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Metal mining industry in Finland – development scenarios to 2030

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ABSTRACT

The Finnish metal mining industry and mineral exploration have experienced rapid growth in recent years. The new activity has mainly focused on gold, and base, ferrous and platinum-group metals. The rapid growth has raised both hopes concerning the economic benefits and fears of environmental degradation, and has aroused local and national conflicts between differing viewpoints. In this paper, we assess the possible future development of the metal mining industry in Finland by constructing three scenarios presenting possible developments of the industry in economic and environmental terms. These are: 1) the best-estimate scenario, 2) the base-level scenario and 3) the maximum scenario. The best-estimate and maximum scenarios show continuous growth in the industry in the coming years if the profitability outlook of mining projects and prospects remains positive. Growth is indicated for both economic and environmental factors, especially in the value-added, waste mineral generation and indirect CO_2-eq emissions. In the base-level scenario, there is a small growth observed during 2010–2020 but otherwise the indicators in this scenario show a declining trend. The metal mining industry appears to have a good potential to provide benefits in Finland, especially in the economically regressive northern and eastern areas. However, sufficient management of the economic and environmental impacts as well as successful corporate-stakeholder responsibility strategy is needed to maintain the industry's social license to operate.

1. Introduction

The metal mining industry is currently experiencing a marked boom in Finland, and the mined volumes have already surpassed previous all-time highs. The new mining activity is especially based on base metals and gold, but deposits of platinum-group and ferrous metals are also actively being developed. Before the current boom, the economic importance of the metal mining industry in the Finnish economy was relatively minor. However, interest in the mineral resources of the country has now risen, and Finland was ranked highest in the Fraser Institute's 2012/2013 survey for mining companies (Wilson et al., 2013). There are now hopes that the mining industry will generate new economic activity, especially in the economically regressive areas of eastern and northern Finland (Hernesniemi et al., 2011; Törmä et al., 2013; Törmä and Reini, 2009), and possibly also provide a boost for the other industrial sectors and the Finnish economy on a wider scale (Finland's Minerals Strategy, 2010; Hernesniemi et al., 2011; Reini et al., 2011). At the same time, concerns have arisen about the need to achieve a sufficient balance between regional socio-economic benefits and environmental impacts (e.g. Eerola, 2008; Haltia et al., 2012; Rytteri, 2012). In particular, the continuous environmental problems at one of the largest new mining operations (e.g. Talvivaara, 2013a, 2012a,b,c, 2010) have partly eroded the general trust towards the mining industry in the country (Rytteri, 2012), although many of the mining companies in Finland are performing well in their environmental protection (e.g. HS, 2012; Inmet Mining, 2012; YLE, 2013). However, the Finnish government has taken a stand on supporting the good industry practises by an action plan for the "sustainable mining industry in Finland 2030" (MEE, 2013).

Mining can have an effect on the local and national economy in many different ways. In general, the public sector income generated by mining activity comes in the form of mining royalties and other

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types of taxes (Brewer, 2005; Crowson, 2009; Waye et al., 2009). The linkages between mining and other sectors, such as equipment suppliers, downstream processing and service sectors, also determine the economic importance of mining in a host country (Crowson, 2009). In Finland, the main public economic benefits of mining are derived through mining investments (through benefits to the construction industry and real estate taxation), profit taxation (being 24.5% in 2013) and income taxation (Törmä et al., 2013; Törmä and Reini, 2009). Additionally, landowners receive royalty payments. Activities related to the minerals industry, construction industry and metals industry, in particular, have already benefited from the new mining activity (Törmä et al., 2013).

While the economic effects of mining appear at national, regional and local levels, pressures on the environment and society mainly occur at the local level. The use of land for mining and waste piles, the water needed for processing, and dust and noise may cause problems for the surrounding ecosystems and social structures if not properly controlled (see e.g. Aswathanaryana, 2003; Craig et al., 2010; Kessler, 1994). The energy usage and related green house gas (GHG) emissions may have an effect on the climate, and acid mine drainage (AMD) and heavy metal leakage forms a long-term risk for water ecosystems (Akcil and Koldas, 2005). However, the scale of the environmental impacts is always site specific, and is dependent on the mining and processing methods, ore type, quality of environmental management and risk control, and the ability of the local ecosystem to buffer the impacts (Kauppila et al., 2011).

