonesia (Spiegel et al., in press; Mongabay, 2015). Finally, although the ban did curb mercury exports, it did not prevent the formation of new mercury export hubs.

VARIOUS NATIONAL APPROACHES

Legal frameworks and programs are emerging across governments to formalize the ASM sector, since its potential to become more environmentally and socially responsible is increasingly recognized (UN Environment, 2017, p. 20). Progress is slow, however, and limited by both a lack of resources and by government strategies that do not always match the miners' needs, priorities and capacities (UN Environment, 2017, p. 20). Many national policies fail because they do not consider the variety of ASM characteristics, and thus the specific needs of varied mining sites, or because they are too restrictive, consisting of too many or overly complicated administrative steps or requirements, among other reasons.

Other reasons for the failure of ASM formalization include the focus on taxation and fees/royalties by ASM operators, which are instead an incentive to sell minerals on the black market (UN Environment, 2017; GAHP, 2014). Miners also lack access to adequate financial resources, like credit to invest in better technologies, which stems from a lack of formalization and thus a lack of support from financial entities (UN Environment, 2017).

Formalization does not necessarily have an impact on ASM miners' EHS performance, but a better EHS performance can support formalization of the sector (Marshall & Veiga, 2017). Despite the general argument for formalization as a necessary first step towards cleaner ASM practices, the authors argue that education should come first. While disagreements exist, a recurring issue that has gained majority consensus is the lack of engagement with the ASM community (Spiegel et al., in press) and a need for holistic/system knowledge approaches (Fritz et al., 2016).

Table 9 shows different practices and focuses by various governments, and their success or failure.

TABLE 9. CASE STUDIES: VARIOUS APPROACHES TO TACKLING EHS IN ASM

COUNTRY	SITUATION
GHANA	**ASM status**: Regulated. ASM has been recognized as contributing to the country's development since 1989. **EHS impacts**: Failures on the ground due to poor safety practices, dust and fumes from drilling, improper working tools, lack of protective equipment, land degradation, contamination of surface and ground water. Mercury amalgamation is a common practice. Exposure to mercury and lead emissions. Illegal foreign miners from China, Togo, Burkina Faso, Ivory Coast tend to degrade the environment more severely than local people (destroying cocoa farms, protected forests). The increase of migrants has increased mechanization and thus the surface area of mined land and the level of soil and water body contamination. **Regulation**: Minerals and Mining Act 2006 (Act 703), Small Scale Gold Mining Law (PNDC Law 218 of 1989). **ASM miners' obligations:** Mining is allowed only with a licence, granted only to Ghanaian citizens. **Support for ASM miners**: Technical services through district centres in charge of compiling a register of ASM operators, supervising their activities, providing advice and training. **Regulation issues**: Lack of regulatory enforcement by the Minerals Commission of Ghana. Procedures to get a licence are time-consuming and expensive—thus miners prefer to operate illegally. The PNDCL 218 does not precisely address EHS issues and does not propose EHS measures, unlike China and South Africa. There are EHS regulations in the mining sector but not specific to the ASM context (Minerals and Mining (Health, Safety and Technical) Regulation, LI 2182). **Mercury use in ASM**: Legal (Small Scale Gold Mining Law, PNDCL* 218 of 1989). The use of explosives is also legal (Minerals and Mining Act, 2006). **Reference**: Bansah et al. (2016); Obiri et al. (2010)
SOUTH AFRICA	**ASM status**: Regulated by the Mineral and Petroleum Resources and Development Act (MPRDA), 2002. **ASM operators' obligations**: Submit a monthly production report. **Regulation issues**: Low level of compliance, making it difficult to monitor and gather statistics on the sector. **EHS regulation**: Mine Health and Safety Act (MHSA), 1996. Specific to ASM. Monitors EHS impacts and supports research in the field. ***MHSA (Act 74, 2008)***: EHS, training, records on employees. **National Environmental Management Act (NEMA), 1998**: environmental management practices. **Reference**: Bansah et al. (2016)
INDONESIA	**ASM**: Regulated through the Mineral and Coal Law (2009) at a regional level (decentralized). Indonesia has ratified the Minamata Convention on Mercury. **Mercury use in ASM:** Banned. **ASM operators' obligations**: Have a licence, operate in designated areas, but no clear mechanism for licensing is defined. **Regulation issues**: Decentralization is considered an important factor in the growth of illegal ASM in the country. There is a lack of institutional and technical assistance in ASM. Thus, impacts of the activity cannot be easily assessed and compliance is difficult to enforce. Costs and bureaucracy to acquire licences and environmental permits and comply with regulatory requirements are high and administrative processes are slow. Dispossession and land-use policies are also considered obstacles to monitoring ASM activity. Policy-makers and the media focus on promoting ecological cost assessments and awareness raising on toxicity to support phasing mercury out of the country, and it is believed that more holistic approaches are needed to succeed. **Reference**: Bansah et al. (2016); Spiegel et al. (in press)

* PNDCL – Provisional National Defense Council Law (Ghana Law Reform Commission)

COUNTRY	SITUATION
TANZANIA	**EHS impact**: Gemstone and diamond extraction degrades land, pits are left abandoned, river siltation and sedimentation observed due to ASM activities. **ASGM obligations**: Use of retorts is compulsory with mercury, but mercury use without retorts is still taking place. **Regulations**: ASM operators have the greatest impact on the environment but are not recognized by the law. This compromises how their activities are managed and negative impacts remedied. The government is taking steps towards formalizing the sector; stakeholder engagement is needed, including local government. The National Environment Management council has voted to develop environmental management plans to be implemented after a mining site is closed. Measures to share environmental best practices with ASM will be implemented. In 2010, the government issued regulations to simplify the environmental impact assessment requirements in ASM, but this was not effective; the needs of ASM operators were assumed, rather than assessed in collaboration with the operators themselves. New strategies are being developed with support from the World Bank. **Reference**: UN Environment (2017, p. 23, 29–30), Evers et al. (2014, p. 10–11), Davies (2014)
KENYA	**Regulations**: Constitution of Kenya 2010, Articles 62: all minerals are defined as public property and are vested in the national government. **Article 69(1)**: the state must ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources. Environmental Management and Coordination Act (EMCA), 1999: covers all aspects of environmental concerns. **Mining Policy and Mining Act, 2016**: gives direction on the management of all mineral resources. **Mining Act, 2016**: provides for the management of artisanal miner operations under Sections 92–100. This covers issuing permits, establishing county offices, compensation for the use of land and sale of minerals, while Sections 176–181 provide for EHS conservation. The provisions cover land use, restoration and mine closure plans, environmental protection bonds and occupational health and safety. Various mining regulations are underway and will operationalize the Mining Act. Environmental sustainability in ASM in Kenya is regulated mainly by the constitution; the Mining and Mineral Policy, 2016; The Mining Act, 2016; Environmental Management and Coordination Act, Cap 387 of the laws of Kenya. Other sectoral environmental laws and policies: National Environment Policy, Wildlife Conservation and Management Act, Forests Act, etc. **Further improvements needed**: Clear coordination mechanism for the artisanal mining sector, technical procedures for licensing and permits (e.g., Environmental Impact Assessment procedures) should be adapted for ASM capacity, developing more adequate legislation for the protection, health and safety of artisanal mining operations, develop clear incentive mechanisms to encourage technology transfer, develop clear guidelines on access to credit and credit schemes, build capacity to monitor and enforce environmental regulations. **Reference**: UN Environment (2017, p. 30–32)

In general, policy and regulatory frameworks on EHS in ASM that also contribute to the local development do not fit miners' needs or are undeveloped, and the benefits of technical alternatives for miners are not well demonstrated (UN Environment, 2017). Barriers to further improvements include the lack of access to geological information, the lack of adequate management tools, the lack of capacity building, and restricted access to finance and appropriate technologies (UN Environment, 2017). For instance, there is not enough information to know exactly how much mercury is being used in ASM. In general, contrary to LSM, a full environmental impact assessment is not a requirement for ASM.

OTHER INITIATIVES AND TYPES OF ORGANIZATIONS INVOLVED

AFRICAN MINING VISION

The African Mining Vision (AMV) was adopted in 2009 at the African Union Summit and shows the commitment of African countries to exploit natural resources sustainably (African Union, 2009). The fact that this initiative is defined by African nations themselves gives it country specificity. Making ASM one of its main workstreams, the AMV recognizes the contribution of ASM to local economic development. Oxfam (2017, p. 10) describes it thusly:

> The AMV follows the 2002 Yaoundé Vision on ASM adopted by the Communities and Small-Scale Mining (CASM) Africa Initiative in 2005 to call for a participatory ASM development strategy that focuses on the formalization of the ASM sector and its integration into local and regional economic development and land-use plans and strategies, especially Poverty Reduction Strategies; and reviewing mining policies to incorporate a poverty reduction dimension to ASM strategies.

One of the initiatives resulting from this common vision is the African Minerals Governance Framework developed in 2016.[9] Among the interventions proposed, one goal is to develop sustainable mining practices in an safe, environmentally and socially responsible way, and engage the mining community directly. The African Minerals Development Centre, an organization tasked with implementing the AMV in member countries, asks and supports governments to develop a "sustainable environmental, health and safety plan to reduce or eliminate the adverse effects of ASM" (Oxfam, 2017, p. 13). However, it does not provide specific guidelines as to how this can be done in practice (Oxfam, 2017).

GLOBAL ENVIRONMENT FACILITY GLOBAL OPPORTUNITIES FOR LONG-TERM DEVELOPMENT

The Global Environment Facility is an important funding body for projects on ASM and hazardous substances. In 2016, the Global Opportunities for Long-term Development (GEF GOLD) was launched to support the phasing out of mercury use in ASGM and reduce EHS risks in the sector. The United Nations Industrial Development Organization (UNIDO) is one of the main organizations in charge of implementing the project. Eight countries will benefit from it: Burkina Faso, Colombia, Guyana, Indonesia, Kenya, Mongolia, Peru and the Philippines.

Concrete actions will start in 2018 with a focus on formalization, establishing gold-buying schemes, capacity building at the national level on mercury-free technologies, awareness raising and knowledge sharing.[10]

THE OECD DUE DILIGENCE GUIDANCE FOR RESPONSIBLE MINERAL SUPPLY CHAINS

The OECD developed a guidance document (the *OECD Due Diligence Guidance for Responsible Mineral Supply Chains*) to support companies in sourcing minerals and in building more transparency along the supply chain, as required by the US Dodd-Frank Act and the recent European directive on conflict minerals.

In this context, a specific guidance has been issued on sourcing gold from ASGM to support the phasing out of mercury in ASGM, in cooperation with the Global Mercury Partnership. While the ASGM specific guideline does not mention EHS impacts, the general OECD Due Diligence Guidance refers to areas causing economic, social and environmental harm, but does not specify the meaning of these terms.

Implementing agencies and NGOs include Partnership Africa Canada, the Artisanal Gold Council, Alliance for Responsible Mining, Solidaridad, Fairtrade and PACT.

[9] See www.africaminingvision.org; https://www.uneca.org/stories/towards-african-driven-mineral-governance-framework.

[10] See https://www.thegef.org/news/gold-shines-opportunity-artisanal-miners-reduce-and-eliminate-mercury-use; https://www.thegef.org/news/helping-burkina-faso-eliminate-mercury-use-artisanal-and-small-scale-gold-mining-sector.

Other multilateral and bilateral programs are: the Global Mercury Partnership,[11] the Sustainable Artisanal Mining Project,[12] the ACP-EU Development Minerals Programme[13] and the Capacity Building for Responsible Minerals Trade Project.[14]

UN ENVIRONMENT CHEMICALS AND WASTE BRANCH

The UN Environment Chemicals and Waste Branch coordinates UN activities related to chemicals management at a global level, following priorities defined by governments. Its work is done in direct contact with countries and aims at building national capacity for clean production processes, proper use and disposal of chemicals, and knowledge sharing on the latest available information on safe chemical uses. This organization also has a mandate to coordinate global actions such as policy frameworks, guidelines and programs for the reduction or elimination of chemical-related risks.

In relation to chemical use in ASM, the UN Environment Chemicals and Waste Branch plays a major role in building capacity in ASM countries, developing and ratifying the Minamata Convention, coordinating the Global Mercury Partnership, and implementing NAPs with a variety of partners.

THE ARTISANAL GOLD COUNCIL

The Artisanal Gold Council is a not-for-profit organization based in Canada made up of experts from around the world working on environmental, social and organizational issues in ASGM. Their work is based on filed studies and collaborations with on-site experts to develop solutions with a bottom-up approach that fits the local context and the characteristics of each ASGM site.

Their activities focus on training, awareness raising, education and capacity building on topics related to such things as health, environment, governance, livelihoods, technological practices, market access.[15]

LEVIN SOURCES

Levin Sources' ASM-PACE initiative involves the study of ASM in protected areas and critical ecosystems, focusing on reducing ASM impacts on biodiversity and ecosystem services in 32 countries worldwide. Actions include improving environmental performance, engaging stakeholders and disseminating knowledge about best practices.[16]

A HOLISTIC APPROACH TO EHS

Measures taken by countries like Indonesia, aimed at eliminating the use of mercury in all ASGM sites by forbidding the use of mercury or the ASM activity itself, are not effective. Governments need to adopt a progressive approach to eliminating the use of hazardous chemicals (Spiegel et al., in press). Indeed, such bans can constitute a barrier to better environmental practices, since governmental bodies or external organizations like NGOs and intergovernmental organizations cannot support ASM operators when the activity is considered illegal. In this context, as underlined by Seccatore et al. (2014), some governments chose to legalize ASM activities, such as Ecuador in 1991, so that miners can get access to safer technologies via national and international cooperation programs.

It is important to train miners on site to raise their awareness of mercury toxicity, but also inform others, such as children. Health care workers need training on the prevention, diagnosis and treatment of mercury poisoning via, for example, cooperation between NGOs and miners' associations like the NGO Ban Toxics and the Benguet Federation of Small-Scale Miners in the Philippines (Køster-Rasmussen et al., 2016). There should be direct contact with the miners to disseminate information—using intermediaries is not always effective (Køster-Rasmussen et al., 2016). Any attempt to stop

[11] See http://web.unep.org/chemicalsandwaste/global-mercury-partnership.
[12] See http://sam.mn/%D1%82%D3%A9%D1%81%D0%BB%D0%B8%D0%B9%D0%BD-%D1%82%D1%83%D1%85%D0%B0%D0%B9/.
[13] See http://developmentminerals.org/index.php/en/.
[14] See http://mneguidelines.oecd.org/FAQ_Sourcing-Gold-from-ASM-Miners.pdf; http://www.oecd.org/daf/inv/mne/OECD-Due-Diligence-Guidance-Minerals-Edition3.pdf.
[15] See www.artisanalgold.org.
[16] See http://www.levinsources.com/assets/pages/Global-Solutions-Study.pdf.

