Ergonomic issues associated with Artisanal and Small Scale Mining in Ghana and PNG - “Observations from the Field”.

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Artisanal and Small Scale Mining (ASM) is one of the oldest forms of income generation in mineral rich developing countries. While no universal definition exists, traditionally ASM is identified as being low capital intensive, high labour intensive and mostly employing rudimentary equipment and mining techniques. It is distinguished from large scale/industrial mining by low levels of production, lack of long term planning, and poor safety, health and environment conditions. An estimated 20 million people in at least 80 countries are active in ASM and at least another 100 million depend on the sector for their livelihood. Some estimates place the figure higher at closer to 30 million. In 2009 the International Commission on Occupational Health (ICOH) and the International Ergonomics Association (IEA) jointly sponsored the publication “Ergonomic guidelines for occupational health practice in industrially developing countries”. Recent fieldwork undertaken in Ghana and PNG provided the opportunity to utilise the guidelines to assist reviewing work practices commonly seen in ASM activities in these countries. This paper reflects on some of these observations.

The paper provides some examples of observed work practices in the ASM sector and identifies gaps where interventions could be implemented to improve health and safety (H&S) conditions. It offers examples of "reasonably practicable" interventions that have been implemented highlighting some of the initiatives Ghana and PNG are undertaking to improve ASM conditions while raising awareness with workers and their communities.

Key words: ASM, SSM, H&S, ergonomic, Ghana, PNG

1. Introduction
The actual number of people engaged in ASM is not known largely because limited data is available on the sector. Incident or injury information is not well recorded and interventions aimed at reducing injury are largely instituted ad hoc. While often little or no formal training is provided to those operating in the ASM sector, examples from the field indicate that many adopted work practices fall somewhere between intuitive task adaption and dangerous work practices. There is a lack of awareness and information on good practice and improved methods and in many cases a lack of incentives to adopt good practices.

Globally the number of people directly and indirectly dependent on ASM is estimated at 100 million and reportedly this number is steadily increasing due to the recent worldwide mineral boom and diversification of rural livelihoods. Taking place in more than 80 countries and producing approximately 15-20% of global minerals and metals ASM is a significant driver of local economic development (Buxton, 2013; World Bank 2013). While it represents an important livelihood strategy for many rural households and brings with it a significant amount of risk and vulnerability including difficulties with government licensing schemes, land disputes, environmental degradation and health and safety issues. Hilson (2012) argues that driven by poverty ASM miners become trapped in a vicious trap of poverty with the situation exacerbated by low levels of skill and technology, poor ore recovery levels and low earnings. Siegel and Viega (2009) comment further most ASM workers lack access to the social and economic infrastructure needed to break the cycle and move ahead. With the situation compounded by environmental and health issues, and without being able to either increase earnings or retain a larger share of earnings the situation is perpetuated.
Most often ASM workers are locked into a poverty cycle and obtaining mechanised equipment to assist them increase their ore recovery rate is often not financially attainable. ASM generally is labour intensive, involving long hours of repetitive heavy work digging, shovelling, lifting, carrying and dumping rocky overburden to expose underlying valuable mineral deposits and employing rudimentary equipment and mining techniques - usually picks, shovels, sluices and pans. The most labour intensive of these tasks, and those that have the least economic return are the tasks often falling to women involved in ASM activity. It is not uncommon to see women working with children by their side. However, the face of ASM is changing as miners gain access to low level mechanised equipment, and as commented by Viega et al. (2004) it is becoming difficult to make a clear distinction between “artisanal” and “small scale” mining leading to the term artisanal and scale mining (ASM) being often used to include both artisanal and small scale mining. These operations range from individuals panning along riverbanks to organised mechanised operations.

In summary, the key characteristics of ASM are:

- Labour intensive operations
- Semi- or un-skilled workforce
- Low levels of mechanisation
- Low income levels
- Low productivity, recovery and efficiency rates
- Largely unregulated informal or illegal mining operations
- Often undertaken in conjunction with other subsistence economic activities such as agriculture
- Often seasonal
- Often undertaken in remote areas
- Minimal health and safety knowledge
- Often undertaken in extremely hazardous working conditions
- Large proportion of female mine workers
- Widespread use of child labour
- Environmentally damaging
- Public health concerns – water contamination, sanitation.