Although local communities may welcome the increased employment and wealth, tensions develop in many cases between these communities, the national government and mining companies (Crowson, 2009) as a result of contradicting views on the benefits and drawbacks. In general, the social aspects of mining encompass the well-being of personnel and the local community in which mining is performed. In practice, mining companies implement corporate social responsibility (CSR) strategies to strengthen their relationship with local people. These strategies generally include company performance reporting and programme to increase employee well-being and safety. The CSR strategies can also include various ways to increase the well-being of local communities, for example through investments in schooling and common infrastructure, and by funding and taking part in societal activities. Recent discussion in Finland about the social effects of mining (Eerola, 2013, 2008; Jartti et al., 2012; Mononen, 2012; Rytteri, 2012; Sairinen, 2011; Ziessler et al., 2013; Ziessler-Korppi, 2013) has focused on the social license to operate (SLO), which is a derivative of the local stakeholders' approval or acceptance of the mining activity (Prno and Slocombe, 2012). While CSR is an institutionalized umbrella framework for mapping and assessing a company's performance in social, environmental and economic terms, the SLO, as part of CSR, can be seen as a general viewpoint on a company's performance in achieving and maintaining the trust and approval of local stakeholders (Ziessler-Korppi, 2013).

The mining industry has already noticeably grown in Finland (PwC, 2012), and if the economic and political conditions remain favourable, this growth is expected to continue in the long run. In this paper, we assess three possible development scenarios for the metal mining industry in Finland. We consider the possible development lines in both economic and environmental terms through production, the levels of employment, material flows, energy use and carbon dioxide equivalents (CO_2-eq). Discussion is included on the possible challenges in achieving acceptability of the mining industry in Finland, and how the negative environmental and social aspects could be mitigated and positive aspects emphasized in the future.

2. Materials and methods

2.1. The mining model

To model the expected changes in the metal mining sector, we constructed a model based on the individual performance data of each mine (mine-by-mine approach). Public data sources, for example annual reports, public authority reports and environmental impact assessment reports, were used as source material. The structure of the model is described in Fig. 1, and the included mines are presented in Table 1 and Fig. 2. The expected amount of ore mining at each mine site in the studied years currently served as the only variable factor in this model. The variance in ore mining at individual mine sites was based on the possible plans for expanded production and possible extensions on the mine-life (based on deposit type: closed or open ore body, and the intensity of exploration at the site). Several mines have no plans to change the level of production, and in these cases, the mined amount was assumed to remain the same. The mine-specific constants specified in Table 2 describe the parameters for mineral flows and energy use, as well as the product mass and value per mined tonne of ore at each mine site. The scenarios were constructed by changing the expected amount of mined ore at mine sites at scenario end years (2020 and 2030), and aggregating the results.

Approaches to model mining and mineral futures vary, and several studies have already considered the future of mining in different contexts. These include narrative scenario-based works (e.g. World Economic Forum, 2010) which focus on considering the possible (geo)politics driven changes in factors affecting demand and supply of raw materials, and broad visions such as in Finland (Finland's Minerals Strategy, 2010) and Australia (Mason et al., 2013, 2011). Quantitative approaches have included regional projections considering the effect of political actions to the future resources use (e.g. Giljum et al., 2008), and global trajectories including system dynamic modelling reflecting differing societal perspectives (van Vuuren et al., 1999) or estimates of possible peaking of the resources use (e.g. Northey et al., 2014). The basis for the modelling in these studies generally varies from demand based (Giljum et al., 2008; van Vuuren et al., 1999) to supply based (Northey et al., 2014).

Comparing to these, the mining model presented in this paper falls to the group of supply based models, as the used data is mine by mine (or deposit by deposit)-data. However, the scenario hypotheses have been constructed after possible changes at the global markets (reflecting demand) and politics (national and international) which links the model also to the narrative scenario works (World Economic Forum, 2010). The biggest difference to the other supply based models is that the presented model covers only the mines and deposits occurring in Finland, when, for example, Northey et al. (2014) considers the global resources use. The goal of the presented modelling is to consider how the mining industry would most probably develop in a small, open economy (like Finland) affected by the changes in the global minerals market and the national and international minerals policy. In addition, our interest is to consider what kind of challenges the projected development lines would probably inquire at a local level.

2.2. The scenario-building hypotheses

Three scenarios are described in this paper: 1) the best estimate (BE) scenario, 2) the base-level (BL) scenario, and 3) the maximum (MAX) scenario. The BE scenario describes the most probable evolution of the Finnish metal mining industry in a positive market and political situation for mining. The BL scenario describes the

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