WOA, a key issue in ASGM, should first address the needs and beliefs of miners; they should have a choice between the different possible alternatives (Veiga et al., 2014). Table 10 suggests steps to take when addressing the EHS issues of rudimentary techniques.

TABLE 10. STEPS FOR SUCCESSFUL TECHNICAL INTERVENTIONS IN ASM

CONCEPT	ACTION
Know the miners	Identify the miners' strength and weakness.
Identify the problems	Identify the main technical needs to improve production.
Be known	Create links of friendship and trust with miners and their community members.
Promote technologies	Demonstrate the efficiency of the 'new' technology to extract gold from the miners' tailings to create credibility.
Educate patiently	Start the education process slowly, explaining why the new technology works better.
Do not complicate	Use technical concepts and language familiar to local miners.
Let miners decide	Demonstrate more than one new technology and let the miners decide what is best for them.
Be flexible	Check the receptivity to new technologies and be prepared to demonstrate more than one option.
Pick the right people	Train the trainers (select local leaders).
Gold is more important for them	Show the economic advantages of new technologies first and then show the reduction in environmental and health impacts.

Source: Veiga et al., 2014

Beyond technologies and education, it is crucial to consider the site-specific characteristics of ASGM and the needs of the mining community (bottom-up approaches), and to engage directly and empathetically with miners and local stakeholders to build trust (Hilson et al., 2007; Fritz et al., 2016). It is essential that policy-makers understand the environmental and social impacts of ASM for an informed new legislation. Using simple language with graphics or pictures can better support dialogue with and engagement of miners and their community. Considering the site-specific characteristics also means that any alternative should be more cost- and time-efficient for miners (Drace et al., 2012).

Another important point is to involve multiple stakeholders to decide the socioeconomic acceptability and technical feasibility of mercury-free techniques from the miners and their community´s perspective (Spiegel et al., in press; Muradian & Cardenas, 2015). Such approaches should, however, be implemented from a long-term perspective that enables trust to be built within the community and with external organizations, a necessary precondition to identify and understand the power relations on site and ensure the success of such projects (Spiegel et al., in press; Saldarriaga-Isaza et al., 2015). This needs to be understood by donors, government officials, and other stakeholders involved in phasing out mercury use in ASM and reducing all EHS risks in general.

4.0 ASM INTERFACE WITH LARGE-SCALE MINING

This section explores the interface between ASM and large-scale mining (LSM): where and how the two activities meet; the risk of conflict due to competition for land and mineral rights, and the challenges presented for both. It also looks at positive examples of interaction, the ways in which the two have worked and can work together, and areas where mutual socioeconomic development and positive change can be achieved.

CONTEXTUALIZING THE ASM–LSM INTERFACE

ASM activities are increasingly in contact with LSM operations, making the probability for conflict—as well as the potential opportunity for cooperation between the two—greater than ever before. This is due to the growth of the ASM sector in rural, largely impoverished communities across the developing world over the past two decades, as well as the propensity for LSM companies to exploit increasingly marginal deposits. To meet demand, mining companies are exploring new frontiers and neglected resources consisting of lower-grade and hard-to-access deposits previously uneconomical to mine on a large scale due to the high levels of capital, technology and infrastructure required. These are also areas where, traditionally, artisanal and small-scale miners may already be present, living and working near surface deposits. Furthermore, as new deposits are opened via exploration activities and roads they may attract small-scale miners to the area in rush-type situations (CASM, 2009: Wall, 2009).

The instances where ASM and LSM activities meet have usually been underscored by tension and conflict over land, access and control of mineral deposits as well as the right to mine. In many countries the mineral governance framework favours foreign direct investment in the LSM sector over local ASM, leading to significant power imbalances and clashes over claims. LSM companies not only have a dominant position in the political and legal spheres, but also in terms of their significant financial resources and access to geological knowledge and sophisticated mining technologies, giving them a much greater advantage over ASM when competing for the same claims.

Often, extensive mining concessions are given over to LSM companies without communities being informed or consulted. This leads to LSM companies essentially arriving overnight and dispossessing informal small-scale miners of claims they believe to be rightfully theirs through customary land tenure systems and traditional laws—despite not having a permit or licence to mine under statutory law. This can create significant tension and conflict if the community and miners are not actively and meaningfully engaged prior to the start of large-scale activities, especially where force and other methods are used to evict and police miners and communities. It can also lead to the encroachment of unlicensed and informal miners onto LSM concessions (Okoh, 2013; Verbrugge, 2017).

Another area of interaction between the two is when small-scale miners act as “pathfinders” or “barefoot prospectors.” During the exploration phase, junior mining companies will often follow small-scale miners in order to identify and search for potential new claims, only to later evict them from the site once they have obtained a licence, or place them in marginal parts of the concession where returns may be low and resources limited to a few years of mining (Carstens & Hilson, 2009; Luning, 2014).

Fundamentally, what all the challenges and conflict between LSM and ASM have in common is competition over limited land as well as overlapping concessions and poorly managed land allocation programs (Siegel & Veiga, 2009). Formalizing the sector as a starting point, addressing power imbalances and supporting small-small miners to access claims that have geologically proven reserves, it is argued, would help to improve relations between LSM and ASM and ameliorate instances of conflict (Hilson, 2013; Verbrugge, 2017).

CORPORATE SOCIAL RESPONSIBILITY AND ASM–LSM RELATIONS

Although the legal framework for ASM and LSM varies from country to country, increasingly many international codes, regulations and voluntary initiatives by organizations and the industry itself require LSM companies to make commitments to integrate social and environmental concerns in their business models. In some cases, these provisions and voluntary initiatives also include points that either directly relate to or cover areas of the ASM sector (CASM, 2009):

- UN Voluntary Principles on Security and Human Rights
- UN Global Compact
- Kimberley Process
- Equator Principles
- Extractive Industries Transparency Initiative
- OECD Guidelines for Multinational Enterprises
- ILO Declaration on Principles and Rights at Work
- International Council on Mining and Metals (ICMM) Sustainable Development Principles
- Sustainable Development Goals (SDGs).

Working with local communities is important not only in order to meet legal and voluntary social and human rights requirements and to ensure that communities benefit (including local small-scale miners), but increasingly it is also necessary to gain a "social license" (broad acceptance or approval from the local community and other stakeholders) to operate. However, in some cases corporate social responsibility (CSR) has had a negative impact on ASM–LSM relations. Characterized by long histories of tension and mistrust due to years of poor communication and engagement and failed promises, some CSR programs do little to benefit the local community—and may instead act to fuel the tension. This is particularly the case when mining concessions change hands between different, discrete mining companies multiple times over the course of a mining life cycle, and is particularly acute at the exploration phase. Often the surrounding mining community may have been consulted on numerous occasions (or not at all) and promised various things. But as the mining licences change hands, these promises and "inherited CSR commitments" may not be upheld, communities may have built up unrealistic expectations, and the points of contact and dialogue they may had with the mining company may no longer exist or be ineffective (Hilson, 2011).

Beyond CSR, it is also important to consider ways in which LSM companies can contribute to the shared value of the local communities and businesses in which they operate. These can be through linkages to local input services and business, local content initiatives, ensuring they have a positive sustainable impact, and if necessary finding ways to interact positively, dialogue and work with ASM (Prieto-Carrón et al., 2006; Kemp, 2009; Ramdoo, 2013; Geipel, 2017). Some examples follow of ASM–LSM interactions as part of LSM CSR policies.

EXAMPLES OF ASM–LSM INTERACTION

TRIBUTER SCHEMES – AKWATIA, GHANA

In Ghana, a large-scale mining company, Great Consolidated Diamond Limited (GCDL), located in Akwatia, in the Eastern Region, operates "tributer" schemes which are systems that involve registration of all ASM operators encroaching on a property and demarcating areas for small-scale miners to work on the LSM company's concession (Aryee, 2003). Miners apply for permits from GCDL for a small fee, are required to undertake medical and safety checks before starting work, and must sell a portion of the diamonds won back to the company. Dialogue is maintained via a miners' association. In return, GCDL is able to work marginal deposits that are uneconomical to mine on a large scale, and miners act to protect the concession from encroachment by unlicensed operators. However, the tributer system is not without its challenges due to the difficulties of effectively managing such a large area. As a result, some unlicensed miners have encroached on parts of the concession where it is difficult to manage and control operations (Nyame & Grant, 2012; McQuilken & Hilson, 2017).

NEGOTIATED SOLUTION – PHILIPPINES

Through the Acupan Contract Mining Scheme in the Benguet province of the Philippines, ASM operations are allowed to take place in 22 clearly delineated "working places" inside a large-scale mining concession, owned by Benguet Corporation (CASM, 2009). Under the contract, the company is responsible for the overall planning of the mining operations; for maintaining the main tunnel portal and the gold processing facilities; and for processing and selling all the gold to the Central Bank, while mining activities are outsourced to contracted ASM associations. A critical analysis by Verbrugge (2017) argues that this type of negotiated solution may act to reinforce historically rooted inequalities between ASM and LSM as well as between elite small-scale miners and informal workers. The author shows that many informal small-scale miners are essentially forced to enter agreements and terms set by the company due to their informal status and imbalanced power relationship.

DIALOGUE – SAN SIMÓN, BOLIVIA

ASM operators began arriving and illegally working on a concession belonging to the Bolivian/Canadian mine exploration consortium Excalibur/Eaglecrest in San Simón, Bolivia, from the start of its operations. Beginning with local people, in total over 500 small-scale miners encroached on the concession, working on some of the richest deposits and creating environmental damage, contaminating the area with 15 tonnes of mercury per year. The local and municipal authorities were largely unable to enforce the legislation due to the remoteness of the location. The small-scale miners formed the San Simón Mategua Mining Company (SSMMC) and entered into a dialogue with Excalibur, reaching an agreement in 1996. The agreement allowed the miners to work on the concession providing that SMMC became formalized and worked in designated areas; in return Excalibur agreed to hire local labourers and contribute to CSR commitments (Hentschel et al., 2003, p. 71).

Photo: IIED/Steve Aanu

GOVERNANCE AND POLICY CONSIDERATIONS

Large-scale mining companies face much of the pressure and responsibility for effectively preventing and resolving conflict with ASM communities, as well as taking the blame for poor interactions. However, the state certainly has a much greater role to play in mediating tensions; developing a conducive policy environment that presents a level playing field for ASM; and preventing conflicts over land arising in the first place (Hilson, 2002). There are various potential governance and policy approaches, from completely separating the two activities to finding ways in which the two can work together side by side. Given the highly dynamic and diverse nature of ASM and the varied sociopolitical landscapes in which it takes place, any intervention would need to be assessed on a case-by-case basis. It would also need to take into account any historical precedents at a particular site and be set within a broader mineral governance framework that protects the rights—and enhances the ability—of small-scale miners to access mineralized land with proven geological reserves. Any approach would be most effective by being embedded within an inclusive and holistic formalization program that prioritizes the socioeconomic development of ASM.

Five main governance and policy approaches for ASM–LSM interactions are outlined below.

1. SEPARATE ASM AND LSM BY DEMARCATING CONCESSIONS FOR ASM AND CREATING "ASM ZONES"

Given that most tension and conflict between ASM and LSM are due to access to land and the imbalance of power between the two, this approach suggests demarcating specific areas for ASM activities with proven geological reserves. While this idea is not new, it has witnessed a resurgence in recent years as tensions between LSM and ASM have intensified in some parts of the world. When demarcating areas for ASM, it is important to ensure the following: they have proven geological reserves, so that miners can access finance and other support services to improve their operations; the reserves will allow for long periods (10 or more years) of mining; and the process of awarding concessions is undertaken in a fair and transparent manner. Furthermore, ASM zones need to be in areas that miners want to mine. Encouraging mining companies to shed unwanted or unused land as part of their concessions, and preventing exploration companies from speculating and selling land multiple times without breaking ground, could help free up more areas for ASM activities and prevent illegal encroachments (Steinmüller, 2017; Hilson, 2017).

2. REMOVAL OF ASM FROM LSM CONCESSIONS

This is the least effective measure. Companies will often remove small-scale miners from their concessions by force. Though completely legal, this approach is unlikely to yield any meaningful solution in the long run given the way in which it is conducted—and the fact that many informal miners may feel it is their land or that they have the right to mine. The success rate is even slimmer if enforced removals are not combined with other formalization programs, or if the miners being evicted have nowhere else to go—and so may return at a later date.

3. COOPERATING, INCORPORATING AND TRANSFORMING ARTISANAL AND SMALL-SCALE MINERS

There are numerous ways in which large-scale mining companies can work with small-scale miners, including by shedding off and identifying land for ASM activities within their concessions. These include: exploring the potential for tributer and buy-back arrangements; technical support; equipment leasing schemes; and opportunities for small-scale miners to process and refine their ores, making them part of their supply chains (CASM, 2009). The mineral governance framework of a country should effectively prioritize ASM and address power imbalances, thus enabling small-scale miners to access high-value areas with proven geological reserves. This would help mitigate the underlying tensions that often lead to conflict, leaving LSM to concentrate on ensuring sustainable links to local communities and working with ASM in mutually beneficial ways.

4. DIALOGUE BETWEEN ASM AND LSM

The process of consultations, information sharing on concessions and agreements between LSM and ASM should begin in the exploration phase and include all affected stakeholders. There is also a need for better information, understanding and awareness of customary and statutory laws and regulations that affect land titling for small-scale miners. Governments also need to play a role in creating streamlined dialogue and communication channels between LSM and ASM. These communication channels need to outlast changes in ownership and licensing, and help small-scale miners to have a voice and air their grievances in effective ways that reduce the potential for conflict (CASM, 2009; McQuilken and Hilson, 2016).

