GOXI
sharing in governance of extractive industries
INNOVATION SERIES

Management of Mining Waste
October 2017

The GOXI LEARNING SERIES – SEPTEMBER 2017-APRIL 2018

Management of Mining Waste and Design for Closure

Knowledge extracted from webinar and Goxi forum Discussions

1. Emerging Critical Issues

Introduction to mining waste and human rights

This webinar provided an overview of mining waste management, with a special focus on the need to design mine waste facilities to ensure safe and orderly closure once mining has ceased. The webinar also touched upon Human Rights issues related to mining waste management and mine closure, and what that implies in terms of governance. The different stages in the mining process (from planning to post-closure) were discussed, although the focus was on the phases of exploitation and closure. Case studies from Mozambique, Brazil and Sweden were used for discussion and sharing of experiences.

An overview of the different types of waste that are produced in and around mines, in terms of their characteristics, potential environmental impacts, and management challenges was given. The geochemical and physical properties of such waste were considered, including the potential for contamination to the surrounding and downstream environment.

Importance of mining waste management

The mining sector produces large amounts of waste. Normally, most of the waste is classified as non-hazardous. However, even non-hazardous waste may have characteristics that can make it a potential source of long-term environmental and health related impacts. Furthermore, the shear amount of waste produced often makes issues related to finding adequate areas to store the waste important, as well as to ensure that the design of the facilities is such as to minimize the risk to people living nearby and/or downstream.

Four important issues related to mining waste

1. Mining waste makes up 80 percent of all solid waste generated in Sweden.
2. The presence of sulphides in mining waste means a risk for acid rock drainage which in turn can cause severe environmental impacts.
3. Mine waste facilities are often large, and if poorly designed, they may fail.
4. Once a mine closes the impact may be long-term. This involves a closure-long term risk/liability.

Access to relevant information and rights to public participation need to be assured

Local stakeholders need to be involved. Access to information is required for communities so that they can be adequately informed and meaningfully participate in discussions with the government and mining companies. Participation also helps to ensure that extractive projects address the rights of affected communities.

Potential impacts may be local (at worst regional), and long term

Environmental impacts can affect local people's rights to health, water, food, and housing. At worst, the impacts of mining waste can be regional and long-term.

Access to justice should be guaranteed in case of environmental damages

Environmental impact can affect people's rights to health, water, food, and housing. This means that people have a right to participate in decision making on issues that affect their lives and health. In addition, people in communities affected by extractive projects should also have the right to access justice.

Past experiences show that poor and/or vulnerable communities may be especially at risk in this regard

The risks of accidents must also be minimized through adequate land use planning, provision of information to the public, and establishment of warnings systems where appropriate.

Communities need to share in some of the benefits

Mining waste is often the number one environmental challenge in a mining project. Mining waste and human rights are strongly interrelated. Precious minerals usually belong to the state and in such a case, the benefits are distributed in accordance with national policies. If mining waste is not managed and regulated responsibly, it can cause negative impacts to local communities. Mining, like any industrial venture, is meant to benefit the investors, who may or may not be local or even national. It is important that local communities and the local economy also derive substantial benefits from mining projects.

Good outcomes in mining are possible

It is possible to reduce contamination with modern techniques and effective management. More mining waste does not necessarily mean greater environmental impacts. For example, the relatively small but numerous abandoned mines that exist in Sweden (pre-1969) are still the source of discharges of hundreds of tons of metals to surface waters every year. Conversely, the much larger and more modern mines that exist now and have been the subject of proper environmental legal requirements will typically have environmental permits that allow yearly discharges to surface waters in the order of tens or at most hundreds of kilos of metals annually.

Thus, there are indeed good examples of how to efficiently manage and store mining waste.

What to do with mining waste?

The storage of mining waste can be complex. Below is an overview of what can be done with main waste materials.

