

THE MARKET OF WATER RIGHTS IN CHILE:  
MAJOR ISSUES\*

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ABSTRACT

*Many economists advocate the use of tradable water rights as the most efficient system for allocating scarce water resources among alternative economic uses. According to this view, a private market in tradable water rights would maximize the economic value of the resource; would help to reduce costly public infrastructure investment and would foster private investment in irrigation. The case of Chile, which in 1981 established a system of tradable water rights, is fairly unique and provides important lessons for other LDC's. The paper reviews the major issues and controversies that have surrounded the practical implementation of this system in Chile.*

*The paper contends that the system in Chile has worked reasonably well although some amendments may be needed. Among other things, a more complete definition of non-consumptive rights is called for and transaction costs arising from incomplete legalization of water titles, lack of infrastructure, and free rider problems need to be reduced. However, all in all, fine tuning of the system, rather than drastic reform, seems the most advisable policy recommendation. In this sense, the conclusions of the paper differ from some policy prescriptions recently proposed by the government.*

*Finally, the paper emphasizes some particular characteristics of the Chilean experience that have contributed to an adequate functioning of the system and that should be taken into account when implementing similar schemes in other countries.*

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## I. INTRODUCTION

Many economists advocate the use of tradable water rights as an efficient system for allocating scarce water resources among alternative economic uses. In an efficient market for water rights, the value of marginal productivity of water would be equated across different possible uses, thus maximizing the economic value obtained from the scarce resource. Thus, the market is the most efficient mechanism to allocate the resource in the absence of information asymmetries, transaction costs and externalities. Furthermore, so the argument goes, establishment of water rights, by securing private property, would have a positive effect on private investment in related infrastructure and maintenance. Even more, in some instances, a private market for water rights could act as a substitute for costly new investment in water infrastructure. In this regard, instituting a market for tradable water rights, is seen as a particularly attractive policy option for less developed countries. In spite of all the potential benefits that are attributed to a system of tradable water rights, few less developed countries have implemented such a legal institution. In this regard, the Chilean experience with its Water Code is fairly unique. The Code, implemented in 1981, established a comprehensive system of tradable water rights which continues to operate until today.

This paper provides a brief account of how the system has worked in Chile, and reviews many of the major issues and controversies that have surrounded its practical implementation. The main objective is to highlight issues that need to be taken into account when implementing similar systems in other countries as well as to single out some key research areas for the future.

Given that we are concerned with eventual implementation problems of similar systems in other countries, we have made emphasis on particular problems detected in the Chilean case. However, this is not to say that the problems occurred in Chile overcome the potential and actual benefits of this kind of system. By the contrary, all in all, we contend here that the system has worked satisfactorily and that no clear cut superior alternative seems available at this moment. Fine tuning of the existing institutional framework, rather than a drastic change of it, seems the most advisable policy agenda for Chile in this area.

## II. LEGAL AND INSTITUTIONAL BACKGROUND<sup>1</sup>

The first Chilean Water Code was promulgated in 1951. This Code distinguished among private and public property of water, but allowed the State to give concessions to private parties. These concessions 'worked' as if they were private property. Water transfers were allowed among private parties only if the use of water remained the same. If a change of use was involved, as for example from irrigation to industrial use, free transfer was not allowed, and instead the concession had to be returned to the State and a new concession had to be requested. Simultaneous requests were solved according to a list of priorities for water uses (drinking, irrigation, industrial). Concessions were temporary until it was demonstrated that the works needed to make use of the water had been built (irrigation channels, etc.).

In 1969, and concurrent with the Agrarian Reform that the country was implementing at that time, a new Code was promulgated which established that all waters were State property, with no exception. The State continued to give concessions to private parties but could obtain them back with no compensation for damages. These concessions

<sup>1</sup> This section is based partially on Bauer (1993), chapter II.

could not be transferred nor sold among private parties. From an historical perspective, this piece of legislation represents a breaking point with respect to previous and posterior legislation which, using different approaches, have enforced private property of water resources.

The Water code of 1981, currently in effect, was a result of government concerns about further improving the efficiency of water use and, more important, to strengthen private property. Some distinctive features of this law are the following: i) water rights are completely separated from land rights and can be freely transferred, sold and bought. Their private property status is warranted based on the property laws of the Civil Code; ii) application for new water rights is not conditional on the type of use and there is no priority list for different uses of water; iii) water rights are allocated by the State with no charge, and in the case of simultaneous requests for the same water rights, these are allocated to the best bid. There is no specific tax for holding water rights<sup>2</sup>; iv) the role of the state in resolving conflicts is very limited, and relies on private negotiations and the judiciary system; iv) in addition to the usual consumptive use, the concept of non-consumptive use is introduced, which refers to the right that allows to use water but with the obligation of replenishing it at a stipulated quality and/or manner.

According to this Code, private parties are required to hold water rights for the exploitation of surface as well as ground waters which are national goods of public use<sup>3</sup>. Different categories of consumptive and non-consumptive rights are defined. Permanent as opposed to eventual rights allow the use of a specified amount of water (volume by unit of time, for ex, liters per second) with no restriction, unless the water supply is not enough for all parties holding water rights over it. In this case, water is distributed proportionally ('aliquotas'). Eventual rights, however, only allow the holder to use water when surplus water is available after satisfying permanent water rights. Continuous rights allow to use water uninterruptedly during 24 hours a day, discontinuous rights imply that two or more people take turns to use water.

Currently, it is estimated that approximately 300,000 water users and 4,000 water user associations exist in Chile. A gross breakdown by uses of water is presented in Table 1. Non consumptive uses are greater than consumptive uses. It should be noted, though, that these two uses are not comparable because for a given volume of water only one consumptive use is possible together with one or more non-consumptive uses. Among consumptive uses, the most important one, by far, is agriculture.

<sup>2</sup> Previous to this Code of 1981, DL N° 2603 of 1979 was promulgated. This Law considered an initial fee for allocation of new water rights and a tax for holding water rights.

<sup>3</sup> Exceptions to these rules are mining concessions and wells for domestic consumption. Mining concessions are granted by the Ministry of Mining and allow the 'owner' to exploit all resources including water within the concession's boundaries. Individuals do not require water rights to build a well inside his/her property if it is to be used for domestic consumption (Water Code, article 56).

TABLE 1  
USES OF WATER IN CHILE

Uses of Water	Volume of Water		
Consumptive uses	700	m <sup>3</sup> /sec	(100%)
Agriculture	623	m <sup>3</sup> /sec	(89%)
Domestic	42	m <sup>3</sup> /sec	(6%)
Mining/industrial	35	m <sup>3</sup> /sec	(5%)
Non-Consumptive uses (1)	1,500	m <sup>3</sup> /sec	
Total	2,200	m <sup>3</sup> /sec	

Notes: (1) Basically for the generation of hydroelectricity.

(2) The above breakdown is an average for the country. Important variations can exist among different rivers.

Source: Based on information provided by Muñoz (1994).

From an institutional perspective, the following institutions play an important role in the implementation of the Water Code of 1981 and the Irrigation Laws:

- Water user associations (WUAs): their main role is to distribute water and enforce its correct use by its members, and to collect fees for construction, maintenance and administration of irrigation infrastructure. Three different types of associations are considered in the Water Code: *juntas de vigilancia* which are supervision committees in charge of monitoring the use of natural sources of water such as rivers, *asociaciones de canalistas* which are associations of channel users usually in charge of administering primary infrastructure such as dams and main irrigation channels, and *comunidades de aguas*, which are water communities responsible for secondary infrastructure, such as distribution channels. Except for the *comunidades de aguas*, these associations have a collective legal status, which allows them, for example, to take out loans collectively.
- General Directorate of Water (DGA, *Dirección General de Aguas*): a government agency within the Ministry of Public Works which has overall responsibility for water use planning, and the development and exploitation of water resources. Specific tasks include: administration of the National Hydrometric Service, control of activities of the *juntas de vigilancia*, and approval of all major hydraulic works. In the last years, its main activity has been to regulate the distribution of water rights and to prepare technical reports needed for conflict resolution.
- National Irrigation Commission (CNR, *Comisión Nacional de Riego*): a government agency in charge of planning, evaluating, and approving investment projects in irrigation infrastructure, which involves coordinating the activities of several public institutions and private organizations. The CNR's council is chaired

by the Minister of Commerce and includes the ministers of Finance, Public Works, Agriculture, and the head of MIDEPLAN (Cabinet level Planning Office), as well as the executive secretary of the CNR. CNR is involved in the implementation of the irrigation laws for major and minor works, together with the Directorate of Irrigation.

- Directorate of Irrigation (DR, *Dirección de Riego*): a government agency primarily in charge of executing the technical and economic studies of irrigation investment projects financed by the State, after they are approved by the CNR. The construction is let for bid to private construction companies.

