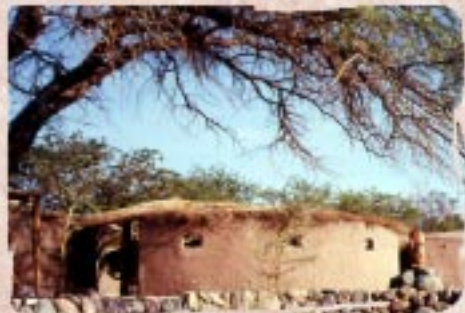


Millennium Ecosystem Assessment:

**HUMAN WELL-BEING AND
SUSTAINABLE MANAGEMENT IN
SAN PEDRO DE ATACAMA - CHILE**



EXECUTIVE SUMMARY

RIDES



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Millennium Ecosystem Assessment
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*The mission of the advisory committee was to work alongside the project and help to ensure that all viewpoints were considered in the assessment. Nevertheless, opinions expressed in this report are the sole responsibility of the project team and do not necessarily reflect those of the members of the advisory group. A rough draft of this document was available for revision and comments by the group between 4 and 11 March, 2005. We thank the group for the comments thus received.

Evaluación Ecosistémica del Milenio: Bienestar humano y manejo sustentable en San Pedro de Atacama, Chile

Resumen ejecutivo (Millennium Ecosystem Assessment: Human well-being and sustainable management in San Pedro de Atacama, Chile – Executive report)
RIDES

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Santiago, March 2005

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FORWARD

We heard about the global initiative "Millennium Ecosystem Assessment" (MA) in 2002. The conceptual framework it proposed caught our attention; we were particularly interested by the opportunity to analyse ecosystems, the services they offered and human well-being in an integrated way. We were contacted by the MA secretariat, who gave us further information on the initiative and its focus and encouraged us to present an idea for a project in Chile. After preliminary consideration and discussion with colleagues and certain stakeholders in the north of Chile, we presented a proposal for an ecosystem assessment project in the municipality of San Pedro de Atacama. We chose this geographical area for the following main reasons:

- The area possesses a very unusual ecosystem: a salar (salt flat) in one of the driest deserts in the world.
- The area has complex social and cultural characteristics: the majority of the population are Atacameño.
- There have been rapid and intense economic, social, cultural and environmental changes due to vigorous economic activity æ largely tourism and mining æ and past, present and future tensions connected with access to ecosystem services (notably water).

The project began mid-2003, after a preliminary research period, and concluded in February 2005. Our main objective at the outset of the assessment was to contribute toward a more sustainable form of management of the municipality's ecosystems. We wanted to inform the main stakeholders from the private and public sectors and the community at large, about the services provided to us in the municipality by the ecosystems and how we are affecting the capability of these ecosystems to continue providing those goods and services necessary for our well-being. Therefore, we defined the main goods and services to be studied both at the outset of the project and through work sessions with the main stakeholders involved, the ecosystem users. These were: water resources; minerals; possibilities offered by the ecosystems for tourism, astronomical observation and agriculture; and biodiversity. The latter is considered the cornerstone for all the other goods and services.



Our main objective at the outset of the assessment was to contribute toward a more sustainable form of management of the municipality's ecosystems. We wanted to inform the main stakeholders from the private and public sectors and the community at large, about the services provided to us in the municipality by the ecosystems and how we are affecting the capability of these ecosystems to continue providing those goods and services necessary for our well-being. Therefore, we defined the main goods and services to be studied both at the outset of the project and through work sessions with the main stakeholders involved, the ecosystem users. These were: water resources; minerals; possibilities offered by the ecosystems for tourism, astronomical observation and agriculture; and biodiversity. The latter is considered the cornerstone for all the other goods and services.

It seemed essential to invite all the relevant stakeholders to participate in the project from the very start and to keep them informed and involved throughout. Toward this end,

early on in the process, we elected an advisory committee to accompany the project in its development and help us to analyse and make relevant decisions. The advisory committee was made up of 17 people, representing the relevant ecosystem users from many diverse sectors: indigenous Atacameño communities, communal and regional public services, mining companies linked to the ecosystems, those working in tourism in the municipality, the regional university, and the San Pedro irrigation association.

We met diverse challenges during the course of the project. It was not always easy or fully possible to access the relevant information. We had neither the funding nor the time to generate original information (i.e. information that did not exist prior to the project) so we could not reach more categorical conclusions on some issues. Lastly, the tensions that have long existed between diverse stakeholders (particularly due to water use) made it difficult to achieve active and ongoing participation from all stakeholders in all project activities.

In spite of the limitations we faced, and those inherent in the work team, we trust the activities carried out by this project and the results we present here will be of use to those making decisions that affect ecosystems in the municipality. We also hope that the lessons learnt through this experience can be of use to similar future efforts in other parts of the country or even in other countries.

The project team will continue, as far as possible, in our commitment to sustainable development in the municipality. In fact, in the near future, we hope to continue with some of the activities related to this project in the municipality.

This executive report is aimed at all those interested in the municipality ecosystems and their sustainable management to satisfy the well-being of their users. Those requiring further information can access the specific project products, listed at the end of this report.

We would like to thank all those who supported us and also those who provided us with criticism during the course of the project. It is they who helped us to learn and thus improve our work. We are open to any questions, comments or suggestions that might arise so please do not hesitate to contact us.



Hernán Blanco
Executive Director
Recursos e Investigación para el Desarrollo Sustentable



I. THE MILLENNIUM ECOSYSTEM ASSESSMENT

(www.maweb.org)



The MA seeks to meet the needs of decision makers and the public for scientific information concerning the consequences of ecosystem change for human well-being and the options for responding to those changes.

The Millennium Ecosystem Assessment (MA) is an international work programme designed to assess, over a five year period (2001-2005), the capacity of ecosystems to continue providing for human well-being and life on earth, in view of the huge and ever-growing pressure exerted on them over the last fifty years. The programme was launched by the U.N. Secretary-General Kofi Annan and is funded by the World Bank, the World Wildlife Fund (WWF), the United Nations, donor countries and private foundations.

The MA brings together scientists, decision-makers from international organisations, national governments, the private sector and civil society from all over the world in order to provide an integrated assessment of the consequences of ecosystem changes on human well-being and the options available to us to improve the conservation of these ecosystems and protect their contribution to human needs.

In addition to the global assessment, subglobal assessments are being carried out in numerous countries, including Canada, Chile, China, India, Papua New Guinea, Peru, the Philippines, Portugal, South Africa, Sweden and Vietnam. These subglobal assessments aim to respond to the needs of decision-makers at the scale at which they operate (be it local, regional or national), to strengthen global findings from a more concrete reality and interact with the focuses, data and models from the global analysis.

The MA seeks to meet the needs of decision makers and the public for scientific information concerning the consequences of ecosystem change for human well-being and the options for responding to those changes.

It is hoped that the MA will provide relevant guidance for decision-making for government, NGOs, indigenous groups and industry as well as at the main international conventions relating to ecosystems, such as the Convention on Biological Diversity, the Convention to Combat Desertification, the Ramsar Convention on Wetlands, and the Convention on Migratory Species.

The MA also seeks to contribute to the Millennium Goals defined by the United Nations and the Plan of Implementation of the World Summit on Sustainable Development held in Johannesburg in 2002.



1.1. HUMAN WELL-BEING AND ECOSYSTEMS: A FRAMEWORK FOR THE ASSESSMENT

One distinctive feature of this initiative is the creation of a unique and innovative **conceptual framework**. This is based on the belief in a dynamic and mutually dependent relationship between people and ecosystems; i.e. changes in the ecosystems affect human well-being and vice versa. Figure 1.1 illustrates this conceptual framework.

An **ecosystem** is a dynamic complex of plant, animal and microorganism communities and the nonliving environment interacting as a functional unit. Humans are an integral part of ecosystems.

Human well-being has multiple constituents, including basic material for a good life, freedom and choice, health, good social relations and security. Well-being is at the opposite end of a continuum from poverty, which has been defined as "a pronounced deprivation of well-being". The constituents of well-being, as experienced and perceived by people, are situation-dependent, reflecting local geography, culture and ecological circumstances.

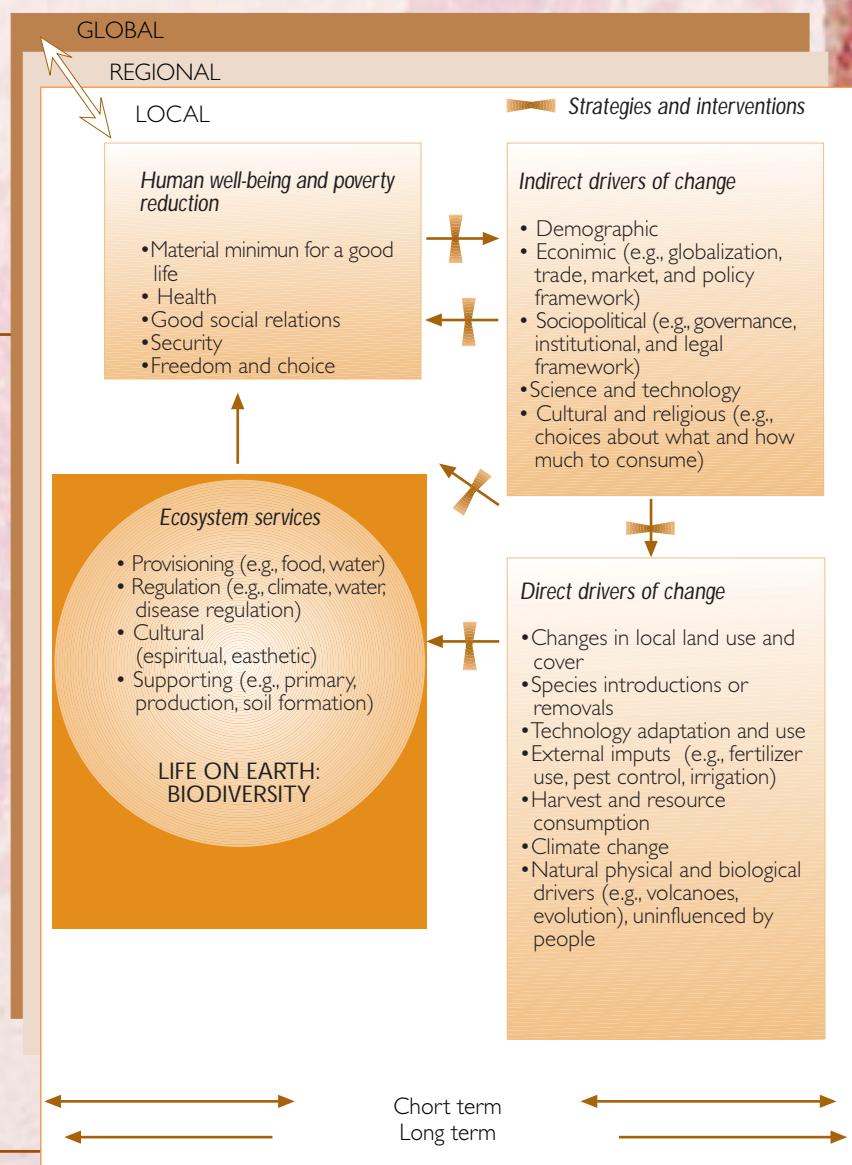
The concept of ecosystem services is central to understanding the relationships between society and ecosystems. "Ecosystem services" are the benefits people obtain from ecosystems.



Figure 1.1:
Conceptual framework for the Millennium Ecosystem Assessment

Changes in factors that indirectly affect ecosystems, such as population, technology, and lifestyle (upper right corner of figure), can lead to changes in factors directly affecting ecosystems, such as the catch of fisheries or the application of fertilizers to increase food production (lower right corner). The resulting changes in the ecosystem (lower left corner) cause the ecosystem services to change and thereby affect human well-being. These interactions can take place at more than one scale and can cross scales. For example, a global market can lead to a regional loss of forest cover, which increases flood magnitude along a stretch of a river. Similarly, the interactions can take place across different time scales. Actions can be taken either to respond to negative changes or to enhance positive changes at almost all points in this framework (black cross bars).

Source: MA, 2003: 37.



These include tangible services, such as food, wood and water; and other intangible services, such as soil fertility, climate regulation and cultural values.

We all depend on the services provided by ecosystems, even though human well-being is also affected by other factors. Therefore, if we allow capacity of ecosystems to provide these services to deteriorate, sooner or later our well-being will suffer.

Typically in ecosystem assessments, issues such as food production, potable water supply, fishing and conservation are tackled separately. In contrast, the MA examines all the benefits humans obtained from ecosystems in an **integrated** manner. It is designed to provide information for better understanding of the relationships and commitments connected to decision-making with regard to the services an ecosystem provides.

The MA promotes the involvement of the ecosystem users and the incorporation of their knowledge of the ecosystem as a fundamental part of the local level assessments. The MA seeks in this way to give a direct and concrete response to the different needs and interests of decision-makers, establishing bridges between scientific knowledge and practical know-how.

Appropriate policy-driven interventions can generally reduce or prevent ecosystem degradation and so increase the contribution of ecosystems to human well-being. However, substantial knowledge of the ecological and social systems involved is required in order to determine when and how such interventions should be made. Top quality information does not guarantee better decisions, but it is a requisite for sound decision-making processes.

The MA proposes that, in order to achieve an integrated ecosystem assessment, it is necessary to describe the **conditions and trends** of ecosystem services and their relationship to human well-being, as well as to identify direct and indirect **factors and drivers of change** that affect both the ecosystem and the social context. Possible future **scenarios** can then be constructed based on the above information, in order to identify a set of **responses** to the current challenges and so achieve more adequate ecosystem management.

Lastly, the MA promotes the involvement of the ecosystem users and the incorporation of their **knowledge** of the ecosystem as a fundamental part of the local level assessments. The MA seeks in this way to give a direct and concrete response to the different needs and interests of decision-makers, establishing bridges between scientific knowledge and practical know-how.

The first MA report was published in 2003; an in-depth presentation of the aforementioned conceptual framework. The assessment results at global and subglobal levels will be available from May 2005.



● Sub-Global Assessments: Approved Assessments

Africa (southern regions), Canada, Caribbean region, Chile, China (western regions), India, Kenya, Norway, Peru, Papua New Guinea, Philippines, Portugal, Sweden, Trinidad, Vietnam

▲ Sub-Global Assessments: Associated Assessments

Araruto and Timor Seas, Argentina, Asia (central regions), Australia, Brazil, Colombia, Costa Rica, Egypt, Fiji, India, Indonesia, Morocco, Saudi Arabia, United States

II. HUMAN WELL-BEING AND SUSTAINABLE MANAGEMENT IN SAN PEDRO DE ATACAMA

The subglobal assessment in Chile was coordinated by RIDES, and took place in the municipality of San Pedro de Atacama (SPA), El Loa province, in the II Region of Antofagasta, Chile¹. It lies between latitudes 22°22' S and 24°21' S and longitudes 67°00' O and 68°40' O. Figure II.1 shows a map of the municipality of San Pedro de Atacama.

The municipality has a total area of 23,439 km², divided into two main geographical units. The western zone encompasses the Salar de Atacama basin. This is the largest salar basin in Chile (3,000 km²), and possesses a watercourse system that supports numerous bird species, including all three species of flamingo existing in Chile. In terms of climate, the area lies within the extremely arid Atacama desert, known to be the driest desert in the world. There are several oases in the area, which are fed by watercourses from the altiplano (high Andean plateau) and the main settlements (San Pedro de Atacama, Toconao, Peine) are located around these oases.

The eastern zone constitutes the precordillera (Andean foothills), cordillera (the Andes) and the subdesertic steppe of the Puna de Atacama. These are the high altitude areas, characterised by a high altitude tropical climate with summer precipitation. The precordillera has extensive gorge systems with some settlements (Río Grande, Camar, Talabre) and archaeological remains from the zone's first inhabitants. Lastly, the cordillera and puna sectors are characterised by huge volcanoes over 6,500 metres high (Licancabur, Lascar) and highland plateaus. Systems of flat grasslands and peat bogs develop on these plateaus, providing pasturelands for native camelid species and enabling some human settlement (Machuca).

II.1. CHARACTERISTICS OF THE AREA

The high degree of social complexity in an adverse physical environment constitutes the main characteristic of the area, and indeed of this entire sub-global assessment. Over the last twenty years the municipality has experienced considerable change, mainly brought about by the mining boom of the 1980s, the explosion of tourism since the 1990s, and the passing of the Indigenous Law in 1993.

The first clear effect of the mining activity and tourism has been the dramatic increase in the area's population, which has doubled in twenty years, and the ongoing and ever-increasing flow of tourists. This has led to a marked change in the lifestyles of the Atacameño communities, particularly those living in the settlements of San Pedro de Atacama (related to tourism) and Toconao and Peine (related to non-metal mining), partly on account of the new jobs available and partly due to living alongside new social groups that have settled in the area.

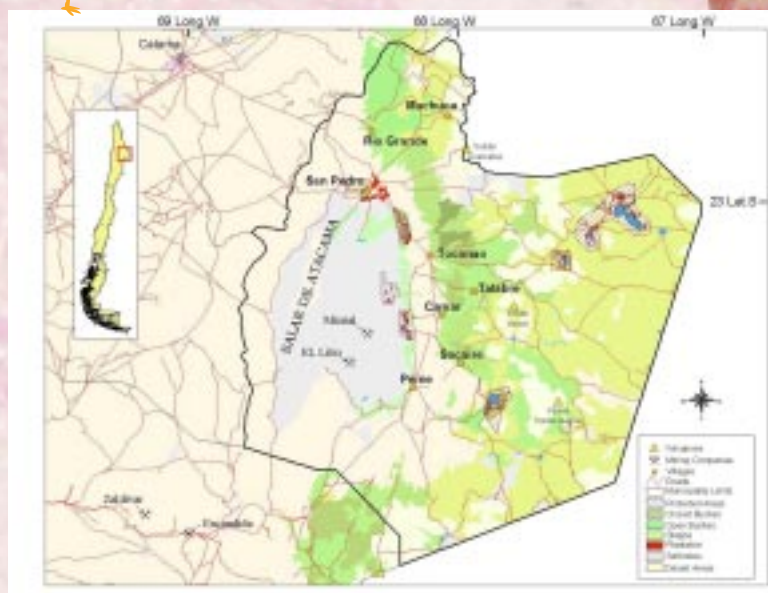
The population

- The municipality of SPA has a total population of 4,969 inhabitants (INE, 2002). The majority are of Atacameño origin (58%)², followed by Chileans born outside the region (43%), and a significant group of foreigners (7%)³.
- 20% of the population do not live permanently in the municipality and about 50,000 tourists visit the area each year.

The SPA area has historically been a route convergence point, where different cultures and world views (including Spanish,



Figure II.1:
Map of the municipality of San Pedro de Atacama
Source: Authors' elaboration.



1) In accordance with the Chilean political-administrative system, we use the term 'local' to refer to the level of the municipality, and the term 'regional' to refer to Antofagasta, the II Region of Chile.

2) About 3% of these belong to other ethnic groups such as Quechuas, Aymaras and Mapuches. Other sources quote a still higher indigenous presence in the municipality.

3) These percentages total over 100% because they correspond to different indicators from the census (indigenous ethnic identity and municipality or place of birth).



Box II.1: ATACAMEÑO IDENTITY IN THE PRESENT DAY*

Since the 1990s, following the passing of the Indigenous Law, the fact that existing indigenous communities manifest an identity within the categories defined by the State has triggered two mutually-complementary processes: ethnogenesis (self-identification of a determined social group as part of an ethnic group united by a shared mythical past); and ethnification by the State (the construction of indigenous identity by means of a political and legal process) (Gunderman, 2000).

