Mining in isolated areas: Establishing bridges for the development of socio-environmental management

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An appreciation of the economic values of socio-ecological issues and the identification of business risks and opportunities by integrating these issues into company operations, is a major change of how we understand and conduct business. This change was marked by The Economics of Ecosystems and Biodiversity (TEEB) report, launched in 2010. Since then, an extensive toolbox has been developed on how to measure the economic value of ecosystem services, which extends to broader aspects, both ecological and cultural.

The mining industry has been exposed to high financial and reputational costs in locations that are environmentally or socially vulnerable and where socio-ecological problems have arisen. Taking care of local people and biodiversity, and the value of it, should not only be a legal obligation, it must be understood as a vital component for medium and long-term industry success. Thus, mining has integrated many tools for environmental management; the emphasis being put into preventing and compensating immediate environmental impacts and restoration practices. Notwithstanding the importance of these recommendable actions, a sustainable approach requires supplementary tools for community participation and an integrated system for the conservation of ecosystem services, which —so far— have rarely been sufficiently implemented.

Andean mining activities are concentrated in isolated, mainly arid and semiarid areas, which are characterized by low human population density and low ecological net production. It is therefore often assumed that environmental and social vulnerability is relatively low. Yet, the physical and social isolation has produced some of the world's most valuable biological and cultural diversity, which 'Indigenous communities' value deeply. In this paper, emerging evidence on the global importance of these areas for natural and cultural heritage is reviewed and summarized, and strategies on how mining can improve their total ecological footprint highlighted. Similarly, strategies on how to better interact with local communities and how to draw opportunities that will change the focus from mitigation to prevention are presented.

INTRODUCTION

Why is biodiversity, from a biological and cultural perspective, crucial for the sustainable business development of the mining industry, particularly in isolated areas such as northern Chile? *Per definition*, mining is not sustainable because mineral deposits are being removed and are thus not available any longer. Therefore, sustainability in mining refers either to business sustainability or to sustainable development albeit both aspects are intrinsically interwoven. Economic profitability is the backbone for both because only the generation of revenues allows business to invest in positive socio-environmental actions. Profitability is also crucial as bad financial performance or, in the worst-case scenario, bankruptcy deflects all social and environmental risk and cost to the current and future society (e.g. Finnie et al., 2009). Sustainable development refers to the long-term net benefits in the environmental, social and economic realms whereby the sum of these benefits must be at least the same as the combined values prior the onset of mining.

Mining is vulnerable to socio-ecological problems and has been exposed to high financial and reputational costs in the past. Mining produces more hazardous waste than any other industry (Finnie et al., 2009). Current and future problems due to contamination, pollution and over-use of natural resources, in particular water, are obvious and easy recognizable. Thus, it is not surprising that some mining companies were on the forefront in adapting environmental management systems such as ISO 14001 (OECD, 2005), publishing information on economic performance, environmental information and social relations in sustainability reports (Perez & Sanchez, 2009), or achieving impressive successes in de-polluting some contaminated sites (Blacksmith Institute, 2009).

Many mining activities, e.g. the majority of Andean mines, are concentrated in isolated, mainly arid and semiarid areas. These are characterized by low human population density and low plant net production. It is often assumed, therefore, that the environmental and social vulnerability is relatively low in these regions (Lagos et al., 2002). Yet, a large number of social conflicts have arisen recently here (e.g. SDSG, 2010, Kronenberg, 2013). For example, Romero, Méndez and Smith (2012) have issued a stark warning: "*If the pertaining political changes are not implemented as soon as possible, without any doubt we are going to repeat the desolation and abandonment characterizing the ghost towns that remained after the nitrate mining boom*".

In this paper, we shed light on the emerging discrepancy between the increasing efforts to reduce the environmental footprint and to better include socio-environmental aspects in mining policies and procedures on the one hand, and the rising number of social conflicts on the other hand.

