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# Global Changes and Unsustainable Development in the Andes of Northern Chile

Hugo Romero and Andrés Rivera

## 1. Introduction

Global changes are for most scientists mainly physical or biological events. For those trying to participate in sustainable development of underdeveloped regions, globalization of the economy, politics, culture and urban life is as important as the physical and biological phenomena.

The need to observe and interpret recent geographical and environmental conditions is still considerable in regions like the Andes, which, due to their enormous extension along the South American continent, are receiving the direct impact of the deep socio-economic-cultural transformations which are currently affecting Latin America. The Argentinean, Bolivian, Chilean and Peruvian highlands (Altiplano) are in the contrasting position of being marginal landscapes in marginal countries, while at the same time they are a focus of economic interest. Because of their renewable and non-renewable natural resources, these areas are a center of attraction for intense foreign and domestic investment.

If wealth were measured in terms of sustainability, the Andes would have to be considered rich. They have been one of the world's most habitable spaces since civilization developed here more than 4000 years ago. Andean landscapes have contributed, and continue to contribute, to the progress of the world economy by providing a lot of biodiversity, natural resources (water, minerals, flora and fauna), potential and real energy (gravitational, thermal, petroleum and eolic), ecological services (water storage, biogeochemical cycles) and cultural endowments (value and intersubjectivity in the man-environment system, medicinal plants, spatial and temporal organization of ecological belts, sacralization and rites as a way to wisely conserve and manage natural reserves).

However, it is the capitalist definition of wealth which has always imposed the conditions for global assessment of the natural resource bases – either in terms of the provision of technology, capital and markets for regional products, or in terms of the extra-regional decision making and control. After the external debt crisis of the 1980s, most Latin American countries were forced to use their natural resource potential to attract international investment and to balance their economies. These countries used several mechanisms to enhance their comparative advantages: special legislation to ensure capital flow and to allow the rapid metropolitan repatriation of benefits; privatization of national assets to transfer property from national to transnational agents; low salaries to reduce the costs of production, and failure to provide environmental regulation and enforcement.

The rationality of investing capital in marginal regions instead of developed center regions is mainly based on short-term projects and rapid extraction of natural resources and raw materials. The rationality for permanent life in the Andes, on the other hand, is based on social adaptation to long-term natural and cultural cycles. This paper analyses the conflict between modern and traditional rhythms. We use the example of the recent development of Puna de Atacama, the marginal Altiplano of Desierto de Atacama, in the arid North of Chile, where over 5000 million \$US was invested in 1995 to produce larger quantities of minerals, especially copper, for the world market. Nearly 6000 lt./sec of extra water are needed to support the mining, agricultural and urban expansion that is now taking place in the middle of one of the most arid deserts in the world. This development seriously threatens the survival of local communities and biodiversity. We suggest the establishment of a Permanent Regional Trust Fund to maintain environmental and economic diversity. Local societies must be included and compensated during the modernization process.

## **2. Climatic Change**

The Climatic Change in the last 20 000 years is one of the main environmental features of Puna de Atacama. The South American arid diagonal has shifted during this period of time, and rainfall has changed significantly. Paleoclimatic evidence from salars and closed basin sediments show that the Altiplano is an unique geocological region. This environment is highly fragile due to the extreme variability in precipitation (GROSJEAN, 1994). Analysis of the origin of superficial and underground water is suggesting that modern components in the recharge water are lower than the detection limit of tritium in the lower Loa river (<3500 m elevation.) and very rare in the upper valley and the Altiplano (ARAVENA, 1995). The formation of the large ground water bodies took place as a result of very different climatic conditions and environmental factors which facilitated infiltration (vegetation, land cover, intensity and amount of precipitation). Such conditions have not been observed in this area for the last 4000 years (MESSERLI et al., 1993).

Short-term climatic fluctuations are caused by the El Niño and La Niña phenomena. The occurrence and higher frequency of El Niño during the eighties and nineties could be related to heavier rainfall. Such events had a great impact on population and damaged infrastructure, like e.g. the flooding of the coastal cities of Antofagasta and Taltal in May 1992. On the other hand, El Niño seems to be a major cause of dramatic and persistent drought events in the Altiplano, like those between 1987 and 1991. Increasing aridity affected especially the oasis.

Air pollution megasources are also located in this area. The refinery at Chuquicamata for example – the largest open mine in the world – has been discharging 364 tons/day of SO<sub>2</sub> and 1.1 tons/day of arsenic into the regional atmosphere (ARTEAGA and DURAN, 1995), and polluted 2000 ha of soil with SO<sub>2</sub>, particulated matter, Cu, Mo, Cd, Pb and As (MINISTERIO DE AGRICULTURA, 1994). Every year, health emergency situations are declared in the adjacent city of Calama with a population of 150 000.