Inserted into modernity through economic activity, the indigenous communities of northern Chile are taking advantage of these "new political opportunities" to discover new meaning in their identity in the following ways:

- Revaluating of the "mythical past", filling it with meaning for the present and future,
- Creation of formal indigenous organisations focused on their rights and productivity,
- Local development projects administered from an ethnic viewpoint, abandoning the hitherto passive role in public policy,
- New identity with regard to "others",
- Demands to recover lands and resources based on ancestral rights.

The Atacameño people demand the right to conserve and foster their culture and strengthen their identity through the recognition, respect and promotion of their traditions and cultural and historical patrimony (Comisión para un Nuevo Trato, 2003). This must begin by recognising the cultural and ritual value of Patta Hoiri or mother earth and establishing the inviolability of the guardian hills (cerros tutelares), water resources and land of economic use to the Atacameños (pasturelands, herb-collecting lands, agriculture) and other land of sacred and cultural value. However, this challenge faces growing disinterest from the younger generations regarding their indigenous patrimony and culture.

*Extract from "Patta hoiri and Likantay people: rescuing the knowledge of the land", Beatriz Bustos G., Hernán Blanco P. 2004, document prepared for the MA conference "Bridging Epistemologies", Alexandria, Egypt.

Chinese, Yugoslavs and Africans) come together; interact and are exchanged; the concept of "foreign" is far from new to local people living in this area. Nevertheless, mutual discrimination, indifference and distrust cause constant rifts between the different groups and block opportunities for development.

The new economic activities and significant public investment have helped alleviate poverty in SPA to the extent that in 1996 it was removed from the list of 20 most poverty-stricken municipalities in Chile.

Poverty

- According to available data, in the year 2000, 14% of the municipality's population were classified as poor: This indicates a reduction in poverty since 1986 when this percentage was over 30% (MIDEPLAN). This trend could have been influenced by the arrival of migrants from higher socio-economic levels with different lifestyles.
- For the year 2000, the average income per family in the municipality was 320,000 Chilean pesos. This value is below both the national average (64%) and the regional average (52%)⁴. Nevertheless, the Human Development Index (UNDP) classifies the municipality's income as "very high".
- Social inequality is a key problem in Chile and studies suggest that the gap between the wealthy and the poor is particularly evident between the indigenous population and the rest of the country (MIDEPLAN).

Local employment has enjoyed a gradual but constant transformation. SPA has shifted from being a municipality where the main activities were agriculture and livestock, to one where most of the labour force work in construction, mining and tourism. This has led to greater 'monetisation' of people's lives and a distancing from the earth and its resources.

Employment

- The main activities generating employment in the municipality are directly or indirectly related to the use of ecosystem services: construction (18%), hotels and restaurants (15%), and mining (11%).
- In 1982 agriculture represented about 32% of the Economically Active Population in the municipality; in 1992 this figure only reached 21%. Tourism has been the fastest growing sector in the last decade (10%).
- Amongst the Atacameño people, 9% of the working population are involved in agriculture.

The Indigenous Law laid down the foundations for a change in the situation and long-awaited recognition of the indigenous peoples by the government and Chilean society in general (Box II.1). As a result of this law, the municipality was declared Atacama La Grande Indigenous Development Area and this has given the Atacameños greater control over their ancestral lands and the use of public funds. The challenge for the Atacameños is two-fold: to connect traditional production activities (agriculture, livestock, craftwork) with tourism and the economy in general, through diversification and technology development; and to generate favourable conditions for them to participate in the services demanded by mining activities. In other words,

4) It should be noted that average income for the II Region is one of the highest in the country due to mining activity. However, this influence is not perceived in SPA.

the Atacameños must take advantage of the opportunities by revaluing their own identity in order to become a part of local development. This process has not been easy, however, due in large to the need for capacity development in indigenous organizations and leadership, and particularly in the absence of a unified vision of the future that such a huge challenge requires.

Opportunities for governance

- In 1997 the SPA municipality was decreed an Indigenous Development Area (Área de Desarrollo Indígena or ADI), representing a socio-territorial space for the State administrative bodies (including regional government, the National Indigenous Development Commission or CONADI, the Ministry of Agriculture, the National State Property and the General Water Department) to focus their action and resources on the harmonious development of the fourteen Atacameño Communities.
- The Indigenous Development Area is made up of three commissions dealing with: social development, production development and land and water. Environmental issues are dealt with by a subcommission.
- There is scarce participation by the private sector or non indigenous population, even when the Law allows it.
- In 2001 the Programa Orígenes was set up to offer support to indigenous peoples in rural areas and to strengthen indigenous development areas (local and territorial participative planning processes, community projects, production projects, cultural projects and traditional medicine projects).

Tourism seems to be the preferred development option for both the Atacameño communities and outsiders, be they resident in the area or just passing through. This activity experienced sudden and unregulated growth triggered by the arrival of entrepreneurs who set up the first campsites and tourism agencies, followed by hostels and restaurants, and finally diverse categories of hotels and internet cafés. At the start of the 1990s, the communities began to realise that large sums of money were being generated in the area, none

“[Thanks to the project] we finally managed to work together and collect data to plan fair and sustainable distribution of the benefits of biodiversity in the Salar de Atacama and the traditional knowledge associated with this”.

Alonso Barros, Director of the Padre Le Paige Archaeological Museum.

Box II.2:

Main ecosystem users

Ecosystem users	Description
Atacameño peoples	14 Atacameño communities, represented in the Atacameño Peoples Council); rural tourism network Red Likanhuasi.
Regional universities	Archaeological Research Institute and Museo R.P. Le Paige of the Universidad Católica del Norte; Universidad de Antofagasta.
Mining companies	SQM, Sociedad Chilena del Litio, Minera Escondida Limitada, Compañía Minera Zaldívar
Tourism operators and entrepreneurs	Hotels, hostels, campsites, tourism agencies, internet cafés, etc.
Government authorities	Regional government and local authorities.
Public services	Coordinated through the ADI: including CONADI (National Indigenous Development Corporation), Programa ORIGENES – MIDEPLAN (Ministry of Planning), CONAF (National Forests Corporation), CONAMA (National Environment Commission), DGA (General Water Department), SERNATUR (National Tourism Service).
Astronomy observatories	Radioastronomy project ALMA (Atacama Large Millimeter Array) in the Chajnantor valley.

Source: Authors' elaboration.

of which were improving the standard of living of the land's ancestral 'owners'. The Red Likanhuasi was established a decade later; the first community-based tourism initiative and a pioneer experience in co-management of tourist attractions within protected natural areas.



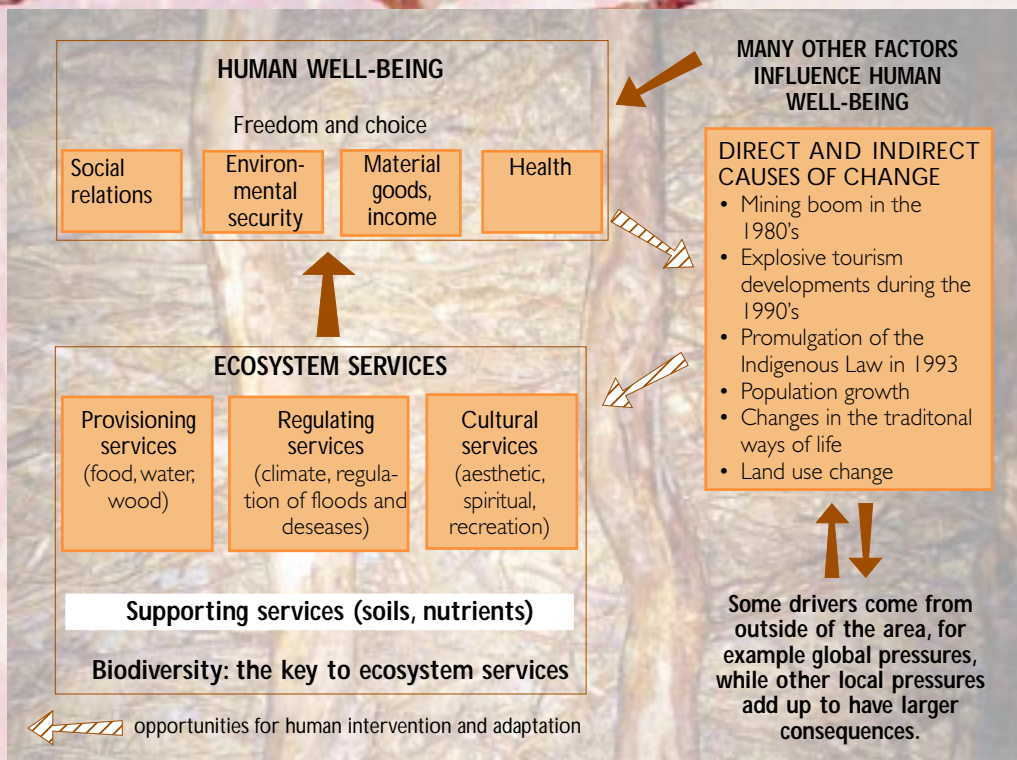


Figure II.2: **Human well-being and ecosystem services in San Pedro de Atacama**
Source: Adapted from MA (2003).

Public participation at the local level

- The percentage of population participating in social organisations (51%, MIDEPLAN) and the formal rate of community organisation (16,6 organisations per 1000 inhabitants; National Municipal Information System) in SPA are among the highest in the region and the country.
- However, according to available information and perceptions gathered, the degree and level of participation (commitment) is fairly low (60% of the population claim they do not participate, PLADECO, 1999). Lack of leader credibility is one of the causes for this.

In this context, where legitimate indigenous demands, a high concentration of government development initiatives, large-scale mining, an emerging tourism industry and globally-relevant astronomy projects all converge, it was a priority and constant challenge throughout the initiative to generate dialogue and trust between the different users and the project team (Box II.2). Establishing an advisory committee and setting up complementary participation activities for the community were cornerstone to the whole assessment process (this issue is tackled in the following section).

The aforementioned situation alongside the focus used in this project are presented for illustrative purposes in Figure II.2:

II.2. THE FOCUS OF THIS INITIATIVE

As part of the MA, the project adopted both the conceptual framework and the values that inspired this global initiative (described in detail in the first part of this document). However, given the flexibility of the initiative, each approved subglobal assessment has its own distinctive characteristics, determined by such factors as: geographical and cultural context; capacities and expertise of the relevant institutions and work teams; and available time and resources.

The focus of the project Human well-being and sustainable management in San Pedro de Atacama possesses two main characteristics: on one hand, the development of the assessment process has been based on MA concepts; and on the other, a strong participatory component has been adopted within the context of multiple ecosystem users.

There were two stages to the assessment process. The first, called the **Base Line** stage, took place between May 2003 and June 2004 approximately. Over this period all available information on each of the ecosystem services⁵ identified by the users and on the social, economic, administrative and cultural situation in the zone was collated and categorised. In terms of the conceptual framework, special emphasis was placed on identifying the conditions and trends and the factors of change for each of the issues researched.

In the second Assessment stage, from July 2004 to January 2005, the work was directed towards more in-depth analysis

5) It should be noted that the base lines on biodiversity and water resources were drawn up by specialist consultants: Programa Interdisciplinario de Estudios sobre Biodiversidad of the Universidad de Chile and Aquaconsult Cía. Ltda., respectively.

of water resources, the creation and development of scenarios and the formulation of responses or recommendations for sustainable management in SPA.

This research process would have been impossible without the involvement and ongoing participation of the ecosystem users. This component of the assessment enabled the progressive development of opportunities for dialogue and reciprocal trust. The creation of the project advisory committee proved to be the central axis of this process, offering a space for governance to the seventeen participating representatives⁶ from the different user groups (a list of members of the advisory committee is included at the beginning of this report): the Atacameño community, the public sector, local government, tourism operators, mining companies and inhabitants of the municipality.

At the outset of the project the work team proposed the creation of an **advisory committee** as a forum to:

- Provide and share information, knowledge and experience between the members;
- Express and integrate different perspectives and interests;
- Generate trust and dialogue between relevant stakeholders;
- Move beyond institutional boundaries and express and discuss issues in a broader and more transparent way.

Seven meetings were held during the assessment process, in which the work team and advisory committee progressed through the stages and concepts of the assessment: trends and conditions (discussion on base lines), factors of change (plenary dialogue), scenarios and responses (group workshop). Alongside this, the meetings gave opportunities for the participants and their respective institutions to present their interests and challenges regarding the ecosystem and human well-being. Researchers from abroad, working on other subglobal assessments or coordinating the MA also participated and gave presentations.

This advisory committee became the first and only instance in the municipality in which multiple stakeholders have sat down together to discuss the important issues for local sustainable development from their different perspectives. The participants have proposed to continue with the group after this initiative is over.

Apart from the advisory committee, the project also set up a series of **complementary activities**, in alliance with numerous organisations and companies. These activities attempted to make real contributions to the inhabitants of the municipality. Box II.3 describes the activities held in San Pedro de Atacama within the framework of the project.

Box II.3:

COMPLEMENTARY ACTIVITIES SET UP WITHIN THE FRAMEWORK OF THE PROJECT

Activity	Description/ objective	Participants/ beneficiaries	Collaborators
-Workshop with Atacameño leaders	-To identify the experiences, initiatives and concerns of the Atacameño communities on ecosystem management. -To present and discuss the project and conceptual framework and methodology of the MA (with an emphasis on scenario-building) with the Atacameño communities.	10 leaders 6 professionals	Atacameño Peoples Council, CONAF, Programa ORIGENES
-Trip with children from the municipality to Laguna Chaxa	-Visit by a group of children from different settlements in the municipality to Laguna Chaxa, in the Los Flamencos National Reserve and follow-up a talk on environmental education. -Complementary artistic modelling workshop in the children's schools, with materials donated by the initiative.	109 children 16 teachers and parents	Municipal Education Department, Atacameño community of Toconao, CONAF, SQM, Cía. Minera Zaldívar, Minera Escondida Ltda.
-Meetings and video on traditional knowledge	The video "Patta hoiri and Likanantay people: rescuing the knowledge of the land" records the two meetings held in San Pedro de Atacama and Toconao, in which Atacameño elders shared their memories, legends and traditions concerning the heavens, volcanoes, water and earth with children and adolescents from the community.	30 elders 90 children and adolescents	Atacameño communities of SPA, Toconao and Séquitor, Toconao primary school
-Donation of two solar water heaters	-The project led to the donation of two solar water heating systems to the settlements of Machuca and Camar, the former for a community tourism hostel and the latter for a large low-income family. -Follow-up on the economic, social and environmental impacts of these systems.	11 in Camar 42 community initiative partners in Machuca	Universidad Técnica Federico Santa María, Camar community, Programa ORIGENES

6) It is important to point out that all meetings were open to the public and other interested persons and institutions were gradually integrated into the discussions, constituting an important contribution to the debate.

III. ECOSYSTEM SERVICES IN SAN PEDRO DE ATACAMA

Ideally, the offer or availability of ecosystem services (e.g. water; tourist attractions or minerals) meets the demand or use, and existing use levels do not threaten the ability of ecosystem to provide those services in the future. Also, challenges to ecosystem services are associated not only with quantity but also quality, and such services are needed at specific times and places, which do not always coincide with availability. This section presents a summary of the situation for the main ecosystem services analysed in this project. Time and money limitations led the team to dedicate more resources towards the analysis of water resources, tourism and biodiversity.

III.1. WATER RESOURCES IN THE WORLD'S DRIEST DESERT⁷

The Salar de Atacama water basin is a closed system: What consequences might this have now and in the future?

Being a closed system means that water within the basin can only leave by evaporation and evapotranspiration or through the uses man makes of it. There is no outflow of water into any other water basin or the sea.

In a closed basin, the difference between renewable and non-renewable water resources is not the same as in open basins;

in fact, any water extraction that takes place will have an effect on the ecosystems involved.

The challenge is to find the method and volume of water use that, on the one hand, satisfies the zone's development needs, and on the other, does not have a strong or irreversible impact on the natural systems. Numerical simulations require further data and interpretations before they can predict the effects of exploitation with any real accuracy.

How does the basin's water cycle function?

The water enters the basin in the form of precipitation (rain or snow); it then flows either over the surface or underground. The water leaves the basin as a result of evaporation and evapotranspiration or through extraction for human use. Figure III.1 illustrates the water cycle in the Salar de Atacama basin.

What is the direction of underground water flow, and what consequences can this have now and in the future?

In the area around the Salar the underground waters run from the north, east and southeast into the Salar depression. The direction of these flows has considerable consequences on the effects of the different water uses. For example,