ASM operates in a complex system of overlapping drivers, challenges and constraints. While there have been many interventions initiated within the ASM sector by donor agencies (e.g. World Bank, UNDP) it is often argued that mostly they have failed because of the approach taken in designing and implementing them rather than the type of project (D’Souza 2014). Reflecting on a decade of mining and sustainable development a 2012 IIED report observed that much work in the international NGO community has focussed on issues such as mercury use, formalisation of the ASM sector, child labour and conflict minerals – addressing the problems of ASM rather than driving developments like improved market access, credit and technical assistance. Meaningful interventions in the ASM sector remain illusive with authors arguing there is an urgent need to take into account existing socio-economic systems when considering how ASM can best contribute to poverty reduction and sustainable development.

2. Artisanal and Small Scale mining in PNG

Reports indicate over 100,000 are persons involved in alluvial mining across PNG, with 2006 figures indicating the sector to be worth around US$80,880,000 and contributed 1.4% of national GDP (World Bank). It is estimated 20% of SSM are female and 30% children under the age of 16 years (Moretti 2006). With non and semi-mechanised activity undertaken in family units of less than 10, this group comprises almost 99% of total SSM operations (Lole, 2005; Javia and Siop, 2010). Women are generally excluded from hard rock mining operations and men face additional H&S issues working in these operations. While researchers
argue most of the SSM population lacks the financial and educational capacity required to undertake fully mechanised or larger scale mining operations (Lole, 2005; Crispin, 2006), many SSM operators are now looking for opportunities to form joint venture (JV) operations that may provide necessary capital and skills to increase production levels and improve livelihoods (Crispin, 2006; Moretti, 2007). PNG legislation does not differentiate between “artisanal” mining and “small scale” mining and the term “small scale mining” (SSM) is used to identify all mining operations in this sector.

During the colonial era mining the sector was dominated by Europeans who employed PNG nationals, but by the late 1960s most had abandoned their leases and increasing numbers of nationals commenced their own operations (Moretti 2007). Since independence in 1975 SSM has rapidly increased in scale with the sector now financially underpinning economic activity in much of rural and remote PNG. Unlike in other parts of the world, PNG recognises the SSM sector as a legal contributor to the national economy with estimates of up to 90% of alluvial gold production extracted by rural based miners using sluice boxes and panning dishes and by mechanised operations using predominantly portable dredges, water pumps and excavators. Alluvial gold and placer gold is found almost everywhere in PNG with many sites in remote areas making it difficult financially and technically to locate mechanised equipment on site. As a result, simple non-mechanised techniques are employed and mercury remains widely used with between 60% and 90% of SSM operations reportedly using it to capture and amalgamate the gold (Crispin 2006).

3. Artisanal and Small Scale mining in Ghana
The number of ASM workers in Ghana is estimated at over 1,000,000. The actual number not known due to limited data on illegal small scale miners which make up 70-80% of those engaged the activity (Hilson 2003; Yakovleva 2007; Tscharke 2009). Ghana has two types of ASM operations: those licensed to operate on a government recognised lease and those operating without a lease (Nyame et al. 2009). In reality the distinction between the two groups is somewhat blurred as many licensed miners end up mining illegally beyond their lease boundary, often on concessions owned by large scale mining operations and many operate illegally due to administrative processes generating lengthy delays between application and granting of leases. Similar to PNG legislation, Ghana does not make distinction between “artisanal” mining and “small scale” mining (Aubynn 2009). With increased mechanisation occurring in the sector there is discussion regarding introduction of a third tier to mining legislation to differentiate between artisanal mining and small scale mining, while retaining current large scale mining legislation. In 2012, reportedly approximately one third of the nation’s gold production was estimated to come from ASM activity however recent figures indicate this has fallen slightly due to the falling price of gold and the government’s clamp down on illegal mining operations (Ghana Chamber of Mines 2013). Despite falling prices, in many rural areas in Ghana ASM continues to replace subsistence agriculture as the primary income earning activity (Hilson & Garforth 2013).

