ENVIRONMENTAL AND SOCIAL CONSEQUENCES OF GOLD MINING IN MONGOLIA

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Abstract: With growing global population and fast advances in technology, our demand for raw materials gradually increases. Gold belongs to the most valuable resources, being also relatively rare. As gold deposits available to hard rock mining are limited, extraction of fine fractions of this metal becomes more important. In order to maximize extraction of dispersed gold, mercury is often used to amalgamate with the metal. This method is very popular with artisanal miners all over the world, including Mongolia. In this article we present environmental and social threats posed by artisanal gold mining in Mongolia.

Słowa kluczowe: Mongolia, małoskalowe kopalnictwo złota, problemy środowiskowe, problemy społeczne.
Key words: *Mongolia, artisanal gold mining, environmental problems, social problems.*

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1. Introduction

With growing global population and fast advances in technology, our demand for mineral raw materials gradually increases, especially in case of non-ferrous metals. Gold can be listed among the most wanted non--ferrous metals in the world. Yet, it belongs to the rarest metals, with average content in the upper lithosphere of 0.005 ppm. There are two types of gold ores:

– lodes – bound to high temperature hydrothermal veins in volcanic rocks, with quartz veins and metamorphic rocks, and

– placer deposits – bound to clastic rocks and developed via erosion of lodes. They are common in alluvial sands and gravels, also in sandstones and conglomerates.

In both types of ores gold can be present as variously-sized particles. Exploitation of ores characterized by huge gold nuggets is relatively easy and effective. For smaller, yet still visible particles, gravitational methods can be used, thanks to significantly higher density of gold in comparison to its surroundings (Denver Mineral Engineers Website).

However, sometimes gold is so dispersed, that it cannot be extracted with these methods. In such cases, the only effective methods of gold extraction are chemical ones, with the use of substances, in which gold dissolves. In such chemical methods mercury and cyanides are commonly used, as the easiest in application and also the most economical (Goetz 2007).

Both mercury and cyanides are critically dangerous to exposed humans or animals. However, environmental threats they pose are different. Cyanides are highly toxic and in sufficiently high doses cause rapid death. They are easily soluble in water, hence can be transported and distributed in the environment. When used in gold mining, cyanides remain in form of CN- ions. As such they are stable only under high pH (above 10). Therefore, under typical environmental conditions cyanide ions are unstable and degrade quickly into non-toxic substances. Moreover, cyanides do not accumulate in living organisms, posing on risk of biomagnification. Having these considered, cyanides can be viewed as dangerous only during application period. In case of mercury, environmental threats are much more pronounced, which will be described later on.

The aim of this article is to describe environmental and social problems caused by mercury-based artisanal gold mining in Mongolia.

2. Mercury-based artisanal mining and its environmental consequences

Mercury forms amalgams – alloys that can be regarded as solutions in liquid or solid state. Most of metals forms amalgams with mercury. Usually, upon heating, mercury completely evaporates from an amalgam, which makes it useful for extracting gold dust from geological matrices. This type of small-scale gold extraction from placer deposits became a main source of income for 10 to 15 Mlns of people, including approximately 3 Mlns of women and children, in at least 70 countries. Small-scale mercury-based gold extraction comprises 15% of worldwide gold production. Unfortunately, mercury-based mining brings about serious environmental and social threats.

Mercury is a toxic heavy metal naturally occurring in relatively low amounts in the Earth's crust (Göthberg and Greger 2006). It is produced during volcanic eruptions, rock weathering and processes of transpiration (plants) and decomposition (Okang' Odumo et al. 2014). However, its human activities that cause the largest emissions of mercury to the environment. Mercury is still used in batteries, fluorescent lamps, thermometers, dental amalgams and in pesticide production (Chung and Chon 2014). Yet, the most significant human-related source of mercury (approximately 11% of total antropogenous input) is artisanal gold mining (Boularbah et al. 2006). Considering the fact that antropogenous mercury emissions prevail over its natural sources, it can be estimated that artisanal gold mining comprises about 50% of total mercury emissions to the environment (natural and antropogenous).