On the other hand, the climate is one of the main regional resources: it has a great eolic and solar potential (CORFO, 1993). The abundance of clear skies induced the

European nations to install the European Southern Observatory (ESO) at Cerro Paranal. The lack of rainfall allows the operation of open mines all year round.

### **3. Globalization of Economy**

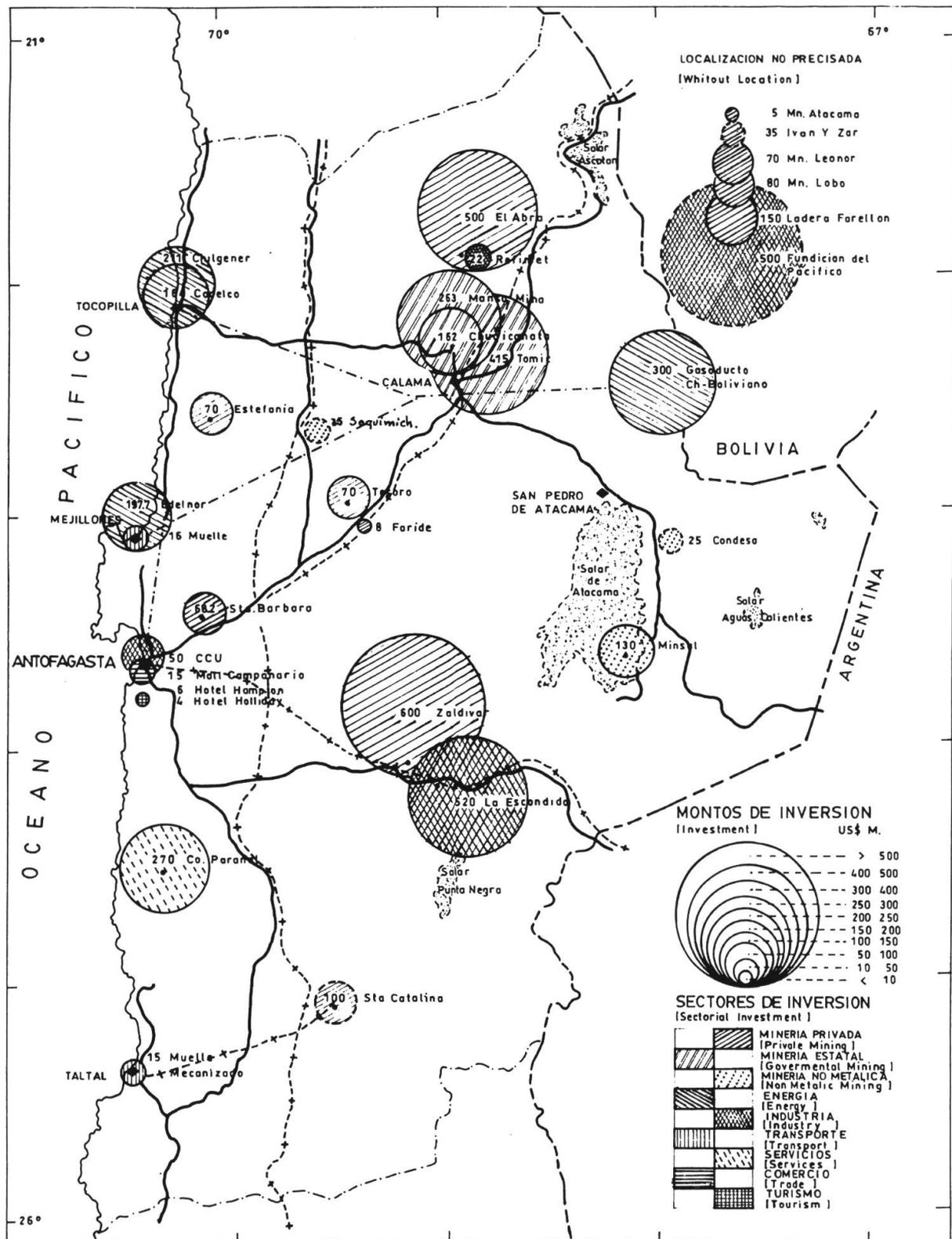
The internationalization of regional economies, the free-market principle, and the privatization process (i.e. the denationalizing of national investment and the privatization of land ownership and water rights) have produced a new and strong demand on the natural resource base. Production factors were modified, traditional land use changed and broke up the highland-lowland interactions. Special regulations like e.g. the Water Code were modified in order to allow individual transactions of resources at market prices without any restriction.

