

OECD GLOBAL FORUM ON ENVIRONMENT:
MAKING WATER REFORM HAPPEN

**Water Management Problems
in the Copiapó Basin Chile:
Markets, Severe Scarcity and the Regulator.**

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Some nice pictures of the Copiapó Valley!!!



Water Management Problems in the Copiapó Basin Chile

This case study focus on the **factors that led to the dramatic failure of water management in Copiapó Basin**, and the efforts needed to address the challenges arising from **intense competition** for scarce water resources between **mining, agriculture and human consumption in the basin in the future.**

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1. Water Regulation in Chile
2. Water Resources in the Copiapó valley
3. Water rights and water uses
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6. Policy recommendations

Water Regulation in Chile

- * **Water Law of 1981** was introduced, establishing that although water resources are public assets, **water rights** can be granted to individuals and firms interested in using the resource, in the same way as any real estate.
- * This property rights allocation is governed by civil law and protected by the constitution. **Water rights are, therefore, traded, inherited, and subject to the same rules of a real estate.**
- * Thus, the Chilean model was exceptional not only by the introduction of water rights and markets, but also because the limited powers of the State to intervene in the management of the resources.

Water Regulation in Chile

One of the main objectives pursued by the Chilean water legislation was the creation of a water market, which could efficiently set a price that reflects the real opportunity cost of the resource. The system of rights must also have the flexibility to adapt to the existence of natural variability on the availability of the resource in the short and long term, without undermining the property right.

Water Regulation in Chile

- * **The most important reforms to the Water Law introduced in 2005** were the establishment of a water flow restriction according to an ecological minimum; hence the State could reject granting rights to preserve environmental values.
- * **In addition, the reform included** the possibility of creating water reserves under exceptional circumstances, the need of a justification in the water rights application, a fee in the case of non-use of water rights, and the obligation to report transactions on water rights.
- * **None of the reforms meant important changes to the model of allocation of water rights, and they just intended to improve the market functioning,** so the primary definitions of the Water Code of 1981 still apply in Chile.

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Water Resources in the Copiapó valley

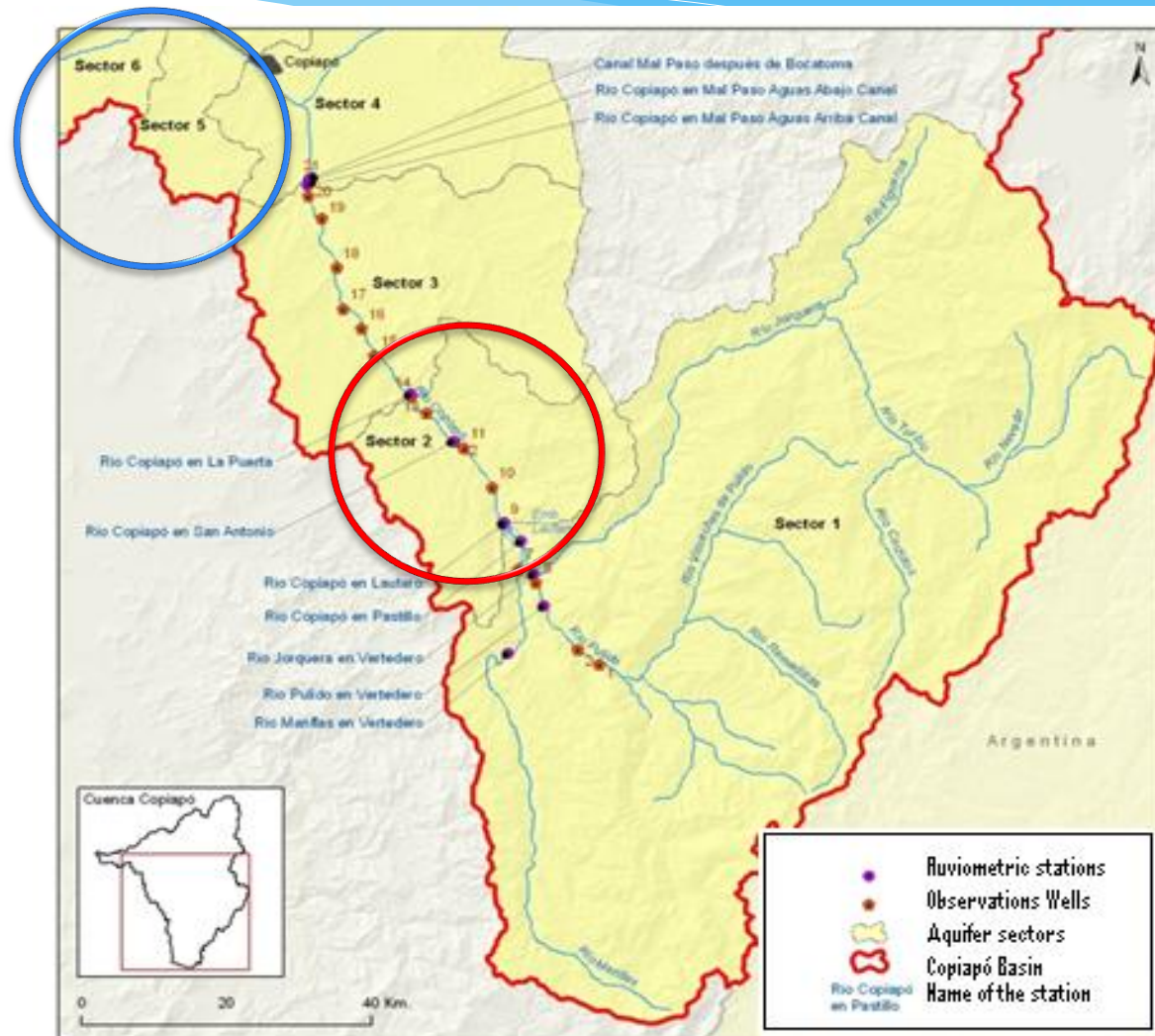
- * **Copiapó is located in a very dry area and almost all water resources in the Copiapó basin** come from Manflas, Pulido and Jorquera rivers, in the upper and mountainous part of the basin.
- * The other contributing areas hardly produce regular flow, but only in the presence of extreme rainfall. **While Manflas, Pulido and Jorquera rivers receive between 40 and 60 millimeters (mm) of average annual precipitation, Copiapó receives only between 10 and 30 mm.**

