Water resources management at the mining industry in Chile

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ABSTRACT

Water resources are a major topic of concern for public and private entities globally, even more with access to water being recognized lately as a human right. On the other hand, water is also a key input to many industries, which see how the competition for the resource has increase while supply of fresh water has decreases as a result of exploitation of surface and groundwater sources and effects of climate change. In Chile, mining industries are located mostly in water scarce areas, managing to solve the problem of water availability by developing desalination plants along the northern coast of the country. However, desalination plants are located hundreds of kilometres from mining operations, converting water in an expensive input due the energy required to pumping. On top of this, water resources are relevant to all stakeholders of mining projects, and environmental legislation along with social empowerment of communities, adds difficulties to the use of the resource. There is agreement among the industry about the relevance of water management in their operations; however in practice, the real challenge is to address the issue in its whole context, considering all complexities in a comprehensive manner, creating a culture of sustainable use of water throughout the company that can last over time. This works presents a general methodology to assess the development of a water strategic plan to manage water resources for the mining industry in Chile, as an effort to help companies with this important challenge. The paper addressed the identification of key stakeholders, challenges and risks that face the industry today, giving them a framework to develop water strategies.

INTRODUCTION

Water is an essential resource for mine operations. In Chile, mining industry accounts for around 2% of total water consumption of the country (CM, 2014). Despite not been the greatest consumer of water, because of the relevance of mining industry in Chile (representing more than 50% of export countrywide (Cochilco, 2008), and its predominant location in very water scarce areas, water consumption is definitively a sensitive and strategic issue for all mines. Water is use in mining for exploration, mineral processing, dust suppression, slurry transport, smelting, refining and employee requirements.

Nowadays mine operations are facing hard challenges. The International Council for Mining and Metals (ICMM) has published a paper called International Water Issues for Mining (ICMM, 2009), which presents a summary of water issues, trends and recommendations for the industry where some of the most relevant challenges identified are:

- Mining operations and their water use change over time.
- Increase involvement of communities in mine approval processes
- Increase stringency in the regulatory environment
- Increase demand for water resources
- Climate change expect to bring hydrological changes and increase climate variability

These challenges are also present in Chile, with most of the mines (except for Codelco divisions; Andina and Teniente) having less than 100 mm/year of hydrological availability (CPP-UC, 2012). Moreover, it is estimate that all mine sites in the country will have a decrease in precipitations to 2040, while in the same period most of the country´s largest mine companies are projecting expansions that will increase production, and consequently their water needs (CCG-UC, 2010).

In anticipation of these needs, the industry have found in desalination an option to provide water in a relatively reliable way for their operations, and to become independent of groundwater, which is a resource that is over allocated and highly impacted. However, desalination plants are located on the coast, meanwhile, most of mine have their operations hundreds of kilometres inland, at attitudes that can go up to 4.000 (AMSL), making it very energy consuming and therefore expensive its transport.

Since last years the Chilean environmental legislation has experienced modifications, including the creation of new institutions like the Environmental Superintendence and the Environmental Courts. Environmental audits of mines have increased being the industry with the largest percentage of them in the country (QP, 2013). Also the new Environmental Courts allow any particular individual to place complaints related to environmental issues, enhancing the relevance of environmental compromises and behaviour of mines to avoid any legal and reputational risks that could affect its operations.

Communities are also a factor that needs to be considered very carefully and planned ahead in terms of participation, involvement and communication strategies, since they have shown more empowerment and influence in the decision making process of authorities related to mines. In addition, the importance of the correct application of ILO 169 in matters related to the industry has required specialist to be involved in all phases of the water management process.

Important efforts have been made in the industry to develop strategies to manage water resources in a sustainable way and to report water accounting as an approach to address the magnitude of their requirements and to communicate it transparently to the community (WRI, 2010).