5. GEOGRAPHICAL INFORMATION SYSTEM (GIS) MAPPING

Mitchell (2016) argues that precise maps showing (mainly large-scale) mining concessions in many developing countries can be found either through Spatial Dimension[17] or in the relevant governmental ministries, and may help understand overlapping land use. However, these are generally not made public—or only accessible by paying expensive fees—because they are designed to "provide geospatial information to mining companies, investors and governments to avoid overlaps with other mining operations and to highlight where there is space for more mining concessions" (Mitchell, 2016, p. 1118). However, there is potential for broader use in resolving disputes over overlapping claims to land (including ASM). The author mentions USAID's Mobile Application for Secure Tenure (MAST), which provided training, support and technology for Tanzanian landholders to map their (World Bank-promoted) Certificates of Customary Rights of Occupancy using mobile technology.

Bebbington et al. (2014) also used maps for this purpose in research with the Clark Graduate School of Geography (Cuba et al., 2014), which visualizes spatial overlaps between extractive concessions and river basins, agricultural land use, and protected areas in Peru and Ghana. While this study focused primarily on large- or medium-scale operations run by corporations, others have attempted to use GIS data for mapping ASM activities. For example, Patel et al. (2016) identify areas of small-scale mining (SSM) activities using a classification of remotely sensed Landsat data to determine locations of spatial overlap between SSM and LSM concessions, in the context of conflict between LSM and ASM. More recently, a project based at the University of Adelaide and working in Burkina Faso and Mali is looking at optimizing potential land-use scenarios (including LSM, ASM and agriculture) using remote sensing data and mapping products (Ostendorf et al., n.d.).

Photo: IIED/Magali Rochat

[17] "Spatial Dimension develops, implements and supports FlexiCadastre, the enterprise scale land management solution adopted by leading mining companies and governments worldwide." See www.spatialdimension.com/About/Our-Company.

5.0 ALTERNATIVE LIVELIHOODS AND DIVERSIFICATION

Alternative livelihoods and diversification literature in ASM looks at one of two issues:

1. Programs developed by donors, governments or large-scale companies to move people out of ASM into other livelihood activities.
2. ASM as a diversification strategy, particularly for those reliant on agriculture, but also those struggling to gain employment in other sectors.

Literature in the second category is more common than the first, and focuses on ASM either as an alternative to other livelihood options that have become unviable or unavailable due to industry/economic downturn and structural adjustment, or as a supplement to these (particularly agriculture). Most of this literature focuses on ASM in sub-Saharan Africa, and particularly Ghana.

There is a body of work studying livelihood diversification in rural areas more broadly (and particularly in relation to agriculture) but without a focus on ASM. This provides good background context to the issue. According to Reardon (1997), evidence from field surveys in the late 1970s and 1980s showed that a substantial share of non-farm income made up the total income of households in rural areas in Africa. Non-farm earnings account for 35–50 per cent of rural household income across the developing world (Haggblade et al., 2010). Rural areas also have significant self-employment with considerable farm/non-farm linkages (Nagler & Naudé 2017; Haggblade et al. 2010).

Reardon's (1997) review of 22 field studies looking at household income diversification, small enterprises and inter-sectoral linkages in East, West, and Southern Africa highlights the limited empirical understanding—or knowledge base—of the rural non-farm sector, which still appears to be the case. The paper, however, points to the following trends relevant to the ASM sector from the limited evidence that exists:

- Rural non-farm activity is concentrated in the dry season in the semi-arid tropics of Africa (less so in the tropical highlands and the humid and sub-humid tropics, where there is more than one rainy season, so the crop production period covers much of the year). Earnings from the local non-farm sector increase with the year's rainfall in a given zone, and earnings from the migration labour market fall when rainfall increases.
- In areas that are not close to major cities or mines, labour supply by rural households to the *local* non-farm sector (including in jobs linked to the agricultural sector) is much greater than that to the migratory labour market.
- However, in regions where the agro-climate is poor, households tend to earn more from migration than from local non-farm activity, managing income risk or coping with crop income shocks by diversifying labour supply outside of the area.
- At the household level, labour is allocated to the non-farm sector either because relative returns are better in that sector, or because farm output is inadequate, for example due to drought or lack of land. These labour allocation strategies may be long-term or short-term.
- Cash sources from farming are important in starting non-farm enterprises and pay transaction costs to obtain non-farm employment.
- Compared to poorer households, upper income strata households have higher shares of non-farm income as a percentage of total income, and in absolute terms of non-farm earnings. Education levels and skills are also key determinants of off-farm labour and enterprises.

ASM IN RELATION TO EXISTING LIVELIHOODS

Hilson and Garforth (2012) argue that "agricultural poverty" (hardship induced by an over-dependency on farming for survival), has fuelled the rapid expansion of ASM operations throughout sub-Saharan Africa. They argue that the "get-rich-quick" perception of artisanal miners by policy-makers and donors has misinformed sector-specific legislation and extension programs. There is great diversity among those engaged in ASM, ranging from skilled individuals who have migrated from urban areas in search of work due to redundancy in the private and public sectors, to those whose livelihoods are largely reliant on subsistence farming. This important fact is rarely considered by policy-makers (Hilson & Garforth, 2012). Hilson and Potter (2005, p. 113) found that "a declining standard of living has not only attracted recent school graduates but has also persuaded a wide range of former professionals, semi-skilled labourers, and retrenched large-scale mine workers to relocate to the many rural reaches of the country where artisanal gold mining can be readily carried out". Similarly, Banchirigah (2008) claims that the numerous and diverse range of employment opportunities provided by the ASM sector—ranging from menial work such as digging, hauling, ore washing, to vending and bookkeeping positions—is one of the key drivers of ASM's growth.

This background is important, as alternative or diversified livelihood schemes need to be based on an understanding of the population they are targeting, which varies considerably from context to context and even from individual to individual. The motivations of a pit owner will be quite different to the motivations of a young female hauler. This diversity must be recognized.

BOX 1. GHANA ASM AND ALTERNATIVE LIVELIHOODS

During interviews conducted by the researcher in Mpohor District in the Western Region of Ghana in 2014, *galamsey* (the term for illegal/informal ASM in Ghana) was said to represent both a primary source of income for a large proportion of the population, as well as a supplementary source of income for those involved in agricultural activities. ASM was also said to provide supplementary income to those employed in other areas—for example, civil servants and teachers, as well as school-aged children—who would work in ASM on weekends to pay for their education and living expenses.

Research undertaken by local NGO Friends of the Nation (2016) found that some of the key drivers pushing local youth into *galamsey* included:

- Financial constraints
- Lack of start-up capital to establish small and medium-scale businesses, such as carpentry shops or electrical shops
- High levels of unemployment in the community
- Demise of bread-winners
- Inadequate financial support to learn a skill, trade or further education
- Poor educational background, coupled with inadequate skills
- The urgent need to remedy unforseen circumstances that need immediate finances
- To support family and other dependents whose jobs cannot cater for the entire needs of the family.

ALTERNATIVE LIVELIHOOD INITIATIVES

According to Hilson and McQuilken (2014), it was not until the late 1990s that donor support for ASM in sub-Saharan Africa had a livelihoods dimension. This is potentially linked to the emergence of the sustainable livelihoods approach, a popular method used by aid agencies in the 1990s—particularly the United Kingdom's Department for International Development (DFID) (Morse et al., 2009; Hilson, 2016). In 2003, the United Nations Economic Commission for Africa (UNECA) reported an increasing number of people turning to ASM as an alternative livelihood. In many cases this was driven by growing economic crises; the effects of structural adjustment, particularly in sub-Saharan Africa, where unemployment increased; redundancies in large-scale mining due to declining mineral prices; and decreasing rural livelihood choices, chiefly in areas affected by man-made and natural disasters (mainly droughts and floods) (Hilson & McQuilken, 2014, citing UNECA, 2003, p. 2).

A number of governments and donors have implemented alternative livelihood projects in an attempt to diversify the economies of rural communities dependent on illegal artisanal mining for sustenance (Hilson & Banchirigah, 2009). Alternative livelihood programs have also been popular among LSM companies as part of their efforts to curb illegal mining on or near their concessions (Aryee et al., 2003). For example, Banchirigah (2008) provides some details of programs implemented by AngloGold Ashanti in Ghana, including vegetable farming, snail cultivation and grasscutter[18] rearing, as well as assistance in account-keeping and conflict management, water management and environmental sanitation, and teacher training. Other principal large-scale operators (e.g., Newmont and Goldfields) have implemented similar programs.

Aryee et al. (2003) reference a study undertaken by Ghana's Minerals Commission that identifies a number of alternative livelihood or local economic development projects operated by mining companies like AGC (Bibiani) Limited, Resolute Amansie Limited, Abosso Goldfields Limited, Bogoso Gold Limited and Satellite Goldfields Limited in their respective communities.

More recently, the government of Ghana has announced a five-year Multilateral Mining Integrated Project—an "alternative livelihood programme for illegal miners," expected to cost USD 10 million (Adogla-Bessa, 2017a; 2017b). However, the focus of the program appears to be on applying technology, law enforcement and supervision rather than fostering alternative livelihoods. That said, the program includes a rehabilitation component—the ministry will engage small-scale miners and youth in tree-planting activities to reclaim land that has been destroyed through ASM. It remains to be seen whether it has drawn on lessons from previous alternative livelihood programs, many of which have not been successful.

Hilson and Banchirigah (2009) argue that there is little evidence to show that alternative livelihood programs are slowing the growth of ASM. The authors claim that in sub-Saharan Africa, alternative livelihood programs have mainly been agrarian-based. They question the viability of these programs, given that in many contexts ASM itself is the alternative livelihood to agriculture (see also Sippl and Selin, 2012). Many smallholder farming activities have become unviable for reasons that include the structural adjustment programs introduced across sub-Saharan Africa from the late 1970s to 1990s, and associated changes, including a decline in value of many export crops and removal of subsidies on inputs such as fertilizers (Banchirigah & Hilson, 2010; Tschakert, 2009). Tschakert's study concludes that the alternative livelihood options and local market opportunities that would be attractive to miners in southwest Ghana are sparse, particularly for women. Income-generating activities that would be available to miners are often less lucrative (e.g., plumbing, car fitting and petty trading); would require start-up funding or access to land (poultry and cocoa farming, taxi driving, bartending); or are "simply beyond the reach of a group with a relatively low education level" (e.g., nursing, teaching) (Tschakert, 2009, p. 30).

Policy-makers have placed "little value on the prevailing pattern of de-agrarianisation unfolding in sub-Saharan Africa" and failed to "concede that the rapid growth of ASM in sub-Saharan Africa is, in large part, a response to the unviable state of smallholder farming" (Banchirigah & Hilson, 2010, p. 159). In Sierra Leone, Maconachie and Hilson (2011) observed a lack of in-depth knowledge among government officials on alternative livelihoods and the strategies around them. Banchirigah (2008) argues that governments and companies tend to assume that all miners will pursue alternative income-generating activities if they are available, which is not the case.

There is a body of work on livelihood diversification in sub-Saharan Africa showing that while the wealthy are able to diversify into lucrative non-farm activities, poor people tend to get stuck in an "asset poverty trap" that prevents them from doing so (Fisher, 2007). For example, Yakovleva (2007) investigated female participation in ASM in the Birim North District in the Eastern Region of Ghana. She found that a large proportion of women in ASM used to be involved in petty trading and struggled due to financial constraints, despite having "skills in various trades such as in knitting, sewing, hairdressing, baking, palm oil production and other food processing" (Yakovleva, 2007, p. 35). Similarly, many former farmers in Madagascar have abandoned farming in favour of artisanal ruby and sapphire

[18] The grasscutter (or marsh cane rat, or ground hog) is a wild rodent increasingly raised as a source of bushmeat and income in West Africa.

mining and its various linked opportunities in Ilakaka and Sakaraha, such as “driver, translator, security guard, middlemen; bars/restaurants owner, and suppliers of water, petrol and entertainment to mining areas” (Cartier, 2009, p. 85). Therefore, it is important to recognize the economic dynamics behind those alternating between livelihood sources, given the push factors to ASM and its enticingly disproportionate financial gains.

Donors or companies developing alternative livelihood schemes must attempt to understand the needs of beneficiaries, taking account of traditional economic activities and labour migration, and building on existing knowledge: according to Ofei-Aboagye et al., (2004, p. 27), “Schemes involving complete re-skilling and/or importation of skills cannot be expected to be assimilated and taken up immediately.” Perks (2011. p. 1117) argues that a significant number of miners in the Democratic Republic of Congo would face barriers even if they tend to readily “exit and re-orientate their skills, networks and experience towards other economic activities”:

> These barriers are of both a technical livelihood nature and a more profound structural nature [relating to debt, predation and security], influenced by past economic development and subsequent urban migration, land access and the established trade and power relationships in the country’s mineral-rich areas.

District Assembly officials in Ghana have indicated that alternative livelihood programs should be linked to their own poverty reduction schemes and plans; in other words, LSM companies and donors implementing alternative livelihoods schemes should work together with local government (Ofei-Aboagye et al., 2004). This would ensure alignment with local needs, priorities and strategic plans, thereby gaining local buy-in—which is crucial for the successful implementation of diversified livelihood schemes.

More recently, the concept of “diversified livelihoods” (used interchangeably with the term “alternative livelihoods”) has been fostered by some groups working with these types of programs in ASM. This recognizes that attempting to move people straight out of ASM into other livelihoods is not a realistic approach, given the lack of alternative employment opportunities, and that most alternative livelihood programs have not been successful. Value addition or “beneficiation” programs to encourage diversified income-generating activities as part of the ASM supply chain have also shown promise, as opposed to trying to divert miners into alternative livelihoods. Some examples are provided in the following sections.

BOX 2. GHANA DIVERSIFIED LIVELIHOODS PROGRAM

A diversified livelihoods program was delivered by a local NGO, Friends of the Nation, in the Western Region of Ghana from May 2015 to June 2016. The following recommendations were made to improve the success of future diversified livelihoods programs:

- Undertake a comprehensive baseline to make sure that you understand the context and interests of the intended beneficiaries (miners).
- Take into account the “opportunity costs” for miners (i.e., how much they can earn per day in mining, versus how much the proposed activity may earn them, taking into account time away from mining for capacity building).
- Recognise that the intervention should not be undertaken with the intention of completely removing beneficiaries from ASM, but to build their skills in alternative income-generating activities that they can gradually move into or use as a diversified income stream in addition to ASM.
- Make sure you align interventions with plans, programs and/or other activities that already exist within the local area (collaborate with local government where possible).
- The training needs to be good quality.
- Women tend to make better targets of diversified livelihoods programs than men due to their lower earning capacity in the ASM sector and the nature of their work.