Under current socio-economic and political conditions in developing countries, such as Surinam, Guiana, Indonesia, Phillippines and a part of the western Africa's coast, mercury-based gold mining is the easiest and the cheapest way of obtaining this metal. Popularity of small-scale mercury-based gold mining as a major source of income started in 1980 with discovery of gold ore in Serra Pelada in Brazil. This discovery attracted thousands of individual miners, estimated at 300,000–500,000. Over the period of 1980–2000 more than 1,500 tons of gold were extracted there with the use of mercury-based method. Due to environmental and cultural significance of Brazilian rainforest, many research were performed to study post-mining mercury levels and their impact on local inhabitants.

Elemental mercury and its organic derivatives are highly toxic, mostly due to their negative influence on central and peripheral nervous systems. Inhalation of mercury vapors can cause serious damages to digestive and immune systems, lungs and kidneys, leading to severe dysfunctions or even death. Children are the most susceptible to mercury poisonings. Moreover, an important problem is posed by mercury and its methylated derivatives accumulating in aquatic organisms, as they can cause food poisonings, especially in populations with high participation of seafood in their diets.

Even local antropogenous emissions of mercury can have global consequences, as this metal is subjected to long-range transport and biomagnification, which can cause serious threats to environment and human health worldwide (Reis et al. 2010; Wang et al. 2011). Over the last two decades, Mongolia has become one of the leaders in mercury-based artisanal gold mining.

3. Gold mining in Mongolia

Mongolia is generally rich in metallic raw materials. Gold ores (lodes and placer deposits) occur there in many valleys, mostly in the valleys of rivers Yeruu, Kharaa, Tuul and Orkhon. In the watersheds of rivers Erdenet and Orkhon copper ores are located. Ores of other metals, such as iron or tungsten, can be also found in these territories, yet they are less economically important. Mining areas, both small-scale illegal and huge