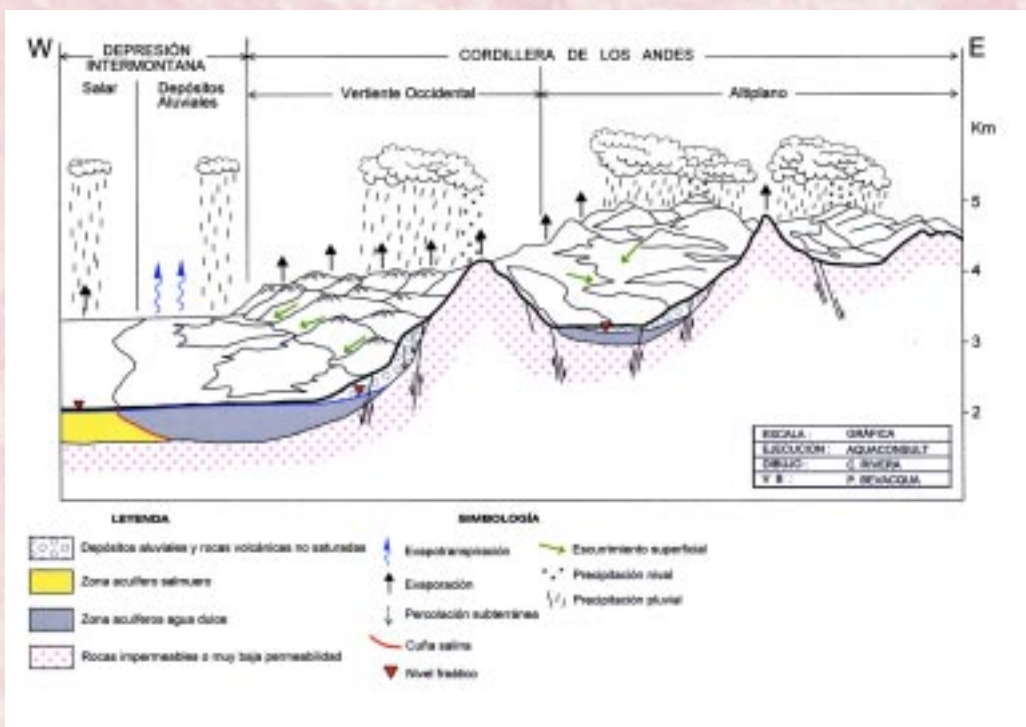
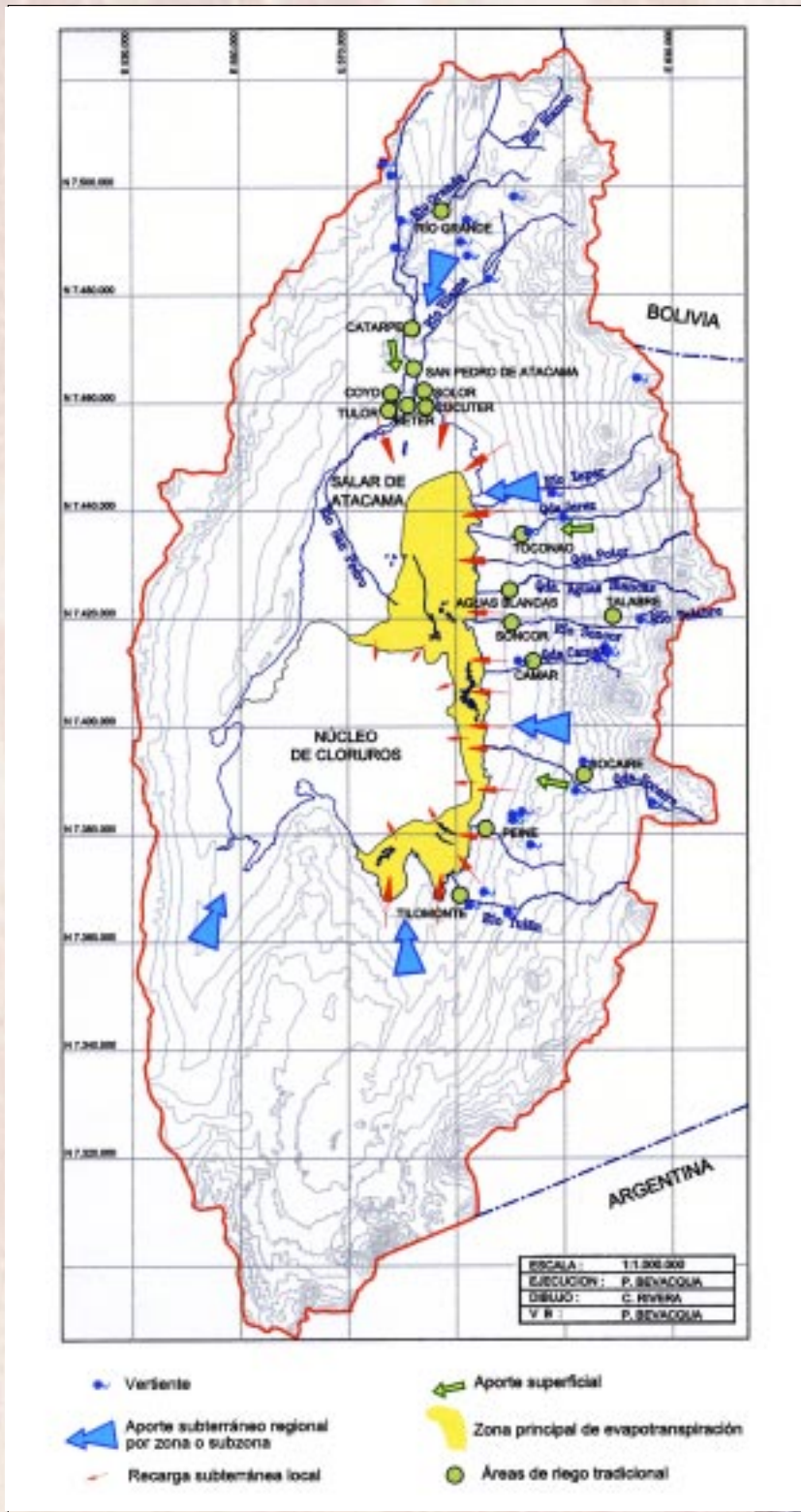


Figure III.1:
General hydro-logical cycle in the Cordillera de los Andes sector, northern Chile
Source: Aquaconsult (2005).

7) The information in this section comes from a report specially prepared for this project by Aquaconsult (hydrogeological consultants). The full reference for the document is: Aquaconsult, 2005. Informe final de recursos hídricos, Proyecto Bienestar Humano y Manejo Sustentable en San Pedro de Atacama. Aquaconsult: Santiago, Chile. The comments of Sr. Sven Renner, a hydrogeologist who reviewed the document, have also been taken into consideration.



Figure III.2:
Diagram of surface and underground water flow into the depression of the Salar de Atacama hydrographical basin (SAT)
 Source: Aquaconsult (2005).



What is the annual water contribution or recharge in the basin?

The latest research has led us to conclude that the average annual flow volume into the Salar is approximately 5 m³/s. In other words, this value gives an indication of the maximum water available for eventual extraction from the basin. If the water consumed does not exceed the average recharge rate for the system, no harmful effects on the ecosystem will be generated.

Nevertheless, it must be acknowledged that there is not enough information available to be able to simulate the water cycle of the Salar with any precision. The total volume of water being extracted is uncertain, as is the amount of evaporation that takes place, and still less is known about the interaction between these two factors. The fact that the volume of water rights granted is much higher than the current extraction volume is an additional threat to sustainable management. Should extraction levels rise to the full volume of water rights granted (be it for production or sale, should this become profitable), then water levels would drop considerably.

extraction from the south and particularly the southeast of the Salar basin does not interfere at all with the amount of water available in the northern sector of the basin. Likewise, extraction from the north of the basin does not limit the amount of water available for extraction in the south-eastern part of the basin. The situation is illustrated in Figure III.2.



How many water rights⁸ have been granted and in which sectors are they concentrated?

Within the hydrological basin of the Salar de Atacama 162 water rights have been granted for a total of 6,223 l/s, distributed between 2,234 l/s of surface water (73 rights) and 3,989 l/s of underground water (89 rights). Surface water rights are mainly held in the north of the Salar; around San Pedro de Atacama, and in the east, whilst most of the underground water rights are in the southeast of the basin.

In the altiplano of the municipality of San Pedro de Atacama, i.e. the basins lying to the east of the Salar basin, there are a further twenty surface water rights, for a total caudal of 2,770 l/s.

By comparing the rights granted (6.2 m³/s) with the water recharge rate of the basin (about 5 m³/s) it can be seen that the volume that could be extracted is on average greater than that coming in to the system. This is a sure call for concern. However, it should be pointed out that extraction rates are only higher than calculated recharge rates in the southeast of the

basin. This situation has been regulated by means of a special agreement between users and the General Water Department (with an Early Warning Plan) and a restriction of water flow. In spite of this, the system is very complex and comparison between offer (recharge) and demand (use) is not that simple.

It should be noted that no water rights are required for brine extraction from the nucleus of the Salar, since this extraction falls under the Mining Code. Table III.1 and Figure III.3 provide a summary of the situation.

How many water rights are currently being requested and where?

To date, total requests for surface water rights are 3,277 l/s and for underground water rights 4,096 l/s. Surface water requests are mainly concentrated in the altiplano zone. Requests for underground water rights are concentrated in the altiplano and the eastern and south-eastern areas of the Salar. Table III.1 and Figure III.3 indicate the amounts and locations of the requests.

Table III.1:

Monitoring of surface and underground water in and around the Salar de Atacama by mining companies*

Source: Aquaconsult (2005).

PARAMETER	SITE OR AREA	RESPONS. COMP. NY	SITES Required by							PARAMETER OR METHOD									
			Type	Total quantity	EIA	DIA	DGA	Own decision	Currently monitored	Level	Flow rate	Phys-Chem quality	Area	Bio. Param(I)	Geoph. Images	Satel. Images	Meteor. Station	OBS.	Info. Source
I. Central Salar de Atacama																			
1 Brack water aquifer	Nucleous of the Salar	SQM	Obs. well	42	12	3		27	Yes	e/1month	c/3month								1
		SCL		30				30	Yes										2
2 Sweet underground water	Eastern Edge (Barros Negros-Chaxas- Puillar; Aguas de Quelana, Salada-Saladita Interna)	SQM	Obs. well in 6 locations																
3 Surface recharge of lagoons	Puente San Luis (Cauce Burro Muerto)	SQM	waste disposal	1	1	0			Yes		e/day	e/6 day							1
4 Condition of lakes	Lagoons (Burro Muerto, Chaxas Barros Negros, Puillar; Interna Salada- Saladita)	SQM	lagoons	7					Yes	e/3 month	e/3 month	e/3 month	e/3 month					**	1
5 Underground recharge of lagoons		SQM	lagoons	2					Yes										1
			wells	2					No										1
II. Eastern border of the Salar																			
1 Aquifers on the eastern and south-eastern edge	Southeastern section	SCL	wells	3			3				e/1month	e/1month							2
	Eastern section	SQM	wells	4			2	2			e/1month	e/1month							3
III. Southern section of the Salar, aquifer Monturaqui- Negrillar-Tilopozo (MNT)																			
1 Underground water from aquifer		MEL y CMZ	well pump	26			26		Yes	contin.	e/1-4year								1
		MEL y CMZ	obs. well	46	46				Yes	e/1month									1
2 Surface water discharge zone	Tilopozo wetland, La Punta and La Brava lagoons	MEL	lagoons	7	7				Yes	e/3 month	e/3 month	e/3 month	e/3 month	contin.					1
3 Underground water - discharge zone	Tilopozo	MEL	well ("TP")	3	3				Yes					e/3 month					1

Information Sources: 1) SQM Salar *et. al* (2003); 2) Carlos Sáez, pers. comm.; 3) Valentín Letelier, pers. comm.

*The Table presents the activities considered in a monitoring plan established within the framework of the Environmental Impact Study presented in 1996 to the Regional Environment Commission (COREMA) of the II Region of Antofagasta by SQM for the project: "Desarrollo minero en el Salar de Atacama, Tercera Etapa: Producción de sulfato de potasio, ácido bórico con ampliación de la capacidad productiva de cloruro de potasio" ("Mining development in the Salar de Atacama, Third Stage: Potassium Sulphate and Boric Acid production with an increase in production capacities of Potassium Chloride").

** In agreement with CONAF (1995).

8) A water right, or a right to use water, in accordance with the Water Code of 1981, Art. 6, is a concrete right to make use of water resources, with the requisites and in accordance with the rules prescribed in the Code. The most salient consequence of this is that once a right is acquired by any party, the law allows for the exchange of rights in accordance with market conditions, thereby creating a water market.



Table III.2:
Water supply for irrigation to the main agricultural communities in the Salar de Atacama basin
 Source: Aquaconsult (2005).

LOCALITY	NEARBY SOURCE	APROX. FLOW RATE (l/s)		CROPS				
		C	P	APROX. AREA (hec)		N° IRRIGATORS		AGRICULTURAL PRODUCTS
				(*1)	(*2)	(*1)	(*2)	
1 Machuca	Río Machuca and Vertiente	138	124	-	17.6	-	33	
2 Río Grande and San Pedro	Río Grande and San Pedro	1.157		85		49		Maize, garlic, lima bean, potato, onion, carrot
3 Vilama	Quebradas Vilama, Puritama and Purificar		212					Alfalfa, maize
4 Solor	Pozo 5	2						
5 Celeste	Vertiente Celeste	4						
6 Toconao	Quebrada Jere and others	1887		44		220		Fruit (grape, quince, pear, plum, fig, apricot, orange, lemon). Secondary: alfalfa, wheat, maize.
7 Aguas Blancas	Quebrada de Aguas Blancas	200						
8 Talabre	Vertiente Salta 2, Talabre Catarape	212		-		18		Alfalfa, lima bean, fruit, vegetables
9 Soncor		11						
10 Camar	Vertientes Turbaca, Corcate Camar 1 and Camar 2	25	1	40		16		Maize, wheat, pumpkin, tomato, alfalfa
11 Socaire	Río Socaire and Quepe	181	5	-				Maize, wheat, vegetables, alfalfa
12 Peine and Tilomonte	Vertiente Ossa, Viste, Tarajne and Tulan	64	10					Maize, alfalfa
Others users		80						
TOTAL:		4.182						

Abbreviations: C: Constituted P: Pending

Information Sources: (*1): Information gathered by the consultant through consultation with the person in charge of each locality (2003); (*2): CEPLA Catastral (1991).

Comments (*): Agricultural communities in zones 1 and 2 have rights of access to more than 2,000 l/s from the altiplanic zone (Zone 0).

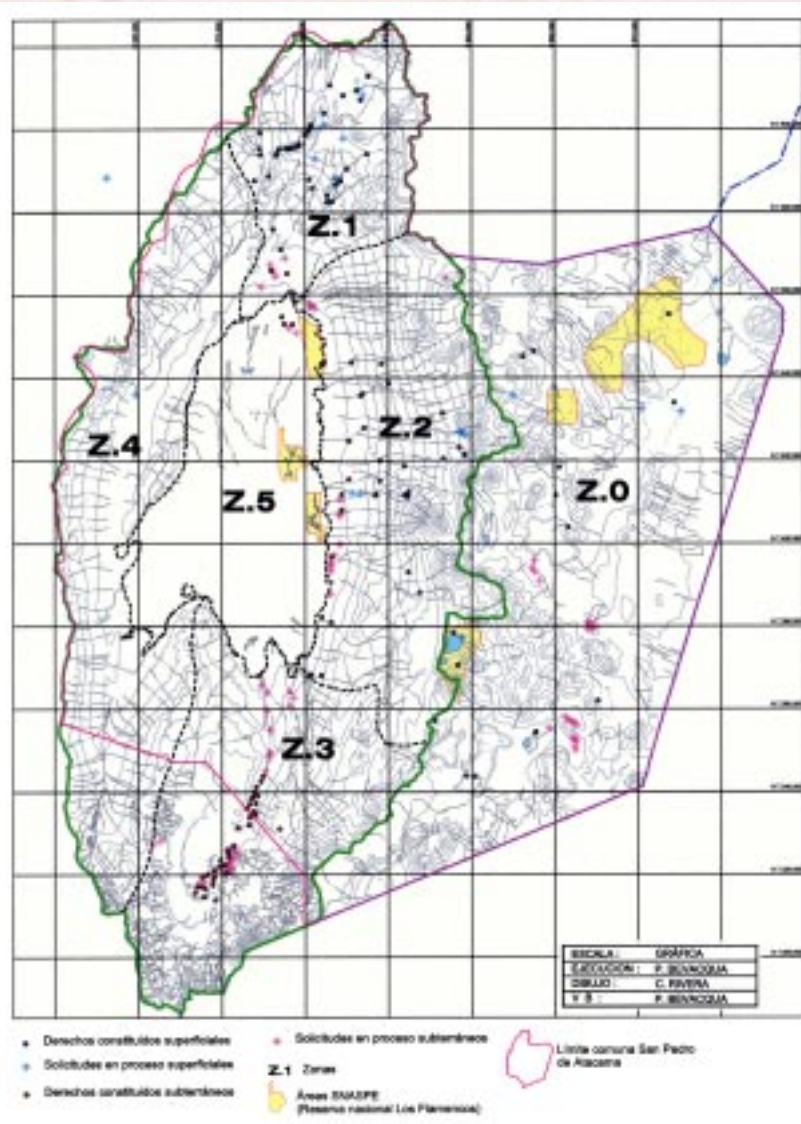


Figure III.3:
General distribution of water rights and requests in the SAT basin and altiplano basins in the municipality of SPA
 Source: Aquaconsult (2005).



Table III.3:

The provision of potable water to villages in the Salar de Atacama desert

Source: Aquaconsult (2005).

LOCALITY	HABITANTS		SOURCE (*2)	COORDENATORS UTM (*2)		APROX.FLOW ACCORDING TO RIGHTS l/s(**)	TREATMENT		LEGAL SITUATION C/P
	Nº of PEOPLE (*1)	FAMILIES (*1)		NORTH	EAST		WITH	OUT	
1 Machuca	11	5	Vertiente	7.503.915	594.600	0,9		x	C
2 Río Grande	93	27	Río Grande	7.495.890	588.305	-		x	C
3 San Pedro	1.616	446	Pozo Profundo	7.468.934	585.085	100 (***)	x		P
4 Toconao	579	133	Vertiente Silapeti	7.438.700	610.000	8,0		xx	C
5 Talabre	80	12	Vertiente Salta	7.421.560	628.300	1,6		x	C
6 Cámar	45	8	Quebrada Pepina	7.411.710	613.910	2,7		x	C
7 Socaire	299	58	Río Socaire	7.388.150	617.500	130		xx	C
8 Peine	240	56	Vertiente Chaquisoques	7.370.600	626.700	2,3		x	C
TOTAL :	2.963	745							

Abbreviations: C: Constituted P: Pending XX: Chlorinated water

Information Sources: (*1) SGA Iberisis; (*2) Information gathered from various sources.

Comments:

(*) Some rights of water use pertain to the regional water provisioning company for potable water. At present the company is not extracting the full amount of water that it has a legal right to access. If the company did use the full amount, extraction rates would far exceed the available water reserves in the basin.

(**) In some cases the sources of water for which rights are indicated in this table are used for irrigation. As a result, the amount of water used for consumption constitutes a minor fraction of the total.

(***) While the village of San Pedro de Atacama has a right to access 100 l/s of water from the local well, the inverse osmosis plant, which purifies all water for human consumptions, has a maximum total water capacity of 10 l/s.

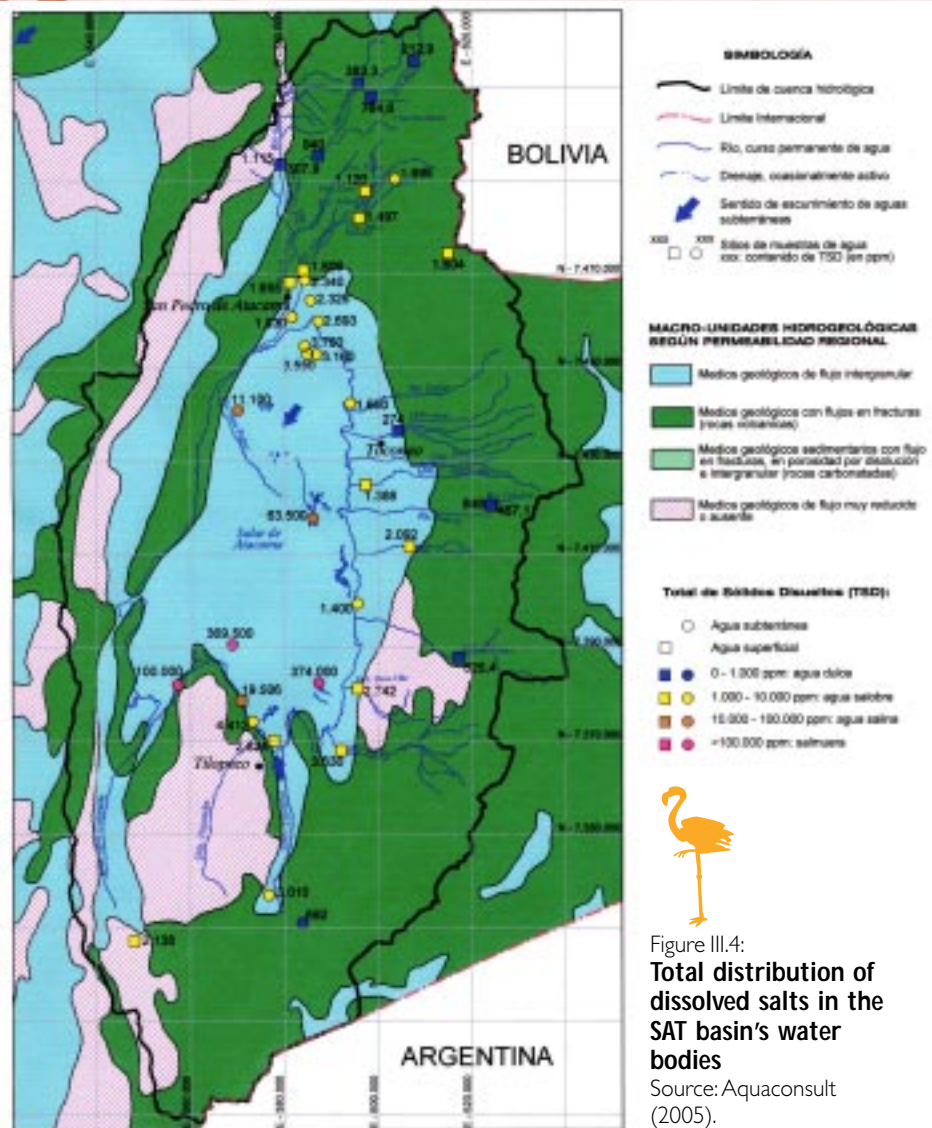


Figure III.4:
Total distribution of dissolved salts in the SAT basin's water bodies

Source: Aquaconsult (2005).