In the Puna de Atacama, the main investments have been made in mines. Canadian, US Companies, and the state-controlled Corporación del Cobre (CODELCO) are investing or making decisions to invest \$US 520 million in El Abra in 1995, and another \$US 850 million in new copper mines like Radomiro Tomic and Mansa Mina, including some renovation in Chuquibambilla. A consortium composed of the state of Chile and the Sociedad Química y Minera de Chile is investing \$US 130 million in a lithium plant in Salar de Atacama; an Australian/British consortium is investing \$US 520 million in the copper mine La Escondida; an Finnish and Canadian Company \$US 600 million in Zaldivar; a US company is investing \$US 160 million in the gold mine La Coipa and an British-American society \$US 80 million in Lobo. Here we mention only some of the largest projects.

After 20 years of continuous application of the neo-liberal economic model, Chile is not only showing a permanent economic growth rate of over 6% annually, but also demonstrating extraordinary regional specialization. This specialization is based on intensive exploitation of the natural resources: mines in the north, agriculture in the center, and forestry in the south. Annual revenues amount to \$US 10 000 million annually for exportation of these products.

Additionally, new services, energy, sanitary facilities and trade are necessary to sustain the growing urban population. This is especially the case in settlements that are located in the core of the modernized areas, e.g. Antofagasta (pop. 250 000) and Calama in the Atacama desert: \$US 460 million have been invested to generate thermoelectric energy in Tocopilla and Mejillones, \$US 300 million in a natural gas pipeline between Bolivia and Chile; \$US 25 million in shopping centers and hotels in Antofagasta, and over \$US 30 million in the rehabilitation of harbors at Mejillones and Taltal.

As a result of rapid economic growth, traditional mountain economies which are based on agriculture and livestock are clearly becoming depressed. The local population has been forced to migrate to the lowlands in order to get employment, housing, education, and health services. As in many other regions, the modernization process is excluding the local communities and concentrating the population in slums around the main cities. The scarce water resources are now allocated to short-term and more profitable activities which disturb traditional cultures.



- Capital Regional (Regional Capital)
- ◆ Centros urbanos (Urban settlement)
- Localizacion de proyectos (Project location)
- Proyecto en ejecucion (1995) (Project undergoing execution)
- Proyecto en decision (Project undergoing decision)
- Caminos principales (Main road)
- Ferrocarril (Railway)
- - - Gasoducto

Fig 1: Amount and sectors of investment in northern Chile

Local tourism may be one of the few options to prevent rural exodus. The oasis of San Pedro de Atacama with its 2500 permanent inhabitants receives more than 25000 mainly European visitors annually. This exceeds the seasonal capacity and requires more sophisticated services. Although some local people, especially women, participate in the business, most of the decisions are taken by extra-regional investors. The development of local entrepreneurial capacity and training in touristic services is needed, but the most urgent needs are to preserve natural and cultural values, to provide enough drinking water and to sustain food supply for this increasing market.

#### **4. Conflicting agents**

The regional scenario of a long-term trend towards desertification and a short-term trend towards growing economic investment, especially in mining and urbanization, incorporates three actors that demand water:

- the national and foreign mining investors,
- the drinking-water and sanitary company (Empresa de Servicios Sanitarios de Antofagasta, ESSAN),
- local inhabitants and farmers.

All of them have one problem in common: the increasing demand for water.

The water company has attempted to extract water from salars and lakes in the Altiplano, but the long distance to the big cities and the high costs were reasons to reject this approach. Other projects, like sea water desalinization, have also been stymied by the high costs and the regionally fixed rates for drinkable water. The profitability of these private companies is another constraint.

Thus, the only solution to satisfy growing urban demand is to buy water of the Loa river from local farmers. One major purchase took place in January 1995, when ESSAN bought 32.76 lt./sec for \$US 2.79 million from Ganadera (livestock) Abaroa. In addition, the company works with an international partner to raise \$US 7.5 million to treat waste water in Antofagasta city. In this sense, one of the most feasible projects is to treat and re-use waste water from Calama city for irrigation (ESSAN, 1995). For this purpose, a water trade-off between the company and the farmers should take place, as should a meaningful technological innovation in agricultural practices. However, this requires a higher level of confidence between the actors and a real commitment in technical and financial collaboration between both sectors.

The mining companies become more and more environmentally concerned, either because of the real lack of water resources or because of the international environmental pressure from donors, and approval of national laws and regulations to conserve water. They try now to find ways to avoid water extraction from the Altiplano, to optimize its use, to recirculate the resource in different productive processes, and to replace the old system of mineral concentration by lixiviation. However, as the water in the Water Code is considered a free good, the Companies are not forced to invest in saving this resource.

