



Sustainable Mining in Thailand: Paradigm Shift in Environmental Management

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Abstract

Thailand's mining industry has always been considered as an industrial activity generating significant environmental burdens. This is because environmental management in the sector was given lower priority compared with economic benefits. The resulting adverse environmental effects in areas surrounding some mining areas required government interventions. Accordingly, the sustainable development of mineral resources requires a delicate balance of economic, environmental and societal considerations. To respond to this challenge, Thailand needs a paradigm shift in environmental management towards sustainable mining, in order to maximize benefits from exploitation of the mineral resources, whilst ensuring co-existence and mutual benefits of mining activities and their surrounding communities.

This article seeks to provide some information about a fundamental change in the principles, approach and strategies of environmental management towards sustainable mining in Thailand. The main mechanism includes changing in visions and strategies towards sustainable mining, applying various sustainability assessment tools in licensing and decision-making processes, decentralizing the environmental monitoring system to local authorities and communities, as well as enhancing the use of the sustainable development principle to all mining operators through various projects. An establishment of a rehabilitation fund, a health surveillance fund and a community infrastructure improvement fund are also required for development of any new mining project to guarantee rehabilitation works and risk management efforts during and after the mine's life.

Keywords: Mining industry; Sustainable development; Paradigm shift; Environmental management; Sustainable mining; Thailand

Introduction

A significant challenge facing the mining and minerals industry today is to demonstrate its contribution to the welfare and well-being of the current generation without compromising the potential of future generations for a better quality of life. The 'triple bottom line' concept, which includes environmental performance, economic contribution and societal responsibility, is adopted to approach this target. To respond to

the environmental sustainability challenge, the mining and minerals production must minimize environmental impacts through its life cycle, from extraction through processing and products distribution, as well as mine closure and rehabilitation. This is best accomplished through effective environmental management. In terms of economic sustainability, the mining industry must supply essential raw materials to other sectors supporting economic prosperity, while considering resource

scarcity, especially for non-renewable energy and resources. The industrial operations also require addressing the needs of all stakeholders throughout the various stages of operation. There is now a growing expectation for corporate social responsibility (CSR), which requires individual companies to support community groups that are potentially affected by their activities.

Mining background and problems from past mining operations in Thailand

Thailand has a long history in mining. In its early stages, tin played a vital role in driving national economic growth. Its history can be traced back to the 13th century, when it was alloyed with copper in casting bronze images of the Buddha [1]. In the 1980s, tin mining was dominant and became one of the country's major sources of revenue. In addition to tin ore, there was some exploitation of other minerals including tungsten, antimony, fluorite, gemstones, lead, zinc and lignite.

Under the Minerals Act (1967), last amended in 2002 by the Minerals Act no. 5, and pursuant Ministerial Regulations, environmental protection measures as well as mine reclamation and rehabilitation shall be carried out by the mining operation under the supervision of the responsible governmental agency. However, in the past,

the mining industry in Thailand is considered as an industrial activity that generates significant environmental problems. This is because, by nature, mining activities involve the removal of an underlying non-renewable resource and require both short-term and long-term use of the land. Accordingly, land use conflicts were inevitable as population density increased. Besides, environmental management in the mining sector was given low priority compared to profits, resulting in adverse environmental effects in some areas that necessitated government intervention.

Since environmental awareness was formerly not taken into account, mines' operations in the past typically lacked any kind of pollution control measures or post-closure rehabilitation plan, resulting in heavy metal contamination in some areas. Some abandoned mines were left behind and effectively wiped out by toxic loads to the environment. Examples of these include arsenic contamination in Ron Phibun, Nakhon Si Thammarat Province; lead contamination at Klity Creek, Kanchanaburi Province and cadmium contamination at Mae Sot, Tak Province.

In the above examples, the contaminations have been addressed through various remediation measures and techniques as summarized in Table 1.

Table 1 Summary of problems from the past mining operations and remediation measures

Problems and Impacts	Remediation Measures
Case 1: Arsenic contamination at Ron Phibun District, Nakhon Si Thammarat Province	
<ul style="list-style-type: none"> The contaminated area was a part of the Southeast Asian Tin Belt where tin mining was operated over a 100 year ago. In 1987, the arsenic-related health problems were discovered among the people of Ron Phibun district [2]. Mine tailings, ore processing, slag piles, as well as the naturally high abundance of disseminated arsenopyrite in alluvial deposits of the mid and lower catchment were identified as major sources of the arsenic contamination. 	<ul style="list-style-type: none"> Since the discovery of the arsenic intoxication problem, a number of researchers have been interested in and many efforts have been made to solve the problem by various organizations. During 1998-2000, a study was conducted by the Japan International Cooperation Agency (JICA) and a long-term treatment plan was recommended to the Thai government to remove 132,650 m³ of contaminated soil from the affected area [2]. However, the proposed measure was not implemented by the Thai government due to the cost, estimated at over 660 million Baht. Accordingly, a number of lower-cost alternative approaches have been explored and applied to solve the problem.