Waste rock and overburden	Process tailings
Use or recycle-often appropriate and possible within mine sites but to a very minor extent outside	Use or recycle-seldom possible. However, re-mining of old waste is a quite common procedure for old gold mines
Backfill in underground workings and open pits-sometimes possible.	Backfill in underground workings and open pits- this is sometimes possible.
Safely store-normal procedure.	Safely store-normal procedure.

Key recommendations for storing mining waste

Geochemical and chemical issues	Geology and mining	Geochemical
Mining waste with ARD potential and/or contaminants must be safely contained in the long-term	Avoid covering ore reserves with waste. Make it possible to re-mine the waste in the future	Avoid oxidation (ARD) through adequate covering Isolate/separate certain fractions Treatment of process chemicals

Why the need for “design for closure”?

The orderly closure of a mine is normally a costly exercise and needs to be identified and included in the economic evaluation of a mineral reserve. Cost of a closure of a mine is dependent on set objectives (environmental as well as-socio economic). It is, therefore, important to set objectives for the closure at the beginning of the mining project, and to have a dynamic plan because the cost of closure will change with time. All this means there is a need to ensure that the necessary financial resources are available at the end of a mine’s life, especially when income from the extraction has ceased. In some instances, mines may be forced to close earlier than planned e.g. due to unforeseen commodity price variations. In these cases, there is even more of a need then to ensure that adequate financial resources are available for an orderly closure.

The development of a mining closing plan should be done very early in the process

The large amounts of waste produced, and the considerable cost of adequately managing it, make it important to plan for closure and post-mining rehabilitation at the earliest stages of the mine cycle, and to also ensure that rehabilitation is being done concurrently with ongoing mining. Thus, there is a need to start planning for closure before a mine is commissioned. A closure plan should be considered in the EIA process, and made part of any environmental permit. Ensuring adequate planning for mine waste management in turn requires an interplay between operator, regulator and the public.

Key issues that need to be considered when closing a mine

There are a number of technical and administrative issues that need to be addressed when closing a mine most of which have financial implications:

- Cost estimates require expertise and experience, both from the point of view of the regulators and the mining companies.
- Any environmental guarantee or bond that is set aside must be guarded against potential effects of inflation and exchange rate fluctuations.
- The cost of closure of a mine is dependent on the set objective, and will change over time. The availability of funds need to be ensured and protected and should not be allowed to be used for addressing any other issues.
- Closure of a mine can be a difficult process. It is important to guarantee the availability of expertise.

Key recommendations for designing for closure:

- Set the objectives and start planning early.
- If there is potential for ARD, then there are special needs for confinement, covering and possible treatment of effluents (long term) - it is essential to consider this at the design stage.
- It is important to undertake rehabilitation as early as possible.
- A key challenge is control of water. This can be done through a combination of:
  - Drain tailings ponds (unless flooded closure design)
  - Re-profile surfaces to prevent ponding
  - Use covers to minimise infiltration and dusting
  - Revegetation, surface features and limited slope angles to reduce erosion
  - Lower infiltration, reduction in internal water levels and increased stability
  - Design for maximum floods/rainfall (spillways and diversion channels

2. Questions from Webinars and GOXI Audience (examples)

- Are mining activities allowed in protected areas?
- What is the cost difference of different designs for tailings dams, specifically an upstream raise compared to a downstream raise?
- How can we mainstream biological diversity in mining activities?
- In the case of tailings sites, some people suggest depositing tailings on the seabed, arguing that there will be less severe environmental effects, especially in tropical areas where rainfall is plentiful. What would be the consequences of depositing waste in such away?

- What are the best types of guarantees that the state can request from a company to guarantee a correct remediation and closure plan for a mine?
- On the country specific examples, do funding agencies (e.g. Multilateral Development Banks) impose environmental and social safeguards that affected the design and planning outcomes?