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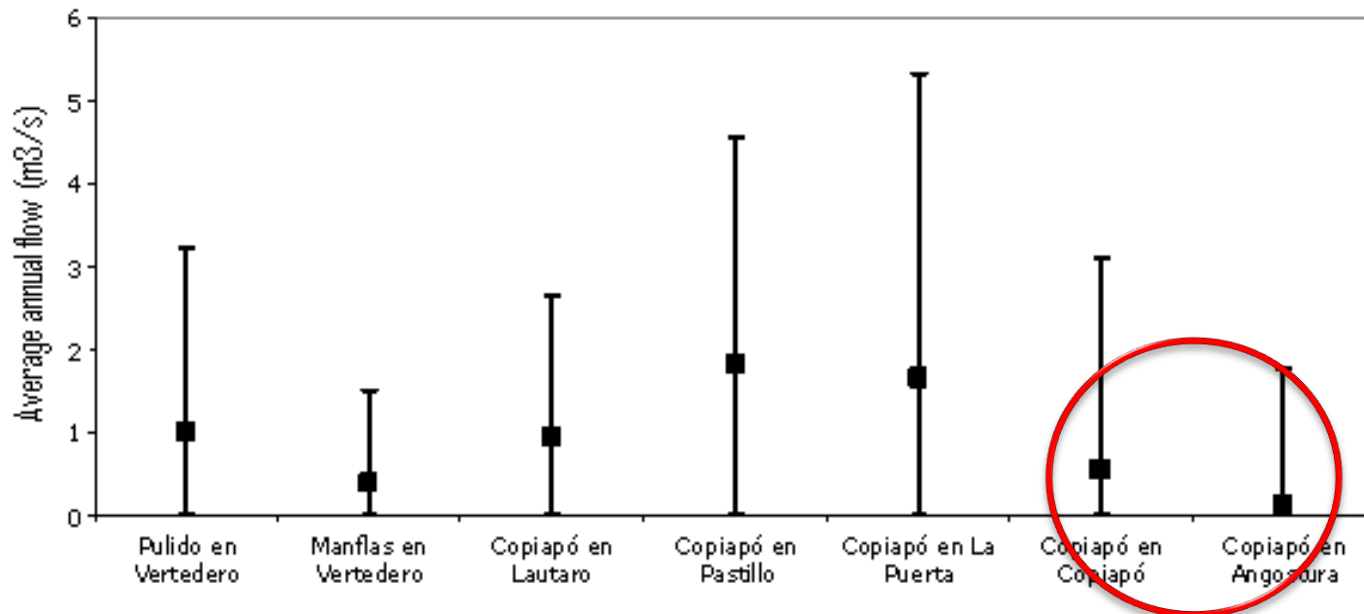
Water Resources in the Copiapó valley

- * **The amount of surface water in the Copiapó River is quite different depending on the section.** The biggest flow is located at the west side of Lautaro reservoir, located on section 2, with 1.8 m³/s.
- * **To the west of Copiapó in Section 5 and 6, the river is usually dry and the average flow is close to zero,** even in wet years it can only reach up to 1.7 m³/s with a probability of 15%.
- * **90% of consumption in sections 4 and 5 is originated in the agricultural sector and it is supplied mainly from wells with a total extraction of about 1 m³/s.**

Flows and consumptions



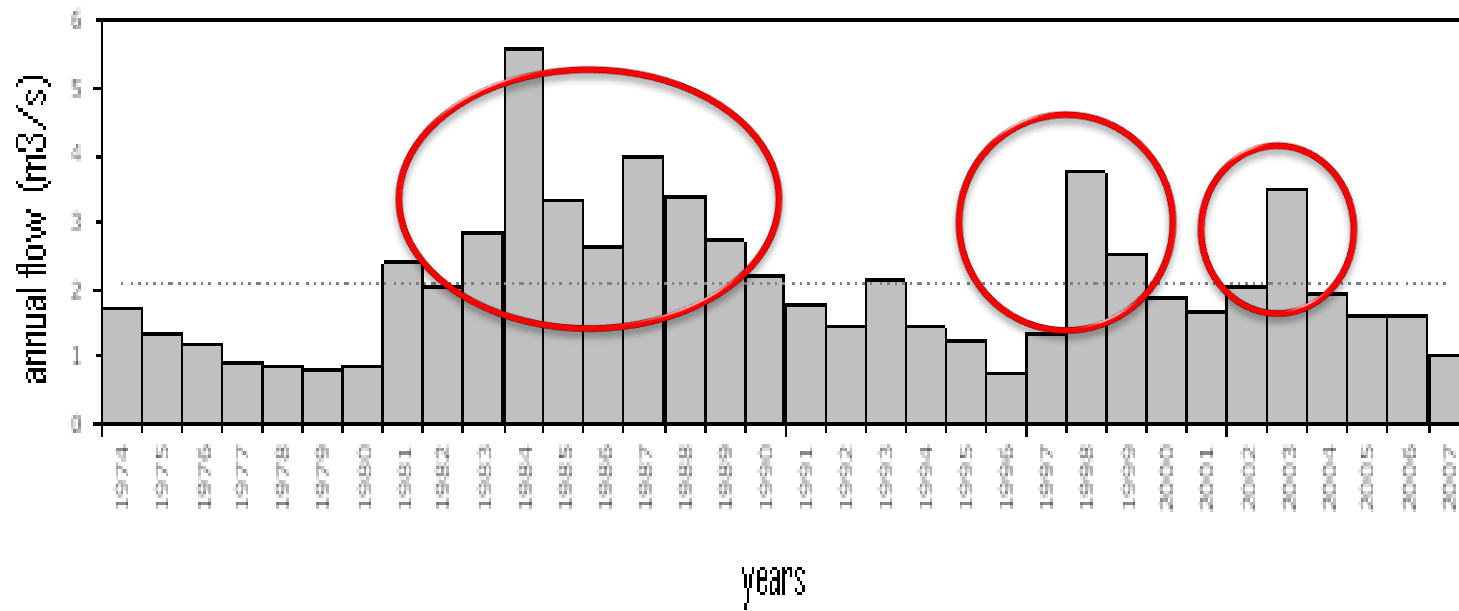
*Average annual flow distribution throughout the basin.
From the upper side (Pulido on Vertedero), to the
lower part (Copiapó on Angostura)*



http://www.observatoriocuenca.cl/copiapo_hidricos_cantidad_detalle.php

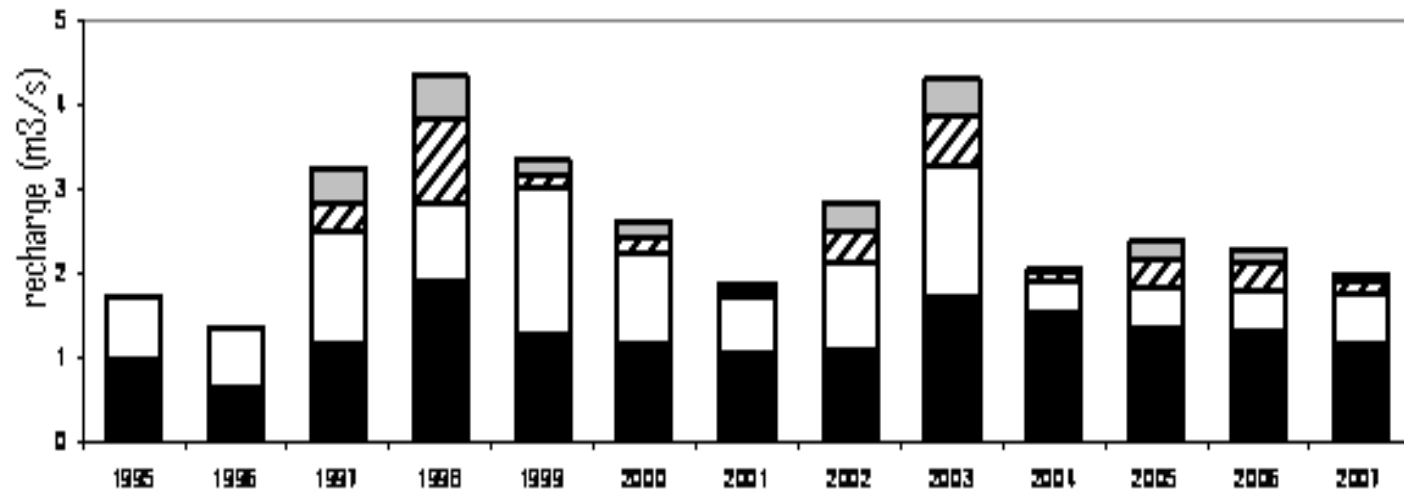
Annual recharge to the aquifer of Copiapó

- * The annual recharge presents an enormous variability, with an average value of 2 m³/s.