In 1995 the regulation of surface water rights used by the indigenous and agricultural communities began; corresponding to practically all the surface water draining into the Salar depression. This regularisation process, set up by the National Indigenous development Corporation (CONADI), is still underway for minor water bodies.

What is the quality of the water?

The water generally contains dissolved solids (an indicator of salinity) in medium (surface water; from 320 to 4,250 ppm) to high concentrations (underground water around the perimeter of the *salar*; from 1,500 to 4,000 ppm) and in very high concentrations (underground water at the nucleus of the *salar*; from 4,000 to 370,000 ppm). Figure III.4 indicates current water quality in the Salar basin.

How much water is used in agriculture and where is it extracted?

The most recent records on irrigated surface areas date from the year 1990. It is a priority for this information to be updated. Agricultural water rights

total 4.2 m³/s (mainly surface water) with a further 1.1 m³/s under request (also surface water).

Table III.2 presents data from the records available. It is clear that these data do not necessarily concur with one another, on account of the lack of up-to-date information.

How much water is used to supply settlements and where is it extracted?

Drinking water rights total 818 l/s in the municipality (surface water); of which 800 l/s belong to the regional water supply company, who originally requested them for use outside the municipality of San Pedro; however, this could also be put to other uses. There are requests for a further 1,873 l/s (mainly surface water). Table III.3 presents detailed information for each settlement.

There are certain inconsistencies in the information available because a significant part of the drinking water supply comes from the water rights mainly used for crop irrigation; accurate figures on daily drinking water consumption per inhabitant are not available due to the absence of water consumption statistics for most of the settlements.

How much water is used to supply the mining industry and where is it extracted?

To date, mining activities in the municipality only consume underground (brackish) water, mainly extracted from the southeast of the salar basin, and brine extracted directly from the nucleus of the salar. By way of example, Table III.4 below shows the water consumption by mining companies in 2003. It is important to point out that, to date, mining activities have not generally used all the water rights they possess.

Nevertheless, in the year 2000, the Riochilex mining company was granted (underground) water rights totalling 450 l/s to supply the Spence project in Sierra Gorda from wells located in the extreme north of the salar.

How much water is used for recreational activities and where is it extracted?

The only registered recreational users are the thermal baths of Puritama and the Pozo No.3. Their water rights come to 2 l/s (surface water) and 18 l/s (underground water).



Table III.4:
Water and brine consumption by mining companies - 2003
Source: Aquaconsult (2005).

Company	Year when exploitation of water/brine began	WATER RIGHTS l/s	CONSUMPTION IN 2003 l/s
CONSUMPTION OF BRACKISH WATER:			
Sociedad Chilena del Litio(SCL)	1983	23	13
Compañía Minera Zalvidar (CMZ)	1995	1.188	134
SQM	1996	240	75
Minera Escondida Ltda.(MEL)	1998	1.836	1.168
TOTAL		3.287	1.390
CONSUMPTION OF BRINE WATER: (**)			
Sociedad Chilena del Litio(SCL)	1983	-	79
SQM	1996	-	573
TOTAL			652

Comments and abbreviations:

*: In addition to the four mining companies indicated here, other mining companies have begun to exploit water resources (ej. Riochilex: 450l/s), and other water resource development companies have obtained rights that also allow them to sell water to mining companies.

**: Annual net average

What other water uses should be considered and what are the requirements?

Other uses are related to the quality and stability of the ecosystem and the services it provides. Some examples are:

- Water to maintain the flat grasslands and peat bogs
- Water to supply sceneries of outstanding natural beauty (e.g. Chaxa)
- Water to sustain local traditions and beliefs.

Although requirements are already in place in Chile to ensure minimum water levels in surface water bodies (minimum ecological flow rates) in order to guarantee the survival of their ecosystems, there is still a dire shortage of information and experience on how to calculate these values and implement monitoring systems.

What can be said about the observed trends in precipitation, surface and underground water levels?

The meteorological observation stations located in the centre and south of Chile have recorded a significant drop in precipitation (rainfall) over the last 100 years.

There are no long-term precipitation records in the municipality of San Pedro de Atacama; existing meteorological stations were first set up in the 1970s. Existing records show no significant trends.

The same problem exists in the case of the fluviometric stations used to measure river water levels; no clear-cut trends can be identified due to the relatively short period of operation. In addition, the huge seasonal variation in river water levels further hinders the identification of any significant trends.



Table III.5:
Results of the calculations on renewable resources
 Source: Aquaconsult (2005).

ZONE N°	SOURCES Area	RENEWABLE RESOURCES (m³/sec.)		
		Surface	Underground	Total
1	Extreme north	0,30	0,97	1,27
2	NE Border (until Qda. Sancor)	0,21	0,84	1,05
3	NE Border (between Camar u Tulán)	0,25	0,46	0,71
4	Monituraqui-Negrillar	0	0,88	0,88
5	Borde W (Qda. Agua Colorada and Cordillera de la Sal)	0	0,03	0,03
Total				3,94
6	Salar de Atacama			

Are the salt lakes of the Salar connected to the brine being extracted by the SQM and SCL mining companies?

Rainfall in the Salar has an intense and immediate effect on brine levels in the salt lakes. On account of this, rainfall is assumed to be the main source of recharge for brine, although this needs to be confirmed through monitoring and future interpretations. Monitoring of the wells located in the saline nucleus of the Salar over the last eight years have backed up the above assumption, with levels rising still higher than those at the outset of the monitoring period (1997).

Hydrological monitoring of the surface water bodies within the Salar; i.e. the Burro Muerto water channel, did not demonstrate any evidence of effects caused by water extraction for mining activities up until 2002.

Has water extraction (particularly underground water extraction) had any impact to date on the ecosystem in general and the Salar's salt lakes in particular?

Hydrological monitoring of water levels at the eastern edge of the Salar has not recorded any effects of the pump extraction used to supply mining activity. Nor has any effect been recorded, up until 2002, on the extraction through wells in the salt lakes and nearby surroundings. These water bodies are naturally characterised by low water levels.

In the Monturaqui-Negrillar sector declines in water levels have been detected in accordance with hydrogeological models of the aquifer under exploitation.

Up until 2002, after seven years of monitoring hydrological and hydrogeological data and other environmental parameters, no negative impacts had been detected on lakes and wetlands or their fauna.

The monitoring period has included a period of drought and another of abundant rainfall; these natural conditions have allowed experts to research the response of the water systems to natural variations. However, the study areas represent very fragile ecosystems that are particularly sensitive to

water cycle changes, so monitoring must continue; it would even be appropriate to increase the number of monitoring sites. The monitoring of the salt lakes and their immediate surroundings, both in the saline nucleus of the Salar and the fresh water aquifer system, must be paid particular attention.

In spite of the above evidence, inhabitants in the area perceive changes in the ecosystem (particularly regarding water levels in wells and water availability in the rivers) but have no way to channel their concerns. Attempts could be made to transform these undocumented perceptions and memories into qualitative or semi quantitative data, validated and interpreted by scientific tools.

Could additional water extraction take place in the municipality and in the Salar de Atacama (e.g. for new hotels or mining ventures)?

Generally speaking, when granting water rights in the SPA municipality, the General Water Department (DGA) have followed the criteria set down in the Water Code. In addition, in May 1999 the DGA drew up a document titled "Evaluación de la disponibilidad de recursos hídricos para constituir derechos de aprovechamiento en las subcuencas afluentes al Salar de Atacama, II Región" ("Assessment of the availability of water resources for allocation of rights of use in the sub-basins flowing into the Salar de Atacama, II Region"), with the aim of establishing whether further resources existed for allocating new rights of use in the sectors of the basin.

The study was based on the (previously mentioned) division of the basin into five supply zones (Zones 1 to 5) and the Salar itself (Zone 6). The study concluded that renewable resources did exist, as listed in the table below.

It is evident from the aforementioned recharge figures that water availability is stretched in the municipality. For this reason, a detailed analysis, like that of the DGA, of each new requirement must be carried out before any decisions can be made.

How many tourists can the municipality receive without exceeding water supply capacities?

There is not enough information available to answer this question with any degree of certainty. There are certain inconsistencies between the information on water rights for the settlements and the available records on effective water use. Accurate information on drinking water consumption and resource availability is required urgently in order to estimate how many people can effectively be supplied with potable water. However, enlarging the (inverse osmosis)

water purification plant for drinking water in San Pedro de Atacama is an even more important priority; current installations can treat less than 10 l/s, while the plant's capacity and water rights come to 100 l/s. It is also important to treat waste water to enable other uses, such as irrigation.

What does the future of water availability look like, and what will be the effect of climate change?

There is no systematic, well-founded information with which to understand the effects of climate change. As stated above, significant progress is required concerning the quality and quantity of information on water in the municipality.

Clearly, if current water use levels and rights climb as expected, there will not be enough water available to satisfy all uses (including ecosystem conservation).

III.2 TOURISM AND LOCAL DEVELOPMENT: THE PROMISING GIFT OF THE ECOSYSTEM⁹

What relevance does San Pedro de Atacama have as a tourist destination in Chile?

SPA is one of Chile's best known tourist destinations; Figure III.5 puts SPA amongst the top eight destinations in the country for foreign tourists. Over fifty thousand people are estimated to visit the municipality every year and over 60% of these are foreign tourists (mainly Europeans, particularly French tourists).

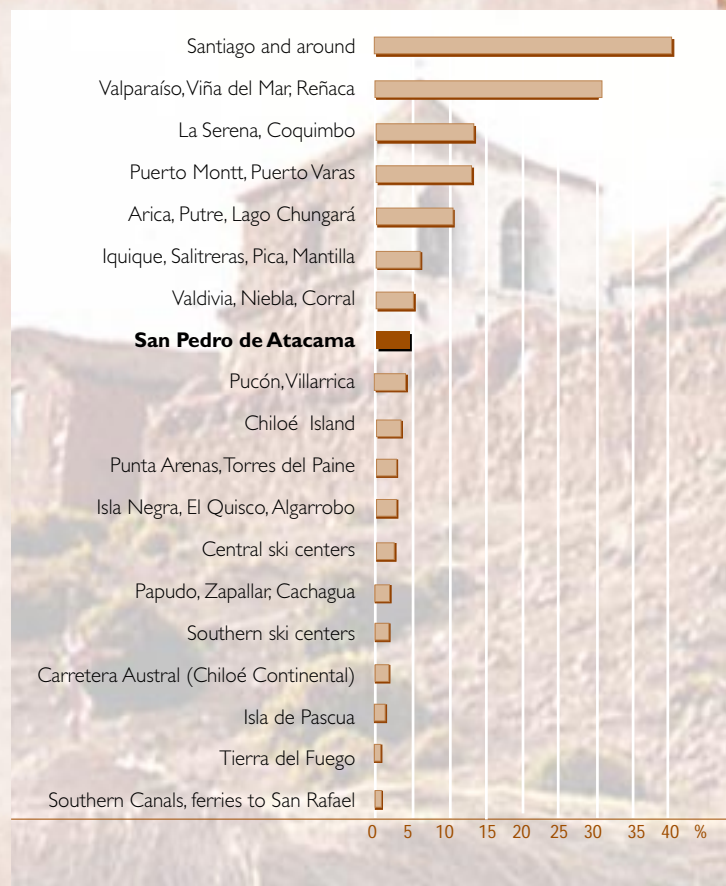
In 2000, it was estimated that tourism in SPA brought in over five million US dollars in foreign currency. Due to its importance, part of the SPA municipality was declared a Zone of National Tourist Interest.

What are the main tourist attractions in the municipality?

The major attractions of the commune include the mountain landscapes, lakes and lagoons, and the traditional villages with their historical and cultural heritage. Some of these attractions are located within the Reserva Nacional Los Flamencos. This reserve was created in 1990 and has a total surface area of 73,986 hectares. The area is divided into a number of markedly different sectors; these include: the *Salares de Tara y Aguas Calientes*, the *Salar de Pujsa*, the *Miscanti-Miñiques* lakes, *Soncor*, *Aguas de Quelana* and *Tambillo* in the Salar de Atacama. Figure III.6 presents a map of the *reserve*. The areas in red are co-managed by CONAF and the Atacameños.



Figure III.5:
Chile: Places most visited by foreign tourists
Source: Sernatur, 2002.



⁹⁾ The information in this section comes from the report on tourism written by RIDES for this project.

Box III.1:

SAN PEDRO DE ATACAMA: MAIN TOURISM ATTRACTIONS

Settlement	Cultural attraction	Natural attraction
San Pedro de Atacama	San Pedro de Atacama church Colonial house Archaeological museum Pukará de Quito (ancient Inca fort) SPA festival Ayllus (indigenous communities) Plaza (town square) Feria Artesanal (craft fair) Aldea Túlora (archaeological remains) Catarpe (Inca archaeological remains) Pozo Tres (oasis) Festival of Santa Rosa de Lima Festival of the Week of SPA Festival of San Juan Water channel cleaning Puripicar and Gatchi archaeological sites Festival of the Virgin of the Candelaria	Valle de la Luna Cordillera de la Sal Valle de la Muerte Llano de la Paciencia Cordón Barros Arana Licancabur volcano San Pedro river Vilama river El Tatio geyser Puritama thermal baths Cejas and Tebinquille lagoons
Toconao	Toconao church and bell tower Quebrada de Jere Pictograph of the Quebrada de Jere Liparita quarry Festival of San Lucas	Salar de Atacama Lagunas de Chaxas Laguna Barros Negros Quebrada Zápar
Laguna de Socaire	Town Culto de Talatur ceremony Festival of San Bartolomé de Socaire	Miscanti Laguna de Miniques Laguna de Legía
Peine	Peine old town Capilla de Misiones ruins Kocha de Peine Pictograph of the Cueva de Peine Inca Tambo de Peine Festival of San Roque de Peine	Tulán canyon
Río Grande	Stone engravings Quebrada de Río Grande. Festival of San Santiago de Río Grande. Río Grande carnival	
Tilopozo	Tilomonte archaeological site Tulán archaeological site	Tilopozo thermal baths Cerro de Lila Monturaqui crater
Talabre	Old town Virgen del Rosario	
Cámar	Festival of San Antonio de Cámar	
Puna de Atacama	La Mesa Fiesta de San Santiago de Manchuca Tara archaeological site Guatín archaeological site	Salar and Laguna Tara Salar and Laguna Aguas Calientes Salar Quisquiuro Salar Pujsa Laguna Tuyajto Zaparelli river Socompa volcano Láscar volcano Putana volcano Zaparelli volcano

Source: Authors' elaboration.

The main tourism attractions in the municipality are described in Box III.1.

How much of the resources generated by tourism actually remain in the municipality?

This highly relevant question is difficult to answer with the information available. Although there are estimates on how much tourists spend in SPA, this information must be gathered and analysed in a systematic way in order to be used to calculate effectively how much of the resources generated by tourism remain in the community.

Daily spending estimates according to the category of tourism indicate the following values:

- Special interest tourism : 400 to 500 US dollars
- Standard tourism: 150 to 300 US dollars
- Low-budget tourism: 50 to 80 US dollars

To what extent do the Atacameños participate in tourism activities?

The municipality has been the most innovative in Chile in co-managing its tourist attractions (under the leadership of CONAF), getting the Atacameños involved in the management of protected areas and archaeological sites. Co-management has been possible in Chaxa (Los Flamencos National Reserve), the Miscanti and Meñiques lakes, the Valle de la Luna, and the archaeological sites of Pukará de Quito and the archaeological settlement of Tulo; with joint support from CONADI, the Universidad Católica del Norte (Padre Le Paige museum) and the Consejo de Monumentos Nacionales (National Monuments Council).

The Atacameños have also generated their own tourism network, called *Likanhuasi*, based on tourist hostels at diverse locations in the municipality and diverse other services. From an economic perspective, the Reserva los Flamencos, which receives approximately 40 thousand visitors per year, and which is managed under a co-management contract with the indigenous communities, generates an income of approximately 250.000 dollars per year. This amount is channeled in the following ways: 40% to community tourism projects, 30% conservation activities and 30% is administered at the discretion of involved communities.

What are the main benefits of tourism for the municipality?

According to figures from the 2002 census, tourism provides a significant share of the employment in SPA: directly in hotels and restaurants (15%), and indirectly through trade (10%), construction (18%), and transport and communications (9%).

The aforementioned co-management practices are an ever-growing benefit for the community. Also, foreign currency generation is significant, at some 5 million dollars a year (although there are no figures to confirm that this sum effectively remains in the municipality).

Lastly, tourism is the preferred development engine for the municipality for a large number of relevant stakeholders; it is the industry that guides the actions of diverse public and private institutions.

What is the nature of tourism in San Pedro de Atacama?

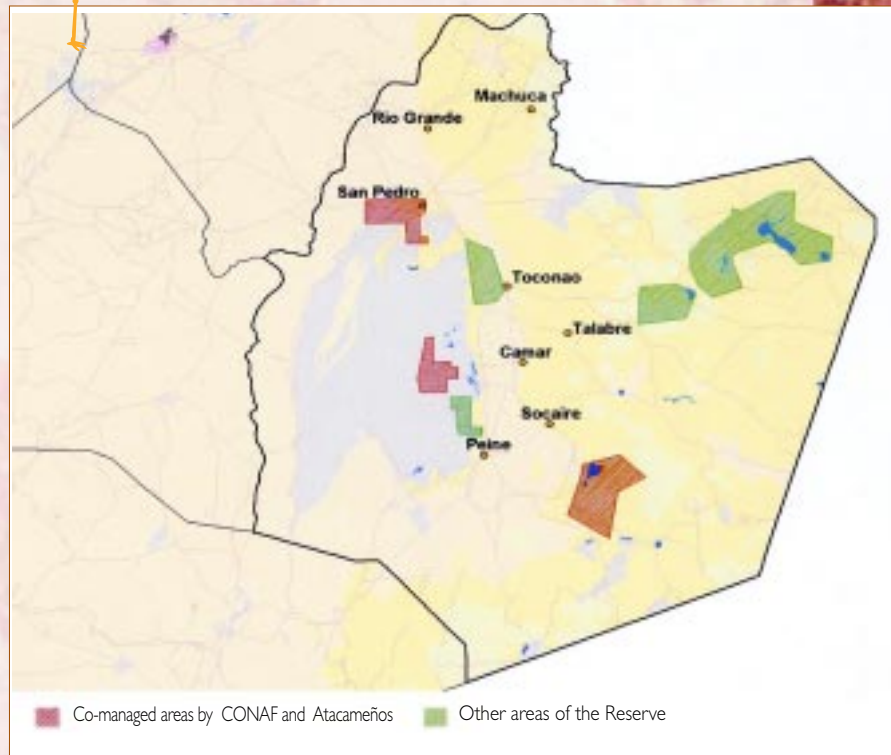
The offer of tourism services is almost wholly concentrated in San Pedro de Atacama and is fairly broad and heterogeneous in nature and quality. Services providing lodging include: two first class hotels aimed mainly at foreign tourists; 5 three or four star hotels; some 16 hostels and 2 official campsites. During the peak season the offer broadens still further to include a series of informal providers offering rooms to rent or back gardens for camping.