Problems and Impacts	Remediation Measures
	<ul style="list-style-type: none"> Although around 3,000 m³ of the high-grade arsenopyrite waste was collected and placed in a secured landfill, the waste disposal measure had a limited impact because quantities of arsenic had already leached from the stored waste into the underlying soil while the secured landfill areas were being prepared [2]. Since 1994, all mining activities in the area have ceased and other mitigation programs have been applied additionally including the provision of an alternative safe water supply.
Case 2: Lead contamination at Klity Creek, Kanchanaburi Province	
<ul style="list-style-type: none"> The area is associated with extensive Galena (PbS) and Cerussite (PbCO₃) deposits where lead mining and processing were operated since the early 1980s. Contamination of Klity Creek was caused by discharge of wastewater, containing approximately 3-4% lead content from the froth flotation plant through both surface runoff and retaining pond [3]. In 1997, lead contamination became critical when the old retaining pond breached into the Klity Creek due to heavy rain and flooding [4]. Wastewater from the pond contaminated 17,540 m³ of river bank sediment with around 833 tons lead content and affected nearly 19 km along the Klity Creek [3]. In 1999, the Department of Health found dangerously high blood lead levels among villagers who consumed the creek water with many children suffering physical and cerebral abnormality. 	<ul style="list-style-type: none"> Since the discovery of lead contamination, the froth floatation Plant was closed. Water, aquatic plants and animals in the creek have been prohibited for drinking or consuming. In the affected area, some of the lead tailings and the bottom sediments which are identified as major sources of the contamination were transferred to a secure landfill. Environmental monitoring programs were set up by various governmental agencies.
Case 3: Cadmium contamination at Mae Sot District, Tak Province	
<ul style="list-style-type: none"> The affected area was classified as the richest source of zinc mineral in Thailand, located in Mae Sot district, Tak province. Since 1977, three mining companies were started zinc operation in the area. In 2003, research activities have identified significantly elevated levels of cadmium in sediment, soils, rice grains and rotation crops. As cadmium normally occurs in combination with zinc deposits, therefore the zinc producers were suspected as polluter and they were asked for accountability. 	<ul style="list-style-type: none"> Since the discovery of the cadmium intoxication problem, many organizations has been monitored with the objective to identify the contaminated area for implementing remediation plan and find the best available practice to clean up the contaminated area. As a result, intensity of contamination area has been identified and land use management scheme has been proposed to limit the spreading of heavy metal within the designated area.

Problems and Impacts	Remediation Measures
<ul style="list-style-type: none"> • However, the unclear source of contamination, between natural origins and man-made activities, rendering it difficult to claim accountability from the zinc mine [5]. 	

The current situation of Thailand's mining industry

Since 1980, the economy of Thailand has expanded considerably. The Gross Domestic Product (GDP) at current prices shows that during 30 years, the size of the Thai economy has expanded nearly sixteen-fold when measured in Thai Baht. This makes Thailand the 29th biggest economy in the world in 2011, which account for 11,091,270 million Baht (US\$ 369,709 million).

Thailand has a well-diversified economy, driven by services, industry and agriculture. Services and the industrial sector have replaced agriculture as the two main economic drivers of GDP, accounting for 52.40% and 39.00% of GDP in 2011, respectively. In 2011, agriculture accounted for only 8.60% of GDP.

The country has rich deposits of mineral resources such as limestone, granite, marble, feldspar, gypsum, potash and rock salt, tin, copper, lead, zinc, gold, silver, coal, oil shale and gemstones. Although the mining industry's contribution to the nation's GDP is relatively low, varying from 2.28% in 2002 to 2.90% in 2010, it still plays an important role to the country as a main sector that provides essential raw materials to others supporting economic prosperity, including manufacturing and agriculture.

At present, the Thai mining industry comprises 663 mines and quarries, 547 mineral processing plants and 35 metallurgical plants. In 2011, around 40 minerals were produced throughout the country, valued approximately 60 billion Baht. Over 80% of minerals production serves domestic demand, with the remainder exported to other countries. Exports include gypsum, anhydrite, ball clay, dolomite, feldspar, limestone, tin and zinc, which have an overall export value of approximately 30 billion Baht. On the other hand, various minerals are imported to serve domestic demand (coal, aluminium ore, barite, bentonite, feldspar, granite, marble, sulphur, talc, titanium ore, zinc ore and zirconium ore). In 2011, imports were valued at around 60 billion Baht.

