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IMPLEMENTATION OF POLICY RESPONSE PACKAGES TO PROMOTE SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES

Confronting Sustainability in the Mining Sector
Role for a Sustainability Fund

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NOTE

The views and interpretation reflected in this document are those of the author(s) and do not necessarily reflect an expression of opinion on the part of the United Nations Environment Programme.

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EXECUTIVE SUMMARY

I. Introduction

The last two decades have shown progress in establishing baselines for sustainable development in diverse industries, including the mining sector. There have been various initiatives that, stretching beyond the concerns of a specific company or country to an international level, must be considered in this context. Amongst these are: the Mining, Minerals and Sustainable Development Initiative, the Consultative Forum for Sustainable Development of Non-Ferrous Metals, and the Mineral Resources Forum of the Environmental Programme of the United Nations.

In the mining sector the question of sustainability is more complex than in most other industries. This is mainly due to two reasons:

1. production is based on a finite resource, at least on a local scale
2. there is normally a strong degree of interdependence between mining exploitation and the local or regional community.

In the past, there have been proposals in Chile to create a Sustainability Fund based on an additional tax on mining exploitation.[1] However, in both the theoretical studies and in general debate, many questions regarding the Sustainability Fund remain unanswered. Some of the more basic ones are:

- How should the collected funds be earmarked? It is unclear whether the aim is to pay "compensation" to the state, or if the motivation is linked to sustainability at the mining area / regional level.
- Is an additional tax on mining exploitation justified or could there be other forms of financing?
- Who should administer the funds?
- How should the funds be distributed?

Moreover, the permanently occurring conversion of capital - in the form of contributions by the mining sector to infrastructure, to the community, or to the formation of human or social capital - has not been discussed sufficiently.

The present study offers a detailed analysis of the Sustainability Fund proposal and investigates the answers to the aforementioned questions. Sustainability is basically seen at a local level, and the analysis is directed at sustainability within the mining regions,[2] rather than on a national scale. In this sense, the argumentation underlying imposing taxes on the exploitation of natural resources - which is directed towards paying compensation to the state and towards national sustainability - is different to the Sustainability Fund proposed here which has a more local incentive.

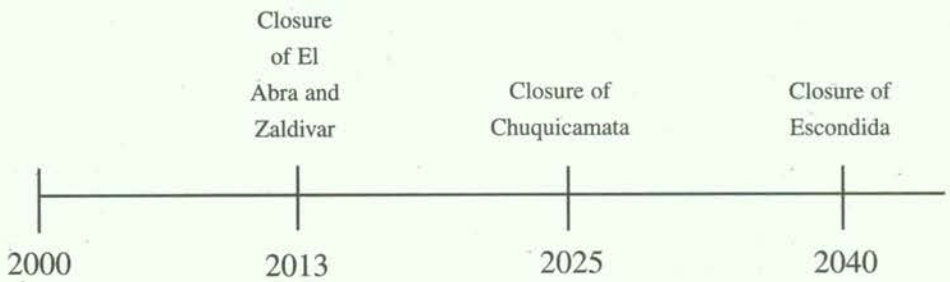
[1] For example: Villarzú (1997), Claude (1997), Bitar (1997).

[2] Specifically the Antofagasta Region (Region II) due to the importance of the mining sector in terms of production, export, investment and employment.

II. Sustainability issues

The present study analyses the economic, social and environmental sustainability issues related to mining at the national and in greater detail, the local level. The crucial issues that have to be confronted to assure sustainability at the local level include the need for greater diversification of production, the problems related to use of water resources, issues related to biodiversity, as well as the challenges of integrating mining companies into the local community.

Economic aspects
In 1996, the mining sector contributed 56, 47, 22 and 15 per cent of the GDP in Regions II, III, IV and I respectively. Between 1979 and 1999, the percentage of investments in Regions I, II, III and IV in mining were 98, 95, 98 and 93 per cent respectively. In the context of diversification of production it is important to look at the lifetimes currently estimated for the most important mining operations[3] in Region II:



Social aspects
The most significant social aspects concern the transitory nature of mining employment for many of the workers, and the integration of the mining company into the community. In the past the integration or lack of integration was termed "camp culture". Although there has been progress in recent years towards a greater integration into the local community, it is necessary to advance the discussion on the different focuses applied by the different companies, and of evaluating the successes and failures. Additionally, in Region II, due to the high percentage of indigenous population in the region[4] there is the relationship between the mining sector and the indigenous groups to be addressed.

Environmental aspects
Problems such as abandoned tailing dams, the use of water resources, and the impacts on landscape and biodiversity are issues that have still not been systematically analysed. These subjects must be addressed in order to plan the Fund's activities.

Abandoned tailing dams present a serious risk for the population and the environment. In Chile there are approximately 658 tailing dams between Regions II and VII, in addition to other mineral

[3] They are responsible for between 80 and 90 per cent of the regional production. Data is as of 2001.
[4] According to figures given by CONADI, the figure is about 25 per cent, supposing all rural population is indigenous

deposits such as: tailing deposits, leaching gravel deposits, mining residue deposits, filtered tailing deposits, etc. According to an official survey on tailing dams, approximately 28 to 40 per cent of the tailing dams in Chile are abandoned.

With regard to water resources, water consumption in the desert Northern Regions is a crucial issue. In Region II, the mining industry is the main owner of the total water rights (11,208 l/s), which is close to the total water offer estimated to be available. On the other hand, agricultural activity is the main water consumer in the region, consuming significantly more water than the rights they hold. There is a potential for conflict if the mining industry should wish to make use of all their water rights. Other problems relate to the lack of information with regard to the market for water rights, as well as to the sustainability of the aquifers, the interaction between underground water and surface water, combined with the absence of a law establishing a minimum ecological flow to assure a sustainable development of each ecosystem. Finally, some groups within Chilean society find themselves at a disadvantage regarding their participation in the water use rights market. This is particularly the case of the indigenous peoples where their different cultural perception of water resources, as well as their lack of tradition or training in participating in the sale and purchase of water use rights could constitute a significant problem.

There is little information about the impact of mining activity on biodiversity. The effects upon biodiversity have only been studied in private sector Environmental Impact Studies (EIS), and even then only at a relatively generic level.[5] The impact upon aquifers and salt pans is not generally analysed in great detail. The high Andean plateau zone of Region II, where there is a large number of salt pans as well as a significant number of mining operations, represents one of the most fragile and inhospitable Andean ecosystems, due to the combined effects of low temperatures and extreme aridity.

On the basis of the assessment of sustainability as well as an analysis of existing policy instruments to confront sustainability issues, the study proposes creating a Sustainability Fund that would be based on voluntary contributions or on a special tax. The current level of voluntary contributions by mining companies in the region is assessed in order to provide input on the two alternatives.

Private mining companies make the largest voluntary contributions to the region in the form of assistance to their employees. For example, in 1998 the mining company La Escondida (MEL) set aside US$11 million to help their employees; the Compañía Minera Zaldivar (CMZ), in 1998 set aside US$6 million with the same purpose. Generally, the contributions made by the companies to their workers are mainly in the areas of education and housing, whereas the contributions to the community are in the areas of education and health.

Quantifiable contributions to the community do not normally exceed US$200,000 annually, with the exception of Chuquicamata which contributes US$1.3 million annually, and La Escondida which has created a foundation dedicated to strengthening local community issues with a budget

[5] Except for some very exceptional initiatives by different companies (such as the flamenco or the marine biodiversity projects by La Escondida Ltda., or the biodiversity guide for schools published by the Compañía Minera Zaldívar.

of about US$3,000,000 annually. However, the non-monetary contributions, through the contribution of goods, human resources, time and infrastructure loans is often very significant. Various examples of these contributions are given in the study. It must also be remembered that quantifying the contributions has often been impossible, especially in terms of infrastructure, so this figure is not included in the amounts mentioned.

III. The Sustainability Fund

The proposed Fund would be dedicated to priority sustainability issues as defined by a participative process in which all regional actors have a say. The recommendations in the study should serve as a basis for concrete discussions on the activities to be coordinated by the Sustainability Fund.

Economic aspects

There do not seem to be many options for alternative development within Region II. The task, therefore, is not only centred on the identification of potential alternatives, but also on an expansion of the other production sectors alongside mining. In this context, the idea of consolidating a production cluster around the mining sector has been considered, parallel with the need to diversify production.

Two types of potential mining clusters for Region II are identified: if the policy objective is regional competitiveness, then the cluster must be orientated towards the main suppliers. If the policy objective is regional development, then the cluster must be orientated towards the small and medium-scale suppliers. Since the small and medium-scale suppliers in the region (services, commerce, hotels and industry sectors) make up 99 per cent of the companies and 97 per cent of the work force, and one of the main objectives of the 2001 Regional Development Strategy is "increasing retention of profits within the region", the regional industry's attention as a group should be in adding long-term social and economic value. This supports the idea of favouring a cluster focused on development.

Different private and public initiatives exist that could be contribute to a more systematic approach, and when considering potential activities for the Sustainability Fund. The report describes these existing initiatives in some detail. On the basis of this information the study proposes that the Fund should concentrate on encouraging investment in science and technology in the mining sector, as well as on promoting increased and constant information flow between universities and companies, and on mitigating the information asymmetry between large mining companies and the suppliers.

Environmental aspects

Regarding water conservation and use, a diagnostic study of the current market situation for water in the region is proposed, including an evaluation and analysis of the functioning of the market. This will generate concrete proposals on how to improve efficiency and increase information availability and accessibility. A study should be carried out to identify the water offer in each basin and propose ways of encouraging technological innovation and fostering investment in irrigation techniques. The generation of an exchange mechanism for buyers and sellers of water rights could be considered. Finally, it is proposed that the sustainability fund sets aside resources to assist the indigenous communities in the acquisition and inscription of their water rights.

Regarding biodiversity conservation, the Fund should be directed towards compiling information on biodiversity and establishing a register (in areas where information is insufficient or incomplete) of which species are found in different sectors of the region and in what state of conservation; detecting which ecosystems are important for the conservation of biodiversity and how fragile these are, etc. The salt pans, due to their diversity and fragility and the fact that they contain endemic species, are extremely important for the conservation of biodiversity. The large number of salt pans should be studied in an integrated way, creating registers of the species that live in them or that depend upon them in some way. The Fund could also carry out studies on the biology of species with conservation problems and support the possibility of breeding programmes. Another important function for the Sustainability Fund could be the protection of natural areas that are interesting for their biodiversity and unique ecosystems.

Social aspects

The study has elaborated some specific areas to be taken into account including, above all, a list of socio-economic and cultural issues and a definition of priority areas.

The need to create or strengthen a regional identity and a sense of caring for the quality of life in Antofagasta and the region has been identified as one of the priority issues. For example, improvements could include enhancing and improving the beaches, creating more park facilities, more sporting facilities, improved museum facilities, etc. But it has also been emphasized that it is not only physical infrastructure that is required, but very often programmes and contributions in terms of human resources, or, sometimes, a change in attitude.

Coordination and the creation of social capital should be encouraged. In this context, two specific initiatives could be undertaken by the Sustainability Fund: 1.) An "exchange for project ideas" could be established at the regional level. This "exchange" could be an Internet site (run by the Sustainability Fund) where project ideas could be posted by anyone interested, and discussed with other actors. 2.) Once a year an event could be organized in which ongoing and finished projects carried out by the mining companies, other companies or the public sector, are presented to the public. This same event can help to foster coordination and cooperation in generating new project ideas and to raise public awareness to the achievements of the region.

ABBREVIATIONS AND ACRONYMS

ARD	acid rock drainage
CIPMA	*Centro de Investigación y Planificación para el Medio Ambiente*
CMZ	Mining Company Zaldivar
COCHILCO	*Comisión Chilena del Cobre* (Chilean Copper Commission)
CODELCO	*Compañía Nacional del Cobre* (National Mining Company)
CONADI	*Corporación Nacional Indígena* (National Indigenous Corporation)
CONAF	*Corporación Nacional Forestal* (National Forestry Agency)
CONICYT	*Comisión Nacional de Investigación Científica y Tecnológica* (National Commission on Scientific and Technological Research)
CORFO	Production Promotion Corporation
DFID	Department of Internal Development
DGA	*Dirección General de Aguas* (National Water Authority)
DIA	Environmental Impact Declaration
EIA	Environmental Impact Assessment
GDP	gross domestic product
GMI	Global Mining Initiative
GNP	gross national product
IDRC	International Development Research Centre
IIED	International Institute for Environment and Development
INE	National Institute of Statistics
MEL	*Minera La Escondida Ltda.*
PROFO	*Programa de Fomento*
SAG	*Servicio Agrícola y Ganadero* (Agricultural and Livestock Service)
SERCOTEC	*Servicio de Cooperación Técnica* (National Agency for Technical Cooperation)
SERNAGEOMIN	*Servicio Nacional Geológico y Minero*
SNASPE	National System of State Protected Wildlife Areas
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization

CONTENTS

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Thanks are due to the participants of the two workshops that were organized at the national and regional level who made valuable contributions to the project team.

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UNITED NATIONS ENVIRONMENT PROGRAMME

The United Nations Environment Programme (UNEP) is the overall coordinating environmental organization of the United Nations system. Its mission is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing and enabling nations and people to improve their quality of life without compromising that of future generations. In accordance with its mandate, UNEP works to observe, monitor and assess the state of the global environment, and improve our scientific understanding of how environmental change occurs, and in turn, how such changes can be managed by action-oriented national policies and international agreements. UNEP's capacity building work thus centers on helping countries strengthen environmental management in diverse areas including freshwater and land resource management, the conservation and sustainable use of biodiversity, marine and coastal ecosystem management, and cleaner industrial production and eco-efficiency, among many others. UNEP, which is headquartered in Nairobi, marked its first 25 years of service in 1997. During this time, in partnership with a global array of collaborating organizations, UNEP has achieved major advances in the development of international environmental policy and law, environmental monitoring and assessment, and our understanding of the science of global change. This work has, and continues to support, successful development and implementation of the world's major environmental conventions. In parallel, UNEP administers several multilateral environmental agreements including the Vienna Convention's Montreal Protocol on Substances that Deplete the Ozone Layer, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (SBC), the Convention on Prior Informed Consent procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention, PIC) and most recently, the Cartagena Protocol on Biosafety to the Convention on Biological Diversity as well as the Stockholm Convention on Persistent Organic Pollutants (POPs).

DIVISION OF TECHNOLOGY, INDUSTRY AND ECONOMICS

The mission of the Division of Technology, Industry and Economics (DTIE) is to encourage decision-makers in governments, industry, and business to develop and adopt policies, strategies and practices that are cleaner and safer, use natural resources more efficiently and reduce pollution risks to both human beings and the environment. The approach of DTIE is to raise awareness by fostering international consensus on policies, codes of practice, and economic instruments through capacity-building and information exchange and by means of pilot projects.

ECONOMICS AND TRADE BRANCH

The Economics and Trade Branch (ETB) is one of the Branches of the Division of Technology, Industry and Economics (DTIE). The work programme of the Branch consists of three main

components: economics, trade and financial services. Its mission is to enhance the capacities of countries, particularly developing countries and countries with economies in transition, to integrate environmental considerations in development planning and macroeconomic policies, including trade policies. UNEP's mission in this field is also to address the linkages between environment and financial performance and the potential role of the financial services sector in promoting sustainable development. The trade component of the Programme focuses on improving countries' understanding of the linkages between trade and environment and enhancing their capacities in developing mutually supportive trade and environment policies, and providing technical input to the trade and environment debate through a transparent and a broad-based consultative process.

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1. INTRODUCTION

Over the last two decades there have been efforts to establish baselines for sustainable development in a number of industries. The criteria for sustainability have been partly reflected in a number of international certification and eco-labelling systems, as well as in codes of conduct and environmental auditing schemes. In very general terms, these systems refer to an internal environment policy or policy of sustainable development, a compliance with prevailing environmental standards and norms, the relationship between the company and the local community, and other issues related to the exploitation of natural resources.

In the mining sector, there has been a significant search for effective instruments of sustainable development. At the international level there are currently at least four important initiatives to consider: the first is the Global Mining Initiative (GMI) which is organized by the mining companies and aims at the promotion of sustainable development, having on its short term horizon an International Seminar on the topic in 2002. The second is the Consultative Forum for Sustainable Development of Non-ferrous Metals, organized by the International Copper Study Group, the International Nickel Study Group and the International Lead and Zinc Study Group. The purpose of this forum is to discuss and develop the necessary components for an action plan for the implementation of sustainable development. The third initiative is the International Council on Metals and the Environment, and the fourth is the Mineral Resources Forum of the United Nations Environment Programme.

In the mining sector, the question of sustainability is undoubtedly more complex than in most other industries, basically for two reasons:

1. production is based on, at least locally, a finite resource;
2. there is often a strong degree of interdependence between the mining exploitation and the local and regional community.

In the 1980s, the first point led to the development of what is known as the "weak sustainability theorem", which proposed the conversion of the natural capital, the resource, into other forms of capital. The creation of a Sustainability Fund was suggested in order to put into operation the conversion of the resource and provide a permanent income flow through interest payments from the fund.

However, in this proposal, many questions remain unresolved. Some of these are:

- Who should collect the funds?
- Who should administer the funds?
- How should the funds be distributed?
- Does the distribution depend on the ownership of the resource or on other criteria?
- What should the funds be destined for?

If the conversion of natural capital into other forms of capital is really related to sustainability, then with the funds collected, sustainability in all senses should be assured: economic, social and environmental. However, this view does not provide an answer to what that sustainability is. Thus, it appears that the conversion of capital is only a partial answer to the complex issue of sustainability, and that rather than offering the final word on the issue of sustainability, it should provide only an orientation to what should be seen as the basis of sustainability: the provision of a permanent income flow. This permanent income flow might be obtained through the creation of a fund, or it might be obtained through reinvestment of the capital into other industries, technological innovation, or the provision of a social and environmental infrastructure such as the creation and development of social capital, the improvement of public space, the protection of the environment, etc.

What is clear is that there are many different issues that have to be considered concerning the overall question of sustainability, which cannot be resolved simply by providing a formula for the amount of capital to be accumulated over time.

In Chile, the discussions in 1997/1998 on imposing additional taxes on the exploitation of natural resources can be understood partly against this background. Even though there were also other relevant arguments in that discussion,[6] several proponents suggested the creation of different types of Sustainability Funds. The amounts proposed were very similar in each case. Also, the possibility of creating an Environment Fund based on voluntary or specific obligatory contributions was raised.[7]

On first view, from an environmental perspective, the imposition of a tax on the exploitation of a resource would seem only a partial solution, as the tax is not directly linked to solving any of the specific issues of sustainability,[8] and thus does not provide an incentive to encourage certain behaviours related to sustainability. Another complication of taxation in the Chilean context is that, by constitution, earmarking of tax receipts is not permitted, and only in very exceptional cases can a presidential decree lift this regulation.

In the following chapters, the question of sustainability and the potential use of a fund to promote sustainability will be analysed in detail. The different analytical steps will include the following:

1. Identification of the issues of sustainability related to the mining sector
2. Analysis on the regional level -
   - identification of sustainability issues in the selected mining region
   - analysis of existing instruments and initiatives
   - analysis of the usefulness of the proposed Sustainability Fund
3. Recommendations for activities of the fund
4. Examination of the financial base of the fund.

[6] For example, the question of the distribution of the Ricardian rent that has been considered excessive by some actors, the ownership of the resource by the state, the question of foreign investment and its influence on the exchange rate, or the question of the different tax situation between state owned and privately owned companies.

[7] See Blanco, Borregaard, Wautiez (1997).

[8] Except for the question of the finiteness of the resource.

2. SUSTAINABILITY AND THE MINING SECTOR

Sustainability[9] in the mining sector is intrinsically related to the economic, environmental, social and cultural sustainability of those countries or regions which depend heavily on mining as a source of income and development.

With regard to economic impacts, it is important to determine the sector's importance for the country, and identify which regions depend heavily on mining for their development and survival. Moreover, it is important to know what proportion of the resources invested in mining in a specific region remain there, and what proportion is transferred to other zones of the country or other nations. With minerals being a non-renewable natural resource, if sustainable development is to be achieved, it is important that a share of the natural capital remains in the region in the form of human, financial or technological capital, thus permitting the zone's growth and progress to be maintained once mining operations close down.

On the other hand, mining uses a large quantity of environmental inputs for production (air, water, soil, etc.). A sustainable use of these resources should be achieved, minimizing potential effects on the ecosystem, biodiversity and people's health. Additionally, it is important that the mining companies' use of environmental resources does not affect other production activities in the region, nor the future generations' option to use these resources. To the degree that this is achieved, a sustainable use of the resource will be taking place, in the knowledge that these resources will be available in the future.

On social issues, there are variables related to the socio-economic as well the socio-cultural dimensions. In the socio-economic dimension there is unemployment, effects on indigenous communities, company-community relations with regard to investment into education and health, as well as the management of post mine closure social issues. Probably the most important aspect of the socio-cultural dimension is the emergence of "camp cultures" that develop in the mining areas.

There are various studies which tackle the theme of mining sustainability, either from one aspect (economic, environmental or social) or in its entirety. Some of the institutions involved in financing or carrying out these studies are the World Bank, the United Nations Industrial Development Organization (UNIDO), the United Nations Environment Programme (UNEP), the International Development Research Centre (IDRC), and the International Institute for Environment and Development (IIED).

II.1 Mineral taxation versus sustainability fund

In the past, mineral taxation has been proposed as a means to counter some of the sustainability issues mentioned above. Governments are aware of the need to minimize environmental damage, to internalize environmental costs, to create two way linkages between the mining companies and the local economy, and to take care of the social and cultural needs of the local communities, especially in the period after mine closure. They are also aware of the fact that in most cases the

[9] In Annex 1 there is a brief description of the general concept of sustainability.

government is the owner of the resources and should therefore receive part of the surplus obtained through minerals exploitation - the resource rents should accrue not only to the company but also to the government, as national assets are being depleted.[10] Finally, governments are aware of the situations that can lead to excessive rents and therefore want to tax these excessive rents in particular ways.[11]

The tax structure is one of the traditional policy instruments with which public goals are pursued. Taxation schemes have thus been elaborated in order to maximize a return to society on the exploitation of mineral resources. The different methods of minerals taxation have been described in the literature,[12] and a brief overview is offered here. Basically three types of taxation schemes are distinguished:

- rem ("goods") taxes
- personal taxes
- special tax provisions.

The following table summarizes the different approach in each of these categories:

[10] This is what is referred to as the Hotelling rent, which takes account of the inter-temporal scarcity and thus is often referred to as the "user cost" of the scarce resource. For a more detailed description see for example Figueroa (1999), pp.141-164.
[11] For a discussion of the concept of excessive rents see Figueroa (1999), pp.106-116.
[12] For details see Otto et al. (1997) and (1999). Other examples include Figueroa (1999) or Otto (1995).

Table II.1: Different methods and practices of minerals taxation

Tax method	*Tax base*
Rem taxes	
Specific or unit royalties	rates defined in terms of volume or weight
Ad valorem royalties	rates defined in terms of value
Sales taxes	rates defined in terms of value
Export duties	rates defined in terms of value of sales
Property taxes	fixed rate on the assessed value of reserves and physical plant
Import duties	rates defined in terms of value of inputs
Registration fees and stamp duties	fixed amount
Land usage or rental fees land	rates defined in terms of some measure of size of
Personal taxes	
Proportional income taxes income	rates defined in terms of a percentage of taxable
Progressive or additional profits taxes	invokes a significantly higher income tax rate on all taxable revenues after the project has earned a specified threshold rate of return on its total investment
Resource rent taxes	taxes on the basis of the user cost of the resource
Withholding taxes	tax applied to interest and dividends (basically on the repatriation of profits)
Special provisions	
Foreign exchange controls	requirement on foreign investors to surrender foreign exchange earnings to the central bank, companies having to repurchase foreign currency at official rates ("tax" based on the spread between buying and selling rates)
Government equity	reservation of the right by the government to become equity participants in mining projects
Environmental and performance bonds	requirement for the establishment of performance bonds as security for post-mine closure risks

Source: Author's elaboration on the basis of Otto et al. (1997).

In traditional tax schemes, not much emphasis is given to issues of sustainability. The objective is predominantly fiscal revenue creation, with the argumentation of Ricardian rents,[13] ownership, or the existence of excessive rents.[14] The resource rent is potentially the tax most closely related to sustainability issues. Royalty schemes, reflecting issues of ownership and as such a concern with the depletion of the resource, deal with the resource rent in an inefficient way, as these schemes are mostly based on a percentage of gross rather than net income. Resource rent in its pure form would imply that, as Otto et al. (1997) state; "taxes are deferred until all expenditures have

[13] These are the traditional rents derived from differences in the quality of the resource or the overall business. For a discussion of Ricardian rents in the context of minerals extraction see Figueroa (1999), pp.141ff.

[14] ibid.

been recovered and the project has yielded a pre-specified rate of return on investment. Only then, a very high rate of marginal tax is applied to all subsequent operating revenues."

Even though there are basically two sustainability issues that should be taken into account in government policy regarding mineral taxation (one directed at sustainability on the local level and the other directed at earning a return on the depletion of national assets and capturing excessive rents), local issues have mostly become secondary, and the collection of funds for the overall government budget has been at the foreground of tax schemes. The literature available did not offer sufficient information to add another column "destination of tax receipts" to the above table, which could have related the taxation schemes to their objectives, including sustainability issues. The tax schemes that could potentially be related to sustainability issues are resource rent taxation, royalties, environmental taxes and performance bonds.

In practice, in the 25 countries and states[15] analysed in Otto et al.'s (1997) study, income taxes, royalties and value added taxes are the most widely used. In tax burden terms, less significant but also widely used, are land use fees. In some countries, requirements to use local goods and services apply. Resource rent taxes or environmental taxes are not mentioned in any of the 25 countries under analysis. However, excess profit taxes have been applied in some of the countries. Resource rent taxes are not considered to be significant taxes.[16]

The applicability of the above-mentioned schemes in the context of sustainability can thus be regarded as very limited. Even if resource rent taxation schemes were more widely used, the question of sustainability would be directed at the destination of tax receipts more than at the tax itself. Thus, mineral taxation should not be considered to be either a widely used or an efficient means of addressing sustainability issues, especially when considering the local level. New approaches will have to be developed to deal with social, economic and environmental sustainability at the local level. These approaches do not necessarily have to be based on taxation, but should be efficient and effective instruments to tackle clearly identified and well-defined issues.

One of the first approaches is the proposal for a Sustainability Fund. The reasoning for a Sustainability Fund is based on the understanding that the sustainability of economic development in the mining regions requires that part of the revenue of mining exploitation be destined to the formation of capital in the region. This conversion of natural capital into other forms of capital should guarantee a permanent income in the region. Different authors[17] have elaborated different formulae to calculate the "value" of the natural capital, or the portion of the rent that should be invested into capital formation in the form of a Sustainability Fund. This approach is directly related to the resource rent taxes, but it contains the additional element of indicating, at least in a general way, that the receipts should be destined to creating more sustainability in the mining region, directing attention towards local sustainability issues. However, several questions on the general approach of the Sustainability Fund remain open:

[15] Ethiopia, Ghana, Ivory Coast, Namibia, South Africa, Tanzania, China, India, Indonesia, Kazakstan, Papua N.G., Philippines, Uzbekistan, Western Australia, Greenland, Sweden, Argentina, Bolivia, Brazil, Chile, Mexico, Peru, Arizona USA, Ontario Canada, and Nevada USA

[16] See Otto (1997) Table 3.4.

[17] Interested readers are referred for example to Gomez-Lobo (2000) and the sources cited therein.

- how are sustainability issues identified?
- how would the fund be administered?
- how should the funds be distributed?
- should the basis for the Sustainability Fund be net revenues or should it be some other obligatory or voluntary commitment?

Additionally, that the formation of capital cannot be abstracted from social and environmental considerations, which have to be part of the "calculation" of capital conversion, has been an issue raised.

This new approach places clear emphasis on local sustainability. The present study picks up on this point and follows it through by proposing to "turn around" the discussion of taxes directed at sustainability issues. That is, instead of looking at revenue first and then at its destination, it proposes to analyse first the destination of revenue, i.e. the sustainability issues at stake, then the potential role for a Sustainability Fund, and only finally the options for raising revenue.

Before proceeding, a brief discussion of mineral taxation in Chile is presented. The most important taxes are income taxes, different types of tax deductions,[18] a withholding tax on loan interest paid to foreign lenders as well as on dividends remitted abroad, a value added tax of 18 per cent, and a land use fee of about US$8 per hectare.[19]

The study by Otto et al. (1997) indicates that Chile is a country with one of the lowest comparative tax rates (an effective rate of 33 per cent), only surpassed by Argentina (an effective rate of 25 per cent), and the highest after-tax rates of return. Arguments of competitiveness must be understood within this context. Comparatively seen, the Chilean tax regime does not seem to impose, at the moment, an excessive burden on the companies.

The discussion on minerals taxation was very lively in 1997 - 1998. The first to announce the need for an additional tax on mineral exploitation was Juan Villarzu, then Minister of the Presidency. Villarzú's[20] argumentation centres on the depletion of the resource, the need for accumulating funds for long-term investment, as well as the excessive rents that were present in the sector. Additionally, a tax could help improve the exchange rate. Others followed suit, and the arguments for and against additional taxation have involved different issues each time. For example, Rodrigo Egaña,[21] Director of the National Commission for Environment, argued that the additional tax would reflect the environmental costs of mining exploitation, basically referring to the

[18] See Otto et al. (1997).

[19] This last one is the only one relevant for regional tax receipts, as it is stipulated that 70 per cent of the receipts should accrue to the Regional Development Fund and 30 per cent to the municipalities. However, the income generated through this mechanism amounted to barely US$30 million throughout the country in 1999 (see Borregaard and Leal, 2000). Given that according to the Constitution of 1980 the Chilean State has the ownership of all mineral deposits in the country, the Mining Law of 1982 established that the State can concede exploration or exploitation permits to persons or companies. These concessions imply the right to appropriate all resources within the mining concession. The concessions are transferable rights that can be sold to third persons or companies. The concession for exploration lasts four years, whereas the concession for exploitation is indefinite and has to be paid annually. Its annual value corresponds to a tenth part of the Unidad Tributaria Mensual (UTM) per hectare, an inflation-linked monetary measure that is used in many contexts of taxes / contributions to the State. At the end of 1999 this signified a payment of approximately US$8.3/ha.

[20] See for example Globe and Mail (1997) or Mercurio (1997).

[21] See El Diario, 16 September 1997.

exhaustibility of the resources, whereas the counter-arguments refer to the disincentives for investment, as well as a resistance to a tax that would establish a more level playing field for state owned versus privately owned operations.[22]

On the other hand, some politicians as well as academics have focused on the destination of tax receipts. Sergio Bitar,[23] head of the Partido Por la Democracia, proposed the idea of introducing royalties (0.25 per cent of sales) and earmarking the receipts for a fund for technological development. Carlos Ominami,[24] a senator, proposed an additional 5 per cent tax on income to finance social policies. Finally, Claude (1997) proposed the creation of a Sustainability Fund dedicated to the creation of human, natural, technical, and scientific capital.

In summary, discussion on the taxation of mineral exploitation has included many different perspectives. However, there has not been a systematic nor in-depth follow-up to the arguments. There is a lack of concrete and detailed proposals, and there has been no discussion or analysis by the actors involved on the necessity, the appropriateness, the efficiency or the acceptability of a Sustainability Fund; neither has there been any discussion on the financial base of the Sustainability Fund.

Thus, the current project will analyse in detail the potential role of a Sustainability Fund, elaborate a specific proposal for a Sustainability Fund for the Region of Antofagasta, and discuss the financial base, with alternatives ranging from voluntary contributions to tax-type contributions.

Several ex ante principles of a scheme oriented towards achieving sustainability in the context of mineral exploitation should be kept in mind. The scheme has to be:

1. locally oriented
2. oriented towards the destination of funds collected, not only towards the collection of funds
3. complementary to existing efforts.
4. to the extent possible, efficient and effective.

[22] For example, an additional tax on CODELCO is the 10 per cent of its sales that is accruing to the Armed Forces.
[23] See El Diario, 18 June 1997.
[24] See Estrategia, 9 December 1997.

3. SUSTAINABILITY ISSUES IN THE MINING SECTOR IN CHILE

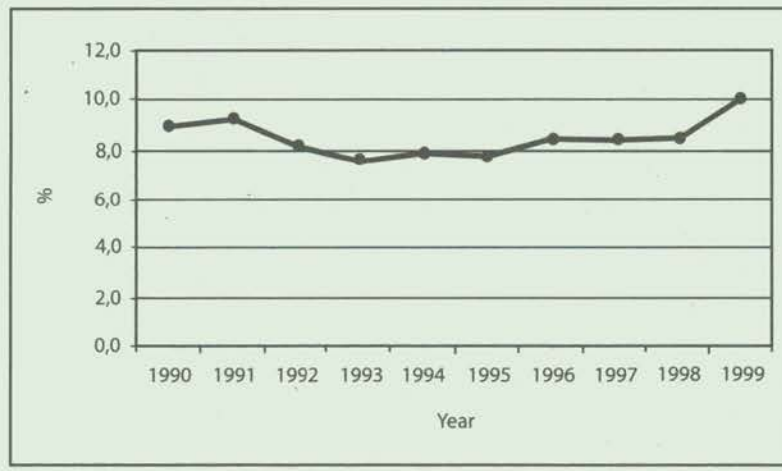
III.1 Economic impact of the mining sector

The mining sector in Chile is made up of the mining of metals, non-metals and fuels. The most important sub-sector is the mining of metals, which exported an average of US$6,986.3 million a year in the last five-year period (1995-1999). Copper is the most important mineral within this sub-sector, followed by gold, molybdenum, iron and silver. The second most important sub-sector is the mining of non-metals, which exported an average of US$276.7 million a year in the last five-year period (1995-1999). Iodine, saltpetre, lithium carbonate and table salt are important within this sub-sector. The fuels sub-sector is the least important in economic terms and is made up of coal, crude oil and natural gas.

III.1.1 Gross domestic product (GDP)

As a result of the efforts to achieve economic diversification in the 1970s, the mining sector has lost importance in relation to other export sectors. During the last decade, the mining sector contributed 8.5 per cent of the country's annual gross domestic product (GDP). The sector lies fourth in importance of contribution to GNP (gross national product), coming below the manufacturing industry; shops, hotels and restaurants; and financial services. Generally, the mining sector's contribution to GNP has been maintained relatively constant during the last ten years (Graphic III.1).

