

Water markets: case study of Chile's 1981 Water Code

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Abstract

G. Donoso. 2006. Water markets: case study of Chile's 1981 Water Code. *Cien. Inv. Agr. 33(2): 157-171*. The main objective of this study is to develop a case study of the market of water use rights established in the Water Code of Chile of 1981. The evaluation of the Water Code of 1981 shows that this allocation system based on water rights market has significant economic benefits. However, the adequate application of this system requires strengthening the institutional framework to achieve the integrated management and sustainable use of water. Additionally, one can conclude that the performance of the water use rights market in Chile has been variable. The variability in performance of the market can be explained by problems both related to and independent of the allocation system. The most important problems independent of the water allocation mechanism are those arising as a result of unavoidable transaction costs, externalities due to inadequate definition of use rights in the Water Code, and uncertainty regarding the availability of water. Likewise, certain problems related to the allocation system have been identified problems such as the lack of adequate and timely information; the difference between nominal and in rem (latin term used to describe jurisdiction over property without regard to personal jurisdiction) rights; conflicts arising between users due to the sale of traditional rights; avoidable transaction costs; and the hoarding of non-consumptive rights. In summary, the water use rights market represents a useful allocation mechanism for water resources. However, it is necessary to reformulate the regulatory framework of this mechanism so as to reduce the existence of conditioning factors that have limited the efficiency, sustainability, and replicability of this allocation mechanism.

Key words: Chile, institutions, water markets, water policy, water resources management.

Introduction

Allocation mechanisms based on water use rights markets have been implemented in the case of Chile, India, Pakistan, USA and Australia (Garrido, 1998 and Bauer, 2004). These cases indicate that the market mechanism represents an efficient means to allocate water for two main reasons. First it secures transfer of water from low value to higher value activities. Second, it puts the burden of information collection on water users and avoids problems of asymmetric information common in centrally planned situations. However, to operate

properly, water markets require well developed water conveyance facilities and the appropriate institutions to define water rights and water endowments contingent on water availability. It is also necessary to have a complete set of rules for trading in water endowments and in water rights. Finally, institutions are needed to oversee trading activities and resolve conflicts when they arise.

The main objective of this paper is to develop a case study of the market of water use rights established in the Water Code of Chile of 1981. This case study thus analyzes the formulation, development, implementation, and evaluation of the results of the operation of the Water Code of 1981, which establishes a water rights market as a water allocation system. With this end, the

following section provides a detailed description of the Chilean case of water rights allocation. The third section analyzes the performance of the water rights market established in the code. The fourth section describes the lessons learned from the code's application. The fifth section includes bibliographic references.

Description of the case study

This section describes in detail how the mechanism for allocating water rights was designed and implemented in Chile.

Allocation of water resources prior to the 1981 Water Code

Prior to the promulgation of the 1981 Water Code, there were a number of proposals and ordinances aimed at legislating the allocation and use of water. The following provides a brief description of their most important contributions.

The first national set of regulations governing water use dates from 1819 and was authored by O'Higgins, who issued an Executive Decree defining the size of an irrigation system, the form of sale and the parties responsible for the outlets.

The Civil Code, which governed as of 1857, was the first instrument to define how "the rivers and all waters running within natural banks are national goods for public use". In addition, it stipulated that access to water is achieved through "grants", "given by competent authority".

The water distribution ordinance of 1872 established rules for the distribution of water during periods of drought. This ordinance created what is now referred to as permanent and contingent rights.

A number of legislative proposals prior to 1951 eventually gave rise to the 1951 Water Code. This code represents a continuation of the principles contained in the Civil Code referred to earlier, of which the most important is the principle that water continues to be a national good for public use.

The 1930 Water Code introduced the concept

of Water Use Rights, while the 1951 code develops this concept more fully, establishing that "The Right of Use can only be acquired by a grant given by the President of the Republic in a manner established in this code".

Article 12 of the 1951 Code defines Right of Use as follows: "The Right of Use is an *in rem* (latin term used to describe jurisdiction over property without regard to personal jurisdiction) right covering waters in the public domain and consisting of the use, enjoyment and disposition thereof, under the requirements and in accordance with the rules specified in this code". Moreover, water rights are for purposes of use, enjoyment and disposition, without this constituting a transfer of ownership of the water.