As an example of the real potential to save water, CODELCO has reduced water consumption in mineral treatment from 1.76 m<sup>3</sup> per ton material in 1980 to 0.91 m<sup>3</sup>

water per ton in 1994, which is equivalent to recirculation of 1230 lt./sec. (LIZARRAGA & HERNANDEZ, 1995). The extraction of water is still very important in salars like Ascotan y Carcote and the San Pedro River in order to supply the new projects in El Abra and the Radomiro Tomic mines with water. However, extraction threatens recharge and the bio- and socio-diversity of these areas. Other private and international companies, like Escondida and Zaldivar, have been prospecting and exploiting ground water bodies and superficial streams in the southern part of the region.

Mantos Blancos, a mine located only 45 km inland from Antofagasta does not own enough water rights and has, therefore, to buy water from the railway company (Ferrocarril Antofagasta-Bolivia) and from ESSAN. Under such constraints the mine reduced consumption and invested in technological innovation (ARIAS, 1995). Finally, Minera Michilla is desalinizing sea water. Each company tries to deal with its own resource restrictions, making apparent the need to design a general and strategic regional plan, together with a real assessment of the quantity, quality and recharge rate of available water.

The third actor are the farmers. Most agriculture is subsistence agriculture, and most of the land is already abandoned because of reduction of water for irrigation, soil salinization, extreme partitioning of land, low profitability, and emigration to urban settlements. As a consequence of the persistent processes of devaluation and acculturation, some oases, like the communities located along the Loa River (Calama and Toconce), show the results of failed adaptation strategies and cycles of domination. They lose gradually their autonomy and the capacity to make decisions about the use of their territorial resources.

If there is no firm intervention by the regional government, these communities will continue to sell water rights. The mines, the water company and speculators offer nearly \$US 11 000 per m<sup>3</sup> today, which is equivalent to many years of soil and crop conservation and management. In the valleys of the Atacama desert, agriculture without water is obviously not feasible and the land is completely useless.

On the other hand, the communities around the Salar de Atacama (San Pedro de Atacama) and some oases in the Loa River (Chiu Chiu and Caspana) have a more direct link to the even Pre-Tiwanaku tradition of the Atacameños, and have developed close relationships to land and water. They have usually fought to conserve their traditions and to keep their autonomy; for a long time they opposed the attempts of foreign cultures to impose themselves. They have responded organically and used the empowerment resulting from the recent Indigenous Law to constitute «water communities» and to avoid the selling of individual rights.

Some attempts have been made with regard to the water trade-off between farmers and ESSAN, but they have been unsuccessful because of the poor organization among local people and the lack of dialog with the water company.

## **Conclusions**

It is necessary to formulate a strategic plan for water allocation, harmonizing the different actors, overcoming the mutual lack of confidence, and elaborating common aims and policies.

The optimization of water use must be a shared goal. Each sector should participate in saving the resource, improving its management, and using the available quantity and quality according to specific needs.

A geocological allocation of water according to areal sustainability is required. The coastal urban settlements and mines should desalinate sea water and recycle waste water. This in turn sets the water resource free for use in the uplands. The fresh water should be conducted to inland settlements, agricultural land and mining. There, recirculated water must be used by mines and recycled water by agriculture.

An intense water use trade-off among the three different actors is required. The agricultural sector should substantially reduce water consumption, and community reorganization is needed in terms of agricultural practices and land ownership. An improvement in the quality of irrigation water is also needed to avoid salinization and to increase the soil productivity. Mines and water companies must cooperate to modernize agriculture by contributing financially to improve its technology and productivity. This is crucial in order to maintain the local food supply and liberate water for competitive uses. The mining sector must reduce its consumption of fresh water, improve the technology of material treatment, and recirculate the resource. It should also explore and diversify its water sources and allow the government and the local people to share the knowledge about the resource. The water company that supplies drinking water should recycle waste water and promote concern and training among the population about the desert environment in which they are living.

As a consequence, the state, as it is represented by the Regional Government, should be committed to the design and implementation of multisectoral policies, plans and programs for water management. For this purpose, a Permanent Trust Fund for Regional Development is essential. Funds have to be generated by profitable and successful economic activities. This would pay for access to Water Rights, and emphasize regional investments in human resources, training and education, productive diversification, research and development, compensation to local people, etc.

From a scientific point of view, efforts are urgent to evaluate the quantity, origin, quality and renewability of water resources. The Swiss Project on Climatic Change in the Andes, conducted by Professor Bruno Messerli, has been a great support and a source of inspiration in applying environmental science to sustainable development of marginal regions. The concern of the authorities, entrepreneurs, local people and scholars about the necessary social and environmental sustainability of economic progress increased.

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