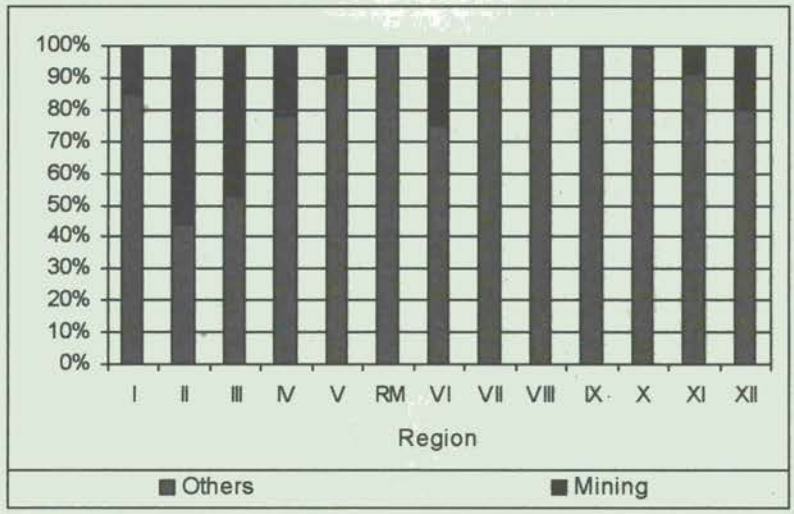
Graphic III.1: Percentage contribution of the mining sector to GNP (1990-1999)



Source: Author's elaboration with data from the Chilean Central Bank (1999).

However, for many regions of the country, but especially in the north, the mining sector is still the main source of growth and income. For example, in 1996, the mining sector contributed 56 per cent, 47 per cent, 22 per cent and 15 per cent of GNP of the Regions II, III, IV and I, respectively. In the case of the south of Chile, mining is only an important source of income in Regions VI and XII, where it contributes 25 and 20 per cent of GNP, respectively (Graphic III.2).

Graphic III.2: Contribution of mining to regional GNP (1996)



Source: Author's elaboration with data from the Chilean Central Bank (1999).

The high dependency on mining as a source of income, especially in Regions II and III, implies a risk in terms of sustainability of economic development, due to the ever-present threat of the closure of mine operations. The lack of diversification in GNP can cause economic depression, and transform regions into a burden for the country. In this context, it is important that part of the income obtained in each region through the exploitation of their non-renewable resources be reinvested into generating new sources of income and diminish the dependence upon this sector. This will avoid situations such as that experienced in Region I during the 1970s with the closure of the saltpetre mines, and in Region VIII during the 1990s with the closure of the coal mines.

III.1.2. Labour force

The size of the labour force employed in mining has decreased during the course of the last decade, dropping from 76,843 people in 1990 to 56,799 people in 1998. Between 1995 and 1998, the number of people employed in the sector was approximately 1.1 per cent of the country's total workforce. Within the mining sector, copper production contributes around 61.3 per cent of employment, followed by mining of non-metals (10 per cent), gold and silver (8 per cent) and fuels (4.8 per cent) (Table III.1).

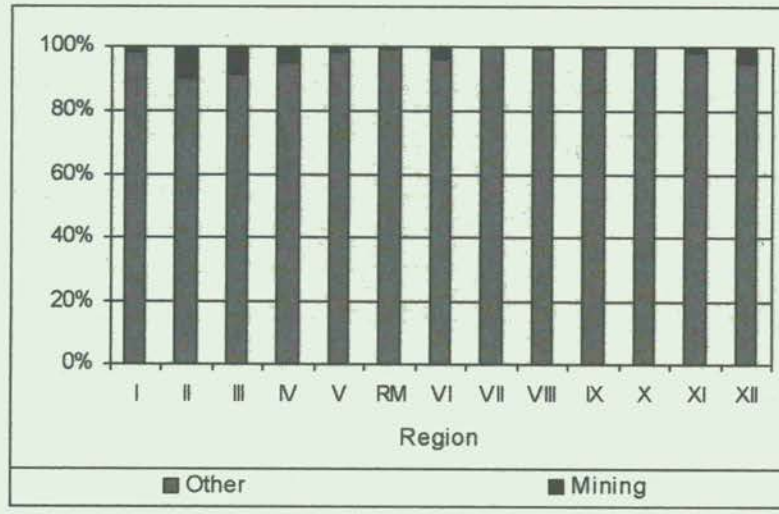
Table III.1: Personnel employed in mining

SECTOR	1990	1991	1992	1993	1994	1995	1996	1997	1998
METAL MINING	**59.746**	**61.446**	**61.135**	**57.364**	**55.327**	**52.947**	**51.057**	**46.964**	**41.097**
Copper	46.248	47.408	46.537	43.158	41.064	40.176	39.912	38.062	34.824
Iron	2.757	2.766	2.679	2.413	2.148	1.941	1.811	1.595	1.282
Manganese	266	289	287	280	281	250	241	224	209
Lead and Zinc	531	556	432	390	290	306	311	275	249
Gold and Silver	9.944	10.426	11.200	11.123	11.544	10.274	8.782	6.808	4.533
NON-METAL MINING	**3.594**	**3.400**	**3.487**	**3.413**	**3.526**	**3.290**	**3.142**	**4.809**	**5.637**
FUELS	**13.503**	**13.076**	**10.291**	**7.327**	**6.782**	**6.484**	**5.536**	**4.581**	**2743**
TOTAL MINING	**76.843**	**77.920**	**74.913**	**68.104**	**65.635**	**63.669**	**60.426**	**56.799**	**56.799**
TOTAL COUNTRY	**4.459.600**	**4.540.400**	**4.877.400**	**5.109.300**	**5.122.800**	**5.174.400**	**5.298.700**	**5.380.200**	**5.432.400**

Source: Author's elaboration with data from the Service of Geology and Mining (2000).

Even though mining has a certain importance at the regional level, contributing almost 10 per cent of direct employment in Regions II and III, it is far less significant with regard to its contribution to GDP. In the south, the sector is virtually irrelevant as a direct source of employment, except in Regions XII, VI and XI, where mining offers 4.7 per cent, 4 per cent and 2 per cent respectively of employment (Graphic III.3).

Graphic III.3: Contribution of mining to regional employment (2000)



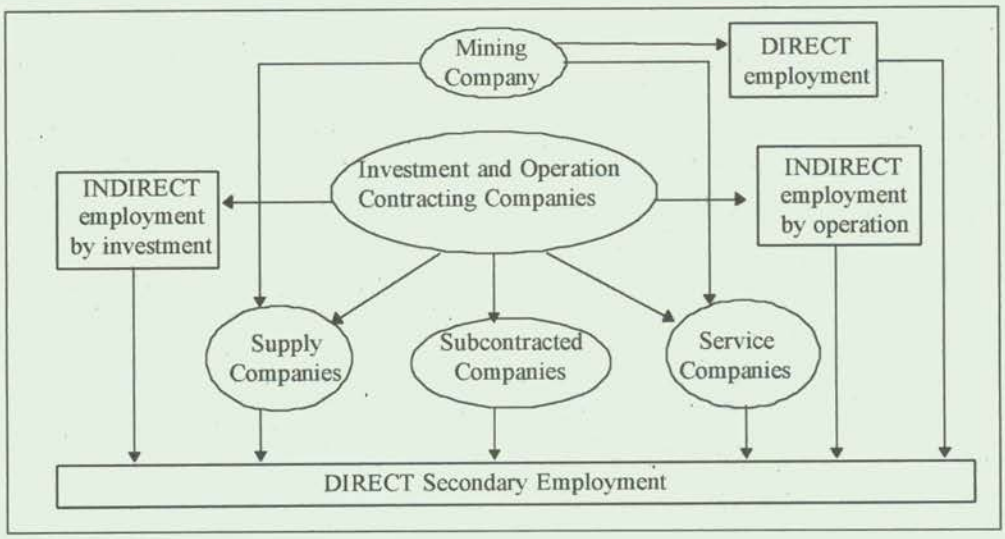
Source: Author's elaboration with data from the National Institute of Statistics (INE) (2000).

However, indirect employment generated by the sector is fairly high, especially in the northern regions, where there are a greater number of mining companies. Indirect employment includes permanent contractors of operational labour such as: maintenance, security, transport, catering and technical support, amongst others; contractors who have been employed in construction, extensions or alterations; and finally secondary indirect employment, which corresponds to all commercially-related businesses to the mining companies, such as: subcontractors, service companies, suppliers and other dependents (Figure III.1).

A good example of the importance of indirect employment generated by the mining companies is the case of Minera la Escondida Ltda., (MEL), that operates in Region II. Table III.2,25 sums up the relationship between the different types of direct and indirect employment generated by the company. Thus it can be appreciated how, for each worker in MEL, another 5.2 persons are permanently employed (without counting the employment created by investment work such as constructions and extensions).

Estimates show, taking into consideration direct and indirect effects, the company's contribution represented 9.7 per cent of the total employment in Region II, and 18.2 per cent of the jobs in Antofagasta in 1996.

Figure III.1: Direct and indirect employment generated by mining companies



Source: MEL (1997).

Table III.2: Employment generated by la Escondida mining company (1991-1996)

	Type of Employment	*Place of Residence*	*Index of Employment*
Direct Escondida employment (a)	Permanent	II Region	1.00
Operation indirect employment (b)	Permanent	II Region	0.86
Indirect secondary employment (c)	Permanent	II Region	4.33
Total indirect regional employment (b+c)	Permanent	II Region	5.20
Total Regional Employment (a+b+c)	Permanent	II Region	6.20
Indirect through investment (d)	Temporary	Others	1.44
Total Employment (a+b+c+d)			7.64

Source: MEL (1997).

[25] This Table is based on analysis of the economic and social impact made by Minera la Escondida Ltda.

If this information is extrapolated to the rest of the mining companies in operation, employment generated by the mining sector can become quite significant.

Another important theme is local and regional contracting and acquisition, versus that on a national or international level. For example, according to the corporate administration manager of Minera La Escondida, 65 per cent of the company's operative costs are assigned to the regions.

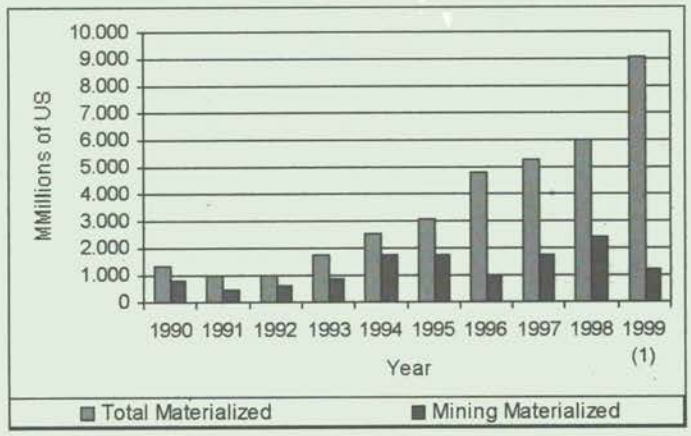
Another example is the Placer Dome Group, whose policy is to hire the maximum number of local people in order to contribute to the well being of the community, only hiring foreign employees when specialized knowledge and experience is not available locally. For example, in the Mina La Coipa, of the aforementioned company, all but one of the 475 employees are Chileans from Copiapó or neighbouring communities (Grupo Placer Dome, 1998).

In view of this, it becomes vitally important to increase the diversity of employment sources in the regions that rely heavily on mining, and reduce their dependence on the mining industry, so that when mining operations close down, the mining sector workers can be absorbed by other productive sectors. This will reduce the social costs associated with high indices of unemployment, such as an increase in delinquency, drug addiction and prostitution, which lowers the quality of life for the region. Furthermore, diversification of employment permits the reduction of costs associated with inter-regional migration of workers and their families searching for new work, and averting the slow death of towns and cities.

III.1.3 Foreign investment, production and exports

Foreign investment in Chile in general, as well as foreign investment specifically in the mining sector, have increased during the last decade. During the first half of the decade (1990-1994), investment in the mining sector reached 32.6 per cent of total investment in the country. Investment increased from an average of US$883 million a year during this period, to an average of US$1,605 million a year during the second half of the decade (Graphic III.4).

Graphic III.4: Foreign investment in Chile 1990-1999

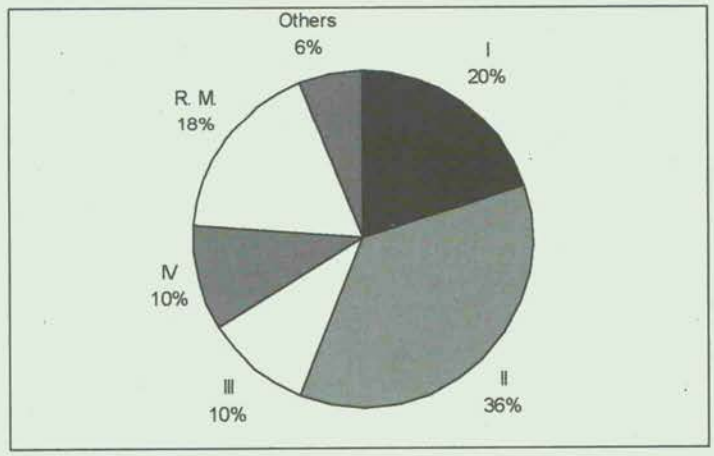


(1) Provisional figures.

Source: Author's elaboration with data from COCHILCO (2000).

Between 1974 and 1999, 36 per cent of the materialized investment in mining was in Region II, 20 per cent in Region I and 18 per cent in the Metropolitan Region; the remaining percentage was distributed between Regions IV, V and VI (see Graphic III.5).

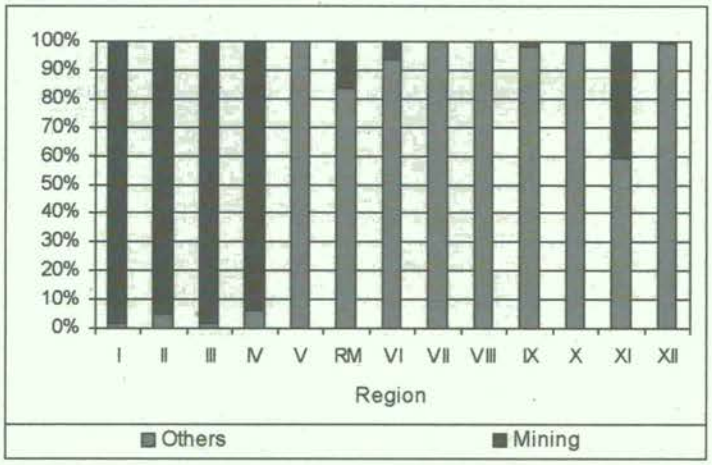
Graphic III.5: Regional participation in materialized foreign investment in mining 1974-1999



Source: COCHILCO (2000).

In northern Chile, almost all investment has been in the mining sector. For example, between 1979 and 1999, 98 per cent, 95 per cent, 98 per cent and 93 per cent of the investments made in Regions I, II, III and IV respectively, were in mining. In the case of the Metropolitan Region the investments in the mining sector were only 19 per cent. In the south the investment in mining has not been significant, except in Region XI which was 68 per cent (Graphic III.6).

Graphic III.6: Materialized foreign investment in mining by region 1979-1999



Source: Author's elaboration with data from the Committee of Foreign Investments (2000).

The significant investment in mining in the northern regions of the country, as well as creating wealth and development, can also produce an excessive rhythm of resource exploitation, accelerating its depletion. The implied risk is an early decline in the mining regions, producing the effects of recession and unemployment described previously.

Additionally, due to the high percentage of foreign investment in mining, the earnings generated by the exploitation of the resource may leave the country to be reinvested in the countries from where the capital originated. To the degree that this flow of capital abroad is greater than the opportunity cost of the capital invested, the country's welfare will be affected.

Another important aspect is that the mining sector is one of the main clients for energy. For example, in Region II, there are three thermo-electrical plants (Tocopilla, Mejillones and Taltal), based on coke and natural gas, that produce 1,122 megawatts (MW) and whose main client is the mining sector. Mine closure would leave the region with an over-capacity of energy infrastructure, and a reduction in profits for the electric companies, resulting in a reduction in investments and a possible increase in unemployment.

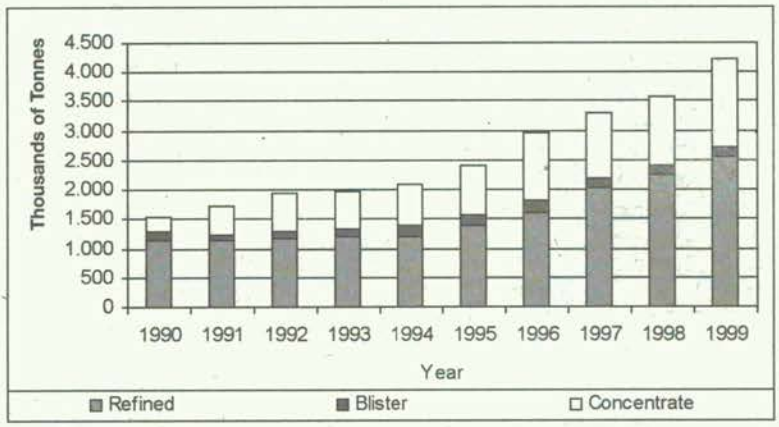
Finally, there is a plan to build a megaport in Mejillones in Region II, primarily on the basis of copper exportation. This signifies an important investment in the region, generating income and employment,[26] but its economic survival would be closely linked to the mineral exploitation in the zone.

Of the total exports made by Chile between 1990 and 1999, 46.71 per cent were exports from the mining sector, with copper being the principal mineral, representing 38.7 per cent of all national exportation. The average exported value of the copper for the first five years of the 1990s was US$3,822.8 million a year, while in the second five year period this value increased to US$6,074.5 million a year, signifying an increase of almost 60 per cent.

[26] Even though generation of employment is most significant only during the construction phase.

The main copper product exported is refined copper, especially cathodes. Blister copper and copper concentrate are also important exports, especially the latter, with a sharp increase during recent years (Graphic III.7).

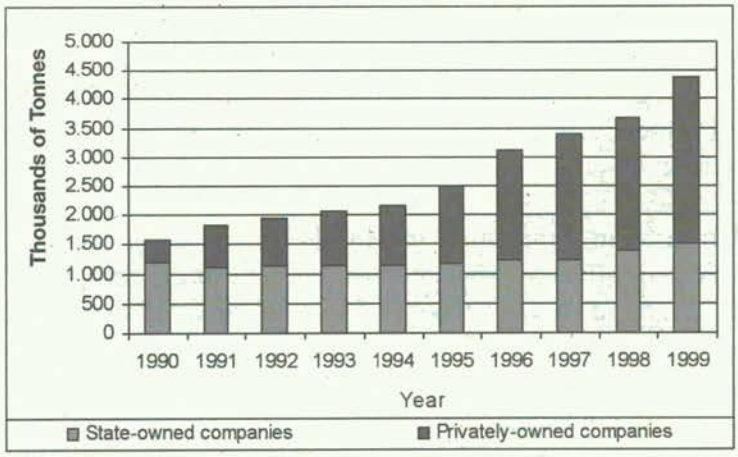
Graphic III.7: Exports of copper by product 1990-1999



Source: Author's elaboration with data from COCHILCO (2000).

As seen in Graphic III.8, copper production on a national scale increased over the 1990s, up from 393 thousand tonnes in 1990 to 2,875 thousand tonnes in 1999. This significant increase in copper production was due especially to the increase in private production and the opening of new mines, especially La Escondida, Candelaria, Zaldivar, Cerro Colorado, El Abra and Collahuasi, amongst others.

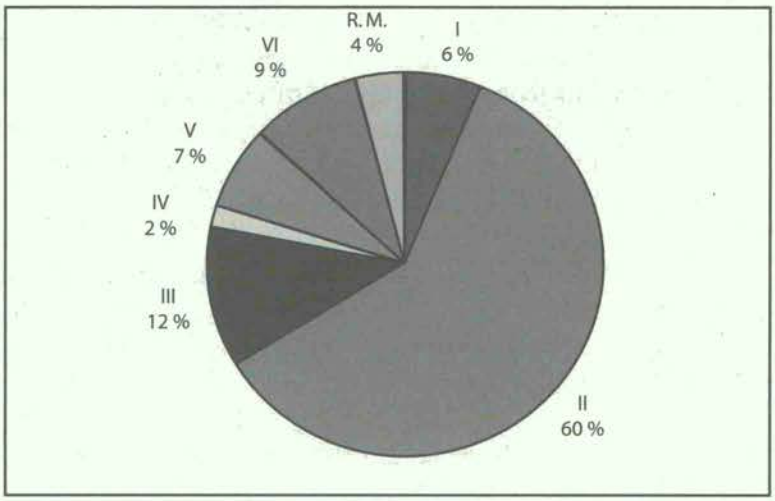
Graphic III.8: Copper production by company 1990-1999



Source: COCHILCO (2000).

Region II is the main copper producing region, with 60 per cent of national production, followed by Region III with 12 per cent of production and Region VI with 9 per cent. The remaining percentage is distributed between Regions I, IV, V and the Metropolitan Region, as seen in Graphic III.9.

Graphic III.9: Regional participation in copper production (1998)



Source: COCHILCO (2000).

III.2 Environmental impacts of the mining sector

Mining and metallurgic processes have an impact on the natural environment as well as on the socio-economic and cultural environment. Historically, the most significant environmental problems resulting from mining activity have been:

- air contamination by emission of gases and breathable dust particles imbued with heavy metals;
- soil contamination by particle matter, dissolved metals and the presence of salts in liquid effluents;
- marine, underground and surface water contamination by emission of liquid effluents containing particulate matter, dissolved metals, acids and salts;
- over use of water resources especially in desert areas;
- contamination of flora and fauna that absorb air, water and soil contaminants;
- effects on landscape by open pit mining activity;
- land subsidence caused by subterranean mining activity;
- direct contamination of people, both in the community and work environments, bearing in mind that all the aforementioned points also affect humans, one way or another;
- loss of biodiversity.

III.2.1 Air contamination

The various mining and related construction activities mobilize tremendous quantities of dust particles. These particles may produce negative impacts solely due to their physical nature. Such impacts include:

- reduction in visibility
- aesthetic impacts, such as coating houses, cars, laundry with dust
- health impacts, such as respiratory diseases and allergies, due to airborne contaminants
- damage to vegetation-gardens, commercial crops, vineyards
- health impacts that might result from consumption of contaminated foods grown on contaminated soils
- physical damage to equipment
- impacts on soils, water quality and aquatic life due to airborne dust.

Mineral processing, and most specifically smelting operations, release massive quantities of potentially toxic airborne particles and gases. These include the various sulphur, carbon, and nitrogen compounds commonly detected in air monitoring. In addition, they may include toxic concentrations of various metals such as arsenic, nickel, lead, cobalt, mercury, etc.

The resulting impacts may involve the following, especially if the operations are located near cities or towns:

- reduction in visibility, smog, haze
- aesthetic impacts: discoloration and erosion of building surfaces, cars, laundry due to acids produced
- corrosion of metals, damage to equipment and impairment of operation
- health impacts: respiratory diseases, allergies, skin rashes, toxic reactions.

These airborne contaminants can harm both mine workers and citizens at significant distances from the mine operations. The latter often have no direct economic connection to the mine operations, and did not choose to expose themselves to such impacts. Mining companies have faced significant liability costs from some of the health-related impacts, but such data were not available.

The following additional impacts often occur:

- chemical damage to vegetation and soils which can impair crops, potentially rendering them toxic for human or animal consumption;
- impacts to water quality and aquatic life, such emissions from industrial sources in Europe and the USA are known to contribute to acid rain and acidification of lakes;
- contamination of laboratory analyses by air pollutants;
- negative impacts on tourism and development.

The main environmental consequences of mining expansion in Chile so far identified have been, without doubt, atmospheric contamination through emissions of sulphur dioxide, arsenic and particulate matter. These contaminants are released in the pyrometallurgical processes carried out in smelters. Table III.3 summarizes the principal characteristics of the smelters currently operating in Chile.

Table III.3: Copper smelters in Chile

Smelter	*Owner*	*Capac. production (tonnes/day)*
Chuquicamata[1]	Codelco, División Chuquicamata	5,000
Potrerillos	Codelco, División El Salvador	1,500
Caletones	Codelco, División El Teniente	3,500
Hernán Videla Lira (Paipote)	Enami	170[2]
Ventanas	Enami	380[3]
Chagres	Minera Disputada de Las Condes	n/i
Refimet	Refimet (Chile)	260[4]

Source: Author's elaboration from Lagos and Velasco (1994) and personal communication with Gerardo Muñoz, CODELCO (November, 1997).

Notes:
[1] Chuquicamata is currently the largest copper smelter in the world.
[2] Estimated capacity as of 1993 (63,000 tonnes).
[3] Estimated capacity as of 1993 (140,000 tonnes).
[4] Estimated capacity as of 1993 (95,000 tonnes).

Table III.4 presents some available data on sulphur emissions from several smelters.

TABLE III.4: Approximate sulphur emissions from smelters in chile

Year	Chuquicamata's Smelter	Paipote's Smelter	Ventanas Smelter
	Sulphur (Tonnes/year)	Sulphur (Tonnes/ year)	Sulphur (Tonnes/ year)
1993	215,000		64,000
1994	160,000		62,000
1995	150,000	35,000	60,000
1996	160,000	30,000	55,000
1997	115,000	20,000	45,000
1998	105,000	17,000	23,000
1999	120,000	10,000	15,000

Source: Lagos, Lehudé and Andía (2000).

As can be seen in the above table, most companies decreased their sulphur emissions between 1993 and 2000 by incorporating better technology and initiating decontamination plans to reach government-imposed health standards.

In the case of the Chuquicamata mine and plant facilities, the sulphur emission goal has been fulfilled since 1993. Emissions with particle matter were fully compliant in 1998. In the case of Paipote, the emission goal has been complied with since this information was reported to the Regional Health Service in 1997. In the case of Ventanas, the emission goal was complied with in the 1994-1998 period, but the health-based air quality standard for sulphuric acid was exceeded ten times in 1998, six times in 1997 and a similar number of times in the previous years. It should be added that this information is based on a few measurements per year, and no information was available regarding the level of production of the smelters at the time when monitoring was carried out for particle matter (Lagos, Lehuede and Andia, 2000).

There is no systematic monitoring of the effects of air pollution due to dust and particles on mine workers in Chile.

III.2.2 Water contamination[27]

Mineral processing produces numerous products and waste that can cause water contamination: tailings, waste rock, laboratory wastes, chemical reagents and contaminated containers (solid waste), blasting compounds, smelter slag / dusts, spent leached ores, ore stockpiles. In addition, the associated infrastructure that must be developed to support a large mining and processing operation generates sewage waste, water treatment sludge, oils, petroleum, diesel fuels, etc. All this can cause contamination of surface and ground waters, whether or not acid rock drainage (ARD) develops.

The various exploration, test, and construction activities may result in damage to vegetation, and most importantly, an increase of sediment loads in water bodies (rivers, lakes, oceans), which can harm water quality and aquatic organisms.

Extraction, diversion and dewatering of predominantly clean water sources can reduce the water quality in the lakes or ground waters where extraction occurred. In many environments, water that comes from dewatering operations must be impounded or re-injected into the subsurface. These operations often result in undesirable chemical interactions between the drained water and the rock or sediment it later contacts, which can release elements such as arsenic, contaminating surface and ground waters.

Mining (both underground and open pit) breaks and crushes rock, creating new pathways for oxygen, air and microbes to react with the rock. Thus, both underground workings and open pit walls may generate ARD, which can contaminate ground and surface waters for decades or even hundreds of years after mine closure. This occurs where "significant" amounts of sulphide minerals are present in the ores and waste rock, and causes a lowering of water pH to about 1.0 to 4.0, which then mobilizes many other chemical constituents, such as toxic metals and non-metals. ARD-impacted waters draining from underground mine workings have negatively affected thousands of miles of streams in the USA alone. Open pit mines that produce ARD may result in an acid, toxic lake forming within the former excavation after the dewatering wells have been shut off. Such conditions may also contaminate ground waters around the pit area. This latter process may be aggravated because open pits are often connected to older underground workings that provide preferred pathways for migration of the contaminated waters.

Simple mining processes (without ARD generation) also contaminate waters by increasing the amount of suspended sediments (and other soluble constituents released), and by increasing concentrations of nitrates and ammonia due to the blasting compounds used. All these processes can result in increased eutrophication and contamination of water bodies.

Indigenous / artisanal mining techniques and placer mining greatly disturb surface gravels, causing tremendous increases in suspended sediment loads and mercury contamination. In such situations, wastes are totally uncontrolled.

[27] This section is based on Moran (2001).

Waste rock, which may account for more than 80 per cent of the rock mined at many copper sites, often contains elevated concentrations of sulphide and toxic metals and non-metals. This waste rock is normally disposed of in piles on the ground at the edges of pits, or outside the workings. Many contaminants can be leached out of these waste piles, contaminating surface waters and ground waters. Undesirable chemical releases from waste rock can occur even where acid is not added to the piles or where ARD fails to develop. Because of the increased surface area of the broken rock, chemical reaction rates are increased. Also, many contaminants may be mobile under high pH conditions (above approximately pH 8.5), for example sulphate, arsenic, manganese, iron, mercury, lead, nickel, selenium, molybdenum, vanadium, uranium etc. These constituents are often common in copper ores and in desert environments where alkaline waters predominate.

Mineral processing activities sometimes involve grinding the ore, adding various chemicals, and possibly several physical separation processes. These processes result in wastes called tailings, which contain several metal and non-metal residues from the ore, but also contain high concentrations of the process chemicals. These compounds may include kerosene and other petroleum-based or organic compounds, organic acids, cyanide and related compounds, various acids, lime, etc. At modern operations, these tailings are generally sent to engineered impoundments which are often lined with synthetic liners. At older operations, or in areas of lax overseeing, tailings may be disposed of directly into stream channels or into the ocean. Where uncontrolled, these tailings obviously cause significant contamination of all water bodies.

The water and soil contaminated with waste held in the tailing dams can affect people's health in the long term, since the absorption and metabolization of these toxic substances produce teratogenic effects, which cause embryonic deformation; carcinogenics, which cause cancer; and mutagenics, which provoke chromosome alterations, in turn altering the genetic load of the cell (Sierra, 1998).

On the other hand, the water-soluble toxic metals that are transferred through the soil to watercourses by leaching, acidify and contaminate the underground water, and provoke filtering of the waste and sediments into the continental and marine water bodies. Acid water is produced by contact of the water with the metals contained in the tailing dams in the presence of oxygen and carbon dioxide, aided by micro-organisms that act as oxidation catalysers. The greater the amount of water and oxygen in contact with the mineral, the greater the amount of acid water produced. However, in the north of the country, where precipitation is low and geological faults facilitate the underground water percolation, there is no great risk of acidity.

The metal sediments can induce changes in the composition of marine water, drastically affecting aquatic life (Wilber, 1998 quoted by Sierra, 1998). It is estimated that 67 per cent of fine sediments can cause changes in marine fauna by reducing light penetration, suppressing photosynthesis in the organisms that many invertebrates feed on, leading to the death of both these and their vertebrate consumers. Also, the sediments can interfere with the particle filter system of some organisms that fulfil a food and respiratory function, restricting their surface area and thus diminishing the aquatic species' disease resistance (Sierra, 1998).

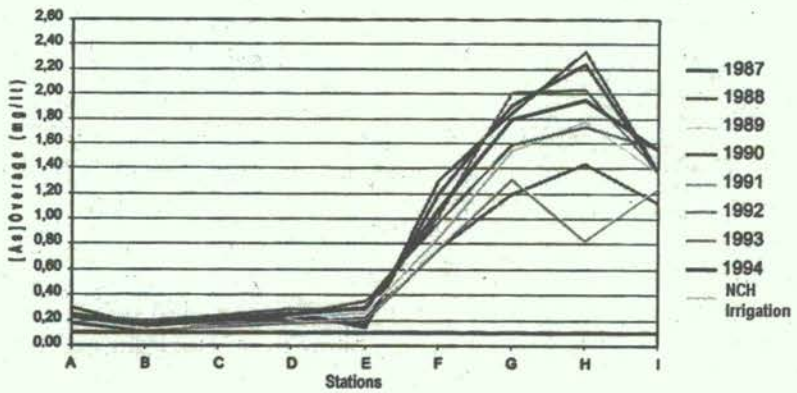
With regard to water contamination in Chile, there is no systematic monitoring or specific study of acid mine drainage, or the impact of the mining activities on water quality. However, there are various measurements and data that can provide an orientation in this regard. For example, in 1990, due to a judicial verdict, the División Salvador of CODELCO, (Region III), had to install a tailing dam with a treatment plant to treat and store the production waste, thus avoiding the evacuation of the tailings into the sea. For over 30 years these tailings had been emitted into the Bay of Chañaral, provoking the deposit of sand silts with heavy metals and the accumulation of copper and heavy metals in some marine species.[28]

Another example is the Planta Osvaldo Martínez, of ENAMI, located downstream from Diego de Almagro, (Region III) whose tailings flowed into the Río Salado until 1990, when a tailings dam for sulphurs was installed, solving the problem of discharge into the river.

Currently, mining activity still causes contamination in the rivers San José, Loa, (Region II), Limari, Cogotí (Region IV), Aconcagua, Chacabuquito, Rapel (Region V) and the Alhué marsh and in the Pampa del Tamarugal (Region I) - Quebrada Cahuisa (Universidad de Chile, 1999).

One of the few studies on mining and water contamination was carried out by Universidad de Chile (1999). It shows that the river Loa has consistently exceeded the regulated levels for arsenic in irrigation and drinking water. Graphic III.10 demonstrates that between Station A (at the Lequegna reservoir) and Station E (before the union with the Rió Salado), the level of arsenic in irrigation water is on average two times greater than the permitted level. It is also observed that the concentration of arsenic increases from the mouth of the Río Salado (Station E) out to sea until reaching a maximum of 25 times greater than the regulated level for irrigation at Station H of Quillahua.

Graphic III.10: Concentration of arsenic measured by the DGA at 9 stations of the río loa



Source: Universidad de Chile (1999).

[28] See also section on "Biodiversity".