The Water Code of 1981 has been subject of several criticisms, which have motivated two amendment proposals prepared by the Government, but not approved by Congress yet. The primary concerns are speculation with water rights<sup>4</sup>, environmental problems and conflicts among consumptive and non-consumptive users. The first proposal, sent to Congress in December of 1992, was prepared by the Ministry of Public Works. The major modifications are: forfeiture of water rights if not used during 5 years; inclusion of the justification of use as a prerequisite to apply for new water rights; increased authority for DGA in conflicts related with water pollution and third party effects, and creation of Administrative Associations of River Basins. Water users, particularly farmers, have opposed the legislation because they perceive it as a threat against private property of existing water rights and an increase of the administrative discretion of the government in water allocation (based on Gazmuri and Rosegrant, 1994; CCC, 1993b). The second proposal, which modifies the first one, is currently being prepared by an Interministerial Commission including members of the Ministries of Public Works, Agriculture and Public Properties, and the Commissions of Energy and Environment. Some of the modifications are: norms to improve the functioning of the DGA and payment of a license for holders of water rights actually not using the resource. Topics such as water quality and Administrative Associations of River Basins were postponed for further analysis.

There are two other pieces of legislation related with investment in irrigation infrastructure which are to be mentioned:

- Irrigation Law for major works (*Ley de Fomento al Riego N° 1.123 of 1981*): this law allows investment in major water development projects using State funds, including new works such as dams and interbasin channels, as well as rehabilitation and improvement of existing irrigation works. The final design and preparation of terms of reference for the construction of these works requires beneficiaries representing at least 50% of the newly available water rights to accept the project as proposed, and commit to reimburse the State for its costs under agreed terms and conditions. Until 1990, no investments were made under this law. During the 1990-93 period approximately US\$ 156 million were invested in new works benefitting 113,500 hectares, and US\$ 3.8 million were spent for the rehabilitation and improvement of existing works which benefitted 28,500 hectares (The World Bank, 1994, Annex H).

<sup>4</sup> Particularly because power companies have been accused of holding water rights in southern Chile only for speculative purposes.

- Irrigation Law for minor works (*Ley de Fomento a Obras Menores de Riego N° 18,450 of 1985*): basically a subsidy to promote private investment in the construction and improvement of irrigation infrastructure, not exceeding an investment of approximately US\$ 690,000. It subsidizes up to 75% of the costs of design, construction, equipment, and other, of minor works and improvement of existing infrastructure (for example, lining of conveyance and distribution systems). Approximately US\$ 105 million have been invested in minor works and improvement (including the private contribution). On average, the subsidy element has amounted to 52%-61%, and it has benefitted approximately 40-60 thousand hectares per year. This law was recently extended until year 2,000<sup>5</sup> (The World Bank, 1994, Annex H).

### III. THE RECORD OF TRANSACTIONS

Chile has a strong tradition of water allocation through water rights, particularly for irrigation purposes. Notwithstanding the changes in the legal status of water rights described in Section II, water allocation based on 'tradable water rights' has occurred since the 1920's. Casual observation indicates that an important proportion of all allocated water rights are not legalized, but are respected. Few conflicts have arisen because of third parties trying to appropriate these non legal rights. Efforts have been made in recent years, by the DGA to legalize water rights as well as water user associations, by organizing and subsidizing massive inscriptions (Muñoz, 1994)(see section IV.5).

'New' water rights are said to be scarce, but this is a relative statement and depends on the type of water right. In the case of surface waters, most of the consumptive rights which are permanent have already been allocated to private parties. Other types of water rights are still available though, such as, eventual ones for consumptive use, as well as non-consumptive rights. Groundwater is a relatively unexploited resource and consumptive as well as non-consumptive water rights are available for private parties (Muñoz, 1994).

Transactions in the market of water rights can be permanent or temporary (sales or leases). Information about the dynamism of this market in Chile is scarce. The literature has put certain emphasis on the number of transactions as a way of analyzing the functioning of the system. In the following subsections – III.1, III.2 – we review the available evidence on transactions. However, we would like to stress that the number of transactions provide little guidance with respect to the more fundamental question of whether the market works in an efficient way. An efficiency analysis would suggest looking instead for particular episodes when transactions helped to reallocate the water rights across economic agents *in response* to changes in the derived demand for water. We turn back to that issue in section III.3.

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Other modifications introduced were: i) an increase in the maximum amount of the investments from approximately US\$ 345,000 to US\$ 690,000; ii) eligibility for application for almost all farmers, including small landowners, non organized water communities and other parties in the process of legalizing their land titles.

### 1. *Permanent transactions: sales*

Several studies were reviewed searching for evidence to support the idea of an active market of permanent transactions of water rights. The evidence found is non conclusive and the comparison among the studies is very limited because of the different type of information included: number of transactions, regions of the country, volumes of water traded, monetary values, change of use (agricultural, hydropower, etc.), and other information. A brief summary of each study is presented below.

Bauer (1993) presents some information about records of transactions of water rights collected at the Water Registry of Los Angeles (500 kms south of Santiago), and concludes that for the 1980-91 period, 25% of the water rights transactions were separate from the land. On average, 12 sales per year were observed for an irrigated area of 65,000 hectares. The study concludes that even though permanent transactions occur on a routinary basis, their frequency is relatively low. No information is presented about volumes of water traded nor the values involved.

Hearne (1994) provides qualitative and quantitative information about transactions of water rights in four river basins in northern and central regions of Chile. In the case of the first section of the Maipo river (central region), the author indicates that there have been very few transactions among farmers during the last eight years. The water company of Santiago, EMOS, currently owns 1,369 shares and has been involved in the market of water rights, because it needs the equivalent of 3,000 shares of Río Maipo water by year 2,020. In the Elqui River basin, the transfer of water rights would be limited. Intersectorial transactions do occur, as in the case of ESSCO, the regional water company which bought 28% of its current water-use rights (292 shares of the river). ESSCO actually declined to participate in the construction of the Puclaro dam because it was financially more attractive to buy water rights to secure its water supply than to invest in the dam. Hearne reports that 47 permanent transactions were identified for the period 1986-93 including transfers among farmers, developers and urban companies, involving 712 shares of the river which in a 'good' year represent 712 lts/sec. Prices paid per share range from US\$ 1,100 paid by ESSCO up to US\$ 2,500 per share for small lot developers, and 'far less' for individual irrigators. In the Limarí valley, the market seems to be very active. The sample of transfers totaled 9.2 million m<sup>3</sup>/year of water, which included 73 irrigators. Transaction prices range between US\$ 3,000 and US\$ 4,500 per share for an average volume of water of 4,500 m<sup>3</sup>/year.

Using a crop budget analysis, the paper also provides estimates of the net gains associated to the trade of water rights for river basins Elqui and Limarí. In the case of Elqui, average net gains per share amount to US\$ 2,459 which includes rents for buyers and sellers, with transaction costs estimated at US\$ 56 per share. The *total* net gains associated to trade of water rights in this area for the period analyzed are US\$ 1.75 million. In the case of Limarí, the average net gains per share amounts up to US\$ 1.62 per m<sup>3</sup>/year, with transaction costs of US\$ 0.04 per m<sup>3</sup>/year. The total net gains associated to trade in this area are US\$ 14.9 million during the period of analysis.

Gazmuri and Rosegrant (1994) present quantitative information about transactions of water rights *not linked to land transactions* that occurred between April of 1993 and April of 1994 in three Water Registries: Santiago, Chillán and Bulnes. It can be observed that the proportion of the total water flow, that was traded during that period of time, decreases as one moves towards the south of the country. These proportions are 3%, 1.2% and 0.6% for Santiago, Chillán, and Bulnes respectively. In Chillán and Bulnes, the total number of transactions was 72 and 91 respectively and occurred only among farmers. Five hundred and eighty seven (587) transactions were recorded for Santiago, involving 720 lt/sec, the water

needed to irrigate approximately 360 hectares in this part of the country (approximately 2 lts/sec per hectare). A breakdown of these transactions is presented in Table 2.

TABLE 2  
TRANSACTIONS OF WATER RIGHTS (SEPARATE FROM THE LAND ONLY)  
WATER REGISTRY OF SANTIAGO, 1992

Water Registry of Santiago	Transactions between Farmers	Transactions between Farmers and Urban Water & Sewage Companies	Transactions between Farmers and Mining Companies
Number of Transactions (Total = 587)	76 transactions (13%)	499 transactions (85%)	12 transactions (2%)
As a % of the total volume of transactions (Total = 720 lt/sec)	677 lt/sec (94%)	22 lt/sec (3%)	7 lt/sec (1%)
Estimated value of transactions (Total = US\$ 366,050)	677 lt/sec x US\$ 500 equals US\$ 338,500	22 lt/sec x US\$ 950 equals US\$ 20,900	7 lt/sec x US\$ 950 equals US\$ 6,650

Source: Based on Gazmuri and Rosegrant (1994).