There are some 20 establishments offering restaurant services, at least three of which also function as bars and night entertainment centres, in addition to those hotels offering dining facilities either exclusively for guests or for the public in general.

Visits to places of interest are organised by specialised agencies or tour operators responsible for the transport and trip coordination to the most attractive sites in the area. These locations are distant and isolated, in the desert or cordillera, so specialised transport is often necessary. In SPA there are over 20 agencies of this kind offering similar tourism alternatives. This business is very reliant on the circumstances, so life cycles of the agencies vary significantly – some have been operating for over 10 years, while others last only one season.

Commerce consists of small grocery stores. Other services present in the locality include: two bus companies, diverse cafés (including internet services), one currency exchange, two craft fairs and shops with local produce and craftwork. There is no bank or any other financial institution; nor are there supermarkets.

Figure III.6:
Map of Los Flamencos National Reserve
Source: Authors' elaboration.



What are the major impacts of tourism on the ecosystem?

The problems relate to the inadequacy of certain basic services in the municipality, particularly regarding refuse collection and disposal (only SPA has an organised collection and disposal service) and drinking water supplies (drinking water is only treated in SPA). In the former example, there is concern regarding the accumulation of rubbish along particular tourist circuits (e.g.: Río Grande – Machuca). In the latter case, despite a lack of data, there is growing concern over increases in water extraction and its possible consequences.

On the other hand, there is also concern that mass tourism could alter the very characteristics of the zone that tourists have traditionally come to experience (e.g., disturbing the tranquillity of places like the Valle de la Luna).

What are the major impacts of tourism on human well-being?

The major impacts relate to the alteration of traditional ways of life in response to the spontaneous and rapid growth of tourism in the area. As a result, one problem that stood out during the course of this initiative was the absence of a shared vision (e.g. between tourism operators, public services and the Atacameño community) regarding how to develop or strengthen tourism in the municipality. While some prefer to favour special interest tourism, others see no reason to reject traditional tourism (more mass-orientated and less selective than the former). This situation has created friction amongst the Atacameños as well as between



Atacameños and other members of the community.

The precarious nature of the employment is another problem associated with tourism. Unfortunately, due to the nature of the social surveys, there is not enough information available to quantify or characterise this situation. Nevertheless, people familiar with the sector give clear testimony of the informal nature of the labour conditions.

How many tourists could visit the attractions of SPA without causing degradation?

There is no substantial consistent information; only a few university theses have tried to give estimates for some specific sites, such as Chaxas (in the Los Flamencos National Reserve). In order to answer this question the priority sites (i.e. those most in need of control and regulating) must first be selected and then analysed for "load capacity" (or something similar). There is currently one project underway (led by EUROCHILE) that will tackle this issue, amongst others.

What are the main challenges facing sustainable tourism?

To start with it is necessary to validate, consolidate and implement a tourism development strategy for the municipality with a strong component aimed at strengthening indigenous local organizations involved in tourism. The diverse stakeholders, including the Atacameño Peoples Council, SERNATUR, local government and the Atacama La Grande Indigenous Development Area, are all aware of this need and are taking steps to fulfil it.

On the other hand, the quality of tourism services on offer (e.g. hotels, restaurants, transport services and tourist guides) in the municipality must be improved and regulated. One alternative with an increasingly strong international following is the certification of services. Certification could fulfil two roles: to raise and regulate service quality and to ensure service sustainability.

What are the aspirations for tourism in the municipality?

This question triggers considerable discussion between relevant stakeholders. There are diverse viewpoints on how tourism in the municipality should be developed and strengthened.

Some of the challenges that need to be tackled include: the lack of coordination, administrative powers and representation of the private sector; and the as yet incipient role played by the Atacameños.

Within this context, the ADI Atacama La Grande could constitute a fundamental actor in strengthening the administration of tourism by indigenous communities.

III.3. MINERALS IN THE DESERT: THE ENDURING TREASURE

Is mining a service provided by the ecosystem?

If we take the definition of an ecosystem service provided by the broader Millennium Ecosystem Assessment, namely "all those benefits we obtain from the ecosystems", mineral exploitation is without a doubt one such benefit. It is the abiotic characteristic of this ecosystem that allows minerals in sufficient quality and quantity to make mining both desirable and feasible. Nevertheless, unlike other ecosystem services, this service is finite and of limited capacity. Minerals are a finite, non-renewable resource; consequently, today's mining activity will at some stage come to an end or make way for another. The problem boils down to a decision on how to use this service: when to exploit the minerals and to what degree. In Chile, as in most countries, this decision depends on the market, subject to valid legal conditions.

How important are mining activities in this region and in the rest of the country?

Historically mining has always held a key position in the country and it continues to do so today. In spite of diversification in the Chilean economy, mining is still the largest economic sector: totalling almost 10% of Gross Domestic Product (GDP) and 50% of exports. In 2000, in the Antofagasta region, mining represented over 60% of the regional GDP; it is the region with the most mining activity in Chile (MMSD South America team, 2002).

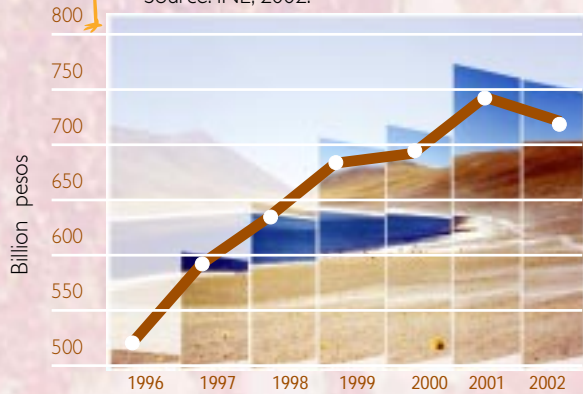
The Antofagasta Regional Development Strategy recognises mining as one of the main sources of economic activity and development, but it also acknowledges the activity's weaknesses due to the use of non-renewable resources and its limited influence on local employment. On account of this, the development of a cluster has been proposed, based on mining but generating new activities that provide more resources and employment in the region. Table III.6 lists statistics on population numbers and employment in the region.

It should be highlighted that mining in the region experienced a 9.2% annual growth rate between 1988 and 1999, far higher than in the rest of the country (SERNAGEOMIN, 2003). This trend can be seen in Figure III.7.



Figure III.7:
Antofagasta region, Chile: Mining GDP trends

Source: INE, 2002.



What are the main characteristics of the mining activities in the municipality?

The zone of San Pedro de Atacama has witnessed mining activity since Pre-Columbian times. The Incas and the inhabitants of San Pedro developed techniques to work the noble metals they extracted from the salar, such as copper and lithium. Hence, mining has always been a part of local culture. However, the scale of operations and quantities of material extracted by so-called “new mining” has drastically altered the relationship the communities living in the Salar have with the mineral resources of the area. Mining has shifted from being a traditional activity related to a sense of identity provided by Patta Hoiri (mother earth), to being a source of employment and income provided by large multi-national mining companies.

There are currently diverse mining operations in the municipality. There are four companies of principal significance in terms of size and their relationship to the ecosystem in the municipality. Two operate directly in the Salar de Atacama: SQM and Sociedad Chilena del Litio; and two operate outside the municipality but extract underground water from the southern zone of the Salar. The main characteristics of these four companies are presented in Box III.2.

What minerals are extracted from the Salar de Atacama and what are their uses?

- Fertilizers (potassium chloride, potassium sulphate, potassium nitrate, sodium potassium nitrate and other specific fertilizers; the latter three are produced outside the Salar the Atacama with nitrate derived from *caliche*): industrial cultivation, fruit and vegetables.
- Industrial chemicals (boric acid, technical-grade potassium nitrate): diverse uses in products, including glass, explosives, transfer fluids, glass fibres and cellulosic insulation.
- Lithium and its derivatives: lubricants, glass and ceramics, batteries, aluminium, pharmaceutical remedies, high-performance composites, air conditioning,

To what extent does water consumption by mining activities currently affect other water users in the municipality?

This is an issue of great concern to many stakeholders in the municipality. This project’s report on water resources, following consultation with public bodies and the companies themselves, established the water consumption and supply sources for each of the four main mining companies.

“This project’s distinctive stamp has been the strong component of participation involved; participation not only in the sense of listening to and including the opinions of social stakeholders interacting in the Salar, but also because they managed to develop a methodology wherein the experiences and opinions that were developed were shared between everyone; they were used to build up the body of the project and as a tool with which to project the future”.

Francisca Greene, Anthropologist, inhabitant of San Pedro.



Table III.6:
Antofagasta region, Chile: economic and workforce statistics

Population		Mining GDP as % of regional GDP in 2000	Employment (per 1000)		Average salary (Chilean pesos)	
Urban	Rural	65%	Regional	Mining	Regional	Mining
482,546	11,438		159,3	22,9	317,913	649,269

Sources: INE, supplement survey on income, 1998. INE, Results of the 2002 Census. INE, National Employment Survey, 1997. Corporación para el Desarrollo Productivo (Production Development Corporation), Antofagasta region.

Box III.2:
MINING COMPANIES WITH A RELATIONSHIP TO THE ECOSYSTEMS IN THE MUNICIPALITY

Company Characteristics	SQM	Sociedad Chilena del Litio (SCL)	Minera Escondida Limitada (MEL)	Minera Escondida Limitada (CMZ)
Location	Mines in Pedro de Valdivia, María Elena, Pampa Blanca, Salar de Atacama and the Uribe sector	Salar de Atacama, La Negra sector; 270 km southeast of Antofagasta	Lower slopes of the Domeiko Cordillera, up to 3,100m above sea level in the Atacama desert and 170 km southeast of Antofagasta	Pampa Augusta Victoria, 175 km southeast of Antofagasta, at 3,300m above sea level
Ownership	Main 'A' series shareholders: -Inversiones El Bolso Ltda. (Canada, 37.5%) -Soc. de Inversiones Pampa Calichera S.A. (Chile, 37.5%) -Inversiones RAC Chile Ltda. (Israel, 13.4%)	Chemetall GmbH-Cyprus Foote (USA, 100%)	-BHP Ltd. (Australia, 57.5%) -Río Tinto (United Kingdom, 30%) -JECO (Japan, 10%) -IFC (2.5%)	Pleasure Dome Group (Canada, 100%)
Year of installation	In the Salar de Atacama: 1994	1982	1988	1995
Investments in 2002	In the Salar de Atacama: US\$ 300 million	million US\$ 71.6	million US\$ 4,000	million US\$ 600
Mineral exploited	Brack water is exploited for the following products: Potassium Chloride, Potassium Sulphate, Boric Acid and brack water rich in Lithium.	-Lithium -Other non-metal minerals	Copper	Copper
Production in 2002 (1000 metric tonnes)	(in 2003) Potassium Chloride 286, Potassium Sulphide 161, Lithium Carbonate 22,3, Boric Acid 11,3, Potassium Nitrate and Potassium Sodium nitrate 558,6 and other specific fertilisers 276,6	16 (lithium)	758	147.7
Exports in 2002 US\$ millions	553,8	30,00	1.634,3	No data available
Reserves	The Salar de Atacama holds over 40% of world lithium reserves	The Salar de Atacama holds over 40% of world lithium reserves	2,408 million tonnes of copper (0.97 % yield) 21,022 thousand tonnes of fine copper	464 million tonnes of copper (0.67% yield) 3.1 thousand tonnes of fine copper
Useful lifespan (years)	530	530	40	20
Certifications	ISO 9000	ISO 9000	ISO 14000 Clean Production Agreement Global Reporting Initiative (voluntary guide)	ISO 14000 Clean Production Agreement Global Reporting Initiative (voluntary guide) ISO 17025
Employment	3.024 direct employees (including all tasks). In the Salar de Atacama SQM employs 315 and an approximately equal number of contractors.	-Mining employees: 45 -Contractor companies employees: 69	- Mining employees: 2,345 - Contractor companies employees: 1,847	- Mining employees: 800 - Contractor companies employees: 1000
Area (community/town) of influence	Operates mainly in the Salar; but with some workers from Camar, Talabre, Socaire and Peine.	Peine	Regional	Regional

Source: Authors' elaboration based on information from companies' annual reports.

There is a summary of this information in the section of this report on water resources. Those requiring further information can refer back to the original report on water resources for more details.

In summary, the hydrogeological research and analysis developed by this project reveal that, according to available information, mining company consumption does not affect or interfere with other consumers in the Salar de Atacama basin. There are several reasons for this, including the direction of flow of underground water in the basin and the apparent independence of the underground water bodies in the basin.

What are the current total exploitation and exploration concessions?

The rules concerning application for and granting of mining concessions are set out in the Mining Code, Law No. 18.248. The Code states, amongst other conditions, that exploration concessions may last no longer than four years, while the duration of exploitation is undefined. Tables III.7 and III.8 give information on concessions granted in the municipality of San Pedro de Atacama.

There are a total of 789 exploration and exploitation concessions (including those still in process, paid and unpaid) in the municipality of San Pedro de Atacama, representing 427,345 ha. This means that 13.4% of the land area is under concession in the region of Atacama (SERNAGEOMIN, 2003).

What are the major impacts of mining on human well-being in the municipality?

The positive aspects of the relationship between mining and human well-being are mainly due to employment possibilities and the general contribution to economic activity in the municipality. With regard to the former point, it should be noted that mining does not have intensive labour requirements; moreover, the workforce available in the municipality is mainly unqualified so it has low potential for participation in mining activities.

In 2002 the four main mining companies (MEL, CMZ, SQM and SCL) had some 8,000 employees, including contractors. There is no data available on what percentage of the workforce are from the municipality; however, the proportion is assumed to be low due to their low level of qualifications.

Mining also contributes to the municipality's economic activity through its diverse service requirements (e.g. lodging, transport, food). This contribution, although recognisably significant, cannot be accurately calculated due to the lack of information at municipality level.



Table III.7:
Exploitation concessions in the municipality

	Metal mining (ha)	Non metal mining (ha)
Concessions in process	4,347	17,343
Paid concessions	36,756	215,443
Unpaid concessions	256	600
Total concessions	41,359	233,386
Total hectares under concession for exploitation in the municipality	274,745 ha (7.8% of hectares under concession in the region)	

Source: Information obtained from SERNAGEOMIN (2004).



Table III.8:
Exploration concessions in the municipality of San Pedro de Atacama

Paid	concessions (ha)	150,300
Unpaid	concessions (ha)	2,300
Total	concessions (ha)	152,600 ha (5.6% of hectares under concession in the region)

Source: Information obtained from SERNAGEOMIN (2004).



The migration of workforce into the region as a whole, and into the municipality of San Pedro de Atacama in particular, is one significant phenomenon linked to the increase in mining activity in the municipality. This has affected social and population patterns, particularly in Peine and Toconao, where SQM and SCL's mining operation encampments are installed.

One positive aspect of the relationship between mining and human well-being has been the variety of education programmes and socially responsible activities that the companies organise in the municipality (above and beyond the legal requirements). These initiatives are summarised in Box III.3.

With regard to the negative aspects of the relationship between mining and the community, a significant proportion of the community, particularly Atacameños, express negative perceptions of mining activity. These perceptions mostly relate to the historical problems between mining and the communities, mainly due to competition over water supplies.

One challenge for mining companies, particularly those operating in the Salar de Atacama, is to make greater efforts to approach the local community and become active participants in the life of the municipality (leaving behind the image of separateness perceived by many). There are basic steps

Box III.3:

SOCIALLY RESPONSIBLE ACTIVITIES ORGANISED BY THE MINING COMPANIES IN THE MUNICIPALITY OF SPA

Compañía Minera Escondida Limitada works actively with the community of San Pedro de Atacama through an independent foundation of the same name. This includes programmes in the following areas: education, health, cultural identity, social development and tourism, research and Atacameño textiles.

Compañía Minera Zaldivar directs its activities at a regional level through the following activities: apprenticeship programme for the mining industry, scholarship programme for students, sportspersons and teachers, a housing plan for company workers, aid in the construction of the "Don Bosco" Technical Industrial College and donations to children's homes, community support centres, libraries and firemen.

SQM carries out the following activities with the community: research grants to universities, educational trips for the community, work experience for students from the region's technical colleges and donations to social support centres.

SCL organises activities such as community infrastructure projects, aid with energy supply and cleaning and maintenance in the municipality of San Pedro, with special emphasis on Peine, school scholarships for employees' children and educational activities.

Other activities include: seminars for park guards from the RNLF Soncor, improving the access road to Chaxa and extra-curricular activities with schools in Toconao.

Source: Authors' elaboration based on information from the companies' annual reports.

the companies must take, for example, to make a systematic effort to get to know other stakeholders in the municipality, to offer and disseminate more information on mining activities and to set up permanent effective mechanisms for communication.

What are the major impacts of mining on the ecosystem?

The risks (or negative impacts) of the relationship are directly linked to water consumption and sustainability issues that will be dealt with in greater detail in the section on water and the report on water resources drawn up for this project. Environmental emissions of gaseous, liquid and solid residue particles are also relevant, particularly when they are not adequately managed. The mining companies in the Salar de Atacama do not generate significant levels of residues since processing depends largely on the sun and most of the residual salts are reintroduced into the ecosystem.

The mining companies undertake diverse research and monitoring initiatives to avoid or mitigate risks and sometimes even intervene to ensure that the environment is able to recuperate. One noteworthy example is the joint programme to monitor water resources that the four companies have carried out in the Salar de Atacama, following an agreement with the regional CONAMA. The companies have also undertaken individual initiatives, or in association with public bodies (particularly CONAF) to monitor water-related issues in the Salar de Atacama (in the case of SQM). Minera Escondida Limitada have carried out diverse research and monitoring initiatives and environmental recuperation interventions in diverse sectors within (and outside) the municipality, covering issues related to water resources and flora and fauna.

What are the possibilities for mining activities in the future?

The Salar de Atacama and other salars in the municipality hold a significant percentage of world stocks in the minerals discussed above; this fact, alongside the growing global demand for these minerals and for copper exploited outside the municipality, leads to the conclusion that this activity could have a very active future.

What are the challenges to making mining a sustainable activity?

This issue has been the subject of intense debate over the last few decades. In terms of the economically viable extraction possibilities, minerals are a non-renewable finite resource. Some argue that, in practice, some forms of mineral mining (such as copper) have enjoyed a considerably longer lifespan than originally forecasted due to advances in technology over the course of the operations. Be this as it may, mining operations evidently have a finite lifespan and on account of this it is difficult, if not impossible, to talk of sustainable mining ex-

exploitation. However, attempts are underway to generate a more sustainable mining activity, through efforts such as production clusters and the creation of human and social capital. The objective is for mining exploitation to generate resources that allow the projection of economic activity beyond the useful lifespan of the mine. All the private and public stakeholders in the municipality of San Pedro de Atacama should assume this focus in a coordinated way.

Therefore, the municipality faces diverse challenges, such as:

- To define development priorities: To what degree should mining be developed? Is it possible to define some places that would remain available for mining and other; protected areas for example, that would not?
- To ensure planning and management measures, including public-private cooperation mechanisms, that consolidate the preferred development priorities.
- To find a way for the diverse economic activities in the municipality to work together harmoniously without affecting the capacity of the ecosystems to continue providing goods and services.

"[The project] offered a good opportunity for all those with concerns about the Salar de Atacama to express their views on the opportunities available to us for improving administration in a clear and transparent way".

Andrés Camaño, Environment Management, Minera Escondida.



