Mine Scheduling Considering Hydrologic Scenarios

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ABSTRACT

Water plays an important role in the mining industry because it must be used for ore processing and in the case of open pit mines it is used for irrigation of haul roads. Due to changes in climate conditions, water availability should be considered in mine plans during the whole life of mine. For example, in the particular case of central Chile, it is important to mention that a persistent rainfall deficit has prevailed since 2010 to date leading to a market decline in water reservoirs among other effects, which particularly affected water supply of a mining operation in central Chile.

The purpose of this work is to show the differences in the mine plans in terms of the net present value (NPV) considering water availability constraints for a mine operation located in central Chile with its water supply provided by a nearby river. There were 4 hydrological scenarios evaluated in the first 10 years of the mine plan, considering 3 cases of different capacities for the processing plant.

The main conclusions of this work is that NPV shows a decreasing tendency as more in the future the hydrologic scenario takes place, because the water required for some months is greater than the water available. Also, in this case study, there is no convenience for increasing the processing plant capacity in relation to case 1, due that the CAPEX is greater than the discounted profits.

INTRODUCTION

In this introduction chapter two topics are going to be discussed: mine planning and the role of water in mining.

The mine planning process in open pit mining begins with a geologic block model that contains ore and waste. After introducing parameters such as slope angles, costs, prices, and the metallurgical recovery, the final pit is obtained as a result. The final pit limits defines what is economically mineable from a given deposit. It identifies which blocks should be mined and which ones should be left in the ground (Dagdelen, 2001). The mining program schedule may extend over many years and involve a lot of capital expenditure and risk (Lerchs and Grossman, 1964). Therefore a correct definition of the ultimate pit and its phases is relevant to maximize the value of the mining business. The final pit or ultimate pit is divided in a series of interim pit phases that reflects successive cutbacks (Williams et al., 2009). Since economic scenarios, as well as geologic and geotechnical data change in time, the mine planning process is dynamic.

Water plays a major role in the mining industry. In the operation it must be used for the ore processing and in the case of open pit mines it is used for the irrigation of haul roads. The issues and concerns is about the quantity of water consumed by mining activities, and impacts in water quality (which, in turn, often affect water availability). In fact there has been an increasing focus on mining and water issues leading to more regulations in water rights and responsibilities, and more attention to water management and potential environmental impacts associated with mining (Mudd, 2008). As described, it is possible to figure out the importance of water for the mining business. This implies that it must be incorporated in the mine planning process. Just to show the important role of water in the mining industry, it is useful to mention that in year 2015 an ore processing plant located at Los Bronces Mine in central Chile, suffered a stoppage of 29 days regarding water scarcity (Minería Chilena, 2015) which certainly impacted its business.

It is worth mentioning that changes in climate conditions must be considered in mine plans. For example a persistent rainfall deficit has prevailed in central Chile since 2010 to date, leading to a market decline in water reservoirs among other effects. The observations in central Chile indicate a regional mean precipitation trend of -3.7% decade^{-1} between 1979 and 2008 and a trend of -7.1% decade^{-1} between 1979 and 2014 (Boisier et al. 2016) (**Figure 1b**). This so called megadrought has no precedents in local records and contributes to a long standing dry trend in the region (Boisier et al. 2016). It is also important to point out that glaciers in central Chile has shown a significant ice-mass reduction with an accelerated trend in recent decades (Carrasco et al., 2008). This megadrought combined with the ice mass lost certainly affects basins which supply water that is used in mining, energy, and agriculture.

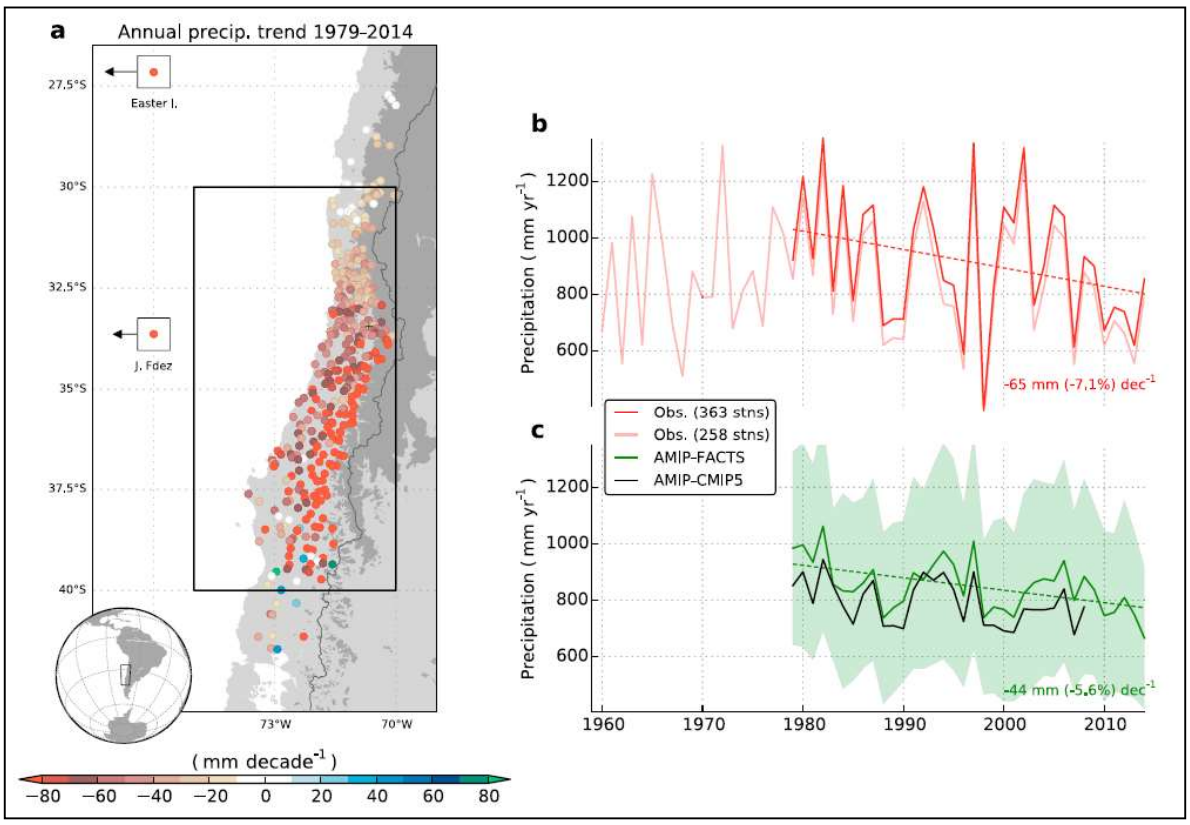

Figure 1 (a) Trends of annual precipitation observed in rain gauge stations in Chile between 1979 and 2014. Time series of annual mean precipitation in central Chile based on (b) rain gauge observations and (c) SST-forced GCM simulations. Dashed lines indicate the corresponding linear precipitation trend from 1979 to 2014. Box in Figure 1a shows domain used for regional average (Boisier et al. 2016).

Based in the facts stated in this introduction chapter, the objective of this study is to evaluate the impact of hydrologic scenarios in mine planning for a mine located in central Chile. In particular, it is focused on how water supply has impacts in the economics of a project in terms of the net present value (NPV).

METHODOLOGY

The methodology to undertake the present work is as follows:

1. Select a case study based on an ore deposit. This deposit will be located in a basin that will supply water for the operation.
2. Determine the water consumption for ore and waste.
3. Determine the water availability of the river from the basin that supplies water to the deposit.