3. Health and safety issues in ASM
A study by Hentschel et al (2002) found most common occupational health and safety deficiencies in ASM linked to lack of awareness of the risks in mining coupled with lack of education and training. An extensive literature review reveals globally most health and safety issues faced by SSM workers are attributable to:

• Competing socio- economic demands
• Inadequate equipment
• Lack of training in and access to information on mineral geology, mining and minerals processing methods
• Lack of business skills to improve mining operations
• Lack of safety, health and environmental management practices.
Without adequate knowledge of good safety and health practice workers face unacceptable work related risk forcing them into actions that by western standards would be viewed as unsafe and unacceptable. A 2012 IIED report argues there is a lack of incentives for this sector to adopt good practice.

When Assistant Director of the PNG Small Scale Mining Branch of the Department of Mines, Lole (2005) reported the main cause of death in SSM as overhanging materials falling on miners while they were boring or tunnelling in alluvial ground. He argued the fundamental safety issue was that most miners lacked knowledge and skills on health and safety which in turn translated to inability to identify hazards and underestimation of the risk of being injured or killed, as the primary goal was to access high grade gold for economic survival. The Inspectorate Division of the Minerals Commission, Ghana reports similar findings from ASM sites. Lack of understanding and knowledge of health and safety issues by those working in the sector means interventions aimed at reducing injury and improving work practices are extremely challenging. The 1999 ILO report indicated non-fatal deaths in SSM were up to six to seven times that of formal large scale operations (Hinton et al 2003). Widespread informality within the SSM sector generally leads to under reporting of accidents and deaths and limited regulatory recording practices increase the difficulty in gathering accurate and reliable data. Review of current literature review does not indicate a decreasing trend.

Global awareness of H&S in ASM has largely focussed on the widespread use of mercury in the gold amalgamation process. Mercury use has captured worldwide attention and numerous networks and NGOs have worked to develop ethical supply chains leading to the creation of Fairtrade and the Fairmined Gold Standard. It is not uncommon for small scale miners to burn gold amalgam in confined spaces including the family home exposing them and their families to its neurotoxic effects. In addition, its ability to cross the placenta causing foetal abnormalities, bioaccumulation in food sources, and pollution of waterways significantly increases H&S risks within these already vulnerable ASM communities. Women’s reproductive role increases their vulnerability to mercury and other heavy metals in water and food supplies with mercury known to severely affect foetal development (Hinton et al 2003; Hayes, 2008). As part of the effort to eliminate the use of mercury in gold processing worldwide Ghana last year signed onto the Minamata Convention on Mercury, a global treaty to protect human health and the environment from the adverse effects of mercury, and is committed to mercury pollution abatement. PNG has yet to sign on.

A typical narrative from PNG:

“[I] know I shouldn’t burn the mercury on the stove at home, but the days are long and I am bending and panning all day – I get home tired. I get up early to get my housework done and my children to school, then I travel by truck to river – it is a long way. I spend long hours lifting, shovelling and throwing stones – it’s a long day and by the time I get home I am exhausted. If the day is too long I bring home the gold and do it (the amalgamation) at home so I can sell it to pay for food”.

Method

Information for this paper was collected during field visits to Ghana and PNG undertaken as part of a larger project focussed on providing in-country assistance on ASM health and safety (H&S) management. Direct field observation, photos, video footage and individual interviews have been used to form an overall picture of work related issues faced by both ASM workers and those who have the regulatory responsibility for managing H&S issues.