III.4 BIODIVERSITY: THE INTANGIBLE KEY TO ECOSYSTEM SERVICES¹⁰

What is the nature of biodiversity in the municipality?

Two major environmental systems exist in the municipality of San Pedro de Atacama, extremely arid desert at lower altitudes (around Salar de Atacama) and tropical arid zones at higher altitudes (altiplano). This defines specific conditions for the area's biodiversity. Although there is no astounding wealth of species in the main groups (plants and mammals) compared to other parts of Chile, some groups (such as reptiles and amphibians) consist almost entirely of endemic species. The area possesses about 430 species of vascular plants, 238 species of terrestrial invertebrates, 14 reptile species, 2 amphibian species, 133 bird species and 24 mammal species (Table III.9, and Figure III.8).

Four major types of vegetation formations have been identified in the municipality: the Salar de Atacama desert, which covers the Salar de Atacama itself and the neighbouring sectors; and three other formations corresponding to increasing altitude: Pre-puna shrubland steppes, altoandino (high Andes) sub-desertic steppe and the alto-andino steppe of the Atacama puna.

How important is biodiversity for ecosystem services?

Although it cannot, in itself, be defined as a service, biodiversity is the cornerstone for the development of other ecosystem services, such as nutrient recycling and carbon sequestration. It also plays a fundamental role in the development of other services such as tourism and agriculture, since it provides the elements that support these services (e.g. components of biodiversity, genes, species, communities, landscapes).

In desert zones like the municipality of San Pedro de Atacama, biodiversity is a very important element since it regulates the functioning of the ecosystem. For example, biodiversity defines the ecosystem biomass (the totality of living organisms in the ecosystem), which allows the ecosystem to function under a variety of conditions. This determines the conditions of adaptability and resilience that maintain a diversity of living organisms even in seemingly inhospitable ecosystems like deserts.

How important is biodiversity for human well-being?

Biodiversity plays a direct role in regulating and supporting some of the ecosystem services fundamental for human well-being, e.g. services obtained directly from the ecosystems, such as food, wood for fuel and genetic resources.



Table III.9:
Municipality of San Pedro de Atacama:
Species diversity

	Total	Endemic
Plants		
Angiosperms	420	52
Gymnosperms	3	0
Pteridophytes	3	0
Fauna		
Terrestrial invertebrates	238	-
Vertebrates		
Reptiles	14	9
Amphibians	2	2
Birds	133	1
Mammals	24	0

Source: PIEB (2004).



¹⁰) The information in this section comes mainly from the report specially drawn up for this project by the Programa de Estudios Interdisciplinarios en Biodiversidad (Interdisciplinary Study Programme on Biodiversity or PEIB) of the Universidad de Chile.

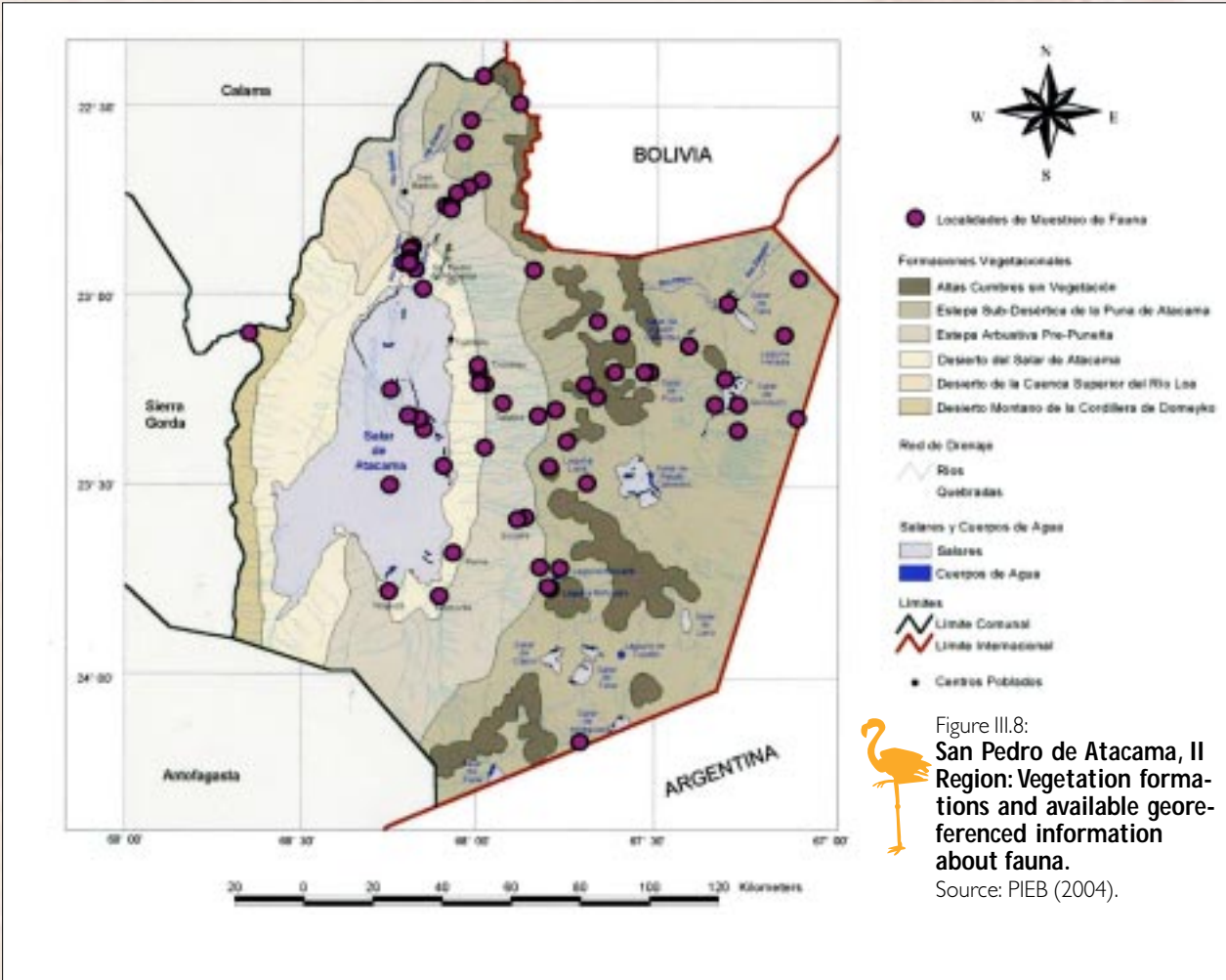
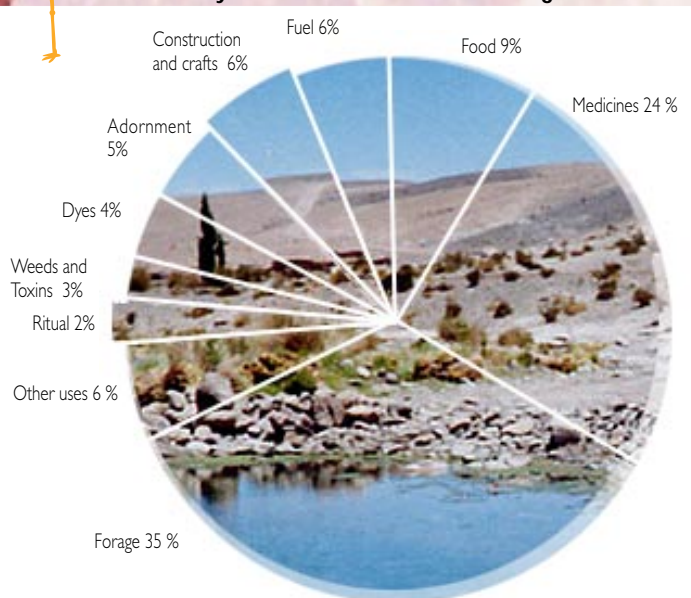


Figure III.8:
San Pedro de Atacama, II Region: Vegetation formations and available georeferenced information about fauna.
 Source: PIEB (2004).



Figure III.9:
San Pedro de Atacama: Services provided by biodiversity related to human well-being



Source: Villagran *et. al.*, (1998).

In the municipality of San Pedro de Atacama, it is possible to identify some resources that have a direct relationship with human well-being, for example, the use of plants (see Figure III.9). Biodiversity also plays an indirect role in the development of certain activities relevant for the municipality, such as the co-management of some areas of the Los Flamencos National Reserve by the Atacameños and the National Forestry Corporation. In this case, the presence of certain species means that the reserve can be developed into a tourist attraction (e.g. flamingos at Laguna Chaxa).

What is the condition of biodiversity in the municipality?

It is difficult to define one general condition for biodiversity in the municipality of San Pedro de Atacama. While some elements are protected and even increasing (see below, this section), others are under constant pressure due to their traditional uses: for example, some altiplano plant species used for fuel (llaretas) or crafts (cardón). However, there have been no assessments as yet to determine their current situations.

The oasis ecosystem, in an extremely arid desert environment, is very vulnerable to changes in water availability or land use. Pressure over land use is mainly an issue in areas with greater concentrations of agricultural land near the larger settlements, such as San Pedro de Atacama, where agricultural land is being handed over to tourism development projects. Desertification is not so evident due to the arid nature of the environment, but specific ecosystems, such as flat grasslands and peat bogs are very vulnerable to overgrazing and water variations.

In monitoring projects carried out by the National Forests Corporation and the mining companies (particularly SQM and Minera Escondida Limitada) some emblematic species of the salar ecosystem, such as the flamingos, showed an increase in their population compared with a few years ago (CONAF, 2002). The introduction of exotic species has not yet become a general problem in the area; the increase in caprine livestock could put pressure on food supplies for native camelid species and experiments are underway to introduce trout into some watercourses in the Machuca sector; the impacts of which have yet to be assessed.

What are some of the trends in biodiversity?

There is no systematic information to identify trends and changes over time or in space in the biodiversity of the municipality. Monitoring has only taken place for some “charismatic” species (e.g. flamingos) in some sectors of the municipality (the Salar de Atacama). The same is true for water, a vital resource for biodiversity in the area due to its scarcity. Surface and underground water is only monitored in some sectors of the Salar de Atacama, linked to mining companies’ legal commitments to the environment.

How could global changes (e.g. climate change) affect biodiversity?

There is no specific information for the municipality. Information on a continental scale indicates an increase in precipitation in tropical highland zones in the extreme north of Chile (CONAMA, 1999), so similar trends are likely in the highland areas of the municipality of San Pedro de Atacama. Data at a global level indicates rapid reductions in snow cover in subtropical and tropical zones (Cavieres *et. al.*, 2002), which could have significant consequences on water resource management in the sector.

What are the key biodiversity zones that require attention in the municipality?

There is still no systematic vision that might enable the

prioritisation of relevant sites for biodiversity conservation in the municipality of San Pedro de Atacama; this has only been possible in the north of Chile at a regional scale (IPCC, 2001). These reports identify the northeast of the municipality and the Laguna Lejía in the altiplano as relevant zones for biodiversity conservation.

The Salar de Tara has also been included in the RAMSAR list of Wetlands of International Importance. Current environmental protection of the Los Flamencos National Reserve in the municipality of San Pedro de Atacama, gives the opportunity for conservation work at sites within the Salar de Atacama and in some altiplano lakes and salars. The task of drawing up

a systematic plan for biodiversity conservation in the municipality – a big step towards improving decision-making on natural resource management and conservation – is still pending.

What does the future hold for biodiversity in the municipality?

It is impossible to guess an accurate scenario for biodiversity in the municipality without further information on current biodiversity conditions and trends. Studies are urgently needed to assess in greater detail the possible effects of climate change in the zone. More base information on the components of biodiversity must also be generated in order to determine future conditions more accurately.

“[The project] has enabled us to update data and, above all, to enhance the information available on water resources in the area”.

Alejandro Pizarro, Regional Secretary of the Ministry of Agriculture in the II Region.



III.5 THE ATACAMEÑO'S HERITAGE: AGRICULTURE AND ANIMAL HUSBANDRY

What are the main characteristics of agriculture and animal husbandry in the municipality?

Agricultural practice in the municipality occurs at a subsistence level. This is largely due to the limitations of the ecosystem for implementing large-scale agricultural production. About 24,000 hectares of land in the municipality is suitable for agriculture; 90% of this area is natural grassland (Figure III.10), mainly used as pasture for camelids and goats.

Soil is predominately alkaline in the municipality of San Pedro de Atacama, with high salt content, making it unsuitable for

intensive agricultural practices (such as fruit cultivation), except in some specific areas like the Quebrada de Jere in Toconao. Alfalfa is the main permanent crop (Figure III.11), followed by vegetables, fruits and cereals (Figures III.12 and III.13).

Prehispanic agricultural patterns have persisted in the municipality, consisting of hundreds of small irregular-shaped chacras (holdings) and a communal irrigation system (Table III.10 and Figure III.14).

Pastoral activities are more difficult to quantify. For example, the National Statistics Institute's Agriculture and Fishing Census gives livestock statistics for the whole province rather than the municipality. Nevertheless, there is significant caprine and camelid pasturing in the municipality.



Table III.10:

Property distribution according to land use (in hectares)

Source: VI Agriculture and Fishing Census, Instituto Nacional de Estadísticas (National Statistics Institute), 1997.

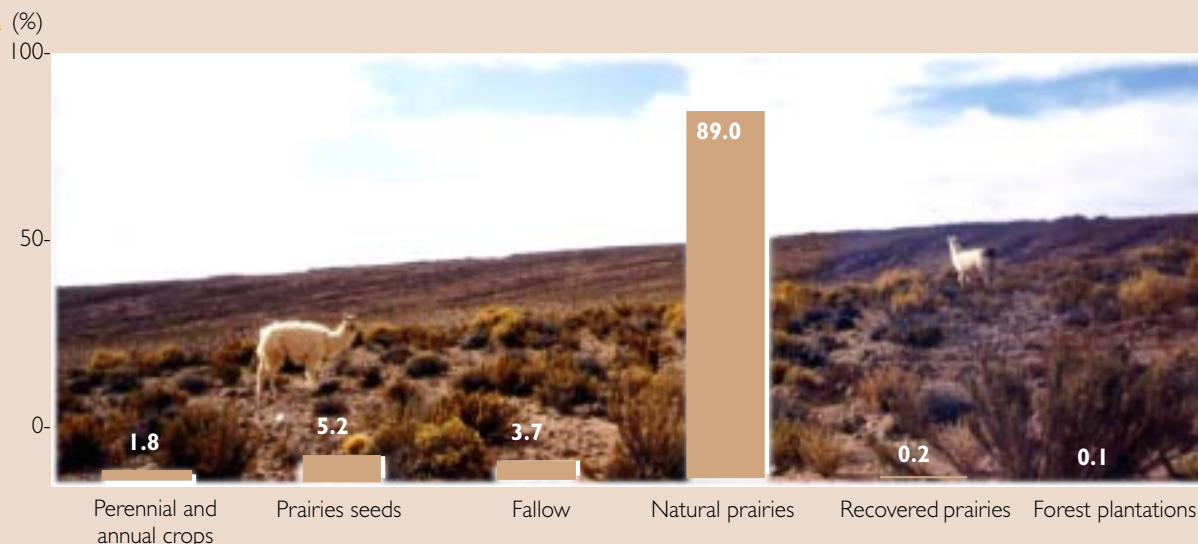
Level of exploitation	Perennial and annual crops	Cultivated prairies permanent and rotational	Fallow	Recovered prairies	Natural prairies	Forest plantations
< 1 ha	69,8	80,3	37,1	1,2	0,2	0,7
from 1 to 5 ha	204,5	521,1	287	20,1	13,1	2,8
from 5 to 10 ha	111,5	353,8	194,1	12,4	15,6	3
from 10 to 20 ha	35,9	200,1	204,3	8,6	21,5	0
from 20 to 50 ha	9,1	55	55,1	0	3	17
from 50 to 100 ha	0	40	1.006,7	10	1.305	0
from 100 to 200 ha	0	0	0	0	100	0
from 200 to 500 ha	0,2	6	0	0	100	0
from 500 to 1000 ha	0	0	0	0	49	0
from 1000 to 2000 ha	0,4	0,5	0	0	1.757	0
2000 ha and more	0	0	0	0	19.232	0



Figure III.10:

Main land uses in the municipality of SPA

Source: VI Agriculture and Fishing Census, Instituto Nacional de Estadísticas (National Statistics Institute), 1997.



Can agriculture and animal husbandry satisfy human well-being?

Agriculture and animal husbandry contribute to local families' food and income. According to the last census, 4.7% of the population in the municipality (mainly Atacameños) are involved in agriculture. Agricultural activity has fallen in recent years largely due to young people migrating to other municipalities and new job opportunities in tourism and mining. Although these figures might seem low and are falling, agriculture and animal husbandry enjoys historical links with the

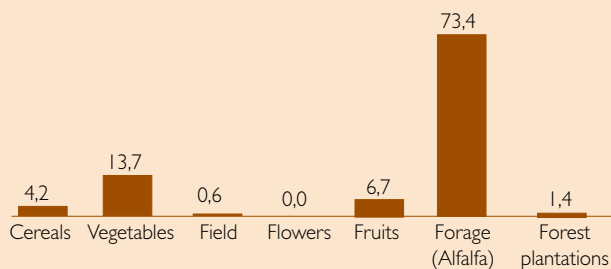
traditions and festivals of the Atacameño people. As a result of diverse initiatives by the Atacameños, public institutions and national and international organisations, there are presently a variety of efforts underway to recover and revalue these and other traditions.

To what degree can agriculture and animal husbandry damage the ecosystem?

The desert environment, with a few specific exceptions, offers very limited possibilities for agricultural activity. Soil alkali-



Figure III.11:
Main crops cultivated in the municipality of SPA (The % refers to total cultivation)
Source: VI Agriculture and Fishing Census, Instituto Nacional de Estadísticas (National Statistics Institute), 1997.



“Rides has, for the first time in the area, brought together people and organisations directly involved in all levels of decision-making in the Salar de Atacama basin, in order to think about and project the future based on as much collected information as possible. Thank you for your huge contribution, which has given us the tools to envisage sustainable development for the zone”.

Juan Sota, councillor of San Pedro de Atacama.



Figure III.12:
Main vegetables cultivated in the municipality of SPA (The % refers to total horticultural cultivation)
Source: VI Agriculture and Fishing Census, Instituto Nacional de Estadísticas (National Statistics Institute), 1997. Estadísticas, 1997.

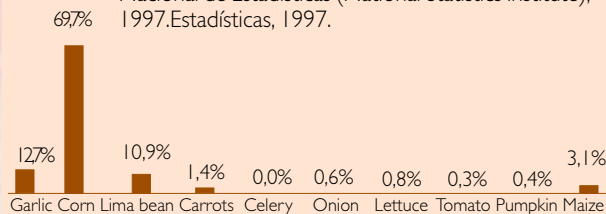


Figure III.13:
Main fruits cultivated in the municipality of SPA (The % refers to total fruit cultivation)
Source: VI Agriculture and Fishing Census, Instituto Nacional de Estadísticas (National Statistics Institute), 1997.