The 1951 Code defines water use priorities through a listing of preferential categories developed as a result of political interest in establishing such a system. In this manner, priorities were established for use in cases where there is competition for the same water. In addition, it established an order of priority for use as follows: drinking water, potable water services, domestic use and sanitation for the population, followed by railroads, power generating plants, industry, mills and other uses. Where there was competition for the same category of use, the relevant authority would select the largest enterprise with the greatest utility. This decision-making authority resided with the relevant administrative chief.

The 1967 Water Code, implemented in a political environment in which increasing power was being concentrated in the hands of the central government, reinforces the concept of water as being within the public domain and "changes the legal nature of Right of Use" with this new legal formulation consisting of "giving it the status of an *in rem* administrative right".

The new legal character of use rights consists of an *in rem* administrative right, in which the State grants the use of the national good for public use, subject to norms of public law. The State grants the right to use, but never to own, the water.

Rights of Use become administrative and forfeitable, and the process of reallocating water is carried out after suitable planning, to be implemented using "rational and beneficial use rates".

The 1967 Code abolishes the preferential lists and establishes drinking water provision and services as the top priority. For a given geographic area, a determination is made of the priority for industries, agricultural categories and water use technologies. On the basis of these factors, maximum permissible volumes are then established.

Allocation of water resources through the 1981 Water Code

Based on the political changes that occurred in Chile in 1973, the economic paradigm changed from one in which the State must protect and oversee optimal allocation of resources to one in which the market is responsible for allocating resources in an efficient manner.

The different instruments and ordinances outlined above, including the codes in existence prior to 1981, were limited in their ability to allow for the formation of an efficient water market consistent with the new economic system. These limitations were related primarily to the definition of Rights of Use, the amount of information available to users, transaction costs, potential harm to third parties, mechanisms for resolving conflicts, speculation in water resources, and institutions or legal frameworks needed in order for the market to function properly.

In synthesis, the underlying philosophy of the Water Code of 1981 is to establish permanent and tradable water use rights so as to reach an efficient allocation of the resource.

The water rights system established through Legislative Decree 2.603, of 1979, and the 1981 Water Code, codify the system for granting water rights, maintaining the status of water as a national good for public use. Nevertheless, water rights enjoy broad protection under a special legal framework and can be freely transferred. As a result of implementing an overall system for protecting private ownership,

derived from the 1980 constitution, water use rights have been strengthened in the sector, with rights granted by the State (constituted), as well as common law uses and other special uses (recognized by the State) also gaining protection.

The current legislation establishes complete and permanent freedom in the use of water to which one has rights, with individuals permitted to use the water for whatever purposes and in whatever manner they wish. It is not necessary, in requesting rights, that one in any way justify future use. Nor is it necessary in transferring water rights to continue the previous type of use to which the water was put, with individuals permitted to freely make changes in such use, e.g., from irrigation to human consumption. The only limitation relates to the quantity of water that may be extracted from natural sources, with the requirement that users must show proper regard for the particular status of the rights involved.

As can be concluded from the above paragraphs, the main feature of the new Water Law is that it added freedom of access to the creation and free transferability of water rights. In achieving this objective, the protection and the content of water rights were strengthened. At the same time, the law established the freedom to transact such rights - along with, or separate from land - and allowed owners of water rights the freedom to determine how and where they are to be used (Vergara, 1998).

Water use rights. While the 1981 Code considers water to be in the public domain, it creates for individuals a Right of Use over water, with the same constitutional guarantees as are provided for property. Based on this right, individuals may use, enjoy and legally dispose of water with complete freedom (Vergara, 1998).

Figueroa (1995) defines the right of use as the authority to access a natural source in order to extract from it a supply of water at a given point or use the water without removing it from the body of water - in both cases, on an exclusive basis. Once the river waters enter a canal as a result of exercising the right of use, they lose their status as a national good for public use.