Reardon (1997) pointed to evidence of households or communities earning income from off-farm activities to pay for farm inputs. The International Institute for Environment and Development (IIED) Issue Paper *Artisanal and Small-Scale Mining and Agriculture: Exploring Their Links in Rural sub-Saharan Africa* (Hilson, 2016) provides several examples of studies showing the synergies between ASM and farming in sub-Saharan Africa and how these linkages can provide a platform for wealth creation.

According to Hilson (2016), policies and institutions need to recognize and respond to the complementarities and linkages between agriculture and ASM, rather than one or the other as alternatives. This is particularly the case in sub-Saharan Africa, where an alternative livelihoods agenda has been promoted that focuses on moving people away from informal ASM to farming. This agenda has failed to recognize that "a great number of these individuals are already involved in various agricultural activities" (Hilson, 2016, p. 557). Lahiri-Dutt's (2008) research into gender and livelihood issues in small mines and quarries in South Asia also presents ASM as providing an additional source of income to what miners receive from subsistence agriculture.

Other examples include Hilson and Garforth's (2013) research conducted in Ghana's Eastern Region highlighting the interdependence between ASM and smallholder farming, by showing that families often turn to *galamsey* to supplement their farming incomes and to purchase agricultural inputs. Hilson et al. (2013, p. 109) found that ASM has injected considerable wealth into many of Ghana's northern localities, in the process helping to stabilize their economies and alleviate the hardships of tens of thousands of farm-dependent families. Hilson and Van Bockstael's (2012, p. 413) research investigating the changing livelihood dynamics in diamond-rich territories of rural Liberia found that "many farm families are using the rice harvested on their plots to attract and feed labourers recruited specifically to mine for diamonds." Jaques et al. (2006) point to the complementarity between ASM and farming as creating significant wealth in Burkina Faso, albeit mostly for pit owners who have the business prowess.

Other authors who have supported this idea include Cartier and Bürge (2011), who examine the catalyzing role of ASGM income in reinvigorating non-mining activities such as agriculture and processing- and service-oriented industries in Sierra Leone, thereby reducing vulnerability and reliance on elites. Kamlongera (2011) investigates the linkages between subsistence agriculture and

ASM in rural Malawi, sharing perspectives from miners themselves on the contribution of both sectors to their livelihoods. Kwai and Hilson (2010) found that a growing number of smallholder farmers in the Mbeya regions of southern Tanzania are turning to ASM for employment and financial support. Maconachie et al. (2006) found linkages between mining and agriculture in many mining communities resulting from the emergence of mining, which in turn created markets for local produce.

Hinton et al. (2003) provide a positive example from the Tapajo's region in Brazil, where ASGM helped small entrepreneurs to invest in cattle farming, palm tree and acacia nut production. ASGM also led to the construction/upgrade of roads to support the transportation of agricultural products (where previously air was the only means of transport). In Ghana, infrastructure in many rural areas in the Western Region (including schools) has been attributed to ASM. In fact, research across the region suggests that profits from ASM are invested into local infrastructure and business, but more quantitative/empirical research into this area would be worthwhile.

Value addition or beneficiation (increasing the economic value of the ore by producing a higher-grade concentrate) is a key area of promise where ASM can be seen to bolster other livelihood mechanisms as part of the supply chain. Many national governments in sub-Saharan Africa have policies encouraging the beneficiation of precious minerals, and there are also a number of government and private sector initiatives focused on in-country beneficiation. These include the following (Seda Platinum Incubator 2014; Sippl & Selin, 2012; Labonne, 2003; Malawi Ministry of Mining, 2013; Hinton et al., 2003b; IEG, 2014b):

- Ethiopia, where the World Bank has sponsored lapidary and jewellery-making courses through the Ministry of Mines in Ethiopia.
- Ghana's Precious Minerals Marketing Corporation, a state-owned enterprise that has a jewellery production unit and diamond-cutting and polishing plant.
- Malawi, where the Mines and Minerals Policy of Malawi has committed to promoting investment in downstream value-addition of minerals in the country, such as cutting and polishing gemstones and producing jewellery.
- South Africa's Small Enterprise Development Agency Platinum Incubator and Mintek which, with financing from different government grants, has assisted rural communities with beneficiation and added-value activities.
- Mali, where the Sadiola Gold Mining Project, created by Anglo Gold, provided technical assistance and resources to further ASM; as well as alternative revenue-generating activities such as agriculture, jewellery production and dye and soap fabrication.
- Tapajo's region in Brazil, where the government and NGOs developed jewellery schools in mining areas to add value to miners' products.
- Nigeria, where a World Bank Sustainable Management of Mineral Resources Project (SMMRP) run from 2004 to 2012 established a lapidary school in Jos, which trained 15 commercial cutters in the gemstone and dimension stone industries as well as nine trainers who were expected to train 500 commercial cutters within the next five years.

The ongoing success of these projects has not been evaluated recently and could be an area for future research—revisiting/evaluating previous livelihoods or value addition projects to draw out lessons.

6.0 MINERAL CERTIFICATION SCHEMES FOR ASM

This section outlines the wider mineral certification agenda for ASM. It provides a brief overview of current fair trade and conflict-free initiatives, and highlights ongoing challenges and debates from the literature on long-term sustainability and the overall contribution to wider formalization efforts for the sector.

BOX 3. KEY TERMS

Certification is the procedure by which an independent or third party provides assurance that a product, process or service complies with a given set of production standards.

A certification label, mark or accompanying certificate controlled by the standard-setting body is usually applied to the product or packaging to show consumers that compliance with the specific standards has been verified.

Together, the system of rules, procedures, standards and management for carrying out certification is referred to as **a certification system, scheme or initiative**.

Standards outline the technical specifications and precise criteria that must be followed to achieve certification, and define guidelines for doing so.

Fair trade is the overarching movement concerned with promoting greater equity in international trading partnerships between the global North and South. It aims to contribute to sustainable development by offering better trading conditions and securing workers' rights for marginalised producers.

Source: FAO, 2003; Fridell, 2006; Hudson et al., 2013; WFTO, 2017.

OVERVIEW OF MINERAL CERTIFICATION INITIATIVES FOR ASM

Over the past decade, a number of ethical mineral certification schemes have emerged that either directly target or include provisions for the ASM sector. They are promoted by their designers as development interventions with the potential to play a key role in formalization and address operations' negative social and environmental impacts (Blackmore et al., 2013; Echavarria, 2014; IGF, 2017). The rapid proliferation and rise to prominence of ASM certification initiatives can be attributed to a range of interlinked factors. These include:

- Growing public awareness following high-profile campaigns on "blood diamonds" and "conflict minerals," resulting in a call to action as well as increased reputational risks for companies (Global Witness, 2006; Amnesty International, 2015).
- Growth in consumer electronics and other devices that contain conflict minerals—a significant proportion of which come from ASM operations in the African Great Lakes Region (Levin, 2010; Barume et al., 2016).
- The introduction of due diligence and conflict mineral regulations that require companies to report on the origin and traceability of minerals in their supply chains:
    - Section 1502 of the 2010 Dodd-Frank Act, though it may be repealed under Donald Trump's presidency (SEC, 2012).
    - The OECD Due Diligence Guidance (OECD, 2016).
    - The Kimberly Process Certification Scheme (KPCS) for diamonds (KPCS, 2017).
    - The European Union's recently passed conflict minerals regulations (EU, 2017/821).
- Increasing demand from a core group of concerned jewellers, activists and consumers for "ethical jewellery" produced in a socially and environmentally responsible manner, inspired by the considerable market success of fair trade certification initiatives for agricultural commodities and growth in ethical consumerism (Hilson, 2008; Childs, 2008; Valerio, 2013; Fair Jewellery Action, 2017).

- The opportunity for NGOs and development partners to seek interventions that mitigate the adverse impacts of the ASM sector and support its formalization, in order to realize its potential for community development (Blackmore et al., 2013).

As a result of these varying drivers, two broad categories of certification initiatives have emerged. The first group are those that fall under the umbrella of "fair trade," termed here as **ethical mineral certification schemes and standards**. These are also aligned more closely with development and sustainability interventions in their efforts to foster responsible ASM cooperatives, provide assurances concerning minimum standards of production, and support the wider formalization of the sector; addressing its associated negative socioeconomic and environment impacts in the process. Examples include:

- The Alliance for Responsible Mining's **Fairmined Standard for Gold from Artisanal and Small-Scale Mining, including Associated Precious Metals** [Fairmined Gold] (ARM, 2014).
- Fairtrade International's (FLO's) **Fairtrade Standard for Gold and Associated Precious Metals for Artisanal and Small-Scale Mining** [Fairtrade Gold] (FLO, 2013).
- The Diamond Development Initiative's (DDI) **Maendeleo Diamond Standards™** (MDS) (DDI, 2016a, 2016b).

Under both the Fairmined Gold and Fairtrade Gold Standards, once certified, mining organizations receive a guaranteed minimum of at least 95 per cent market value for their gold. This is calculated according to the London Bullion Market Association (LBMA) price fix (the price of gold which is set twice daily by the LBMA). Certified mining cooperatives are also paid a 'social premium' for their gold which is used for community development projects. Under Fairmined the social premium is set at USD 4,000 per kg. An additional USD 2,000 per kg is also payable (making USD 6,000 per kg in total) as an 'ecological premium' if the operations meet certain environmental criteria such as mercury-free production. The same is true for Fairtrade Gold, except that the additional ecological premium is calculated based on 15 per cent of the LBMA fix. It is also noted in the Fairmined Gold Standard that 'ARM reserves the right to change the level of the Premium' with any such change being negotiated with miners (ARM, 2014, p. 44).

The second group of certification schemes are primarily **chain of custody** initiatives concerned with ensuring traceable and transparent supply chains from mine to market that are free from conflict and human rights abuses. These initiatives are borne largely out of the need for companies within global mineral supply chains to meet international regulations, voluntary codes and initiatives, and ensure good business practices. Many of these initiatives utilize and work in partnership with ethical mineral certification schemes to help with responsible sourcing from ASM communities, and have been developed in tandem (Blackmore et al., 2013). Examples include:

- The World Gold Council's **Conflict-Free Gold** (World Gold Council, 2012)
- The Responsible Jewellery Councils' **Chain of Custody** (RJC, 2017)
- The International Tin Research Institute's (ITRI) **ITRI Tin Supply Chain Initiative** (ITRI, 2017)
- The Swiss State Secretariat for Economic Affairs and Swiss Better Gold Association's **Better Gold Initiative** (SBGA, 2017).

GLOBAL DISTRIBUTION OF CERTIFICATION INITIATIVES FOR ASM

As Table 11 shows, the majority of certification activities that directly target ASM have been focused in Latin America, where the original Fairmined and Fairtrade Gold standards were developed and piloted from 2009 to 2013 (Maldar, 2011). In sub-Saharan Africa, the main focus has been on developing conflict-free, traceable and transparent supply chains and is now also the location where both ARM and FLO are undertaking pilot schemes to scale up their certification initiatives.

TABLE 11. GLOBAL DISTRIBUTION AND STATUS OF SELECTED ASM CERTIFICATION INITIATIVES

INITIATIVE	COUNTRIES	DESCRIPTION OF RECENT PROJECT-RELATED ACTIVITIES
		LATIN AMERICA
Fairmined Gold	Bolivia, Colombia, Peru	Seven certified mining cooperatives in three countries in the region, with 20 additional organizations working towards certification, and 80 toward better practices.
Fairtrade Gold	Peru	One listed certified mining cooperative in Peru (MACDESA), established in 2004 by a group of 478 associates with 200 miners and 550 families; hard rock mining with cyanide leaching plant and relatively high mechanization. Have worked previously, and are currently working with ASM operators in Bolivia, Colombia, and Peru to reach certification.
Solidaridad	Argentina, Bolivia, Colombia, Peru	Worked with a number of mining cooperatives to help meet certification criteria for Fairmined and Fairtrade Gold standards.
Better Gold Initiative	Peru	Works with already formalized mining companies to provide access to markets through transparent and traceable supply chains that have third-party certification, and capital for ASM-related investment projects with fair conditions. Working with three gold mining communities in Peru that produce Fairmined and/or Fairtrade-certified gold.
		SUB-SAHARAN AFRICA
Fairmined Gold	Burkina Faso, Mali, Senegal	Piloting certification under ARM's West Africa project. All miners in the project are organized in cooperatives or equivalent. In April 2015, hosted workshop with local partners, miners and government agencies from all three countries to learn about Fairmined certification. Regional workshop held within piloting Fairmined certification and mercury emission reduction.
Fairtrade Gold	Kenya, Tanzania, Uganda	2012–15 project Extending Fairtrade Gold to Africa, funded by Comic Relief, worked with over 1,100 miners indirectly and directly. Activities included training on mining techniques, health and safety; developing ASM network, advocacy activities, and linking with European jewellers and consumers. There are currently two Fairtrade-certified mining cooperatives in sub-Saharan Africa: 1) SAMA in Uganda, which was certified in 2016 and has 35 miners producing 5 kilograms of gold per year, and 2) MICODEPRO in Kenya, which first registered in 1999 and has 31 members.
Maendeleo Diamond Standards™	Democratic Republic of Congo (DRC), Central African Republic, Guinea, Sierra Leone	Diamond Development Initiative (DDI) launched in 2005 to further the reach of the Kimberley Process Certification Scheme (KPCS), such as through registering miners and forming cooperatives, training, advocacy and community development projects. Its MDS launched in 2016 to work with 14 ASM groups in Sierra Leone with plans to scale up to DRC and West Africa in 2016/17. The MDS ensure compliance with the KPCS, as well as minimum standards of production, workers' rights, environmental responsibility, community engagement, and fair pricing set through dialogue and participation.
Solidaridad	Ghana, Kenya, Tanzania, Uganda	Since 2009 the Dutch NGO Solidaridad has been working with five already registered and legal mining organizations towards meeting minimum certification standards. Signed memorandum of understanding with Ghana Minerals Commission in May 2017 to support formalized miners in operating responsibly. Supported mining communities in Kenya, Tanzania and Uganda to improve operations with the aim of becoming certified.
Just Gold, Partnership Africa Canada	DRC	Aims to develop an independent, equitable and sustainable system that brings legal, conflict-free and traceable gold from artisanal mine sites in the DRC, by testing and implementing the OECD Due Diligence Guidance, and the regional certification standards of the International Conference of the Great Lakes Region.
ITRI Tin Supply Chain Initiative (ITSCi)	African Great Lakes Region (Burundi, DRC, Rwanda)	Developed in 2010 in tandem with other chain of custody programs and initiatives in the region. Focuses on the practical implementation of a chain of custody system (traceability) from large, medium and small-scale mines to smelter, and is designed for use by private sector operators, with specific roles for government agents and ITSCi program actors. Operates bagging, tagging and tracking system, working with approximately 1,000 mine sites, involving 80,000 miners and 375,000 dependents.
		ASIA
Fairmined Gold	Mongolia	Working with one gold mining cooperative, Xamodx. Certified January 2015; first organization certified Fairmined Ecological Gold; hard rock mining; 130 NGO members (22 women, 108 men); previously herding communities, started mining in 2006 following consecutive years of harsh winters (*dzuds*).

