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**Review**

# Environmental stewardship for gold mining in tropical regions

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**Abstract :** Mining has gained strong popularity in recent years due to the increase in global demand for metals and other industrial raw material derived from the ground. However, information and good governance regarding activities related to mining is still very much lacking especially in underdeveloped and developing countries in the tropics. In Malaysia, the importance of environmental stewardship in mining is a new phenomenon. The new National Mineral Policy 2 calls for compliance with existing standards and guidelines, stresses on progressive and post mining rehabilitation as well as promotes the gathering and dissemination of information, best mining practices, public disclosure and corporate social responsibility. Our preliminary studies however have shown that its implementation may have been hampered by inadequate legal and administrative structures, lack of freedom of information, physical inaccessibility, lack of information and public participation. In this presentation, the above issues and measures to reduce the impact of mining, particularly that of gold on the environment with a special focus on Malaysia is discussed. These measures include alternative gold extraction methods, appropriate tailing dam construction and management, health risk assessment and risk management, compliance with the Cyanide Code and liberalization of access to information, facilitation of access to justice, the strengthening of legal and administrative structures as well as corporate accountability to the public as part of corporate social responsibility.

***Keywords****: access to information, cyanide code, environmental stewardship, gold mining, tropical region*

## Introduction

The increasing global demand for metals and other industrial raw material has increased mining activities throughout the world in recent years. In the tropics, most of these metals and gemstones are frequently found in sensitive areas such as the rainforests. Mining these natural resources often leads to major destruction of the rainforest ecosystem and disrupt the livelihoods and health of the people living nearby and downstream of the mining operations. This paper discusses the problems associated with gold mining in the tropics with a special focus on gold mining in Malaysia and proposes some steps in reducing the impact of gold mining on the environment and human livelihoods.

## Problems associated with gold mining in tropical regions

In the tropics, many gold mining operations are based on surface mining. The mining methods employed put heavy reliance on hydraulic techniques which clear river banks, floodplain forests and caused a huge amount of silting downstream. The enrichment process associated with gold mining also creates a lot of dust, which permeates the immediate environs, having an immediate impact on health and environment (Ripley *et al*., 1996.)

Use of mercury and cyanide to extract gold from sediment are common practice. Both cyanide and mercury are toxic to the environment and human health. Organic mercury compounds are more toxic than elemental mercury. Methylmercury for example, is highly bioaccumulative and increases along the food chain. Even though only traces of $Hg^{o}$(I) persists in soils and sediments (Biester *et al.*, 2002, Kabata-Pendias and Mukherjee, 2007), it can be methylated by abiotic and microbial processes in soil systems and is the primary source of methylmercury compounds in soil (ATSDR, 1999; Environment Canada, 2002).

Butler (2008) reported that small-scale miners, such as those practiced in the Amazon, are less efficient with their use of mercury than industrial

miners, releasing an estimated 2.91 pounds (1.32 kg) of mercury into waterways for every 2.2 pounds (1 kg) of gold produced. In examining the risk s of mercury discarded into the Madeira river in the Amazon by gold miners, experts came to the conclusion that mercury would make its way into the food chain, and that it is important to study the levels of mercury in fish and other living organisms that may make up the diet of the people living downstream (International Rivers, 2006).

Cyanide, a highly toxic compound, is also often used to separate gold from sediment and rock. While cyanide is generally claimed to be carefully monitored to prevent its escape into the surround environment, spills do occur, especially when they are not closely monitored. The effects of poisoning can be widespread, especially when a waste-holding pool overflows or breaks, as it did in Guyana in August 1995 (Butler, 2008). The carbon-in-leach method which involves the use of noxious cyanide poses the risk of escape into nearby water courses or land which is toxic for both human and animals and can cause a lot of damage to the ecosystem. This enrichment process also creates a lot of dust particles, which negatively impacts the immediate environments, causing health and environmental problems (Ripley *et al*., 1996.) The other major problems in the employment of cyanide for gold mining activities come from the transportation, handling, usage and disposal of this chemical.

Apart from mercury and cyanide, gold extraction from sulphide ores involves the risk of acid drainage from tailings which can in turn lead to the release of many heavy metals, such as cadmium, arsenic, lead and others. Once seepage has started it is very difficult to arrest the chemical reactions that fuel this process, and the environmental consequences are extensive.

Most tropical forests are replete with biodiversity being home to a multitude of faunal and floral species, some of which are rare species and to indigenous people. Their populations are on a rapid decline due to the destruction of forest habitats arising from the sedimentation problem and chemical pollution from these mining activities. The destruction in fact begins during the exploration stage itself, that is, before mining rights are granted. Furthermore, it is a common practice that concessions are granted to mining companies without regard to the benefits derived from biodiversity conservation (Butler, 2008).

Much is still unknown about mercury interaction with the environment under tropical conditions. Yin *et al.* (2012) recognized the existence of major knowledge gaps which include molecular interactions of Hg and monoethyl Hg and HgS(s) and FeS(s) and the role of natural organic matter in these interactions.