METHODS

Based on a quantitative literature analysis, the analysis of socio-environmental conflicts linked to the mining industry in Chile, and a qualitative literature review, we identify gaps between the goals of sustainable development and the emerging socio-environmental conflicts for mining with an emphasis on the Chilean mining industry. The quantitative literature analysis uses electronic databanks (*Elsevier ScienceDirect, JSTOR, Medline, SpringerLink, Taylor & Francis Online, Web of Knowledge, WileyOnline*) to screen for articles in peer-reviewed journals published during the last two decades (1994 to 1 July 2013). We searched for the co-occurrence of the keyword "mining" together with other relevant keywords in the title. Articles out of context (e.g. leaf-mining insects, data mining)

were excluded. We analysed the OCMAL report on socio-environmental conflicts in Latin America with regard to the mining industry in Chile (OCMAL 2013).

RESULTS AND DISCUSSION

Evolution of the environmental agenda in mining

It was not till the mid 1980s that environmental issues were considered within business management. The early 1990s led to a mining boom in Chile and triggered important economic growth, which had also a positive impact on local communities (Lagos, 2002). Especially during and following the 1992 Earth Summit in Rio de Janeiro Earth the mining industry became focus of attention because of its disastrous environmental record with regard to contamination, pollution and water use. A significant change of environmental policies followed on all levels leading to the imposition of new environmental laws in many national jurisdictions and new requirements for international standards, especially regarding trading with the United States and the European Union. Correspondingly, a sharp increase of scientific papers dealing with environmental problems of mining was observed from approximately 1998 onwards (Table 1). The vast majority of studies dealt with the imminent problems of pollution and contamination.

Table 1 Number of peer-reviewed articles in scientific journals containing the keyword "mining" alongside selected keywords. Shown are the total number of papers found (∑) and the proportions for the time periods 1994-7, 1998-2001, 2002-2005, 2006-2009 and 2010-2013 (up to 1 July 2013) in percent. Periods with major publication activity are highlighted in grey.

Keyword/s alongside "mining"	∑	1994	1998	2002	2006	2010
"contamination"	166	0.1	12	20	26	28
"pollution"	276	0.1	16	18	28	30
"environmental impact assessment"	22	0.1	14	41	9	23
"conservation"	30	0.2	13	27	13	27
"habitat", "ecosystem"	42	0	12	31	24	31
"conflict"	22	0	5	5	36	55
"sustainability"	45	0	2	18	33	42
"social responsibility"	22	0	0	23	27	50
"biodiversity"	8	0	0	13	25	63
"ecosystem services"	5	0	0	0	0	100

Whilst most mining companies initially resented the new regulations, the industry then started to embrace a new policy based on the recognition that *business as usual* was not an economically sustainable option any longer in the face of significant problems in reputation, sustaining profits, and maintaining the social licence to operate. This led to the launch of the Global Mining Initiative, GMI, in 1999 and the formation of the International Council on Mining and Metals, ICMM, in 2001 to advance the industry's commitment to sustainable development. Between 2000 and 2005, a series of guidelines and codes of good practice were developed and voluntarily implemented by the

major mining companies, often exceeding requirements set by national jurisdictions. Concurrently, the industry was an early user of environmental impact assessments, EIAs, as mirrored by the peak in papers on mining-related EIAs in the 2002-4 period (Table 1). Mining was also leading in the introduction of voluntary certification of environmental management systems, EMS, e.g. by certification according ISO 14001. Clearly, the introduction of ISO 14001 into Chilean mining created major successes, e.g. the gradual reduction of SO_2 emissions or the increase of environmental awareness within companies (Newbold, 2006).