Sources: Maldar, 2011; DDI, 2016a, 2016b; ARM, 2017; FLO, 2017; ITRI, 2017; PAC, 2017; SBGA, 2017; Solidaridad, 2016; 2017

CHALLENGES

Overall, bringing these standards and mineral certification schemes to fruition in the first place represents progress. These schemes have played a role in reaching and raising the profile of marginalized ASM communities and their daily challenges to a global audience and consumers; helped to address the negative impacts of ASM activities through working with operators to become certified and the related benefits of doing so; and ensured a more responsible approach to sourcing minerals in conflict-affected and high-risk areas (Levin, 2010; Blackmore et al., 2013; Childs, 2014; Hilson & McQuilken, 2016). However, there are concerns in the wider academic literature regarding the current implementation and future long-term potential of certification initiatives for the ASM sector—particularly of Fairmined Gold and Fairtrade Gold (Hilson et al., 2016).

The following points should be considered not as a challenge to their existence, nor take away from the positive development impacts they have made, but rather as potential ways forward. They are key considerations and refinements to maximize the potential of such certification initiatives, to reach as many artisanal and small-scale miners as possible and contribute to supporting the wider formalization of the sector.

OVERCOMING ELITE CAPTURE, SELECTIVE EMPOWERMENT AND TARGETING 'LOW-HANGING FRUIT'

There are concerns that certification initiatives are not reaching the "poorest of the poor"—the most marginalized ASM communities in need of the greatest support. This is due to the certification requirements mining communities have to meet, which are deliberately stringent, mirroring the approach taken in agriculture. While both technical and financial support is provided to help miners meet these obligations, with many organizations working closely with communities over several years, the certification process still carries burdensome costs. Many of the mining communities that have been certified in Latin America were already licensed (a precondition to certification); were formalized; have been operating for well over a decade; and have a high degree of mechanization and expertise, including cyanide leaching plants and employing engineers (Blackmore et al., 2013; Hilson & McQuilken, 2016). In some cases, chain of custody certification schemes may be having an adverse impact on small-scale miners, by enabling buyer companies to identify and eliminate minerals originating from ASM in their supply chains, due to the risks involved (McQuilken, 2016).

Similarly, the focus countries of FLO's pilot initiatives in East Africa (especially Kenya, where the first two mining organizations to be certified comprise just over 60 miners in total) are not, traditionally, the location of sizeable and historic ASM workforces when compared with countries such as Ghana. Thus, while it is important to demonstrate proof-of-concept, the approach taken of working with relatively small, readily certifiable groups raises concerns about the transferability and scalability of such schemes to more complex ASM landscapes with much longer histories of informality and deeper structural challenges to formalization. As such, there are concerns that certification schemes are targeting low-hanging fruit (Hilson, 2014), and empowering a select group of already licensed (and in some cases relatively affluent and highly organized) mining cooperatives who are able to meet the criteria. To extend the benefits of certification, more needs to be done to address the fundamental and structural issues of informality. This can be through advocacy and dialogue with government, and working with unlicensed, informal groups to help bring them into the legal domain where they may then be supported to become certified (Hudson et al., 2013; Blackmore et al., 2013).

GREATER UNDERSTANDING OF THE COMPLEXITIES, FUNCTIONING, AND LOCAL DYNAMICS OF ASM

This point applies to all efforts directed at improving and formalizing the ASM sector, but its importance is well illustrated by recent efforts made by ARM and FLO to scale up their interventions in sub-Saharan Africa. As a wealth of literature demonstrates, ASM activities are extremely diverse and heterogeneous at global and local scales; thus, certification schemes need to adapt to take account of these characteristics in order to be successful. There is already evidence from FLO's pilot project that the differences between ASM operations have been greatly underestimated, as well as the social, cultural and economic conditions between Latin America, where the original Fairtrade and Fairmined Gold Standards were developed, and sub-Saharan Africa. This has slowed both the progress and impact of their interventions (Keller et al., 2013; Hilson & McQuilken, 2016).

Another example of the need to better understand ASM dynamics is the focus on so-called "unscrupulous middlemen," which proponents of certification schemes argue trap miners in poverty through poor prices and unfair trading terms. However, while this may be the case in certain instances and geographies, a growing body of literature is showing the complex relationships between miners, traders and middlemen. Middlemen provide loans to sponsor mining activities, offer access to markets, and can form long-term mutually beneficial relationships in complex supply chains of production and labour hierarchies (Fold et al., 2014; Geenen, 2015; McQuilken & Hilson, 2017). This is particularly beneficial in the absence of formal financial institutions and microcredit schemes willing to lend to both informal and formal small-scale miners. Often, middlemen are legitimate market players also making a livelihood in challenging economic circumstances, addressing information and power asymmetries to enable fairer trading terms. Extending schemes to work with middlemen rather than cutting them completely out of supply chains could be a more bottom-up approach that keeps more value from mining activities in local communities. A greater understanding of the functioning of ASM supply chains and the roles of the multiple actors within them is therefore needed (McQuilken & Hilson, 2017).

LONG-TERM SUSTAINABILITY AND CONSUMER DEMAND

There are concerns regarding the longer-term sustainability and viability of fair trade mineral certification schemes due to their reliance on Western markets, ethical consumption, and catalytic bodies such as FLO. At present, most of the schemes are geared towards supplying the ethical jewellery market; however, there is no requirement for sustainable and ethically sourced minerals to come from ASM. In terms of growing consumer demand, there are also debates over the incentives for small and medium-sized jewellers and retailers to promote ethical jewellery, given that it may undermine the ethical credentials of their other products.

Though the market may be growing, it is still limited by consumers' willingness to pay more for what are already expensive, luxury, one-off purchases; and by the limited real value of having a fair trade labelled item, as well as limited consumer knowledge of ASM and the trust consumers place in jewellers and jewellery experts, rather than themselves, to ensure due diligence (Carrigan et al., 2015). As Blackmore et al., (2013) make clear, for certification initiatives to scale up and be sustainable there is a need to develop the business case for industry players to want to ensure sustainable supply chains and source from ASM communities where possible. Artisanal and small-scale miners are already part of existing global supply chains; the key is to help them become formalized so that they can remain there and properly benefit economically and developmentally from their hard-won minerals.

Overall, while mineral certification schemes have certainly had positive impacts, their ability to support wider formalization efforts in the ASM sector appear somewhat limited due to the small number of communities that they are able to reach. Certification schemes should, therefore, be seen as a way to ensure supply chains are traceable and transparent and free from conflict. They should also raise awareness of the plight of small-scale miners and effect greater changes in society, provide a source of ethical minerals for the jewellery and electronics sector, and support a select number of miners and their communities to improve their position. Certification may complement formalization efforts in ASM, but it should not replace or be prioritized over wider formalization programs and policies. Until the more fundamental barriers to formalization are addressed, and the majority of miners are formalized, certification will remain limited in its scope to support large numbers of artisanal and small-scale miners in breaking free from the poverty trap.

7.0 ASM FORMALIZATION AND STRATEGIES FOR SUSTAINABLE ASM

This section provides an overview of global formalization efforts for the ASM sector. First, by defining what formalization is, why it is important, and an explanation of key terms; second, by outlining some of the key components of formalization programs, and; third, by providing examples of current formalization initiatives underway in different regions of the world.

WHAT IS FORMALIZATION?

Formalization is the **process** of bringing informal income-earning activities and economies such as ASM into the formal sector through legal, regulatory and policy frameworks. Formalization is, however, more than just legalizing and regulating economic activities. It also concerns the activation, monitoring and enforcement of such regulations, as well as the inclusion of marginalized miners in the process of developing, adapting and revising legal frameworks and support to meet such regulatory obligations in order for them to be effective. A well-designed formalization process generates the enabling conditions within a sector so that it can be integrated into the formal economy.

BOX 4. KEY TERMS

Formalization – The process of bringing informal income-earning activities and economies into the formal sector through legal, regulatory, and policy frameworks, as well as the extent to which such laws and regulations are successfully activated, implemented, and enforced by the relevant authorities.

Formal ASM – Operations that have the requisite licenses and permits required by law, and conform to regulations, policies and management practices.

Informal ASM – Operations that do not have the requisite licenses and permits required by law, but through social and cultural norms, rules and practices that have developed over many decades have a "social license to operate" from the local community, or other local actors who do not have power or authority vested by the state to award mineral rights, concessions, and permissions to mine.

Legalization / regularization – The legality refers only to the legal regulatory framework that makes ASM legal.

Licensed and legal ASM – Operations that have a mining license and any environmental permits and permissions as required by law.

Unlicensed / illegal ASM – Operations that do not have a mining license and any environmental permits and permissions as required by law.

WHY IS FORMALIZATION IMPORTANT?

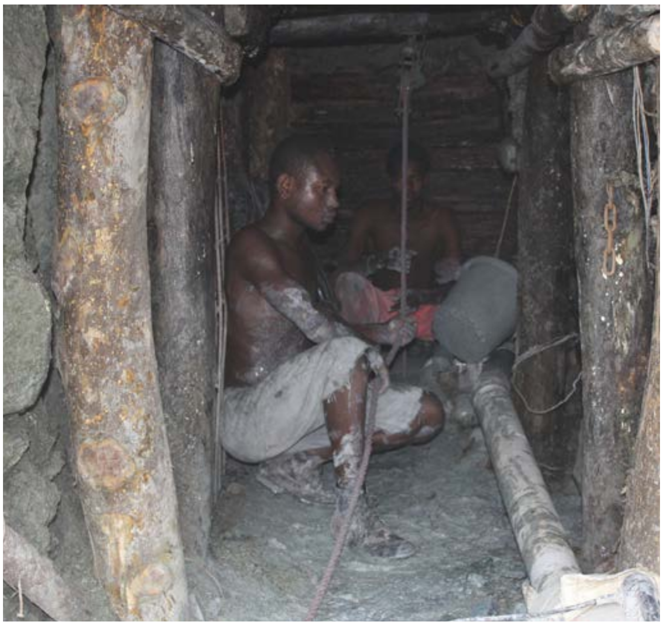
Formalization is high on the agenda for the ASM sector. The majority of artisanal and small-scale miners operate informally and illegally without the requisite licences and permits required by law. Globally, estimates suggest that in many countries 70 to 80 per cent of small-scale miners are informal (ILO, 1999) and in some countries these figures are even higher (EEITI, 2015). Because of the sector's pervasive informality, a wide range of damaging socioeconomic, health and environmental impacts and development challenges have emerged, trapping most miners in cycles of poverty and leading to community impoverishment (Hilson & Pardie, 2006).

Informality also leaves the sector open to corruption, embezzlement, and criminality and results in lost revenue for local and national governments. The fact that most miners operate informally, illegally, and outside of formal governance frameworks means they are not afforded the benefits of legal protection, nor are miners or their communities able to access support services needed to address negative "expressions of informality," leaving them out of reach of government (Hilson & Hilson, 2015). The sector's transition to the legal sphere is therefore an acute priority if the negative impacts of operations are to be addressed and the many positive attributes of the sector are to be fully realized, in terms of jobs, wealth creation and its significant contribution to national budgets. As Hilson and Maconachie (2017, p. 1) spell out in a recent publication: "the push to formalise ASM has never been greater."

GLOBAL POLICY DEBATE: ENTREPRENEUR VS. POVERTY-DRIVEN NARRATIVES

As is now widely accepted (Barry, 1996; ILO, 1999; Hilson & Hilson, 2015), ASM is *predominantly* a poverty-driven activity supporting millions of impoverished people in rural landscapes across the globe. One of the greatest reasons that formalization efforts have been unable to move large numbers of miners into the formal economy is the lack of understanding and failure of policy frameworks to recognize the sector's poverty-driven nature and break the poverty cycles miners are trapped in (Nöestaller, 1994; Hilson & McQuilken, 2014). Low levels of technology and poor geo-prospecting (relative to LSM activities) lead to low recovery and productivity, reduced incomes and an inability to accumulate funds and return investments to debtors. A lack of capital traps miners in rudimentary, inefficient mining and processing techniques with low returns. Poor quality of life and health due to dangerous working conditions and practices exacerbate the poverty cycle further. These factors are compounded by a large number of miners competing for limited land and resources, keeping them trapped in the informal economy and preventing them from accumulating capital and investing to improve their situation.

There is also a burgeoning number of highly educated and well-connected **necessity-driven** and **opportunistic entrepreneurs** who have access to significant capital investment, and are able to navigate the often complex sociopolitical and bureaucratic landscape needed to obtain a licence (Hilson & Hilson, 2015; Verbrugge & Besmanos, 2016). These entrepreneurs tend to be the concession owners and licence holders. In the process of formalization, it is important that they are supported to take more responsibility for the welfare of their employees, mitigate the adverse impact of their operations on the environment and communities, and ensure that they adhere to regulations. They should not, however, be the main and sole targets of formalization initiatives (Hilson & Maconachie, 2017).



Instead, formalizing the sector means improving the structural conditions and operations of all artisanal and small-scale miners, moving them along the spectrum of informality and increasing their degree of formalization regardless of where they are found (Weng, 2015; McQuilken & Hilson, 2016). A broad-based, integrated and inclusive approach to formalization needs to be taken, which focuses on the poverty-driven aspect of the sector. Removing bureaucratic licensing and administrative processes, demarcating areas for ASM, providing access to technical and financial support, and including marginalized operators in the process through dialogue and consultations would naturally also provide immeasurable benefits for necessity-driven entrepreneurs already well-established in the sector. However, a formalization program designed solely for entrepreneurs risks failing to reach and address the barriers to formalization facing the majority of impoverished artisanal and small-scale miners. Such a move would likely be limited in its impact and could risk creating an elite group of small and medium-scale miners, while further entrenching other ASM groups—and the vast majority—deeper into the informal economy.