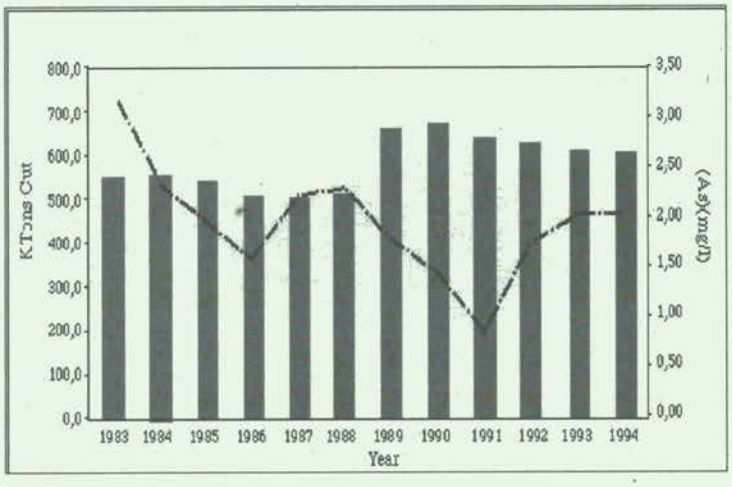
Table III.5: Name of the water quality monitoring stations of the DGA in the río loa used in the study

No.	*Station*
A	Río Loa at Lequegna reservoir
B	Río Loa at Quinchamales
C	Río Loa at Alcantarilla Conchi n°2
D	Río Loa at outlet of Conchi reservoir
E	Río Loa before union with Río Salado
F	Río Loa at Yalquincha
G	Río Loa at Finca
H	Río Loa at Quillagua
I	Río Loa at river mouth

Source: Universidad de Chile (1999).

Graphic III.11 shows the behaviour of copper mining operations in the Río Loa basin (Chuquicamata, El Abra and Radomiro Tomic) and the arsenic concentrations that have been detected at the closest monitoring station located downstream from these operations.

Graphic III.11: Copper production in the basin of the Río Loa and arsenic concentration at the station downstream from the mining operation



Line: Arsenic Concentration.
Column: Copper Production

Source: Universidad de Chile (1999).

It can be seen that there is no apparent relationship between the level of copper production and the arsenic concentration in the waters downstream of the Río Loa. The coefficient of correlation between both variables is 0.53. This confirms that arsenic concentrations in that area are due rather to natural conditions than mining activities.

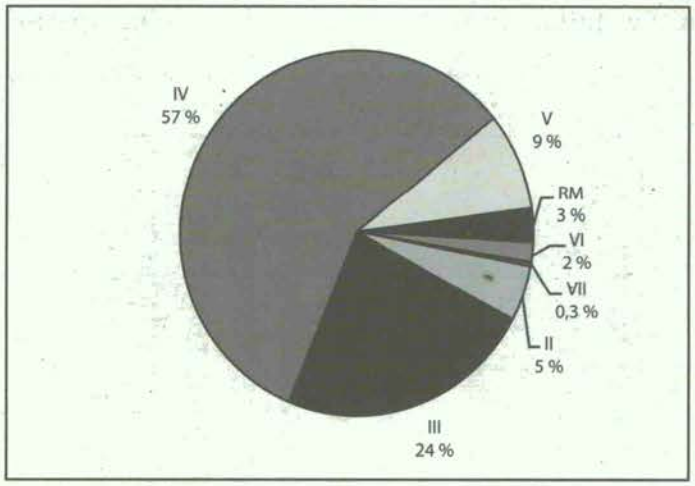
III.2.3 Mine closure and abandoned tailing dams

Due to the fact that mining makes a temporary use of the earth, the mining companies must try to achieve a satisfactory "abandonment" condition when extraction work is finished. Such an abandonment condition can be defined as "a state in which continual intervention by man to protect the population, flora, fauna and terrestrial environment from the damages or risks caused by the mining activity is not required, and where the areas that were used for mining can be used for other purposes such as recreation, agriculture and forestry" (Stogran, 1999).

One of the main problems of abandoned mines is the abandoned tailing dams which present serious risks for the population and the environment. In Chile there are approximately 658 tailing dams between Regions II and VII,[29] in addition to other mineral deposits such as: reservoirs of water with solution, tailing deposits, leached waste deposits, mining residue deposits, filtered tailing deposits, etc.

The greatest number of tailing dams are found in Region IV, with 57 per cent (375 dams) of the total number of dams registered in the country. The second zone is Region III which has 158 dams (24 per cent), followed by Region V with 59 dams (9 per cent). The remaining 10 per cent is shared between Regions II, VI and the Metropolitan Region (Graphic III.12)

Graphic III.12: Distribution of tailing dams by region, 1989 and 1990



Source: Author's elaboration with data from SERNAGEOMIN (1989 and 1990).

According to the survey of tailing dams developed by the National Service on Geology and Mineral Resources (SERNAGEOMIN) between 28 per cent to 40 per cent of the tailing dams in Chile are abandoned, implying serious environmental and health risks.[30] For instance, there were 53 tailing dams in Region V in 1989, only 18 of which were in operation, 22 out of service,

[29] The last survey was between 1989 and 1990 and has not been updated. However, as this study concentrates on the abandoned tailing dams, the year of the information is not so important because the tailing dams abandoned at that date continue to be so today.

[30] This is an estimate based on the number of abandoned mineral plants.

12 abandoned and 1 under construction, as well as 7 additional projected dams (SERNAGEOMIN, 1989).

Chilean regulations for dam design and construction do not establish guidelines for their maintenance at the end of their useful lives and their consequent abandonment, although they do set rigorous regulations for construction. However, dams built with old techniques continue to exist, and have a high seismic risk, especially in Region III (Tromben, 1996).

On the other hand, according to the aforementioned survey, 8 per cent of the tailing dams are in unacceptable condition, 14.1 per cent are in unacceptable to deficient condition and 14.9 per cent are in deficient condition (Table III.6).

Table III.6: Quality of tailing dams in chile 1989-1990

Type of mineral residue		*Quality of deposits*								*Total number*
		N	U	U/D	D	D/A	A	A/G	G	
Tailing dams		38	58	114	117	95	114	72	50	658
Tailing deposits		1	1	0	3	2	17	0	2	26
Filtered tailing deposits		0	0	0	0	0	0	3	0	3
Leached waste deposits		2	0	0	0	0	43	2	2	49
Reservoir of water with solution		1	5	0	0	1	51	0	5	63
Coarse tailing deposits		0	0	0	0	0	0	0	1	1
Tank with solid residue		0	0	0	0	0	3	0	3	6
Unusable waste dump		0	0	0	0	0	1	0	0	1
Totals	Number	42	64	114	120	98	229	77	63	807
	% of Total	5.2	8.0	14.1	14.9	12.1	28.4	9.5	7.8	100

N: No information; U: Unacceptable; U/D: Unacceptable to deficient; D: Deficient; D/A: Deficient to acceptable; A: Acceptable; A/G: Acceptable to good; G: Good

Source: SERNAGEOMIN (1989 - 1990).

The main risks associated with failure of the tailing dams are the threat to life, river and underground water contamination, material damage and destruction of agricultural land. Furthermore, negative health effects in people could be brought about in the long term through the accumulation of toxic substances absorbed by the gastrointestinal tract, skin and respiratory system.

Dam collapse can be brought about by tremors or earthquakes, and though less likely, intense rainfall which could erode the containing walls and flood the rivers. It is important to point out that a significant percentage of the tailing dams located in Regions III, IV, V and VI have suffered considerable damage on account of the violent tremors in recent years. For example, in Region V, the earthquake of La Ligua in 1965 provoked the failure of one of the tailing dams in the Los Maquis plant, emptying about 30,000 tonnes of liquid waste which ran 5 km downstream, causing 250 deaths due to the effect of the Quebrada los Maquis. Likewise, the earthquake in La Ligua in 1971 once again caused the failure of another tailing dam in the same plant, although the amount of waste emptied was less than in 1965. The earthquake in San Antonio in 1985 once again provoked the failure of dam A3 in the Los Maquis plant, the same one that had been dama-

ged in 1965, producing liquefaction passes and contaminating the gorge again (SERNAGEOMIN, 1989).

In the majority of abandoned tailing dams in the north of the country, the probability of erosion by intense rainfall is generally low to zero, however in the south this probability increases due to higher precipitation (from 500 to 2,000mm/year). The probability that rainfall causes minor failures, such as partial undermining of the walls, is moderate to high for all the country's dams, except those located in Regions II and III. In 1987 the Pérez Caldera reservoir was close to overflowing, putting the lives of the people of a Santiago neighbourhood at risk.

The survey of tailing dams developed by SERNAGEOMIN between 1989 and 1990, analysed the probabilities of the collapse of each of the tailing dams and/or the partial failure of their walls, grading the probabilities as remote, low, moderate, high and very high. However, in general, analysis of the environmental effects or problems that the collapse or damage of mineral residue deposits could generate is superficial and with little detail. The survey essentially limits itself to naming the most evident environmental effects without quantifying or analysing the consequences.

III.2.4 Soil contamination

Mining activities significantly affect land use, land stability (particularly with underground exploitation), and land quality, due to the disposal of solid or liquid residues. In Chile, the first effect is generally insignificant, since mining is developed in desert areas with little or no population. For the same reason, the second effect is not very relevant either due to the fact that the majority of the mines are open pit.

As for the land quality, little is known about land degradation from metal ions or other products generated by mining activity. The majority of copper deposits are found in the high mountains or the desert, so that if an accumulation of contaminants has occurred, the impacts have not been perceived. On the other hand, ground contamination by contaminated river water has only been reported on few occasions.

The clearest cases of ground contamination have been brought about by the Paipote smelter, where sulphur and arsenic emissions affected nearby grape cultivation, and in the Huasco valley where the particles (sedimented iron) and toxic gases from the iron pelleting plant affected nearby olive tree cultivation. In the latter case, in 1992, a Supreme Court ruling against the company forced it to undertake a decontamination plan. Similarly, in the Aconcagua valley, particle emissions from the Chagres smelter affected cultivation in the valley, but to date it has not been possible to irrefutably prove that the particles come from the smelter. In the Puchuncaví valley sulphur dioxide and arsenic particle emissions from the Ventanas smelter and the neighbouring thermal plant, affected cultivation in the valley.

III.2.5 Water use

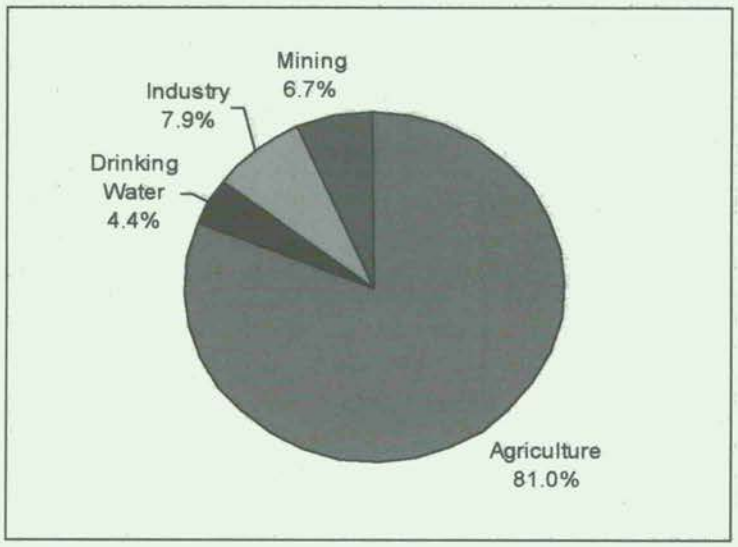
Lack of water can become a significant problem in desert areas; most often in these areas the principal source of water is ground water - often at significant depths - which has travelled long distances from recharge areas in the mountains. (The Atacama Region of Peru and Chile is typical

of such a situation). Water may need to be transported from areas many kilometres away from the mining sites in order to supply the needs of mineral processing, drinking water, dust suppression, etc. Such diversions cause competition for water with other sectors of society, possibly reducing the supplies to towns, cities, and indigenous groups. Frequently these diversions will create negative impacts on lakes or saltpans due to the reduction of water levels, reduction of fresh water inflow, and may damage local wildlife. In some areas of Chile, Bolivia and Peru, water diversions near international borders, can lead to serious trans-boundary conflicts.

Dewatering for opencast mining inevitably lowers the local, and sometimes regional, water level. This can cause springs to dry up, and lower water levels in neighbouring wells. The latter increases the costs of pumping water to the surface for those affected, or may force them to re-drill or deepen wells. Such dewatering may reduce stream flow or lake levels. Reduction in flow of springs and streams can harm livestock and wildlife, as well as domestic and municipal water uses. Dewatering ceases when mining stops, but water levels may take many years to recover their levels.

In Chile's case, the main water-use sector in the country is agriculture, which requires 81 per cent of total national demand. The second most important sector is industry which uses 7.9 per cent of total demand, followed by the mining sector with 6.7 per cent (Graphic III.13).

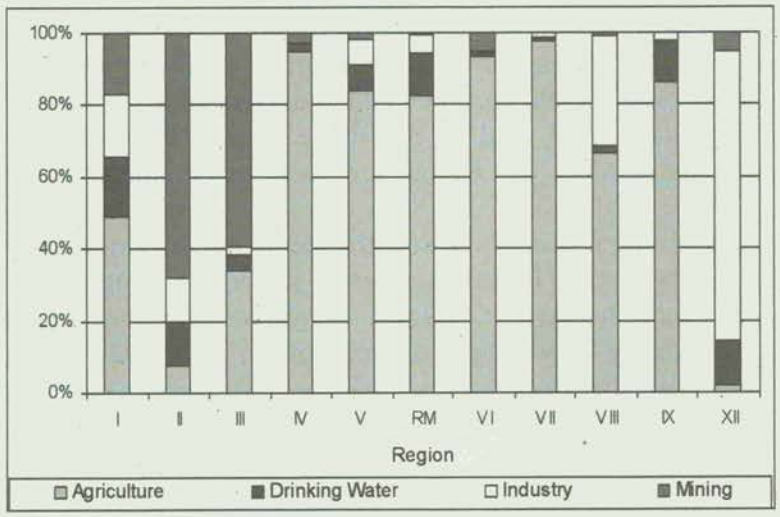
Graphic III.13: demand for water use by sector, 1993



Source: Dirección General de Aguas (DGA) (1994).

The water consumption of the country's mining sector is approximately 45,500 l/s monthly. This consumption is mainly concentrated between Regions I and IV and Regions VI and XII. Water demand from the mining sector is particularly important in Regions II, III and I of the country, where the sector requires 68 per cent, 60 per cent and 11 per cent respectively of the total water demand (Graphic III.14).

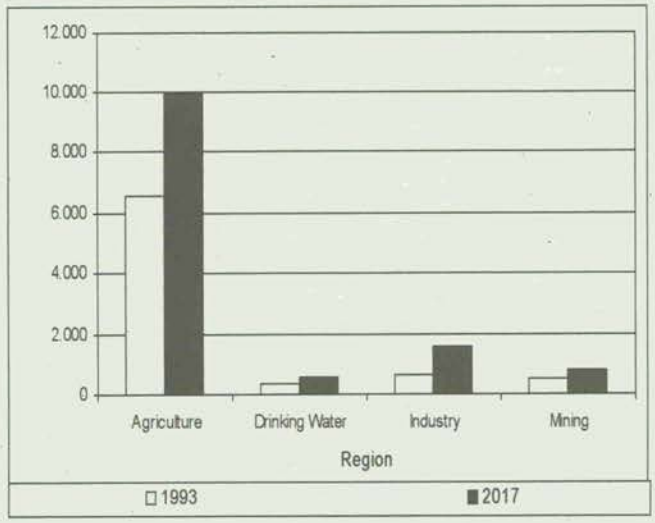
Graphic III.14: Distribution of regional water consumption by sector, 1993



Source: DGA (1993).

According to the study "Analysis of the current and future use of water resources in Chile", carried out by the Dirección General de Agua (DGA) in 1996, in which demand for water resources was projected between 1993 and 2017, an increase in demand is expected in all the productive sectors. The sector that will present the greatest percentage increase in demand is the industrial sector, increasing from 53,000 l/s monthly to 131,700 l/s monthly. However, the greatest increase in the amount of l/s required is expected from the agricultural sector, where demand will increase by 3,375,000 l/s a year. The sector with the least percentage growth and volume of demand is the mining sector, with an expected increase in demand of 253,000 l/s a year between 1993 and 2017, which corresponds to a 46 per cent increase (Graphic III.15).

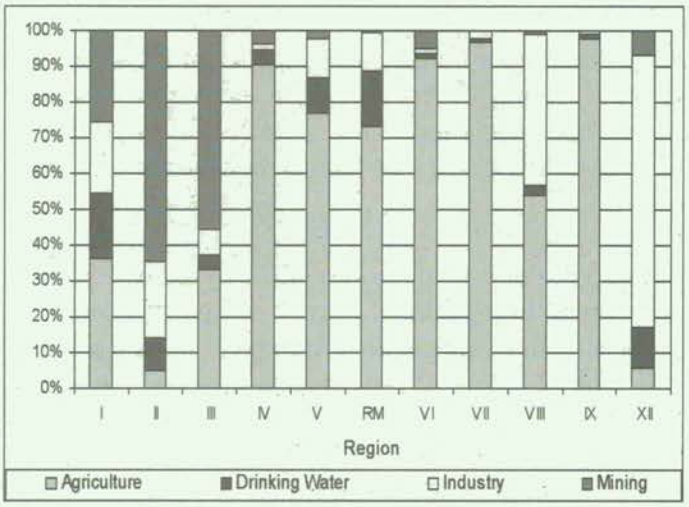
Graphic III.15: Estimation of the increase in water demand 1993-2017



Source: DGA (1994).

The increase in water demand from the mining sector will come mainly from the northern regions of the country, principally Regions I and II, which will increase their demand by 123 and 72 per cent respectively. This implies an increase in water consumption of 17,300 l/s a year in Region I and 41,300 l/s a year in Region II (Graphic III.16).

Graphic III.16: Distribution of the regional water consumption by sector, 2017



Source: DGA (1993).

On account of the increase in water demand from the mining sector in northern Chile, a price increase in water use rights is likely, due to the low elasticity of supply of the resource.

The potential sale of water use rights from agriculture to mining could cause a number of problems. One problem occurs when the rights that produce return flows are sold on the market, either totally or partially, to a mining company that could be located on the other bank of the river or in another sector. This means that the volume of flow downstream is reduced or used up completely. According to the water code, downstream users do not have the right to demand indemnity because water rights are not assigned for return flows, these being conditional upon circumstances and availability depending on decisions taken by the users of these rights (Donoso, 1999).

A different case results when the farmer sells common law, unconstituted rights, since in this case the farmer does not possess the rights he believes he has over the water he does not use, or return flows that are made use of by other users. Furthermore, it has generally been observed that because the farmers' rights do not establish a value for time unit and form of use (consumption, non consumption, eventual, permanent, continuous or discontinuous), they try to sell more than they really have; they try to sell all the water their land captures with continuous use and consumption rights, when in reality they only use a part of the captured water, returning the rest to the watercourse by way of overflow, and they have never used their rights in a continuous manner, sincthe months when they require water are usually when there is no rainfall (September to March) (Donoso, 1998).

The aforementioned situation is further aggravated because, according to Peña (1995), practically 70 per cent of the water used by farmers returns to the watercourse, providing a supply source downstream. Furthermore, in the north of Chile in the rivers Elqui and Aconcagua the return flows are vitally important since reduction or elimination due to sale or more efficient watering systems, could drastically affect the total flow of a section of the river (Rosegrant and Gazmuri, 1994).

Additionally, the reduction of return flows can also affect the survival of the watercourse's flora and fauna. The law does not establish a minimum ecological flow that would assure a sustainable development for each ecosystem. Therefore, when there is a transfer of water from the agricultural sector that has a low use efficiency of the resource, to the mining sector with its greater efficiency, a reduction of return flow occurs, reducing the watercourse volume and increasing the risk to life in the ecosystems.

There is a serious lack of any kind of information relating to the water market. This lack of information means that for the mining companies it is very difficult to contact rights holders wishing to sell their usage rights. Companies often have to expend considerable effort in searching out these people. Besides, the lack of information amongst farmers, who do not generally know the true value or price of water, creates a negative externality, as the right is not used in the manner most appropriate to benefit society (INECON, 1995). On the other hand, Donoso (1998) signals that the asymmetries[31] of information gives rise to a price that does not reflect its true social value, and that the level of water traded is below the optimum level in the absence of an ideal market.

In cases where the mining companies use underground water for exploitation, it is important to determine if the aquifers used are confined or not. If the aquifer is confined, implying that there is no entry or exit of water, its use would correspond to exploitation of a non-renewable resource. In this sense, the use of water would mean a cost to future generations with regard to its optional value.

III.2.6 Biodiversity

Mining activity, particularly site exploitation, can considerably alter the existing ecosystems (Blanco, Wautiez and Borregaard, 1998). In Chile, there are no specific studies on the impact of the mining sector on biodiversity.

Studies on the impact any activity could have on a zone's flora and fauna tend to be complex, since the effects can be direct or indirect, habitat deterioration, repercussions on reproductive cycles, etc., etc. Furthermore the impact can occur far from the exploitation area, for example, in the marine ecosystems located at the mouth of a river that carries waste from a mine. On the other hand, in order to know if a zone's biodiversity has diminished, it is necessary to know what was in place before the development of the activity, that is, it is necessary to have a baseline. This has only recently been required, so the impact of mining activity that has been taking place for many years on the natural ecosystems, is difficult to quantify.

[31] Lack of equality or equivalence of information between parties.

In the case of Minera La Escondida in Region II, a baseline study was carried out in the area of Coloso, where a Concentrate Plant, Cathode Plant and Shipment Port were built. This study was undertaken in 1989-1990, before initiation of the installations. Regarding the aforementioned, it is important to emphasize that in the case of La Escondida, at the time when the environmental impact study was carried out, Chile's government did not have an environmental policy, so the company voluntarily applied international evaluation procedures.

According to Blanco et al. (1998), the impact of mining on biodiversity could be more important when new projects are developed, especially in Regions I and II, because they include very vulnerable Altiplano ecosystems of great ecological interest.[32] In the case of Region I, the National System of State Protected Wildlife Areas (SNASPE) was exempted in order to authorize exploration.

The possible effects that mining could have on biodiversity and landscape, both in the prospecting and exploration stages and during the mining activities, are summarized as follows (CONAMA, 1994):

1. Environmental risks during geological survey, prospecting and exploration:
   - Damage to flora and fauna by infrastructure and noise caused by topographic and geological mapping.

2. Environmental risks from underground mining:
   - damage to flora and fauna by controlled explosions;
   - damage to flora and fauna by movement of mountainous parts;
   - damage to flora and fauna by site and building construction;
   - damage to flora and fauna by infrastructure installation;
   - damage to flora and fauna by waste dump formation;
   - damage to flora and fauna by cutting down of forests for timber;
   - damage to flora and fauna by secondary human sites.

3. Environmental risks from open pit mining:
   - destruction of flora in area of exploitation;
   - partial destruction and alteration of flora by changes of strata levels;
   - destruction of flora by infrastructure installation and air and water contamina tion;
   - disturbance and displacement of fauna by noise, air and water contamination, especially by "silting" and reagents.

4. Environmental risks from mining exploitation in the sea:
   - Destruction of stationary marine organisms.

5. Environmental risks from abandonment of mining activities, basically abandoned tail ing dams (Universidad de Chile, 1999):
   - In coastal zones (for example, Bahía de Tal-Tal in Region II and Bahía de Chañaral in Region III), alteration of coastal habitat, diminution of flora and

[32] See species present in Region II, "The Antofagasta Region".

fauna, and contamination of beaches.
- In river catchments (for example, Ríos Copiapó, Huasco, Elqui, Cachapoal), contamination risks from floods or geomechanical faults, contamination risks from rainwater percolation.
- In agricultural zones (for example, Valle de Elqui in the IV Region), ground contamination.
- In national parks (for example, Parque La Campana in the V Region), aesthetic and landscape alteration, risk of acid drainage.

Two cases of environmental impacts generated by mining activity are presented in the following text, where some type of damage to flora and fauna has been established. These are cases of contamination caused by copper mining in the Bahía de Chañaral, Region III, and by the Complejo Industrial Ventanas, Region V.

The case of Chañaral Bay (Poulsen, 1999). For more than 50 years the area around Chañaral has been exposed to pollution from the El Salvador and Potrerillos copper mines located in Chile's Region III. From 1938 to 1975, about 150 million tonnes of untreated copper mine tailings, generated first at Potrerillos and later at El Salvador were routed into the Salado River, reaching the sea at Chañaral Bay. In 1975, the dumping site at Chañaral Bay was moved to Caleta Palito, a rocky beach 8 km north of the town of Chañaral. This site received approximately 126-150 million tonnes of untreated waste similar to Chañaral Bay, until 1990. In 1990, the disposal of untreated waste from tailings was banned, and as a result the company built a tailings sedimentation dam.

The long term dumping of copper tailing has caused a severe impact on the area. The consequences are especially characterized by an increase in copper concentrations and extensive geomorphological alterations. These consequences influence the marine ecosystems and reduce the potential for extraction of marine resources.

The main effects that have been produced by this activity over natural ecosystems are the following:

1. Reduction of light penetrability: plankton communities are affected by permanent suspension of solids.
2. Geomorphological alterations: there has been a significant reduction in the depth of the bay. The continuous redistribution of sediments has furthermore damaged the ability of the seabed to support vegetation and benthic communities.
3. Impact on biodiversity: surveys show an important decrease in abundance and diversity of flora and fauna in the intertidal and subtidal species. The biodiversity in the poll uted areas (Caleta La Lancha and Caleta Palito), have significantly fewer species than the unpolluted areas (Pan de Azúcar and Caleta Zenteno). Both the abundance and diversity of birds in the area has decreased. This is likely to have been caused by the reduction of marine organisms in the area. Since 1990, and following the end of the untreated tailing dumpings at Caleta Palito, a slow re-establishment of intertidal species in the polluted sites is becoming apparent.

The case of Ventanas (Poulsen, 1999). Heavy pollution has resulted from the Ventanas industrial complex located within Region V of Chile. The complex includes the government-owned copper smelting corporation Empresa Nacional de Minería (ENAMI), the Chilgener coal-fired power station, a petroleum refinery, a cement plant and a private copper smelter.

A high concentration of heavy metals and arsenic deposits are seen in a 5 km belt around the ENAMI smelter chimney. This contamination has produced damage to both agricultural cultivation and livestock, which although they do not represent flora and fauna in the sector, can reflect the type of effect this industrial complex could have on the natural ecosystems. Some of these effects are:

1. On agricultural cultivation: the atmospheric pollution is believed to be one of the principal reasons for reduced agricultural productivity in the area. Only 1 per cent of the 30,000 hectares of agricultural land around the smelter can be used at a sustainable rate.
2. On livestock: among the fauna, sheep and cattle are especially sensitive to copper in the diet. They are most vulnerable in dry years when the animals eat older grass and have contact with the soil that contains accumulated concentrations of copper. In nota ble dry years of the 1980s, up to 20 per cent of the ewes died after eating grass at a farm 30 km away from the smelter. Another farm 8 km away from the smelter reported the deaths of 8 per cent of Hereford cattle together with a decline in fertility from 90 per cent to 42 per cent.
3. On forests: acid rain caused by SO2 and NO2 is a serious problem to the trees in the area, together with acid mists blowing from the plant. In various locations there is visual evidence of damage to the foliage of eucalyptus and pine trees, often characte rized by necrosis of young shoots.

An increase in copper and sulphur content in the soil surrounding the Ventanas smelter has been detected (Ginocchio, 1997). The copper levels varied from 20 ppm[33] in the sample stations furthest from the smelter to 60 ppm in the most contaminated stations. These concentrations, are similar to or greater than the critical toxic levels of 20 to 30 ppm for the majority of vegetation. At the level of individual species, richness diminishes closer to the contamination source, with a greater diminution of introduced species than native ones.

III.3 Socio-cultural impacts of the mining sector

The mining sector operations can have important social and cultural impacts, especially where it becomes the predominant productive activity in a region or community. The influx of workers and their families into areas previously sparsely populated, or the predominance of mining activities over several hundreds of years, clearly have significant impacts in socio-cultural terms. In traditional mining areas such as Region II, the mining sector contributes substantially to the creation of a regional identity.

[33] Parts per million.

Exploitation of Chile's natural resources has a very different influence on local culture and population from one region to the next. The differences depend on the diversity of natural resources (varying from one to several), their nature (renewable or non-renewable) and habitat conditions (higher or lower demographic density).

Also, the arrival of multinational or international companies is an important factor that can have a significant impact on the region's social and cultural variables. Different company cultures, as well as the different national cultures of the employees may integrate or conflict with each other. If foreign investment becomes predominant, there may be a reaction in the sense that political parties become more patriotic or locally oriented, and local institutions acquire particular strength. Distrust may arise between the companies, the public sector and the local community if the foreign companies do not make efforts to integrate in a harmonious way.

Probably the most emblematic socio-cultural characteristic in mining regions that has been criticized is the culture of company towns, and the isolation of the company from the rest of the community. This phenomenon has been described by several authors, referring to different regions and specific companies in Chile.[34] The recent move of the whole company town of Chuquicamata into the city of Calama, which was motivated by an attempt to avoid the effects of the air contamination which are strongest in areas near to the copper smelter, has set new signals of social integration to mining communities in Chile.

Other potential socio-cultural impacts beyond the company town phenomenon include:

- a rise in alcoholism
- a rise in the use of drugs
- a rise in prostitution, homosexuality and related diseases
- a rise in income differences
- improved educational or health services
- division in the community between those that "belong" directly or indirectly to the mining sector and those that do not.

In Araya et al. (2000) these different impacts are analysed for different regions and three related mining companies in Chile. The findings of that study are summarized in the following.

With regard to the overall index of human development[35] for the year 1992, the mining regions[36] can be found in the upper to medium rankings of the country (1st, 4th, 5th, 8th and 9th rankings out of thirteen). This shows that in general there seems to be no indication of either positive or negative linkages to the variables included. With regard to poverty, the mining regions also perform in the average range of the country.[37]

[34] See for example Geisse, (1997)

[35] This index includes indicators on life expectation, literacy, education, and income per capita

[36] Regions I, II, III, IV and VI - see section on Economic sustainability.

[37] According to a study by Raszinsky et al. (1993) these regions had percentages of 22.7, 26.3, 33.9, 33.1, and 34.1 with an average of 28.5 for Chile.

With regard to sexual behaviour, drug addiction and alcoholism, there are few statistics available. However, Araya et al. (2000) state that mining areas are characterized by a high degree of machismo, fostered especially by common law rules of exclusivity, as well as by the work shifts lasting several days. Also, the authors state that a high fluctuating population linked to the mining companies, has led to an increase in prostitution in the mining regions. They explain this by looking at the increase of this type of activity in areas that have traditionally not been mining areas, but have experienced only recently an influx of mining investment. The study concludes that there has been "... a significant increase in remunerated sexual activity over the last period, in the three areas under study ...". Concerning statistics on AIDS, there is no indication of hot spots in the mining regions - they all perform in the lower range of the ranking.

With regard to education, the mining sector generates a demand for skilled labour that is very often not available locally, regionally and sometimes not even at the national level. At the same time, there is substantial pressure on the mining companies to contract at the local or regional level. In this context, mining companies have developed different strategies. According to Araya et al. (2000), the different companies studied in Chile have implemented internal training programmes such as on the job training and apprenticeships, as well as external strategies which include financing improvements in technical education at the local and regional levels. It has to be pointed out, however, that this type of education is specifically oriented towards mining operations only. Finally, the companies have an impact on local suppliers in the sense that the larger companies have high standards of security and quality and impose these standards on their suppliers and contractors, a fact which has led the larger companies to carry out brief training programmes with suppliers to upgrade the quality of their services.

The contribution of the mining sector to the local health services can be substantial. This contribution is often motivated by the objective of fostering good community relations, but also, where employees are integrated into the respective community, in order to provide improved services to the workers of the company. Examples of investments in this area are numerous.[38]

The experience in Region II of the deterioration in production and exports of the salt mine has made a strong impression on the culture in mining regions. There is a belief in the cyclical "boom and bust" character of the regional economy, and the transitory nature of economic activity. This, combined with the "company town" style of life as well as the influx of foreign labour, have brought along an attitude of impermanence towards living in the mining regions. As some authors have pointed out,[39] this attitude contributes to a very family-oriented or individual-oriented style of life in which there is not much room for community and public activities.

A problem that can arise in a mining community is a feeling of unfulfilled expectation that was created with the arrival of large investments related to the mining sector. This has been well-documented by Araya et al. (2000) in the case of the gold and silver mining company Fachinal.[40] It was stated that "there was a profound frustration when the community noticed that several of the promises of the company were not complied with", referring to promises of contracting

[38] See for example Araya et al. (2000) or annual reports of the different large mining companies.

[39] Czischke (2000).

[40] Gold and silver exploitation started in 1996 in Region XI (with an initial investment of US$85 million).

services locally. Thus, with these experiences disseminated, there is a situation of distrust amongst the different local or regional actors.[41]

In a sustainable development strategy, all of these issues will have to be monitored, and if they are identified as real problems they will need to be confronted, and different mechanisms and instruments applied to solving them. The positive impacts of mining companies with regard to education or health infrastructure should be acknowledged.

In response to the social issues discussed above, some companies have produced a systematic policy, and created provisions for the management of community-company related issues, as well as for post mine closure social issues.[42]

III.4 Conclusion

As can be seen from the preceding analysis, the social, economic and environmental impacts of mining activities are rather different for each region. These differences, combined with the fact that resource exhaustion tends to be local in character (at the national or international level substitution, recycling and new exploration is continuously presenting new scenarios), imply that regional analyses are required in order to find the appropriate policy instruments. Region II was selected for the current analysis, given the importance of the mining sector in terms of production, export, investment and employment.

[41] See especially situation in Region II described below.
[42] See for example Epps (1997).

4.THE MINING SECTOR AND SUSTAINABILITY IN REGION II (REGION OF ANTOFAGASTA)

IV.1 The environment in Region II

The area comprising the Antofagasta Region covers some 125,306 km2 (the second largest region in Chile, 16.7 per cent of total national territory). It is located in the north of Chile between longitudes 67°00' to 71°31' west and latitudes 21°00' and 26°00' south.

Its morphology is a central valley and the Altiplano region, bounded by a coastal plain and mountain range to the west, and the Andes mountain range to the east. The region may be divided up into six distinct geomorphologic provinces which rise step-like west to east, from sea level to over 6,000 metres, as follows:

- The Pacific coastal plain
- The Cordillera de la Costa
- The Atacama desert (the Depresión Intermedia or Pampa Central)
- The Pre-cordillera Andina zone (Depresión del Río Loa and the Depresión Prealtiplánica)
- The Altiplano (and Cordillera Andina) zone.