In this way, the distinctive elements that comprise a water use right represent a given natural source, a supply of water defined in units of volume and a point of extraction or capture point. Moreover, from a legal perspective, the law defines the specific content of each of the rights, classifies them as consumptive and non-consumptive, subject to permanent and contingent exercise, continuous, discontinuous or alternating. Permanent and contingent rights relate to scarcity, while continuous or discontinuous rights relate to the time during which the water is used (Figuerola, 1995).

Each type of Right of Use has its own characteristics, which are given below: 1. Consumptive is the right of use that does not require that the water be returned after being used, and the owner of this right may totally consume the water in any activity. 2. Non-consumptive is the right of use that obliges the user to return the water, observing certain requirements, as specified in the definition of the right. Non-consumptive rights must be used in a manner that does not interfere with or limit the exercise of consumptive rights.

In addition, consumptive and non-consumptive rights can be exercised in a permanent or contingent manner and in a continuous, discontinuous or alternating manner, as described: 1. Permanent rights. Are rights to use water in specified amounts, unless the source of supply contains insufficient amounts to meet these needs fully, in which case the flow shall be distributed in equal parts. 2. Contingent rights. Are those that only authorize the user to utilize the water at times when the original flow of water is more than sufficient to satisfy permanent rights. 3. Continuous rights. Are those that permit the use of water in a constant manner, 24 hours a day. In other words, the right can be exercised during the entire day, every day of the year. 4. Discontinuous rights. Are those that only permit water to be used during given periods. In other words, they can only be exercised in periods and at times defined in the title. 5. Alternating rights. Are those in which the use of water is distributed among two or more persons who use the water successively.

There are currently two types of water rights:

those that are entered in the relevant Real Estate Registries, and other, equally valid ones that are not registered in the corresponding Real Estate Registries. The latter are largely the result of the fact that the current Code declared valid: rights of use recognized by executive rulings, as of the date of their promulgation; those arising from grants given by competent authority, provided that they are currently being used and exercised; and those acquired by prescription. It also provided that the exercise of rights of use recognized or constituted under previous laws shall be governed by their rules, and grandfathered any pre-existing formally registered rights already on record as a result of the rules explained earlier (Figuerola, 1995).

Initial allocation of water use rights. In Chile, the procedure for acquiring a water use right begins with an application that must be completed and that meets the following requirements: 1. identification of the source from which the water is to be captured, specifying whether the water is surface water or ground water; 2. indication of the quantity of water to be extracted, expressed in liters per second; 3. specification of the points at which the water is to be captured and the method of extraction; and 4. indication of whether the right is consumptive or non-consumptive, permanent or contingent, continuous, discontinuous or alternating.

The administrative procedure requires that this application be published in the *Diario Oficial*, a daily Santiago newspaper, and in an appropriate regional newspaper, where applicable. If the applicant is a single individual, and there is water available, the right of use must be granted and the water authority may not refuse to grant it.

On the other hand, if there is competition for the water rights, they are to be allocated through a bidding process (auction) with an award to the user who offers the highest bid. However, in cases in which there is a societal interest in allocating the available water to a user who did not offer the highest bid, the President of the Republic, and he alone, may order that the auction be voided and may allocate the water to one of the other bidders. In order to establish original use rights, a prior application is not always required. The Director-General of

Water is empowered, on his own initiative, to offer available flows at auction.

The corresponding public entity (or the courts, as the case may be) is obliged to grant new water rights to new applicants once the three requirements cited above and, specifically, the existence of discharges not previously granted to other individuals, are confirmed. It may not refuse to grant new water rights without infringing a constitutional guarantee.

Nonetheless, is important to highlight that the State, based on evidence of monopolistic behavior, endorsed by the antimonopoly commission, has refused to grant new water use rights. In fact, the Constitutional Court has established that the State can impose additional conditionalities to grant new water use rights by reformulating the Water Code. Due to these situations, the dispositions of the Water Code of 1981 that force the State to grant new water use rights are under revision (Peña, 1999).

The resolution establishing the right of use is codified in a public document and entered in the property registry of the competent Real Estate Registry and in the Registry of the General Directorate of Water (DGA). Merely by operation of law, land owners have rights over surface water that is surrounded by, emerges from, runs through or disappears within their land.