- * After 1993, there were only three years when values were higher than 2 m³/s. The period between 2004 and 2010 has been characterized by dry conditions.

Seasonal distribution of recharge to the aquifer between La Puerta and Desembocadura



Sector 3 on black; sector 4 on white; sector 5 cross hatched; sector 6 on grey

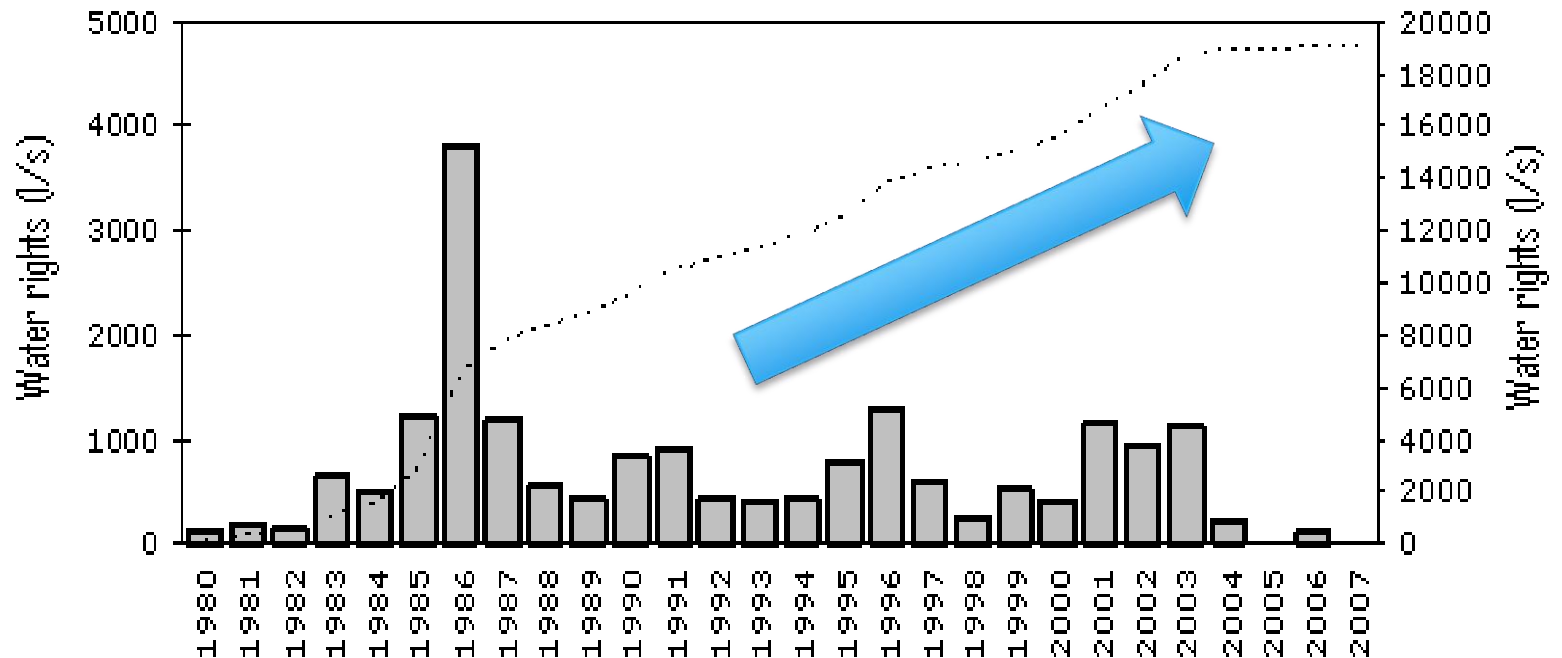
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Water rights and water uses

- * **Most of groundwater rights on the Copiapó aquifer have been awarded under the 1981 legislation.** The latest survey conducted by the DGA in 2009 indicates that in total 17,754 m³/s of water rights were granted in the aquifer.
- * **In order to grant these amounts of rights extremely optimistic assumptions were made.** It was expected by DGA that only 20% of the rights granted would be effectively used, because it was granted for farming purposes.
- * **At the beginning, these use levels could have been reasonable, while there was some abundance of water and low pressure from new sectors to acquire rights. Nevertheless, when scarcity increases, effective usage goes up, but DGA failed to adjust the parameters.**

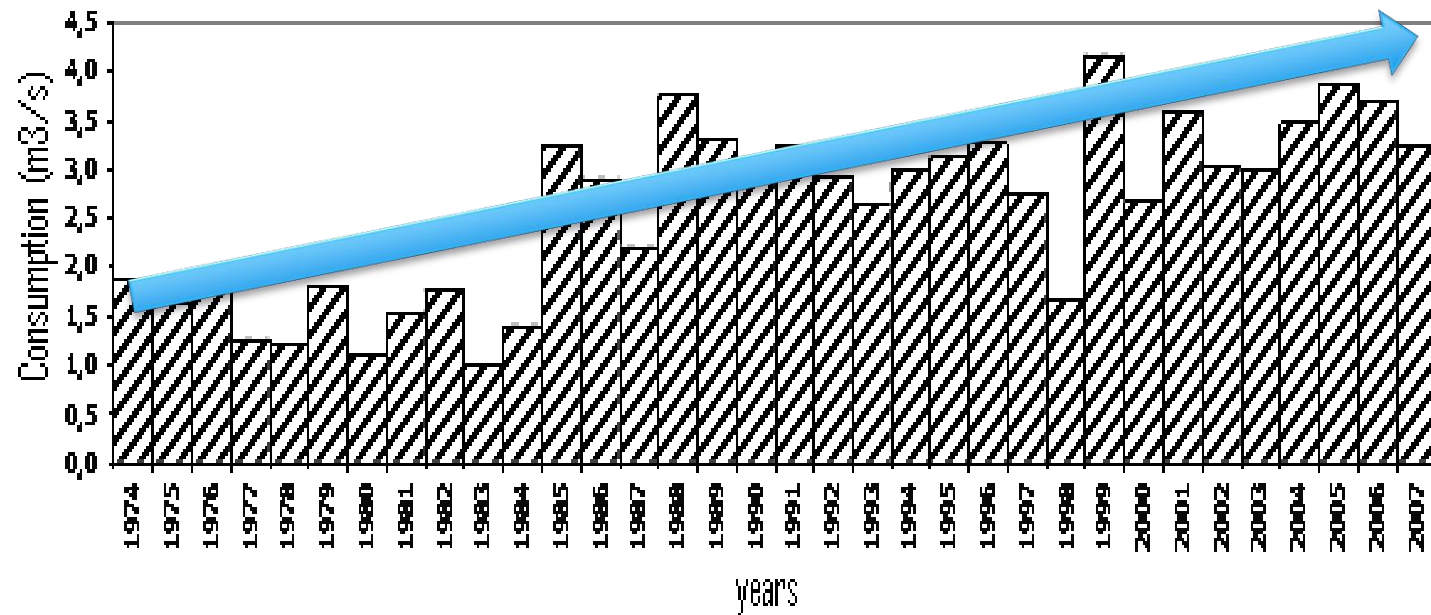
Water rights granting on the Copiapó aquifer