Subsequently, topics about social responsibility, sustainability and biodiversity in mining started to emerge in the literature (Table 1). However, the number of these papers is a magnitude of order less than the papers about contamination and pollution. This mirrors the mining industry's general approach to mitigate environmental contamination at mining and processing sites. For example, in his review of sustainability in metal mining, Dold (2008) focuses solely on environmental contamination such as the discharge of heavy metals and other toxic agents, SO_2 and CO_2 emissions and acid drainage. Similarly, the first two *Enviromine* conferences of 2009 and 2011 focus on technological aspects of contamination prevention, mitigation and clean up. Northey, Haque and Mudd (2012) recently analysed sustainability reporting of the major copper producing companies around the world and provide operational data for use in life cycle analysis of copper products. These authors only consider material, energy and water consumption as well as greenhouse gas emissions for calculating the "environmental footprint". The focus on these issues and the corresponding technological fixes raises many concerns, in particular the quality of data collected and reported, and the important issues that are not raised or are being side-lined.

Many studies challenge the quality of data collected and reported for EMS certification and sustainability reports. Murguía & Böhling (2011) have analysed the conflict at the Argentinian flagship open pit mine Bajo de la Alumbrera using the company's 2009 to 2011 Sustainability Reports, which follow the Global Reporting Initiative, GRI, guidelines. The study reveals major discrepancies between reported indicators *versus* data reported by stakeholders or published in the literature. Environmental indicators were the most contentious and least reported. EMS certification including ISO 14001 has the major setback that it certifies environmental management and progress, but not performance. Standards are often applied inconsistently (Newbold, 2006), can lead to ceremonial behaviour, prefer mainly technical and administrative improvements (Boiral, 2007), and do not require disclosure of quantitative information. There is little evidence that EMS-certification has a significant positive impact on environmental performance nor that EMS-certified companies perform better than non-certified companies (Hertin et al., 2008). Even when quantitative data are published, most companies in most countries do not publish them and this has not been solved by the introduction of GRI guidelines (Hertin et al., 2008). For mining, Perez & Sanchez (2009) stress that reporting on environmental performance' did not reach full scores across companies and time.

The impacts of mining on biodiversity are rarely adequately addressed as mirrored by the very small number of papers mentioning "biodiversity" alongside "mining" in the title (Table 1). However, there is an increasing trajectory of published papers after 2010 and this raises hope that these issues will be better considered in the near future. Biodiversity is the sum of all life on Earth, its genetic and phenotypic variation, and the communities and ecosystems the organisms are part of. It is the foundation for ecosystem services and human life. Although pollution and contamination are important drivers for loss and change of biodiversity, habitat change and degradation are the major drivers. Studying critically endangered, endangered, or vulnerable mammals, birds, and amphibians, habitat change was identified as cause for the threat in approx. 85% of cases, compared to approx. 10% for pollution and approx. 20% for climate change (Pereira, Navarro & Martins,

2012). In other words, the minority of papers on and approaches for mitigation of environmental problems deal with the most severe and urgent problem for biodiversity. Land use change is one of the primary driving forces of regional ecosystem change. Yet changes in human density and human land use following mining operations have been rarely addressed.

Specific habitats such as the ecologically important Andean wetlands in northern Chile are focus of conservation action (Romero, Méndez & Smith, 2012). There are indeed many biodiversity-related projects supported by mining, but these projects are often short-term (COCHILCO, 2006a). Safe some exceptional cases such as the work on flamingos by Minera Escondida of BHP Billiton, in collaboration with Conaf, the results and achievements have not been made accessible to the general and academic public or being scrutinized by a peer-review process. Moreover, a substantial number of these projects are managed and implemented by government agencies. Asmüssen & Simonetti (2007) show that state protected areas are seriously underfunded and receive only 0.03% of the national budget despite that there are sufficient resources, but these are invested into agriculture, fisheries and forestry, which in turn encouraging resource overexploitation. Of course, mining is not responsible for state expenditure, but mining list tax payments as part of their corporate social responsibility (COCHILCO, 2006b). The serious underfunding was recently conformed by Waldron et al. (2013). The study identifies Chile being one of the ten countries worldwide, which invest the least in biodiversity! The ten most highly underfunded countries for biodiversity conservation are in descending order: Iraq, Djibouti, Angola, Kyrgyzstan, Guyana, Solomon Islands, Malaysia, Eritrea, Chile, and Algeria.