Table 2 shows that an important number of transactions occurred among farmers and urban companies (85%), nevertheless the volume of water involved in each transaction, on average, was very small (0.044 lts/sec). A significant 94% of the volume of water was traded among farmers, thus no change of use was involved, and on average 8.9 lts/sec were transferred in each transaction, which corresponds to the water needed to irrigate 4.5 hectares in this part of the country (2 lts/sec per hectare). The total volume of water traded among farmers corresponds to the water needed to irrigate 338.5 hectares in the Santiago area, which overall has approximately 56,000 hectares of agricultural land. According to Gazmuri and Rosegrant (1994), the average price reported for a transaction of water rights is US\$ 500 per lt/sec, with prices ranging between US\$ 300 and US\$ 1,000 per lt/sec.

Urban companies bought 22 lts/sec from farmers, which corresponds to the water needed to supply approximately 10,000 people (each person requires on average 200 lts per day), which is less than the estimated increase in water supply needed by EMOS given the population growth rate of this very populated area of approximately 90,000 people per year (assuming a 2% of the 4.5 million inhabitants). Thus, EMOS is apparently not relying heavily on the market for the purpose of increasing its water supply.

Comparison among the 3 studies is limited because of different type of information presented in each of them. Nevertheless, some general comments are possible:

- Hearne indicates that the participation of the urban company EMOS in the water market of the Santiago area is very limited. This statement is somehow supported by Gazmuri and Rosegrant which indicate that only 3% of the volume of water traded in the Santiago area corresponds to water sold by farmers to urban companies, even though this volume does not satisfy the increase in the annual demand for water faced by EMOS. Thus, EMOS is currently not relying on the market to increase its supply of water.
- In general, there is no discussion about what an active market implies in terms of the frequency of transactions and/or volume of water traded. The question of what an active market means, in order to compare with the situation in Chile, is still an open question, and requires further research. Hearne (1994) provides useful estimates of net gains associated to the trade of water rights.

## 2. *Temporary transactions: leases*

The market of temporary transactions of water rights seems to be far more active than the market of permanent transactions according to the studies reviewed. Hearne (1994) reports about transactions among neighboring farmers in a few channel systems in the Maipo, mostly involving a year of use of a share of the river in exchange for payment of the annual WUA service fee. More frequent temporary transactions are reported for northern regions of the country: Arica and Iquique, two very dry regions in northern Chile with acute water scarcity problems, and the Limarí valley. The water company, ESSAT, rehabilitates and rents wells from farmers in order to supply water to the city of Arica. Thobani (1994) reported that these farmers are being paid US\$ 5,000 per month by ESSAT for the option of pumping these wells if needed. North of Santiago, in the Limarí River basin (semi dry region), temporary leasing is a very frequent and well organized activity. This area is characterized by its good irrigation infrastructure, which consists of three Reservoirs (La Paloma, Cogotí and Recoleta) with a storage capacity of over 1,000 million cubic meters and many interconnecting channels (Hearne, 1994). Gazmuri and Rosegrant (1994) report that the price of a three-month water lease is approximately US\$ 90-120 per liter/sec delivered on site during periods of low water flow.

Another active market of temporary transactions takes place at the Diguillín River, about 500 kms. south of Santiago. Short term leases and rentals of water rights are an everyday event in the region. Most of the farms have dams to accumulate the overnight water flow, and use it during daytime. Some even have winter dams to stabilize summer water flow (Gazmuri and Rosegrant, 1994). Further south water is less scarce, thus the value of the resource is low and there is little incentive for conserving water and/or making a more efficient use of it, for example, by leasing water rights on a short term basis. It is expected that in the near future this situation will change because of increased competition for the resource among fish ponds (aquaculture) and winter crops which require its maximum water during winter when water flows are particularly low (Del Canto, 1994).

### 3. *Concluding remarks*

Although some authors contend that "few" transactions in water rights have taken place (Hearne, 1994; Bauer, 1993), it is rather difficult to draw any significant conclusions from the evidence reviewed so far. For one thing, it does not seem reasonable to judge the performance of the system by the number of transactions, as they depend on the initial allocation of rights, which, if close to optimal, should generate a small number of transactions. As mentioned before, the question about the performance and dynamism of the water market in Chile is hard to answer and would require some kind of quantitative analysis of permanent and temporary transactions. Currently, no formal data are available to conclude about this issue, and further research is required. Yet, some qualitative assessments are possible.

First, it should be emphasized that the system worked well in the Elqui River basin, as it allowed the water company of the region to buy existing water rights and hence not to undertake costly new infrastructure investments (Puclaro Dam project) to cope with the increasing water needs of urban population. It seems difficult to argue that an alternative water allocation system could have achieved this same result without at least generating strong political friction arising from a seemingly discretionary removal of water rights from farmers to the urban water company. Under this system, the transfer of water rights takes place in a context of voluntary trade with perceived advantages for all the parties involved. A similar situation applies to the water company supplying the northern city of Arica which has leased some pumps from the farmers to obtain water. In this latter example, though, there seems to be a case of externalities caused by the presumed overexploitation of the aquifer by the water company which would have lowered the level of the aquifer beyond reasonable levels, thus affecting the rest of the farmers in the area. The 'overexploitation' hypothesis has not been scientifically proven yet. An additional factor that might explain the particularly low level of the aquifer are subsequent very dry years which have impeded the natural recharge of the aquifer (El Mercurio, 1994)<sup>6</sup>.

Second, it is apparent that the market operates with substantial transaction costs. One source of transaction costs in Chile is the fact that around 50%-65% of existing rights are not legally inscribed, thus limiting the extent of a spot market in permanent water rights. A possible consequence of this is that we observe a more active lease market: leasing, unlike permanent transactions, may take place with or without legal verification of the property status of the resource. In this sense, the market "works" not only because of the institutional framework provided by the Water Code, but also because there was a tradition of allocation through "water rights" in Chile, a tradition that goes back at least to the 1920's. Care should be taken then when implementing similar systems in countries where traditional allocation rules take other forms. In this sense, public investment in some form of infrastructure may act, in particular circumstances, as a complement for markets in tradable water rights (see section IV.2).

<sup>6</sup> Even though some farmers have rented their pumps to ESSAT, this company has also installed new pumps to exploit the aquifer in the Azapa Valley, presumably with the authorization of the DGA. Currently, the farmers have accused the company of heavily exploiting the aquifer in order to supply water to the city of Arica (I region) with the consequent damages for agriculture. Farmers also argue that the 'Government' had other alternatives to obtain water without damaging their activities. ESSAT argues that in this way it can assure Arica a 24 hour drinking supply, which until recently was only 8-12 hours. The Azapa farmers have demanded the company in courts, hoping to have ESSAT stop its pumping of the aquifer soon (El Mercurio, 1994).

#### IV. MAJOR ISSUES

##### 1. *Consumptive and non-consumptive uses*

Several conflicts have occurred among different users of water resources, particularly among consumptive and non-consumptive ones. The concept of non-consumptive use was introduced explicitly in the Water Code of 1981, and enables to allocate water rights to those users that do not 'consume' the resource, such as hydroelectric companies. According to the Code, non-consumptive water rights as well as consumptive ones are defined as a volume per unit of time (m<sup>3</sup>/sec), unless water supply is not enough for all holders in which case the resource is to be allocated on a proportional basis. For all practical purposes though, and since decades, the proportional system is the one used in Chile for water allocation.

In Chile most rivers run in the east-west direction, that is from the Andean mountains to the Pacific Ocean. The following geographic breakdown of water users is commonly observed in Chilean river basins and helps to understand some of the conflicts which have occurred among users:

- Upper part of the basin: mostly non-consumptive uses, i.e. hydroelectric companies.
- Middle part of the basin: mostly consumptive uses, i.e. farmers, water supply companies.
- Lower part of the basin: both uses, i.e. farmers, population centers, and recreation.

##### a. Externalities

Even though consumptive and non-consumptive uses correspond to two qualitatively different types of water uses, because the first one actually consumes the resource, while the second one restores the resource for further use by other users<sup>7</sup>, in practice they are deeply interrelated. In some cases, and for varying reasons, this interrelationship translates into an externality caused by consumptive users on non-consumptive users and vice versa. If the market does not internalize these externalities, an inefficient economic allocation of the resource occurs. As will be discussed below, some externalities are originated by an incomplete definition of property rights, because elements such as water quality, opportunity of use and others are not adequately dealt with. Some examples follow.