Formalization policy-makers must not lose sight of the fundamental and largely poverty-driven characteristics of ASM. They should aim to remove the barriers of registering and obtaining a licence in the first instance to bring miners into the legal domain, where they can be supported and regulated to reduce the negative impacts of ASM activities. Punitive task forces and government sweeps to destroy ASM camps and communities often fail in the long term, as they do not address the fundamental barriers to formalization and drivers of ASM. They simply move activities elsewhere, perhaps to previously untouched land and forests—creating more environmental damage and destruction.

KEY FACTORS FOR SUCCESSFUL ASM FORMALIZATION

To be successful, an integrated approach to ASM formalization is needed that simultaneously addresses the key barriers associated with the sector. The approach also needs to support and incentivize miners to become formalized due to the real benefits afforded to them. To be effective, the following factors need to be considered.

CONDUCIVE AND COMPREHENSIVE LEGAL FRAMEWORKS

Most countries now have in place a regulatory framework for ASM that legalizes activities and requires operators to purchase a licence before engaging in work. However, in many countries ASM has simply been added on to mineral governance frameworks, which were originally designed and developed for the LSM sector and to prioritize and attract foreign direct investment. As a result, the ASM sector is often a policy afterthought, and its largely poverty-driven characteristics are unaccounted for (Hilson & McQuilken, 2014). Legal frameworks, therefore, need to be adjusted to remove the barriers to formalization, be supportive and accessible rather than punitive, and account for the diversity of ASM operations.

In countries where ASM is still considered illegal, or for which no governance frameworks exist (making it a legal but unregulated activity), new comprehensive legislation must be developed that is specifically relevant to ASM and accounts for its diverse characteristics. In countries where ASM is legal, reforms to existing legislation may be needed so that governance frameworks consider all the specific characteristics of ASM, and are more comprehensive in their approach and prioritizing of the ASM sector for national development (UN Environment, 2013a). For all legal frameworks, artisanal and small-scale miners need to be provided with support to help meet the criteria.

Legal frameworks need to consider:

- Criteria for defining and categorizing different types of ASM activities, allowing for even the most rudimentary "dig and wash" operations to obtain a licence and be eligible for support.
- Duration and renewal, and transfer and upgrade of licences.
- Enabling large-scale mining companies to shed off land to ASM that is uneconomical to mine industrially.
- Types of entities able to operate under ASM mining titles, such as individuals, cooperatives and groups of hired labour, in line with local operational dynamics.
- The permitted level of mechanization and processing techniques (e.g., mercury and cyanide).
- Environmental, safety, and labour standards by level and scale of ASM activities.
- Ensuring women can own land, be in possession of a licence and obtain bank loans without the need for a male signatory.
- Inclusion and active participation of ASM associations and communities in consultation processes.
- Monitoring and enforcement activities cognisant of the varied compliance capacities of ASM operators and the various scales of mining activities.

- Requirements for community investment projects or sharing of royalties locally.
- Taxation, royalty, and buying regimes.
- Rehabilitation of land and mine closure.

STREAMLINED AND ACCESSIBLE LICENSING PROCESS

In most countries, licensing is the most significant barrier to formalization. Once miners are licensed, governments can work with them to address the negative impacts of operations. Despite many countries having a short time period (10 days to one month) to award licences on receiving an application, the process of obtaining a licence can be a challenging, costly, time-consuming and onerous task. Applicants are often required to travel long distances to regional and national government offices to obtain the necessary documentation and submit applications; in some cases, it is reported that miners may have to make informal payments to brokers and corrupt officials along the way. Nonetheless, they wait for up to several months or even a year before finally receiving their paperwork. This is due to the bureaucratic process involved, centralization of government, and overlapping or unconnected institutions at national and local levels.

These factors either preclude or discourage the majority of miners from obtaining a licence, leaving the process open only to an elite group who are often well connected and able to navigate and afford it. The licensing process in many countries, therefore, needs to be open and transparent; streamlined, in order to make it easy and rewarding to obtain a licence; and less expensive. This could be achieved through:

- Decentralizing the process so that local government offices can process and award licences.
- Removing overlapping roles and responsibilities of government departments and/or bringing disparate institutions together, creating a streamlined licensing procedure for miners to obtain licences and support.
- Creating online electronic licensing platforms (provided miners can access the Internet in rural and remote locations) to make the process transparent and less open to corruption, accompanied by basic training on how to use electronic systems.
- Providing different categories of licences with differentiated requirements so that it is easy for the most impoverished ASM operator to obtain and meet the criteria for a licence. Once licensed and legal, government and development partners can support them to improve their activities and address the negative expressions of informality.
- Providing access to support services and processing centres once licensed to incentivize miners to become licensed.

ACCESS TO GEOLOGICALLY PROSPECTED LAND

Access to land is a common barrier to formalization and can result in miners entering environmentally sensitive areas, becoming a source of conflict between LSM companies and ASM. Demarcating geologically prospected areas specifically for ASM activities so that miners can access finance and support services by using the geological information as collateral for bank loans could help confine activities to specific areas and thus improve both the social and environmental impacts of ASM. The costs of geological prospecting are often high for governments. As such, it is not uncommon for governments to award ASM concessions without having undertaken geological surveys to know whether or not the land is sufficiently mineralized to be viable for mining (Siwale & Siwale, 2017). There are also reports of government awarding land to small-scale miners where geological surveys have been undertaken and shown little to no viability (e.g., in Zambia, as reported by Siwale & Siwale, 2017). One way around this issue could be to ensure that LSM companies and prospectors are required to shed off land deemed uneconomical for industrial mining but suitable for ASM, and to retain data for use by national geological survey departments (Hilson & Maponga, 2004; IGF, 2017).

ACCESS TO GEOLOGICAL DATA

Mapping a country's potential mineral reserves and land use, and providing access to this data is "a necessary prerequisite for determining and demarcating locations appropriate for ASM activity" (Hilson & Maponga, 2004, p. 25). As Hilson (2007, p. 239) emphasizes: "Without information about communities, baseline geological data, and knowledge of indigenous practices, how can appropriate technologies, policies and assistance schemes be devised and implemented?"

Lack of geological data about mineralized deposits results in miners undertaking their activities in an ad hoc manner, largely by guesswork and trial and error, resulting in low mineral recovery, investment losses, greater environmental degradation and encroachment on LSM concessions (Friends of the Nation, 2010; Hilson & Maponga, 2004; Clifford, 2011). This commonly results in conflict. Insufficient geological knowledge also results in the use of inappropriate equipment and assistance schemes for ASM (Hilson and Maponga, 2004). There is a great need for geological surveying services in ASM to assist operators to locate economically viable deposits, which, according to Clifford (2011, p. 359),

> "has benefits beyond a good working relationship; it avoids environmentally degrading practice by enhancing the longevity and efficiency of sites, as miners leave non-gold bearing land undisturbed and do not have to constantly relocate operations. As a result, profitability is improved, and miners may be in a better and more inclined position to pay taxes, invest in cleaner equipment, and develop into more business-like enterprises…"

However, there are limited examples of geological services being provided to ASM operators (or available in an accessible form), as government and donor attention in this area has tended to focus on LSM and attracting foreign investment (Huggins et al., 2017; Siwale & Siwale, 2017). Miners "are instead left independently to assess land, through costly consultants or unreliable basic prospecting" (Clifford, 2011, p. 359). As Huggins et al. (2017, p. 145) assert, "ASM actors rarely have access to geological maps, information communication technologies, or relationships with high-level government actors—all benefits enjoyed by large industrial mining companies."

According to Hilson and McQuilken (2014: 6), a number of African countries began providing assaying services for ASM operators in the 1990s, through funding from the World Bank and German Technical Cooperation (GTZ). For example, an assaying facility was installed in Tarkwa, Ghana. However:

… in Ghana—and in other African countries, such as Zimbabwe, where moves were also made to provide assaying services—it was quickly realised that most of the groups being targeted were comprised more of the 'dig and wash' and 'hit and miss' variety of miner, specifically individuals who were living 'hand-to-mouth' with no knowledge of, or need for, such advanced analytical techniques. These services, therefore, would have likely only appealed to a small share of miners, if at all: namely, those in possession of a licence, as informal, unregistered operators would have likely done everything possible to avoid contact with authorities over fears of potentially revealing their whereabouts." (Hilson and McQuilken, 2014)

The possibility of donor funding for assaying services was recently raised again in Ghana without discussion of the previous facility, revealing the cyclical nature of ideas for interventions in the sector—as well as a general lack of institutional knowledge within government departments and donor bodies of ASM interventions.

Aryee et al. (2003, p. 138) mention an initiative in Ghana funded under the World Bank's Mining Sector Development and Environment Project focused on "providing better geological information to small-scale miners through the assistance of geologists working in the field to delineate recoverable ore bodies on small-scale mining concessions." According to the authors, the areas identified to have potential for ASM were delineated for licensing to small-scale miners. However, it is not clear whether this project came to fruition, or the information shared with the appropriate government departments.[19] There were also attempts to fund geo-prospecting and census work through CASM in the 1990s, but the grants were too small to fully finance these activities (Hilson & McQuilken, 2014, p. 116).

Photo: IIED/Steve Aanu

Due to a focus on LSM investment, many donor projects have aimed to improve the efficiency and transparency of mining cadastre systems in Africa through the introduction of computerized and decentralized cadastres and GIS technologies (World Bank, 2012; Ortega et al., 2009; CEEST, 2009). For example, in 2015 the Australian government provided funding to the Minerals Commission of Ghana for a two-year project to develop a fully GIS-based computerized mining rights cadastre system for processing, managing and monitoring mineral rights and licences in Ghana (Essabra-Mensah, 2015; Australian High Commission Ghana, 2015). The online repository (web-based portal) was launched in July 2016 (Amadou, 2016), replacing the previous semi-computerized Mineral Rights Administration System and presenting two datasets: LSM and ASM licences (GNA, 2016).[20]

Although the data is made available publicly on a read-only basis, it is hoped that the portal will not only promote transparency but also stronger collaboration between relevant government institutions (Amadou, 2016). Previously the system relied on hard copy documents, and there were also issues around different zoning maps and cadastral systems being used for LSM and ASM concessions, leading to overlap (and resulting conflict) in some cases. The Government of Zimbabwe's Draft Mineral

[19] According to Hilson and Yakovleva (2007, p. 419), "[the Geological Survey Department of Ghana] has failed repeatedly to provide the government with detailed geological data, a necessary first step towards identifying suitable areas for prospective small-scale miners. This exercise was supposed to commence following the launch of the World Bank 'Mining Sector Development and Environment Project' in 1995, under which US$1.66 million was allegedly given to the Geological Survey Department to develop 'a program to make better geological information available to small-scale miners through the establishment of teams of geologists trained and equipped to delineate recoverable ore bodies on mining concessions. Failure to do so has left the government in a state of disarray, forcing the understaffed Minerals Commission to rely heavily upon an applicant's geological knowledge, which in many cases, leads to further delays in decisions on licenses."

[20] According to Amadou (2016), the Minerals Commission had been attempting to implement a fully-fledged cadastre system since 1999.

Policy (October 2013) has also called for the establishment of a functional, user-friendly national mineral cadastre information management system (Pact, 2015).

FlexiCadastre is a mining cadastre and mineral rights management system developed by the company Spatial Dimension, launched in 2003 after winning a World Bank-funded project to implement a new computerized mining cadastre system for Mozambique (Spatial Dimension, 2015). It has since implemented many World Bank Sustainable Management of Mineral Resources Projects (SMMRP). The system uses a web portal for data management and GIS technologies to facilitate the administration of mineral titles in multiple jurisdictions, with the aim of improving stakeholder communication, reducing corruption and improving transparency (CEEST, 2009; Spatial Dimension, 2014). It can be used for both LSM and ASM (Spatial Dimension, 2013). Countries in Africa currently using the FlexiCadastre system include the Democratic Republic of Congo, Ethiopia, the Ivory Coast, Kenya, Liberia, Mozambique, Rwanda, Senegal, Tanzania, Uganda, and Zambia (Kolver, 2013; ArcGIS, 2014). Spatial Dimension has also developed mineral tenement/cadastre management systems for the Lao People's Democratic Republic and Papua New Guinea (see Spatial Dimension 2015 for other private and public sector clients and funding agencies).

However, some problems have been reported with accessing the system in regional offices. For example, in Tanzania, it was reported that the server is based in the capital city and is very slow in regional areas; mining officers reported that it could take up to two hours to access the system and could only enter and search for one or two licences in this time (CEEST, 2009). In Nigeria, a similar system sponsored by the World Bank SMMRP but developed by a different company has also encountered various challenges, including the absence of supporting datasets and lack of system maintenance, as well as data entry issues such as duplication of entries and inconsistent spelling (Ozah et al. 2011). The lack of adequate and uninterrupted electricity supply has also caused problems for the computerized system. These types of basic capacity and infrastructure challenges need to be considered when implementing technological strategies to improve the governance of ASM in developing countries.

ACCESS TO CAPITAL

There is a lack of literature on strategies for economically empowering ASM operators, due to a focus on LSM when discussing the links between mining, poverty and development opportunities. Debt and poverty traps plague the ASM sector, linked to its informality and the inability of miners to access finance due to their non-legal status. This creates a "double bind" (Hinton, 2006, p. 134) for miners, as a certain level of capitalization is required to register and gain a concession and buy the necessary equipment to mine and process minerals.

Many ASM operators are poor and forced to borrow money from informal and often inequitable channels (Banchirigah, 2008), such as loans from traders and licensed buyers (Labonne, 2003). Kelly (2014, p. 105) discusses how corruption and fraud play into the debt cycle, with the "power holders" in ASM making the vast majority of profit, while those doing the work on the ground "make barely enough to survive". Drawing on interviews with key informants and focus group discussions in ASM communities in South Kivu Province of the Eastern DRC, the author points to "irregular payment of salaries, fraud, theft, and disenfranchisement" as some of the reasons for debt bondage among youth working in ASM.

UNECA's (2002–12) *Compendium on Best Practices in Small-Scale Mining in Africa* provides a set of "success factors" for various areas of development in ASM. In the area of access to credit and finance, these include (UNECA, 2002–12, p. 84):

- Drafting a small-scale mining lending policy.
- Establishing loans targeted to specific needs of small-scale mining projects.