Entities important to the implementation of the 1981 water code. There various institutions concerned with the functioning of the water code, and they play a major role in the process of allocating water resources.

Under the institutional framework established by the Water Code of 1981, the water resource management roles assigned to the State are the following: 1. To measure and determine the availability of water resources and to generate the necessary databases that allow for a well informed management of water resources. 2. To regulate the use of water resources avoiding third party effects and their overexploitation. For that purpose the State must analyze the availability of water resources and potential water use conflicts before granting new water use rights and other authorizations such as

changes in water distribution infrastructure and 3. To conserve and protect water resources, by means of an environmental impact assessment system and environmental policies.

The responsibilities of private sector are: 1. To study, finance, and implement development projects associated with water. In this process, water use rights represent their commercial assets and water is considered to be a productive input and 2. The distribution of water and its proper use by the members of user organizations, as well as for the construction, maintenance and management of irrigation structures. Three different types of such organizations are provided for in the Water Code: boards of control, canal-users' associations, and water communities.

From the perspective of the State, the positive institutional characteristics are: 1. The concentration in a single institution of the research and management water resources and 2. The institutional separation of the different tasks that must be undertaken by the State.

With respect to the effectiveness of this institutional framework, it is important to point out that during the last 15 years there has been wide debate with respect to possible revisions of the regulatory norms, giving rise to a discussion of the advantages and limitations of alternative definitions. Initial efforts in 1992 included proposals to: allow the DGA to cancel and redistribute unused water rights, create river basin administrative organizations, and allow the DGA to consider the maintenance of water quality and minimum river flows before authorizing new water rights. As Bauer (2004) points out, this proposal met with significant opposition since the expropriation of unused water was considered by some to be an unconstitutional infringement of private property rights and the river basin organizations were poorly defined.

Due to the opposition, the 1992 reform was replaced by a less ambitious proposal which was presented to the Congress in 1996. Under the 1996 proposal, all newly constituted and unused water rights would be taxed. The tax was designed to provide an economic incentive

for speculators and water use rights hoarders to forfeit their unused rights. This proposal was accepted by the Chilean congress in 2005.

Resolution of conflicts. The Water Code provides that conflicts occurring among users and between users and the organization shall be considered and resolved by the board of the user association, acting as arbitrator, and the police may be employed to help enforce its decisions. More specifically, the board, in its capacity as arbitrator, considers the following issues: 1. water allocation; 2. exercise of the rights that *comuneros* have as members of the community; and 3. conflicts that arise regarding any of the previously mentioned points between *comuneros* and the community.

The arbitrator makes decisions by an absolute majority of its members, and rulings must at least carry the signatures of those who concurred with the majority agreement. Moreover, the Code stipulates that it is advisable for those in the minority to also sign, indicating the reasons for their dissent. Decisions in these arbitration proceedings are notified by certified letter and notification is reckoned as of the second day after the decision has been handed down. In addition, if necessary, the board may seek the assistance of the police by appealing to the judge with authority in the territory where the ruling is to be enforced. The judge is merely required to establish that those who issued the ruling are actually the members of the community board and that the board is legally recognized.

Finally, anyone who believes himself to be harmed by an arbitral ruling may lodge a claim with the ordinary courts within a period of six months from the date of notification.

Performance of the Water Code of 1981

Since the establishment of the water allocation mechanism based on a market of water use rights in Chile, a series of empirical and theoretical studies have been carried out to determine: the existence of a water use rights market and the number transactions; water use rights market efficiency; bargaining, cooperation, and strategic behaviors of market participants; and the marginal gains from trade.

Several authors, (Gazmuri and Rosengrant, 1996; Ríos and Quiroz, 1995; Hearne and Easter, 1995; Gómez-Lobo and Paredes, 2001; Donoso, Montero and Vicuña, 2001) find evidence of active trading for water-use rights, specifying that the markets are more active in those areas where the water resource is scarce with a high economic value. These studies indicate that the market mechanism has, in general, represented an efficient water allocation system.