Water rights and water uses

- * Although the recharging capacity was known by the DGA, the resource consumption of the aquifer from 1985 on, consistently exceeded the 3 m³/s.
- * **From that date overexploitation was in place since consumption values were above the long-term recharge.**

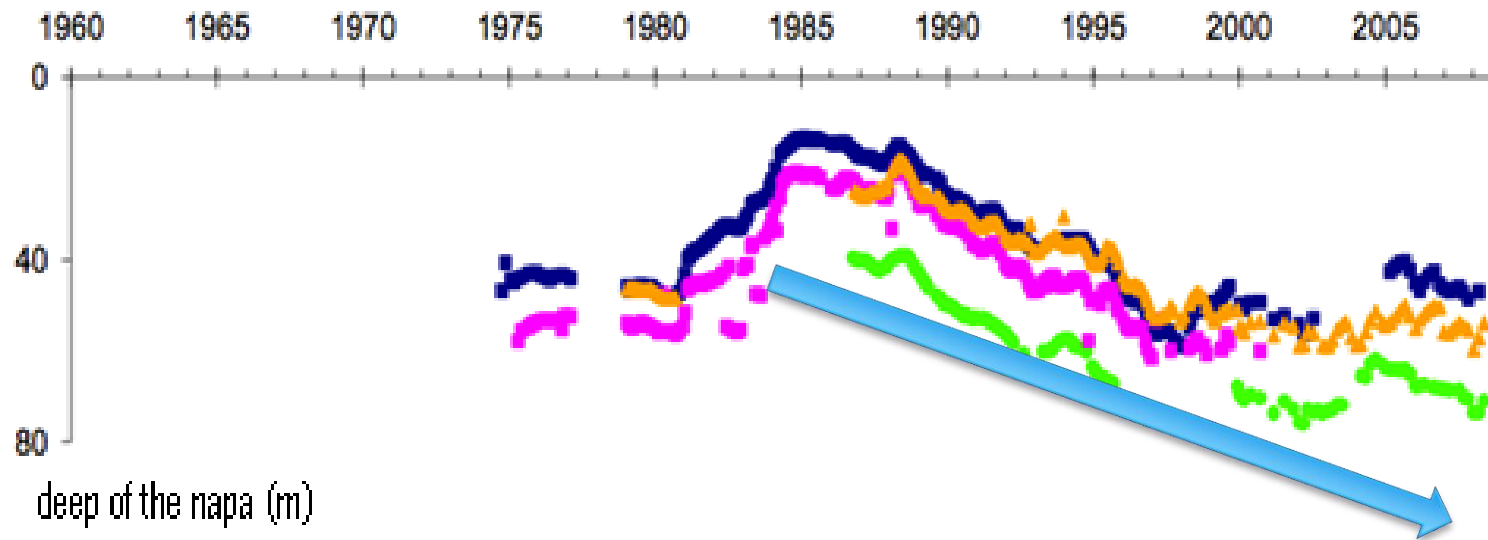
The evolution of consumption for sectors 3, 4, 5 and 6.



The Tragedy of the Commons...

- * **Agents that were interacting on the basin could notice an over consumption** because, it was necessary to go deeper to get groundwater on pumping wells.
- * The decline in the groundwater level of section 3 and 4, reaching depths between 50 and 70 meters, far deeper than those observed on previous periods. As a consequence of this, pumping costs have been rising considerably in the last few years.
- * **They knew an overexploitation process was going on!!!**

Observation wells in the area immediately downstream from La Puerta

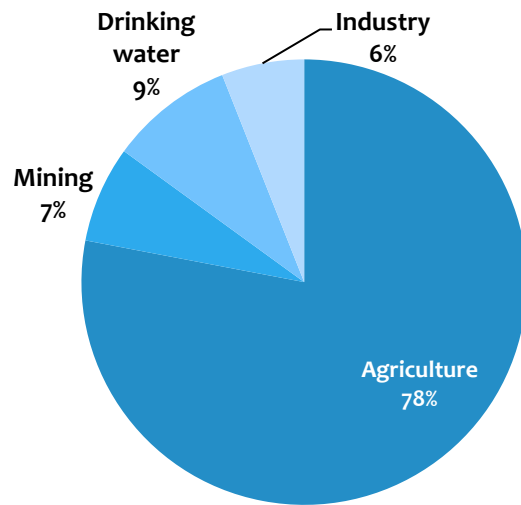


The tragedy of the commons is a dilemma arising from the situation in which multiple individuals, acting independently and rationally consulting their own self-interest, will ultimately deplete a shared limited resource, even when it is clear that it is not in anyone's long-term interest for this to happen.

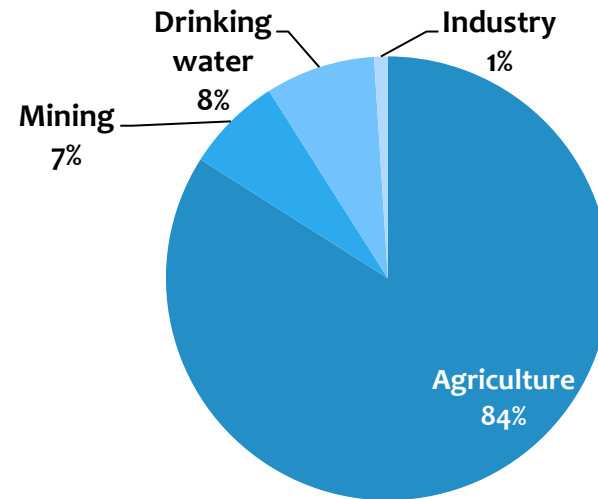
On the Water demand

- * In 2010, the demand for water reached 6 m³/s.
- * This meant twice the total sustainable recharge of the aquifer.
- * 84% represents agricultural use, 7% mining industry, 8% drinking water and 1% industry.
- * On the other hand, 60% of total consumption was concentrated on sectors 3, 4 and 5, downstream of La Puerta.
- * The relative distribution of the demand have not changed in the last 10 years, but the demand has increased in about 1 m³/s.