Information generation on the impact of mercury or cyanide on the environment may be hampered by the difficulty in conducting research ascertaining the complex ways that these chemicals interact with the environment, inaccessibility of the areas to be studied, lack of funding for such research and the unreliability of some existing reports. For example Jahanbakh *et al*. (2002) found that water is not a good indicator for aquatic pollution as methylmercury reacts differently in the presence of sediment. They concluded that for chronic pollution of fish and aquatic plants, sediments are more appropriate indicators. In most cases, mercury poisoning are chronic in nature, and the inappropriate use of indicator for mercury poisoning can cause the symptoms to be missed. A case in point is the report by International Rivers (2006) where a panel of experts reported that the EIA data on River Madeira sediment accumulation in the reservoirs were "inconsistent" and "unreliable". Furthermore, Morna and Clarke (2002) reported that available modeling of cyanide releases into rivers and groundwater after a rainstorm, as a means to predict the degree of damage (contamination) may be potentially erroneous due to inadequate or poor rainfall data, especially for the wet tropical conditions which are subjected to large rainstorms.

Most studies have been conducted on the miners. On the other hand, there are only few studies showing the impact of mercury from gold mining on the people who live around the gold mining areas in tropical regions. However, a study of the children living near a gold mine in the Amazon has shown that more than 80% of the 246 children studied had hair-mercury concentrations above the permitted mercury level of 10 µg/g. This level of mercury pollution is thought to be sufficiently severe to cause adverse effects on brain development (Grandjean *et al.,* 1999). Our preliminary study on the impact of gold mining activities on human health in Malaysia points to a possible link between gold mining activities and chronic levels of cyanide compounds in neighbouring communities.

Human health risk assessment of the impact of the chemicals used in gold mining in Malaysia is compounded by certain socio-political factors. One of the more important factor is the general lack of culture of information sharing and accessibility to justice. As a consequence the experience has been that some members of the community reacted with suspicion in considering the intention of such studies and initially resisted to being party to the studies.

Information and good governance regarding activities related to mining and their impact on the environment are still very much lacking especially in

underdeveloped and developing countries in the tropics. The experience of the residents near a gold mine in Malaysia illustrates this state of affair (Table 1). Access to data in Malaysia is hampered by the operation of the Official Secrets Act, The Internal Security Act and the Printing and Publications Act. These laws serve to entrench the culture of non-disclosure of information by any official government agency out of a sense of extreme caution. They also serve to hobble the dissemination of research data and publications by academia affiliated to public universities.

Table 1: Case study of public action in gold mining

| **Case study on the efficacy of public participation and protection under the Environmental Laws and the Legal System, Malaysia** |
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| When the residents near a gold mine in Malaysia, applied to the court to review the Director General's (of the Environment)(DG) decision not to have a detailed EIA, they met with difficulties. In the events leading up to the decision to take legal action, the residents were not sufficiently informed of the public meeting organized by the mining company to inform them of their resumed , largely reconstituted operations. Questions posed by the residents were not given detailed replies. Only assurances were given that the operation of the mine would be safe, without details given of any management or crisis management plans. The residents found it difficult to access information on the PEIA and other related reports. Whenever they met as a group, there would be police presence constraining them. They had difficulty in securing permits to hold a dinner unconnected with the mining protest, but connected to the residents generally. On application for judicial review, High Court held that the letter by the DG was not a decision but a mere letter to inform them that a review was not necessary. As it was "not a decision", the court could not review it. Residents are hampered by the expense of taking such a finding on appeal. |

Where the law is adequate, it is often found ineffective as there is weak enforcement of those laws, or obfuscation by unclear administrative procedures. This has been found to be due to political and economic pressures, or to the lack of capacity of the government agencies. When the administrative procedures are clear, the next hurdle would be obstacles to access to information by affected individuals or communities. Finally a weak judicial system and high costs of bringing an action distances the forum of appeal and due review from these affected persons. Ultimately transparency and good governance is compromised. Unless political will addresses the lack of focus on the protection of environment and on the safeguard of the health of communities, the scale of impact of these mining activities will not be small.

Some of the laws concerning gold mining industry in Malaysia are the Mineral Development Act, 1994; State Mining/Mineral Enactments; State Mineral Ores Enactments; and State Raw Gold Dealings/Buyers Enactments and Environmental Quality Act 1974, and the amendments and regulations thereto. In practice, a pre-requisite to the granting of a license to operate a small-scale mine, a preliminary environmental impact assessment (PEIA) is required. This PEIA should be based on the mining process to be used. In Malaysia, if the mine is a small-scale (ie less than 250 acres), a detailed EIA is not required. However, this limit on land area for such activities that can cause severe damage is questionable.

## Reducing the impact of gold mining on the environment

Metal mining is now prevalent in many countries given the current high global demand for the commodity. At the same time, the global community is very much in cognizance of the need to conduct all industrial activities in a sustainable manner. Mining activities in Malaysia have been going on for centuries. However, until more recently, they have been subjected to only few regulations. In recent years, we have seen laws and regulations that control these activities are in place. However, these laws and regulations tend to attach inadequate importance to environmental safeguards.