Arid areas are generally viewed as marginal because of low biological productivity and low value of ecosystem services (O'Farrell et al., 2011), but this is misleading for Andean arid areas. Chile's arid region is biologically unique, irreplaceable and similarly important as the biodiversity hotspots in, e.g., Southern Africa yet the importance for global conservation is insufficiently acknowledged. Funk & Fa (2010) used ecoregions, geographical zones that represent groups or associations of similarly functioning ecosystems, to identify priority areas for conservation based on species richness, and numbers of endemic and threatened species. The Atacama Desert ecoregion scores high for the proportion of endemic species. Yes, net plant and animal productivity and species richness are relatively low, but the number of endemic species is relatively high, meaning the region has been generating unique flora and fauna. Thus, the ecoregion belongs to the worldwide Top 100 ecoregions. Similarly it is listed amongst the Conservation International Hotspots and WWF's Global 200 ecoregions, highlighting the area's international importance for biodiversity and biological conservation. In the Atacama Desert ecoregion are the majority of Chile's mining operations located. How these operations have affected the ecoregion as a whole and extinction risk for single species remains uncertain. Even for mammals, which are alongside birds amongst the most studied organisms on the planet, there is a striking information gap (Valladares Faúndez, 2012).

From 2010 onwards, a new topic entered the discussion attention for sustainability in mining: ecosystem services (Table 1). This follows the worldwide realization that all the emerging environmental awareness and conservation actions on all levels – from individuals to NGOs and to business, from national jurisdictions to international treaties – has failed to reduce biodiversity loss. The International Convention on Biological Diversity, CBD, in 2002 manifested the international commitment to achieve a significant reduction in the rate of biodiversity loss by 2010. Yet, numerous publications demonstrate that this target failed spectacularly. Despite some local successes, all combined data on of the state of biodiversity showed continuing declines but all combined data on pressures on biodiversity showed increases (Butchart et al., 2010). The publication of *The Economics of Ecosystems & Biodiversity*, TEEB report in 2010 marked the emergence of new strategy aimed at

supporting the struggle against the tide of the fast disappearance of the world's biodiversity. It draws attention to the economic benefits of biodiversity by highlighting the growing economic cost of biodiversity loss and ecosystem degradation. One approach is the anthropocentric, monetary valuation of ecosystem services, i.e. the ecological mechanism and processes that fulfil and sustain human life. Despite the complexity of the task – especially in developing countries (Kenter et al., 2011) - and the current impossibility to give economic values to some ecosystem services (Li et al., 2011), first results are emerging from the mining industry. For example, the loss of ecosystem services in a coal mining area in China by far exceeded the economic value of mined coal over the last 50 years (about US$ 2001 million *versus* US$ 870 million, Li et al., 2011).

In Chile, the majority of mining operations are located in the upland arid regions in the north of the country. Here, ecosystem service valuation takes place explicitly. Water resources are very scarce, but essential for both, mining and people. Especially farming in downstream areas is highly affected by water scarcity and pollution. The current legislation, the 1981 National Water Act, leaves water rights to the free market; water rights are owned and can be freely traded by private persons and entities. In the North, water rights have attained peak market prices and mining is outcompeting farmers and local people (Oyarzún & Oyarzún, 2011). Despite the introduction of voluntary, informal water roundtables, access to water, over-use and pollution are central to the emerging social conflicts outlined in the next chapter. Moreover, a recent study on the valuation of ecosystem services in arid regions of Southern Africa has demonstrated that economic values are generally low in arid biomes compared with values derived for other biomes and regions (O'Farrell et al., 2011). Critically, these values do not adequately reflect the benefits for local communities and even small changes in access to natural resources can have major welfare effects.