- Making the government a grantor so that small-scale miners do not have to have collateral when applying for loans.
- Making the amount of the loan based on actual requirements following an assessment by mining experts from the government.
- Establishing equity-based financing to promote joint ventures.
- Establishing hire-purchase schemes that enable small-scale miners to access and acquire equipment through the payment of small affordable instalments.

The UNECA compendium also identifies different schemes in ASM for access to credit and finance: loan-based financing schemes; equity-based financing schemes; hire-purchase schemes; donor and government support schemes; financing through cooperation between small and large-scale miners; and buyer credit schemes (UNECA, 2002–12, p. 11). Some of these are discussed further below.

MICROFINANCE (CREDIT AND SAVINGS)

The increasing interest in microcredit for ASM in the 1980s died down in the decade that followed, according to Hilson and Ackah-Baidoo (2011, p. 1194), as "most donors, NGOs, and private sector organizations began shying away from the idea altogether." The authors claim that this was because of a series of poor results from projects such as the Swiss-funded MEDMIN and APEMIN projects in Bolivia and the Central Region Development Commission (CEDECOM) equipment-sharing program in Ghana. Issues with these projects included unrealistic demands placed on borrowers and high loan default rates, as well as the implementing officials' lack of industry experience. However, UNIDO's 2002–08 Global Mercury Project incorporated a focus on microfinance issues (while also addressing mercury pollution) in gold mining areas. It was run in partnership with a number of national governments, including Brazil, Indonesia, Laos, Sudan, Tanzania and Zimbabwe (Spiegel, 2012).

Hilson and Ackah-Baidoo (2011) describe the principles that made the "Grameen bank" a success in providing microcredit for ASM operators in the Yale mining camp in Talensi-Nabdam District, Northern Ghana, and recommend applying these to ASM microcredit programs. These include social collateralization (i.e., lending money to groups, who are more likely to repay a loan than individuals); devolved responsibility to borrowers; and borrower discipline. Microfinance schemes in Tanzania have met with relative success as they have followed the Grameen model, which encourages "individuals to unite and form 'trust groups' (typically, five to eight people who know each other) to borrow money or equipment collectively, and to hold each other accountable for repayments" (Hilson & Ackah-Baidoo, 2011, p. 1195). Both Spiegel (2012) and Hilson and Ackah-Baidoo (2011, p. 1194) suggest that equipment loans could be a better alternative to cash to ensure that "finances dispensed are used to purchase the required technologies and not siphoned."

GRANTS

A World Bank SMMRP run from 2004 to 2012 in Nigeria provided a total of 245 grants amounting to about USD 9 million to 147 ASM cooperatives as well as 98 community entities, which included sub-projects to enhance granite, sand, gravel and laterite quarrying (IEG, 2014b). Another World Bank SMMRP run in Uganda from 2003 to 2011 included a community grant scheme which provided grants to pilot more efficient and safer ASM practices. To receive a grant, miners had to form a group and be further trained in financial management and procurement (Sheldon et al., 2013). An unexpected consequence of the training and grants scheme was that it motivated several ASM associations to start village savings and loan associations that could provide small loans to members in times of need (e.g., to build housing, school fees, family emergencies, burial expenses, and festive occasions) (IEG, 2014a). Establishing funds to assist ASM operators to rehabilitate land has also recently been considered by donors such as the World Bank.

GOVERNMENT LOAN FACILITIES

Siegel and Veiga (2009) suggest that rather than focusing on grants, donors could assist in setting up user-friendly government loan facilities that help carry the risk. The authors provide examples of two successful government loan facilities for the ASM sector in Namibia and Mozambique:

> In Namibia, the government used a Minerals Development Fund to provide US$92 million in loans for projects emphasising the sinking of shafts, exploration, and mine expansion. Using low interest rates, slow payment periods, and minimal bureaucratic overhead, 92 percent of loans have been repaid. A similar fund in Mozambique offered financing, provided that miners could show a license, proof of collateral (20 per cent of loan amount), a feasibility study, and plan for loan repayment. (Siegel & Veiga, 2009, p. 55)

Tanzania has also taken steps through World Bank-financed initiatives to provide small-scale grants from a revolving fund and establish an equipment leasing scheme (Fold et al., 2014). The Zimbabwe Government Mining Industry Loan Fund is another example of a specially designed equipment and cash loans scheme for ASM which, although short-lived, was considered to be best practice (Spiegel, 2012).

ACCESS TO EQUIPMENT

Equipment and financing go hand in hand and, along with geological information and licensing processes, are considered fundamental barriers to formalizing ASM. As Perks (2016, p. 814) notes (referring to the cases of Tanzania and Rwanda), one of the main bottlenecks for ASM operators is the lack of resources to be able to "replicate or adapt mining techniques." According to UNECA (2002–12, p. 27), most countries lack local capacity to produce appropriate technology for ASM, and many have imposed restrictive fiscal terms on importing technology (i.e., high import duties). As a case in point, the Chinese are credited for better access to both equipment and finance in Ghana (Hilson et al., 2014). For example, Crawford et al. (2015, pp. 12–13) explain the history of the ubiquitously used *changfa* crushing machine in Ghana, which was introduced by a group of Chinese miners from Hunan province in 1998. It is said that the group tried to engage with the Ghana Minerals Commission to encourage ASM miners to use their machinery, but the commission showed no interest.

Hilson and McQuilken (2014) point to two publications on gold processing technology and mining equipment (Priester & Hentschel, 1992; Hollaway, 1993) that are useful for highlighting the appropriate equipment for ASM, as well as the barriers preventing ASM operators from adopting more efficient technologies. These barriers include the high cost and the level of technical expertise required to operate them effectively. In a similar vein, UNECA (2002–12, pp. 27-53) outlines a number of programs promoting more efficient and cleaner technologies during the 1990s that were considered "best practice." These include assaying facilities in Zimbabwe managed by the Department of Metallurgy; the Shamva Mining Centre in Zimbabwe,[21] set up to provide small-scale gold miners with appropriate technologies and skills in mining and processing gold; the Tarkwa Mining Centre in Ghana, which housed an assay laboratory and demonstration plant; the GTZ-University of Zimbabwe Riverbed Mining project; the Uis Tin Mining Project in Namibia; and the UNIDO Abatement of Mercury Pollution program in Ghana and Tanzania (1998–2001), under which the ThermEx[22] retort was developed. Many of these technology initiatives are still referred to in recent publications as best practice.

According to Hilson and Potter (2003), in the mid-1990s World Bank and other international funds were used to purchase equipment that was either not suitable for small-scale miners or was not accompanied by appropriate sensitization and training. While some interventions were promising,

[21] The Shamva Mining Centre was Zimbabwe's flagship programme. It was intended to be a "one stop shop" where miners could access a range of technical services, including assistance with processing their gold (Hilson et al., 2007). However, this particular centre had demand in excess of its ability to provide services.

[22] "ThermEx retort is a glass retort that is compact, with dimensions comparable to two cigarette packs, and weighs approximately 1 kg. The ThemEx glass retort allows miners to observe the entire process of separation of mercury and gold from the amalgam." See http://repository.uneca.org/bitstream/handle/10855/14009/Bib-55456.pdf.

"there was little chance for problems experienced with potentially promising interventions such as Shamva [Zimbabwe] to be corrected over time or for novel medium-to-long-term ideas such as assaying services to be critically re-thought" (Hilson & McQuilken, 2014, p. 6).

UNECA (2002–12, p. 82) describes in detail specific best-practice technologies in ASM, including for drilling, blasting, surface mining, underground mining and processing (crushing, grinding, sizing, flotation and gravity concentration techniques), providing the following list of success factors for applying best-practice equipment in ASM:

- Simple in design and can be produced locally
- Uses accessories, e.g., grinding media, which are readily available
- Mobile, easy to install and operate
- Powered by small diesel engines (diesel is available in most mining areas)
- Cheap and can be afforded by individual miners
- Efficient, with minimal environmental impacts
- Low power consumption
- Uses selective mining techniques that can focus on particular types and grade of ore
- Applies methods that combine both manual and mechanized processing techniques.

Despite the many technologies and guidance documents available, there is still widespread lack of knowledge among miners about the benefits of adopting more efficient and environmentally sustainable technologies in their operations (Aryee et al., 2003;). Ghanaian miners listed the equipment they lacked that would be important for efficient and safe operations, including: excavators (to prevent cave-ins from the build-up of tailings),[23] water pumps, coolers (to run water pumps) and ore-washing equipment (e.g., sluice installations) (personal communication, 2014). Spiegel (2012, p. 517) provides a similar list from information gained through a microloans project in the Ingessana Hills in the Blue Nile State of Sudan, aimed at supporting the transfer to improved technology. The list of core equipment often identified as priorities for miners includes: small jaw crushers, small ball mills, compressors, sluice boxes, carpets and vinyl mats for sluice boxes, water pumps, elliptical amalgamation barrels, centrifuges to remove excess mercury, retorts (to prevent mercury emissions and allow mercury recycling), gas burners (to speed up the retorting process), and safety equipment.

According to Hinton et al. (2003, p. 99)

> [s]everal technologies and methods commonly utilized by large-scale mining operations can be downsized to smaller scale operations. However, the likelihood that miners will adopt these large-scale methods, or those developed specifically for ASM, depends upon some key factors. For an artisanal miner, these factors include: (1) increased or comparable simplicity, (2) quick recovery of the economic mineral, and (3) demonstrated financial gain. Other practical aspects, such as the availability of materials (chemicals, steel rods, piping, generators, etc.), capital and operating cost requirements and access to technical support, also influence acceptance of new techniques.

HIRE-PURCHASE LOAN SCHEMES

Finding alternative approaches to technology is advised "rather than ignoring artisanal miners, outlawing them or handing out free 'giveaways' to certain groups in the form of equipment donations or financial grants" (Spiegel, 2012, p. 508). Attempts to improve ASM technologies may be most effective if they encourage groups (rather than individuals) to collectively acquire new equipment through hire-purchase loan schemes (Spiegel et al., 2005).

[23] It is worth noting that the Ministry of Lands and Natural Resources in Ghana has recently clamped down on the use of excavators in informal operations, and has removed 544 excavators from mining sites around the country (Adogla-Bessa, 2017b).

Along with the assaying laboratory and processing plant set up in Tarkwa, Ghana, in the early 1990s, the Minerals Commission also set up equipment at other field sites, and had an equipment leasing scheme, whereby equipment manufactured in collaboration with local fabricators was made available on a sale or loan basis (UNECA, 2002–12, p. 29; Hilson & McQuilken, 2014, p. 6). The Global Mercury project also included a hire-purchase scheme to assist miners to progressively buy a range of equipment.

CENTRALIZED PROCESSING CENTRES

Centralized processing centres are one strategy to enable alternative access to equipment and technology and promote EHS-friendly operations. The first processing centres were established in Ghana, Venezuela and Zimbabwe by governments and other project donors. As well as providing processing facilities, the centres have served a role in providing information about environmental management (Hinton et al., 2003). Unfortunately, they have faced a number of issues, based in large part on a lack of prior research on their target beneficiaries. A centralized processing centre in Bolgatanga, Ghana, for example, was underutilized because it was too far away from the mining area and the equipment wasn't tailored to local geological conditions (Hilson et al., 2007). Centralized processing centres are most effective in countries with localized gold deposits but not as effective where gold is widely dispersed and miners have to transport ore far beyond the mine (Hilson et al., 2007), as this raises transport costs and presents security issues. In addition, processing centres require ongoing resources for labour, equipment, maintenance and administration (UNIDO, 2015).

Ghana's new five-year Multilateral Mining Integrated Project among other activities intends to set up a centralized processing plant, which miners will be able to use for a fee (Adogla-Bessa, 2017b; Asamoah, 2017). Questions must be asked about the extent to which lessons are learned from previous initiatives, such as the Tarkwa Mining Centre. For example, the idea of centralized processing centres was discussed in multistakeholder forums in Ghana (with Minerals Commission and other government officials present), and the previous demonstration processing plant set up in Tarkwa was not raised. In fact, many stakeholders working with ASM in Ghana were not aware of the potential or possibility of mercury-free processing methods. There is certainly a sense that everyone wants to have the next "great idea" for fixing the "ASM problem," without drawing on lessons from the past. It appears that with technical support provided to ASM, the same ideas are cyclical and there is a need for initiatives to build on previous knowledge, capitalizing on past successes and failures.

CAPACITY BUILDING

In the 1970s and 1980s, international capacity-building and technology transfer programs were often designed and conducted by experts from the global North, with a limited amount of time spent on the ground understanding the needs and priorities of the global South—yet feeding new systems (Sippl & Selin, 2012). According to Hilson and McQuilken (2014), the 1980s witnessed an influx of technical support to ASM operators, mainly in sub-Saharan Africa. The early 1990s were also dominated by technically oriented interventions, with many of the capacity-building and technology transfer programs implemented by intergovernmental organizations (such as UN Environment, UNDP, UNIDO and UNITAR) and donors (e.g., the World Bank and GTZ) focusing on environmentally friendly mining processing methods, particularly reducing mercury use and pollution (Sippl & Selin, 2012; Hinton et al., 2003).

It was not until the mid to late 1990s that support for ASM started to look at community and livelihood issues more broadly (Hilson & McQuilken, 2014) along with a focus on formalizing the sector (Hentschel et al., 2003). During this period, for example, GTZ contributed funding to the Small-Scale Mining Project,[24] which established seven district support centres in mining regions in Ghana, intended to facilitate licensing processes and provide decentralized support to miners (Hilson & McQuilken, 2014; Banchirigah, 2008).

[24] GTZ, according to Hilson & McQuilken (2014), became the "face" of bilateral aid for ASM in sub-Saharan Africa in the 1990s, and were heavily involved in delivering technical support in Zimbabwe and Ghana, in partnership with civil society, under the SMMP.

Poor understanding of the makeup and dynamics of ASM communities has led to the design of many inappropriate technologies and support services (Banchirigah, 2008). Hilson and McQuilken (2014) criticize the technical support provided by donors through the 80s and 90s for their top-down approach, lack of knowledge of target populations and local context, as well as their short-term nature and lack of planning for ongoing funding and support to ensure the sustainability of interventions. This issue is not confined to that period and can still be seen in interventions today.

More recently, World Bank-funded initiatives in Tanzania, which include setting up new technical advisory services in existing state institutions like geological surveys, national universities and vocational training institutions, have been praised for focusing on local institutional partnerships (Fold et al., 2014). Similarly, a recently established agreement in Ghana between the Minerals Commission, National Association and University of Mines and Technology and the Ghana National Association of Small Scale Miners will develop a training program consisting of six training modules aimed at teaching good practices in surveying, prospecting, mining, mineral extraction and environmental and safety management to small-scale miners in the nine mining districts in the country (Yeboah, 2015).