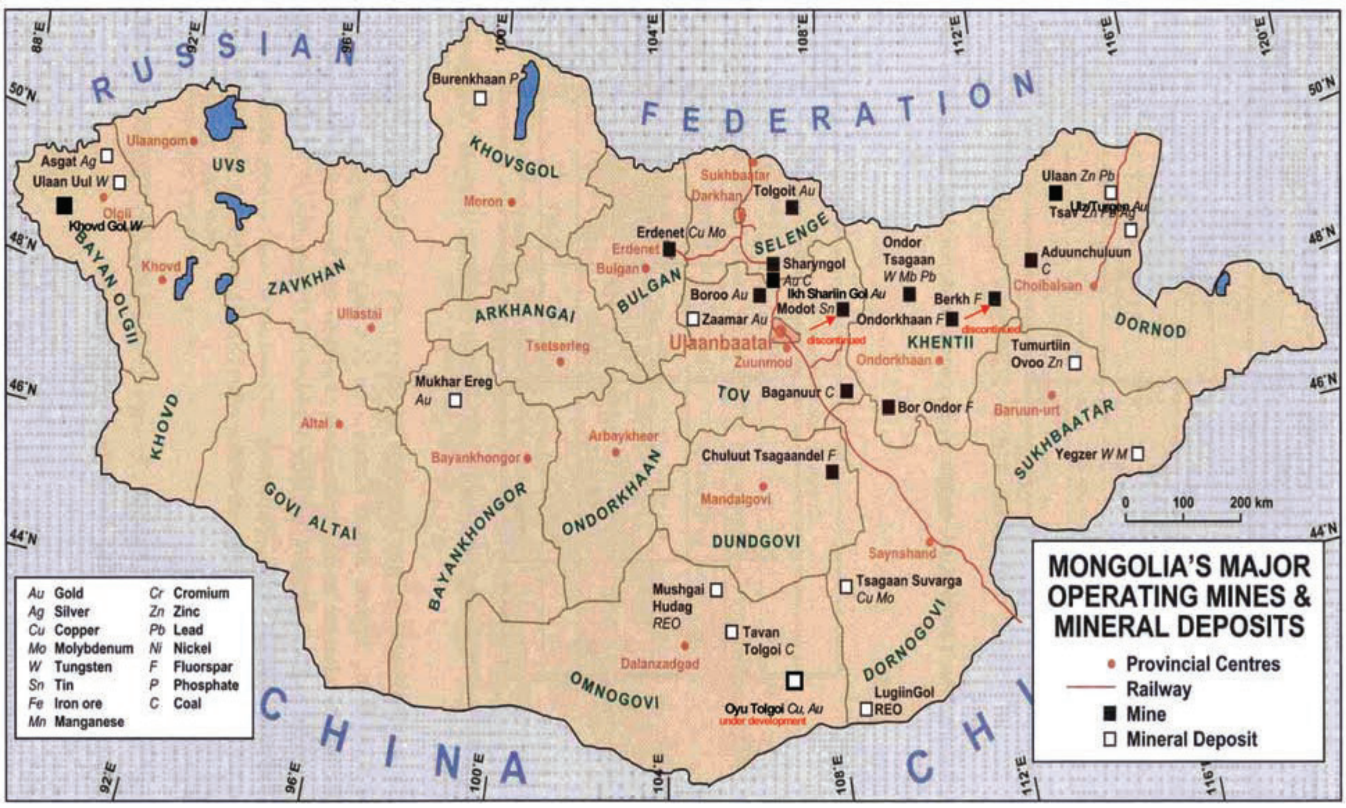

Fig. 1. Major Operating Mines and Mineral Deposits in Mongolia
Source: Mongolia: A Review of Environmental and Social Impacts in the Mining Sector, maj 2006
Ryc. 1. Główne kopalnie eksploatacyjne i złoża minerałów w Mongolii
Źródło: Mongolia: A Review of Environmental and Social Impacts in the Mining Sector, maj 2006

legal mines, is located in the watersheds richest in ores (Fig. 1).

Development of mining areas causes removal of riverine vegetation, changes in river morphology, including disturbance of riverbeds, and decrease in soil fertility. It can also affect water turbidity and nutrient loads (especially phosphorous) transported by river water. In the vicinity of the mines, increasing concentrations were observed for phosphates, ammonia ions and cyanide ions.

Apart from increasing turbidity caused by deepening of riverbeds and disturbance of sediments, pollution caused by ore unloading, acidification of mine waters, changes in the hydrology (due to drainage) and deterioration of air quality (due to enhanced transport) were observed near the mining areas.

Furthermore, expanding mining activities in river valleys lead to decline in water quality. As soon as toxicity thresholds for certain substances are exceeded, biodiversity losses grow rapidly and river capacity to self-regulation is severely disturbed. Over the last years, in the abovementioned valleys and along tributaries of main rivers, more mining shafts have appeared. Numerous shafts are located in the valley of river Kharaa, where a significant decrease in water quality was observed.

Limited water resources in Mongolia are under constant pressure of expanding mining activities, industrial development, urbanization and intensive agricultural practices. As a result huge part of Mongolian waters becomes acidic or polluted with heavy metals (Thorslund et al. 2012).

Over the past hundreds years, Mongolia remained out of public interest, as it stayed out of trouble and avoided major global problems, focusing on its pastoral economy. Over most of the 20th century, Mongolia remained a satellite of the Soviet Union, providing it with resources and propagating Soviet ideology. After the collapse of the Soviet Union, Mongolia regain opportunities for democratization and took a global market of raw materials by storm. However, economic transformation lead to inflow of poorer inhabitants of rural areas into cities and to dynamic development of informal sector of economy.

With abundant resources of raw materials and one of the fastest growing economies in the world, Mongolia provided numerous opportunities for various mining activities. Nowadays, Mongolian authorities should work on mitigation of environmental losses caused by exceeding mining activities. Especially, as mining became crucial for Mongolian economy and development of this country (Rendoo et al. 2016). There are significant deposits of coal, copper, tin and uranium in Mongolia, yet it is gold, that is the most important. Currently, gold mining generates 70% of hard currency inflow to Mongolia (Government of Mongolia (GM) 2011).