Groundwater demands 2002 -2010

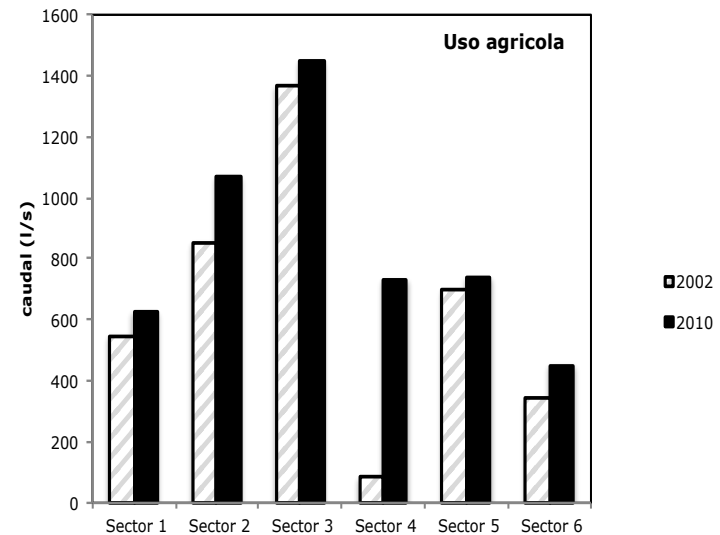
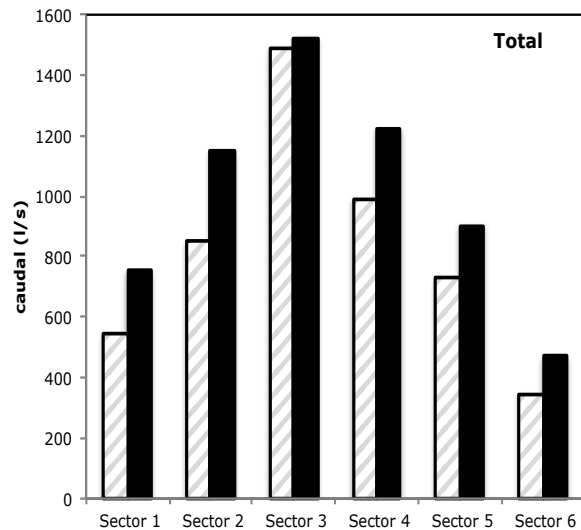
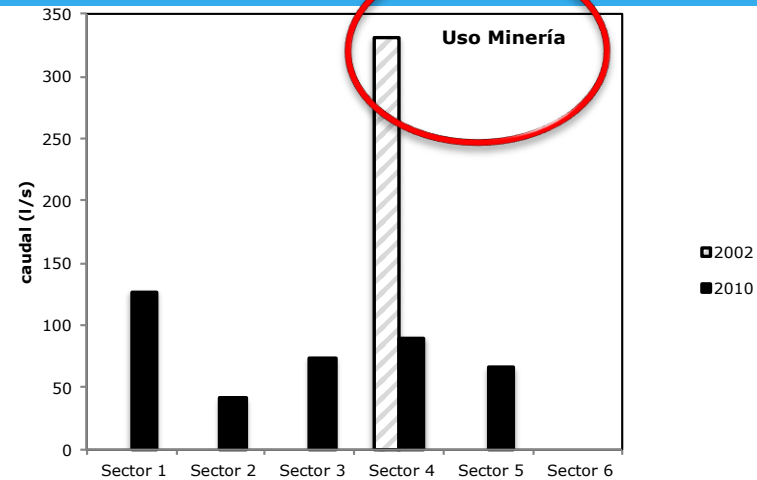
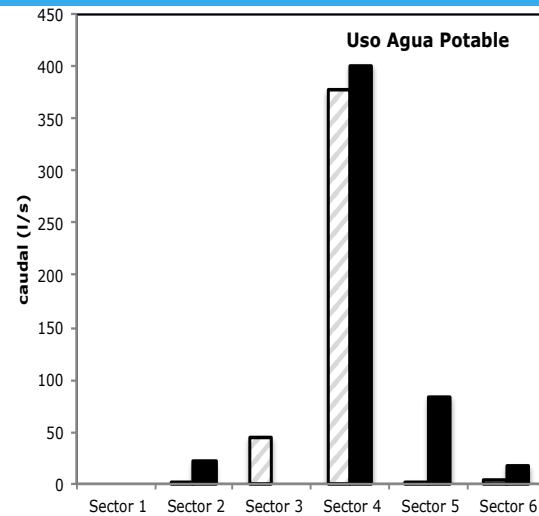


2002



2010

Use of groundwater by activity and sector



Intense competition for scarce water resources between mining, agriculture and human consumption in the basin

- * **An interesting issue to consider is the dynamic efficiency and equity effects of this regulatory model.**
- * In areas where mining activities coexists with the fruit growing industry, the rising price of minerals will produce an expansion of mining activity and hence the opportunity cost of water for mining projects will increase.
- * In the short term, mining companies are willing to pay more than US\$ 2 per m³, compared to the fruit industry, which is willing to pay only about 0.2 US\$ per m³.
- * This situation will create a kind of a **Dutch disease effect** not only in the labor market but also in the water market.
- * Indeed, mining companies are desalinating seawater and moving it up to 3000 meters above sea level, which means that these companies are willing to pay outstanding prices for water.

Dynamic efficiency?

- * **Static efficiency** would imply that all the water rights would be eventually transferred to the mining sector. This would lead to a drastic reduction in Chilean fruit production, where the country used to have a huge comparative advantage and brand image.
- * **If Chile leave this fruit market, when the mining boom is over, it would be difficult to build again the fruit industry;** hence from a perspective of dynamic efficiency it is not clear that full tradability and an unrestrictive application of the law of one price is a good solution.
- * In addition, the potential agriculture slow down will have very damaging social effects, such as structural unemployment.

What happened to the market?

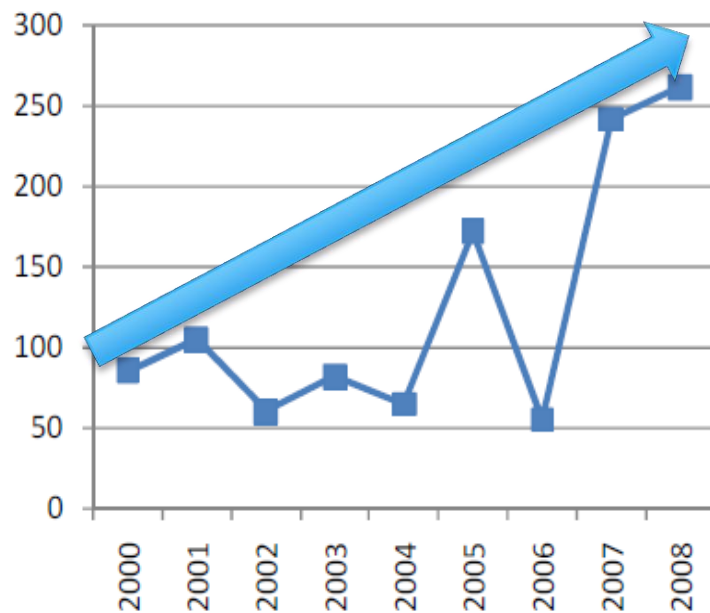
- * **In Chile, the water market started with several and deep problems, that prevented it to work properly.**
- * First, the initial allocation of water rights was granted for any firm or person interested, allowing in some cases huge levels of market concentration.
- * Secondly, the minimum amount of resource for the ecology was never appropriately calculated and granted.
- * Thirdly, the institutions arrangements for a good market functioning were never properly put in place. As a consequence of this last point, for instance, information about market transactions is almost impossible to get.

What happened to the market?

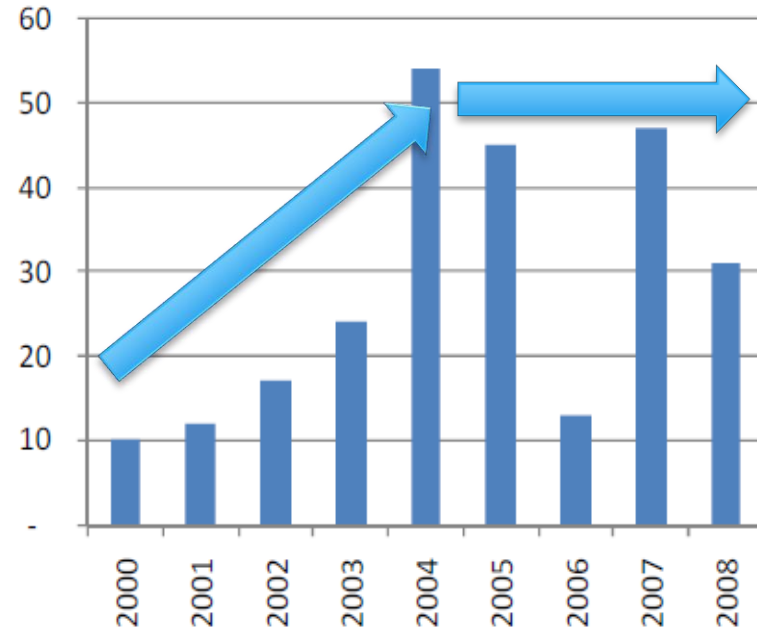
- * Finally, watchdog institutions caring for the correct functioning of the market did not have the right human and legal resources to ensure the protection of the resource, the efficient infrastructure to allow the transactions, an efficient mechanism for conflict resolution, and effective enforcement of the water rights, among other problems (illegal extraction of water is almost 1,000 l/s per year).
- * **Summing up, almost all the requirements for a market to be efficient were not overseen in the 1981 law.**