On the other hand, others authors such as Bauer (1995, 2004) and Hadjigeorgalis and Riquelme (2002) state that the efficiency of water markets has been poor due to the existence of thin water markets. In the extreme position, Bauer (2004) states that the Chilean case shows that water rights markets have not worked well in the context of poor institutions. More specifically, he points out that “the problem areas include a range of critical management issues, such as social equity, environmental protection, river basin management, coordination of multiple water uses, and resolution of water conflicts” (Bauer, 2004). However, a fair assessment of the Chilean Water Code of 1981 requires the recognition that these issues were not explicit objectives of the Code. Thus, as Bauer (2004) states, but later disregards, “it may be unfair to criticize the Code for its failures to solve them later” (Bauer, 2004).

From these studies one can conclude that the performance of the water use rights market in Chile has been variable. A key conclusion of these studies is that water markets are more prevalent in areas of water scarcity. They are driven by demand from relatively high valued water uses and facilitated by low transactions costs. In the absence of these conditions trading has been rare and water markets have not become institutionalized in most valleys. And although market transactions are still rare they are becoming more frequent in areas subject to economic growth (Hearne and Donoso, 2005).

In the Paloma System, for example, water is scarcer with a high economic value (especially for the emerging agricultural sector). This generates a strong competition for water between users, which in turn causes the temporary and permanent water markets to be very active,

determining the prices of transactions. In the Maipo system, on the other hand, water supply is greater and demands from the agricultural sector lower. In the first section of the Mapocho river (1SMapocho) there is significant demand of water by the drinking water companies that hold 66% of the water rights in this section. They are continuously buying water, and together with the real estate companies, they account for 76% of the rights traded during the 1993-1999 period. Due to this strong competition, the sellers have a great negotiating power that tends to determine the prices of the transactions. In the first section of the Maipo river, on the other hand, the potential buyers and sellers of water rights are not clearly identified like in the 1SMapocho. The principal buyer of water rights in this section is the Empresa Metropolitana de Obras Sanitarias (EMOS), which has adopted a passive attitude in the purchase of water rights, waiting for good offers to buy water rights. In the rest of the sections of the Maipo and Mapocho rivers, water is abundant chiefly because of the contribution of return flows of underused water from the higher part of the basin. This has led the water rights market in these areas not to become institutionalized in these areas.

Problems independent of the allocation system affect the efficient allocation of the resource but are not considered to be related to the free transferability of water rights. In other words, the existence of a rights market neither creates nor aggravates the problem. Furthermore, the problems represent an impediment to reallocating of the resource under any allocation system. At the same time, problems related to the allocation system affect the efficiency in allocating water resources and are related to the water market system.

Problems independent of the allocation system

Among these problems, most notable are those arising as a result of unavoidable transaction costs, externalities due to inadequate definition of use rights in the Water Code, and uncertainty regarding the availability of water.

Unavoidable transaction costs. The transfer of water rights in the market model presents unavoidable transaction costs. Unavoidable transaction costs are created due to the cost of

modifying the water distribution infrastructure. These transaction costs are unavoidable, i.e., they relate to a contractual obligation resulting from the particular characteristics of water resources. These costs must be absorbed, regardless of the water allocation system. Thus, such costs are not relevant in analyzing the transaction costs related to the water market, but it must be borne in mind that the market allows a larger allocation of the resource in localities with superior water distribution infrastructure. It should be noted that the greater the relative scarcity of the resource, the less importance these unavoidable transaction costs have.

In the Maipo River basin, for example, there is a rigid-pipe infrastructure (the main water distribution system is made up of a structure that separates the flow into multiple off takes), and modifying it is expensive. This cost has been assessed at approximately 10% of the value of the right in section one of the Maipo (1Smaipo), with this percentage diminishing as the total volume of water transferred increases, preventing, in some cases, a significant number of transactions, particularly between users who are widely separated geographically.

