Resources Policy 38 (2013) 60–67

Contents lists available at SciVerse ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Toxic mercury versus appropriate technology: Artisanal gold miners' retort aversion

Jesper Bosse Jønsson [a,*], Elias Charles [b], Per Kalvig [c]

[a] University of Glasgow, School of Geographical and Earth Sciences, University Avenue, Glasgow, G12 8QQ, United Kingdom
[b] School of Public Health, Catholic University of Health and Allied Sciences, P. O. Box 1464, Mwanza, Tanzania
[c] Geological Survey of Denmark and Greenland, Øster Voldgade 10, 1350 Copenhagen K, Denmark

ARTICLE INFO

Article history:
Received 1 March 2012
Received in revised form
6 September 2012
Accepted 7 September 2012
Available online 27 September 2012

Keywords:
Artisanal and small-scale mining
Mercury
Retort
Appropriate technology
Gold
Tanzania

ABSTRACT

Mercury-usage in artisanal and small-scale gold mining (ASGM) has accelerated in developing countries during the last thirty years resulting in negative environmental and health impacts. As awareness of mercury contamination from ASGM has grown, a number of strategic initiatives have been introduced to reduce the impact of the toxic substance. The adoption of the retort, a device capable of recycling up to 95 per cent of mercury in gold extraction, constitutes a broadly recognized approach. Based on case-study research in Tanzania, this paper examines an ASGM area, which has been targeted by several mercury-reducing efforts. Based on survey data, key informants interviews, and visitor observations, the paper examines the impact of these efforts on mining techniques and residents' attitudes towards the use of mercury. Despite the seemingly obvious advantages from adopting retorts or other mercury-reducing techniques – economic, environmental, and health-wise – miners continue to use mercury haphazardly, while demonstrating an only limited awareness of the toxicity of the substance. The paper discusses the possible explanations behind this as well as possible ways forward in facilitating the reduction of mercury in ASGM operations.

Introduction

For the last 15 years, scholars and practitioners alike have called for the introduction of mercury-reducing technologies to be adopted by the artisanal and small scale gold mining (ASGM) sector in developing countries in order to reduce the harmful side effects of mercury-usage for gold extraction. Artisanal and small-scale mining (ASM) plays a significant role in the livelihoods of millions of people throughout the developing world.[1] ASM involves labour-intensive mineral extraction by individuals and groups with limited capital investments making use of rudimentary technologies. The sector is responsible for the extraction of a wide range of minerals and metals, precious as well as industrial. The continuous increase of the world market price for gold over the last decade has meant that ASGM in particular has attracted a significant number of people, especially throughout the developing world (Hentschel et al., 2002; Jønsson and Fold, 2011).

An estimated nine million people are engaged in ASM in Africa, with another 54 million depending on the sector as an indirect livelihood source. Tanzania is considered to have the second largest number of people engaged in ASM in Africa (Hayes, 2008) with the majority involved in gold mining. Due to miners' high degree of informality and mobility, their numbers are difficult to assess, but a recent World Bank-funded study estimates the number to be 685,000.[2] While ASGM is carried out in at least 15 of mainland Tanzania's 25 regions, most gold miners are found in the Lake Victoria Gold Fields, especially in Geita District, which has been estimated to have around 150,000 people engaged in ASGM (Tesha, 2003).

Mercury (2012) estimates the annual mercury consumption from ASGM in Tanzania to be as much as 45 t indicating the magnitude of the 'mercury problem'. During gold extraction with mercury, miners typically mix the mineral concentrates with mercury with their bare hands, after which they heat the gold–mercury amalgam resulting in the mercury evaporating. The vapours pose an immediate health threat to people close to the extraction site. The mercury vapour gradually condenses on the ground and enters the drainage system and subsequently the food chain, where it eventually causes damage to humans. Mercury is harmful to the central nervous system and may eventually cause irreparable brain damage (e.g., Appleton et al., 2004; Chibunda, 2008; Tomicic et al., 2011). Gold extraction using retorts is commonly referred to as effective, environmentally

* Corresponding author. Tel.: +255684723728.
E-mail address: jesper.jonsson@glasgow.ac.uk (J. Bosse Jønsson).

[1] In this paper, 'artisanal mining' and 'small-scale mining' are used interchangeably.

[2] Personal communication Dr. Crispin Kinabo, Tan Discovery, 16 June, 2012.

0301-4207/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.resourpol.2012.09.001

sound, and appropriate for artisanal and small-scale miners. Retorts are simple, inexpensive and robust devices, which if properly used and handled can recycle between 75 and 95 per cent of the mercury used during gold extraction (Maponga and Ngorima, 2003; Telmer and Stapper, 2012).