Evolution of price and transactions of groundwater

Groundwater price dynamics



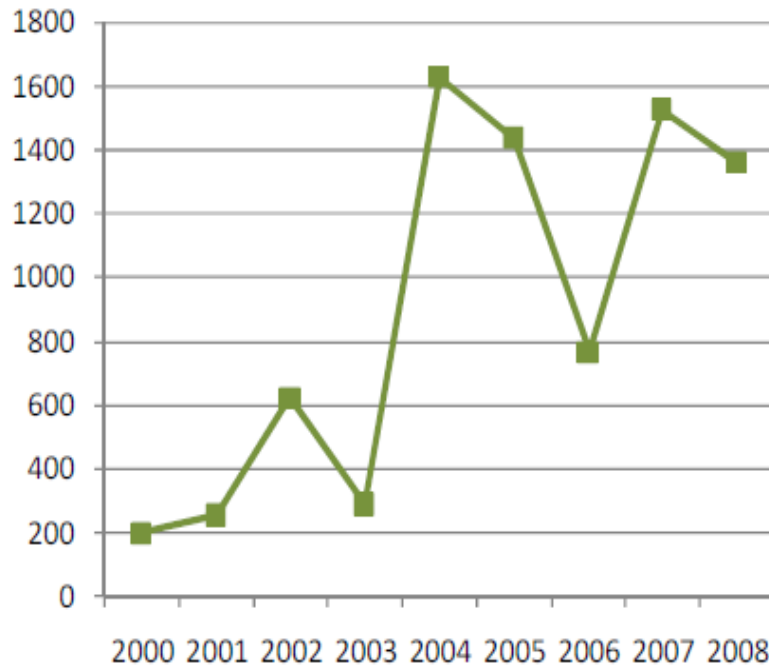
Number of Transactions



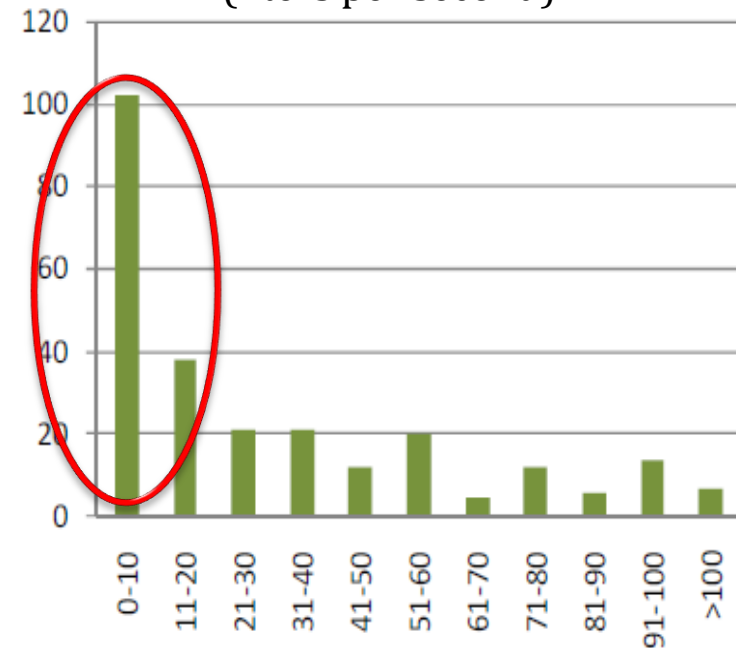
Sources: Bitrán y Asociados based on the database of the real state register

Evolution of flow transactions

Transactions
(liters per second)



Number of transactions by flow
(liters per second)