The first example deals with the construction of the Laja-Diguillín irrigation complex which extracts 65 m<sup>3</sup>/sec from the Laja River to conduct them to the Itata River Basin. This project was opposed by non-consumptive users located downstream of the intake point, such as tourism and ecological associations, because of the potential impact on the Salto del Laja water fall and the increase in pollution of Bío Bío river because of a diminished water flow<sup>8</sup>. A second example are the various conflicts that have occurred among farmers and hydroelectric companies because the latter have affected the downstream water flows received by farmers, by retaining water to fill up reservoirs (for example, Pehuenche company) and also by diverting waters to conduction channels in order to maximize energy production (see Bauer, 1993 for a detailed description of these conflicts).

<sup>7</sup> Further use can be impaired by non consumptive users if water degradation (i.e. increased salinity, temperature) and/or delays in water restoration occur.

<sup>8</sup> The diminished water flow can imply less dilution capacity, thus increasing the treatment costs for the water company of Concepción city which extracts drinking water for the population (CCC, 1989, pág. 272).

In both examples, the definition of property rights is incomplete. The case of recreation is a classic example of a good for which nobody actually holds property rights. The Water Fall is a public good and no non-consumptive rights have been allocated to it. Thus the externality caused on tourists and others, which perceive a benefit from watching the water fall with abundant water, cannot be internalized unless the Government or another party holds water rights 'in representation of' the water fall and is able to exercise them. Actually, one of the amendments proposed for the Water Code is to have minimum ecological flows for each river to preserve biodiversity and others, which is a way of dealing with these kind of issues (see section IV.6).

Water quality matters can also be a cause for externalities. The Water Code (art 14), indicates that a non-consumptive right entitles the use of water without physically consuming it and compels the owner to restore the water as stipulated in the deed or private contract evidencing ownership. The extraction or restoration of water shall not damage the rights of third parties over the same water with respect to quantity, *quality*, substance, opportunity of use and other characteristics. The Water Code does not say anything though about a consumptive use (such as the extraction of water for the Laja-Diguillfn Complex) affecting the water quality of a downstream user by modifying the quantity of water. In general, the use of clean water to dilute pollution is not considered a beneficial use in other countries, and the 1981 Water Code is not an exception. Other environmental legislation does exist in Chile, which basically prohibits the act of polluting waters when certain uses are affected, but as far as known, it does not consider a case for increased pollution caused by a diminished water flow (see section IV.6 for brief discussion on environmental problems in Chile).

This problem of incomplete definition of property rights has been accentuated because of the interpretation of property rights by courts, and has been an additional source of conflict among consumptive and non-consumptive users. As mentioned above, the Water Code (art 14) states that non-consumptive users should not damage the opportunity of use of other parties when restoring the water flow. Nevertheless, conflicts have occurred among farmers and hydroelectric companies in some river basins, as the Bfo Bfo and Maule basins. The hydroelectric companies have been accused of retaining and storing water temporarily to minimize their cost of generating electricity, and to fill up reservoirs, which is consistent though with the behavior of a firm that maximizes profits. Farmers located downstream have complained in the courts because of damage, and because the filling of reservoirs is *not* a non-consumptive use of water. According to Bauer (1993) the ruling of the courts in these cases has not settled the general issue about interpretation of non-consumptive and consumptive rights explicitly. In most cases though, hydroelectric companies have been compelled to let the water flow without interruption and to restrict dam filling to surplus flow season, to avoid damages to downstream users.

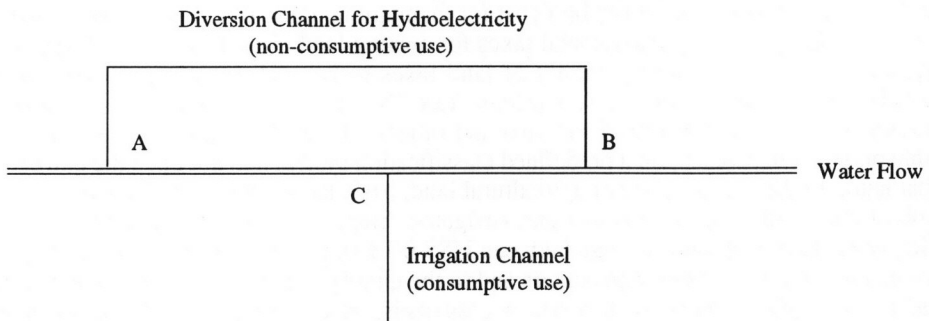
#### b. Speculation

Another debated issue is speculation. Several hydroelectric companies have been accused of buying and/or requesting water rights only for speculative reasons, and of actually not using them. This has raised several conflicts with other water users such as farmers. According to the Water Code of 1981 though, the holder of a water right, consumptive or non-consumptive, is not compelled to actually "use" it. Two other factors must be considered in the discussion, which illustrate how these apparently 'speculative' behavior problems are really not such.

## Sequence of allocation of water rights

This first aspect is illustrated in Figure 1 below. Imagine a system of proportional allocation of water rights, as the one in Chile, were permanent consumptive rights have been allocated for 10% of the water flow at point C. Then, non-consumptive rights are requested for the remaining 90% of the water flow at point A, which will be returned to the river at point B. After that, consumptive users request an increase in their share of the water flow, up to 15% (extracted at point C). According to the Water Code, DGA cannot allocate more permanent consumptive water rights for the remaining 90% of the flow existent at point C, because it will be non-existent when diverted by the hydroelectric company.

FIGURE 1



This situation occurs in some of the Chilean rivers, such as the Bío Bío river where hydroelectric companies hold non-consumptive rights, but actually do not use them (Del Valle, 1994). Some of these hydroelectric companies requested a significant number of non-consumptive rights to the DGA in the early eighties for their future development programs (construction of hydroelectric dams) *before* consumptive rights were requested for that same water flow. DGA's response to this situation has been to allocate only *eventual* water rights to consumptive users, because permanent rights will strictly not be available when the hydroelectric company starts diverting water for non consumptive use. Nevertheless, and because non-consumptive rights do exist over this flow and can be exercised at some time in the future, thus decreasing the water flow in real terms, those eventual consumptive water rights will be nominal because no surplus flow will be available for them. Obviously, this situation is rejected by farmers which foresee an important scarcity problem with water in the future, and which might have a negative evaluation of long term projects because of uncertain water supply. An alternative for consumptive users is to request additional water rights for the flow downstream of point B, and to assume the costs of conveying water (upstream) to their location.

Because transactions among consumptive and non-consumptive water rights in the market are not possible (two 'different' goods), the market is unable to solve this situation by allocating the resource to its best valued use, be it consumptive or non-consumptive. This economic inefficiency seems aggravated by the existing conflict among water users which is

currently not being taken care of. Thus, the sequence in time in which consumptive and non-consumptive rights are allocated does affect the efficiency of the final allocation of the resource as in the case illustrated. The ultimate cause of this problem is the definition of non-consumptive rights, because as seen, non-consumptive rights can decrease the water flow available for consumptive uses on certain parts of a river. Thus, the practical implementation of the 1981 Water Code has generated a conflict among consumptive and non consumptive users, which is not caused by speculative behavior as is commonly stated.

### Opportunity cost of holding water rights

The issue is whether there is a systematic difference between the opportunity costs faced by those "speculating" and those "using" their rights. As a matter of fact, such a difference does exist, at least in theory. The Chilean tax system does not include an explicit cost for maintaining water rights (such as a 'patrimonial' tax). Nevertheless, farmers which irrigate land are affected by an implicit cost for maintaining these rights. Farmers, as well as other economic agents, pay patrimonial taxes for owning land. The value of the land, which is the basis for calculating the amount of land taxes to be paid, is determined by the SII (Servicio de Impuestos Internos; Chilean Tax Department) on the basis of several characteristics such as rurality of the area and others. Thus, the classification of land for taxable purposes depends upon a predefined classification system and not upon the current use of that land. In the specific case of agricultural land, basic land values vary depending on the region of the country and access to water (irrigated '-riego'- versus non irrigated - 'secano'). Basic per hectare land values range between US\$ 0.13 and US\$ 10,730.0, and are adjusted according to the distance to urban centers and to the quality of the roads. Adjustment factors range down to -50% in the case of fluvial access roads. According to the SII, factors such as better infrastructure, access to water, and others are considered as 'improvements' to the land and thus result in higher fiscal land values, as well as in higher taxes. By contrast, those holding non-consumptive rights do not pay any taxes on the 'asset' represented by those rights.