Paradigm shift in environmental management towards sustainable mining

With regard to experience gained from past mining operations, in conjunction with the importance of public participation and stakeholder involvement, the Thai government recognized the need for a paradigm shift in environmental management in the mining sector. The new paradigm consists of five elements, including changing in visions and strategies towards sustainable mining, applying various sustainable assessment tools in mining licensing and decision-making processes, decentralizing the environmental monitoring processes to local authorities and communities, enhancing the use of sustainability principle to all mining operators, as well as establishing various funds, including rehabilitation fund, health surveillance fund and community infrastructure improvement fund for the development of a new mining project.

1. Changing vision and strategies towards sustainable mining

Following the emergence of the sustainable development concept, defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' [6], numerous international and national groups called on governments, local authorities, businesses and consumers to accept and adopt strategies in support of this concept.

As a member state of the United Nations Commission on Sustainable Development (UNCSD), Thailand also agreed on this concept and began the task of conceptualizing sustainability and integrating the concept into sector development plans. The Ministry of Industry (MOI), in association with the Office of National Economic and Social Board (NESDB), have set visions and strategies for the whole industry sector of Thailand and set a vision to move from a 'knowledge based industry' towards an 'innovative and sustainable industry'.

In line with this overarching vision, the mining and minerals industry also set its own vision and strategies towards 'sustainable mining'. The new visions and strategies include:

1) Supply essential raw materials not only minerals, but also recycled or alternative materials to all sectors supporting economic prosperity, in particular industries and agriculture;

2) Create adding values in the minerals with processing technologies, metallurgical technologies as well as recycling technologies;

3) Encourage and foster all activities relevant to the mining industry to ensure that their performance is in accordance with national and international best practices and are friendly to the surrounding environment and community.

In responding to the sustainable mining challenge, the DPIM's has established operational strategies in three aspects as follows:

1) Economic:

- Mining and minerals industry supplies adequate raw materials to all sectors supporting economic prosperity, especially downstream industries (e.g. cement, construction, ceramic, chemical) as well as other sectors (e.g. agriculture, services).

- Exploitation of natural resources in ore extraction and minerals processing is efficient, and adding values are created.

- Enhance the use of recycled or alternative materials to reduce consumption of minerals, which is extracted from primary natural resources.

2) Environmental:

- Mining activities and operations are friendly to the ecosystem and communities.

- Mining industry minimizes its environmental impacts.

- Energy consumption in ore extraction and minerals processing is efficient.

3) Social:

- Mining activities and local communities can co-exist and mutually develop.

- All stakeholders relevant to the mining activities are safe and healthy throughout the mining life cycle.

- All stakeholders are encouraged to understand and comply with the principles and practice of CSR.

- CSR standards and guidelines are provided for the mining industry and involving stake-

holders are encouraged to understand and comply with these standards and guidelines.

- CSR networks are created to motivate and foster all mining companies in Thailand to perform CSR as a part of their businesses, which will eventually become a generalized requirement of society.

2. Use of sustainability assessment tools in mining licensing and decision-making processes

A growing number of tools for management and monitoring of sustainable development have gained worldwide acceptance in the last decade. Environmental Impact Assessment (EIA), Health Impact Assessment (HIA), Strategic Environmental Assessment (SEA), Life Cycle Impact Assessment (LCA), Sustainable Development Indicators, Sustainability Reports, and the CSR are some samples of such tools.

Although the various approaches towards sustainability assessment are making strong progress, the development of assessment tools remains in its infancy. In fact, very few and no complete sustainability assessment tools have been developed so far, especially when considering tools to assess sustainability at the operational level.

The DPIM realizes that, up to now, there is no specific sustainability tool that can be used alone to assess the complete range of sustainability issues faced by mining operations. Each tool has advantages and disadvantages, therefore they are subject to some purposes of users.

In order to maximize benefits for mining operations, the DPIM therefore decided to use various sustainability tools in combination. Environmental Impact Assessment (EIA), which is a primary tool mandated under Thai legislation since 1975, is used in assessing all relevant issues that concern stakeholders before launching a mining operation project. More recently, the Strategic Environmental Assessment (SEA) has been adopted to ensure that environmental and possibly other sustainability aspects are considered effectively in policy, plan and programme making. Health Impact Assessment (HIA) has also been adopted to assess health impacts of policies, plans and projects relevant to the mining industry. Apart from these impact assessment tools, the DPIM also used regulation enforcement and strict monitoring to ensure that mining

activities generate minimum adverse impacts for local communities and the environment.