Sources: Bitrán y Asociados based on the database of the real state register

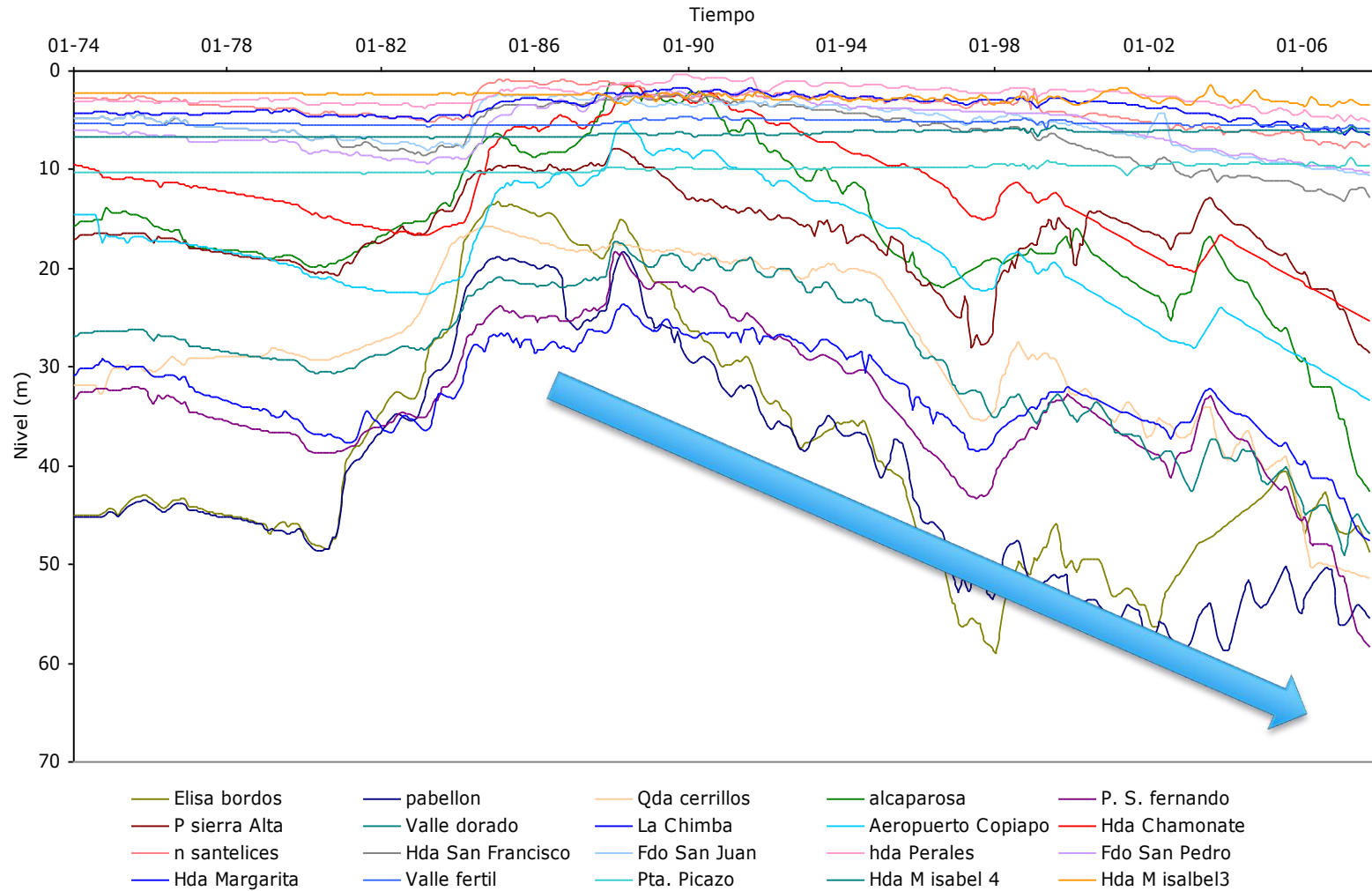
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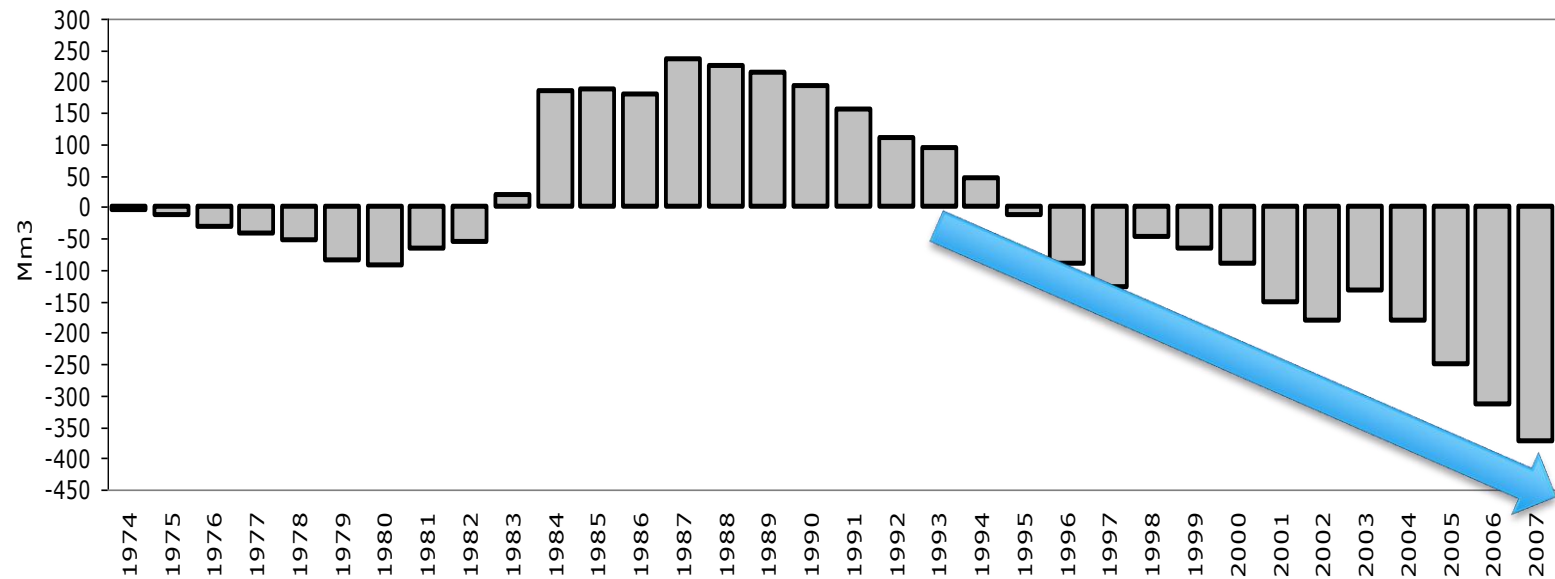
Current overexploitation of the aquifer and future implications

- * An alarming behavior is observed on the annual variation of the annual gains and losses of the volume of the aquifer.
- * Indeed, after 1990, losses are much more frequent, much higher, while gains are much more unusual and of lower amount. As shown in the next figure, if you compare 1973 and 2007, aquifer losses represent about 450 million of m³.