To accomplish a sustainable management of water resources, a company requires definition and elaboration of standards, guidelines, and plans, with the support and active involvement of managers and directors of the whole company. This is relevant for a company not only because is sociably and ethically their responsibility, but because is a critical point for their businesses. Some examples of companies that have already take action on that direction are Rio Tinto, AngloAmerican and BHP Billiton which have develop water strategies and water management standards for their operations.

Although each mine site faces different challenges related to water resources, this paper proposes a general methodology that aims to be a contribution to the industry to achieve a sustainable management of water resources.

GENERAL METHODOLOGY FOR SUSTAINABLE WATER MANAGEMENT IN MINES

The general methodology proposed consists of four phases, schematized in figure 1. Although the entire company should be responsible of a correct management of water at the mine, there should be a specific area in charge of the subject, which would typically be the Strategic Resources Planning or the Sustainable Department.

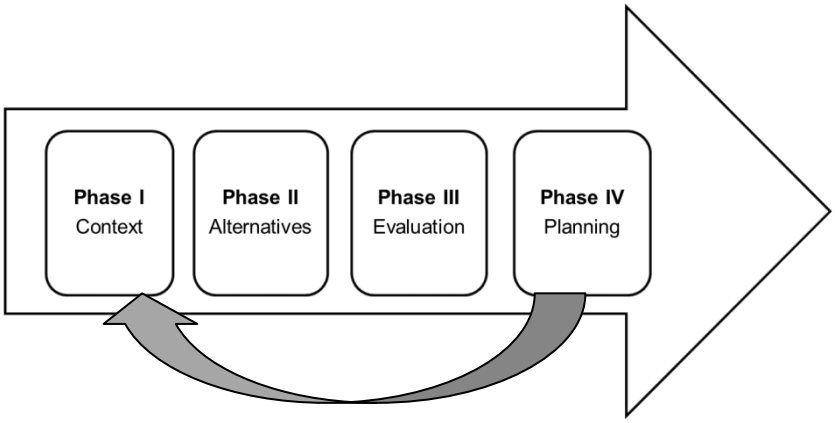

Figure 1: General methodology proposed to manage water resources in the mining industry. The arrow represents the iterative character of the process.

Phase I: Context

To understand the background where a company is immersed in relation to water resources, the first step should be defining the context where the management would take place. The context includes technical, economic, social, environmental and legal actual conditions that concern the mine site and its operation. At least the following elements have to be identified as part of the context:

- Water balance (related to the operational plan of the company)
- Current state of the water sources of the company
- Key internal stakeholders (definition of internal water consumers and suppliers, including the responsible of each department)
- Key external stakeholders (all groups or individuals that might have a level of interest and power related to the mine operation and its resources)
- Site specific issues (e.g. climate change, competition of resources, water legislation, environmental regulatory system, community empowerment, ILO Convention N°169, reputation)
- Opportunities and risks (e.g. energy supply, changes in water law, water distribution, water pollution, unplanned environmental impact, operational water risks)

Phase II: Alternatives

After defining the context, the possible alternatives or measures are identified. These alternatives can be divided in three groups: the ones to find new sources of water, the ones to improve the use of existing sources (e.g. by reducing the amount of water used or increasing the efficiency of its use), and the ones that seek for a sustainable management of the resource (Arizona). As part of the identification process each of the key internal stakeholders is asked to define possible appropriate measures or projects that can contribute to those efforts.

The following table lists example of alternatives / measures divided in the three groups.