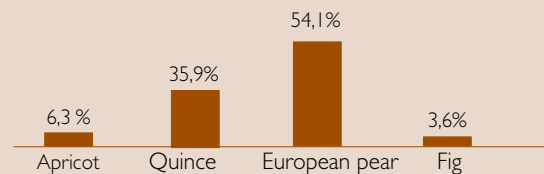
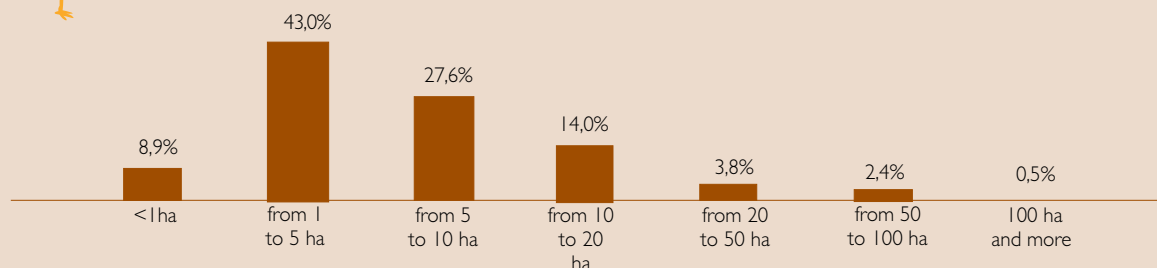


Figure III.14:
Property distribution in the municipality of SPA (The % refers to the total land area held under private property)
Source: VI Agriculture and Fishing Census, Instituto Nacional de Estadísticas (National Statistics Institute), 1997.





linity, high salinity in the water and traditional monoculture practices all have significant negative effects on the ecosystem, e.g. in terms of soil salinity. However, to date no serious environmental problems associated with agriculture have been detected, probably due to the low intensity of agricultural practice and its localisation.

What capacity does the ecosystem have to sustain more extensive agriculture and pasturing? Where could this take place in the municipality?

These questions are relevant to decisions on land and resource use (notably water). Although modelling and analysis tools do exist to answer these questions, the information necessary for this kind of analysis is not readily available. For example, with the right information on hand, such tools can be used to estimate the number of livestock (caprine, ovine, camelid, etc.) a specific area can support or the number of hectares that can be given over to any specific crop.

What does the future hold for agriculture and animal husbandry?

There are various factors that constrain the ability of agricultural and pastoral activities to grow as productive activities in the municipality. One of these factors is the ecosystem and

its limitations: water supply is a factor limiting activities in the municipality, as already mentioned in this report; this limitation is compounded by soil conditions that do not allow for intensive activity. Apart from these environmental factors, social, economic and cultural conditions have tended to favour other economic and productive activities, particularly tourism and mining. The migration of the younger population from the countryside to towns and cities further limits the possibilities for growth in agricultural and pastoral sectors.

In spite of the above, promising and interesting initiatives do exist that could revitalise agriculture and pasturing activities. In fact, the production plans in the Atacama La Grande Indigenous Development Area (ADI) have assigned a sizeable budget to initiatives related to agriculture and pasturing; agricultural projects 9%, livestock 17%, irrigation 45%. INDAP dedicates 50% of its contributions to production plans within the ADI, and CONAF 5%. Production plans relating to agriculture include: a livestock development plan (involving the communities of: San Pedro de Atacama, Quito; Larache, Solor; Séquitor; Coyo, Toconao, Talabre, Cámar; Socaire, Peine, Cámar; Machuca and Río Grande) and an irrigation infrastructure improvement plan (involving San Pedro de Atacama, Quito; Larache, Séquitor; Solor and Coyo).

III.6 THE DESERT AIR IS A WINDOW TO THE HEAVENS

The skies of the Antofagasta region are definitively the best skies that a human being can access on the planet. [...] This place boasts some 360 clear nights every year.

(Chilean Astronomy Network, contribution to the design of an astronomy trail in the II Region, 2002).

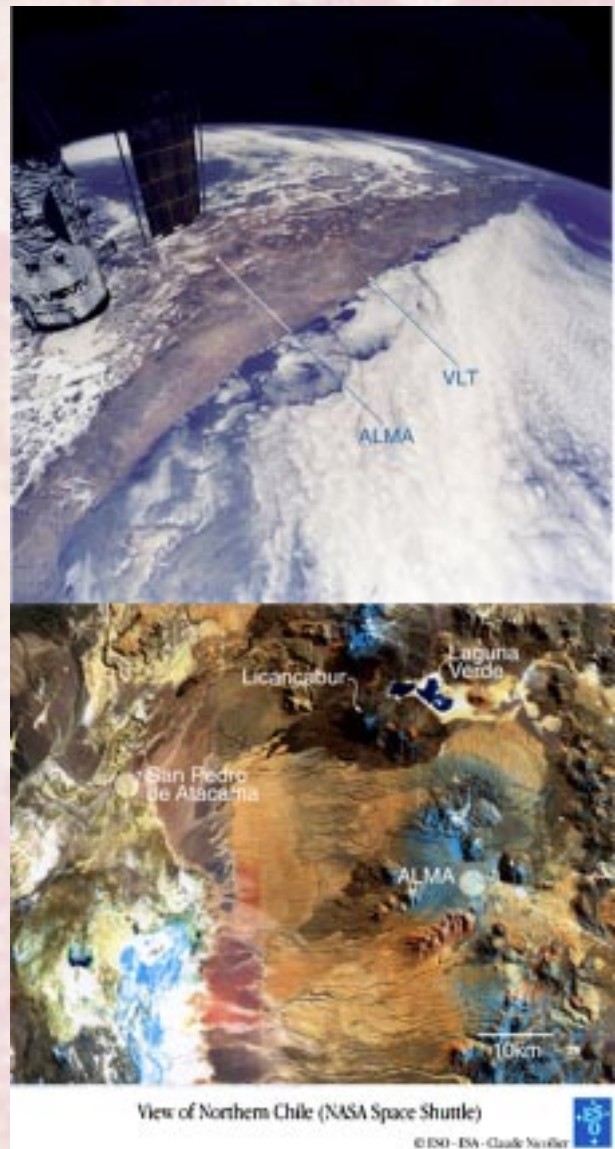
To what extent is astronomical observation a service provided by the ecosystem?

The ecosystem is characterised by the absence of precipitation and the high percentage of days of the year with clear skies, which, combined with the altitude, long stretches of flat or gently sloping land and dryness of the air, all lend themselves to conditions of remarkable visibility. These characteristics make the municipality one of the best places for astronomical observation in the world. In this context, it can be said that this activity can occur precisely because of the particular characteristics of the municipality's ecosystem; in other words, it is a benefit directly obtained through the existence of this ecosystem.

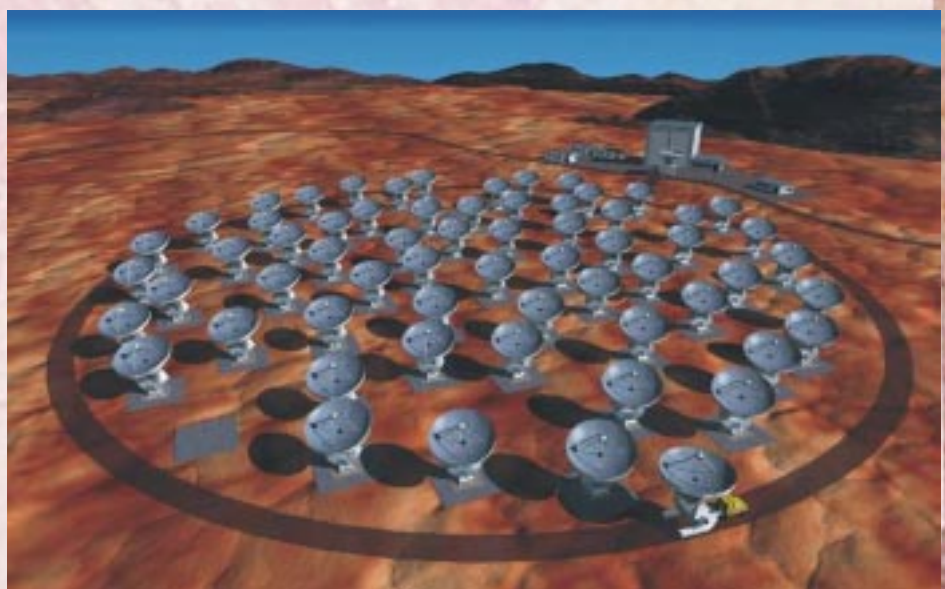
What initiatives are underway in the municipality?

The most important project is ALMA (Atacama Large Millimeter Array). This project, aimed at building a radio-telescope to operate at millimeter and sub millimeter wavelengths, is the result of international cooperation between Europe and North America. It consists of a network of radiotelescopes 5,000 metres above sea level on the high-

land plain of Chajnantor, east of San Pedro de Atacama. There are also a series of installations around Toconao, and construction for this project is planned until 2008.



ALMA and other similar projects constitute an opportunity to materialise and strengthen access to scientific knowledge and progress. Although achieving such access at a municipality level is difficult, the very presence of the installations and the scientists could offer opportunities for interaction for the community.



Another three projects in Chajnantor are:

- **LAT:** Large Atacama Telescope (astrobiology), directed by Cornell University, the United States.
- **CBI:** Cosmic Background Imager; directed by the California Institute of Technology.
- **OWL:** Overwhelming Large Telescope, of the European Southern Observatory (ESO).

What is the relationship between astronomical observation, human well-being and ecosystems in the municipality?

The relationship goes back thousands of years, and manifests in the importance attached to the sky and stars in Atacameño culture. At present, and in a different sense, projects like ALMA can be a source of employment for the municipality, particularly with regard to building work and services provision. Also, ALMA has promised its collaboration with the community (Toconao) by means of specific donations.

ALMA and other similar projects constitute an opportunity to materialise and strengthen access to scientific knowledge and progress. Although achieving such access at a municipality level is difficult, the very presence of the installations and the scientists could offer opportunities for interaction for the community. In addition to this, SERNATUR and EUROCHILE have been working to implement an "Astronomy Trail" that would pass through the municipality.

Without doubt, certain conditions are necessary for the relationship between astronomical observation, the community and the ecosystem to be a positive one. Some issues of concern are: changes to the natural landscape caused by the projects (roads, infrastructure, etc.) and levels of electric lighting



in towns in the municipality (that could affect the absence of light necessary for some of these installations).

What does the future hold for this activity?

The climatic conditions are very favourable for this activity. One unknown element is the effect that global climate change might have on the municipality in general and this activity in particular.

On the other hand, if the municipality wishes to take full advantage of the opportunities this activity represents (e.g. employment, donations, interaction with scientists), it must propose a strategy that involves capacity-building in order to provide a more specialised workforce.

One particularly attractive opportunity is to favour the development of initiatives, such as tourist services, which integrate traditional Atacameño perspectives on the sky and the stars with the scientific knowledge associated with projects like ALMA.

THE ATACAMEÑO CULTURE IS PART AND PARCEL OF THE ALTIPLANO ECOSYSTEM

Ever since their very beginnings, the Atacameño people of the Andes have had common traditions and a shared world view. This world view is based on a holistic and integrated understanding of the relationships between human beings and the land or Patta Hoiri (mother earth), a concept embracing the guardian hills, the water – generator of life, the soil, the ancestors and the heavens.

Even though this complex and interesting system of knowledge was not systematically incorporated into this project*, we have identified three relevant types of knowledge of the ecosystem:

- **Ecological knowledge** - "what is happening in the ecosystems": involves knowledge of flora and fauna and diversity, as well as ecological dynamics (processes and functions) across different interrelated spatial and temporal scales.
- **Technology and knowledge** of management practices: ancestral techniques to maintain or increase the ecosystems' capacity to provide services.
- **Symbolic knowledge**: knowledge of religious rituals and functions in the landscape and nature. This also refers to the value and importance of nature in the Atacameño culture.

The following box presents a description of each type of traditional knowledge (ecological knowledge, technology and knowledge, symbolic knowledge) in terms of its source (those who hold the knowledge), contents, distribution, means of transmission and its relationship to ecosystem services.

Traditional knowledge in SPA

Source	Types	Contents	Distribution	Transmission	Ecosystem services
Elders	1-2-3	Uses, practices and meaning of nature in the traditional	Very small number of elders in the smaller lifestyle settlements.	Oral	Support and cultural
Shepherds	1-2	Plants to feed livestock, their distribution and life cycle. Location and quantity of water sources. Herding landscape and routes. Fauna characteristics	Very small number of shepherds in the smaller settlements.	Families and individuals. Oral and through practice.	Support and regulation
Farmers	1-2	Irrigation systems and cultivation techniques. Flora characteristics.	A significant number in each settlement.	Families and individuals. Oral and through observation.	Support
Healers	1-3	Names, uses and importance of medicinal plants, geographical distribution and rituals associated with their use.	A small number of individuals.	Selective, Oral, through practice and observation.	Support and cultural
Individuals	3	Importance of landscape, myths and traditions (rituals, dances, festivals)	Young people and adults interested in preserving and continuing the traditional lifestyle.	Oral and through practice.	Cultural
Anthropologists (museum)	1-2-3	Recollection of past and present uses and the "state of the art" in different aspects of traditional knowledge.	Team of researchers.	Documents, seminars and courses (for the Atacameños)	Cultural

Source: Authors' elaboration.

*The knowledge and interests of the Atacameño people were incorporated through the presence of representatives in the advisory committee, a special meeting for Atacameño leaders and a series of complementary activities (trip for Atacameño children to the Los Flamencos National reserve and a video documenting meetings about traditions between the elders and the children).

IV. SCENARIO-BUILDING FOR THE MUNICIPALITY OF SAN PEDRO DE ATACAMA

IV.1. WHAT ARE SCENARIOS?

All human beings are decision-makers on a daily basis and at different levels. When we make a decision we try to mentally anticipate the future in order to identify, in the present, the best path towards our goals for the future. However, our plans inevitably encounter unexpected situations and events that hinder or impede our objectives. Therefore, making decisions always implies taking a risk. How can we incorporate the unexpected that we cannot foresee into our decision-making? Scenario-building is a systematic methodology that enables us to reduce some of the possible risks by using our creativity.

On scenarios:

- They have been intensely used in interesting ways to analyse the state of the environment at a global scale (e.g. for climate change, water, trade and sustainable development).
- They are possible future situations, stories or examples, created with carefully constructed arguments, of what could happen under different circumstances.
- They are a tool to summarise and communicate the diverse paths our world could take in the years to come.
- They help us to understand decisions that are made and their possible consequences.
- They can be qualitative (stories) or quantitative (generally models, presented as figures or tables).
- Well-built scenarios should satisfy the objectives for which they are created; they have a dose of creativity, they are well-documented, possible and consistent, they broaden understanding of the issues and transmit the complex interactions between the social and ecological systems.

Following the MA guidelines, the project developed scenarios as a tool to facilitate the debate on relevant issues, in order to help identify recommendations for the ecosystem and for human well-being.

IV.2. CREATING SCENARIOS

The scenarios are based on the **uncertainty** we are able to identify. When collating and analysing information the focus was on answering the following questions:

- What are the **trends** and **conditions** of human well-being and the services provided by the ecosystem?
- What **factors** have caused or are causing changes in the ecosystem and in human well-being?

Also, in order to create consistent and coherent future scenarios within local circumstances, diverse information sources were consulted, including prior international experiences, and the conceptual framework of the MA and base line reports drawn up within the framework of the project. In addition, there were meetings with the advisory committee, a workshop with Atacameño leaders to discuss the possible future scenarios and interviews in the field with strategic informants. Finally, Francisca Greene, anthropologist and inhabitant of SPA, reviewed the scenarios.

As a result of this process, the **base line** or **current situation** was drawn up and **three possible scenarios** were proposed for SPA in the year 2025. These were defined by a combination of two central themes – economic situation and political situation (governance). The three scenarios are:

Box IV.1:

POSSIBLE SCENARIOS FOR SPA

Growth and development: This scenario begins by taking maximum advantage of current opportunities for public and private investment in infrastructure and human capacities, cooperation between sectors and recognition of indigenous demands, thus generating growth and employment. However, there is greater pressure on resources, with ever-increasing immigration and tourism ventures. The main characteristics are: modernisation and growth, exacerbated competition and individualism and a weakening of public structure.

Nothing changes: The main characteristic of this scenario is accelerated economic growth, but without regulations sensitive to the diverse local needs and particularities of the ecosystem. This gap leads to a sudden break in the agreements for social and political stability, bringing conflict and exclusion between sectors. The main characteristics are: resource privatisation, larger-scale tourism, loss of traditions, emigration from the zone and lack of environmental concern.

Surviving in adversity: This scenario is marked by strong economic decline leading to a cut in public investment and private backing. Poverty and need demands aid measures, restricting local development and causing 'outsiders' to emigrate. Adversity forces people to turn to natural resources and ancestral knowledge, with a return to agriculture and traditional medicine, amongst other things. This requires special care to be taken of the ecosystem, with organisations and spontaneous mechanisms arising as needed to resolve problems. Social integration, concern for the environment, strengthening of cultural identity and reciprocity are the main characteristics.

- **Growth and development:** Local decision-making and economic growth
- **Nothing changes:** Centralised decision-making and economic growth
- **Surviving in adversity:** Centralised decision-making and economic decline.

Box IV.1 gives a brief presentation of the three aforementioned scenarios. The complete descriptions can be located on the CD along with all the reports and documents drawn up within the framework of this project.

IV.3. THE WORKSHOP ON SCENARIOS

The intention of the scenario-building we proposed was to generate a dialogue on the future in order to reflect upon the present. Toward this end, in the sixth advisory committee meeting we held a group workshop, where each participant, after reading the base lines, was given one of the three scenarios and asked to imagine themselves inside this future situation in order to analyse it critically.

The task was to identify the positive elements (opportunities) and negative elements (challenges) of each scenario and make relevant recommendations on how to take advantage of the opportunities and avoid future threats as far as possible.

Thanks to the participants' high level of commitment an interesting dialogue and debate arose, which gave the project work team the necessary inputs to formulate the project responses and recommendations. Several of the proposals that arose in the workshop are now underway or being projected and several more reflect the creativity of the ecosystem users. One important point to mention is that when it came to deciding who should implement these measures, all three groups working on the respective scenarios agreed it was necessary to involve and integrate all the local groups and inhabitants without discrimination. Box IV.2 presents recommendations proposed by the advisory group in the aforementioned workshop.



Box IV.11:

Workshop results: recommendations from the advisory committee

- Strengthen the community and inhabitants' participation in governance and decision-making
- Plan and regulate use of resources: water; land; promotion of natural energy.
- Revitalise culture: ancestral medicine, multicultural education, etc.
- Redefine real participation and operation mechanisms in the Indigenous Development Area (ADI) and methodologies for public investment.
- Implement strategies to regulate tourism and management to strengthen special interest tourism.
- Integrate companies into local challenges (companies with local identity)
- Encourage the community as a whole to work on a conflict management plan to use with individuals who act against the interests of the organisation.



V. RESPONSES FOR SUSTAINABLE MANAGEMENT AND HUMAN WELL-BEING

Responses are seen as recommendations, made by the work team and the advisory committee, to enable the different ecosystem users and decision-makers to tackle the challenges facing the sustainable management of ecosystems and human well-being in SPA.

This product is the result of the research and participation process, and as such it integrates the information obtained from diverse sources, including:

- Base lines on ecosystem services and human well-being drawn up for this project.
- Scenario development and workshop held with the advisory committee.
- Preliminary MA reports.
- Sustainability criteria defined by the project work team (Box V.1).
- Interaction between the work team and institutions and individuals of SPA.

A series of proposals were thus drawn up that were discussed and added to in the final advisory committee meeting and are presented below. The tables give a general description of the recommendations, each group's objective, possible executors of the measures, time period or scale and geographical reach or scale implied.

The recommendations are grouped into two main interconnected issues. Those recommendations relating directly to social or administrative issues are listed first, followed by those referring to specific ecosystem services. The final section includes recommendations arising from the lessons learnt by the project team over the course of the project, which could be helpful for similar experiences in Chile or the rest of the world in the future.