Based on a sample of land values for regions IV through IX, the average amount of taxes paid for the *best* agricultural land in the irrigated and non irrigated categories is approximately US\$ 45 and US\$ 6.5 per hectare per year respectively. The tax factor is 2% of the fiscal value of the land ('impuesto territorial'). This difference can be significant depending on the income level of the specific farmer. Thus, in theory, a farmer holding water rights pays more taxes to the government than one not holding them. In practice, however, the situation is different. On the one hand, many water rights are not legalized thus meaning that the Tax Department has no access to information about 'improvements' to the land, and second, farmers which 'improve' their land by buying water rights and building the necessary irrigation infrastructure, are eligible for a 10 year tax exemption. Thus, the conversion from 'non irrigated' to 'irrigated land is exempt of taxes during 10 years, unless the land is sold to a third party. According to a member of the SII, the number of farmers which actually pay a higher land tax because of buying water rights and having access to water is negligible. In the case of *non agricultural land*, though, the value of the land with or without access to water is the same. That is, if an industry is located on non agricultural land and buys water rights as an input for its industrial processes, the value of the land for taxable purposes remains the same.

*Summarizing*, there is a potential distortion in the market of water rights, because farmers are the only ones actually 'paying' for keeping their water rights in time (in theory at

least). Further research is needed to determine if the magnitude of this distortion is significant or not, particularly because of the existence of a tax exemption for farmers 'improving' their land when buying water rights. An additional problem is that if reassessment of the land occurs every 5 years, for example, and a given party sells its water rights, it will have to continue paying higher taxes than it should; and viceversa. This can cause an economic inefficiency problem because it can lead to 'incorrect' decisions. The obvious policy recommendation is to introduce an explicit 'patrimonial' tax that equates at the margin the opportunity cost of not "using" the rights across different holders. Even though this idea of imposing some kind of water user fee is not rejected upfront by many water users, thus it is politically acceptable, a major problem of implementation with such a system does exist, which is related with the lack of a complete and detailed register of water rights. As mentioned before this is so, because between 50% and 65% of water rights are traditional and are not legalized, and also because no unique register of water rights exist. From a legal point of view, only those water rights registered at the corresponding public institution, the *Conservador de Bienes Raices* (Real Estate Registry) are valid, but these registers are not complete nor compiled at the national level. Bauer (1993) indicates that these registers are not even compiled at the county level.

#### c. Conflict resolution

According to the 1981 Water Code, the judiciary system is to solve conflicts among consumptive and non-consumptive users after WUAs and the DGA fail to do so<sup>9</sup>. This has been the case with many conflicts among farmers and hydroelectric companies, which have been slowly resolved in courts, thus imposing an economic cost for society. Apparently, private resolution of conflicts at the WUA level is not taking place more often mainly because of a problem of equivalence among consumptive and non-consumptive water rights. The Water Code defines the existence of '*juntas de vigilancia*', which include all users of a river basin, that is consumptive as well as non consumptive users, but apparently they are impeded from having an important role in these matters by definition. The Water Code establishes that each water share has the right to one vote in the corresponding '*junta de vigilancia*', without distinguishing among consumptive and non-consumptive users. This results in a disproportionately high participation of non-consumptive right holders negatively affecting the voting of consumptive right holders, because many non-consumptive rights can be granted at many points in a river basin (Hearne, 1994). This voting issue has implied that the '*juntas de vigilancia*' of rivers continue to be, for all practical purposes, only farmer associations, with no real authority to solve conflicts between consumptive and non-consumptive users (Bauer, 1993; CCC, 1989).

#### d. Concluding remarks

All of the issues and conflicts related with consumptive and non-consumptive uses described above have resulted from several shortcomings in the Chilean Water Code, basically the definition of water rights and some implementation problems. None of them can be attributed to the system itself. As a result of this situation, some changes to the Code have been proposed, among others to have water rights expire after 5 years, if they are not being used for productive purposes to account for the 'speculation' issue. It must be said

<sup>9</sup> The DGA has to prepare technical reports for conflict resolution.

though that this proposal has been resisted by farmers who believe this amendment would damage the private property status of water rights, because it obliges them to justify the use of the resource.

We contend that most of these problems can be solved with better "fine tuning" of the system rather than drastic reform. Very often, conflicts between consumptive and "non-consumptive" rights have arisen because the "non-consumptive" use involved a certain degree of consumption, by altering the timing at which consumptive users would like to dispose of the resource, and in some more extreme cases precluding consumptive uses (see discussion about Figure 1). Moreover, this problem with the definition of non consumptive rights can be present in a market based system as well as under an administered system, it is not inherent to the market itself. The policy prescription would then be to move towards a more precise definition of non consumptive water right, for example, by having a minimum flow release clause under certain circumstances to avoid problems with consumptive users. Another policy prescription would be to associate to each non consumptive right a fraction of a consumptive right, to account for the general interrelationships between consumptive and non consumptive rights. This is a topic for further study. A second improvement, which was included in the 1992 Amendment proposal is to have 'minimum ecological flows' for all basins. This would prevent externalities such as the 'water fall case' described above, and other recreational and biodiversity issues. A third improvement, which needs more analysis, is the implementation of an explicit 'patrimonial' tax that equates at the margin the opportunity cost of not "using" the rights across different holders. A fourth improvement requires the creation of new institutions, such as Watershed corporations with consumptive and non consumptive users, and government parties to enhance conflict resolution. Obviously the cost of establishing and operating these corporations should be compared to the benefits of solving conflicts<sup>10</sup>. Finally, a more efficient Chilean judiciary system would improve conflict resolution and reduce the economic costs for society. This prescription goes beyond the Water Code though and deals with a more serious problem that affects the Chilean society in all matters.

## 2. *Infrastructure*

There are two aspects of infrastructure which are interrelated with the functioning of a market of tradable water rights which must be considered: minimum level of infrastructure and operation and maintenance (O&M) costs of infrastructure.

### a. Minimum level of infrastructure

The market for water rights seems to be more dynamic, and hence more effective, in areas with a minimum level of infrastructure, such as the Limarí and Diguillín river basins. The Limarí area is located in a semi dry area characterized by three reservoirs which all together store 1,000 million cubic meters, and a good irrigation channel system. The major reservoir, La Paloma, is publicly owned but in the process of being transferred to the private

<sup>10</sup> These Watershed corporations can solve not only consumptive versus non consumptive users conflicts, but also environmental and other problems which are inherent to multiple use river basins. The establishment of these corporations was also considered in the Amendment proposal of the Water Code.

sector (WUAs)<sup>11</sup>. The two other reservoirs were transferred to the private sector. The second area, Diguillín, is characterized by a recently built irrigation complex. It is owned by the private sector, but the works were executed and constructed using State funds under a cost-sharing arrangement regulated by the *Ley de Fomento al Riego* (see section II). Several farmers have retention and storage dams to minimize day-night as well as seasonal variations of the water flow (Gazmuri and Rosegrant, 1994). This type of irrigation infrastructure allows to modify water flows easily favoring the working of the market. This raises the issue about the importance of having the government as an active participant in the development of new projects for investment in infrastructure, because in some circumstances the WUAs do not have the technical and/or administrative capabilities to undertake projects of such magnitude.

Very often it is argued that a system of tradable water rights would be a *substitute* for costly infrastructure financed by the public sector. While this is so in many instances, as in the case of the urban water & sewage companies referred before<sup>12</sup>, it should also be taken into account that private water markets do not completely rule out the role of the public sector in infrastructure investment. The policy design challenge lies in designing the optimal level of infrastructure development to complement the working of private markets when predefined social criteria for project evaluation are met. Thus, the improvement in the operation of the market of water rights can be considered as a side benefit of public investment in infrastructure.

In Chile, the *Ley de Fomento al Riego* allows using State funds for major irrigation works but requires active involvement of the private sector. It establishes that at least 33% of the beneficiaries of the works have to approve the project in writing to proceed with the final design of the project, and that at least 50% have to commit to reimburse the State for its costs under agreed terms, *before* the Ministry of Public Works can program construction of the works. It also requires that for a project to be considered for construction with public funds, the price of the land plus the cost of the proposed works, must be at least equal to the commercial value of similar irrigated land in the same region<sup>13</sup>. We contend here that the social benefits of public investment in irrigation infrastructure may go beyond those seen by the direct users, in the sense that by allowing a deeper working of the market in water rights increases the social value of the water resource. It is uncertain, however, whether this additional benefit will be easily revealed by the users when they collectively decide how much to cooperate with the funding of the public investment. It seems then that a "free rider" problem may occur.

The involvement of the public sector in the provision of infrastructure under some circumstances does not preclude, by any means, an active involvement of the private sector as well. Actually, a tradable water rights system should lead to a greater involvement of users in investment decisions that other approaches, thus increasing the efficiency of investment. In Chile, the private sector's involvement might be somehow limited by the existence of non legalized water rights (50-65%) as well as WUAs which are not constituted as is indicated in the Water Code<sup>14</sup>. Even though not having a 'legal' water right or not belonging to a well constituted WUA does not seem to affect the exercise of water rights,

11 Apparently, the transfer process was delayed because of doubts about the capability of the WUAs to operate the system.

12 Referring to ESSCO, the water company that made a cost effective decision when buying water rights instead of investing in the costly construction of a multipurpose dam.