Another relatively successful project was a three-year regional program run from 2013 to 2016 in Mali, Burkina Faso and Senegal through the Global Environment Facility and UNIDO, focused on the transfer of mercury-free technologies (UNIDO, 2015; ARM, 2017). This program provided health education and technology training programs based on workshops, seminars and training, as well as assistance to mining communities to obtain Fairmined Gold certification. As well as assisting four ASM organizations to legalize, and creating a manual on certification, the project provided technical assistance with a focus on integrating women into the mining sector. Through the project, more than 130 women received technical assistance on better production techniques, as well as material support to start a community garden as an alternative source of income (ARM, 2017). Another World Bank SMMRP in Uganda, which ran from 2004 to 2011, provided 180 local trainers with training who themselves subsequently trained around 1,000 miners, 40 per cent of whom were women, in practical mining-related topics, such as mining methods, legal and regulatory issues, business skills, occupational safety and health, and community development (IEG, 2014a).

The UNECA (2002–12, pp. 32–33) *Compendium on Best Practices in Small-Scale Mining in Africa* also mentions several training/capacity-building initiatives run in the 1990s. These include a series of intensive training seminars funded and organized by DFID in conjunction with the Zimbabwe Geological Survey Department and the Small-scale Miners Association of Zimbabwe in 1991. The initiatives introduced participants to the basic principles of geology, identification of rock types and minerals common to gold belts, map reading and interpretation, simple surveying using tape and compass methods, the nature of orientation of veins and shear zones, sampling, mine evaluation and planning, simple exploration techniques and basic financial planning. Also mentioned is the Mintek Training Programme in South Africa (run in the early 2000s) and the Southern and Eastern African Mineral Centre in Tanzania, which provided (among other activities) specialized short, targeted courses, such as a one-week course on gemmology.

In addition, the UNECA (2002–12, p. 34) compendium mentions a Gemstone Cutting and Training Centre in Tanzania set up in the early 2000s and under the small-scale mining component of the Mineral Sector Development Project run by the World Bank and Government of Tanzania. The centre provided lapidary and stone-carving skills to add value to gemstone and mineral production in the country. Some recommendations provided by the compendium in terms of ASM technology include: allocating adequate funding for centres of innovation and adaptation of (appropriate) technology; replicating tested models of equipment hire, pay-back or hire-to-pay schemes from other countries; developing programs for the promotion of efficient technology which enable miners to identify and operate them with the aim of improving productivity and hence earnings; and providing training to trainers to access more miners (UNECA, 2002–12, p. 82).

Photo: IIED/Magali Rochat

Technical capacity-building needs to be tailored to the socioeconomic characteristics of the mining community, to better understand which technologies could or could not work (Spiegel et al., in press). They should focus on contamination and how current bad practices are stigmatizing miners, as well as providing feasible alternatives. Regular and intensive training programs should be set up to educate miners and communities about the pros and cons of the various technology alternatives. These programs need to be stipulated in legislation providing for enforcement and proper monitoring and evaluation. Forging partnerships with community organizations, civil society organizations and the private sector is crucial to successful implementation.

Encouraging miners to form cooperatives and associations is another well-praised initiative, with potential to aid successful capacity building and ultimately encourage formalization and more responsible mining practices, as well as sharing knowledge and resources (Levin & Turay, 2008; Hentschel et al., 2003). In addition to a better success rate for capacity building, organized mining communities in the form of cooperatives are more likely to successfully adopt technological alternatives, as it can be easier to invest the necessary time and money.

Various governments have attempted to encourage miners to organize themselves and formalize their activities using different incentives, including training and providing financial services. For example, the Government of Zimbabwe's five-year economic blue print, ZimAsset (2013–18), "lists two of its outputs as: eight provincial gold processing and buying centres; and the registration of 500 syndicates (i.e., 2,500 registered small-scale miners)" (Pact 2015, p. 51). The World Bank Uganda SMMRP mentioned earlier (World Bank, 2012) included various components such as training and forming mining associations. The resulting 50 ASM associations now benefit from enhanced machinery improving their productivity, with some forming joint ventures with international mining companies (Sheldon et al., 2013).

Recommendations from a (largely unsuccessful) USAID-funded project in Sierra Leone on forming ASM cooperatives include the importance of providing training for cooperative members in how to run a cooperative, with clear accountability and entitlement guidelines, as well as providing sources of contingency funding (Levin & Turay, 2008). However, there is in general a dearth of research on the formation of associations and cooperatives in ASM and this area is recommended for further research.

There is some potential for large-scale mining companies to provide capacity building in the area of environmental management to the ASM sector, particularly when working with associations or cooperatives. Lombe (2003) provides some examples of successful cases of large-scale mining companies providing mentoring on best practice to artisanal and small-scale miners in South Africa and Zimbabwe. A further example is Bolivia, where the Coeur d'Alene Mines Corporation works as a joint venture with organized ASM cooperatives representing 15,000 local artisanal miners (Pact, 2015)..

DIALOGUE BETWEEN ASM STAKEHOLDERS

To ensure that formalization efforts are in tune with realities on the ground, ASM operators must be involved in the process. A platform is needed for positive regular dialogue between ASM key stakeholders, including government, to provide a conduit for inclusive consultation on changes. This would also help with monitoring and enforcement challenges, by improving community relations. Such a dialogue should be informed by research on mining communities to understand the complexity of how operations function in host countries, so that formalization initiatives are in touch with realities on the ground. IIED runs an action and solution-oriented multistakeholder dialogue, a process which—crucially—can support formalization efforts (see Box 5). This program has been implemented in Ghana, Tanzania and Madagascar.

BOX 5. THE IIED ASM ACTION DIALOGUE PROGRAMME

IIED's "action" dialogue program for artisanal and small-scale mining is informed by a 40-year track record in fostering participatory reform and policy change in mining, forestry and other sectors. It is designed to help national stakeholders identify solutions that promote formalized, rights-based, productive ASM within a more inclusive and responsible mining sector. The program provides a much-needed forum for multistakeholder collaboration and knowledge sharing to promote better governance, greater voice, and secure and productive employment—both across the mining sector and complementary rural livelihoods such as agriculture. The program strives to make sure that all stakeholders participate, that the process is locally owned, and that discussions focus on solutions. This way, the IIED dialogues can help align ASM with national priorities and sustainable development agendas.

A successful dialogue needs to be preceded by a process of engaging and preparing stakeholders for dialogue that is action-focused. At the pre-dialogue stage, the IIED model begins with a comprehensive scoping of a country's ASM sector and the socioeconomic and governance structure in which it exists. This is done through two key components—country dialogue research and an ongoing uni- and bi-stakeholder engagement—in collaboration with a country dialogue researcher and dialogue convenor. These two activities help compile a body of evidence that is further distilled through thematic dialogues focusing on key thematic challenges. The resulting ideas for solutions are debated at the national ASM action dialogue. Also at this stage, multistakeholder mapping is conducted, corresponding to various thematic areas—with tentative roles scoped to aid the drafting of a roadmap for reform at the national dialogue. Pre-dialogue discussions offer key sector stakeholders a shared platform to discuss their concerns and perspectives on the main challenges facing the ASM sector. Engagement and research lay the groundwork for identifying solutions that are actionable, with clear roles and responsibilities for multiple stakeholders in the sector. All of this is crucial to support a dialogue that:

- Convenes multiple stakeholders in constructive (solutions-focused/harmonious) discussion
- Identifies clear priorities and next steps within a roadmap for positive reform in the ASM sector
- Gives multiple stakeholders clear roles and responsibilities in that roadmap.

Source: Weldegiorgis and Buxton (in press).

To create the long-term sustainable formalization strategies outlined in this section, a formalization approach must include small-scale miners; be driven by local priorities and dialogues between the various stakeholders (including non-mining ones) at all levels; and develop a co-created roadmap that outlasts the intervention (McQuilken & Hilson, 2016).

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APPENDIX

TABLE A1. ASM POPULATION IN AFRICA

Country	1999			2011		2014		
	Min	Max	Average	Average	Dependants	Min	Max	Average
Algeria								7 000
Angola				150 000	900 000			200 000
Benin								15 000
Bostwana								15 000
Burkina Faso	60 000	70 000	65 000	200 000	1 000 000	100 000	200 000	150 000
Burundi			10 000			10 000	20 000	15 000
Cameroon								40 000
Central African Republic			45 000	400 000	2 400 000	100 000	290 000	195 000
Chad	10 000	15 000	12 500	100 000	600 000	40 000	140 000	90 000
Côte d'Ivoire	10 000	25 000	17 500	100 000	600 000			500 000
DRC			150 000	200 000	1 200 000			2 000 000
Egypt*								
Equatorial Guinea								15 000
Eritrea*				400 000	2 400 000			
Ethiopia	100 000			500 000	3 000 000	200 000	700 000	450 000
Gabon								10 000
Ghana	50 000	300 000	175 000	1 100 000	4 400 000	400 000	1 000 000	700 000
Guinea			40 000	300 000	1 500 000	200 000	300 000	250 000
Guinea-Bissau								7 000
Kenya	30 000	40 000	35 000			100 000	150 000	125 000
Liberia				100 000	600 000			100 000
Libya								7 000
Madagascar	5 000	20 000	12 500	500 000	2 500 000	400 000	500 000	450 000
Malawi				40 000	-			40 000
Mali			100 000	400 000	2 400 000			500 000
Mauritania								20 000
Morocco	5 000	10 000	7 500			70 000	150 000	110 000
Mozambique	700	100 000	50 350	100 000	1 200 000	100 000	300 000	200 000
Namibia	5 000	10 000	7 500			10 000	30 000	20 000
Niger			440 000	450 000	2 700 000	290 000	440 000	365 000
Nigeria	10 000	20 000	15 000	500 000	2 500 000	20 000	100 000	60 000
Republic of the Congo*								
Rwanda	5 000	15 000	10 000			30 000	70 000	50 000
Senegal			3 000					15 000
Sierra Leone	30 000	40 000	35 000	300 000	1 800 000	200 000	400 000	300 000
Somalia								15 000
Somaliland Somalia**								
South Africa			10 000	20 000	-	10 000	30 000	20 000
Sudan				200 000	1 200 000	300 000	2 000 000	1 150 000
Tanzania (United Republic of)	450 000	600 000	525 000	1 500 000	9 000 000	900 000	1 000 000	950 000
Togo						15 000	20 000	17 500
Uganda	5 000	10 000	7 500	150 000	900 000			200 000
Western Sahara*								
Zambia	20 000	30 000	25 000			30 000	80 000	55 000
Zimbabwe	50 000	350 000	200 000	500 000	3 000 000	400 000	500000	450 000
TOTAL	**845 700**	**1 655 000**	**1 998 350**	**8 210 000**	**45 800 000**	**3 925 000**	**8 420 000**	**9 878 500**

** likely existing, **existing (Somaliland Somalia: gold)*

Source: Based on Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017; Hilson & McQuilken, 2014; Hilson, 2009; Ledwaba & Nhlengetwa, 2016; Siegel & Veiga, 2009.

TABLE A2. ASM POPULATION IN ASIA

Country	1999			2003			2014		
	Min	Max	Average	Min	Max	Average	Min	Max	Average
Afghanistan									80 000
Armenia*									
Azerbaijan*									
Bangladesh*									
Bhutan*									
Cambodia**									
China	4 300 000			3 000 000	15 000 000	9 000 000	3 000 000	15 000 000	9 000 000
Georgia*									
India	1 000 000	1 100 000	1 050 000			500 000		12 000 000	
Indonesia	300 000	500 000	400 000			109 000	110 000	250 000	180 000
Iran**									
Iraq*									
Kazakhstan*									
Kyrgyzstan							5 000	15 000	10 000
Lao PDR							5 000	15 000	10 000
Malaysia			4 600						5 000
Mongolia									70 000
Myanmar			14 000						50 000
Nepal			500						120 000
Pakistan	90 000	370 000	230 000				400 000	500 000	450 000
Papua New Guinea	15 000	20 000	17 500	50 000	60 000	55 000	50 000	100 000	75 000
Philippines			200 000			185 000	300 000	350 000	325 000
Russia**									
Sri Lanka									160 000
Tajikistan**									
Thailand			21 500						20 000
Turkey**									
Turkmenistan*									
Uzbekistan*									
Vietnam	35 000	45 000	40 000				50 000	60 000	55 000
Yemen*									
TOTAL	**5 740 000**	**2 035 000**	**1 978 100**	**3 050 000**	**15 060 000**	**9 849 000**	**3 920 000**	**28 290 000**	**10 610 000**

** likely existing, **existing (Cambodia: gold, ruby; Russia: gold, amber; Turkey: coal)*

Source: Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017.

TABLE A3. ASM POPULATION IN LATIN AMERICA

Country	1999			2003	2014		
	Min	Max	Average	Average	Min	Max	Average
Argentina			5 800				5 000
Belize*							
Bolivia			100 000	72 000	130 000	210 000	170 000
Brazil	100 000	250 000	175 000	10 000	75 000	860 000	467 500
Chile	6 000	12 000	9 000				10 000
Colombia	100 000	200 000	150 000		270 000	500 000	385 000
Costa Rica*							
Cuba			5 000				5 000
Dominica			125				
Dominican Republic	2 000	3 000	2 500				3 000
Ecuador			60 000	92 000	90 000	120 000	105 000
El Salvador*							
French Guiana	5 000	10 000	7 500				10 000
Guatemala**							
Guyana	10 000	20 000	15 000		25 000	35 000	30 000
Haiti	4 500						5 000
Honduras							1 000
Jamaica			1 200				1 200
Mexico	20 000	40 000	30 000				40 000
Nicaragua	3 000	6 000	4 500		10 000	30 000	20 000
Panama	3 000	4 500	3 750				5 000
Paraguay**							
Peru	25 000	50 000	37 500	30 000	70 000	150 000	110 000
Suriname							20 000
Venezuela	30 000	40 000	35 000		30 000	70 000	50 000
TOTAL	**308 500**	**635 500**	**641 875**	**204 000**	**700 000**	**1 975 000**	**1 442 700**

** likely existing (El Salvador: gold), **existing (Guatemala: gold, Paraguay: gold and clay)*

Source: Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017.

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