3. Decentralizing the environmental monitoring system to local authorities and communities

As the main governmental regulatory body responsible for supervision of mineral exploration, mining operations, other related-mining activities, as well as compliance with the Minerals Act, the MOI and DPIM have recently reorganized administrative structure with the aim of decentralizing related missions to regional and local authorities. All Provincial Industry Offices have been reorganized and a number of MOI officials repositioned to simplify administrative processes for mining operators by providing a 'single window service' at the provincial level. In line with MOI policy, the DPIM administrative structure has also undergone a reorganization to improve efficiency, reduce costs, and better manage change by increased the number of regional offices from three to seven across the country. As a policy maker and regulator, the reformed administrative structure also has benefits the government, allowing it to work more closely with both business operators and local communities.

Recognizing the people's rights in relation to natural resources management and environmental protection, the MOI and DPIM have recently transferred some mandates for environmental mitigation and monitoring associated with mining operations to local communities, especially the Sub-district Administrative Organizations (SAO). The transferred mandates include monitoring and reporting of environmental issues under the Minerals Act and its related Ministerial Regulations as follows:

- Monitor implementation of mining-related projects after issue of the EIA license and conduct monitoring exercises to ensure that the conditions of the EIA license are being complied with;
- Surveillance of environmental quality during and after mining operations;
- Participation in environmental mitigation and control measures during operation and rehabilitation programs after mine closure, either by participating in some activities or processes, or through projects in consultation with the government.

Moreover, the MOI and DPIM have also transferred further mandates to the SAOs as indicated in Sections 66, 67 and 290 of the 2007 Constitution of Thailand [7], including the following:

- participate in mining licensing and decision-making processes as required by the laws,
- provide useful information to the authorities, not only facts from actual operations, but also feedbacks on policy issues.

4. Enhancing application of the sustainable development principle to all mining operators

Over the past ten years, Thailand has launched various projects regarding to sustainable mining, as shown by the following examples.

- In 2005, the Best Performance Standards project has been established, aiming to set performance standards and guidelines for mining, quarrying, mineral processing plants, rock crushing plants and metallurgy plants. The standards and guidelines have been classified into four indicator categories, including operating management, environment, occupational health and safety as well as public and private collaboration.

- In 2009, the Green Mining Project was launched. The project set six basic principles, including environmental and social responsibility, prevention and reduction of environmental impacts, keeping all stakeholders safe and healthy during mining operations, operating areas are clean and green, transparency and accountability as well as enhancing efficient use of minerals resources, with the aims of the project moving towards sustainable mining.

- In 2009, the Clean Development Mechanism (CDM) was promoted to all operators in Thailand's mining industry. The aims of the CDM related project was to raise awareness and understanding of the concept of carbon footprints, as well as create the resource circulating and build the mining activities and communities towards a 'low carbon society'.

- In 2010, a CSR project was launched, aiming to set standards and guidelines for all mining operators in Thailand. Seven principles were applied, all based on ISO 26000. These include accountability, transparency, ethical behavior, respect for stakeholder interests, and respect for the rule of law, respect for international norms of behavior and respect for human rights.

- In 2010, the Reduce, Reuse and Recycle concept (3R's) was also promoted within the industrial sector with a goal to reduce consumption of non-renewable natural resources, especially minerals. The companies, including mining and metallurgy companies and those generating waste containing minerals and metals, have been strongly advised to use best industry practices to recycle their waste for domestic resource reutilization.

- This project not only helped promote waste recycling and environmental improvement but also sparked the idea of 'urban mining' from industrial and community waste.

- In 2011, the Green Industry project launched by the MOI was adopted in the mining sector. The Green Industry concept consisted of five steps towards organization improvement, including:

- Level 1: Green Commitment
- Level 2: Green Activities
- Level 3: Green System
- Level 4: Green Culture
- Level 5: Green Network

These five principles have been used as an umbrella system to categorize all industrial activities and projects regarding the sustainable principle, with the aim of continuous improvement towards the goal of sustainable development.

5. Establishing rehabilitation fund, health surveillance fund and community infrastructure improvement fund

Apart from setting new visions and strategies towards sustainable mining, adopting various impact assessment tools in authorization processes, decentralizing some missions related to the environmental issues to local authorities and communities, as well as promoting the use of sustainability concept through various projects, the DPIM also recognized the significant external costs that result from mining activities during and after operations. Therefore, the DPIM requires mining operators to establish three funds (the Rehabilitation Fund, Health Surveillance Fund and Community Infrastructure Improvement Fund) before the development of any new mining project.