13 The President of the Republic, however, can ignore this restriction on the basis of 'public interest'.

14 According to the Confederation of Channel Operators (CCC), only 50% of the WUAs are legally registered with DGA (Hearne, 1994).

because traditional rights are respected, it can have an impact on other economic decisions such as investment. Imagine a group of farmers interested in investing in irrigation infrastructure for their common benefit. The lack of individual legal titles will impede this WUA from being legally constituted, thus precluding it from having access to the formal financing mechanisms (e.g. banking system) as a group or to apply to subsidized government programs for building irrigation infrastructure, unless land titles are legalized (e.g. *Ley de Fomento al Riego*). In this situation, it would be necessary to have some members, the wealthier ones which can mortgage other assets (e.g. land), to request financing as individuals, meaning that the financial risk of the project is taken by only some members of the WUA while the benefits are obtained by all of them ('free rider' problem). Thus, the relevant discount rate for such a project is higher when the WUA is not legally constituted, implying that investment projects that otherwise would be profitable are not under this 'non legalized' scenario. Even though the lack of legal water rights might have no effect on actually using the resource, it might have an impact on investment decisions.

b. Operation and maintenance costs

An inadequate operation and maintenance (O&M) of existing infrastructure for irrigation can also negatively affect the performance of the market. As mentioned before, in the past, irrigation infrastructure was publicly owned, but in the present, most investment in infrastructure, including major works is cost-shared by the private sector and the Government, and 'transferred' to the private sector. These works are administered by the legally constituted Water User Associations (WUAs) which are in charge of collecting fees from their members for O&M activities. These WUAs are legally entitled to cut water supply to those members that are at financial fault. Opinions with respect to the adequacy of the O&M tasks performed by these WUAs are diverse. Muñoz (1994) indicates that the level of maintenance is adequate, though not by any means sophisticated. Other authors indicate, however, that the maintenance performed by WUAs is poor, except when the project is developed by the National Irrigation Commission, and then transferred to the users, which is the procedure established by the *Ley de Fomento al Riego* (The World Bank, 1994, Annex H). This suggests that here too free rider problems occur inside WUAs.

c. Concluding remarks

Both issues touch a common problem: the way the market works depends on the level and maintenance of infrastructure; those investing in either new infrastructure or maintenance of the existing one, contribute to the extent and scope of the market, and therefore generate an externality. Whether or not the externality is "internalized" by other economic agents, depends on institutional mechanisms, transaction costs, free rider problems, etc. Enforcing the legal status and power of WUAs seems to be a crucial aspect of the system, as these organizations are the primary responsible for maintenance of infrastructure. Inadequate maintenance increases the loss of water during its conveyance and distribution, and hence increases transaction costs and friction in the market. It should also be considered that WUAs have a potential and important role as investors in infrastructure, directly or by hiring specialized companies, which is currently restricted, in part at least, because of problems with their legal status. In this regard it should be added that those agents "speculating" with water rights will not contribute, at the margin, with efforts

towards infrastructure maintenance and construction, adding then another difference in user costs to the ones identified before (section IV.1).

### 3. *Return flows*<sup>15</sup>

Return flows are common in Chilean rivers, and are a very important source of water for many water users. From a technical point of view, return flows occur because some portion of the water extracted by a certain user is not completely consumed and actually returns to the river flow at some point located downstream. This can occur because of irrigation efficiency being less than 100% and because of losses during conveyance and distribution. Thus, part of the water that was extracted upstream can be reused by a second user located downstream, generating a multiplier effect in the use of water. Even though the return flow problem is not a consequence of water markets, and can exist under any allocation system, it poses certain challenges to the functioning of a private tradable water rights market. Also, the existence of tradable water rights can aggravate the problem because they provide incentives for water users to conserve their water, for example, by improving the efficiency of their irrigation method.

The problem with return flows, is that the total amount of water extracted for consumption in a basin *exceeds* the total upstream flow. Thus, there is a potential deficit of water, that becomes self evident when sales of water rights are made to agents outside the basin, particularly, if the sale implies an extraction from the upper sections which affects the return flows on the bottom sections of a river. The same problem can occur when an upstream user improves its irrigation efficiency, because it will reduce return flows available for downstream users. This reuse of water flows can generate important third party effects because of the externalities generated by upstream users on downstream users when selling water rights and/or improving irrigation efficiency, particularly if traditional rights over return flows do exist. If the water market does not internalize the presence of these externalities, for example, by pricing upstream water rights higher than downstream water rights, the allocation of the resource will be inefficient.

The return flow problem is better or worse solved depending on the definition of water rights. If water rights are allocated on a volumetric basis (volume per time, for example, cubic meters per second), the return flow problem is not solved because every diversion of upstream water fully impacts downstream users. If water rights are allocated on a proportional basis (percentage of the river flow), it will depend on how 'river flow' is defined. If 'river flow' is defined as the upstream flow, thus each agent has a share of the upstream flow, the negative impact of an upstream sale of water on return flows (by reducing them) is shared by downstream users. However if 'river flow' is defined as the sum of the flows diverted by the different channels, the result is 'better' in the sense that the loss is shared by all users, including the upstream owners of water rights.

In the case of Chile, and according to what is stated in the 1981 Water Code, no water rights are allocated for return flows. Thus, the use of return flows is of an eventual nature, and water availability will depend on decisions taken by upstream users. Water users relying on return flows, and which are negatively affected by the sale of water rights involving an extraction of water in the upper part of the river, are not legally entitled to claim damage according to the Chilean Code. However, the permanent water rights assigned

<sup>15</sup> Discussions with Mateen Thobani and Renato Gazmuri were very useful in understanding the nature of the return flow problem.

in a basin are defined as a proportion of the full diverted flow (sum of flows diverted at all channels), thus providing a partial solution for the problem, because the 'loss' is distributed among all water users holding water rights. However, the "solution" is only partial in the sense that an externality still exists, but the cost of it is shared by a large number of agents.

Because of this problem, in some basins the WUAs have agreed to divide the rivers up in sections as in rivers Elqui and Aconcagua, and treat these units as independent markets for water rights. In the case of river Elqui, ESSCO bought water from the 1st section of the river (upstream section) thus damaging downstream users which benefited from return flows. The *junta de vigilancia* unanimously decided to ban transactions to non agricultural uses in the first two sections of the river, allowing them only in the third section (after the last farmer) (Rosegrant and Gazmuri, 1994). Thus, no transactions are allowed among different sections of a river in order to minimize the impacts on return flows. As long as transactions do not involve transferring water among different sections of the river, or outside of the river, conflicts are minimized. This type of approach solves the problem partially, because it does not solve some specific situations, as for example, when a farmer invests to improve irrigation efficiency and negatively affects another water user located downstream. The economic cost associated with this type of prohibitions to trade among sections of a river and outside the basin are the non perceived benefits which would result from more efficient allocations of the resource.

Other approaches to the problem have been implemented in countries as the U.S., and require the intervention of a regulatory agency. For example, in Northern Colorado the solution adopted consists in having the District retain the right to the reuse of the water. This reuse is made available to the water users on the streams within the basin at no charge as often as those return flows appear in the streams. However, no user can prescript a right to those return flows and therefore cannot be damaged or injured if either the pattern or quantity of those return flows is changed. This method of avoiding third party effects is necessary to protect the vested right on the river but is a serious restriction on the free market exchange of water rights (Simpson, 1992).

Another alternative is to split the water right each agent has into a part which would be "consumptive" and another which is non-consumptive (and which is used by some other user downstream who also claims a right giving thus rise to a net deficit at the basin level). Then, transactions outside the basin could be allowed only to the extent that they involve sales of the "consumptive" fraction. As with other solutions though, this amendment also requires substantial sophistication of the market and of the corresponding regulatory authorities. As a first approach to the problem, it could be analyzed whether the basin features some structural characteristics that make the problem a minor one, as it seems to have been the case in Chile, where virtually all consumptive right transactions with non irrigator users take place at the lower end of the basins. Increased scarcity of water resources associated to a country's development, among others, can be expected to increase the importance of solving the return flow problem in an adequate manner.

#### 4. *Groundwaters*

According to the current Water Code, ground and surface waters are national goods of public use, and private parties can hold user rights over those waters. In both cases, and if available, private parties can request water rights at zero cost from DGA. Some categories of water rights, such as permanent consumptive rights for surface waters, have been mostly allocated by DGA though. Thus, interested parties must buy this kind of rights at their

market price or request a different type of water right (e.g. eventual). Depending on the particular case though, it will be cheaper to obtain user rights for groundwater and invest in wells and other infrastructure for its extraction, than to buy water rights in the market. One example is the water company of Santiago, EMOS, which needs to increase its water supply by year 2,000 and has considered buying water rights as an alternative. Currently, it is also analyzing the feasibility of exploiting an aquifer located west of Santiago or to improve El Yeso Reservoir management. In general, but depending on the region and economic conditions, groundwater is still a relatively unexploited resource in Chile (Bauer, 1993; Muñoz, 1994).