The climate is arid and desert-like in the interior, with an arid but fairly humid, sometimes cloudy coastline, seasonal snowfall on the Altiplano and mountain peaks, clear skies and many hours of intense sunshine. Variable patterns of rainfall within the region significantly affect the availability of water resources and use of land, posing problems for water resource management. Generally, annual rainfall varies from less than 10 mm in the zone to the west of the Cordillera de Domeyko (in the Atacama Desert itself there is often no annual rainfall at all) to up to 200mm in the eastern zone (along the upper reaches of the river Loa and the catchments of the Altiplano, rainfall varies between 50 and 100 mm).

The region comprises 52 surface water catchments. The majority of these basins are enclosed, with internal drainage systems that support a few perennial streams and some lagoons. A large number of these are "salares"[43] or evaporite basins, in which the principal natural mechanism of discharge is through evaporation. In most of the Central Valley (Pampa Desertica) there is practically no precipitation throughout the year and therefore no infiltration or surface runoff.

The river Loa (flow 870 l/s) and its principal tributaries constitute the largest surface water catchment in the region and is the only system which discharges perennially into the Pacific Ocean. Other important perennial rivers include the San Pedro Grande and San Pedro Parshall rivers.

Lagoons occur mainly in the highland areas in the east of the region, where it is likely that precipitation exceeds evaporation and where groundwater recharge supports the water balance of these surface waters. Additionally, the region has desert-like ecosystems of great interest and

[43] Salt pans.

importance in the conservation of biodiversity. Twenty areas of great regional importance in terms of conservation of ecosystems were identified, eight of which are under the protection of the National System of Protected Areas. The areas in general correspond to:

- Coastal desert areas of high flora diversity
- Pre-cordillera Andina salt pans
- Altiplano salt pans
- Andean lacustrine systems
- Altiplano steppes.

The ecosystems lie within 4 main zones from west to east: coastal, desert, pre-cordillera Andina and Altiplano.

IV.2 Map of mining operations in Region II

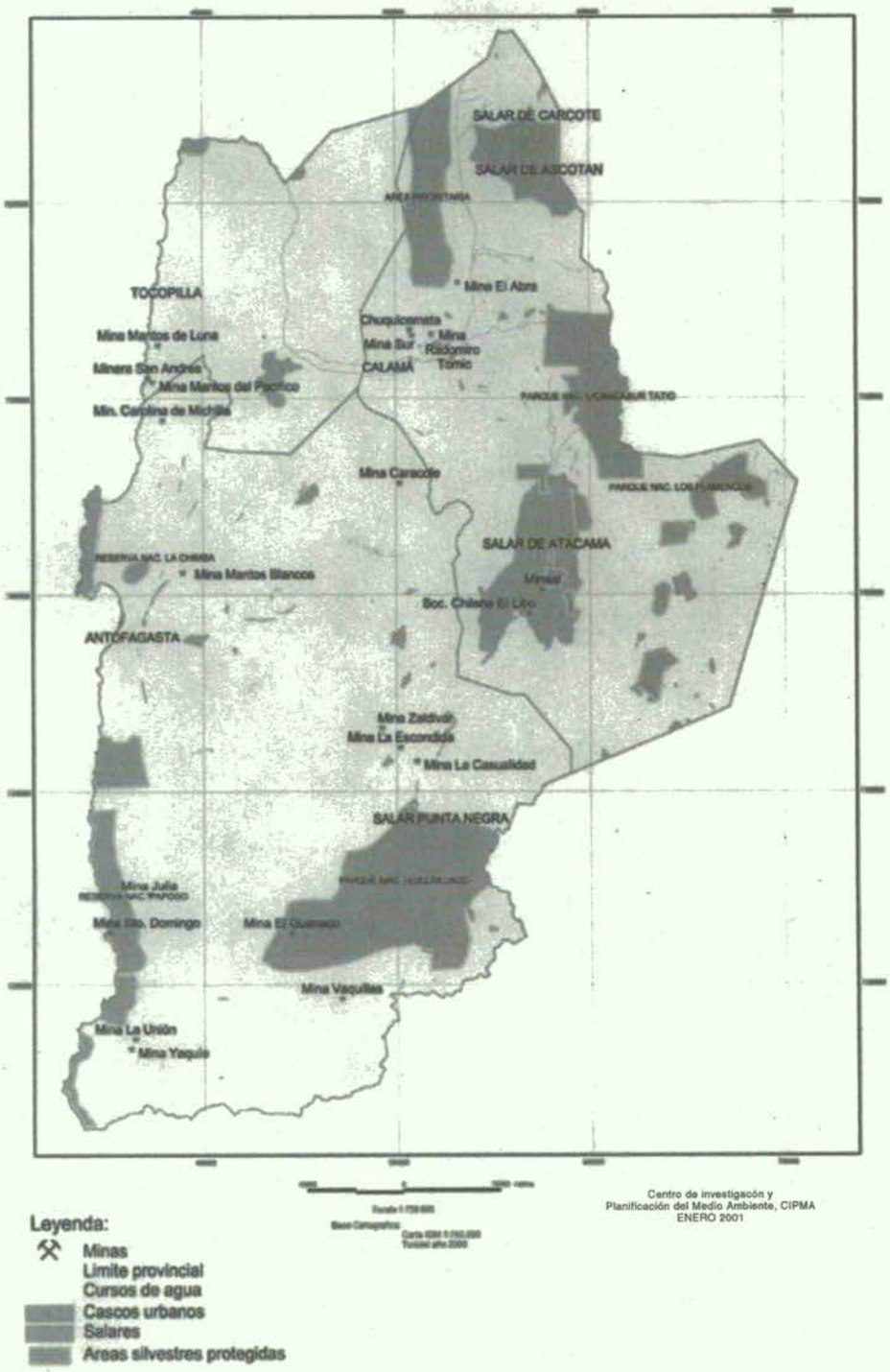

SEGUNDA REGION DE ANTOFAGASTA
Plano de ubicación de minas
SALAR DE CARCOTE
SALAR DE ASCOTAN
AREA PROTEGIDA
* Mina El Abra
TOCOPILLA
Mina Mantos de Luna
Minera San Andres
Mina Mantos del Pacifico
Min. Carolina de Michilla
Chuquicamata
Mina Sur
* Mina Radomiro Tomic
CALAMA
PARQUE NAC. LICANCABUR TATIO
Mina Caracote
PARQUE NAC. LOS FLAMENCOS
SALAR DE ATACAMA
RESERVA NAC. LA CHIMBA
* Mina Mantos Blancos
Minsal
Soc. Chilena El Litio
ANTOFAGASTA
Mina Zaldivar
Mina La Escondida
* Mina La Casualidad
SALAR PUNTA NEGRA
PARQUE NAC. LA PAYUNIA
Mina Julia
RESERVA NAC. PAPOSO
Mina Sto. Domingo
Mina El Guanaco
Mina Vaquillas
Mina La Unión
* Mina Yaquie
Centro de investigación y
Planificación del Medio Ambiente, CIPMA
ENERO 2001
Leyenda:
Minas
Limite provincial
Cursos de agua
Cascos urbanos
Salares
Areas silvestres protegidas

Table IV.1: Mining operations in region II

PROJECT	INVESTOR	PHASE	PRODUCTION
Picacho	Codelco/Chile MINA/Australia	In exploration	Copper Molibdeno: N.D.
El Abra	Codelco/Chile	In operation	Copper Cathodes: 225,000 tonnes/year
Tuina	Yuma Copper Co./Canadá	Under study	Copper Cathodes: 12,000 tonne/year
Faride	CDE Chilean Mining Corp. Familia Callejas	Under study	Gold: 600 kg/year
Leonor/Tesoro	Equatorial Treasure Ltd./Australia Grupo Luksic/Chile	Under study	Copper Cathodes: 60,000 tonnes/year
Elenita	Princeton Mining N.I./Australia	Under study	Copper Cathodes: not defined
Santa Bárbara Modernización y ampliación	Empresa Minera Mantos Blancos (Anglo American)/Sudáfrica	In operation	Copper Cathodes : 31,500 tonnes/year Copper concentrate : 46,000 tonnes/year
Lomas Bayas	Gilbraltar Mines Ltd./Canadá	In construction	Copper Cathodes : 60,000 tonnes/year
Santa Carolina	Outokumpu/Finlandia	Under study	Copper concentrates : 25,000 tonnes/year
fundición La Negra (ampliación)	fundición Refimet S.A. (25,1% American Barrick/Canadá; 24,8% Noranda Incl./Canadá)	In operation	Blister total: 180,000 tonnes/year Sulphuric Acid: 278,000 tonnes/year
Chimborazo	Inmet Mining/Canadá gate Bay/Canadá	Under study	Copper Cathodes: 50,000 tonnes/year
Zaldívar	Placer Dome/Canadá	In operation	Copper Cathodes: 150,000 tonnes/year
Escondida	BHP Utah/Australia RTZ/Inglaterra JECO/Japón IFC/O.I.	In process of extending	Refined copper(1996): 841,000 tonnes/year; Gold: 3,100 kg/year (estimated); Planta de Oxido: 125,000 tonnes/year
El Peñón	Meridian Gold Corp./Canadá	Prefeasibility study	Gold: 3,100 a 6,200 kilos
Cerro Guacate	Codelco/Chile Noranda Minerals Corp/EE.UU.	In exploration	Copper: not defined
Yolanda	Kap Resources Ltd./Canadá 1224 Yukon Ltd./Canadá Corp. Interamericana de Inversiones/OI	Under construction	Yodo: 330 tonnes/year; Nitrato sódico y potásico: 300,000 tonnes/year
a) María Elena y Soc. Coyasur b) Pedro de Valdiva	Química y Minera de Chile	In operation	Nitrato de Sodio y Potásico: 855,000 tonnes/year; Yodo: 4,837 tonnes/year; Sulfato de Sodio: 430,200 tonnes/year
Tocopilla	Cía. Minera Tocopilla S.A.	In operation	Cobre: 5,017 tonnes/year
Carolina de Michilla	Minera Michilla S.A	In operation	Cobre:27,173 tonnes/year
Lince	Minera Michilla S.A.	In operation	Copper:20,195 tonnes/year
Leonor	Cía. Contractual Minera	Under study	Copper: 28,000 tonnes/year

PROJECT	INVESTOR	PHASE	PRODUCTION
Mantos Blancos	Leonor Empresa Minera de Mantos Blancos S.A.	In operation	Copper: 74,865 tonnes/year
Iván-Zar	Minera Rayrock Ltda.	Under study	Copper: 10,000 tonnes/year
El Way	Inacesa	In operation	Cement:279,657tonnes/year; Cal: 28,372 tonnes/year
Las Luces	Cía. Minera Las Luces	Under study	Copper: 7,000 tonnes/year
Altamira	Enami	Under study	Copper: 20,000 tonnes/year
El Inca	Codelco Chile	Under study	Silver: not defined
Radomiro Tomic	Codelco Chile	Under study	Copper:150,000tonnes/year
Chuquicamata	Codelco Chile	In operation	Copper: 616,717 tonnes/year
Tuina	Cía. Minera San Martín	In operation	Copper: not defined
Salar de Atacama	Cía. Minera Salar de Atacama Ltda.	Under study	Cloruro de Potasio: 300,000 tonnes/year; Sulfato de potasio: not defined; Acido Bórico: not defined; Carbonato de litio: not defined
Salar de Atacama	Sociedad Chilena de Litio	In operation	Carbonato de litio: 10,638 tonnes/year; Cloruro de Potasio: 60,760 tonnes/year
San Cristóbal	Inversiones Minera del Inca	In operation	Gold: 1,600 kg/year
Guanaco	Cía Minera Amax Guanaco	In operation	Gold: 930 kg/year Silver: 4,250 kg/year

Source: Directorio Minero de Chile (1999).

IV.3 Sustainability - economic issues in Region II

The regional economy makes up 5.3 per cent of national GDP; the region's production per capita is the second highest in the country (after the Magallanes Region), reaching almost twice the national average. In the period between 1985-1992, the regional GDP grew 45 per cent, with an average annual rate of 5.6 per cent. In the same period the country grew at an average annual rate of 6.5 per cent.

As seen in Section IV.1 "Economic impact of the mining sector", regional economic activity depends heavily on mining, which represents about 60 per cent of the regional GDP, and 32 per cent of the country's mining GDP, and showing a rapid growth tendency over the last few years. The region produces 57 per cent of the country's copper, 71.3 per cent of the molybdenum, 43.8 per cent of the silver, 100 per cent of the sulphur, 100 per cent of the lithium carbonate, 83.2 per cent of the sodium sulphate, and 100 per cent of the saltpetre and iodine. Mining produces 95 per cent of the region's exports, with copper being the most important product; the remaining 5 per cent is made up of fishmeal exports. In total, the zone contributes between 25 per cent and 30 per cent of the country's total exports. The remaining sectors of the economy are: the manufacturing industry (6.2 per cent), transport and communications (6.1 per cent), construction (5.9 per cent), and services (5.6 per cent).

The percentage of direct employment from mining is relatively low (10.9 per cent), but as discussed previously, indirect employment generated by mining companies is significant. Extrapolating from a study carried out by Minera La Escondida SA (1997), to the rest of the companies in the region (on the assumption that the technological level and production functions are

relatively similar), it can be expected that for each person employed directly in each of the companies, there are 5.2 people in the zone employed indirectly. This would indicate that mining is generating about 56.7 per cent of the total permanent employment in the region. Additionally, many important companies such as Grupo Placer Dome, La Escondida, or Phelps Dodge, have a policy of local employment.

In turn, according to CONAMA (1994), there is a marked specialization observed in many localities in Region II. For example, copper mining and the productive activities deriving from it is the main source of work in Calama and Chuquicamata. The towns of María Elena and Pedro de Valdivia only exist due to saltpetre exploitation, and have camp characteristics with no development of complementary activities. The area's high dependence on a specific production activity, can lead to cases like the city of Taltal, which in the past was a prosperous saltpetre shipping port and today is a city in decline, with a decreasing population due to the low profitability of saltpetre exploitation.

Regarding materialized investment in Region II, between 1974 and 1999, 95 per cent of investment was in mining, compared to 36 per cent nationally. This high percentage of mining investment in Region II means that wealth production and development depends strongly on this sector.

The region contributes about 25 per cent of the country's total foreign exchange. However, despite the high value of mineral products, the value added is minimal. This is reflected by a precarious industrial sector, with limited inter-sectoral links. Even if mining continues to be the principal economic activity, steps have been taken to diversify its productive base, such as linking industrial activities based on mining, strengthening small-scale industry, tourism, fishing, transport, agriculture and energy production. However, the energy sector depends strongly on its main client, the mining sector, and this could cause problems when the mines close, as well as leaving oversized installations.

Figure IV.1: Planned closures of mining operation in region II

Due to the above, it is essential that policies are implemented in this region in the medium to long term to diversify GDP, as well as to diversify the sources of employment and investment. In this way, the region's dependence on a non-renewable natural resource will diminish. When mining operations close down, many of the mining sector workers could be absorbed by other sectors,

thus reducing the social costs associated with high indices of unemployment and migration. Economic aspects and strategies to confront them are elaborated in Chapter VII.

IV.4 Sustainability - environmental issues in Region II

Production activities have played an important role in the deterioration of the regional environment and the quality of life of its people. The high water consumption of mining has effects on other productive sectors as well as on biodiversity; effluents can affect coastal zones, whilst emissions from the smelter activities seriously contaminate the air in Calama and Chuquicamata. Also, mining exploitation has produced atmospheric contamination due to the transport, loading and unloading activities in ports and other mineral stockpiling sites, as well as important changes to the landscape.

IV.4.1 Atmospheric contamination

The most serious problems of air quality in the region occur in Chuquicamata and Calama, as a result of the large-scale smelter operations of CODELCO. The most important impact is in the Chuquicamata area. This area has been declared a saturated zone, exceeding the air quality standards for sulphur dioxide and particulate matter. Since 1996, Decontamination Plans have twice been elaborated, the most recent in 2000 (CONAMA). As part of the most recent Decontamination Plan, CODELCO had to move the mining camp, which was located close to the smelter, into the city of Calama.

According to CONAMA (2000), the air contamination in Tocopilla is mainly due to the thermoelectric energy plant in the city, which is indirectly linked to mining. However, Tocopilla's contamination problems are also a direct result of diverse mining activities, such as the concentrates plant for slag treatment and the copper cathodes plant of Compañía Minera Tocopilla.

The María Elena area has significant public health problems due to particulate contamination from a non-metallic mineral processing facility of sulphates and nitrates. This area was declared a saturated zone of PM10,[44] and a Decontamination Plan is being elaborated. In this regard it has been proposed that SOQUIMICH, the plant owners, move their contaminating crushing from an area near to population centres to close to the mine itself. [45]

In Antofagasta, according to CONAMA (2000), a poor to standard air quality is recorded. The area's most significant sources of atmospheric contamination are found in the La Negra sector. These are: Fundición Altonorte and the Cement Factory Inacesa, which have an impact on neighbouring non-urban sectors. Additionally, particulate pollution occurs in the vicinity of the port areas due to loading of minerals. There are also air quality problems associated with the REFIMET copper smelter located some 15 km from the city (DFID, 1997).

[44] Particle Matter.

[45] Personal communication with Juan Ladron de Guevara, Environmental Economics Unit, CONAMA.

IV.4.2 Water contamination

The fact that Region II is one of Chile's desert regions is an advantage. Water is scarce, so there is a strong incentive to use it efficiently, maximizing recirculation in such a way as to produce a minimum of effluents. For example, in the Minera la Escondida, only a third of the water required for operations is currently obtained from natural sources, with the other two thirds being recycled from the operations (Blanco, Wautiez and Borregaard, 1998). Additionally, the almost zero precipitation in the zone (with the exception of the Altiplano zones where precipitation occurs with some regularity), reduces the possibility of saline or acid drainage reaching the surface or groundwater systems. However, cases of surface water contamination have existed in the past due to the discharge of untreated heavy metals effluents, as in the case of the El Salvador mine (Planta Osvaldo Martínez) previously mentioned. Today, according to CONAMA (2000) and DFID (1997), the main problems of water contamination in Region II come from the presence of natural minerals, principally arsenic, boron, sulphates, chlorides and totally dissolved solids, which generally exceed the quality regulations of both drinking and agricultural irrigation water.

Positive concentrations of arsenic are found in most surface water systems in the region. In nearly all major tributaries of the river Loa, the San Pedro river and the Vilama river that feed into the Salar de Atacama, concentrations frequently range from 0.2 to 0.5 mg/l. Boron is very common in surface water in the region. Irrigation waters in the river Loa and Salar de Atacama catchments frequently have concentrations of several mg/l. Sulphates are commonly less than 250 mg/l in the surface water of the river Loa and the Salar de Atacama catchments. However, in some catchments, sulphates vary from several hundred to several thousand mg/l. Chlorides are generally found in higher concentrations than sulphates, and are of particularly high concentrations in downstream sections of the river Loa.

Groundwater quality, like surface water quality, is highly variable and generally depends on the depth of the aquifers and source of groundwater recharge, and whether the basin has any outlet and can be flushed. Total suspended solid concentrations in the fresh end of the groundwater spectrum, generally from shallower groundwater, typically range between 500 - 18,000 mg/l. As such, it is generally not suitable for drinking or agricultural irrigation without treatment. In many enclosed basins, such as the Salar de Atacama, deep groundwater is classified as brine, and total suspended solids concentrations are commonly at the level of 100,000 to 250,000 mg/l (DFID, 1997).

Groundwater is more highly mineralized than surface water, and shows higher concentrations of arsenic, boron, sulphate and chloride. Better quality groundwater is generally found in the shallower parts of the aquifer and near the local zones of recharge; the deeper confined aquifers generally show salinity increasing with depth (DFID, 1997).

There is no certainty about the effects of mining operations on the water resources. Authors (Lagos, 2000) have shown that the presence of certain substances is not directly related to mining activity, but rather a phenomenon due to the high mineralization of the soils in the zone.

Marine contamination occurs from effluent discharge into the sea that contains metals and heavy metals (such as copper, mercury, arsenic, lead) from copper treatment (primarily leaching and flotation processes) and from chemical plants in the coastal zones of Tocopilla, Mejillones and Chañaral.

IV.4.3 Intensive water use in the region

Water shortage is an important issue in Region II, particularly with the rapid growth of mining operations. There is the potential problem that demand for the resource will surpass supply. It is important to remember that in Chile the water rights are assigned (and used) without charge in perpetuity. The transfer of water rights already assigned occurs in accordance with the ability to pay by the interested parties. Since water is a scarce asset in the northern zone, the market mechanism can be assumed to function reasonably well. The problems arise when this mechanism does not reflect the social priorities of the resource use at a regional level.

The situation of water resources in the region is presented in Table IV.2, where water consumption and rights of use are presented by sector.

Table IV.2: Consumption and rights of use by sector in the region II

Sector	Consumption[1] (l/s)		%	Rights given (l/s)	%
Population and non-mining industry	Antofagasta	850		Almost 100% in hands of ESSAN S.A.	
	Calama	250			
	Tocopilla	90			
	Taltal	21			
	Mejillones	14			
	Saltpetre offices	50			
	Total	1,275	12	3,066	19
Mining industry	Escondida	700	2,150		
	Chuquicamata	600			
	Zaldívar	142			
	Soquimich	300			
	Mantos Blancos	60			
	Others	83			
	Total	2,833	26	11,208	69
Agriculture	Hoya río Loa	4,050			
	Salar Atacama	2,647			
	Others	96			
	Total	6,793	62	1,913	12
Total		**10,939**	**100**	**16,187**	**100**

Source: Intendencia (management) Region II (1996).

[1] Includes catchments from surface and underground water.

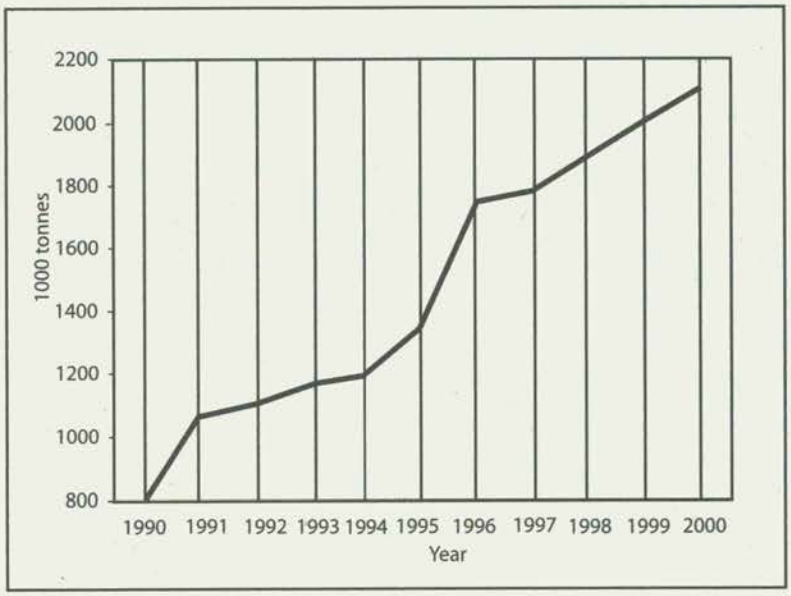
According to the table:

- the mining industry possesses more water rights than the amount of water currently consumed, and more even than the total consumption for all sectors;
- the total rights of the mining industry (11,208 l/s) are close to the estimated total offer of water available in the region, i.e., the mining industry is the main owner of water rights;
- the agricultural industry is consuming significantly more water than the equivalent to its rights;
- agricultural activity is the principal water consumer in the region.

There is potential for considerable conflict, if the mining industry was to make effective use of all its water rights.

Figueroa et al. (1996), present an interesting analysis for the future, the year 2000. To start with, they carried out a projection of the increase in regional copper production (see Graphic IV.1). The average growth turned out to be 265 per cent, made up of 192 per cent copper through concentrates, and 405 per cent of copper through leaching, extraction by solvents and electrical means (Sx/Ex process).

Graphic IV.1: Copper production in region II

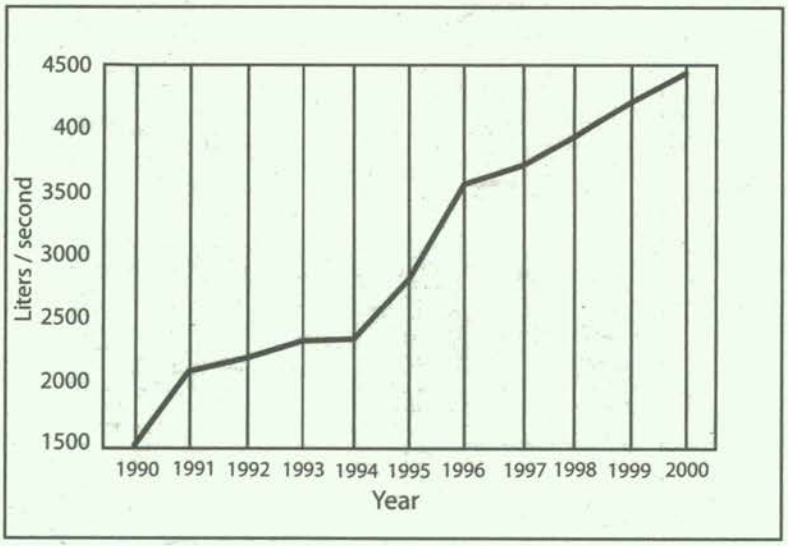


Source: Blanco, Wautiez and Borregaard, (1998).

Water consumption in the region was calculated in 1991 at 10,939 l/s, that is, almost all the available resources, according to Araya (1994), quoted in Figueroa et al., (1996).

Graphic IV.2, shows water use for copper mining in Region II between 1990 and 2000. This estimate is based on the projected increase in copper production.

Graphic IV.2: Water consumption of copper mining in region II[46]



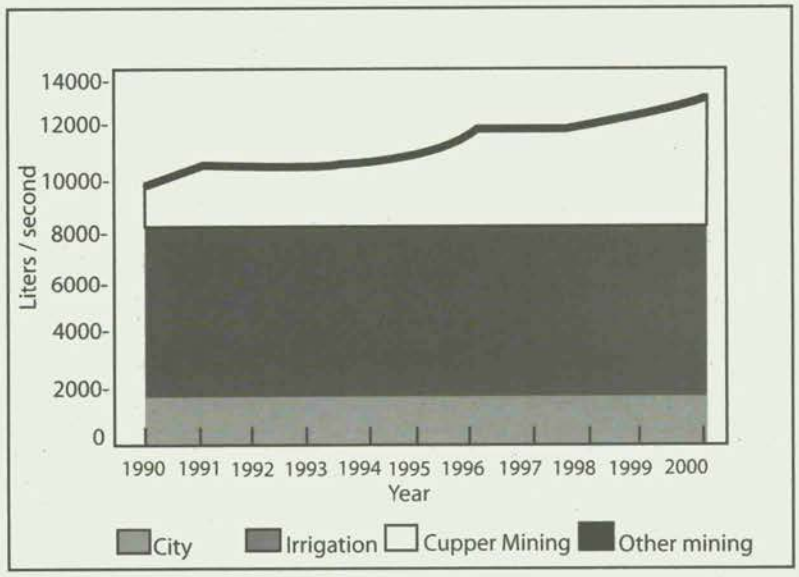
Source: Blanco, Wautiez and Borregaard, (1998).

Copper production through hydrometallurgical processes uses less water per tonne of treated material than traditional copper production. The unit consumption figures can vary between 0.2 and 0.7 m^3/tonne of mineral, whereas the traditional process (grinding - crushing - flotation) generally uses between 0.5 and 2.0 m^3/tonne of treated mineral, without considering the concentrate smelting and refining process. Copper fusion and refining can mean between 5 and 10 per cent additional water use in the traditional process.

Graphic IV.3 shows overall water consumption in Region II during the decade. Araya's information has been used (1994; quoted in Figueroa et al., 1996) for 1991 consumption, and the consumption from copper mining in Graphic IV.2 has been incorporated. It has been assumed that the other sectors also increase consumption, but by much smaller percentages than that of copper mining.

[46] As projected by Figueroa et al. (1996).

Graphic IV.3: Projection of total water consumption in region II



Source: Blanco, Wautiez and Borregaard, (1998).

At the start of the decade, copper mining used 15 per cent of the water in the region, and in 2000 mining is projected to use close to 35 per cent. In 1986, mining generated a little over 50 per cent of the regional GNP, whilst in 1992 this sector generated 65 per cent of the GNP.

In summary, it seems evident that on the basis of the aforementioned data, by the year 2000, water shortages will become significant, since consumption will be more than 1,000 litres per second greater than water availability (11 thousand litres per second).

However, it is important to keep in mind the uncertainty regarding water availability in the region, given that there might be new discoveries in coming years. In this sense, the analysis of Figueroa et al. (1996), is conservative regarding water supply, despite the fact that during the last 10 years new water resources have indeed been discovered (by mining companies), comprising approximately 10 per cent of the total available water.

Another important point that has not been sufficiently considered in the quoted study, is water conservation. Copper mining has made sizeable investments during the last two decades aimed at water conservation. Even though it is known that the investment per unit saved increases when the conservation levels are already high, as in some of the principal mining companies at the moment, this does not mean that these efforts are not going to continue. The same does not seem to have occurred in the agricultural sector, which in the year 2000 will remain the main water consuming sector in the region.

Table IV.3 presents the mineral production (current and projected for 2000), water resource, consumption and effluents for the principal mining companies planned or in operation.

Table IV.3: Water resource use in metal mining in region II

Mine	Mineral	Development Status	Mineral production (tonnes/day)		Source	Water		Effluent
			Current	Projected 2,000		Type	Consumption (m3/day)	
El Abra	Cu	Construction		90,000	Salar de Acotán, Quebrada La Perdiz	UN	44,000	
Chuqui	Cu	Operating	153,000 (sulphates)	154,000 (sulphates)	Ojos San Pedro-Inacaliri-Salado-Toconce-Colane	UN-SF	160,704	Talabre, Salar de la India
Radomiro Tomic	Cu	Construction	90,000	130,000	Recirculation Chuqui	UN	17,280	
Mansa Mina	Cu	Preliminary State			Exploration Phase	UN	16,850	
Mantos Blancos	Cu	Operating	22,000	25,000	FCAB-ESSAN	UN	8,000	Recirculation - evaporation
Zaldívar	Cu	Operating	41,000	41,000	Negrillar	UN	12,600	Recirculation - evaporation
Escondida	Cu	Operating	55,000	115,000	Catchment of Pta. Negra		46,750	Recirculation
Lince-Michilla	Cu	Operating	10,500	10,500	Sea - desalination plant	SEA	Sea water: 3,800 Demineralised: 750	Recirculation

Source: Revista Minería Chilena (1996).

Notes:
UN: underground
SF: surface
SEA: sea

There is evidence that the critical situation predicted by Figueroa et al. in 1996 has effectively emerged in 2000/2001. Several regional newspaper articles have recently referred to transactions in the market for water use rights, based on difficult negotiations between mining companies.

In general, water resource development has concentrated on surface water sources, and intensive development of groundwater resources in the region is relatively recent. Apart from a reduction in groundwater levels in aquifers in the vicinity of Calama, there are as yet no documented cases of significant impacts due to the overexploitation of groundwater. However, concern for the potential impacts of groundwater exploitation has prompted many mining companies in the region who rely entirely on groundwater resources to commission environmental impact assessments (DFID, 1997).

IV.4.4 Soil contamination

There are no studies that determine the effects of mining activity on soil stability and quality in Region II. However, it is estimated that these effects are relatively low due to the fact that mining in this region is developed in desert areas with scarce population. According to a study of Ecology and Development (1995), the main source of soil contamination from industrial mining comes from the Chuquicamata copper smelter, with an estimated affected area of 2,000 hectares.

IV.4.5 Landscape variations

In Region II, the two largest open pit mines are La Escondida of BHP Billiton and Chuquicamata of CODELCO. The pits cover an area of 2.3 by 2.5 kilometres and 1 by 4 kilometres respectively, and a depth of 350 metres and 800 metres respectively.[47] Clearly there is a significant impact on the landscape of these operations

Picture IV.1: Open pit chuquicamata mine

Source: CODELCO, Chile.

However, these pits are in a desert area which would not otherwise be accessible to the community if not for the access road of the mines.

IV.4.6 Environmental risk from abandoned mines and tailing dams

In Region II, there are approximately 32 tailing dams, about 5 per cent of the total tailing dams in the country. Of this number, an estimated 28 per cent are abandoned. Since all these dams are located in desert zones far from urban centres, their collapse or damage does not have significant impact on human health. However, the rupture of one of these could contaminate surface water sources and affect the surrounding wildlife.

[47] Personal communication with Environmental Department La Escondida, personal communication with Public Relations Department CODELCO.

IV.4.7 Impact of the mining sector on biodiversity in the Region of Antofagasta

Biodiversity of the region

The Antofagasta Region is characterized by arid desert ecosystems of great interest and importance in the conservation of biodiversity. According to a study published in the science journal Nature,[48] twenty-five "hot spots" for biodiversity were identified in the world. Two of these are in Chile, with one in the Norte Grande, at the level of the Tropic of Capricorn in the Andean sector of Region II.

The palaeoclimatic sequence of events that occurred in the Atacama desert region deeply affected the composition of the present day ecosystems found there, which are characterized by a low diversity and high degree of endemic species. Human patterns of settlement, mobility and use of resources were also affected (Marquet et al., 1998). According to Marquet et al. (1998), the region has environmental characteristics that are highly variable through time and space as manifested in: 1) an altitude gradient which runs through different physiographical units and affects temperature and rainfall; 2) the river Loa; and 3) the seasonal variability in rainfall.

Figure IV.3: Altitudinal transect of the region of antofagasta

Source: Spotorno et al. (1998).

According to the climatic characteristics of the Antofagasta Region (hyper-desert), it constitutes the northern limit of flora and fauna species from other more productive regions to the south (Veloso and Núñez, 1998).

The river Loa and its tributaries are very important because they give origin to and maintain river[49] ecosystems, and support oasis and water meadow systems, which sustain human and biological life in the desert (Marquet et al., 1998). The most notable freshwater ecosystems are found in the north of the region (DFID, 1997).

[48] Myers et al. (2000).

[49] Transition zone between an aquatic and a terrestrial ecosystem (river Loa/tributaries and desert, in this case). The river systems function as corridors for flora and fauna and, for the area of study, they are where most of the agricultural and fishing activity is concentrated and therefore are subject to high degradation from human intervention (Marquet et al. 1998).

