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A toxic free future: Is there a role for alternatives to mercury in small-scale gold mining?

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ABSTRACT

Although mercury is highly toxic, it is a vital substance for many who depend on artisanal and small-scale gold mining as a source of livelihood. This article examines alternatives to mercury in the artisanal and small-scale gold mining sector. It questions the potential future role of mercury-free alternatives in the sector.

"When [miners were] asked about alternatives to mercury . . . 71 per cent saw no alternative" – Jønsson et al. [15, p. 5]

1. Introduction

Mercury management is a pressing issue in artisanal and small-scale mining (ASM) – low-tech, labour-intensive mineral exploration and/or processing [1]. The sector is a source of livelihood for an estimated 15 million people worldwide, most of whom have taken up activities in an attempt to avert risk, escape poverty and generate supplementary incomes [2,3]. While ASM has the potential to facilitate poverty reduction, it often perpetuates hardship through its highly manual processes, the hazardous nature of its activities, and the lack of alternative economic activities. This perpetuation often occurs when miners turn to the black market to source mercury, which spirals them further into debt through bad loans, leading to negative impacts on human and environmental health [1,4].

The majority of small-scale gold miners depend on mercury to amalgamate gold. Once used, however, this mercury is often discarded into the natural environment, where it transforms into methylmercury, a toxic substance which bioaccumulates in organic tissue, with devastating ecological consequences [5]. Today, artisanal and small-scale gold mining is responsible for an estimated 37% of the globe's airborne mercury emissions, and is one of the leading sources of releases to water [6]. With the recent passing of the UN *Minamata Convention on Mercury*, complementing moves made by the European Union and United States to ban exports of mercury [7], it remains unclear how this will impact on artisanal and small-scale gold miners in the developing world, raising questions on the future directions of mercury management and whether there is a role for alternatives in the future of artisanal and small scale gold mining.

This article critically analyses whether there is a role for mercury-free alternatives in the artisanal and small-scale gold mining sector. Firstly it discusses mercury use and legislation in artisanal and small-scale gold mining. Secondly a review of alternatives to amalgamation is provided, finally a discussion focusing on three sub-Saharan African countries, concluding with a brief after which discussion on the future of mercury management throughout the developing world.

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2. Mercury use and legislation in artisanal and small-scale gold mining

Mercury is commonly used to amalgamate gold from the unwanted gangue. When released into the natural environment, inorganic mercury methylates, bio-accumulating in the environment and human tissues. Extensive mercury poisoning causes damage to the body's neurological system, the main symptoms of which are ataxia, numbness in the hands and feet, muscle weakness and damage to speech and hearing. These symptoms, however, can take time to manifest [9].

The time lag between ingestion or inhalation of mercury on the one hand, and visible symptoms on the other hand, has led many miners to question the link altogether. This ignorance has perpetuated the careless use of mercury in gold mining without adequate protection [5]. Miners can be exposed to mercury pollution in two ways: (1) through the amalgamation process often carried out with no hand protection; and (2) through inhalation, when the amalgam is burned, typically over an open flame, which leads to the vaporisation of mercury, leaving gold behind [10].

In spite of this, mercury remains the most popular method for extracting gold because of the simplicity of amalgamation and relatively low cost. Mercury amalgamation also allows the whole process to be carried out by one person, unlike more technically sophisticated processes [11]. Despite increased technical support, research and global awareness of the toxic effects of mercury, it continues to be used haphazardly. The most widely accepted explanation for this is that miners lack knowledge about the environmental and health-related implications of mercury use [12], and as noted, refusal to accept the link between cause and symptom. Hilson [5, p. 276] argues that there is a serious "shortage of funding for initiatives aimed at educating and training miners about mercury's toxicity", implying there are acute policy and attitudinal barriers to change. These barriers pose serious problems for the future of mercury management, especially in light of recent legislation.

On 19 January 2013, over 140 governments agreed to a legally binding treaty to reduce mercury pollution and emissions for the first time. The *Minamata Convention on Mercury*, named after the Japanese city which experienced serious health damage from mercury pollution in the mid-twentieth century, has been in negotiation for four years. A signing ceremony will be held in October 2013; it must be ratified by 50 nations to take effect, a process which is expected to take another 3–4 years. The convention introduces controls and reductions for mercury in products and industries, whether it is used or emitted, and will also regulate the export, import, and safe storage of waste mercury [13]. Governments of countries where artisanal and small-scale gold mining occurs will be required to develop national plans to reduce mercury emissions "within three years of the treaty entering into force" [14]. The UNEP recognises the severity of mercury pollution from artisanal and small-scale gold mining, by indicating in its 2013 *Global Mercury Assessment* report that the sector is the world's leading source of mercury emissions to air, and well as a leading source of emissions to land and water [6].

The *Minamata Convention on Mercury* is the first piece of international regulation focusing solely on controls and reductions for mercury, however, the impacts of mercury have been recognised through regional legislation in various countries for more than two decades [15]. For example, the Tanzanian *Mining Act, 2010* calls on gold miners to use retorts[1] stating that the "holder of a primary mining licence shall not heat a mixture of gold and mercury (amalgam) to recover the gold without using a retort" [16, p. 6]. Ghana's *Minerals and Mining Act 2006*, though not as precise, also recognises mercury, stating that "small-scale gold miners shall observe good mining practices in the use of mercury for carrying out mining operations" [17, p. 2].

In regions such as sub-Saharan Africa, however, it is difficult to enforce such legislation because the vast majority of miners operate illegally – that is, without a license [18,19]. A case in point is Mozambique where, despite widespread efforts to educate miners about mercury and its environmental impacts, only 5000–10,000 operators are registered [20]. A formalised artisanal and small-scale gold mining economy would certainly go a long way towards reaching miners through mercury awareness programmes, as well as facilitate better control of the metal, in turn, reducing its harmful impacts. Even though there is legislation in place, mercury is still used, and for the past two decades scholars and practitioners have called for the introduction of mercury abatement technology in the sector. The launch of the *Minamata Convention* makes the movement to alternative technology all the more vital for the future sustainability of the sector's participants.

3. Alternatives to mercury and acceptance of mercury-free technology

Viable and appropriate alternatives to mercury are vital, as the future of many livelihoods is at stake. This section of the paper will review these alternatives and subsequently analyse how ASM communities have responded to newly introduced technology to date.

There is a growing literature on alternatives to amalgamation and mercury-free gold extraction [2,21,22]. But despite the availability of a multitude of technologies, most miners are of the view that there are no viable alternatives [15]. This raises questions about the approaches being taken on the ground to promote alternatives and sensitise operators to new systems. It is particularly serious given the existing bans in the EU and United States on mercury exports and the proposed *Minamata Convention*, which aims to systematically eliminate the use of mercury in the sector by 2030. This could have serious and unpredictable impacts on the livelihoods of operators should significant progress not be made by this point to facilitate the acceptance of alternative technology.

[1] A retort is an enclosed system consisting of a crucible connected to a condenser, designed so that when heated, the mercury evaporates from the gold amalgam and is not released into the environment [10].