Hydrological interactions exist in river basins between ground and surface water resources. The exploitation of groundwater can affect other users of ground as well as surface waters, particularly if the natural replenishment rate of the aquifer is lower than the extraction rate. Some of these situations are regulated by the Water Code, specifying several actions that the DGA can implement in case of damages to other users (article 62). One example of conflict occurred at the Elqui River. The Water User Association of the Elqui river opposed the DGA's decision to allocate rights on groundwater resources because of the potential impact on the surface water flow and particularly on return flows, but without success (CCC, 1989). Another example is the conflict between ESSAT and the farmers in the I region of the country (Arica). As mentioned before, the farmers argue that the impact of ESSAT's pumping of the aquifer has been severe and damaging for their agricultural activities because of the decrease in water availability. The DGA would have authorized this level of pumping by ESSAT.

The interrelationships existing between different sources of water highlight the crucial role that must be played by the regulatory authority in charge of providing rights to exploit groundwater. Appropriate institutional development here requires the development of a complete data base for the different basins as well as for the existing users. Otherwise, a private market in surface water could be eroded by "free-lunch" exploitation of groundwater resources. In Chile, the regulatory role has been more or less successfully carried over by the DGA, despite some criticisms as in the Azapa valley case (see footnote 6). Farmer associations have indicated that a stronger role for WUAs in some regulatory matters would be more efficient because they handle better information about specific situations. This would help to decrease the time needed to obtain permits and authorizations, which some private parties claim are currently unnecessarily long.

DGA on the other hand has indicated that in some cases it lacks the necessary information to perform an adequate monitoring task<sup>16</sup>. Thus, even though the Water Code allocates responsibilities to the DGA when third party negative effects are present, for ground as well as surface waters, this agency has trouble diagnosing and detecting some of these situations. In the case of groundwater, DGA has the authority to establish protection areas, by limiting the extraction of the resource, to protect the aquifer. It is not clear though, if DGA has the information needed to determine if the rate of extraction of a certain aquifer is above or below its natural replenishment rate. If a certain user believes it is being negatively affected by other users, it can request the intervention of DGA, which can reduce the extraction rate proportionately for all users (articles 56-68, 1981 Water Code). Consequently, the protection provided by DGA to third parties in these matters would not be as adequate as needed because of implementation problems. When implementing the system

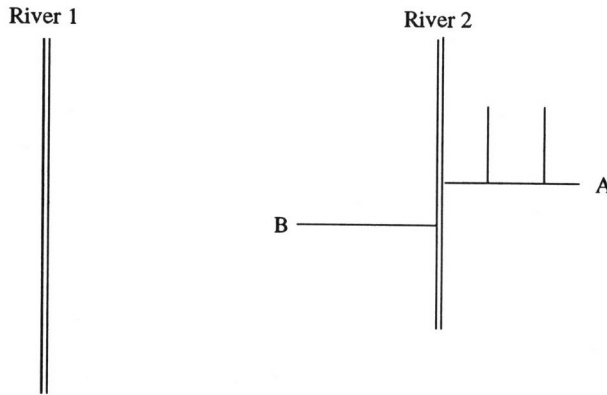
<sup>16</sup> DGA would benefit from having an adequate technical data base, including hydrological information about the basins as well as complete information about the water users (50-65% of water rights are not legalized).

in other countries, care should be taken regarding the necessary institutional and technical development of an efficient agency. As in other areas of public policy, an increased role of private markets in resource allocation calls for a more sophisticated and efficient regulation.

### 5. *Transaction costs*

Several costs are associated to permanent as well as temporary transactions of water rights. These transaction costs are originated by the need of modifying existing infrastructure, obtaining authorization from the relevant private and government authorities, and legalizing titles. Transaction costs are higher for permanent than for temporary trades of water rights, for example, because it is observed that temporary trades occur with or without legalizing the corresponding property titles. It is important to note that transaction costs are present under most water allocation systems, and it is likely that under the market system these are lower than under a centralized management system because information costs are reduced, with the market generating the necessary information and the market users bearing the information costs (Rosegrant and Binswanger, 1993).

FIGURE 2



Three type of transactions can be distinguished for the purpose of this analysis: i) Type 1: transactions within the same intake of the river (within A), ii) Type 2: transactions between different intakes along the river (between A and B), iii) transactions involving water transfers among different river basins (between rivers 1 & 2) (Refer to Figure 2).

#### a. *Infrastructure*

The cost and need to modify infrastructure when performing certain transactions, will depend upon the type of transaction and the characteristics of the existing infrastructure.

*Type 1.* An important part of the irrigation infrastructure, consisting of conduction channels as well as flow dividers, which are used currently in Chile, were built during the

XIX century. Most of this infrastructure was designed and built for fixed water flows. Thus, for certain transactions it is necessary to modify part or all of the physical infrastructure (channels as well as fixed flow dividers) to assure that all users will continue to receive the corresponding water flow<sup>17</sup>. This obviously increases the cost of the transaction. In some parts of the country, though, as for example at the Limarí basin (IV region), the devices used to divide the water flow allocated to different users are adjustable gates ('compuertas'). This kind of devices allow for more flexibility during transactions and reduced transaction costs, because water flows can be modified by simply lowering or raising the corresponding gates. Thus an irrigation system based on flexible infrastructure would reduce transaction costs. Casual observation suggests that even though the investment cost of fixed versus flexible irrigation infrastructure is similar, the operational costs are much higher in the case of flexible infrastructure. These higher operational costs arise, because given that it is much easier to modify the water flows (raise or lower adjustable gates), it requires more monitoring and control of the users' behavior. This is a topic for future research.

*Types 2 & 3.* In general these type of transactions involve investing in costly works. In the case of water transfers, costly constructions are needed to conduct water among basins because of the complex geography of the country (steep slopes and hill separations). One example is the Laja-Diguillín Channel which conducts water from the Laja basin to the Maule basin, which had an approximate cost of US\$ 95 million and was built under a government subsidized program (CCC, 1993a; Bauer, 1993). Even though, no figures are available, it seems reasonable to assume that transaction costs for these type of transactions are significant.

b. Authorization from private (WUAs) and government authorities

A second element that can represent additional transaction costs is the need for obtaining authorization from different institutions (WUAs and DGA basically) for certain transactions. All transactions need to be authorized by the respective WUA. It seems reasonable to expect that an authorization for a type 3 transaction will require longer than for a type 1 transaction, simply because it involves a larger number of users as well as WUAs. The intervention of the DGA is mandatory only when the transaction affects a natural watercourse, that is for type 2 & 3 transactions. Apparently DGA has problems with the processing of these authorizations, and according to different sources these delays take between 6 and 24 months. These delays are caused by lack of personnel, excess of work and excessive centralism, that is lack of autonomy at the regional offices of DGA (Thobani, 1994; Del Canto, 1994). This problem has motivated, in part, some of the private claims for transferring part of the DGA's responsibilities to the WUAs.

c. Lack of legalized water rights

A third element that can increase the costs of transaction are irregularities with the property titles over water. In Chile, an important proportion of water rights are not legalized, that is users do not have the corresponding property titles. Different sources

<sup>17</sup> For minor transactions, it is possible to modify flows by simply putting stones, and other elements, and thus avoid modifying the infrastructure.

reported that between 50% and 65% have not been legalized yet, even though the Water Code of 1981 compelled to do so<sup>18</sup>. Thus, an important fraction of the water rights are exercised on the basis of tradition only<sup>19</sup>. This situation increases the costs of transaction, particularly when dealing with permanent transactions. In the case of temporary transactions, such as short term leases, no legal transfer of water rights is required to perform the operation. The market of water rights would be more efficient if the registry of water rights was simple, transparent and easily accessed by water users.

The costs of overcoming this situation, that is, legalizing water rights on an individual basis can be significant. The current situation with 50%-65% of water rights not being legal, can be an indication that, in the past, the benefits of legalizing water rights were perceived by water users as being smaller than the costs of taking such an action. This perception would be changing though because an increased interest for legalizing water rights is observed among the private sector. Also, the National Association of Irrigation Channels (CNC) has indicated that it strongly recommends its members to legalize water rights to avoid the risk of losing their rights. Some isolated cases have been reported where third parties request water rights which have belonged by tradition to another person.

DGA, on its side, has allocated some funds to the legalization of water rights as well as WUAs. DGA has a special program to legalize the property titles for water rights on a collective basis, which is cost effective because of the existence of important fixed costs such as lawyer fees (Muñoz, 1994). DGA reports that it spent almost US\$ 1 million legalizing water rights as well as WUAs during the 1991-93 period (see Table 3).