In Tanzania, an environment exists seemingly conducive for implementing successful mercury-reducing campaigns. While heating of mercury without using retorts has been illegal since the late 1990s, there are three major incentives for retort application; health protection, environmental conservation, and mercury cost reduction. Moreover, several programmes targeting mercury consumption within ASGM have been carried out since the mid-1990s, especially in the Geita District. Nowhere have the programmes been as intensive and numerous as in Lwamgasa Village (within Rwamagasa Ward), a long established gold mining settlement. This paper examines the current attitudes towards mercury ingestion and retort use in Lwamgasa after 15 years of campaigns attempting to raise awareness of mercury's toxicity and mercury-reducing mining techniques, probing why Lwamgasa's miners are nonetheless generally unaware or reluctant to use the retort in their gold extraction activities, leading us to question the appropriateness of the retort and ASM support schemes.

The paper starts out by addressing mercury-usage and reduction efforts in ASGM, before moving to outlining the background and concept of appropriate technology, and how this is the underlying principle behind a lot of technology tailored for the ASM sector. Subsequently, the case study area of Lwamgasa is presented; a long established gold mining settlement selected for its prominence in previous efforts to abate the use of mercury. The paper then outlines the record of retort promotion and resulting reduction of mercury in Lwamgasa and presents evidence that points towards the need for change, either in technology or in the way technology is introduced. Before concluding, the penultimate section discusses the shortcomings of retorts and ASM support schemes and alternative ways forward in mercury abatement strategies.

Mercury in gold mining: Contamination and abatement

The excessive use of mercury within ASGM has resulted in the sector becoming the number one global mercury polluter (Telmer and Viega, 2009). With growing awareness of mercury pollution since the early 1970s, research into the nature and magnitude of contamination has been on-going. It has focused on: (1) the environmental effects of mercury pollution by testing crops, soil, water, fish, livestock, and air; and (2) the incidence of human mercury poisoning through analyses of blood, urine, and hair samples (Hilson, 2006). This has resulted in numerous studies assessing mercury contamination in ASGM settlements in South America (e.g., Lacerda et al., 1991; Leino and Lodenius, 1995; Mol et al., 2001), Asia (e.g., Appleton et al., 2006; Lombong et al., 2003; Reto, 2002), and Africa (e.g., Chibunda, 2008; Ogola et al., 2002; Taylor et al., 2005; Van Straaten, 2000).

Mercury contamination in and around ASGM settlements is now widely acknowledged and reported, but there is no indication that the research has facilitated significant mercury abatement. Mercury consumption in ASGM on a global level continues to rise (Telmer and Viega, 2009). As human and environmental mercury content assessments mount, providing ample knowledge of the adverse effects of mercury-usage in ASGM (e.g., Baeuml et al., 2011; Bose-O'Reilly et al., 2010; Cordy et al., 2011; Tomicic et al., 2011), observers are increasingly recognizing the need to channel resources into exploring ways to reduce mercury consumption in ASGM and sensitize ASGM communities to mercury-abatement technologies (Hilson, 2006; Spiegel, 2009). This has led to a number of social-oriented publications on ASGM consumption of mercury (e.g., Hilson and Pardie, 2006; Tschakert and Singha, 2007) and a growing number of publications on appropriate technology to facilitate mercury-free extraction methods or, as a temporary solution, mercury recycling (e.g., Amankwah et al., 2010; Drace et al., 2012; Hinton et al., 2003; Jønsson et al., 2009; Maponga and Ngorima, 2003; Vieira, 2006).

Yet, a simple and effective extraction method capable of convincing ASGM operators across a broad spectrum to abandon the use of mercury for gold extraction has not materialized. Many observers thus talk about the missing 'silver bullet' even though various mercury-free gold extraction methods exist, e.g., cyanidation, acid extraction, chlorine processing, centrifuges, improved sluicing, coal–oil gold agglomeration, Gemini tables, smelting, and making use of magnets (Amankwah et al., 2010; Jønsson et al., 2009; Telmer and Stapper, 2012). Some of these, however, are inappropriate given that miners generally have limited education and financial means and often work at remote locations, often without access to electricity and proper infrastructure (Hinton et al., 2003; Veiga et al., 2006).

The iron retort developed by Professor Raphael Hypolito from the University of Sao Paolo is probably the most widely disseminated retort, consisting of four pieces of water pipe material (the crucible, the double nipple, the elbow, and a condensation tube around 30 centimetres long), which is easy to move and carry, does not break easily, and comes in a variety of sizes (see Fig. 1). When using the retort, the amalgam is placed in the end plug, which is heated, e.g., with charcoal, in a bonfire, or with a propane burner. This causes the mercury in the amalgam to vaporize and condense in the tube. The tube is covered by a wet cloth for more efficient cooling. After around 30 min tapping on the cooling tube causes droplets of mercury to slide down into a water bowl from where they can be retrieved. After cooling, the retort is opened and the gold is recovered from the end plug (see Fig. 2). However, very few miners use them in Sub-Saharan Africa (Hilson, 2006; Jønsson et al., 2009). Consequently, with gold prices reaching record levels, mercury consumption within ASGM is on the rise,

Fig. 1. The iron retort.