Field Observations

ASM operates in an extremely complex environment with significant barriers to both economic success and worker safety. For the purpose of this paper observations and interview comments focus on ASM related health and safety issues. By the nature of their operations, ASM miners operate in extremely hazardous conditions.
conditions making them vulnerable to mercury, dust, and chemical exposure, the effects of noise, vibration, musculoskeletal exertion, poor ventilation and lighting, working confined and hazardous spaces, and using inadequate equipment and tools. These conditions often result in significant health and safety issues, with many ASM workers unaware of the resultant long term effects of their exposure. Often ASM workers lack understanding of basic health and safety practices, and where they do have the knowledge most often they lack the financial resources to purchase basic personal protective equipment (PPE) or equipment that help reduce their exposure. Where equipment has been introduced often basic safety practices are absent resulting in additionally hazardous working conditions.

ASM workers face extremely hazardous working conditions when working underground or hard rock mining. There were many reports from the ASM workers of known deaths resulting from pit collapse due to poor design, subsidence or pit flooding. It was also not uncommon to hear of deaths occurring due to asphyxiation from fumes emitted by generators used underground in confined spaces. Often miners are unaware of the risks they are taking, instead focussed on gaining access to high grade gold deposits. Without adequate knowledge of good safety and health practice these workers face unacceptable work related risk leading to them taking actions that by western standards would be viewed as unsafe and unacceptable.

Traditionally ASM is labour intensive and this is reflected in field interviews and observations. With rudimentary tools such as picks, shovels, pans and sluices is not uncommon for workers to use broken or inappropriate tools as often the financial means for maintenance, repair or replacement is lacking. Much of the work is undertaken manually. It is therefore not surprising that joint and muscular pain are amongst the most common limiting physical conditions reported by ASM workers. Much ASM work is undertaken in water logged conditions where workers remove overburden and dig ore to be milled, or sieved and panned for gold particles. Protective clothing is generally not worn mainly due to cost. On some sites rubber boots may be provided however they are often not worn as the workers argue that wearing them slows them down. Additionally they argue wearing wet boots gives them foot sores and infections that do not heal. All ASM operators interviewed indicated access to simple machinery would make their work easier and allow them to mine more efficiently.

Women in ASM traditionally are involved in ore processing activities where they extract mineral remnants by hand from tailings, form human chains to carry large buckets of tailings on their heads, and pan and sluice mud and sand to recover particles of gold. It is not uncommon to see children by their side. Their tasks are the most labour intensive while yielding the lowest economic return. In Ghanaian the women are paid on the number of round trips they perform. They are paid poorly – generally less than a dollar for up to sixty round trips of up to 400 meters to dig, carry and deposit tailings for re-working. Conditions are hot and humid for most of the year, and work continues during the wet season for as long as the deposits can be mined before becoming unworkable due to severe flooding. Despite many of the women reporting foot pain and having abrasions and unhealed cuts on both their hands and feet no protective clothing is worn, the women preferring to not wear shoes even though the terrain is often rocky and uneven – they indicated shoes slowed them down. Whilst clearly a heavy manual task performed in difficult conditions for very little financial return the women interviewed indicated this was a way of earning vital money for their household survival. When asked if a simple manual and portable roller system where the buckets could be placed and pushed along would be helpful, the women answered “no” believing this would deprive them of income – they were concerned about machines taking away their job rather than making it easier and allowing them to perform more trips. Interestingly, when a female SSM lease holder from a non mechanised site was asked the same question she indicated it would be extremely helpful and could see it adapted to different tasks on the site. This same miner indicated one of the significant difficulties she faced as a female miner and lease holder was
her physical capability to perform the heavy tasks required for mining operations. Women in PNG indicated they would welcome simple equipment that made their tasks easier.

Typical field narratives included:

"My back hurts so much because I am physically not strong enough to do the work. The men are much stronger and I have to work so much harder to move the same amount of (overburden) to get to the gold. I am so much slower mining my land and I worry the men will come onto my lease and steal my gold before I can mine it. I have had to get a gun so that I can protect my lease."

(Female SSM and lease owner Ghana)

"My back hurts all the time now and my insides hurt by the end of the day – I am standing in water all day, I have been doing this since I was 7 years old - my body is just so tired, I don’t think I can do this anymore. If there was another way to do this maybe I could keep working”.