One of the tasks of the DGA, according to article 122 of the Water Code, is to maintain a Public Registry of Waters (surface and ground waters). Apparently, DGA is not performing this task adequately because of several reasons, such as the lack of centralized and updated information about the legal status of water rights. As mentioned before this is so, because of the high proportion of non legalized water rights, and also, because sometimes water rights are legalized directly through the Judiciary system, meaning that the DGA, which is the responsible government agency, has no knowledge of these new 'legalizations' and thus its records can be outdated.

18 No quantitative information was found about this subject. These figures represent the 'best guess' of members of DGA and the National Association of Irrigation Channels (Confederación Nacional de Canalistas).

19 This situation does not imply though that people have trouble with actually exercising their rights, because customary rights are respected.

TABLE 3  
LEGALIZATION PROGRAMS PERFORMED BY DGA

Year	Cost of legalization program (1)	N° of organizations and users which benefit
1991	\$ 75.5 million (US\$ 216.2 thousand)	240 ' <i>comunidades de aguas</i> ' 4500 users
1992	\$ 127.6 million (US\$ 351.9 thousand)	403 ' <i>comunidades de aguas</i> ' 6000 users
1993	\$ 163.5 million (US\$ 404.5 thousand)	753 ' <i>comunidades de aguas</i> ' 4 ' <i>juntas de vigilancia</i> ' 13683 users

Notes: (1) The US\$ figures were obtained dividing the Ch\$ figures by the average nominal rate of exchange for the corresponding year.

Source: Based on DGA (1994).

From a public policy perspective, it should be clear that measures must be taken to provide the necessary legal status of traditional water rights. Very often, this process is unnecessarily expensive and cumbersome on an individual basis, but is not so on a collective basis. The future Peruvian Water Code, for example, is expected to consider registering water rights in blocks as a way of solving the lack of titling.

## 6. *Environmental aspects*

Currently, environmental problems belong to one of the most debated issues in Chile. In the case of water pollution, there are several pieces of legislation which address these kind of problems, and some of them exist since the beginning of the century. Nevertheless, their implementation and/or enforcement were not successful in the past, and water pollution is considered as one of the major environmental problems in Chile. Several institutions have been working to improve this situation in recent years by reducing the discharge of domestic and industrial untreated effluents, investment in water treatment facilities and other related actions. Clearly the solution of the water pollution problem in Chile 'goes beyond' the actual Water Code, and requires a general improvement of the institutional framework and a budgetary increase.

The proposal to amend the Water Code includes the creation of mixed organizations (public/private) to manage watersheds as a unit to deal with environmental issues such as the following:

- Water quality (pollution): the 1981 Water Code indicates that water extracted or restored by non-consumptive users should not damage the rights of third parties over the same water, including quality. There is no mention about consumptive users and water quality. Some conflicts have occurred among water users because of quality matters. For example, in the Bío Bío/Laja river basin most of the pollution is originated at the intermediate portion of the basin and its impact is mostly felt at the bottom portion, particularly at Concepción and Talcahuano. This urban area obtains its drinking water from the river which is polluted, and on the other hand pollutes the coastal zone and the fishing industry (Bauer, 1993). The severity of the pollution at the bottom portion of the Bío Bío River depends partially upon the volume and release schedule of water from the Laja reservoir, because of its diluting impact on pollution. Thus, the management of the lake to satisfy the needs of farmers, hydroelectric companies in terms of quantity, has an impact on water quality which has not been dealt with yet.
- Erosion and sedimentation: the lack of forest cover on the hill sides of river basins may cause important problems of erosion and sedimentation which will damage downstream users because of the bad quality of water. Forests also have a role in terms of retaining and regulating water flows. This is a typical situation where upstream users (which cut the forest) can cause an externality on downstream users. A minor although negative impact of forests is that they are consumptive water users (absorption by root system) but do not hold any water rights.
- Minimum ecological flows: the proposed amendment includes establishing minimum ecological flows for each basin in order to protect biodiversity, water falls, etc.. All of these 'goods' are classic examples of situations where social benefits are higher than private benefits, and thus from an economic perspective government intervention is desirable. One practical issue to be solved though is what will happen in those basins where all water rights have already been allocated. One option is to have the government (DGA) buy water rights back if needed. Another topic is to allow the future Watershed Management authorities to decide if the watershed is interested in keeping these minimum ecological flows.

Although dealing with the environmental problems mentioned here has an "easy" theoretical solution, from a practical policy perspective the problem is extremely hard. The "easy" theoretical solution is, of course, to define more "attributes" to water, and to perform the transaction in terms of a commodity defined by an array of attributes (e.g. water of a given quality). From a practical perspective, enforcing such a system may be extremely costly. As in other areas of environmental policy, some mix between market and "command and control" instruments would be called for. The appropriateness of modifying the Water Code to deal with water quality issues is not clear at all given that it is a useful mechanism for obtaining an efficient allocation of water. This is an area for future policy research.

## 7. *Equity*

A controverted issue is the transfer of water rights from small to large landowners as a consequence of the initial implementation of a system of tradable water rights. It is mentioned that after the promulgation of the current Water Code in 1981, small landowners

would have lost their water rights because of lack of knowledge and resources to legalize their property titles in favor of larger and wealthier parties, because if someone claims certain water rights and no formal opposition is observed, in theory, these rights can be allocated to another user. An exception would be small farmers which were part of the Agrarian Reform and were assisted by the government to regularize their titles (Bauer, 1993). DGA seems to have been particularly careful with this issue, considering any evidence of legal or traditional ownership, thus avoiding equity problems. Even though some specific equity problems might be involved with the initial implementation of a private water market, it seems to be a non issue in the case of Chile given the traditional operation of this market among farmers (and previous to the 1981 Code).

## V. SOME LESSONS

This paper reviewed the Chilean experience on tradable water rights with the purpose of deriving lessons that can be used by those trying to implement similar institutional schemes in other countries.

The system in Chile has worked reasonably well, especially in zones where water scarcity problems are more acute. In specific instances, and in agreement with what several economists expect from a system like this (Thobani, 1994; Rosegrant and Binswanger, 1993), the private market has helped to avoid expensive new water infrastructure by allowing frictionless transfers of water rights from agricultural to urban sectors.

Our findings suggest that there are three features of the Chilean experience that contributed to a successful implementation of the system. These are the following:

- *Tradition of trading in water rights:* Tradition helps in explaining why active transaction takes place - particularly in the form of leasing - in spite of having only 35%-50% of the water titles legally inscribed. Respecting the traditional use of water can also avoid an initial inequitable allocation of water rights. The main lesson then is that care should be taken in other countries where private trading in water rights is less rooted in the farming economy. In those cases, a more aggressive titling policy of water rights should be adopted.

- *Regulatory framework:* The DGA has played a reasonable role in terms of regulating the allocation of water resources so as not to conflict with existing rights to surface and ground waters. Criticisms of DGA's role indicate that because it does not have complete hydrological as well as titling information, its performance has been not as efficient as it should. This deficiency is attributed in general to its lack of financial resources. This is a key issue. In the absence of this efficient regulatory framework, a market for surface water could be indirectly eroded by "free lunch" access to competing groundwater sources. The lesson for other countries is simply that a more dynamic market development calls simultaneously for a more sophisticated role of the corresponding regulatory agency. Adoption of an ambitious program of private water rights market without the necessary institutional strengthening of a regulatory agency in charge of all water resources (surface and ground waters) is not advisable.

- *Lucky circumstances with return flows:* Given the particular geographic characteristics of the country, with most consumptive demand lying at the middle and lower

parts of the river basins, return flows have not been a major problem. In some specific cases, this has been resolved by prohibiting to trade consumptive rights outside the river basin and among sections of the river. This result is likely to lower the potential benefits of the market in tradable water rights. For those cases, a more sophisticated definition of the water rights would have to be adopted. But again, this would call for a very sophisticated regulatory power.

The Chilean system is not free of problems, but solving each of them seems more a matter of "fine tuning" of the current system rather than a drastic reform of it. Among these problems it is worth mentioning implementation problems regarding non-consumptive uses, and the possibility that speculative holdings of water rights face a somewhat lower opportunity cost than holding water rights for irrigation purposes. Both problems can be solved with minor amendments to the current system, such as imposing a user fee on water rights for consumptive as well as non consumptive users.

Finally, we identified some issues for future research:

- Appropriate level and kind of infrastructure for market development, which directly affects the dynamism of the water market (sections IV.2 and IV.5). Involves public as well as private participation.
- Interrelationship with environmental aspects (section IV.6)
- Legalization of water rights, which has an impact on the eventual implementation of a water user fee (section IV.1) and the provision of infrastructure by the private sector (section IV.2). Block titling by DGA seems to be a program with high social benefits.
- Groundwater, their interrelationship with surface water and their optimal depletion rate (section IV.4)

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