The high Andean plateau zone of Region II is called Puna Salada and represents one of the most fragile and inhospitable ecosystems due to the combined effects of low temperatures and extreme aridity (Marquet et al. 1998). It is probably these extreme conditions that explain the fact that the fauna of Antofagasta is one of the least studied in Chile. However, these same rigorous conditions would imply that the life found there would exhibit special biological attributes that allow the organisms to adapt (Spotorno et al., 1998; Veloso and Núñez, 1998). This identifies the Antofagasta Region as a natural biological laboratory for extreme environments. For example, Spotorno et al. (1998) detected the following adaptations: a) to the cold: rodents with shorter ears and tails than their counterparts in Central Chile (Abrocoma y Chinchilla) which diminishes heat loss, coats with 25 per cent more thermal insulation (Abrocoma cinerea); b) to the dryness: more efficient kidneys and lower lung and skin evaporation rates in various mammals which diminishes water loss; c) to the absence of vegetation: change in diet from herbivorous-insectivorous to insectivorous-carnivorous, and change from nocturnal to diurnal habits (Abrothrix in the Salar de Atacama).

The coastal-marine ecosystem in the region is distinctive from other systems at similar latitudes, because the Humboldt current brings bodies of cold water from the ocean floor to the surface, bringing an accompanying rich supply of nutrients. This supply stimulates the primary food chain so that there is abundant plankton and benthos. In turn, high populations of pelagic, demersal and benthic species are also found in the region. Some 51 of these species are the foundation of an important industrial (including aquaculture) and artisanal fishing sector.

The ecosystems lie within four main ecological zones from west to east, as described below (DFID, 1997, Di Castri, 1976).

The Coastal Zone. This is located between the sea and the coastal mountain chain, Cordillera de la Costa (approximately 0-1,100m), with minimal annual rainfall, although with a good water contribution from coastal mist. This is the most important zone ecologically, especially in terms of the diversity of flora which has developed under the direct influence of the ocean. In the southern section, some 120 native flora species have been identified, with important representatives of coastal cacti. Northwards, the terrain is typically low open scrubland with the presence of a variety of cacti species. Twenty species of cacti and 11 herbaceous species and shrubs are reported to be at risk. A notable problem in this area is the illegal extraction of cacti for national and international commercial purposes.

Terrestrial fauna diversity is limited, primarily due to past habitat loss and hunting. The guanaco and chinchilla are close to extinction in this zone. Foxes can be found in this area. Sea lions can also be found along the coast. Bird life diversity is greater, with more than thirty species noted, including fisher eagles, pelicans, gulls and peregrine falcons.

Despite the existence of the Paposo National Reserve, there are certain areas which contain significant diversity of flora but which are not under any special administration or control, primarily those beyond the southern limit of the Reserve in the Morro Moreno area (Mejillones peninsula) and the mouth of the river Loa.

The Desert Zone. This is an inland plain between the coastal mountains and the Andes (approxi-

mately 1,100-2,500m), with almost no rainfall and very low humidity. Due to the extreme environmental conditions present in this zone, the ecosystem is very limited and principally located in valleys or ravines. In view of the limited flora and fauna diversity, this zone is of lower priority than those of the coast and Andes. The managed area of Prosopis trees, particularly carob ("algarrobos"), located around Quillagua is most notable.

Pre-Cordillera Andina or Marginal Tropical Zone. This includes the first chains and valleys of the Andes (approximately 2,800-3,800m), with a low rainfall in the summer period and moderate relative humidity due to local effects of rivers and salt pans. The aridity of the zone restricts flora diversity, but that which is present exhibits adaptation to highly saline and parched conditions. In the north, there are large areas with no vegetation cover but to the south diversity is greater due to water supply from aquifers. Here, a variety of native tree species are present under plantation management, including pepper ("pimiento"), carob ("algarrobo"), "chañar" and tamarind, ("tamarugo"), with exotic species such as tamarisk and cypress also present. Regarding fauna, foxes, guanacos and ñandúes can be found. The salt lagoons and the upper catchment area of the river Loa present suitable nesting and feeding environments to the James and Andean species of flamingo and other bird life adapted to the saline conditions. In fact this area is the most important in Chile for nesting of the Andean flamingo. The area is also used by migratory species, such as plovers ("chorlito"), on their north-south migration route.

The historical and current use of the shrub quinoa as a fuel has significantly reduced the abundance of this species. Regarding fauna, one species (the guanaco) is identified as in danger of regional extinction and four are categorized as vulnerable. Significant areas of ecological interest exist which have no associated conservation strategy.

The Altiplano Zone or Tropical Altitude Zone. This is located above 4,000 metres in the Andes and receives moderate summer rainfall. This zone of undulating or flat terrain, exhibits a wealth of flora distributed according to exposure, altitude and microclimates. Two plant formations are of special note, the Andean steppes and wetlands. In the steppes the low temperatures and winds preclude tree growth and only areas of perennial pasture survive. In sufficiently humid areas wetland formations exist; in such areas a great diversity of species can be found, including aquatic, emergent and cushion plant species. These lagoon areas and vegetation formations support fauna which includes the camelids vicuña and guanaco, the rodents chinchilla andina and vizcacha, and bird life such as the ñandú and Andean goose. As with the Pre-Cordillera Andina Zone, the Altiplano Zone is important in terms of providing suitable nesting and feeding habitats for a wide range of birds, and especially for three species of flamingo. At higher altitudes the dominant vegetation formation is llaretal which is present at the vegetation limit in rocky areas around volcano cones.

This is the most protected zone under the National System of Protected Areas (SNASPE), with many salt pans and areas important in terms of endemic and migratory bird life. However, important feeding areas remain without protection (for example the Ascotan salt pan, Lejia lagoon and the Aguas Calientes salt pan). The rodents chinchilla andina, and vizcacha sustain heavy hunting pressure. A total of 7 species found in the area are classified in the Chilean Red Book of Terrestrial Vertebrates, 4 are in danger of extinction both regionally and nationally (including the chinchilla), 1 is rare and 3 are inadequately known.

The number of fauna species present in the region, some of which are endemic, varies according to different authors:

Table IV. 4: Number of fauna species present in the region of antofagasta

CLASSIFICATION	NO.(*) ACCORDING TO (1)	NO. ACCORDING TO (2)	NO. ACCORDING TO (3)
VERTEBRATES			
Amphibians	4 (2)	5	
Reptiles	23 (14)	37	
Birds	184 (2)	181	80 (2)
Mammals	25 (1)	20	25 (2)
INVERTEBRATES			
Insects		192	27 (26)
Molluscs		21	
Crustaceans		3	

(*) Brackets indicate the number of endemic species.

Source: Author's elaboration, based on:

(1) Informe País (Country Report), Universidad de Chile (1999) (compiled from diverse studies).

(2) Veloso and Núñez (1998).

(3) Spotorno et al. (1998).

On the other hand, in the Antofagasta Region there are 84 species of plant and different classes of vertebrate with conservation problems - 14 plants, 18 mammals, 27 birds, 15 reptiles, 4 amphibians and 6 fish (Universidad de Chile, 1999).

In the Andes of northern Chile there is a network of high mountain plateau salt pans, which sustain flora and fauna of considerable richness and singularity, with various species endemic to this bio-geographical region. Information on the Ascotán salt pan is available thanks to a study by the Environmental Impact Assessment (EIA) of El Abra Mine (1994). It would be useful to carry out similar studies on the other salt pans in the region.

The case of the Ascotán salt pan

The Ascotán salt pan lies approximately 130 km north-east of Calama. Sixteen plant species were found in this salt pan. None of these species have conservation problems; however, it should be remembered that the Red Book does not include herbaceous species, which are predominant in the salt pan. The vegetation presents greater richness in the springs' headwaters, where conditions are less saline. As the conditions get more saline, only the most tolerant species remain. The greatest richness and cover is found in the central section of the salt pan. The most common species is Puccinellia oresigena, found in all the tested environments, in diverse conditions of salinity and humidity. The next most frequent species is Scirpus atacamensis, which is found in cushion-type formations, giving the characteristic appearance to the first sections of the springs.

In terms of fauna, generally, two types of habitat were identified: those located at the sources of the springs (eastern sector) and the salty environments located in the centre and the western sector of the salt pan. The first have less salinity and present aquatic vegetation and greater diversity and richness of bird life. The second present low richness and diversity of bird life but sustain higher densities of flamingo. The presence of 31 vertebrate species was determined: 3 mammal, 26 bird, 1 amphibian and 1 fish species. Of these, 25 can be considered directly related to the aquatic environment, whilst the rest can be considered terrestrial species which only pass through the salt pan occasionally. The fish species found is Orestias ascotanensis, an endemic species observed in several of the springs.

Of the 26 bird species observed in the area of study, 22 of them are considered directly related to aquatic environments, whilst the other four are recognized as terrestrial environment species, which use the salt pan sporadically. These four species are: the perico cordillerano (Bolborhynchus aurifrons), the minero de la puna (Geositta punensis), the chirihue verdoso (Sicalis olivacens) and the cometocino del norte (Phrygilus atriceps). The most abundant species were the parina grande (Phoenicoparrus andinus), the pato jergón chico (Anas flavirostris) and the pato puna (Anas puna). The three species of flamingo described in Chile were observed in the salt pan; of these the parina grande was the most abundant and that which showed the widest distribution within the salt pan. This is followed by the parina chica and finally the chilean flamingo. Two migratory bird species coming from the Northern Hemisphere were observed: the playero de baird (Calidris bairdii) and the pitotoy chico (Tringa flavipes). At a regional level, the Ascotán salt pan presents a greater richness and diversity of aquatic birds than other mountain salt pans, such as the salt pans of Surire, Coposa, Michincha and Alconcha as well as the Negro Francisco lagoon, which makes it a site of special importance for these birds. Although it is not recognized as one of the salt pans with the highest density of flamingos, the presence of the three species described in Chile makes it an important site for them.

Source: EIA Project El Abra Mine (1994).

In respect of the protected areas, there is notorious under-representation of arid zone and desert ecosystems in the National System for Protected Areas, SNASPE. In the "Libro Rojo de los Sitios Prioritarios para la Conservación de la Biodiversidad Biológica en Chile" ("Red Book of Priority Sites for the Conservation of Biological Biodiversity in Chile"), seven priority sites are established in Region II:

Priority I (urgent):

- Mejillones Peninsula: based on the nesting of marine birds, the presence of the "lobo de dos pelos", and endemic flora represented as scarce in the SNASPE.
  Regarding flora there are 83 species, 40 of which are endemic, 4 endangered species and 2 vulnerable species. Regarding fauna, there are 69 species, 5 of which are endemic, 1 endangered species, 2 rare and 1 inadequately known species.
- Paposo, extending south until Pan de Azúcar (Region III): based on the fact that it is a coastal zone including 300,000 hectares, with 345 species of vascular plants with a high endemic level. Regarding flora there are 259 species, 134 of which are endemic, 5 endangered species, 13 vulnerable species, 6 rare species and 1 species of interest. On the other hand, there are 68 species of fauna, 7 of which are endemic, 1 endangered species, 3 vulnerable species, 1 rare species and 1 inadequately known species.

Priority II (important):

- Mouth of the river Loa: based on the existence of endemic flora, with one endangered species. There are no details on the fauna.
- Upper basin of the river Loa and Cerro Colorado: based on the scarce or zero representation of vegetation formations represented in the SNASPE. There are 159 species of flora, 26 of which are endemic, 2 vulnerable species and 2 rare species. Regarding fauna, there are 110 species, 6 of which are endemic, 4 endangered species, 8 vulnerable species, 5 rare species, 5 inadequately known species and 1 species of interest.
- Licancabur volcano: based on the existence of endemic fauna shared with Argentina and Bolivia. There are 81 species of flora, 12 of which are endemic and 2 vulnerable species. The fauna is made up of 88 species, none of which are endemic, 3 endangered species, 7 vulnerable species, 2 rare species, 5 inadequately known and 1 species of interest.
- Llullaillaco volcano, river Frío and Punta Negra salt pan: based on the existence of plant formations not represented in the SNASPE, and the presence of Andean flora and salt pans. There is little detail on flora and fauna.

Priority III (of interest):

- Extension of Reserva Nacional Los Flamencos, Quisquiro salt pan, Cerro Lejia, Mucar: based on the endemic flora and fauna. There is little detail regarding flora. As for the fauna, there is 1 endangered species, 6 vulnerable species and 2 rare species.

Impact of the mining sector on biodiversity

The impact of mining on biodiversity occurs primarily through the use of the region's water resources. The issues associated with specific ecological zones and related to mining activities have been identified in DFID (1997) to be the following:

The Desert Zone. The main threat to the integrity of this zone is mining development and utility development such as electricity transmission lines.

Pre-Cordillera Andina Zone. Three principal threats characterize this zone: unlimited concessions for water extraction rights, non-mineral mining from the salt pans, uncontrolled tourism. In particular, the conditions of the Atacama salt pan is predicted to deteriorate significantly should current activities continue, primarily as a result of adverse changes to the water balance.

The Altiplano Zone. The principal threat in this zone is the exploration and use of water resources without consideration for the minimum ecological needs (or traditional indigenous uses). The proposed Bi-Oceanic Corridor development also poses a threat to this zone.

The main marine environment issues of Region II related to mining are the following (DFID, 1997):

- Bioaccumulation of pollutants to toxic levels in commercially and biologically important species;
- Increased turbidity, decreasing light penetration and biological productivity and mud formation, burying benthic species;
- Marine contamination from industrial effluents discharged into the sea containing metals and heavy metals (such as copper, mercury, arsenic, lead) from copper treatment (primarily leaching and flotation processes).

Concerning the terrestrial environment, the main issues related to mining are (DFID, 1997):

- Over-extraction of water for different uses, amongst others mining, adversely affecting salt pans, areas of seasonal pasture and the river Loa catchment in particular.
- Development of mining and associated activities such as road construction, causing habitat loss, contamination, noise and human immigration.

Due to the absence of general information regarding the impact of mining on the environment of the region, the declarations and environmental impact studies of various mining projects were analysed, in which the flora and fauna found in the area of influence of the project and the possible impacts affecting them were described.

The El Abra mine is located in the Loa province, about 55 km north of the city of Calama, 10 km east of the river Loa, at 4,000 metres above sea level. It occupies a surface area of about 2,400 hectares and has water rights for 365 l/s corresponding to underground water capture in the Ascotán salt pan basin and in the Quebrada La Perdiz.

The area's flora is made up of 43 species vascular plants, of which only two are scarce, and little known herbaceous species: Trichocline spathulata and Trichocline caulescens. The Echinopsis atacamensis (giant cactus) is the only species with conservation problems in the area. Regarding fauna, the EIA identified 11 species of vertebrates: 5 mammals, 4 birds and 2 reptiles. Of these 11 species, 4 present some conservation problem (see Table IV.5).

Table IV.5: Vertebrate species with conservation problems at a national and regional level in the mine-plant area of the el abra mine

Species	*Common Name*	*National Conservation State*	*Regional Conservation State*
Pseudalopex sp.	Fox	Insufficiently known	Insufficiently known
Lama guanicoe	Guanaco	Vulnerable	Endangered
Pterocnemia pennata tarapacensis	Suri	Endangered	Endangered
Lagidium viscacia	Vizcacha	Vulnerable	Endangered

Source: Author's elaboration based on EIA of El Abra mine.

Regarding flora and fauna in the mine's water capture area see "The case of the Salar de Ascotán" above. Of the species registered in this salt pan, 8 vertebrates present conservation problems at a national level: 1 mammal, 5 birds, 1 amphibian and the only registered fish. At an international level, 2 species of flamingo (Phoenicoparrus spp.) are considered threatened species by the International Council of Birds.

Table IV.6: Vertebrate species with conservation problems at a national and regional level in the area of influence of the el abra mine

Species	*Common Name*	*National Conservation State*	*Regional Conservation State*
MAMMALS			
Vicugna vicugna	vicuña	Vulnerable	Endangered
BIRDS			
Cloephaga melanoptera		Vulnerable	Vulnerable
Larus serranus	gaviota andina	Rare	Vulnerable
Phoenicoparrus andinus	flamenco andino	Vulnerable	Vulnerable
Phoenicoparrus jamesi	parina chica	Vulnerable	Vulnerable
Phoenicopterus chilensis	parina grande	Vulnerable	Vulnerable
AMPHIBIANS			
Telmatobius halli		Rare	Rare
FISH			
Orestias ascotanensis		Not determined	Not determined

Source: EIA of El Abra mine (1994), modified.

With respect to the hydro-geological impact of the project, the EIA points out that "the underground water capture in Ascotán will bring about a reduction of a little over 50 per cent in the water surplus of the basin. According to the information on ground layers and geological evidence, the surplus (about 700 l/s) corresponds to an underground flow that goes in the direction

of the Salar de Carcote, located due north of the Salar de Ascotán". No more detail is given regarding the effect this water extraction could have on the Salar de Carcote and its ecosystems.

On the other hand, El Abra has requested authorization from the Servicio Agrícola y Ganadero (Agricultural and Livestock Service, SAG) to cover an area of the high sector of the Quebrada Ichuno in order to carry out a process of lixiviation of matter. In this sector there is a small community of 50 llaretas, which would be affected. As the transplantation of this species in other cases has been a failure, El Abra has proposed an alternative mitigation measure, consisting of an agreement with the SAG to develop two studies on the llareta (Azorella compacta Phil): a) Evaluation of the llareta's growth in the area where the main communities are found close to the El Abra mine; b) Study of the germination, nursery breeding and transplantation of the llareta (Convenio El Abra-SAG-CONAF, 2000).

Another mine in the region is El Peñón, located in the Pampa El Peñón, in the zone of the Absolute Desert. Due to the low or zero rainfall there is no natural vegetation in the project area. The fauna is extremely scarce and mainly consists of occasional visitors. In the project's area of influence - approximately 20 km2 - 8 species of vertebrates were detected, 2 of which are in some category of conservation (Table IV.7).

Table IV.7: Vertebrates found in the area of influence of the el peñón mine

Common Name	*Scientific Name*	*Conservation Category*
MAMMALS		
Zorro culpeo	Pseudalopex culpaeus	Inadequately known
Lauchón orejudo	Phyllotis xanthopygus	
BIRDS		
Gaviota garuma	Laris modestus	Vulnerable
Chincol	Zonotrichia capensis	
Bandurrilla de las piedras	Upecarthia andeacola	
Golondrina negra	Progma modesta	
Golondrina de dorso Negro	Pygochelidon cyanoleuca	
REPTILES		
Lagartija	Liolaemus sp.	

Source: Author's elaboration.

Regarding an evaluation of impacts on the biological environment, the EIA points out the following:

- Vegetation and flora: given the non-existence of natural vegetation in the project's area of direct influence, further analysis is omitted in this study.
- Fauna: given that the fauna in the project's area of direct influence is scarce and fundamentally transient, further analysis is omitted in this study.

Due to the above, neither mitigation measures nor follow-up plans are proposed.

In the case of the mining company Quebrada Grande (CMQG), an Environmental Impact Declaration (EID)[50] of the Preliminary Exploration Activity in the river Frío sector (south-west perimeter of the Parque Nacional Llullaillaco) was presented. In the case of the flora there were 22 plant species, none of which has conservation problems. Regarding fauna, 9 species were found, of which 4 mammals have conservation problems according to CONAF's Red Book of Terrestrial Vertebrates.

Table IV.8: list of the fauna found in the river frío sector

Species	*Common Name*	*Conservation Category*
MAMMALS		
Lama guanicoe	guanaco	Endangered
Vicugna vicugna	vicuña	Endangered
Pseudalopex culpaeus	zorro culpeo	Inadequately Known
Lagidium viscacia	vizcacha	Vulnerable
Abrothrix andinus	ratoncito andino	
Phyllotis darwini	lauchón orejudo de Darwin	
BIRDS		
Anas puna	pato puna	
Geositta punensis	minero de la puna	
REPTILES		
Liolaemus sp.	lagartija	

Source: Author's elaboration based on EID of the Preliminary Exploration Activity in the Río Frío sector - Region II. Compañía Minera Quebrada Grande, July 1998.

However, it goes on to say that "the area of direct influence of the activity is without vegetation, and does not constitute an important habitat or place of transit for fauna. According to the available information, species of the biotic environment could eventually be found, but these are not apparent in the area of activity." Additionally it states that "the activity is not located close to any human settlement, and is in an area where the environmental value of the territory will not be affected", despite the fact that the prospecting involves part of the Parque Nacional Llullaillaco in the river Frío sector.

The El Tesoro mine lies 91 km south-east of Calama, in the Sierra Gorda. The water supply will be from underground aquifers located 3 km south-east of Calama (rivers Loa and San Salvador, Vertiente San Lorenzo and Vega 1). The flora and fauna were studied by differentiating three sectors: mine and aqueduct sector, river Loa sector and sector of the wells. The mine sector is abso

[50] The regulation for the system of EIA differentiates between Environmental Impact Declaration (EID) and Environmental Impact Studies (EIS). The latter are significantly more demanding given that they are directed at projects with larger environmental impacts.

lute desert, practically without vegetation, since there are no surface watercourses; the scarce vegetation is restricted to the bottom of ravines and is basically made up of ephemeral species. The river Loa sector is characterized by herbaceous and bush cover, presence of human settlement with related exotic flora, reservoirs, cultivation and livestock. In the sector of the wells, near to Calama, there is abundant herbaceous cover due to near-surface water pockets; there is also human activity (dumps, housing, livestock). With regard to the state of conservation, none of the species observed is found in the categories of endangered, rare or vulnerable. In this EIA other categories of conservation are not mentioned. Regarding flora, there is potentially a high impact through reduction of plant cover and also of the wild animal population due to the water capture which affects the water meadows. Only one of the wells produces springs. In this case it is proposed to use the water only after the third year in order to postpone the impact on the species that live around these springs. Also, the project includes carrying out monthly monitoring to determine the level of the wells in the stations of the rivers Loa and San Salvador, and monitoring the vegetation.

A rich fauna of 60 species of terrestrial vertebrates (49 birds, 7 mammals and 4 reptiles), of which only 22 were observed on site (20 birds, 1 mammal and 1 reptile) was determined. Of the 60 potential species, 8 are in some category of conservation. Of these, the only species really observed in the study area was the zorro culpeo, which falls in the category of "inadequately known".

The impact of mining activity on biodiversity has been studied in more detail in the Minera Escondida (Arcos, 1998). Escondida is located 160 km south-east of the city of Antofagasta, in the Atacama desert, 3,100m above sea level. A 170 km pipeline transports the concentrate produced in the mine to the port of Coloso, located 14 km south of Antofagasta.

In the process of the Escondida EIA, a series of significant adverse environmental impacts were identified due to the industrial activities. These were classified into three groups. The impacts that affect biodiversity in some way are the following:

- Impacts due to concentrate stockpiling and transport in Planta Coloso:
  - reduction of biological productivity through reduction in luminosity in the column of water due to escaping dust.
- Impacts due to port activity in Punta Coloso:
  - bioaccumulation of trace metals in marine organisms.
- Impacts due to underwater effluent discharge at Puerto Coloso:
  - bioaccumulation of trace metals in benthic organisms
  - sub-lethal and lethal effects of trace metals on planktonic and benthic organisms
  - alterations in the structure and functioning of marine communities.

On analysing the environmental effects of the activities of Escondida in Coloso separately, the impacts on biota and marine communities are identified as follows:

- Impact on biota: the conclusion is that mercury and lead concentrations in the undiluted effluent would not produce toxic effects on the marine organisms; the zinc, selenium, cadmium and arsenic concentrations expected in the undiluted effluent would produce sub-lethal effects on marine organisms and the impacts would occur in the area close to

the diffuser (a few metres); the copper concentrations would produce sub-lethal effects on the plankton for a radius of 500 metres around the diffuser and up to 20 metres height from the outlet.

- Impact on marine communities: a localized effect is forecast on the organisms around the diffuser, due to the increase in copper concentrations to a range of 100 metres under the worst dilution scenario. On the other hand, it is estimated that the discharge could provoke a copper enrichment in the sediments close to the diffuser (4 km), although this increase would not have an important impact on the benthos communities. Moreover, it is predicted that neither the intertidal nor the subtidal communities would be affected.

A Leopold matrix was used to evaluate the impacts produced on the marine ecosystems by the emission, taking the most unfavourable conditions regarding intensity, extent, importance and probability of occurrence. A global grading of 72.4 was obtained from a total of 9,000 possible points; the value corresponded to 0.8 per cent of the probabilities of environmental alterations or impacts produced by the underwater discharge, which is considered negligible. Furthermore it was indicated that the discharge would not produce accumulative or irreversible environmental impacts and that the ecosystem in Coloso would not be altered in the long term.

The EID recommended "additional modifications to the installations and capacity of treatment and processing of sulphate mineral of Minera Escondida Ltda.," (September 1999). This would consist of the extension of the Concentrating Plant of Laguna Seca and modification of the Filtering Plant in Coloso. With respect to the environmental value of the project area, it says it is concerned with "places in which there is already industrial activity, so its location would not mean a significant impact on the environmental value of the land". Regarding flora in the Laguna Seca sector, the EID affirms that "it is poor and the species described are widespread and without conservation problems". A list of the species found was not made. Regarding fauna of the same sector, two species of camelids were registered (guanaco and vicuña) by means of indirect evidence, both with conservation problems (danger of extinction). However, they affirm, "the Laguna Seca area is small compared to the habitat area of these animals". Neither the presence of birds nor reptiles were registered in the study sector.

In the area of Coloso, the flora consists of a few species adapted to the extreme desert conditions; 14 species were registered, all herbaceous. The fauna associated with the coastal vegetation is basically composed of small mammals of wide distribution and large mammals such as the guanaco (Lama guanicoe). But at sea level in the marine environment, it is possible to observe a larger number and diversity of living creatures. Throughout the area, 13 species of bird have been registered of which only the species Larus modestus and Larosterna inca are classified as vulnerable. The marine ecosystems present a raised productivity due to coastal emergence.

With its environmental policy, Minera Escondida has developed a project to help the conservation of the flamingo, which is in danger of extinction. It is a very delicate species, particularly in its reproductive habits: it lives in a very arid and extremely saline environment where food is scarce and of low nutritional content, with drastic temperature oscillations (40-45°C in the shade during the day and -20°C during the night). The Atacama salt pan is the largest in Chile, with 3000 km2, of which 12 km2 are surface water. The flamingos reproduce in some of these water

areas. The objective of the Escondida project has been to incubate eggs in the laboratory in order to later release the flamingo chicks into the natural environment. In the lake where the project is being developed, some 2,000 active nests were found in the 1999 season (with 1 egg in each). In natural conditions, 1,400 of these 2,000 eggs would hatch, of which only 300 chicks would survive. On the other hand, in the biological station, 40 eggs extracted from nests were incubated, of which 25 chicks were released in a good enough condition to feed independently, which can be considered a success (video-tape "Proyecto Flamencos", Minera Escondida, 1999).

IV.4.8 Summary of the environmental impacts caused by mining in Region II

In Table IV.9 the main environmental impacts produced by the mining sector in Region II are presented and ranked according to their significance, following Espinoza et al. (1994) who classified all the environmental problems detected in the region according to importance.

Table IV.9: Main environmental impacts produced by the mining

Resource	*Impact*	*Availability of Information*
Air	Air quality problems are associated with particulate material, sulphur dioxide, nitrogen oxides and arsenic produced by smelters and loading of minerals	Regular
Water	Over exploitation of existing water resources that produce changes in hydrological regime, reduction in stream flow, silting of stream and river channels, diminishment of water quality, loss of natural vegetation and wildlife habitat, diminishment of scenic value, increased soil erosion, reduction in natural spring discharges, reduction in size and level of lagoons, reduction in groundwater storage	Poor
	Surface water contamination due to discharge of untreated heavy metals effluents	Poor
	Heavy metals leachate contamination of surface and groundwater due to leakage from tailing facilities	Poor
Soil	Soil contamination around Chuquicamata	Poor
	Landscape variation	Good
biodiversity	Marine contamination from industrial effluents discharged into sea containing metals and heavy metals (Cu, Hg, As, Pb) from copper treatment	Good
	Bioaccumulation of pollutants to toxic levels in commercially and biologically important marine species	Regular
	Increased turbidity of seawater, decreasing light penetration and biologica l productivity and mud formation, burying benthic species	Regular
	Wildlife habitat loss caused by over extraction of water for mining, adversely affecting, in particular salt pans, areas of seasonal pasture and the Rio Loa catchment (this affects, for example, flamingo communities)	Poor
	Habitat loss, pollution, noise and human immigration caused by mining development and associated activities and road construction	Poor

Source: Author's elaboration.

IV.5 Social issues in Region II

Over the last century and a half, mining in one form or another has had a dramatic impact on Region II and on social development. As we have seen in previous chapters, it is a region that relies almost exclusively on this one productive sector. Some of the effects of the industry have been positive and have greatly helped the development of the region, whilst others have been detrimental. The early nitrate mining had a profound impact on the area with the development of many small mining communities. Railways were developed in the region together with port facilities. The town of Taltal started to boom in 1836 with the opening of 21 saltpetre works. It has diminished from a population of over 20,000 during the height of the nitrate boom to approximately 8,000 today. When nitrate mining collapsed, many small mining towns were abandoned and now are a silent witness to a past age. Copper mining has now taken over from nitrates, but mining is an industry which by its very nature will not last for ever. The challenge is to protect the region and the people from a repeat of the social and economic consequences of the fluctuating nature of the mining industry, and to capitalize on the strong infrastructure which has been put in place already.

IV.5.1 "Camp culture"

In the Region of Antofagasta as in all other regions of the country, the historic influence of centralized politics has given the local community a culture of dependence on decisions made by the central powers. However, for Antofagasta's population, unlike other regions, this central political dependence is further reinforced by a dependence on a single production sector, the mining sector. No other region in Chile depends to such a high degree on a single production sector. As mining has often meant locating workers to remote areas, the industry has taken on the responsibility for housing requirements, including building complete mining towns. The responsibility for running the town, education and health has historically been the responsibility of the mining companies. The reliance of a large percentage of the people in Region II on the mining sector and the development of "camp culture"[51] has meant the region has a different social structure and different social involvement, with all of the associated problems of integrating mine workers into the community, due to a low degree of social capital in the form of basic social organizations.

In more recent times there has been a distinct change of thinking in terms of housing policy. Before production at Escondida (MEL) commenced in 1990, the company launched a housing initiative in Antofagasta to assist its employees in the area to purchase their own company-built house or apartment. Escondida subsidized this purchase, offering a key benefit to their employees. By the end of 1998 Escondida had built 642 housing units situated in four different locations in Antofagasta.[52] Another company, Zaldivar (CMZ), implemented another strategy a couple of years later. The company provides a loan for the purchase of a house or apartment in whatever area the employee chooses. After six years with the company, the loan is cancelled, providing a loyalty bonus and in addition, encouraging a better integration into the city, and freedom of choice for the workers.

The mining companies have always provided for their employees in a specific manner, and for

[51] See for example Geisse (1997).

[52] Annual Report and Financial Statements, MEL (1998).

many of them, leaving the "protection" of the company is very hard. Taking responsibility and being involved in local community concerns is a big change from having everything taken care of by the company. In the last ten years, with new mines being opened, there has been a change in culture, and a change in the method of helping the mine workers and their families. There has been an attempt to "wean" employees away from their dependency. The integration of the mining camp Chuquicamata, (population approximately 17,000), into the city of Calama, planned for the upcoming years, will constitute a major challenge in the region. This move does not simply require a great deal of money for buildings, but will require a long term strategy, integrating a range of diverse educational, informational and infrastructural initiatives, and although many mine workers from Chuquicamata already live in Calama (population approximately 90,000), the prospect of absorbing all these extra families is daunting. Amongst others, there are concerns over the ability of the city to cope with the large influx.

IV.5.2 Participation in community activities

Even though there has been a change from housing all miners in the same area, or building a miner's town, workers from one mine tend to have a strong identity of their own, and many activities will be with people from their mine. This possibly explains why there is a lack of interest in participating in neighbourhood committees. Scarcely 4 per cent of the population of Antofagasta are registered in neighbourhood committees, compared to 10-15 per cent nationally.[53] While this may be seen as an indication that a group of people do not care about their environment or who do not want to contribute to the community, on the contrary this might reflect the strong identity with a particular mine and group of workers. When a particular social need is identified, the traditional organization to go to for support and help is the company. Turning to outsider groups or NGOs is not likely when they can get much faster support from their own employer or from fellow workers. All these aspects add to the feeling that the old "camp culture" still exists. This culture, rather than being a negative influence on the integration in a city, should aim to benefit all citizens in the region and be a positive influence on an areas' identity. Section V.2.1. describes several examples of the involvement of mining companies in the socio-economic development of the region they operate in.

IV.5.3 Education

According to statistics,[54] the region has a workforce of 164,100 of which 151,000 are employed, and of these 37,190 have had some form of training. This gives the region a training index of 24.63 which is well over twice that for the Metropolitan area (11.52), which has the second highest percentage of trained workers (Table IV.10).

[53] CIPMA 2000

[54] SENCE Boletín Estadístico (1998).

Table IV.10: Level of training in region II

Region	*Total population*	*Workforce*	*People in employment*	*People with training*	*Training index*
I de Tarapacá	395,000	155,500	144,400	11,530	7.98
II de Antofagasta	465,100	164,100	151,000	37,190	24.63
III de Atacama	271,100	113,100	104,100	8,966	8.61
IV de Coquimbo	573,500	211,900	195,300	13,076	6.7
V de Valparaíso	1,555,700	587,500	531,100	48,826	9.19
VI del L.B. O´Higgins	783,400	290,200	278,400	14,329	5.15
VII del Maule	910,800	350,800	328,300	16,712	5.09
VIII del Bio-Bio	1,925,200	683,500	628,400	45,026	7.17
IX de la Araucanía	869,200	294,200	273,900	13,216	4.83
X de Los Lagos	1.055,600	390,200	370,900	20,990	5.66
XI de Aysén	94,300	38,100	36,700	1,663	4.53
XII de Magallanes	157,100	66,700	62,800	5,950	9.47
R. Metropolitana	6,54,000	2,576,300	2,319,500	267,155	11.52
Total for the country	**15,110,600**	**5,922,100**	**5,424,600**	**504,629**	**9.3**

Source: SENCE Boletín Estadístico (1998).

Section V.2.1. describes in greater detail the involvement of mining companies in education and training in the region.