Box V.1:

CRITERIA FOR SUSTAINABILITY RECOMMENDATIONS

- 1) Integrate values of ecosystem services into the decisions
- 2) Belonging and cultural diversity (non-discrimination)
- 3) Coordination, organisation, collaboration, participation, conflict resolution
- 4) Integrated/holistic focus (coordination between actions, long-term view)
- 5) Precautionary principle in decision-making, always look at alternatives
- 6) Education and knowledge dissemination
- 7) Equality between all the sectors
- 8) Deal with uncertainty
- 9) Encourage initiatives for sustainable markets and consolidate (individual and collective) property rights



V.1. SOCIAL AND ADMINISTRATIVE RESPONSES

Recommendation What? How?	Focus group	Possible executors	Time scale	Spatial scale
1. STRENGTHEN COMMUNITY BONDS (broad concept of community, including stakeholders such as local government, local magistrates, police, etc.)				
Workshop: Citizen participation and conflict management <ul style="list-style-type: none"> Approaches and tools for constructive citizen participation. Alternative conflict management and resolution methods. 	Atacameño Peoples Council (CPA), Atacameño communities, public services, businesses, tourism sector, community at large.	External institution in coordination with local organisations	Short-term	Municipality
Workshop: Sustainable development (SD) and ecosystem focus <ul style="list-style-type: none"> Basic concepts of SD. Services provided by the ecosystems and their consequences for human well-being. Analysis of conditions, trends and factors of change. Scenario design and use. 	School teachers, local leaders, local government, businesses, etc.	External institution in coordination with local organisations	Short-term	Municipality
Atacameño culture, identity and education programme: the value of the Atacameño culture –past and present– must be revealed and disseminated in order to support both the processes within the community itself and its integration with the rest of society. Proposed activities and materials: <ul style="list-style-type: none"> Compendium of Atacameño festivals: brochure (like 'Turistel', the Chilean tourism guide) giving details of the main Atacameño festivals. Atacameño album (20-30 pages): black and white photographs of Atacameño elders and individuals, alongside a biographical description of their life stories; the ancestors, their relationship to the ecosystem and the landscape; this material could be disseminated in schools and sold at tourist sites. Continuation of exchanges between grandparents and young Atacameños recorded on multimedia (for commercial and educational purposes). Continuation of children's' educational visits to the ecosystem: salt flats, archaeological ruins, tourism circuits. Open house in local government building or other place in the centre of SPA: multimedia exhibition on significance of the Atacameño's world. 	CPA, Atacameño communities, public services, private sector	CPA, CONADI, ADI, museum, businesses	Mid-term	Region
Create and develop 'spaces' for public opinion and information: Many people support the idea of creating public spaces as a way of generating transparency, responsibility and debate on the municipality's problems and proposals. Existing possibilities, such as local radio, should be strengthened, and permanent, serious and freely available written publications are needed. Proposed activities: <ul style="list-style-type: none"> A seminar with professionals from the radio and regional and national newspapers to motivate and train people with interests in SPA. 'Needs diagnosis' workshop (SWOT) for greater media development in SPA. 	All community groups	Local government, private initiatives	Mid-term	Municipality, Province
Wide-reaching dissemination of project results; particularly: GIS presentation in settlements, theatre plays to explain scenarios, validation of base lines, etc.	Community at large	RIDES in coordination with CONAMA, CONAF (ADI subcommission)	Short-term	Municipality, Region



Recommendation What? How?	Focus group	Possible executors	Time scale	Spatial scale
2. REVITALISE ATACAMEÑO CULTURE				
Official register and diagnosis of Atacameño traditional knowledge and patrimony: Traditional medicine, culinary practices, crafts, agricultural products, indigenous astronomy.	Atacameño community	CONAF Programa Orígenes Universities	Short-term	Municipality, extendible to Alto El Loa
Participatory study: to generate action programmes to strengthen transfer of traditional knowledge between elders and young people (meetings, audiovisual recordings).	Atacameño community, all community groups	CPA, Orígenes, in coordination with external institution	Short-term at weekly periods	Municipality, extendible to other national and international indigenous zones
Intercultural education • Focused in a transversal way on schools in SPA and Toconao, to tackle discrimination problems. • Locally relevant (Atacameño) teacher training.	Educational community (students, parents, teachers, leaders)	Orígenes, FME, 8 schools, teaching community, students, parents. Mineduc, CONADI, DAEM	Mid-term 1-3 years	SPA, Toconao and settlements
Use and management of indigenous resources: this study, requested by the Orígenes programme, seeks to advance the design of an Indigenous Resources Management and Conservation Plan.	CPA and public services of the ADI	RIDES in coordination with the ADI	Short-term	Municipality, ADI
3. CITIZEN PARTICIPATION: to extend opportunities for multisector participation (relevant for the ecosystem and human well-being)				
Create opportunities for ADI involvement in the private sector (mining, tourism operators, observatories; new rights and duties); e.g. mining companies' annual report to account for their actions in the field of Social and Environmental Responsibility, to plan and follow up on their contributions in accordance with local priorities.	All ecosystem users	ADI	Mid-term, gradual process	Municipality, ADI Extendible to Alto El Loa
Decision-making: to give more weight to sustainability criteria and the aims of the Millennium Assessment in ecosystem: e.g. review of the logical framework used in the productive and social investment projects.	Local government, public services, ADI and its subcommissions	Local government, public services, ADI and its subcommissions, with support from RIDES	Mid-term, gradual	Municipality



Recommendation What? How?	Focus group	Possible executors	Time scale	Spatial scale
4. REGULATE TOURISM				
Consolidate sector organisation and representation Participative proposal for new instances for tourism operators and enterprises to organise the sector. Discuss the need to create a regulatory body for the municipality.	Large and small tourism enterprises	The businessmen themselves. To give incentive to the organisation: SERNATUR, Local government	Mid-term	Municipality
Construct a participative vision of the future of tourism based on the CPA proposal	All sectors	Eurochile	Short-term	Municipality, focused on national and international tourism circuits
Tourism development plan (including aspects of visitor number capacity)	All sectors	Eurochile	Short-term	Municipality and El Tatio
Manual for tourist guides: there is currently a very heterogeneous range of tourist guides available, in terms of quality (training, knowledge of the culture and territory). A manual is proposed in order to give a basic training to guides. This could be a starting point for future guide certification.	Tourism operators	SERNATUR, Red Likanhuasi, Orígenes, Eurochile	Mid-term	Municipality, extendible to Alto El Loa
Sustainability certification of tourism; e.g.: "Ranking" of service quality (no. of complaints in hostels; safety indicators (for tours); to include all the tourism market. This would raise the level of services and protect the image of SPA as a destination.	Tourists Large tourism operators	Local government, SERNATUR, local businessmen	Mid-term, with permanent updating	Municipality
Study on what proportion of resources derived from tourism actually stays in the municipality In-depth quantitative study of the economic benefits of tourism for the permanent inhabitants of the municipality and the Atacameño communities and thereby assess the real potential of tourism to overcome poverty and improve the standard of living.	Local government, SERNATUR, CPA	RIDES will set up a preliminary study; we will seek coordination with local institutions	Short-term	National, municipality
Assess the co-management experience in the Los Flamencos reserve in order to strengthen and promote other protected areas The Atacameño community of Toconao and CONAF have started up a pioneer co-management initiative for cultural patrimony within the SNASPE. This offers the opportunity to learn lessons in order to plan new experiences.	Atacameño community, Red Likanhuasi, all users	CONAF, community of Toconao, Universities or research centres	Short-term	Local, extendible to the region and country
5. HUMAN WELL-BEING STUDIES				
Atacameño base line – detailed analysis of the 2002 Census: recognition of the inequality that exists between the Atacameño community and other inhabitants is seen as an important step towards integration of the groups in SPA.	CPA, decision-makers in the social arena.	Research centre, potentially RIDES, in alliance with MIDEPLAN, UNDP	Short-term	Municipality
Design an Atacameño Human development Index: in order to measure and assess living standards of the indigenous population according to parameters defined by the community itself.	CPA, decision-makers in the social arena.	Research centre, potentially RIDES, in alliance with MIDEPLAN, UNDP	Short-term	Municipality

V.2. ECOSYSTEMS SERVICES

Recommendation What? How?	Focus group	Possible executors	Time scale	Spatial scale	Type
6. WATER RESOURCE MANAGEMENT (SEE SPECIFICATIONS IN FINAL REPORT ON WATER RESOURCES)					
<p>• Work group: ongoing instance for information, analysis and dialogue between those institutions directly connected to consumption, monitoring and protection of water resources and other resources.</p>	All resource users	ADI, DGA, with the support of a bridging organisation and specialised technical team	Short-term, mid and long-term	Municipality, extendible to Alto El Loa	Institutional intervention
<p>Monitoring of hydrological and hydrogeological parameters: Continue work carried out until 2002 at the companies' monitoring programme sites in order to foresee undesirable impacts and apply technically appropriate mitigation measures.</p>	All resource users	SQM, SCL, MEL and CMZ	Short-term, annually	Southern zone of the basin	Monitoring
<p>Establish additional rain gauge and flow gauge sites:</p> <ul style="list-style-type: none"> Improve the hydrological balance in the Salar de Atacama basin and neighbouring high plateau basins Provide additional information on climatic variations. 	All resource users	Work group, regional universities	Short-term, mid-term	Altiplano basins	Monitoring
<p>Establish additional sites to record underground and surface water levels in the SAT basin (north-eastern and northern areas of the Salar and its periphery)</p> <ul style="list-style-type: none"> In unmonitored sectors with increased underground water collection Emphasis on consumption from tourism in SPA 	All resource users	Work group, regional universities	Periodically	Zone north of the Salar	Monitoring
<p>Comparative analysis of satellite images</p> <p>Evolutionary analysis of the physical and biological parameters in lakes and areas where water depth is very limited.</p>	All resource users	Work group, regional universities	Every 2-4 years	Salar basin	Monitoring
<p>Integrated observation of hydrological parameters in the basin</p> <p>Generate an integrated vision of changes through time in the diverse areas of the basin by means of a single database for the SAT basin, including the following parameters at least:</p> <ul style="list-style-type: none"> Underground water levels Lake water levels Lake surface areas Three-monthly database updating and validation Annual interpretation Individual analyses Integrated analysis of all the sites. 	All resource users	Work group, regional universities	Short-term, periodically	Salar basin	Monitoring
<p>Ongoing monitoring of water quality for domestic use</p> <ul style="list-style-type: none"> Physical-chemical and biological parameters of the Chilean drinking water regulations Parameters considered most likely to be subject to variations and cause greater potential damage to human health 	All resource users	Work group, regional universities	Quarterly and monthly	Municipality, settlements	Monitoring

6. WATER RESOURCE MANAGEMENT (Cont.)

Recommendation What? How?	Focus group	Possible executors	Time scale	Spatial scale	Type
<p>Implement an integrated hydrological model of the basin useful to administrate and protect the basin's water resources</p> <p>Requirements:</p> <ul style="list-style-type: none"> • To develop a monitoring period for the northern part of the basin • To draw up a detailed conceptual model of the entire SAT hydrogeological basin <p>Parameters:</p> <ul style="list-style-type: none"> • Replenishing of natural waters • Surface extraction • Underground extraction outside of the SAT basin • Salt water extraction within the SAT basin 	All resource users	Work group, regional universities SQM, SCL, MEL and CMZ	Mid-term	Salar basin	Monitoring
<p>Evaluate permanent monitoring sites in the municipality's high plateau basins (due to the increasing demands for exploration and user rights in the sector)</p>	All resource users	Work group, regional universities	Mid-term	Altiplano basins	Monitoring
<p>Study of perceptions and traditional knowledge concerning changes in water resources: Participative record and validation of observations.</p>	All resource users	Work group, regional universities	Mid-term	Municipality, settlements	Monitoring



Recommendation What? How?	Focus group	Possible executors	Time scale	Spatial scale	Type
7. BIODIVERSITY					
<p>Determine which elements constitute biodiversity in the municipality of SPA (completing base lines).</p> <ul style="list-style-type: none"> Review of species list, adding species not included and including common names of species. 	CPA, Atacameño communities, community at large	RIDES, with the support of CONAMA, CONAF, SAG, regional universities and mining companies	Short-term	Municipality	Records
<p>Incorporate taxonomical groups not included in the PIEB study</p> <ul style="list-style-type: none"> Information review and update for taxonomical groups not included in the PIEB report 	CPA, Atacameño communities, community at large	RIDES, with the support of CONAMA, CONAF, SAG, regional universities and mining companies	Short-term	Municipality	Records
<p>In-depth review of "use of biodiversity"</p> <ul style="list-style-type: none"> A list of native species with patents on the commercial use of their genetic resources 	CPA, Atacameño communities, community at large	RIDES, with the support of Orígenes and regional universities	Short-term	Municipality	Records
<p>Updating of the biogeographical base of the SPA municipality</p> <ul style="list-style-type: none"> Documentation of most up-to-date thoughts and knowledge on the historical evolution of the landscape, and the current distribution of flora and fauna in the municipality of SPA 	CPA, Atacameño communities, community at large	RIDES, with the support of CONAMA, CONAF, SAG, regional universities and mining companies	Short-term	Municipality	Records
<p>Development of a conceptual model of relationships between the components of biodiversity in the Salar</p> <ul style="list-style-type: none"> Creation of a model of relationships between the biotic and physical environments in the Salar 	CPA, Atacameño communities, community at large	RIDES, with the support of CONAMA, CONAF, SAG, regional universities and mining companies	Short-term	Municipality	Records
<p>Development of a Geographical Information System</p> <ul style="list-style-type: none"> Updating of the GIS carried out by RIDES (e.g. vegetation formations and associations, and collection priority sites). 	CPA, Atacameño communities, community at large	RIDES, with the support of CONAMA, CONAF, SAG, regional universities and mining companies	Short-term	Municipality	Records

Recommendation What? How?	Focus group	Possible executors	Time scale	Spatial scale	Type
8. OTHER ECOSYSTEM SERVICES					
Alternative energy: solar, wind power Prospective studies on strengths, weaknesses, threats and opportunities.	Local community, tourism operators	Department of Mechanical Engineering Universidad Técnica Federico Santa María (UTFSM)	Mid-term	Municipality, settlements	Technology transfer
Water recycling Prospective studies on strengths, weaknesses, threats and opportunities.	Local community, tourism operators	Specialised consultant	Mid-term	Municipality, settlements	Technology transfer
Reverse osmosis to reduce arsenic levels in the water: Prospective studies on strengths, weaknesses, threats and opportunities of existing alternative technologies.	All resource users	Jack Stern - TeknoAgua	Mid-term	Municipality, settlements	Technology transfer
Organic and inorganic domestic waste recycling	All inhabitants of the municipality	Local government	Mid-term	Municipality	Intervention



V.3. LESSONS AND RECOMMENDATIONS FOR FUTURE INITIATIVES

- There are advantages and disadvantages when intervening as an external agent. On the one hand, being an external agent allows the team to take an impartial position in the face of the diverse interests and perceptions of local actors. However, being physically distant from the assessment area can introduce obstacles. Therefore, the identification of a key local contact is essential.
- The creation of an advisory group is strongly recommended. This creates space for the sharing of information and for confidence and trust building within and between government institutions and local groups.
- The personal involvement of experts throughout the participatory process positively enhances the contribution of these experts - as in the case of the team that worked on the water issues.
- The level of public participation is highly variable over time, and depends to a large extent on the perception that individuals have of the concrete benefits of their invested effort. In a project of this nature however the results are less tangible in the short term, which makes participation and its continuity difficult.
- The dissemination of preliminary assessment results amongst the stakeholders was highly valued, as was the team's dedication to respect commitments agreed upon throughout the assessment process.
- A key question in this type of assessment is how much emphasis should be placed on the process of participation, and how much on 'hard' research. The answer is situation dependent; in our case, we opted for the former; placing most of the emphasis on the participatory process as a platform for dialogue and a subsequent deepening of the latter.
- Extension activities proved to be successful complements to the central assessment process. These activities helped to generate trust and confidence, and to build networks of support at the local level.
- The international exchange of experiences – such as that between South Africa and Chile for the development of scenarios – was taken advantage of during the assessment process, and was highly valued by the participants.
- The participation of local authorities is essential to ensure the impact of the results. In our case, for both internal than external reasons, the project lacked the necessary commitment of these actors.
- It proved difficult to translate complicated terms and concepts around ecosystems to local people. In addition, it is essential that accessible language is used, and that the entire assessment process is framed in this way.
- Taking an analysis beyond a consideration of provisioning services, by including an analysis of supporting, regulating and cultural services, is very difficult because many of these services are intangible and therefore difficult to measure.
- A conclusive evaluation is difficult to achieve at finer scales due to the lack of adequate and accurate data at the local level. Therefore, a conclusive local level assessment would usually require original research.
- Although the effort to carry out an integrated assessment was cornerstone throughout the assessment process, expert training and common mental constructs still seem to be inadequate to fully capture the complex nature of the system under analysis.

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The following products and results were developed within the framework of the project "Human well-being and sustainable management in San Pedro de Atacama":

• **Publications and documents**

- Final executive report (the present document; so available in Spanish).
- Base line reports on water resources, tourism, biodiversity, agriculture, mining, astronomical observatories and human well-being.
- Article presented at the Alexandria Conference on traditional knowledge: "Patta hoiiri and Likanantay people: rescuing the knowledge of the land" Beatriz Bustos and Hernán Blanco, 2004.
- Multimedia CD with reports, presentation and video.

• **Geographical Information System for the municipality of SPA**

The GIS contains a series of specialised information collated for the project base lines. It therefore represents a full presentation of factors such as water resources, tourist sites, agriculture, protected areas and mining in the municipality. This product will be supplied in CD form, along with a user manual and free visualisation software. Access to the information will be free, in the hope it will be a useful tool for decision-making and territorial planning in both public and private initiatives.

• **Geographical Information System on irrigation in SPA and nearby settlements (ayllus)**

This GIS was developed in cooperation with the Comisión Nacional de Riego (National Irrigation Commission) in SPA as part of the report on water resources. It integrates all available information on irrigation in the town of San Pedro de Atacama and its surroundings.

• **Video "Patta hoiiri and Likanantay people: rescuing the knowledge of the land"**

This video is an approach towards the traditional knowledge of the Atacameño people on the ecosystem and its riches, carefully held in the memories of the elders. It contains a record of the two meetings held in San Pedro de Atacama and Toconao, when the elders shared their memories, legends and traditions on the sky, the volcanoes, the water and the land with children and adolescents from the community. This material was given to all the schools in the municipality, the participating communities, the authorities and regional and national institutions, for educational purposes.

• **Use of solar energy**

The project helped channel the donation of two solar water heating systems by the Universidad Técnica Federico Santa María to a community tourism venture hostel in Machuca and a large low-income family in Camar. A follow-up investigation was carried out to assess the social, environmental and economic impacts of the use of these systems and evaluate their receptivity and possible replication in the zone.

• **International exchanges**

Over the course of the project, we had diverse visitors from abroad linked with the MA: Marcus Lee and Ciara Raudsepp-Hearne, from the MA General Secretariat; Georgina Cundill, from the South African subglobal assessment (SAfMA); and Tian Xiang Yue and Zhan Jingyan, from the Eastern China subglobal assessment (MAWEC). The visitors travelled to the municipality and participated in advisory committee meetings, sharing their work and experiences with the participants.

The documents drawn up within the framework of the project can be viewed at our web page: www.rides.cl or requested by post at the following address:

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