(Older woman from ASM alluvial mining area in PNG)

In PNG alluvial gold mining operations are similar to those of Ghana, however the terrain in PNG differs significantly – much of the country where alluvial gold mining takes place is slip country meaning is it extremely unstable and the areas are prone to landslides. The country is very rich in gold deposits and despite the associated dangers mining activity continues. It is this kind of mining Lole (2005) referred to when he reported the main cause of death in SSM as overhanging materials falling on miners while boring or tunnelling in alluvial ground. He argued the fundamental safety issue was lack of knowledge and skills on health and safety issues translating to inability to identify hazards and underestimation of the risk of being injured or killed. Despite the dangers SSM activity continues in these areas. Much SSM activity in PNG involves alluvial mining taking place along the riverbanks and streams. PNG is mountainous, and the wet season floods rivers and streams washing away mining operations, flooding the land and mining SSM operations. As the waters subside, miners recommence activity in wet slippery conditions, hoping flood waters may have brought some gold with them. Alluvial mining operations are either carried out at the waters edge with panning and sluicing, or beside the water body where overburden needs to be removed to expose any gold below. Small operations like these typically involve all family members with many children, particularly female children not completing schooling in favour or working in family mining operations.

Many of the women from both Ghana and PNG reported extreme tiredness with their mining work additional to their domestic responsibilities, and many confirmed tiredness lead them to undertake what they considered unsafe practices in order to complete their work to get back to their families. Narratives from the field support these observations.

ASM workers are exposed to high levels of dust when milling and grinding to break down larger rocks before sieving and amalgamation. As a protective measure a wet handkerchief is sometimes worn over the worker’s mouth and nose as protection, however on most sites observations indicated most often the handkerchief was worn around the neck providing no protection for the worker. In most instances ASM workers are largely ignorant of the respiratory complications and long term effects of dust exposure that may result from their practices. Without knowledge of the related health issues it is difficult for ASM workers to understand why there is a need to protect themselves and to encourage changing their practices.

As with many ASM practices the key driver is recovery of as much gold as possible, as quickly as possible, and then sold as quickly as possible. Amalgamation and smelting processes involving the use of mercury are quick and can be achieved without the purchase of expensive equipment. Mercury is readily available in both PNG and Ghana despite advocating of mercury free processing by both governments. Most often the
amalgamation slurry is mixed with bare hands, and there are many reports of ASM workers putting mercury in their mouth. Generally no protection is used against the harmful mercury vapours emitted when burning the mercury with many ASM workers ill informed of its toxic effects. Discarded mercury most often finds its way into the soil and water systems of these communities resulting in bioaccumulation in food sources and water and soil contamination. Retorts that contain the mercury in a chamber allowing the amalgamation process to occur without fumes escaping have been developed but inherent superstition around what happens to the gold when it is unseen in the retort means amalgamation generally occurs in open pans. In attempts to reduce mercury exposure central processing centres have been proposed and developed, again superstition is one of the main factors currently limiting their use.

Discussion
Information gathered in-field indicates ASM working conditions are similar in Ghana and PNG with practices observed typifying reported ASM practices throughout most mineral rich developing countries. The absence of recorded H&S data combined with a lack of knowledge and training for those working in the sector means interventions aimed at reducing injury and improving work practices are extremely challenging. Reviewing observed practices against existing guidelines provides a base from which to assess and document current work practices and subsequently develop locally appropriate interventions.

In the workplace ergonomics is applied to the design of equipment, tasks and work organisation to optimise worker safety and productivity levels. In the ASM sector it is often not possible to provide solutions that eliminate identified hazards but in order to be effective H & S interventions need to be “reasonably practicable” solutions to the complex and complicated workings of ASM activity. Low cost effective measures sensitive to cultural and economic drivers have the best chance of longevity within the sector. The development of cost effective and solutions that will be accepted by ASM operators is challenging, however imbedding interventions based on sound risk management and ergonomic principles into work practices and developing specific participatory training programs sensitive workplace and worker limitations have the best chance of success.

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