3. Public authorities and other actors sharing experiences

Case Study 1 - Renova Foundation

This presentation addressed how Brazil has responded to its worst environmental disaster, resulting from the failure of the Fundão tailings dam 5 November 2015. In November 2015, the Fundão iron ore mine tailings dam failed. Following the dam break, 39 million meters of iron ore tailings spilled into the Doce river, and some 18.9 cubic meters of tailings flew through the river and reached the sea. The tailings released into the river lead to numerous cities' water supplies being cut, and disrupted biodiversity along the river.

The dam failure impacted 39 municipalities in the states of Minas Gerais and Espírito Santo. This occurred along a 650 kilometers path to the mouth of the Doce River, where the river meets the Atlantic Ocean. In Minas Gerais, the dam collapse affected the districts of Bento Rodrigues and Paracatu de Baixo, in Mariana, and Gesteira; the district of Barra Longa was also affected. Because of the collapse, 13 employees and contractors working near the Fundão dam died, as well as five people from nearby communities. One person is still missing.

How did Renova Foundation manage the impact?

Brazilian institutions including the mining companies themselves, the government and other stakeholders working with the environment got together and created a innovative solution through the setting up of the Renova foundation, which is explicitly charged with addressing the dam break's consequences. Actions to repair, remediate and compensate were immediately initiated by the Renova Foundation in August 2016. In the aftermath of the dam break, different national organizations were involved. Renova is now working with 70 state organizations including environmental and urban agencies. The Brazilian federal government created an inter-federal committee. They work together in this space, discussing all aspects of the work. Their role is to mitigate the impact of the dam break in collaboration with government, societies and companies in a very complex system. This requires collaboration with many different stakeholders.

A legal agreement was signed between companies and others in order to provide action for repairing the damage and also to look into long-term solutions. The governance structure of Renova guides, validates, audits and supervises the work of Renova Foundation. It includes the executive government in the federal authorities concerned, the judiciary as well as requirements for external audits. It’s a complex system but all stakeholders in decision making process are included in this very innovative and complex structure.

The four steps listed below are noted as good practices in Brazil with action directly implemented after the dam break.

1. Structure stabilization and recovery
2. Sediment containment, Stabilization, Water Clarification
3. Evaluate impacts informed by science (monitoring process) in order to define remedy and recovery
4. Remediate and Recovery

Lessons learned

- The Renova Foundation has already recovered 1150 hectares of forest. This kind of intervention takes a long time. When all stakeholders are at the table and working collaboratively they can move forward in an easier and more effective way.
- People have to live in harmony with the environment. We need to balance social and environmental relations. Many locations are vulnerable to these kinds of disasters. The dam break came as a surprise to many municipalities. It is important to have a better territorial planning process so that people know more about the risks they are facing in their communities – this would help to prepare the community to respond to an unpredicted event. It is increasingly important to develop and implement public policies that prepare the local community and equip it with tools to respond to these types of disasters in a preventive manner.

Achievements: *Doce River is the most intensely monitored river in Brazil*

Water supply and treatment:

- 4 Water pipelines delivered, one in 3 cities
- Water treatment plants improved in 10 cities
- 24 Municipalities with alternative water intakes (water pipelines or wells and water treatment improvements)

Water quality monitoring:

- 80 Physical, chemical and biological parameters of water and 40 of sediments
- 22 Automatic monitoring stations
- 92 Points along the Doce River and coastal zone
- 80,000 Compiled data shared with the environmental agencies

Case Study2 - Sweden

Mining industry in Sweden

Sweden currently has 14 active ore mines (iron, copper, zinc, lead, silver and gold) and produces more than 100 million tonnes/year of mining waste. The large number of closed mines present a risk and there are significant environmental problems at some recently closed mines.

Strategy for environmentally sustainable management of mining waste

SEPA and the Geological Survey jointly developed a strategy for the environmentally sustainable management of mining waste in 2017, the aim of which is to develop a long-term, environmentally sustainable strategy to manage mining waste which is also resource-smart and economically efficient. This strategy includes proposals for improvement of permitting processes, supervision, capacity, knowledge and innovation.