Evidence-based research is important, and the data to be published upon which gaps in laws and regulations can be examined for effective plans of action to be addressed. Efforts should be taken to bring the society beyond reactionary measures and moving towards embedding an ethos of conservation, preservation and building a sustainable environment, in all our systemic processes, for present and future communities.

Given the severity of the consequences of the mining mismanagement, laws governing environmental protection from disasters caused by

mining should be stringent enough to give appropriate protection to the public. For instance, the Malaysian authorities should make it mandatory for all mining operators to conduct environmental impact assessment. The exemption of EIA assessment for land mining for areas less than 250 acres is seen to be incredulous, given that the scale and type of operation may be more important factors to consider for mining activities. The recently launched National Mineral Policy 2 (Malaysia) to address the need to emphasize on the sustainable mining and environmental stewardship of mining activities (Table 2) is much lauded. Nine major thrusts were outlined to achieve its aims.

Table 2. National Mineral Policy 2 (Malaysia). After Ministry of Natural Resources and Environment Malaysia (2009)

| **National Mineral Policy 2 (Malaysia)**<br>**Policy Statement** | |
|---|---|
| To enhance the contribution of the mineral sector to the socio-economic development of the nation through the efficient, responsible and sustainable development as well as the optimum utilisation of mineral resources | |
| **Thrust 3**<br>**Environmental Stewardship** | |
| To ensure that the mineral resources development activities are under taken in a sustainable manner, environmental stewardship needs to be incorporated throughout the development process. This can be achieved through | i. the implementation of the regulatory and self-regulatory, environmental management measures including Environmental Impact Assessment, as well as environmental management system and plan, and audit;<br>ii. the compliance with the appropriate national and state policies, physical plans as well as international agreements;<br>iii. the compliance with the appropriate national and international standards, code and guidelines;<br>iv. ensuring effective implementation of progressive and post mining rehabilitation;<br>v. promoting the recovery, recycling and reuse of minerals, metals and mineral-based products;<br>vi. ensuring the implementation of effective mine waste management measures;<br>vii. promoting and disseminating information on the use of best mining practices, public disclosure and corporate social responsibility (CSR); and<br>viii. the effective implementation of a Mine Safety and Health Management Plan. |

To realize these aims, a national strategic plan, that is, the 2011-2015 Strategic Plan for the Department of Geoscience and Minerals was formulated (Jabatan Mineral and Geosains, 2009). While the national policy and the ensuing strategic plan are encouraging development towards sustainable management of gold mining in Malaysia, several areas such as the need for health risk assessment, public participation viz a viz the lack of freedom of information, and access to justice under the present Malaysian laws still need to be addressed.

As to the latter, the state of Selangor has come forward to enact the Freedom of Information Bill (2011). Such step is greatly needed in other states too where gold mining is practiced to give a broader access of information to the public. In the strategic plan document, an in depth health risk assessment was not adequately addressed.

There is also a need to motivate the gold mining operators to replace the use of cyanide with less toxic substitutes such as thiosulphates to replace cyanide for leaching gold (Yen *et al.,* 2001). Research should be conducted to study the suitability of these

lixiviants for gold extraction under tropical conditions.

The International Cyanide Management Institute was formed under the sponsorship of the United Nations Environment Programme and the International Council on Metals and the Environment (ICME) in year 2000, to review a spate of accidents involving cyanide occurring prior to its formation, and ways to improve the management of cyanide in gold mining operations. The International Cyanide Management Code (Cyanide Code) was drafted with the aim to ensure that operations involving cyanide are certified in compliance to it so as to reduce the potential for future cyanide-related incidents at gold mining sitesGiven the availability of such comprehensive guidelines, national policies and strategies for sustainable mining should take the Code seriously and compel ongoing and future mine operators to be certified under the Code.

In order to reduce the risk arising from poor tailing dam management, mining operators should submit closure plans before the start of mining activity, and deposit the larger portion of the estimated rehabilitation costs; and practice the employment of appropriate designs in tailing dam construction (see Stahl, 2008).

## Conclussions

Mining in tropical regions presents some specific challenges in terms of management. Communities living near or downstream of mining areas continue to be exposed to toxic levels of pollution arising from gold mining activities because little documented research has quantified the level of threat and little attention has been paid to reducing the risk. New appreciation to reform modern mining provides a timely opportunity to protect the health of people who may be affected by gold mining activities. This will also protect the food chain on which we all depend.

Laws and regulations should be more stringent on mining operators in order to safeguard the health of the public and environment. Best management practice should include the employment of alternative less toxic lixiviants other than mercury and cyanide or compliance with the Cyanide Code if cyanide were to be employed. Other recommendations include ensuring the employment of appropriate design in tailing dam construction; assessment of health risk associated with proposed new mines and monitoring of the full range of pollutants that threaten health; for all information to be accessible and comprehensible; for local communities to be engaged in decisions especially when the mining activities directly impact their communities; sufficient reclamation bonds should be secured from mining operators to cover the comprehensive costs of protecting human health during and post mining and the opportunity cost lost to the loss of soil, vegetation and biodiversity; and to have sufficient preparedness on how best to manage cyanide spills.

Plans should also acknowledge possible problems such as lack of political will, inappropriate legislations and/or inadequate funding for research and enforcement.

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