Socio-environmental conflicts & mining in Chile

The attention to corporate social responsibility, CSR, has steadily increased since 2002 (Table 1). This includes projects involving local communities, but CSR also targets other stakeholders such as shareholders, suppliers, customers, and employees (COCHILCO, 2006b). From the OCMAL (2013) study we identified 25 new socio-environmental conflicts linked with mining in Chile between 1985 and 2010. There were two emblematic cases at the end of the 1980s, three cases during the 1990s but from 2000 onwards a dramatic increase was registered, in total 20 between 2000 and 2010 (Figure 1). Altogether 88% of cases were located in arid zones in northern Chile (15 in the regions III and IV; 7 in regions I, XV and II) and only 12% in the southern regions VII, VIII and X. Additional cases of conflicts have been published by the social platform AUNA (www.auna.cl) in 2012. The additional 17 cases are related to mining, but are not solely focused on the mining industry as OCMAL cases. For example, the current conflict about the hydro-energy projects in the southern Chilean Aysén region and the corresponding power lines to the north, are partially driven by mining, as mining activities are substantial energy consumers and the energy requirements are steadily increasing (e.g. energy reports by Comisión Chilena del Cobre, www.cochilco.cl). We have not included these cases here as mining is not exclusively driving these projects. Yet, it is important to be aware of these as they influence the "social licence to operate" for the mining industry.

Most new conflicts arose in region III, where agriculture is crucial for local economic development and where severe damage has previously occurred. All of the conflicts include biodiversity issues as a transversal common factor, although it is not always mention as such. Most of the biodiversity threats are linked with the decrease of water supplies and pollution, which can seriously affect local flora and fauna, and agriculture. Most of the conflicts are related to new mining projects, and remain unsolved or in court.

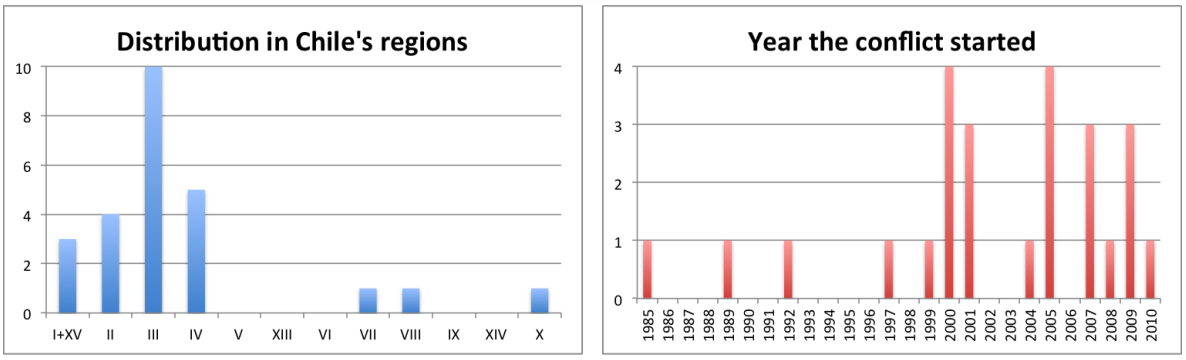

Figure 1 Cases of social conflict with mining in Chile according region (left) and time of onset (right)

Social or environmental conflicts are considered significant risk factors, and reflect in the economic valuation of the company. Increasingly, investors such as pension funds are considering socio-environmental conflicts and ethical behaviour as one important decision-making criterion and international regulations have been set for ethical investment (Mychalejko, 2012). The Ernst & Young (2012) business risk radar for mining and metals for 2012/13 lists several socio-environmental risks in the top agenda. Under the Top 10 is the "social licence to operate", which includes both, social and environmental aspects, emphasizing that it is not just a compliance exercise. "*Governments and communities are also becoming more sensitive to social, political and environmental issues and their expectations of baseline social license to operate practices have now increased*." Of increasing importance as risk factors are "access to water and energy" and "competing demands for land use".