IV.5.4 Indigenous peoples and the rise of tourism

Although Antofagasta and Calama are the most significant towns in the region in terms of mining, San Pedro de Atacama is notable as an important centre for tourism and diversification from mining. San Pedro de Atacama and also many of the surrounding villages have become centres for visitors from Chile and from all over the world. The infrastructure in the villages is fairly basic, but access to these areas is being improved slowly with a good quality tarmac road now linking Calama to San Pedro. The larger mines such as MEL and CMZ, although at some distance from San Pedro, run various schemes to help these outlying villages and indigenous groups. MEL, through its foundation, provides economic and social support to Peine, a town in northern Chile, contributing to its development. A group of workers from CMZ have also worked on projecting the cultural folklore of the country by forming a musical group, the "Atacamitas". The project is called "Cultura Artística a través de Compañía Minera Zaldivar en la ciudad de Antofagasta" and the aim is to promote the music of Latin America and the Andina culture.[55]

IV.5.5 Antofagasta - a place to work but not to live for ever

In Antofagasta and Calama there is the perception that this is a place where people live in the short term to earn money, but is not a place to settle in the long term. These sentiments seem to be particularly associated with people from the south of Antofagasta, whilst those from further north who are more accustomed to the desert conditions are more settled. Antofagasta is a city that is growing, with noticeable changes regarding the quality of life for the residents. Large stores have moved into the area and there is a much greater selection of products in the shops.

[55] Pinta Verde. Inhouse publication CMZ

On the other hand there are still many areas where improvements would lead to an enhanced quality of life, such as the lack of adequate sports facilities, a lack of parks,[56] and the need to clean up natural / recreational areas along the coast.[57] There is a clear discrepancy between the per capita income and the quality of life. This might be a sign of the lack of commitment to the region. However, as has been stated before, mining regions have a very special idiosyncrasy, and commitment to the region is often through commitment to the company. Capturing this commitment to the company and using it to raise the overall commitment to the region is a challenge to be faced.

It is interesting to speculate as to whether improving the quality of life in Antofagasta would change the attitude of people towards staying there after their work has finished. Whereas for some, the desert is not home and never will be, for others certain improvements may make a difference. The next generation that grows up in the city may identify with it and feel this city is their home. The challenge for Antofagasta is to improve the quality of life in order to gain the support and sense of belonging of their citizens.

IV.5.6 The future social sustainability of the region

In terms of social sustainability, the positive interrelationships need to be built upon and a vision for the future developed. This vision has to be developed between all the players. There are many things that have to be taken into account when determining what social issues would benefit the region, maintaining what it already has to offer, but also continue the economic growth and success. The mining operations will have to keep their commitment to the region by being directly involved in the social concerns of the citizens - very often these will be issues that are not directly or even indirectly related to mining operations, but that constitute priority issues for the community of which the mining company is part. Each of the areas should be analysed with regard to their current state and requirements for future development. See Annex 3 for suggested areas for consideration.

[56] The new "Parque de Eventos" should be mentioned, as well as the improvement to "Paruqe Brasil". These two initiatives are setting the stage for improvement in this respect.

[57] See for example CIPMA (2000).

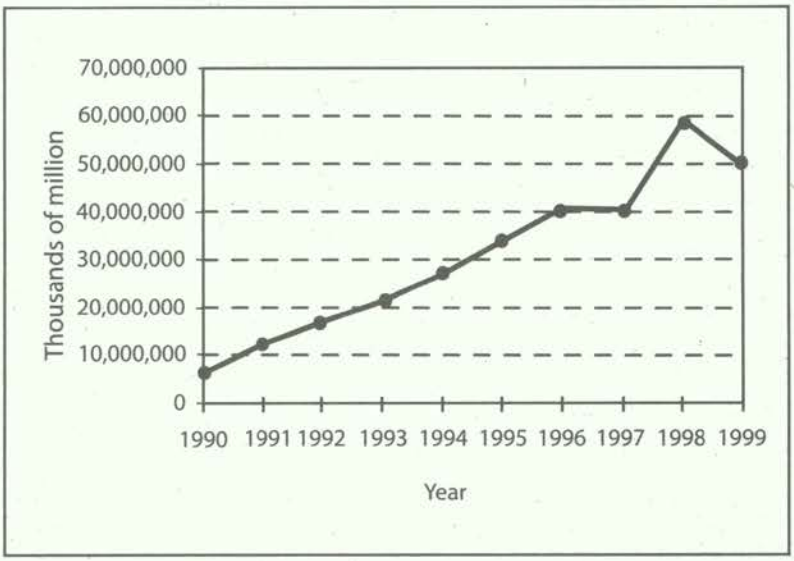
5.INVESTMENT BY THE GOVERNMENT AND MINING COMPANIES IN THE REGION OF ANTOFAGASTA

In the previous chapters, the areas of economic, social and environmental sustainability have been reviewed. However, how much of the mining sector's surplus remains in the region, be it through reinvestment of taxes collected by the state or through voluntary contributions to the community is under continual discussion.[58] The focus of the current study is on the potential role of a Sustainability Fund, so assessment of the current contributions to the community should indicate whether a Sustainability Fund could be based on voluntary contributions or whether obligatory contributions are a more realistic approach. It is necessary to know how much public investment in the region there has been, how much mining companies have invested in the community on a voluntary basis and what have been the main areas of voluntary investment. It should be noted that there is little clarity about private contributions in the region.

V.1 Government contribution to the region

During the last ten years, public investment in Region II has increased, rising from US$6,936 million in 1990 to US$50,238 million in 1999 (Graphic V.1).

Graphic V.1: Public investment 1990-1999



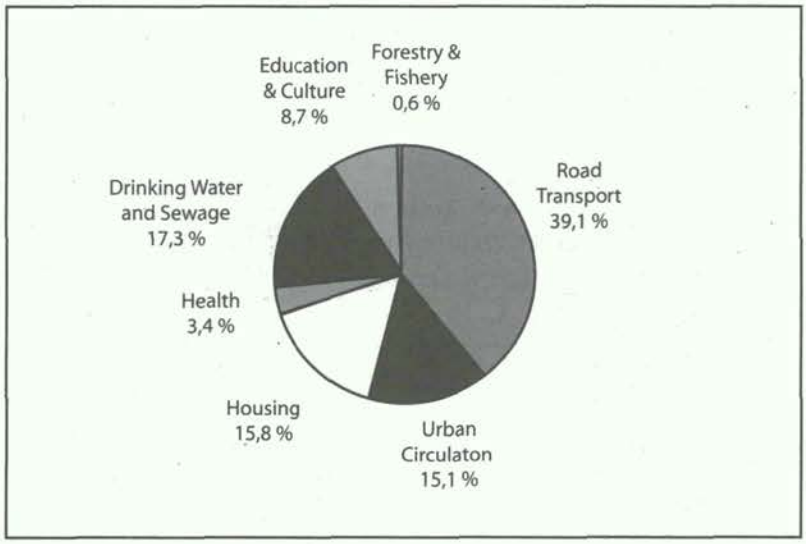
Source: Author's elaboration with data from the Ministry of Planning and Co-operation (MIDEPLAN), (2000).

[58] International Conference of the CEPAL: "Cluster mines in Latin-America," Iván Simunovic. Interview in El Mercurio of Antofagasta, 10 June 2000.

However, in spite of a general increase during recent years, public investment in Region II between 1995 and 1998 was only 4.2 per cent of total national investment. According to Iván Simunovic,[59] president of the Asociación de Industriales de Antofagasta (Association of Industrialists of Antofagasta), this corresponds to only 10 per cent of the total annual contribution (US$1,200 million[60]) made by the companies to central government through surpluses and taxes.

The main destination of government investment in Region II is road transportation, drinking water and sewage, and housing and urban circulation, where 39.1 per cent, 17.3 per cent, 15.8 per cent and 15.1 per cent of the region's budget was invested respectively between 1995 and 1998 (Graphic V.2).

Graphic V.2: Destination of the investment by sectors in region II between 1995-1998



Source: Author's elaboration with data from MIDEPLAN (1999).

Of the investment destined for road transport, between 1995 and 1998, 66 per cent was spent on principal regional routes, 31 per cent on national highways and the remaining 3.3 per cent on local roads of the transport network.

Regarding investment in education, between 1995 and 1998, the highest percentage of this was spent on primary and secondary education (60.9 per cent), followed by secondary technical education (13.4 per cent) and higher education (10.3 per cent) (Table V.1).

[59] Interview in El Mercurio of Antofagasta, 10 June 2000. Quoted by Curverwell (2000).

[60] According to Antonio Sánchez, SEREMI of Region II, the US$1,200 million includes government income from CODELCO.

Table V.1: Investment in education in region II 1995 - 1998

Subsector	Millions of $	%
Management education & culture	276	2,2%
Art & culture	345	2,8%
Training education & culture	18	0,1%
Básica and Media education	7.548	60,9%
Differential & special education	78	0,6%
Technical education	1.657	13,4%
Education for adult	0	0,0%
Kindergarden education	1.049	8,5%
Higher Education	1.278	10,3%
Intersubsector education & culture	147	1,2%
Total	**12.396**	**100%**

Source: Author's elaboration with data from MIDEPLAN (1999).

Note: In Chilean pesos (1998).

V.2 Mining companies' contributions to the region

In this preliminary review, six mining operations have been included,[61] which are:

- Mining Company La Escondida.
- Mining Company Zaldivar.
- Mining Company El Abra.
- Mining Company Meridian.
- CODELCO - Chuquicamata Division.
- CODELCO - Radomiro Tomic Division.

It is important here to realize that the information regarding contributions made to the community is neither complete nor systematic, nor easily available to the public. In this regard, it would be desirable to improve the systematic delivery of information, either in the annual reports or by other means, so that it is possible to realistically determine the contribution made by the mining companies to the communities.

Voluntary contributions are generally included in the overall context of social responsibility, good neighbourhood policy, or others, for example environmental policies and management[62] and public-private cooperation. In the mining sector in Chile, environmental management at the company level has been analysed by Araya et al. (2000) and Borregaard et al. (1998). Araya et al. (2000) analyze the interrelationship between sustainability at the regional level and the management of multinational companies on sustainability issues. Recommendations in their study include the establishment of a corporate mission on sustainability, the establishment of a positive relationship with the community in the exploration phase, the elaboration of a closure plan, participation in regional educational activities, the elaboration of an environmental management system, and participation of the company in regional development activities.

[61] In a more detailed review all companies over a certain size should be included. The operations included here represent about 75 per cent of the regional copper production.

[62] For the mining sector see for example the description of environmental policies and programmes presented in Miller (1997).

Most of the large mining companies in Region II make various contributions to the community, be it through improvements in the infrastructure of cities and roads, support of education by means of employee training and study scholarships, and health programmes. In the present study the quantitative aspects are referred to, though it would be interesting to also consider the quality of donation or cooperation.[63]

The data in Table V.2, shows that the private companies direct their contributions to the region primarily through their employees. For instance, in 1998, the mining company La Escondida (MEL), set aside US$11 million to help their employees. Another example is the mining company Zaldivar (CMZ), which in 1998 spent about US$6 million on helping employees. In general, companies' contributions to their employees are made in the areas of education and housing, whilst the contributions to the community are made in the areas of education and health.

[63] For a discussion of this position in the Chilean mining context see Geisse (2001).

Table V.2: Contribution of mining companies to employees and the community (thousands US$)

Item	MEL		Chiqui & R Tomic		CMZ		El Abra		CMM	
	Community	Employee	Community	Employee	Community	Employee	Community	Employee	Community	Employee
Road		Yes				Yes		Yes		
Lodges		3,000		230		4,800				
Education& Culture	130	8,000	70		55	1,170	9		18	
Work & Training		19		7						
Social Security		60				28				
Health	40									
Silvoagripecuary		250								
Help to Microcompanies	6		35							
Help to Community	7		350				30			
Environment	1,728				680					
Total	1,930	11,000	772	230	735	5,970	67		18	

Source: Author's elaboration using information from: Fundación Minera Escondida, 1998; Minera Escondida Ltda, 1999; Compañía Minera Zaldivar, 1998; Placer Dome, 1998 and personal communications with Jaime Rencoret, Public Affairs Director of El Abra, with Edwin Orchard, Assistant General Director of CMM and Juan Carlos Díaz, Director of Communications and External Affairs of the Chuquicamata.

Note: These numbers take into account only the year indicated. Investment into infrastructure by the mining companies is, in general, heavily concentrated in the first years of operation. Maintenance costs could not be included due to a lack of data. Note that in the case of Minera Escondida the amounts do not consider the capital provided to the Foundation

On the basis of this very preliminary data certainly no conclusions can be drawn. However, the data suggests that contributions are still very limited, except for some very large companies, such as CODELCO´s Chuquicamata and Radomiro Tomic which together contribute US$1.5 million annually, as well as La Escondida which has created the Minera Escondida Foundation, the capital of which is not taken into account in the table.

The contributions to the community on education have been concentrated in different areas, for example, contributions of MEL have mainly been used to develop entrepreneurship and leadership of teachers and students in the community of Antofagasta, whilst the contributions of CMZ, El Abra and CMM have focused on awarding study scholarships to students, teachers and sportspersons from Antofagasta and inland towns. Furthermore, El Abra runs programmes to promote cultural development by means of folklore and community organizations. In the cases of Chuquicamata and Radomiro Tomic, their main contributions to education are by means of financial support in coordination with the regional government and through short-term study trips and practicals.

The contributions to health have been made in two ways: firstly, by direct contributions to infrastructure and setting up services (e.g., emergency first-aid and dental attention), mainly undertaken by MEL; and secondly, by contributions to charities such as the Red Cross, the Corporación de Ayuda al Niño Quemado (Corporation in Aid of Children with Burns) and the Hogar de

Acogida para Pacientes Oncológicos (Home for Cancer Patients), made by CMZ, CMM, El Abra and MEL.

The contributions made by the mining companies to the community seem to have a direct relationship with the installed capacity of the companies. Hence, the greater the installed capacity, the greater the annual contribution to the community. For example, among the private companies analysed, MEL makes the largest contribution to the community in monetary terms[64] and also has the largest annual production (841,000 tonnes/year[65]), the second most important contribution is made by CMZ which produced 150,000 tonnes/year in 1999. Chuquicamata and Radomiro Tomic are special cases, together producing 766,717 tonnes/year (less than MEL), but with a much greater contribution to the community than any other private mining company.

Finally, the contributions of private mining companies bear no relationship to how long they have been in operation.

V.2.1 Examples of contributions made by mining companies to the community

Prior to the start of production in 1990, Minera Escondida Limitada (MEL) constructed a housing project in the city of Antofagasta for its employees, and by the end of 1998 had created 642 homes with an annual investment of about US$3 million. Moreover, as of 1996, the company established a partial subsidy system for the 70 employees in the Santiago office (Minera Escondida Ltda, 1999).

On account of the lack of training centres and qualified technical professionals in Region II, the company created the Instituto Profesional Escondida, with an investment of US$8 million, in which employees are trained in heavy machinery mechanics, plant mechanics and electrical systems.

In general, Minera Escondida channels the majority of its contributions to the community through the Minera Escondida Foundation, whose objective is "the development of capacities and skills in underprivileged social sectors, and improvement of the quality of life by means of the development of projects, especially in the areas of Education, Health and Technology" (Minera Escondida Ltda, 1999). Within this framework, the Foundation has set up a programme with the baselines: youth and adult technical training; creation, upkeep and subsidy of medical, health and educational centres; technological research and its application in the development of natural resources; and improvements with a permanent impact on the community's quality of life. Examples of its investments include a support programme for small-scale companies that benefited 53 people in 1998 with an investment of US$6,000. Also in the same year, the foundation set up programmes of job creation and training for US$15,000, of educational support for US$130,000, of health support with emphasis on a programme of dental aid for US$40,000, of equipping the Gastroenterology Unit of Antofagasta's Regional Hospital, the Home for Cancer Patients and extension of the Infant Oncology Unit of Antofagasta's Regional Hospital, benefiting 19,600 people a year. Furthermore, it set aside US$7,000 for the development of the Atacamenian community[66] (Minera Escondida Foundation, 1999).

[64] It is important to emphasise that the contributions might not be monetary.

[65] The annual production data for each company was obtained from DIRECMIN, (1999).

MEL also collaborates on a large number of cultural events such as: the season of concerts and ballets of the Centro de Extensión Cultural of the Universidad de Chile, sponsorship of the Friends of the Teatro Municipal and the Corporation of Friends of the Museo de Bellas Artes, the television series "Al Sur del Mundo", the ARTV programme "La Música", and children's writing and painting competitions, amongst other things[67] (Minera Escondida Ltda, 1999).

Regarding investments in infrastructure, MEL together with the mining company Zaldívar (CMZ), built a road from La Negra (the industrial area of Antofagasta) to La Escondida. Approximately 45 km of the roads near to La Escondida were built by MEL, with the rest built by both companies. The roads are maintained by both companies (personal communication with Alejandra Wood, 3 December 2000).

In the case of CMZ, the company spent US$55,000 in 1998 in donations and contributions to education, scholarships, health, culture, art and aesthetics in Region II, and US$8,000 to the same at national scale. Moreover, during the same year, it spent US$860,000 on regional employee training and US$33,000 on international employee training (Zaldívar, 1999).

In general, the awarding of scholarships for primary, secondary and university education, as well to teachers and sportspersons, forms part of the company's support of northern educational management. The Educational Support Programme for Region II awards school scholarships of US$1,000 and US$1,500 to outstanding but underprivileged secondary school students. The number of scholarships has increased from 13 in 1997, to 26 in 1998 and 52 in 1999. According to CMZ's sustainability report, during 1998 the Educational Support Programme awarded 10 secondary school scholarships (US$5,000), 5 university scholarships (US$5,000), 5 teaching scholarship (US$7,500) and 5 sports scholarships (US$2,500)[68] (Zaldívar, 1999).

Furthermore, every year the company awards 5 scholarships to a maximum of 20 to its employees, consisting of 75 per cent of the fees, for up to 5 years of technical / university education as well as investing US$275,000 a year in a financial aid programme for employees' children, benefiting 978 children annually.

Additionally, CMZ has developed a housing programme that offers loans for house or apartment purchases. After 6 years the loan is cancelled thereby forming a kind of loyalty bonus. In 1999, a total of 61 employees participated in the programme, acquiring new homes or remodelling existing homes. CMZ's contribution in 1999 exceeded US$816,000. Total programme contributions to date are US$5.57 million. There are 438 employees, 53 per cent of the total CMZ workforce participating in this programme.

CMZ also makes contributions to institutions such as the Red Cross and the Corporation in Aid of Children with Burns. Regarding investments in infrastructure, in addition to the aforementioned road construction "La Negra", the company considered (together with other mining companies) a project for the construction of a port complex in the Mejillones area (Zaldívar, 1999).

[66] For further information see Minera Escondida Foundation,"Record and Balance" (1998).

[67] For more information see Minera Escondida, "Annual Record and Financial Statement" (1998).

[68] These values form part of the aforementioned US$55,000.

The question of transporting sulphuric acid (used by the mine to leach copper ore) was carefully considered during the planning of CMZ operations. Although other mining companies were transporting acid through the streets of Antofagasta, it was decided that CMZ would construct a branch rail line that would bypass the city and avoid any risk of an acid spill within Antofagasta. This decision was taken even though there was no legal requirement by national or local authorities to avoid the transportation of acid through the city. Last year CMZ also took the initiative to investigate further opportunities to avoid acid travelling through Antofagasta with the railway company. As a result, the company has lowered the toll for using the branch line to encourage other mining companies to transport their acid along this route.[69]

In the case of the mining company El Abra, in its 2001 budget, the company set aside US$26,000 for education, of which US$10,000 will be used for educational scholarships to schools in Calama and inland towns, and US$15,000 in direct contributions to the universities in Calama and Antofagasta, schools in Calama, schools in inland towns, and local sports organizations. Furthermore, the company has budgeted a US$28,000 contribution to the Centro de Violencia Intrafamiliar (Domestic Violence Centre) of Calama, the National Indigenous Corporation, and children's homes. El Abra has also set aside US$9,000 to help local sports organizations, local schools and community organizations.[70]

Additonally, El Abra plans to spend US$66,000 on art and culture: US$20,000 for the Cultural Corporation of Calama, local and inland schools for the performing arts; US$16,000 to promote visual arts in the Museum of Calama and local schools; US$15 million for community outreach and art education through folklore organizations, inland communities and local schools.[71] El Abra will also give US$30,000 to community development, by supporting community organizations of Calama and inland towns, CONADI, and the Municipality of Calama.[72] Regarding infrastructure investment, in 1996 El Abra built a 75 km road from Calama to its site, passing outside Chiu-Chiu and improving the accessibility of inland towns north of San Pedro de Atacama.[73]

The mining company Meridian, during its first year of operations in 2000, handed over US$10,000 to the community in scholarships for the University of Antofagasta and US$6,300 for training, awarded through the Asociación de Industriales.[74]

In the case of the Chuquicamata and Radomiro Tomic Divisions of CODELCO, they contributed in 2000 about US$1,516,000 to the community, broken down as follows:

[69] Placer Dome Sustainability Report (1998).
[70] Personal communication with Jaime Rencoret, Public Affairs Director, 22 November 2000.
[71] Ibid.
[72] Ibid.
[73] Ibid.
[74] Personal communication with Edwin Orchard, Assistant General Director, 30 November 2000.

Table V.3: Codelco's contributions to the antofagasta regional community 2000

	Approximate contribution in US$
Codelco - Regional Government Co-operation Agreement Strategic Urban Development Plan of Calama (financial contributions and professional support)	200,000
Project "Citizen Safety and Social Participation in Calama" (financial contributions and professional support)	50,000
Financing of study "Census of Calama's Urban Transport System" with the Secretary of Housing and Urbanism, Region II	20,000
Codelco - Government Agreement OASIS Sustainability Programme (professional support)	100,000
Codelco - Seremi Agriculture Agreement for the Loa Basin Communities (financial contributions and professional support)	200,000
Codelco - Seremi Agriculture Agreement for the Social Reinsertion Programme	20,000
Codelco, Local Companies and Government Agreement for the use of Local Labour (financial support)	30,000
Division Chuquicamata- Government Agreement for Collaboration in Communications (professional support)	30,000
Educational Division - Provincial Education Office Agreement (financial support)	90,000
Division Chuquicamata - Government Agreement Integral Centre for the Prevention and Treatment of Domestic Violence Programme (financial support)	100,000
Division Chuquicamata- Regional Government Agreement for the use of SENCE Surpluses for Training	500,000
Division Chuquicamata - Liceo B-10 Agreement for Dual Education (short-term study trips and practicals support)	20,000
Division Chuquicamata - AIA of Antofagasta Agreement for Supply System(short-term study trips and financial resources)	46,000
Participation in Corporation of Regional Production Development for the Centre of Labour Reinsertion	60,000
Division Chuquicamata- Corporation Reciprocal Commitment of Culture and Tourism in Calama	50,000
Codelco - TDA Agreement for Investigation of Wind-Powered Energy Use in Calama	
TOTAL	1,516,000

Source: Personal communication with Sr. Juan Carlos Díaz, Director of Communications and External Affairs of the Chuquicamata Division, 20 December 2000.

Historically, when the mining companies built towns and took responsibility for all normal community services such as education, health, housing etc., there was no need for social awareness and involvement in community activities. The transitory nature of the mining industry and its associated communities explains the lack of involvement in social structure that a long-established community relies upon. With modern mining practices and greater integration of the mine workers into the local community, all this is changing.

The level of support for the community from the mining company can be clearly seen. What is less evident is the level of voluntary support from diverse groups of mine workers. Although there is an indication of low community involvement in Antofagasta, with only 4 per cent of the popu-

lation registered in neighbourhood committees compared to 10 per cent nationally,[75] the true level of involvement is not reflected in these figures. Contributions from these voluntary groups is diverse and is not just in monetary terms, but frequently in the form of specific technical skills, time or in fund raising efforts. It is very difficult to quantify the benefit to the community of this type of contribution. It is increasingly apparent that the development of the area and the quality of life for the inhabitants has been enhanced by a variety of voluntary contributions, support and help provided by not only the mining companies, but also by the workers who have formed a number of help groups. This help is not always in the form of monetary donations, but on many occasions it is a donation of time or expertise. For example, in 1999 a group of 25 volunteer workers from various areas of expertise from the mining company Zaldivar (CMZ) worked over a ten-month period (a total of 1,645 man hours) in the Regional Hospital of Antofagasta. The hospital had boilers and equipment which were not installed or not working. When the situation became apparent to a group of CMZ workers, they volunteered their time to install the boiler and repaired another with a fuel saving for the hospital of 60 per cent. They then went on to repair other equipment such as stretchers, clinical beds, chairs etc. They have also installed equipment in the kitchens and have just completed a Jardin Infantil for use by 60 children of hospital workers. A training programme for the workers at the hospital was also initiated to ensure the smooth functioning of the hospital in the future.[76]

About 200 workers from CMZ make regular donations from their salaries to the Asociación de Padres con Hijos con Parálisis Cerebral de Antofagasta, benefiting about 20 children. This money helps to provide services such as phonoaudiology, kinesiology and kindergarten education. Additionally, the volunteers have committed themselves to transport the children every week to a location where they have hydrotherapy, and to support the high cost of this.

On the cultural side, a project was started to promote the culture of Latin-American and the Andean people. This group runs classes in music, dance and theatre both at the mine and in Antofagasta. They have also formed a musical group called the Atacamitas who also perform at various functions.

There are various other voluntary initiatives from the mine workers involving the Hogar de Cristo and Hogar de Menores education programmes, and donations of computer equipment. The activities are not confined to Antofagasta but also cover other towns and villages such as Taltal and San Pedro, and also extend to other regions.

Mining companies have also been involved in elementary schools and educational programmes. In an educational project for the fire services in Antofagasta, CMZ produced colouring books for primary school children on preventing accidents in the house.[77] Another educational colouring book they distribute to schools in the region explains about mining activities. CMZ and MEL jointly run an International School in Antofagasta which provides an education for children up to Grade 8. Initially, this school was for the children of the ex-patriot families and provided a curriculum taught in English. Now students come from other companies in the area and represent many different nationalities. There are plans to further open the school to the community and provide a strong English language training in the region.

[75] See UNDP (2000).

[76] Pinta Verde. Inhouse publication CMZ.

[77] It is in print and will be distributed in March 2001

The Foundation of MEL has been created specifically in order to deal with social issues in the region, and to create funds that will make a lasting contribution to the local community beyond the life of the company's mining operation. The foundation has concentrated its work in three areas: education, health, and technology. It is working to:

- provide miners and adults with the necessary technical training for working in trades and technical and business activities;
- establish, maintain and fund medical and educational facilities;
- develop technological research for the development of natural resources;
- make a positive, long-lasting impact on the standard of living in the region.

Other companies have also been involved in supporting education, scholarships, health, culture, arts and aesthetics. They have invested in both regional training and international training for their workers. In general, the scholarships for basic and medium education, university, as well as scholarships for teachers and athletes, are part of their support to the northern educative action developed by the mining sector.

The company El Abra has been supporting Calama with contributions to arts and culture, local schools from interior villages, and a museum. There has been a strong emphasis on arts and culture and reaching out to other communities. The company Meridian has also provided support for education in the region.

Some environmental investments[78] made on a voluntary basis by the mining companies are set out in the Table V.4:

Table V.4: Voluntary environmental investments made by mining companies to the antofagasta regional community, 2000

Company	*Investment*	*Date*	*Total amount(US$)*	*Observations*
CMZ	Geophysical profiles and construction of level observation pit	1999	235,000	Better knowledge of the geometric conditions of the Negrillar aquifer for modelling in a transient condition
	Geophysics, installation of a weather station and constructionof an observation pit in the loading zone	2000	350,000	Widening of the dominion zone of the simulation model of the Negrillar aquifer
	Study of Flora and Fauna in the Negrillar basin	1999-2000	30,000	
MEL	Project of artificial feeding and incubation of flamingos	1996-2000	400,000	
	Study of behaviour of fox population	1996-2000	7,000	
	Study on marine biodiversity	1998-2000	150,000	
	Ocean current study in the Antofagasta Bay	1999-2000	7,000	

[78] Only contributions not brought about by legal obligations, fulfilment of regulations, management plans or measures stipulated within the Environmental Impact Study (EIA) were included.

Metals study in the Antofagasta Bay	2000	5,000
Copper baseline Iquique - Concepción	2000	2,000
Artificial loading system	1999-2000	1,000,000

Source: Author's elaboration based on personal communication with the different mining companies. Information was obtained exclusively for these two companies.

V.3 Comparison of government and mining companies' contributions in Region II

The comparison can only be in relative terms, given that the investment by the government[79] is significantly larger, and based in great part on the taxes levied to the same mining companies. With regard to housing, the contribution by the companies is substantial, where the companies contribute 45 per cent of that offered by the government. In the case of investment in forestry and fishery, Chuquicamata and Radomiro Tomic invest an equivalent of 36 per cent of that given to the region by the government.

Due to the lack of reliable data, it was impossible to establish clear comparisons between companies, between years and between companies and government spending.

It should be kept in mind here that the state spending is significantly less than the taxes obtained from the mining sector.[80] This fact has led to a fervent discussion on the destination of taxes, with political, academic and community members stating that a much larger proportion of the taxes collected in the region should be reinvested there. It will be important to further analyse the compatibility between government and voluntary company investments, identifying priority issues, issues that need more attention, issues that are in the public domain, and issues in which the companies have been more active.

[79] The investment presented here corresponds to that made to the community and does not take into consideration aid to company employees.

[80] See earlier comments.

6. SUSTAINABILITY FUND VERSUS OTHER INSTRUMENTS

VI.1 Introduction

The Sustainability Fund has so far been proposed on a very general basis,[81] and has not really been analysed or designed in great detail, nor has it been compared to other potential policy instruments.[82]

On first view, the Sustainability Fund would appear to be a suitable instrument due to its potential flexibility and application to a wide range of sustainability issues. However, whether or not this instrument can deal with issues more effectively than other instruments[83] is open to debate. In addition, the legal and technical requirements for its application have to be examined, as well as its political viability. Table VI.1 shows a list of the current[84] priority sustainability issues identified in this study. These issues will be discussed in relation to the potential features of the Sustainability Fund.

[81] See for example La Epoca, 6 January 1998, La Nación, 11August 1997 (Marcel Claude), El Mercurio, 14 September 1997 (Juan Villarzú, Sergio Bitar, Carlos Ominami).

[82] The lack of a comparative analysis is common in the use of environmental policy instruments in Chile.

[83] See Annex 1 for a description of existing policy instruments. Supposedly these issues are being confronted by means of the existing instruments and will not be included in the list of priority issues.

[84] It is recognized that this priorization is very dynamic, changing over time.

Table VI.1: Priority sustainability issues in region II

Resource	*Impact*	*Availability of information*
	Economic	
GDP	GDP is essentially generated by the mining activities	good
Employment	The indirect employment generation and investments depend strongly on the mining sector	good
Exports	The regional exports are essentially of minerals	good
	Environmental	
Water	Overexploitation of existing water resources that produces change in hydrological regime, reduction in stream flow, siltation of stream and river channels, diminishment of water quality, loss of natural vegetation and wildlife habitat, diminishment of scenic value, increased soil erosion, reduction in natural spring discharges, reduction in size and level of lagoons, reduction in groundwater storage	poor
	Heavy metals contamination of surface and groundwater due to leakage from tailing facilities	poor
Soil	Soil contamination around Chuquicamata	poor
	Landscape variation	good
Biodiversity	Increased turbidity of seawater, decreasing light penetration and biological productivity and mud formation, burying benthic species	regular
	Wildlife habitat loss caused by over extraction of water for mining, adversely affecting in particular salt pans, areas of seasonal pasture and the Rio Loa catchment (this affects, for example, flamingo communities)	poor
	Habitat loss, pollution, noise and human immigration caused by mining development and associated activities and road construction	poor
	Social	
Social capital formation	Lack of integration of the mining companies in the community	regular
	creation of a regional identity	regular
	prioritization of social and environmental aspects	regular

Source: Author's elaboration.
Scale: very good; good; regular; poor

VI.2 Description of potential instruments

There are basically two categories of potential instruments applicable to sustainability issues, one containing instruments that are generic in character, and the other containing instruments that are directed at a specific environmental, social or economic issue. The first category contains:

- Sustainability Fund
- Voluntary agreements
- Public-private cooperation in the framework of a Regional Sustainable Development Plan.

Table VI.2 gives some examples of potential instruments for specific sustainability issues.[85]

[85] Not including problems for which policy instruments are already in place (see Annex 2).

TABLE VI.2: Potential instruments for sustainability issues

Resource	*Impact*	*Instruments*
	Economic	
GDP the region	GDP is essentially generated by the mining activities.	1. tax incentives for investment in the region 2. CORFO instruments to promote production and exports
Employment	The indirect employment generation and investments depend strongly on the mining sector.	
Exports	The regional exports are essentially of minerals	
	Environmental	
Water	Over exploitation of existing water resources that produce changes in hydrological regime, reduction in streamflow, siltation of stream and river channels, diminishment of water quality, loss of natural vegetation and wildlife habitat, diminishment of scenic value, increased soil erosion, reduction in natural spring discharges, reduction in size and level of lagoons, reduction in groundwater storage	1. improving the market of water rights 2. implementing a technology centre 3. land use planning
	Heavy metals contamination of surface and groundwater due to leakage from tailing facilities.	
Soil	Soil contamination around Chuquicamata	Soil management plans
	Landscape variation	
Biodiversity	Increased turbidity of seawater, decreasing light penetration and biological productivity and mud formation, burying benthic species	1. elaborating biodiversity plans at the national and regional level 2. prohibitions
	wildlife habitat loss caused by over extraction of water for mining, adversely affecting in particular salt pans, areas of seasonal pasture and the Rio Loa catchment (this affects, for example, flamingo communities)	
	Habitat loss, pollution, noise and human immigration caused by mining development and associated activities and road construction	
	Social	
Camp culture	low degree of organization and participation in civil society	
	low esteem for public space	
	culture of transitoriness	

Source: Author's elaboration.

Rather than analysing all of the possible policy instruments for all of the sustainability issues raised, the focus will be on the potential contribution of the generic instruments. However, in order to provide the most effective policy mix, decision makers must be aware of the whole range of instruments available, especially given that the generic instruments are complementary to the specific instruments.

VI.2.1 Alternative or complementary generic instruments

A Sustainability Fund has been proposed on various occasions but has never been applied, whereas the other two generic instruments (voluntary agreements, public-private cooperation in the framework of a Regional Sustainable Development Plan) have been implemented to some extent.

Voluntary agreements

There is no standard definition of a voluntary agreement. The European Environmental Agency has defined these agreements for the purpose of their study as "...covering those voluntary com-

mitments undertaken by firms and sectors which are the result of negotiations with public authorities and/or explicitly recognized by public authorities. Other voluntary approaches, such as codes of conduct, fall outside this scope...".

In the Chilean context, the elaboration of voluntary agreements has been institutionalized under the Secretaría de la Producción Limpia, which depends on the Economics Ministry. So far there have been six voluntary agreements signed between the Secretaría and different industrial sectors. The most recent one being negotiated is with the mining sector. This agreement, the detailed content of which is not yet publicly available, addresses various aspects of environmental management in the sector, including monitoring of acid mine drainage, mine closure, alternative energy use, measurement of arsenic problems in soils, solid waste disposal, and rehabilitation of mining areas.