Shortcomings in the waste management plans

Common waste management plans are not used to their full extent by operators and regulators. Common shortcomings are limited information related to characterization, prevention as well as measures for recycling, closure and rehabilitation. In addition, the financial security do not cover all required costs.

Challenges in reviewing information on waste handling

Measures are insufficient to reach a satisfactory state in environment impacted by the waste facilities. Critical areas include the characterization of the waste, handling of the waste during operation, measures for closure and post closure. It is also questionable whether there is sufficient financial security for covering costs for closure and post closure of the waste facilities.

Impact on discharges to water from small mines not in operation

Two small mines were in bankruptcy after about one year of production. They have leaked large amounts of cadmium, lead and zinc from the waste, in addition the sulphides in the waste have weathered. This happened due to lack of proper management of extractive waste as well as the lack of proper evaluation of the acid producing and neutralization potentials in the wastes.

As a result, the state has to bear costs for these sites. This included 41 million SEK (5 million USD) for water treatment, 88 million SEK (10 million USD) for rehabilitation of one site (rehabilitation of the other site is in the process of decision). Financial securities were insufficient with one of the permits being from a time before the legal condition on financial security had been established.

Case Study 3 - Mozambique

The Moatize mine is a major coal mine situated in the central, inland region of Mozambique. The mining operation is large, and it produces significant amounts of both waste rock and tailings. Waste management at this site was used to illustrate both technical concepts, as well as to discuss the various responsibilities and roles that fall upon the company, the regulators, and other relevant stakeholders.

In terms of regulations three main ministries are involved in Mozambique

Ministry of Land, Environment and Rural Development (MITADER)	• EIA process and environmental permits • EIA's include mining waste management, mine closure and EM • Supervision (audits, monitoring, assessment of reports)
Ministry of Mineral Resources and Energy (MIREM)	• Mining titles • Some environmental tasks, including Mine Closure Plans (MCP's) and environmental surety/bonds.
Ministry of Public Works, Habitation and Water Resources (MOPHRH)	• Important environmental (water) related responsibilities Competent authority for assessing engineering designs and geotechnical/hydrological risk

Moatize coal mine: Main potential impacts during operations▪

Top soil storage	**Waste rock storage and waste rock dumps**	**Tailings storage facility**
• Dusting (haulage) • Dusting and erosion (stockpiles)	• Dusting (haulage) • Dusting and erosion (dumps) • Acid rock drainage • Spontaneous combustion	• Dusting (if dry) • Acid rock drainage • Geotechnical risk (wall failure) • Hydrological risk (uncontrolled release of pond water)

In coal mining, there is less waste produced than in most other types of mining. Waste rock is the most commonly generated waste type at Moatize, and extensive waste rock dumps are needed. Dusting is experienced at the mine site.

Moatize coal mine: Planning for Closure

- EIA and EMP submitted and approved by MITADER, prior to mining.
- Mine Closure Plan submitted to MIREM, but approval not needed before mining.

- Environmental surety requirement exists but is tied to MCP (Vale has corporate guarantee in place)
- Geotechnical and hydrological risk assessments included in the design reports from Vale but the review process by authorities unclear.

Issues when planning for closure

- EIA regulations and Mining law differ and it is possible to mine without approved Mine Closure Plan (MCP)
- Surety for closure is tied to MCP (not EIA), and a MIREM responsibility.
- Form of surety is not set – should it be a corporate guarantee, bank guarantee or cash deposit?
- Is there protection of closure funds from diversion to other authorities or budgets?
- Is there protection of closure funds from devaluation?

Challenges

- Responsibility of Ministry of Public Works, Housing and Water Resources (MOPHR) - do they have adequate capability and capacity in relation to the specifics of mine waste management?
- How is responsibility shared between different authorities and how can this be improved?
- There are several institutions with shared responsibility and there is a need to improve coordination.