Levels of the Aquifer on the observation wells

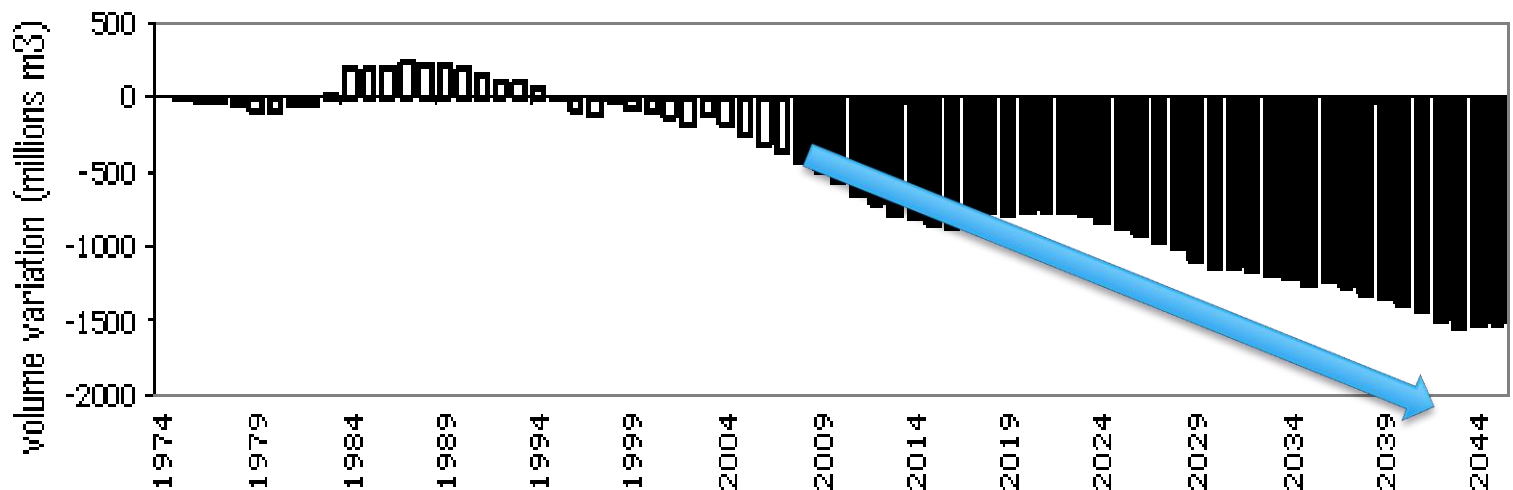


Acumulative volume change in the aquifer with regard of 1973 volume



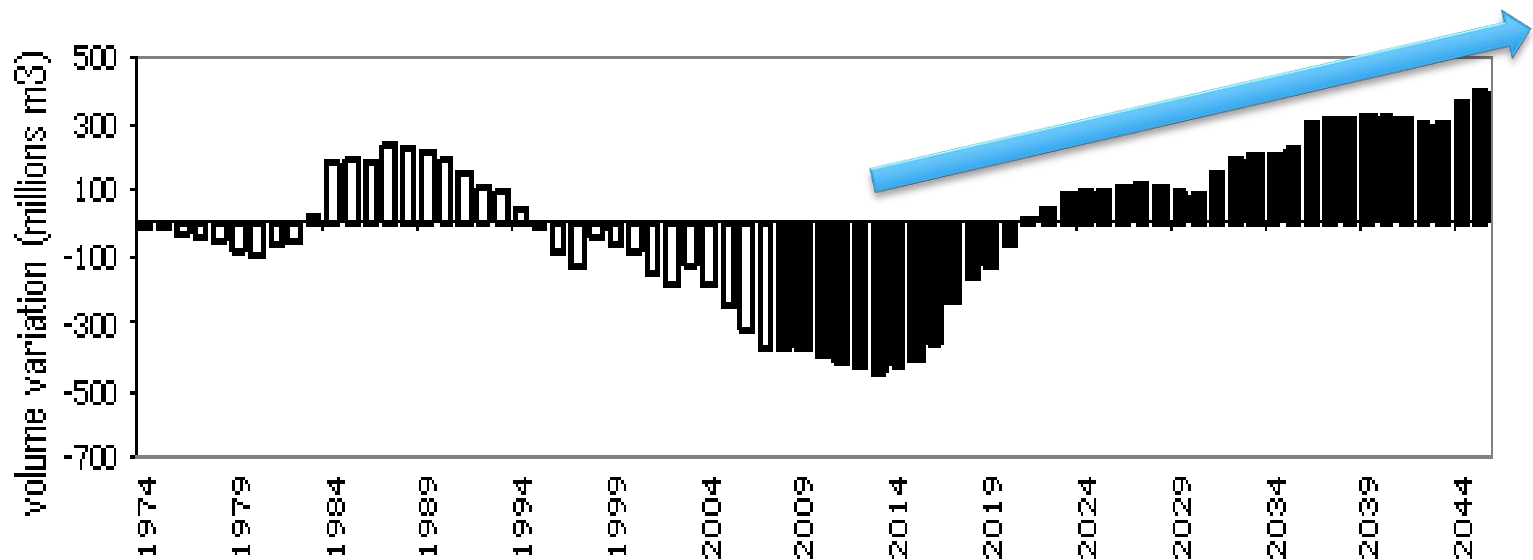
What will happen if the current situation is not improved...

- * A hydro geological model to simulate the aquifer flow was developed.
- * With this tool, it is possible to model the projected volume of water in the aquifer, considering the same level of removals of those existing in 2008.



What will happen if the current situation is not improved...

- * If the future situation is evaluated considering a sharp reduction of the holdings, up to 50% of the total removal of 2008, the aquifer will show a remarkable resilience. As shown on the figure, 10 years after the reduction of exploitation levels, levels similar to those registered 35 years ago might be reached.



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Management of the crisis

* The water negotiation table

- * **The emptying of Lautaro reservoir** and the marked decline of the aquifer, which mainly affects farmers in the middle section of the Valley, became **the key factors that precipitate a conflict that took national and regional political importance.**
- * On 2007, the Regional Government call to the national authorities responsible of the sector for a meeting to find solutions to the conflict. In order to deal with farmers uprising and other pressures groups in the basin, the DGA, the Public Works Ministry and the Regional Government promoted the creation of a private-public body to tackle the crisis, now known as “The Water Negotiation Table”.

Management of the crisis

* The mining sector water negotiation table

- * Conflicts between agriculture and mining for the use of water resources is uncovered in Copiapó, however there are other basins that were incubating similar conflicts. **In this context, the Ministry of Mining proposed a negotiation table to analyze the situation of Copiapó with large mining companies**
- * **In this table, the Ministry of Public Works proposed explicitly the need to discourage the purchase of water rights by mining companies to farmers in the valley of Copiapó, asking companies to seek alternatives for water supply such as, desalinate seawater.**

Management of the crisis

- * **Steps in place to mitigate the overexploitation**

- * On 2008 **DGA canceled an important part of provisional duties previously granted**, especially those given in sections 3 and 4. Of a total of 1.4 m³ / s granted in the entire aquifer, 1.1 m³ / s were nullified. This measure, which under normal conditions would have caused uproar and opposition, was supported by most members of the water table.
- * Another positive outcome of the table was **the identification of illegal extractions on all sections of the aquifer of Copiapó** and the enforcement of water rights. It was key in this regard, the data and information generated to assess the situation of water resources and to share all the information with stakeholders.
- * **For the first time environmental concerns arise, which were put forward by actors who were not direct users of water resources.** In particular, they raised two important issues: the deterioration of the wetland at the opening of the Rio Copiapó, which means a high environmental impact due to intensive exploitation of the aquifer, and the dramatic deterioration of the river throughout the basin.

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Policy recommendations

- * **To the Regulator:**

- * thin the framework of the existing law, **a conservative approach should be followed granting permanent rights base on the availability in dry years**, and granting eventual rights to exploit the resource in humid years, this should be done for surface and groundwater resources. Otherwise there would be an endemic trend toward overexploitation.
- * Usually, **environmental externalities are managed through the analysis of integrated basins**. In Chile despite the advice of multilateral agencies, there is not a government agency involvement, leaving this task to organized private groups. The work of users associations in this issue has had positive results in some places, but it has failed in many others. The economic interest of each party has limited the effectiveness of these schemes.

Policy recommendations

- * **To the Market:** Social costs must be incorporated into the market prices in order to deal with this potential Dutch disease effect. Besides, lack of information, transactions costs, market powers, all symptoms of market failure, must be eliminated...
- * **Markets solutions do not mean automatic and self-maintained solutions.... institutional arrangements, regulations, and regulators are all needed!!!**
- * A central issue that should be addressed is whether the institutional and legal framework allows a proper water management in general and in particular in cases like this.

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Policy recommendations

* **Management objectives on the Copiapó basin**

- * The public policy objective on the Copiapó basin should be to create the conditions for water basin sustainable exploitation from an economic and environmental perspective, having in mind existing activities and those to be developed in the future. What does this general objective means?
- * Firstly, it is necessary to ensure a continuous and quality drinking water supply for the population.
- * Secondly, it is desirable to continue with the high productivity fruit activity on a scale close to that achieved in recent years. This is certainly an efficient agricultural use of water resources, with less than 0.3 liters per second per hectare, which provides most of the employment on the basin. In fact, the fruit of Copiapó is positioned in international markets as earlier export quality fruit, which allows keeping a certain leadership and recognition of the Chilean fruit at the beginning of winter in the U.S. and Europe.
- * Thirdly, the water policy has to facilitate the development of mining, associated with the incorporation of new water to the basin.
- * Finally, from an environmental point of view, it is important to protect the coastal aquifer and its ecological richness. The key question is how to achieve this ambitious set of goals with the current legal framework and institutional arrangements, when there is a declared over-extraction and over allocation of water resources.

Policy recommendations

- * **Some alternatives of water management in Copiapó.**
- * The strategy outlined should be accomplished using and adjusting market mechanism. A command and control approach is beyond the option of Chilean policy making in the sector. To address the recovery of the aquifer, the State has some tools that could potentially use. These mechanisms are: zoning of the aquifer, the declaration of water scarcity zone and the proportional rationing of water extraction among all users. Some of these instruments were created for different purposes, such as facing drought, and its applicability should be reviewed. In addition, some changes of regulation like defining eventual rights for aquifers could be attempted, as they exist for surface water streams.
- * Zoning of the aquifer and declaration of scarcity zone can be very useful to deal with the Transition Phase. Zoning should tend to reduce the current administrative areas, grouping up sectors 1, 2, 3 and 4 in one area (High Zone) and grouping up sectors 5 and 6 in another (Low Zone). The redistribution of rights in the same area should be administratively simple. This reorganization would facilitate the exchange extraction of section 3 and 4 at 1 and 2 for shorter periods, as a temporary measure.

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