The voluntary agreement is basically directed at the collection of information and data on issues that have not yet been confronted, as well as at anticipating the implementation of a regulation that is currently under discussion and about to be established. Of the issues identified as priority, a number of them have not been included in the draft voluntary agreement. At this stage it can be regarded as virtually impossible to modify the list of the issues included in the draft agreement. Once signed by the different parties, this type of agreement is considered obligatory.

The issues so far included in the voluntary agreements have basically been "brown" issues,[86] and have, in general, been related to technological solutions - clean production with clear responsibilities at the company level, rather than planning or cooperation issues. Also, the agreements have been oriented at environmental issues rather than sustainability issues, including social variables. They are not thought of as being widely socially validated due to the lack of participation of all sectors, and no institutional set up that would permit adjustments according to the opinion of the sectors involved.

Regional Environmental Plan

In the past decade several Regional Environmental Plans have been developed in Chile on behalf of different actors. One of these plans is the Plan de Acción Regional Ambiental of Region II, elaborated during 1995-1996.[87] This plan was developed by a British consulting firm at the request of the Regional Authority, with financing from the UK Department for International Development, and in close cooperation with the Ministry of Mining, the regional CONAMA and the Ministry of Planning and Cooperation. The plan included a survey of basic environmental variables in the region, the identification of different Units of Environmental Management (UEM), the prioritization of environmental problems through participatory activities, the identification of sources of finance, and the pre-elaboration of an action plan. The action plan contained general as well as specific recommendations for each UEM. There were, however, no clear responsibilities assigned to each of the activities and no formal commitments were signed. An institutional conflict between the Regional Authority and CONAMA aggravated the situation, and the plan has never been put into practice. Nevertheless, the regional CONAMA has used it as input for the elaboration of the Environmental Policy for Region II, as well as for the environ-

[86] Such as air and water contamination or solid waste disposal.

[87] See DFID (1997).

mental chapter of the Regional Development Strategy. However, once again there were no commitments signed by any of the other public or private sectors.

A Regional Environmental Plan could be combined with specific instruments or with a generic instrument of the Sustainability Fund that corresponds to the mining sector. Alternatively, the different sectors, including the mining sector, can sign specific commitments with regard to the objectives envisaged in the plan. There is concern, however, that this major undertaking is too big a challenge to meet at this stage of environmental policy making. It would mean that the mining sector issues are put into an overall political / institutional context that would be difficult to control. The failure to implement the first Environmental Plan for Region II does not bode well in this regard.

7. PROPOSALS FOR A SUSTAINABILITY FUND

VII.1 Role of Sustainability Fund

The reasoning behind a Sustainability Fund has been based on the understanding that sustainable economic development in the mining regions requires that part of the revenue of mining exploitation should be destined to the formation of capital in the region. This conversion of natural capital into other forms of capital should guarantee a permanent "income" for the region. Thus, in the case of an exhaustible resource, authors such as Hartwick (1989) have shown that investing the rent accrued from resource extraction into other types of capital is sufficient to maintain a constant consumption path.[88]

Different authors have elaborated different formulas to calculate the "value" of the natural asset, or the part of the rent that should be invested into capital formation. According to El Serafy (1989):[89]

$$R = \frac{EAF}{(1+r)^{s/e}}$$

where:
R = user cost
EAF = equivalent annual flow
s/e = stock / annual extraction
r = relevant discount rate

and:

$$EAF = \frac{NPV*r}{\left(1 - \frac{1}{(1+r)^{t}}\right)}$$

where:
NPV = net present value
t = year

Applying the above formulas loosely to the Chilean context for copper production for the year 1995, the following values were established.

Reserves were 185 million tonnes, the average price of copper was US$1.045 per pound, the annual extraction rate was about 4 million tonnes per year, and net income corresponded to about 22.5 per cent of total income.[90] Thus, the net income flow would be approximately US$2,030 million per year, which would imply a user cost to be reinvested of about US$39 million a year.

[88] The extended Hartwick rule takes into account changes in foreign assets (see for example Gomez-Lobo, 2000).

[89] There are variations of this formula by other authors. Interested readers are referred to Gomez-Lobo (2000) and the sources cited therein.

[90] Data adapted from Claude (1997), from Central Bank and Sernageomin.

However, in this calculation, there is no clear position on the extent to which capital formation has to occur through taxation, or can be left to market forces or other mechanisms. Additionally, the calculation above does not take into account voluntary contributions, the formation or depreciation of social or environmental capital, multiplier effects of infrastructure investments or investments into education, etc. The analysis carried out in the preceding chapters helps to shed more light upon many of these aspects. It has become clear that for a Sustainability Fund to be effective, the content has to be clearly defined, and not on an ex ante definition of the monetary base.[91] This chapter analyses the specific content of a Sustainability Fund for Region II.

In general, the Sustainability Fund will be directed at priority sustainability issues as defined through a participative process in which all stakeholders have a say. Thus, the current analysis should serve as a basis for concrete discussions on the types of activities to be coordinated by the fund. It should also serve as a model for defining its role, for example:

- Principle of efficiency and effectiveness - what are the other options / instruments to solve each sustainability issue? How can the Sustainability Fund complement these alternatives?
- Principle of cooperation / avoiding duplication - how can existing institutions / instruments cooperate?
- Principle of prioritization - which are the most urgent issues?
- Subsidiary principle - does it have to be a monetary contribution or can the issue be resolved on the basis of in-kind contributions?

VII.2 Administrative structure of the fund

The fund shall be administered by a private corporation. A steering committee will be established, with representatives from all sectors. An Executive Director will be contracted by the committee. The following is a provisional list of members:

- two representatives from the large mining companies
- one representative from the Industrial Association
- one representative from medium sized mining companies
- one representative from small mining companies
- one representative from the Regional Governor
- one representative from the Regional Ministry of Mining
- one representative from the Regional Ministry of Planning
- one representative from the regional CONAMA
- one representative from NGOs
- one representative from civil society
- one representative from the academic sector.

[91] Whereas the above discussion can be used for the question of the user cost, with the State supposedly owning the resource, it cannot be applied to define the base for the Sustainability Fund.

This scheme of representation is based on the following assumptions:

1. There has to be adequate representation from each sector involved.
2. The industry and the public sector, together with civil society should have equal representation.
3. The large mining companies should have two representatives given that they are the central actors.

VII.3 Content of the fund in its first years

In Chapter V the following issues were identified to be of potential importance for the fund:

- Economic: diversification of production
- Social: integration of the mining companies into the community, creation of a regional identity, prioritization of social and environmental aspects
- Environmental: water use, biodiversity.

Table VII.1: Recommended activities for the fund in the first years of operation

Environmental	Inventory of flora and fauna from a conservationist perspective Integrated study of saltpans Promote cooperation on the protection of flora and fauna Promote the protection of natural areas Creation of a diagnostic study of the current market situation for water Analysis of ownership of water rights Creating mechanisms to lower transaction costs in market for water rights Encourage the adoption of new water-saving technology and developing investigation programmes Acquire water rights, in order to achieve a minimum ecological flow in basins
Social	Prioritization of social issues Foster exchange of ideas and cooperation on projects Assistance to indigenous communities regarding water rights Improving public space Educational programmes directed at establishing regional identity
Economic	Inventory of existing initiatives for the promotion of production Identify the appropriate instruments for the promotion of production Identify the necessary steps and specific appropriate instruments for the cluster development, strengthening existing initiatives and adding new elements Encourage investment in science and technology in the mining sector, as well as promote an increased and constant information flow between universities and mining companies

VII.3.1 Recommendations for promoting economic sustainability

As discussed in Chapter IV, mining activity in Region II constitutes the main growth factor in the zone, contributing close to 60 per cent of the regional GDP. Indirectly, almost the entire regional industrial sector (gas, water and electricity sectors, construction, commerce, tourism, services, transport and communications) is included. With an economy based on one single activity, the extraction of non-renewable resources, there is a clear call for diversification of production in the region. In fact, Culverwell (2000) determines that while one Chilean peso spent on carrying out daily operations or increasing production in Region II's mining sector induces a 0.158 peso pay increase for the sector's workers, it induces an income increase of 1.63 pesos for workers in the other production sectors. In the case of workers with permanent contracts this relationship is 1 and 1.25 respectively.

On the other hand, there do not seem to be many options for an alternative development within Region II. The task, therefore, is not only centred on the identification of potential alternatives, but also on an expansion of the other production sectors alongside mining. In this context, the idea of consolidating a production cluster around the mining sector has been considered for some time now, in parallel with the need to diversify production. This is seen as an efficient strategy to achieve growth and sustainability.

Mining clusters

Since the beginning of the 1990s, the political debate in the Antofagasta Region has focused on the idea of linking the large mining companies with their suppliers within the regional economy, and implementing an integral mining development model based on production and services clusters. This has been considered within the framework of the Estrategia Regional de Desarrollo (Regional Development Strategy) 2001-2006, which proposes the consolidation of mining, industrial and services production complex.

Awareness should also be raised of the fact that a large part of the wealth generated by regional industrial mining is exported, with a very low value added - for example, 95 per cent of the mining production is exported and only 10 per cent of the region's taxes are returned in the form of public investment.

VII.4 Cluster classifications

A cluster is a geographical concentration of interconnected companies and institutions acting within a specific field. It groups together a wide range of industries and other related organizations, and encourages competition. This includes, for example, suppliers of essential materials (such as components, machinery and services) and suppliers of specialized infrastructure. Frequently, clusters also include manufacturers of complementary products, and companies operating in other industries, that are related through their skills, technologies or common inputs. Many clusters also include government bodies, universities, regulatory agencies, study centres and commercial associations which provide training, education, information, research and technical support.

According to Orellana (2000), there are three types of clusters, depending on the degree and form in which the collective efficiency is achieved. The first is the "industrial cluster" with a geographical concentration of companies from a particular sector and the qualified personnel, and implies a drop in prices and thus a reduction in production costs. Secondly, there are the "industrial districts" where the cultural or social conditions facilitate collaboration. Finally, globalization and advances in information and communication technologies are generating a series of changes in production organization which means that physical or geographical proximity are no longer essential for cooperation between companies, or for collective innovation and/or training; these relationships between companies are called "industrial networks".

VII.5 Requirements for the development of a cluster

According to the literature, and as implied by the definition of cluster, there are certain requirements or characteristics found in successful clusters. Orellana (2000) summarizes these characteristics, with the following points being the most relevant:

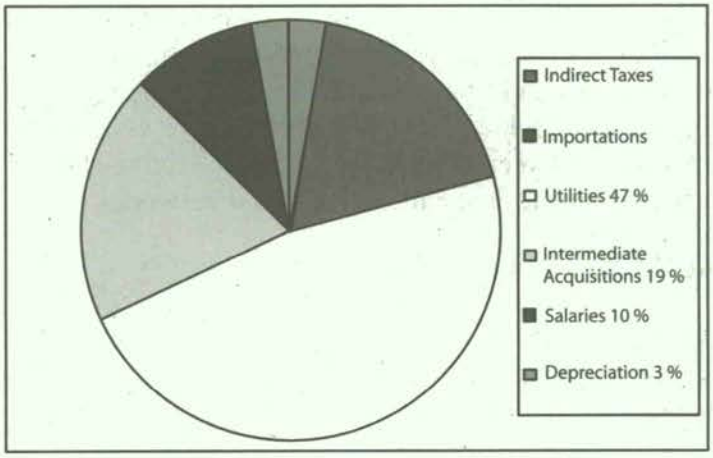
- The existence of a dense mass of large and small companies highly specialized in the production of goods or services necessary for the production of others in the same chain of production or in related chains.
- The presence of institutions such as universities, promotion organizations etc., which also contribute to generating or improving the factors required for the production and/or elimination of eventual market failures, thus bringing about a process of technological innovation which increases the cluster's productivity.
- The existence of joint action between the agents for diverse ends in order to solve sha red problems, to innovate or to break into new markets.
- The existence of a diversified institutional apparatus that provides the necessary public assets to elevate the cluster's productivity, with private investment in public assets also being important.
- The existence of a sophisticated demand as a catalyst for constant innovation in the cluter.
- The existence of a vigorous competitive regime through companies competing by means of improvements in their goods or services (innovation).
- Strong interaction between agents so that there is a free-flowing exchange of informa tion and knowledge useful for increasing the cluster's efficiency and for consolidation of its competitiveness

VII.6 Development of a cluster in Region II

In his study "The integration of small and medium-scale producers in the production chain", Culverwell (2000) proposes the creation of a mining cluster in the Antofagasta Region since there is an opportunity for economic advantage by using the supply chain of the large mining companies to develop local solutions.

The cluster proposed by Culverwell involves a group of mainly large-scale mining companies, based on the fact that 19 cents of every dollar in the mining sector in Region II is spent on transactions between the mining companies and national suppliers (intermediate acquisitions) (see Graphic VII.1).

Graphic VII.1: Dollar breakdown for the mining sector in the II region



Source: Culverwell (2000).

At this level (intermediate acquisitions), the author identifies two types of potential mining clusters for Region II. If the policy objective is regional competitiveness, then the cluster must be orientated towards the main suppliers. If the policy objective is regional development, then the cluster must be orientated towards the small and medium-scale suppliers.

Bearing in mind that the small and medium-scale suppliers in the region (services, commerce, hotels and industry sectors) make up 99 per cent of the companies and 97 per cent of the work force, and that one of the main objectives of the 2001 Regional Development Strategy is an "increasing retention of profits within the region" the regional industry's attention as a group should be in adding long-term social and economic value. This supports the idea of favouring a cluster focused on development.

The support to small and medium-scale suppliers in the cluster allows economic progress to be dispersed and the standard of living in the region to be elevated. In fact, these local producers can supply the regional markets, form further links with other sectors, and broaden the region's industrial base. In this way, as well as increasing employment, the small and medium-scale suppliers offer greater opportunities to make use of the available local knowledge and at the same time contribute to training the local workforce.

The long-term challenge would be to reach a mutual dependence between large mining companies and regional suppliers. This means that the small and medium-scale suppliers should have increased influence and negotiating power with the mining companies. In order to do this, on the one hand they must behave strategically and reinforce collaboration between themselves on some issues, while on the other hand, the mining companies must consider their products and/or services capable of contributing to cost reductions or improvements in quality or competitive innovation. In the long-term, as the small and medium-scale suppliers grow and specialize, they should reach a point of collective efficiency.

In the widest context, successful implementation of a mining cluster in Region II, bearing in mind the strong growth of mining in the neighbouring countries and a mining treaty with Argentina,[92] the cluster services could become relevant at an international level, providing a new dimension to sustainability since they would no longer depend exclusively on resources and production at the regional level.[93]

However, to be successful, a cluster requires certain conditions. In this sense, in Region II, the following points are amongst the biggest challenges for successful cluster development:

- To improve the productive and technological infrastructure
- To instigate investments in the supply chain
- To develop financial capacity for the suppliers, thus stimulating investment in new businesses (risk capital)
- To promote greater interaction between the companies and universities, both to improve information levels and to undertake training, research, etc.
- To promote general and specific mining knowledge
- To encourage investment in research and development in the mining sector
- To generate a more favourable tax framework (regional and tax incentives)
- To "de-bureaucratize" in order to promote investment, especially to promote decentralization of decision-making
- To promote the use of the Internet and other modern technology to encourage contact between suppliers, mining companies and clients.

The creation of a cluster permits a parallel strengthening and development of other productive sectors such as commerce, seryices, transport, communications and tourism, thus broadening the production "haven" of the Antofagasta Region.

Efforts to achieve collective efficiency in Region II

In Region II there have already been some attempts to secure collective efficiency. Culverwell (2000) discusses these in her document:

1. CODELCO, CDP and the small and medium-scale suppliers: by reason of the brief for the development programme for suppliers, the CDP (Production Development Corporation) set up a project to integrate CODELCO's Chuquicamata Division with the small and medium-scale suppliers and a group of new potential suppliers, with the objective of identifying opportunities for better contracts and new business opportunities. In general, the project resulted in mutual benefits, since the mining company strengthened its commitment, and the suppliers, with regional support, increased their cooperation to achieve a short-term commitment.

[92] Chile is in the process of signing a Mining Integration and Complementation Treaty (Tratado de Integración y Complementación Minera) with Argentina.

[93] Orellana (2000) terms this "industrial network".

2. Minera Escondida Ltda. and its suppliers: La Escondida has no explicit policy for regional acquisition of materials with the region's companies. It only makes transactions with regional suppliers if they have complied with the necessary technical and financial requisites. In this context, La Escondida established an instrument of evaluation between the suppliers, dividing them into three size categories - small, medium and large-scale - which facilitates competition between them, since the small-scale suppliers no longer need to worry that the larger ones will take over the market.

3. The PROFO (Associative Promotion Projects) suppliers and the mining companies: in the Antofagasta Region, the SERCOTEC (Technical Co-operation Service) and the CDP brought together a reduced group of suppliers (PROFOs) in order to introduce the principles to build a cluster and indicate its possible applications. The companies grouped themselves into cooperatives according to certain common factors, the idea being that as a group they would increase in size by means of more sales from the new association. Moreover, the objective was to offer specialized products or services, have better access to technology and improve their control of internal costs.

Other initiatives to promote regional development

Several other initiatives in Region II's 2001 Regional Development Strategy point towards promoting regional development. The following are the main projects:

1. Duty-Free Zone in Tocopilla: the Law 19.709, promulgated in 2001, establishes the creation of the Industrial Duty-Free Zone of Tocopilla for companies supplying industrial materials, parts and components for mining, who start business in the zone within five years. These will follow a preferential system - free of VAT, income tax and duties - for a 25-year period. This government initiative, which was intended to reduce the area's unemployment levels, promotes cluster development since it encourages the installation of materials supply companies for the mining sector, thus reducing the mining companies' costs since they will be able to acquire cheaper materials.

2. Development Master Plan for Irrigated Agriculture in Region II: this is a very small-scale project. Although Region II's conditions are not propitious for agriculture due to the scarcity of water resources and the high degree of salinity and aridity of the soil, this is a very important plan for the ethnic minorities inhabiting the valleys and oases of the regio n's inland areas, aiming at self-sufficiency and at maintaining their traditions.

3. Bio-Oceanic Corridor: Region II adhered to the formulation process of the "Tropic of Capricorn Bio-Oceanic Corridor" project which would unite the "Southern Cone" (Conosur) countries with those of South-East Asia, from Antofagasta through Argentina and Paraguay, connecting with the Brazilian transport system at Puerto Murtinho. We believe this project would also directly favour cluster development since it would strengthen port and transport infrastructure with neighbouring countries, reducing transport costs and facilitating and increasing exchange of goods and services between the region and its neighbours.

Production diversification

Finally, it is important to consider the initiatives taken towards greater diversification of production. Although the Chilean government proposes several instruments to promote production, economic development and transformation in the country's regions, in Region II there are no specific programmes to promote either production development or specific emerging sectors. The existing instruments are national in character and participation of Region II is modest.

VII.7 CORFO Instruments

One of the Chilean government's main ways to channel resources is through the Production Promotion Corporation's (CORFO) different programmes. In Region II, CORFO does not have the specific programmes to promote either production development or emerging sectors that can be found in other areas of the country.[94] CORFO's production development instruments in Region II are as follows:[95]

1. Technical Assistance Fund (FAT): an instrument that co-finances the hiring of specialist consultant services for small and medium-scale suppliers, with the aim of incorpora ting management techniques into the companies' operations, or new technologies into their production processes in order to improve competitiveness.

2. Associative Promotion Projects (PROFO): an instrument that co-finances activities undertaken by a group of at least five goods and/or services production companies, intended to achieve both individual and group goals, with the objective of improving competitiveness.

3. Technological Project Financing (FONTEC): an instrument supporting the financing of technologically innovative projects, technological infrastructure projects, associative technology transfer projects, management projects and technology transfer centres, and pre-investment study projects for production escalation in innovation projects.

Table VII.2 shows the turnover through CORFO instruments in Region II. It can be seen that the state's contribution to production development in Region II through these instruments has not been very significant.

[94] CORFO has three support programmes in "special zones" of the country: Plan Arica in Region I; Plan Arauco in Region VIII; and Plan Austral in Regions XI and XII.

[95] These are applicable not only in Region II, but throughout the country.

Table VII.2: Turnover from corfo instruments in region II

(in thousands of US$)

INSTRUMENT	1995	1996	1997	1998	1999	Region II Av. Var. 95-99 (%)	Country Av. Var. 95-99 (%)	Region II Participation 1999 (%)
FAT	238	280	563	814	633	35,3	56,0	5,2
PROFO	106	421	440	357	428	75,6	42,2	4,0
FONTEC	375	441	715	605	221	0,2	126,5	1,7

Source: Ministry of Economy.

VII.8 Scientific and technological development

In terms of activities related to research and development, despite the fact that Region II is Chile's main centre for mining activity, there is a very poor technical preparation for the development of these activities. In fact, the region has only twelve Technology Centres (4.5 per cent of the national total) and a total of 232 researchers (2.2 per cent of the national total).[96] These figures are even more striking if only those involved in mining research are included.

There are, however, initiatives to change this situation. For example, the Universidad Católica del Norte, one of the two principal universities in Antofagasta, is currently applying to CONICYT for funds to develop a "Higher Studies Centre for Mining".

Role of the mining sector's Sustainability Fund

In economic terms, implementation of a Sustainability Fund requires above all the creation of a long-term plan that incorporates specific instruments and projects necessary for the development of a cluster, based on existing initiatives and conclusions already reached by government (and private) initiatives.

Furthermore, bearing in mind the poor efforts in Region II to promote production development and encourage training, research and development - all necessary requisites for the successful development of a cluster - the Sustainability Fund can help to encourage investment in science and technology in the mining sector, as well as to promote increased and constant information flow between universities and companies.

Finally, considering the monopsonic power of the large mining companies in the region and the information asymmetry between them and the suppliers, the fund could contribute to remedy this situation with specific programmes.

VII.8.1 Recommendations for water conservation

The problems associated with water use in Region II can be classified into two issues related to each other. The first corresponds to the efficiency of the assignment of water use rights, whilst the second is related to the availability and quality of the water resource.

[96] Information from the "2001 Regional Development Strategy".

In Chile, the system used for assigning water use rights is based on a market system[97] with tradable rights, where a buyer and seller stipulate a transaction price according to the opportunity cost the water has for each of them.[98] If the market works efficiently, an optimum assignment of the resource will be achieved for society.

As seen in section IV.4.3, the main problems that exist in Chile for the adequate functioning of the water use market are:

1. Poor information on the ownership of existing water rights and their characteristics, with difficulty obtaining this information; the existing information is dispersed and frag mented, with a poor or zero level of processing and serious problems of reliability.

2. High costs of transaction (of rights), including; investigation of an offer and petitions that buyer and seller must carry out, the subsequent negotiations and fulfilment of contracts, as well as, in many cases, the legal recognition of the property's water use rights, contract legalisation, and the acquisition of the necessary permits for water trans fer from the authorities. Moreover, the costs of modifying the physical infrastructure in order to transfer the water to where it will be used will need to include studies by engineers and compensations to third parties affected by the transaction.

3. High speculation and monopoly of water use rights by private interests who will never use the water, but become the sole owners of rights of use with the intention of earning easy money through the future sale of all or part of the rights.

The fact is that some groups of society are at a disadvantage in terms of their access to the water rights market. This is especially true of indigenous communities who have a different cultural perception on the use of water resources.[99] The lack of experience in participating in the sale and purchase of water may be a significant problem if the sole objective is market efficiency. Potential conflicts could well arise. For example, the water company which supplies Calama with drinking water acquired the water use rights of the river Toconce, affecting the town of the same name whose water availability was reduced from 300 l/s to 25 l/s. According to the television documentary "El Mirador" (November, 2000) this caused impoverishment of the community and a reduction in the town's population from 300 to 50 people due to lack of sufficient water to maintain crops and animals. Situations like this should be avoided, and the authorities will need to integrate social and cultural policies into a good functioning of the market.

Problems associated with the availability and quality of the water resource mainly originate from:

1. Failure to formalize common law rights, i.e. to record the number of rights in each basin and the substance of the rights in terms of its essential characteristics. These include: the basin's net flow in volume per time unit, the quality of the water, and whether it is temporary or permanent, continuous or discontinuous. Lack of information creates an

[97] The market system of water was established in the 1981 Water Statute. For more information see Annex 2.

[98] Other assignment systems used throughout the world are the central administration system and that of opportunity costs or tariffs.

[99] It is important to remember that for many of these communities the use of water is an ancestral right handed down from generation to generation (as with the land) and therefore they do not see why they have to buy it.

over-exploitation of the resource, as well as negative external effects on other users because far mers owning common law rights try to sell all the water they capture as continuous consumable use, when in reality they only use part of the water captured and only during the rain-free months (September to March).

2. Lack of hydrological information showing frequency of drought in the majority of basins, meaning that any water shortage (which could be normal) is considered a drought, with inappropriate measures consequently being taken.

3. Negative external effects through degradation in water quality caused by not taking into consideration the costs generated by contamination of the resource by those who transfer their water use rights. The effects are mainly produced through discharge of untreated sewage and industrial liquids, erosion and sedimentation which cause a fall in the water quality.

4. Failure to establish by law a minimum ecological flow for each basin, which would ensure sustainability of each ecosystem. Currently, all the water in a basin can be extracted provided the rights of other users are not affected. Absence of a law is due to the fact that society does not value the life dependent on the river courses.

Given the above points, a Sustainability Fund could intervene in several ways:

The first would be to conduct a diagnostic study of the current market situation for water in the region, and to generate concrete proposals on how to improve efficiency and increase access to information. Furthermore, it would be important to identify any market defects, and sectors of the population that might require some kind of protection if they cannot play a part in the market, and are thus prejudiced by the market system. A study could also be carried out to identify the water offer in each basin and propose ways of increasing the availability and quality of the water resource by encouraging technological innovation and fostering investment in irrigation techniques.

The second line of action would be direct intervention by putting into practice some of the recommendations. For example, a market place for buyers and sellers of water rights could be established. This could be done through a bulletin issued by water channel associations, a web page, or simply an opening an office. The above would help to avoid information irregularity and lessen the costs incurred by those wishing to trade water rights, thus permitting an increase in transactions, more rapid price adjustments, and a knowledge of the value of the water rights by the owners. This would avoid any negative external effects from the inappropriate use of rights producing a benefit for the society. Moreover, the Sustainability Fund could set aside resources to assess the indigenous communities' acquisition and inscription of their water rights.

Technological investigation and the adaptation of existing technologies to the reality of each region is a costly process. The Sustainability Fund could allocate some resources to encouraging new water-saving technology, and developing programmes to improve the technological offer of the region. Otherwise technological innovation tends only to be carried out by certain large-scale mining companies, excluding the small and mid-scale companies.

In this context, CONICYT, with its FONDECYT and FONDEF programmes, have developed projects to improve water use, (11 and 16 respectively). Also the government is currently promoting the adoption of new technology in water use for farmers and small and mid-scale companies, by means of programmes developed by CORFO, INDAP and the Comisión Nacional de Riego (National Irrigation Commission). The Sustainability Fund should participate in these existing programmes.

Furthermore, a proportion of the Sustainability Fund could be set aside to acquire water rights, and ensure the minimum ecological flow in basins.

All options must be analysed in the context of the existing institutions in the area. For instance, the DGA is currently undertaking the construction of a public water register, in order to fulfil the obligation imposed by the 1981 Water Statute.[100] Moreover, the DGA has proposed modifications to the Water Code in order to incorporate recommendations for a minimum ecological flow in each basin. According to Peña[101] (1999), it is important to recognize the value of water when not extracting from the basin, i.e. maintenance of the water resources for river and marine ecosystem conservation, recreational use of rivers and lakes, fishing and sailing, preservation of scenery, tourism, the waste transportation capacity in the water flow, and preservation of wetlands, especially in Regions I and II (areas of vital importance from the point of view of the demands of the mining sector).

Another example is the Corporación Nacional Indígena (National Indigenous Corporation) or CONADI, which has generated a land and water fund to provide subsidies for irrigation and/or drainage schemes, the acquisition of water rights by indigenous communities, and provide information and strategic training for dealing with land and water problems. Moreover, CONADI is proposing modifications to the Water Code to protect and increase the indigenous people's water rights, and has signed an agreement with the DGA for the joint treatment of problems relating to the protection of indigenous waters in all the country (CONADI, 2000).

VII.8.2 Recommendations for biodiversity conservation

Since there is incomplete information on biodiversity in Region II, any initiative directed towards the conservation of biodiversity in Region II is also limited. Any information on biodiversity in the region can basically be found in:

1. Results of the Programa Sectorial Biomas y Climas Terrestres y Marinos del Norte de Chile (Regional Programme of Biomass and Land and Marine Climates of Northern Chile) Region II, Antofagasta. FONDECYT/CONICYT 1996-1998, which consisted of various investigation projects developed in parallel with groups of scientists from diffe rent universities in the country.
2. Environmental Impact Studies (El Tesoro Mine in Sierra Gorda, El Peñón Mine in

[100] Personal correspondence with Guillermo Donoso, Dean of the Faculty of Agronomy and Forestry Engineering in the Universidad Católica of Chile.
[101] Director General de Agua.

Pampa El Peñón, El Abra Mine 55 km north of Calama) and from the Environmental Impact Declarations (Quebrada Grande Mine in the Río Frío sector, extension of the Escondida Mine operations) of mining projects in Region II.

Information from the Biomass Programme is abundant, but in overly biological terms. The information from EIAs, even though fairly complete, refers to specific areas corresponding to direct areas of influence of the projects.

The following are issues to be considered for the Sustainability Fund:

1. Complete the information on biodiversity from a more conservationist perspective (taking the region as a whole). This means creating a register (in areas where information is insufficient or incomplete) to establish which species are found in different sectors of the region and in what state of conservation, and detecting which ecosystems are important for conservation of biodiversity and how fragile these are.

2. The salt pans, due to their diversity and fragility, and to the fact that they support endemic species, are extremely important for the conservation of biodiversity. In the region there are a large number of salt pans which should be studied in an integrated man ner, creating registers of the species that live in them or that depend upon them in someway (some species only visit them sporadically). The variation in water levels over time, and how these are affected by water extraction by the mining companies should be studied. In the most important salt pans in terms of biodiversity, the ecological levels and flows should be determined. Possible relationships between different salt pans, from a hydrological and biological point of view should be analysed.

3. The fund could investigate the possibility of a breeding programme for species under threat. As seen in the chapter "The mining sector and biodiversity in Region II of Antofagasta", Minera Escondida is carrying out a project on flamingo reproduction, has collaborated with various other research projects concerning Antofagasta's marine environment, and is publishing a collection of scientific papers on the results of the studies. Compañía Minera Zaldívar conducted one study on the flora and fauna of the Negrillar Basin, a tributary of the Salar de Atacama, publishing a report with basic information and photographs of the species that live in this zone. Another mining company, El Abra, is the dynamic force behind a study on llaretas in the region, which could result in an important contribution to understanding the species and how to mitigate adverse impact. These pro jects should be coordinated, combining the efforts of different mining companies studying specific species or ecosystems in the region, and obtaining results which would help efforts at conservation, especially by development of mitigation plans. In this way, the studies could systematically advance the knowledge of the region's biodiversity.

4. Another important role for the Sustainability Fund could be in the protection of wilderness areas, since various areas are remarkable for their biodiversity and ecosystems. Some of these areas are indicated below:

   • In the specific case of the Salar de Ascotán, studying the possibility of incorporating

it in the Sistema Nacional de Areas Silvestres Protegidas del Estado (National System of State Protected Wilderness Areas), is recommended on account of its great diversity compared to other salt pans in the region, the fragility of its ecosystems[102]and the fact that it hosts three species of flamingo.

- In the Coastal Zone there are three areas with an important diversity of flora which are currently not protected: the zone neighbouring the Reserva Nacional de Paposo towards the south (extreme south of the region); the Morro Moreno sector (Mejillones peninsular) and the mouth of the river Loa (in the north of the region). In the first case the solution would be to extend the reserve southwards. In the other two cases it would be necessary to create new protection zones, either in the category of National Reserve or National Park.
- Another issue regarding protected areas would be to clarify the definitions of permits issued to explore and carry out mining operations in national parks. For example, in the Supreme Decree of the Ministerio de Bienes Nacionales No. 856, of 3 August 1995, which created the Parque Nacional Llullaillaco, Río Frío sector - Region II, it was declared "a place of scientific interest for mining purposes", which does not prevent "that the Authorities give permits to carry out mining work", with the permission of the President of the Republic.

VII.8.3 Recommendations for social issues

Here the fund could be used to explore a variety of ideas for improving the quality of life in the region that would lead to long-term sustainability after the mining industry operations have closed down. Any social improvements that would help change the perception of Antofagasta as a working location and not as a place in which to settle in the long term, will greatly help the future of the region by giving ownership to the people. On an individual level, some mining companies have already demonstrated their commitment to the region and its long-term sustainability. By working together with the regional and national governments, the achievements so far can be built upon, assuring the future of the region for generations to come.

From the foregoing analysis, there is clearly a need to improve integration of the mining sector operations with the regional identity, and to make use of existing organizational and cultural structures for this integration.[103] Whereas identification with the mining company is a well-established cultural element, identification with the region or community needs to be enhanced.

At the start of activities of the Sustainability Fund, some specific areas can be taken into account:

1. As a first step, the list of issues presented in Chapter VII (Annex 3) should be discussed by the Committee of the Sustainability Fund, who should identify the priority areas. This can be part of a general analysis for the Committee to carry out every two years. Given that the social aspects are so numerous and diverse, it will be essential to focus attention on a few selected priority issues, and depending on these, determine

[102] It is necessary to consider that in this zone the environmental conditions are extreme: very dry and with enormous thermal oscillations. E.g. in the Salar de Ascotán the extreme temperatures measured are 28 and -22°C.

[103] For example not to insist on the creation of new nongovernmental organizations but to foster the organization and integration of mine workers in community concerns.

how the Sustainability Fund would be involved. It is essential to identify in each case whether the issues can be dealt with on other levels or whether there is a specific need for the Sustainability Fund to act. One area already identified as in need of support is an improvement in cultural and other amenities/activities for citizens, with particular emphasis on the needs of the youth.

2. The need to create or strengthen a regional identity and a sense of caring for the quali ty of life in Antofagasta and the region has also been identified as a priority issue. For example, improvements could include enhancing and improving the beaches, providing more parks and sport facilities, museums etc. But it has also been emphasized that in addition to infrastructure, programmes and contributions in terms of human resources, or, sometimes, a change in attitude are necessary.