- In 2005, the Rehabilitation Fund was officially required by the government to guarantee rehabilitation works during and after the mine's life. Holders

of 'mining authorizations', which included all mining tenements granted under the Minerals Act and its amendments, are required to pay a non-refundable amount into the Rehabilitation Fund. The Fund was initially applied with the mine that located in the first category of the watershed area (WSC1) as classified by the government. After that, the rehabilitation scheme was applied to all types and sizes of mining operations. The rehabilitation levy was estimated based on the rehabilitation size at a rate of approximately 34,000 Baht per rai (about 34,000 Baht per 1,600 sq.m.). In addition, progress of the rehabilitation works was required to be reported to the regulators at least twice per year.

- In 2007, the Health Surveillance Fund was introduced to the mining sector as one of the country's most hazardous industry sectors. Health surveillance refers to any risk-based health assessment or biological monitoring used to identify changes in the health of people surrounding the mine sites and other stakeholders who might be affected by mining activities. At the beginning of each project, mine operators will be required to pay around 30,000 Baht per year to the fund and later on the annual amount might be increased, depending on the level of exposure and impact.

- In 2007, the Community Infrastructure Improvement Fund was introduced to the mining sector. The new fund aimed to improve not only the quality of people's lives in local communities surrounding the mine area (e.g. employment opportunities, funding for higher education and medical checkup programs), but also the quality of community facilities (e.g. community centers, recreational buildings, local arenas, cultural and other community facilities). The Community Infrastructure Improvement Fund is required in order to apply for a new metal mining project, especially for gold mining.

Challenges for improvements towards sustainable mining

As mentioned earlier, the development of sustainable assessment tools remains in its infancy. Up to now, there is no individual sustainability tool that can be used alone to assess the complete range of sustainability challenges faced by mining operations.

In order to realize the goal of sustainable development, use of selected sustainability tools in combination will bring benefits to the mining industry. There are still some challenges ahead for the mining industry in Thailand, such as the following:

- Review and revise current sustainability tools as well as related activities and projects that are already applied to the mining industry to find areas improvement.
- Enhance the use of other sustainability tools such as risk analysis and cost benefit analysis as well as disseminate relevant knowledge and guidelines to all mining operators.
- Promote the use of sustainability reports to measure and report companies' key performance indicators.

Some comprehensive and reliable tools can be developed and applied to Thai mining industry in the near future, including:

- Develop sustainable indicators for both operating level (mining companies) and national level. The indicators will assist to translate related issues into quantifiable measures with the final aim of helping address the key sustainability concern.
- Develop a LCI/LCA database for Thailand's mining industry. The database will benefit operations by helping to identify appropriate materials and reduce energy consumption, as well as minimize emissions and wastes.

Conclusions

In recent years, the Thai government has put all the efforts to build sustainable mining not only by placing five elements of the paradigm shift in environmental management, but also working closely with all mining stakeholders. It is obvious that there are many advantages from moving the mining industry towards sustainability comparing to the past, for the following reasons:

- Government sector:
 - Both national government and local authorities have access to a range of impact assessment tools to support their decision-making processes at all levels, including policy, plan and programme level (e.g. SEA) as well as project level (e.g. EIA and HIA).
 - Government agencies can reduce some budget and working-time regarding to business investigation and monitoring,

because business operations are already started with 'willing-ness to do' on ethical codes of conduct, which already exceed legal minimum requirements (e.g. Best Performance Standards, CDM, 3R's, CSR and Green Industry).

- Business sector:
 - The business sector will gain greater trust among stakeholders, especially customers, creditors and governments if they commit to operating under accountability and transparency scheme.
 - Mining activities and communities can co-exist and mutually develop.
- Communities and other stakeholders:
 - Local communities and other stake-holders have many channels for communicating and expressing their opinions, as well as to
 - Share ideas or filing complaints resulted from policy setting (e.g. SEA) and project approval processes (e.g. through EIA and HIA).
 - Local communities and involved stake-holders will share the benefits from CSR activities such as medical checkup programs, education funding and access to improved public infrastructure.
 - The number of protestors against the mining and minerals industry will be reduced if mining operators put their efforts to achieve mutual social benefit and a clean environment.

At present, the challenge confronting Thailand's mining industry is not a question of how well the mining operators can support economic prosperity, but how well the industry can manage its adverse social and environmental impacts. Consequently, the future of the mining industry will depend on the efforts of individual operators to achieve mutual social benefits and a clean environment.

As a policy maker, the DPIM is confident that with all policies put in place and working together between governments, business operators and communities, not only help the mining industry to receive its trust from all stakeholders, but also help the mining industry to build 'Sustainable Society' in Thailand.

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