Alternatives to find new sources of water	**Alternatives to improve the use of existing sources**	**Alternatives for a sustainable management of water**
Constructing desalination plants	Increase or add instrumentation to monitor losses	Monitoring the quality of natural water
Buying water rights from other	Covering open site water storages	Developing warning systems

companies		associated to ecosystems affected by water use
Exploring new areas to develop wells (with their associated water rights)	Implementation of automatized water recovery and control system	Developing and publishing water accounting
Buying surplus water from other mine companies	Increase water recovering from tailings	Publishing water standards and compromises
Buying surplus water from water supply companies	Recovering infiltrations by adding pumping wells	Working with local communities in water issues
Buying water from sanitary companies	Define efficiency indicators (eg. water recovery)	Making restoration plans of areas impacted by water extraction
Exchanging water with owners of other areas	Definition of water targets for each area	Replacing high quality water with saline water

Reference: (ICMM-2012, AA- 2007, SADMM-2010, RT-2012)

Phase III: Evaluation

On the evaluation phase, all possible alternatives are compared considering technical feasibility, cost, time of implementation and impact of expected results in water balance, and to other areas or stakeholders.

The evaluation is carried by an interdisciplinary group integrated by all key internal stakeholders of the company, including at least representatives of the department responsible of water management, and of the departments of production, environment, legal and communities. The evaluation takes place in workshops and meetings and considers as input the results of the previous phases, including the context definition and the alternatives identification. As part of the evaluation, the following elements are discussed and agreed among the participants:

- Time framework where alternatives can be developed
- Possible combination of alternatives
- Assignment of probabilities of the alternatives to be implemented and its risks
- Selection of alternatives to be carried on considering the most probable and less risky scenarios

This evaluation process is time consuming, mainly because it requires the evaluation of all possible combinations of alternatives, and the agreement, among all stakeholders, of the values assigned to the probabilities and risks. For this reason is advisable to have an external consultant to support this process, that can help lead the discussion and analyse all possible scenarios, providing an objective point of view to the evaluation.

Phase IV: Planning

During planning phase different plans are developed to achieve a sustainable water management of the resources in the mine.

Water Strategic Plan: After evaluating and selecting the alternatives that will be carried on, they are planned through a Water Strategic Plan. This plan is developed by the department in charge of water resources and contains the strategy to implement the alternatives selected, considering the time framework that they should take place, their relationship, the efforts needed to be successfully implemented and the responsible of this efforts.

Specific Plans: With the water strategic plan as a framework each area develops its own plans to comply with was is state for its area. Some of the plans that are usually developed for each area are:

- Operational plans, with measures and projects related to minimize water use in the process of the mine
- Optimization plans, with measures and projects to optimize water use along the operations and infrastructure
- Conservation plans, with measures and projects to preserve water sources and ecosystems related (monitoring plans, early warning plans, etc.)
- Authority and stakeholders engagement plans, with measures and project to address relationship and communication with external stakeholders

The plans state clearly the actions, time framework and responsible of the actions described on them.

Water Management Plan: The outputs of the four phases described on this methodology are included in the master plan of water resources of the company or "Water Management Plan". This plan should include the water policy of the company, their standards, guidance and a summary of all plans mentioned before, with time framework and responsible in charge.

ITERATIVE PROCESS

Once finished the four phases described above, the actions designed in all plans are carried on during the year. At the end of this period, the methodology starts again (as represented by the arrow in Figure 1), with the identification of changes to context, possible alternatives (evaluating success or failure of the ones carried in the period before), and actualizing the water strategy and plans for the next period.

CONCLUSIONS

This paper presented a methodology of water management for mine companies in Chile, aiming to contribute to the efforts made previously by mine companies, policy makers and governments. Even though, this paper focused only in water management during mine operations, it is important to have in consideration that a sustainable planning of all resources should be carried since the planning of a mine project, during construction, and through whole life cycle of operations and even after mine closure.

The valued of the methodology proposed in this paper, lies in that fact that was created based on empirical experience working with mine companies, where key factors of success are; planning ahead considering input of all relevant personnel involved in water resources, analysing past, present and future possible conditions surrounding the issue and a constant communication within all actors involved.

Mine challenges are far from being solved, and the future only seems to bring even harder challenges to the industry. In this context it is imperative to take actions now to reach sustainability of mine operations, which will only be achieved by a correct and planed management of water resources.

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