3. Coordination should be encouraged. In this context, two specific initiatives could be undertaken by the Sustainability Fund:
   - A permanent "exchange for project ideas" could be established at the regional level. This "exchange" could be an internet site (run by the Sustainability Fund) in which ideas could be posted by anyone interested, and discussed with the other actors. This online "exchange" could serve at the same time as a source of ideas for cooperation, with profi les of cooperation partners for companies interested in doing something in the community or the region.
   - Once a year an event could be organized in which ongoing and finished projects carried out by the mining companies, other companies or the public sector, are presented to the public. This same event can help to foster coordination and cooperation in generating new project ideas and to raise awareness of the achievements of the region.

VII.9 The financial base for the Sustainability Fund

This final section presents the various alternatives for financing the Sustainability Fund. In Chapter II, the application of taxes directed to sustainability was discussed. In Chapter VI the current contributions from the public sector and the larger mining companies were analysed, and a basis for voluntary contribution by the mining companies was identified.

The possible alternatives for creating the financial base for the Sustainability Fund range from obligatory income tax contributions, to obligatory fixed sum contributions, voluntary agreements, voluntary contributions, as well as incentive based voluntary systems.

Purely tax-based schemes have not proven to be effective instruments, indeed they have not been applied as significant schemes in any of the world's most important mining countries. Several arguments would indicate that to base the Sustainability Fund on taxes would not be the most acceptable option, and that there is more potential in voluntary or semi-voluntary alternatives:[104]

- the study has revealed the general disposition of companies towards voluntary contributions in the region

[104] It is important to keep in mind that the focus of the proposal here is on regional sustainability and not on the compensation to the State for the extraction of a non-renewable resource.

- sustainability issues are extremely dynamic in character, priorities can change from year to year and necessary resources change with these changes in priorities
- with obligatory contributions, there is the potential to "crowd out" the current voluntary contributions by the mining companies
- there is little confidence in the management of resources by the public sector
- there is a need for creative solutions which very often involve in-kind contributions
- many sustainability issues are not exclusively linked to the mining sector - a voluntary approach permits inclusion of contributions other than from the mining sector
- any change in the tax system which includes the earmarking of tax receipts to regional objectives would require, as a minimum, a presidential decree, and according to most experts[105] even a change in the constitution.

Thus, a Sustainability Fund based on voluntary contributions would seem to be the most appropriate approach, but keeping in mind the following:

- the current level of voluntary contribution is still low
- if contributions are purely voluntary, coordination is difficult
- information is primarily with the companies and there are no regulations that would oblige companies to make information public on the selected aspects for the work of the Sustainability Fund
- the day-to-day operation of the fund would have to be assured
- company interests do not always reflect public interests.

To confront some of these issues, the following should be considered:

1. To raise the level of donations, an incentive scheme based on tax credits could be elaborated.

2. The fund has to operate on a permanent basis, with a designated Executive Secretary.

3. The fund is presided over by a committee in which all sectors have representation.

4. With regard to generation of and access to information, there are currently different initiatives: The Voluntary Agreement on Clean Production in the Mining Sector, and the Law of Probity which was promulgated recently by the Chilean Government in order to improve access to public information on behalf of the citizens.

5. The fund still remains open to eventual contributions from an obligatory tax scheme.

[105] See for example Borregaard and Leal (2000).

The first point should receive special attention, as this scheme has to be carefully designed and based on sound economics - with a clear idea of the potential additional funds that are raised compared to the reduction in the tax regime. Analysis of the economic efficiency and effectiveness of alternative incentive schemes is beyond the scope of this study, but considerations for the potential design of the instrument is presented below:

The idea of a tax incentive scheme is being backed up unanimously by the different stakeholders. Many companies have indicated their intention to invest more resources if tax incentives are provided. However, the question of tax incentives seems not only a question of mathematics, but in this context it also becomes a meaningful symbol of public sector cooperation and openness to confront the issue of sustainability. Before a change in legislation can be brought about (something that cannot be expected in the short term), the existing legislation will have to be interpreted and assessed so that a wide range of contributions can come under the umbrella of tax incentives. The current legislation is established in the different laws on donations:

- Donations to universities and institutions for higher education - DFL 1 Ministerio de Hacienda, 1993; Ley 18681 art.69, 1988
- Donations to cultural objectives - Ley 18985 art.8, 1990
- Donations to educational objectives - Ley 19247, art.3, 1993
- Donations in the framework of the Law on Municipal Income - in this framework donations to education, health, and the poorest sectors of society are included.

All the laws refer to the deduction of the donation from taxable income, establishing different maximum amounts in each case. Examples of application of this legislation in the context of sustainable development have been reported in Borregaard and Czischke (2001).

In the context of encouraging initiatives[106] directed at promoting philanthropy and social responsibility, there has been a proposal to expand the current scheme of tax credits to include social and environmental issues.[107]

Incentive schemes that have been proposed by mining companies in the past in other countries might help to orient the design. One example is a scheme developed by Placer Dome in New Guinea in which 2 per cent of the taxes imposed can be spent on local infrastructure and projects, constituting a tax credit. This system was developed by the company together with the Government of New Guinea. According to Mel Togolo, General Manager of Corporate Affairs of Placer Dome[108], the tax scheme was created:

> "... because of concerns that the tax benefits of resource development were not returning to the local mine impacted communities and that the TCS was a way to allow companies to participate in community projects, with the full endorsement of the government. It is a scheme that typifies one of the best examples of collaboration between the industry and the government. ... The scheme has been hailed as being very successful for long-term

[106] See for example Sepúlveda y García (2000) or Consejo Ciudadano para el Desarrollo de la Sociedad Civil (2000).

[107] See Committee of Environmental Philanthropy, various documents 1999, Fondo de las Américas, Chile.

[108] Presentation at the Congress on Earth, Science, Exploration & Mining around the Pacific Rim, 10-13 October 1999, Bali, Indonesia.

community development. It has proven to be one of the most effective schemes in delivering services to the communities by private corporations. Widely supported by the community and by the government, it has clearly filled the gap created by a shortfall in government capacity to undertake community projects."

REFERENCES

1. Arcos, D. (ed.) (1998). "Minería del cobre, ecología y ambiente costero." Minera Escondida Ltda., Editora Aníbal Pinto S. A., Concepción, Chile.

2. Aroca, P. (2000). "Programa EVI de simulación insumo producto para la Región de Antofagasta" Departamento de Economía, Universidad Católica del Norte.

3. Blanco, H., Wautiez, F. y Borregaard, N. (1998). "Impactos ambientales de la liberalización comercial del sector minero chileno". Proyecto elaborado por CIPMA para UNEP.

4. Borregaard, N., Blanco, H. and Wautiez F. (1997). "Exported-led growth and the environment in Chile: an analysis of the induced environmental policy response in the mining sector", CIPMA.

5. ——— N. and Czischke, D. (2001). Manual de Filantropía y Cooperación Ambiental. CIPMA. Santiago.

6. ——— N. y Leal, J. (2000). "Desafíos y Propuestas para una implementación mas Efectiva de Instrumentos Económicos en la Gestión Ambiental de América Latina y el Caribe - El Caso Chileno." Documento de Trabajo. CEPAL. Santiago. Chile.

7. Candia, C. et al. (1998). "Distribución Espacial de la Actividad Productiva y Localización de la Firma Industrial en la Provincias de la II Región", Seminario de Título de Ingeniería Comercial, Universidad Católica del Norte.

8. Cardemartori, J. (2001). "Indices de desarrollo humano y propuestas para una nueva estrategia de desarrollo en la Región de Antofagasta", Instituto de Economía Aplicada Regional, Universidad Católica del Norte.

9. Cheere, E. et al. (1994). Diagnostic agraire de l´oasis de San Pedro de Atacama, Chili" Memoria de Título de Ingeniero Agrónomo del Institute Agronomique Paris-Grignon.

10. CIPMA. (2000). "Experiencias nacionales de filantropía. Caso: Fundación Minera Escondida." Memo.

11. Claude, M. (1997). "Una vez más la miseria. ¿Es Chile un país sustentable?" Colección sin Norte. Lom Ediciones. Santiago, Chile.

12. COCHILCO. (2000). "Estadísticas del cobre y otros minerales 1990 - 1999." COCHILCO. Santiago, Chile.

13. ——— (1999). "Los impactos sociales de la minería privada en Chile" COCHILCO, Santiago, Chile.

14. Código de Aguas. (1981). Editorial Jurídica de Chile. Santiago, Chile.

15. Compañía Minera Zaldívar. (1998). "Trascender generaciones... Informe de sustentabilidad." Antofagasta, Chile.

16. ——— (2001). Flora y Fauna de la Cuenca de Negrillar. Zaldívar. Antofagasta, Chile.

17. ——— (2001). Estudio Biogeográfico de la Cuenca de Negrillar. RGHprime Consultores Ambientales Asociados. Antofagasta, Chile.

18. CONAF. (1996). "Libro rojo de los sitios prioritarios para la conservación de la diversidad biológica en Chile". Muñoz M, Núñez H y Yáñez J (Eds.). Impresora Creces Ltda. Santiago, Chile.

19. CONAMA. (1994). "Perfil ambiental de Chile." Capítulo 19. Efectos ambientales derivados de la actividad minera en Chile, pp.393-415. Alfabeta Impresores. Santiago, Chile.

20. ——— (1995). "Medio Ambiente en Chile: Situación y Programas." Estudio elaborado por Ecología y Desarrollo para el Ministerio de Hacienda y CONAMA. Santiago, Chile.

21. ——— (2000). "Políticas ambientales regionales para el desarrollo sustentable". www.conama.cl

22. Convenio El Abra-SAG-CONAF. (2000). Programa de Trabajo de Estudios Voluntarios. Cooperación El Abra-SAG-CONAF. Dinámica de crecimiento y viverización de la llareta (Azorella compacta).

23. CORFO, Fichas Instrumentos CORFO, www.corfo.cl

24. Cruz, J. et al. (2000). "Influencia del capital social sobre la calidad de vida de personas de escasos recursos" Seminario de Título de Ingeniería Comercial, Universidad Católica del Norte.

25. Culverwell, M. (2000). "La Integración de los Pequeños y Medianos Proveedores en la Cadena Productiva", CEPAL.

26. Czischke, D. (2000). Prioridades sociales y ambientales en la Región de Antofagasta. Memo prepared in the context of the project " Environmental Philanthropy " . CIPMA, Santiago, Chile

27. DFID, Department of International Development. (1997). "A guide to the regional environmental action plan for the Antofagasta Region of Chile". Environmental Resources Management. Santiago, Chile.

28. DGA (Dirección General de Aguas) (1996) "Analysis of the current and future use of water resources in Chile", DGA, Santiago, Chile.

29. Di Castri, F. y Hajek, E. (1976). "Bioclimatología de Chile". P. Universidad Católica de Chile. Santiago, Chile.

30. DIA. (1998). Actividad de Exploración Preliminar Sector de Río Frío - II Región. Compañía Minera Quebrada Grande. Cega Ingenieros Ltda.

31. ——— (1999). Modificaciones adicionales a las instalaciones y a la capacidad de tratamiento y procesamiento de mineral sulfurado de Minera Escondida Ltda.

32. Donoso, G. (1995). "Análisis del mercado de aprovechamiento de las aguas". Panorama Económico de la Agricultura 100. Facultad de Agronomía. Pontificia Universidad Católica de Chile Santiago, Chile. pp. 14 - 17.

33. ——— (1998). "El mercado de derecho de aprovechamiento de agua en Chile". Anuario. Facultad de Ciencias Jurídicas. Universidad de Antofagasta. Antofagasta, Chile. pp. 189 - 202.

34. ——— (1999). "Análisis del mercado de los derechos de aprovechamiento de Agua e identificación de sus problemas". Revista de Derecho Administrativo Económico RDAE. Facultad de Derecho. Pontificia Universidad Católica de Chile. Santiago, Chile.

35. Ecology and Development, (1995). Situación Ambiental en Chile. Study prepared for CONAMA, Santiago, Chile.

36. EIA Mina El Abra, Provincia del Loa, II Región de Antofagasta. (1994). Geotécnica Consultores.

37. EIA Mina El Peñón, Pampa El Peñón, II Región de Antofagasta. (1997). Geotécnica Consultores.

38. EIA Mina El Tesoro, Sierra Gorda, II Región de Antofagasta. (1997). Dames & Moore Consultores.

39. El Serafy S. (1989). "The proper calculation of income from depletable natural resources". In Environmental Accounting for Sustainable Development", Word Bank, Washington DC, USA. pp. 10-18.

40. Epps, J. (1997). "The social agenda in mine development." Industry and Environment. Vol. 20, N° 4, pp. 32-35.

41. Espinoza, G., Gross, P. y Hajek, E., (1994). Percepción de los problemas ambientales en las regiones de Chile. CONAMA. Alfabeta. Santiago.Chile

42. Figueroa, L. (1995). "Asignación y distribución de las aguas terrestres". Universidad Gabriela Mistral. Santiago, Chile.

43. Figueroa, E. et al. (1999). "Economic Rents and Environmental Management in Mining and Natural Resource Sectors". Edited by Eugenio Figueroa for the Universidad de Chile and University of Alberta.

44. Fundación Minera Escondida, (1998). "Memoria y Balance." Fundación Minera Escondida. Antofagasta, Chile.

45. Geisse, G. (1997). "La empresa cuprífera multinacional y el desarrollo sustentable de las regiones mineras de Chile" Ambiente y Desarrollo, Vol XIII, N°4, diciembre de 1997, CIPMA.

46. ——— (2001). "El eje filantropía - responsabilidad social - imagen pública" Ambiente y Desarrollo Vol XVII, N°1, marzo 2001, CIPMA.

47. Gómez-Lobo, A. (2000). "Sustainable development, optimal growth and natural resource accounting in a small open economy".

48. Grupo Placer Dome. (1998). "Se trata de nuestro futuro. Informe de sustentabilidad 1998". Santiago, Chile.

49. Hartwick, J. M. (1989). The Non-renewable resource exploring-extracting firm and the r% rule. Queen´s University, Department of Economics Discussion Paper No.741.

50. Jofré, G. et al. (2000). "Factores críticos de éxito en la adjudicación o renovación de contratos de empresas contratistas con empresas mineras de la II Región" Seminario de Título de Ingeniería Comercial, Universidad Católica del Norte.

51. Lagos, G. (1996). "Requerimientos y desafíos ambientales para la minería chilena." Ponencias del V Encuentro organizado por CIPMA en Temuco, Chile. CIPMA. Santiago, Chile.

52. ——— Lehuedé, J. y Andía, M. (2000). "Sulfur dioxide abatement cost and compliance with health based standards: the case of copper smelters." To be submitted for publication in Resources Policy: June 2000.

53. Marquet, P., Bozinovic, F., Bradshaw, G., Cornelius, C., González, H., Gutiérrez, J., Hajek, E., Lagos, J., López-Cortes, F., Núñez, L., Roselló, E., Santoro, C., Samaniego, H., Standen, V., Torres-Mura, JC. y Jaksic, F. (1998). "Los ecosistemas del desierto de Atacama y área andina adyacente en el norte de Chile". Revista Chilena de Historia Natural 71: 593-617.

54. MIDEPLAN. (1999). "Evolución y estructura de la inversión pública en Chile". Santiago, Chile.

55. Miller, C. G. (1997). "Mining and sustainable development: environmental policies and programmes of mining industry associations." Industry and Environment. Vol. 20, N° 4, pp. 14-17.

56. Minera Escondida Limitada. (1997). "Impacto económico y social Octubre 1997." Escondida. Antofagasta, Chile

57. ——— (1999). "Memoria anual y estados financieros. Año fiscal 1998." Escondida. Antofagasta, Chile.

58. ——— (1999). Video Tape "Proyecto Flamencos". Escondida Antofagasta, Chile.

59. ——— (2000). Colección de Apartados Científicos / Ambiente Marino Antofagasta. Escondida. Antofagasta, Chile.

60. Ministerio de Economía. (2000). "Visión de Chile y sus regiones", www.minecon.cl

61. Montesinos, S. et al (1999). "Análisis del Impacto Psicosocial del Sistema de Trabajo por Turno en la Unidad Familiar" Universidad de Chile.

62. MOP/DP (INECON, Ingenieros y Economistas Consultores Ltda.). (1995). Estudio "Analisis del mercado de recursos hídricos". Informe final, tomos I y II. Ministerio de Obras Públicas. Santiago, Chile.

63. ——— (1995). Estudio "Análisis del mercado de recursos hídricos, marco legal existente y experiencia extranjera. Ministerio de Obras Públicas. Santiago, Chile.

64. Moran,R. (2001) "Mining environmental impacts. Integrating an economic perspective". In: Towards the Integration of Environmental, Economic and Trade Aspects in the Mining Sector. Borregaard, N., Gana, C. (eds) CIPMA, Santiago, Chile.

65. ——— (2000). "Mining environmental impacts. Integrating an economic perspective." CIPMA. Santiago, Chile.

66. Moreno, R., Quiroga, R. y Barrera, O. (1998). "Indicadores Regionales de Desarrollo Sustentable." Documento de Trabajo N° 7, Serie Economía Ambiental, CONAMA. Santiago, Chile.

67. Munasinghe, M. (1993). "Environmental economics and sustainable development." World Bank Environmental Paper number 3. World Bank. Washington DC, USA.

68. Myers, N., Russell, A., Mittermeier, C., Mittermeier,G., Da Fonseca,G., Kent, J. "Biodiversity hotspots for conservation priorities" in: Nature 403, 853 - 858 (2000).

69. Orellana S. (2000). " El incipiente cluster minero chileno" , Área Minera, www.areaminera.com

70. Peña, H. (1995). "Derechos y mercados de agua en Chile." Anales de la Conferencia Nacional sobre Desarrollo del Riego en Chile. Ministerio de Agricultura / Ministerio de Obras Públicas (MOP) / Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO). Oficina de Estudios y Políticas Agrarias (ODEPA), Ministerio de Agricultura. Santiago, Chile.

71. Paulsen, J. (1999). "Evaluation of the Environmental Situation in the Chilean Mining Industry". Special Course, IGG. Denmarks Tekniske Universitet, Dinamarca.

72. Rosales, U. et al. (1998). "Diagnóstico y recomendaciones estratégicas para el sector agríco la de la II Región" Seminario de Título de Ingeniería Comercial, Universidad Católica del Norte.

73. Rosegran, M., and Gazmuri, R. (1995). "Reforming water allocation policy through markets in tradable water rights: lessons from Chile, Mexico and California". Cuadernos de Economía, año 32, N°97. Pontificia Universidad Católica de Chile. Santiago, Chile. pp. 291 - 315.

74. Sánchez, J., Araya, R. et al. (2000). "Análisis Medio Ambiental, Sociocultural y Económico de la Gran Minería y la Comunidad: estudio de casos en Chile".

75. Sepúlveda, C. and García, D. (2000). "Diagnóstico y estrategia para promover la filantropía ambiental en Chile". Proyecto CIPMS; E&D y UACH.

76. SERNAGEOMIN. (1989). "Levantamiento catastral de los tranques de relaves en Chile: Etapa A, regiones V y XIII." SERNAGEOMIN. Santiago, Chile.

77. ——— (1990). "Levantamiento catastral de los tranques de relaves en Chile: Etapa B, regiones IV, VI y VII." SERNAGEOMIN. Santiago, Chile.

78. ——— (1990). "Levantamiento catastral de los tranques de relaves en Chile: Etapa C, regiones II y III." SERNAGEOMIN. Santiago, Chile.

79. Sierra, C. (1998). "El lado oscuro." Induambiente. Año 6 - N°31. pp 65 - 68. Santiago, Chile.

80. Soler, F. (1985). "Medio Ambiente en Chile." Ediciones Universidad Católica de Chile. Santiago, Chile.

81. Spotorno, A., Zuleta C., Gantz A., Saiz F., Rau J., Rosenmann M., Cortes A., Ruiz G., Yates L., Couve E. Y Marín J.C. (1998). "Sistemática y adaptación de mamíferos, aves e insectos fotófagos de la Región de Antofagasta, Chile". Revista Chilena de Historia Natural 71: 501-526.

82. Stogran, W. (1999). "Cierre sin cicatrices." Induambiente. Año 7 - N°39. pp 24 - 28. Santiago, Chile.

83. Tromben, C. (1996). "El cerco verde." Induambiente. Año 4 - N°22. pp 86 - 88. Santiago, Chile.

84. UDAPE (Unidad de Análisis de Políticas Sociales y Económicas). (1998). Barragán, J., Crespo, C., Donoso, G., Escobar, J. "Mercados e instituciones de aguas en Bolivia". UDAPE. La Paz, Bolivia.

85. UNDP. (2000). "Desarrollo humano en Chile. Más sociedad para gobernar el futuro." Firma Gráfica. Santiago, Chile.

86. Universidad de Chile, Centro de Análisis de Políticas Públicas. (2000). Informe País: Estado del medio ambiente en Chile - 1999. LOM Ediciones. Santiago, Chile.

87. Veloso, A. y Núñez, H. (1998). Inventario de especies de fauna de la Región de Antofagasta (Chile) y recursos metodológicos para almacenar y analizar información de biodiversidad". Revista Chilena de Historia Natural 71: 555-569.

88. Vergara, A. (1998). "Derecho de Aguas". Editorial Jurídica de Chile. Santiago, Chile.

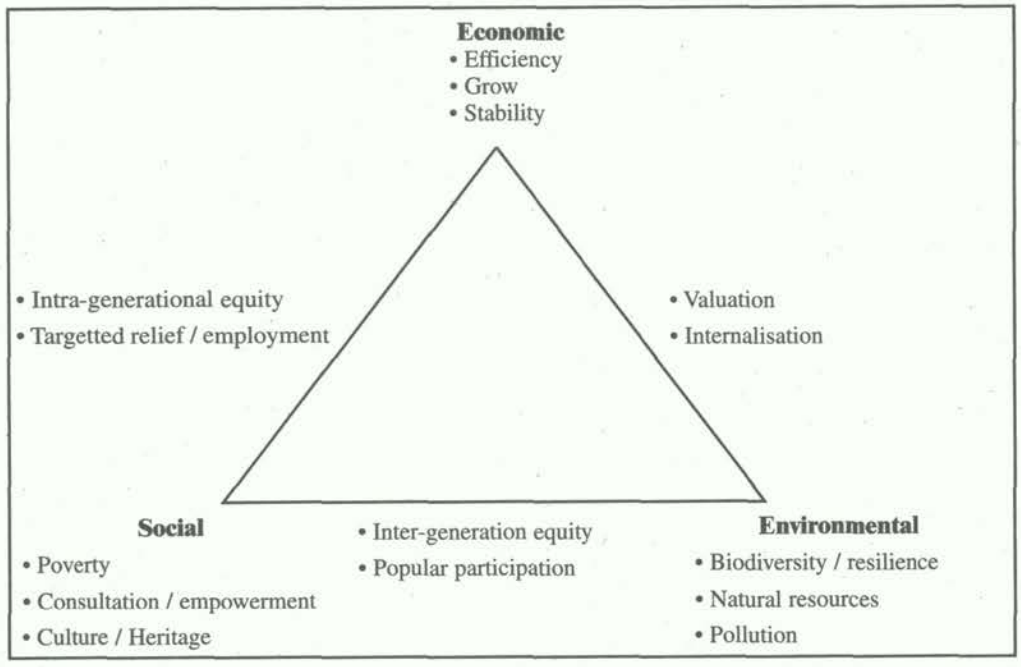
89. Villar, M. (1998). "Jornadas Especiales de Trabajo: Implicancias en el Grupo Familiar" Publicación de Extensión, El Mercurio de Antofagasta.

90. World Commission on Environment and Development. (1987). "Our common future: from one earth to one world." UNXXX. Washington DC. USA.

ANNEX 1

In general, the concept of sustainability contemplates three aspects:[109] economic, ecological and socio-cultural:

Figure Annex 1.1: Trade-offs among the three main objectives of sustainable development



Source: Munasinghe (1993).

The economic approach to sustainability is based on the Hicks-Lindahl concept of the maximum flow of income that could be generated while at least maintaining the stock of assets or capital which yield these benefits. There is an underlying concept of optimal and economic efficiency applied to the use of scarce resources. Problems of interpretation arise in identifying the kinds of capital to be maintained (e.g., manufactured, natural, and human capital) and their substitutability, as well as in economically valuing some of these assets, particularly ecological resources.

The ecological view of sustainable development focuses on the stability of the biological and physical system. Of particular importance is the viability of the overall ecosystem. Protection of biological diversity is a key aspect. Furthermore, "natural" systems may be interpreted to include all aspects of the biosphere, including man-made environments like cities. The emphasis is on preserving the resilience and dynamic ability of such systems to adapt to change, rather than conservation of some "ideal" static state.

The socio-cultural aspect of sustainability seeks to maintain the stability of social and cultural

[109] See for example Munasinghe (1993), World Commission on Environment and Development (1987) and El Serafy (1992).

systems, including the reduction of destructive conflicts. Both intergenerational equity (preserving the rights of future generations) and intragenerational equity (especially elimination of poverty) are important aspects of this approach. Preservation of cultural diversity across the country, and the better use of knowledge concerning sustainable practices embedded in less dominant cultures, are other elements to be considered in this respect.

ANNEX 2

Existing policy instruments

Instruments directed at environmental issues

Despite the existence of many environmental laws applied to the mining sector through time, the use of strict environmental regulations has only been taken on since the beginning of the 1990s. The regulation instruments applied to the mining sector reflect the general situation of environmental management systems in Chile: the use of command and control instruments prevails over the use of economic or others instruments. The environmental issue that has received most attention in the past is atmospheric contamination. A description of the specific regulations applicable to mining follows.

The oldest laws and regulations have mainly dealt with water quality standards and effluents. The first law regarding this is Law 3.133 of 1916, which regulates the neutralization of effluents from mines and foundries. Following that, the 1931 Sanitary Code provides greater authority to the Servicio de Salud (Health Service) to control residues coming from the mining companies. In 1948, a law was passed prohibiting direct emission of mineral residues into the water system, with the intention of protecting agriculture. In 1970, by means of the DS 86, the construction and operation of tailing dams was imposed. This law was only passed after 1.5 million cubic metres of waste buried a town during an earthquake (Lagos, 1996).

In the 1990s, responsibility for the creation and application of environmental laws regarding the mining sector lay with CONAMA and the Mining Ministry. However, the institutional reforms carried out over recent years have also allowed regional authorities a greater degree of participation in environmental decision-making. This explains, for example, the involvement of regional representatives of the health, agriculture, work, housing and mining ministries in the 200 or more environmental impact evaluations carried out by mining companies during the 1990s.

Regulation of atmospheric contamination

As mentioned above, in recent years, environmental legislation in the mining sector has focused on reducing atmospheric contamination. The most important legislation is the Mining Ministry's Supreme Decree 185 of 1992, which defines the quality standards for SO2 and particle matter (PM) from fixed sources in all Chile.

Table Annex 2.1 shows the quality standards imposed by the Decree 185. The decree divides the country into two areas, the first from Caletones to the border with Peru and the second from Caletones to the south. The standards applied for SO2 emissions are less strict in the north than in the south; furthermore, only the southern zone must comply with air quality standards for NO2, MP, CO and ozone. Also, the quality standards for the southern zone are much more demanding and equal to those established by the EPA, however their application is different. The Chilean standards are only applied in populated areas.

Table Annex 2.1: Emission Standards established by the Decree 185

Contaminant	Units	Southern zone standard	Northern zone standard	Average
SO2	ug/m3-ppm	700 - 0.26	1000 - 0.37	1 hour
		260 - 0.10	365 - 0.14	24 hours
		60 - 0.02	80 - 0.03	annual
NO2	ug/m3-ppm	470 - 0.25	-	1 hour
		300 - 0.16		24 hours
		100 - 0.05		annual
Particle Matter	ug/m3-ppm	260	-	24 hours
		75		annual
CO	ug/m3-ppm	10,000 - 9	-	8 hours
		4,000 - 35		1 hour
Ozone	ug/m3-ppm	160 - 0.08	-	1 hour

Source: Elaborated according to Articles 4 and 6 of the DS185.

The Decree 185 also establishes decontamination plans and a time framework for the foundries to comply with imposed quality standards. Decontamination plans have been established for 5 of the 7 foundries that do not comply with environmental standards. For Chuquicamata, Ventanas, Caletones and Paipote, decontamination technologies had to have been installed in 1999. The Potrerillos foundry has a longer time period to comply.

On the other hand, in June 1999 an emission rule for the regulation of the air-emitted contaminant arsenic was established. This rule fixed maximum emissions permitted annually for existing sources. These maximum emissions vary according to the region in which the sources are located - taking specific account of population data - and depending on the metal being processed. New sources being installed at any point within Chilean territory must have an emission of equal to or less than 5 per cent in weight of the arsenic put into the emission source. Moreover, the new arsenic emission sources processing copper compounds must have emissions of equal to or less than 0.024 per cent in weight of that put into the emission source.

The environmental impact evaluation system

Law 19.300 is another important law that, since 1997, obliges companies to submit an Environmental Impact Study (EIS), which is reviewed by CONAMA in order to concede them operation permits. Due to the concern of the industries that the EIS could be bureaucratic and bring about excessive costs and time loss, Chile established a maximum time span to examine and pass or reject the EIS. If CONAMA fails to make a decision within the stipulated time, the applications for exploration or mining concessions are automatically accepted.

Luminescence regulation

Finally, there are regulations that affect the mining sector in a more marginal way. Such is the case of the Supreme Decree 686/98, which establishes an emission rule for the regulation of luminescence contamination. This rule arose from the presence of important astronomic activity in the north of the country and is aimed at protecting the environmental quality of the sky which is under threat from the luminescence contamination produced by lights from cities and mining and

industrial activity.
The rule includes specifications concerning the maximum luminous flux permitted for different light sources, including lights with a nominal flux either less or greater than 15,000 lumens, public street lighting and projector lighting and lighting installations in gardens, beaches, parks, amongst others.

Water use

The water use rights system

The currently valid 1981 civil law establishes the reassignment of resources by means of the free transference of water use rights. In order to achieve free transfer, characteristics are established regarding the definition and protection of rights, the division of rights into smaller units, freedom of water use, free obtaining of rights and the role of the government.

Water is considered national property by Chilean law, however the 1981 Water Code created water use rights, which have the same constitutional property guarantees. By virtue of this right, private parties can legally use, enjoy and dispose of the water in complete liberty (Vergara, 1998). Furthermore, through the same code the state recognizes and protects the common law rights, which are those water uses occurring historically without a prior concession deed from a governmental organization.

According to Article 12, the Water Code establishes that "the rights of use are common-law or otherwise, permanent or casual, continuous or discontinuous or alternating between various parties". The use rights are expressed in flow volumes, that is, in volume per time unit. An example of common-law right is irrigation and an example of non-common-law right is electrical energy generation.

In addition to the definition of the aforementioned water use rights, the 1981 Water Code presents a series of important characteristics in order to assign water to the different economic sectors. These characteristics are:

1. The title holder of the water can transfer his right freely, separate from the land, so that the new title holder can use the water in any other site of the basin and for any use, not necessarily that of the original assignation, thus allowing freedom to change water use (Vergara, 1998).
2. The rights of use can be divided up into parts of the flow volume it represents, just as it can also be divided up in its length.
3. The rights are obtained and maintained without cost.

Pending regulations

There are also important regulations for the mining sector at a formation stage - as is the case of the law to regulate mine closure, or ratification stage - as is the case of the law regulating liquid effluents. The latter has been held up several years, and the mining sector has participated actively in the discussion concerning this law since the maximum limits proposed require considerable adjustments in some mining operations.

ANNEX 3

Social aspects to be considered for sustainability in Region II

1. Health Services
    - 1.1. Hospitals and health
    - 1.2. Human capital
    - 1.3. Equipment
    - 1.4. Technical back up
    - 1.5. Supplies
    - 1.6. Expertise
    - 1.7. Availability to lower income brackets
    - 1.8. Special mining related health problems
    - 1.9. Occupational health
    - 1.10. Mental health facilities

2. Education
    - 2.1. School level
    - 2.2. Literacy level in the region
    - 2.3. Comprehension skills
    - 2.4. Facilities/equipment/books/other supplies
    - 2.5. Achievements compared to national levels
    - 2.6. Sufficient qualified teachers for the region
    - 2.7. University level - sufficient for the region?
    - 2.8. Technical level - sufficient for the region?
    - 2.9. Relevant areas of training
    - 2.10.Training in other areas for diversification from the mining sector
    - 2.11.Level of language training
    - 2.12.Percentage with English language proficiency

3. Employment
    - 3.1. Percentage unemployed; above or below the national average?
    - 3.2. Do graduates from the universities and technical colleges remain in the region after qualifying or do they leave for different parts of Chile or other countries?

4. Population growth
    - 4.1. What are the trends in population growth in the region?
    - 4.2. Are people from the rural areas in the region attracted to the larger cities because of better pay/health facilities/education/housing/general life style
    - 4.3. Age distribution in the region
    - 4.4. What provisions are made for the older members of the community?
    - 4.5. How does the family stability of the community compare with that of the restof the country?

5. Water services
    5.1. Drinking water
        5.1.1. Adequate?
        5.1.2. Question of high levels of minerals particularly arsenic needs to be clarified
        5.1.3. Readily available to all?

    5.2. Waste water
        5.2.1. What treatment facilities are available?
        5.2.2. What are the problem areas as far as waste water treatment goes?

    5.3. Freak weather conditions
        5.3.1. What happens when the rare but potentially heavy rains occur - what provisions have been made?

6. Waste disposal
    6.1 Landfill facilities?
    6.2 Toxic waste facilities?

7. Natural disasters
    7.1. Earthquakes
    7.2. Tsunamis
    7.3. Flash floods
    7.4. Mud slides

8. Other utilities and facilities
    8.1. Clean beaches
    8.2. Fire brigades
    8.3. Public housing programme
    8.4. Parks
    8.5. Sports facilities

9. Other communities
    9.1. Artisanal fishing communities
    9.2. Altiplano communities
    9.3. Gipsy communities
    9.4. Agricultural groups
    9.5. Small mining groups

10. Investment initiatives
    10.1. Initiatives for attracting new and diverse investment into the Region

11. Transport
    11.1. Road transport
    11.2. Rail transport
    11.3. Port facilities
    11.4. Airport facilities

12. Cultural activities
    - 12.1. Theatres
    - 12.2. Cinemas
    - 12.3. Museums
    - 12.4. Workshops
    - 12.5. Extracurricula courses
    - 12.6. Libraries

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