CONCLUSIONS: BUILDING BRIDGES

Mining has been one of the main drivers of cultural development for thousands of years, and remains essential for our current lifestyles. Sustainable mining is key for a sustainable future. Over the last twenty years, the mining industry has been an early adopter of environmental certification, has reduced pollution, has embraced sustainability reporting, has launched many socio-environmental initiatives, and has invested in CSR responsibility projects. Yet, the number of conflicts with local communities has increased. Most of these conflicts are linked with environmental concerns so they cannot be separated from social concerns. To bridge this widening schism and repair the foundations of the relation between mining and the socio-ecological environment, we need first to identify the underlying problems and then to address these.

The boom in addressing the socio-environmental problems has focussed and still is focussing on the more "urgent" problem of water use, energy saving, clean technologies, pollution reduction and mitigation, recycling and waste management. Longer-term objectives have been voiced (e.g. the ICMM initiatives; Johnson, 2005), but the emphasis remains firmly with a technical focus. For example, environmental policies are largely managed by technical or environmental engineers and by lawyers, with natural and social scientists and specialists remaining peripheral for decision-making. The biodiversity of isolated and desert areas is not always easily discovered, and is normally hidden for the non-expert eye. From mammals that live underground, to bacteria highly sensitive to the PH level or water temperature of the wetlands. Valuable archaeological sites remain undiscovered under the desert and some places that might look ordinary for an outsider, can be

actually ancient sacred places of worship. Yet there remains a striking data deficiency (e.g. Valladares Faúndez, 2012). Reporting environmental data remains highly contested and some authors accuse of "greenwashing" and the "credibility gap" (Fonseca, 2010). The GRI is heavily contested in the academic literature as it is perceived as "misleading" or even helping to camouflage unsustainable practices (Fonseca, McAllister & Fitzpatrick, in press). Thus, sustainability reporting can provoke or exasperating conflicts instead of helping to mitigating them (Murguía & Böhling 2011).

A transformation into new business strategies, which considers a broader approach to ecosystem services is required. The damage to the environment has created a global climate change, which set business in front of a very uncertain future. Markets are global, the economy is global and environmental responsibilities must be assumed as global as well. Companies are not longer sole responsible only for their direct production but are considered part of a broader network of suppliers and stakeholders (SDSG, 2010). The economic cost of conflicts cannot be overlooked, as they can create delays that can cost several millions dollars per week, without counting the impact on the company's reputation. Research "*confirm[s] that some of the most significant costs to companies relate to disruptions to production, lost opportunities and the amount of time staff spent managing existing or escalating conflict"* (Davis & Franks, 2011). After facing social and legislative problems during the last few years, and with an increasing international pressure towards the valuation of ecosystems services, mining companies are becoming more aware of the importance of dealing with environmental and social issues from a very early stage of development of a project, till the final closing stage. Prevention is little by little being considered more important than mitigation, although a short-term vision prevails, and long term and consistent plans are still the exception, rather than the norm. Further research would be required to determine the reasons why long term and interdisciplinary programs have not been put into place, why the previous plans failed or were interrupted and why despite the growing interest of the industry from an international perspective, socio-environmental conflicts have increased in the region.

Biodiversity and social aspects are still considered secondary or optional, and managed with a top down approach, which is sometimes contra-productive. The main critic to the current guidelines is their hierarchical approach, which sets the communities and other stakeholders in an unequal relation (Sirolli, 2009). Institutional changes and political changes are urgently required (Bebbington, 2009). Moreover, there remains a strong feeling that governments and legislation are favouring mining companies, for example regarding water rights in Chile. "*Ecosystems and local communities have lost the battle*" (Romero, Méndez & Smith 2012). The "inequalities in the distribution of wealth" can ignite new conflicts (Ernst & Young, 2012). Therefore, "sharing the benefits" is one of the most important emerging risks for the mining industry. Understanding the real value and complexity of socio-environmental aspects and shifting these policies as a fundamental pillar of the business model of the mining industry is vital for the survival of natural resources and the biological diversity of highly endangered ecosystems, the subsistence of vulnerable cultural heritage of isolated communities and the long term economic viability of the mining industry, which is crucial for the economy of the country.

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