Rapid expansion of gold mining can be traced to 1990, hence for over three decades gold causes Mongolian Gross Domestic Income to grow dynamically and continuously, according to International Monetary Fund. For the next few years 10% annual increase of GDI is predicted, from current 5 billion dollars to 30 billion dollars in 2015 (Byambaa and Todo 2011).

Due to significant increase in artisanal, informal gold mining in Mongolia, number of informal gold producers called “ninja” exceeded 100,000. It might sound encouraging, yet these practices have disastrous consequences for environment and society. As “ninjas” use mercury-based methods, usually without any safety precautions, mercury enters the environment in an uncontrolled way, leading to serious health problems of miners and inhabitants living in vicinity of mining areas. Mercury causes described above symptoms of acute toxicity, yet it can also cause chronic poisonings (Agency for Toxic Substances and Disease Registry 1999). According to researchers, poisonings of Mongolian gold miners are mostly due to vapors of elemental mercury, which are extremely dangerous to nervous system, especially for children.

Apart from environmental consequences of gold mining, certain legal and social issues should be identified (Navch et al. 2006). Most of the small mines in Mongolia are illegal, hence all miners work there illegally and among them many children are present. Miners usually live under very harsh conditions - in tents, with no electricity or running water. With no safety precautions, no personal protective equipment and low awareness of mining-bound dangers, working conditions are hard and number of accidents very high. Additional problems are lack of proper hygiene and malnutrition.

Average age of children working in gold mining, mainly boys, is 15. Children mostly dig tunnels and crush stones. However, over 60% of under-aged miners took part in amalgamation process and 30% work with explosives. Hence, children are also victims of work accidents, such as falling into shafts or being buried in a tunnel. Participation of children in gold extraction should be treated as one of the worst form of child labor.

Considering all of the above, a question should be raised, what can be done with these environmental and social problems. This issue is tackled by both Mongolian governmental agencies and non-governmental organizations. The main conclusions are as follows:

– Dynamically developing illegal sector of gold mining is a huge challenge to rural areas, as currently local governments have not enough means to provide their citizens with basic achievements of civilization. Probably, legalization of artisanal gold mining should be a good move. Adequate legal changes are necessary.

– Conflicts between illegal miners and legal mining companies should be extinguished, especially as the mining industry is interested in stabilization and introduction of adequate legal regulations.

– Changes in financial regulations are necessary. Currently, illegal producers sell their gold to Chinese or Korean clients, which negatively influences Mongolian economy. As inhabitants of rural areas have no means for travelling into Mongolian cities, mobile banking services should be establish, which, after legalization of artisanal mining, could buy gold on the spot.

– Urgent solutions are needed for miners health care and for organizational and legal aspects of mercury market.

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ŚRODOWISKOWE I SPOŁECZNE KONSEKWENCJE KOPALNICTWA ZŁOTA W MONGOLII

Streszczenie

Powiększająca się liczba ludności planety oraz rozwój cywilizacyjny i technologiczny powodują wzrost zapotrzebowania na surowce. Jedną z najbardziej pożądanych kopalin jest złoto, będące jednym z najrzadszych pierwiastków. Wobec kurczących się zasobów złota w postaci dużych okruchów, coraz większego znaczenia nabiera pozyskanie złota występującego w bardzo dużym rozdrobnieniu. Najbardziej rozpowszechnioną metodą takiego wydobycia jest amalgamowanie złota rtęcią. Proceder ten rozwija się dynamicznie w wielu regionach świata. Jednym z krajów, w których rzemieślnicze wydobycia złota jest bardzo intensywne, jest Mongolia. W niniejszej pracy przedstawiono środowiskowe i społeczne zagrożenia płynące z takiej formy pozyskiwania złota.