On the other hand, transactions carried out in river basins with flexible-pipe distribution systems occur with much greater frequency. Transaction costs in the Paloma System, for example, are considerably lower than those of the Maipo, due to the existence of a more flexible water distribution infrastructure (consisting primarily of variable gates) and the consequent lower cost of modifying it. This, along with the existence of storage reservoirs, which make water availability more secure, has led to the development of a provisional or spot market in water volumes, called transfers, with great market depth. The volumes transferred during periods of scarcity are more than 10% of the total volume allocated to water users in the sub-basin.

Externalities due to inadequate definition of rights. The free exchange of water rights can produce negative effects on third parties, also called negative externalities, which interfere with the socially optimal and efficient allocation of the resource. One such externality is the reduction of spillovers.

Spillovers are waters that are unused and abandoned by their owners after having been captured from a particular water system. Abandoning waters in this manner occurs by virtue of ceasing to capture the water or by using a portion of it and allowing the rest to drain off underground or on the ground to neighboring land. These flows represent an important source of water for users who do not have original rights to the water.

The problem arises in transferring the water rights through the market, because farmers who use this surplus water experience a reduction in volume and may even be reduced to no flow whatsoever.

In this situation, water users downstream have no legal right to demand compensation under the Water Code, since no rights are assigned to water from spillovers. Thus, the use of these flows is contingent in nature, and the availability of water will depend on decisions made by users upstream.

Another situation - different from that described above - is when the farmer wishes to sell his traditional, non-constituted rights. Traditional rights derive from factual use, granted by virtue of having been traditionally exercised. Rights of this type are legally recognized, but only apply to the quantities actually used by the holder. With traditional titles there is no provision for the following essential factors: 1. Flows expressed in volume per unit of time; 2. Whether the rights are consumptive; 3. Whether they are permanent or contingent; and 4. Whether they are continuous or discontinuous (Vergara, 1998).

This situation creates conflicts between those who receive surplus flows and farmers who wish to sell their traditional rights, since those affected by the transaction require the seller not to exclude from the rights the unused portion of water.

At the same time, the seller believes that the rights to spillovers belong entirely to himself, since he has traditionally captured them. This area represents a gap in the law, since it is not clear how much water may actually be transferred.

According to Ríos and Quiroz (1995), spillovers are common in Chile, and are a major source of water for many users. Despite the fact that the problem with these flows is not a result of the water market and could exist under any system of distribution, it creates a challenge for the water rights market. Moreover, the existence of tradable water rights can aggravate the problem, since it creates incentives for water users to conserve their water, improving the efficiency of the irrigation system.

Likewise, Peña (1999), referring to the issue of spillovers, states: "This means that a transaction involving water upstream affects the quantity of water available downstream. This situation, far from being theoretical, is very real in the country: it is well known that those known as consumptive users never account for more than 30% of the actual water consumed, and 70% of the remaining water returns to the canal, constituting the source of supply for water downstream".

Rosegrant and Gazmuri (1994) maintain that, in Chile, there needs to be legal protection for those harmed by the reduction in spillovers. Furthermore, they indicate that this problem must be solved in the river basins of the Elqui and Aconcagua Rivers, where the spillovers are significant. The authors state that for these basins, "the reduction or elimination of spillovers, due to sales or more efficient irrigation systems, can drastically affect the total flow of a given section of river. Thus, user associations for the Elqui River have divided the river basin into a number of sectors, limiting transactions involving upstream sections of the river to those made between water users".

Donoso (1995) states that the "problem results from the poor design of use rights, not from the allocation mechanism, *per se*". For Holden and Thobani (1995), this is a deficiency in the Water Code, in that it does not explicitly prevent the sale of water that involves loss of water to third parties. However, this problem is controlled, according to the 1981 Water Code: the General Directorate of Water (DGA) is responsible for supervising and authorizing only those transfers that involve changes in the point of extraction, requiring that the request be publicized in a

manner that allows third parties who could be harmed to oppose the transfer. Thus, a number of authors maintain that the law provides sufficient protection to third parties harmed by the reduction or loss of spillovers.

Some, however, criticize this way of solving the problem, preferring that the water authority be given more power, which goes against the principle of decentralizing decision making (basic to the system of free transferability), as represented by the market (Vergara, 1998). Another criticism is that this situation is only a partial solution to the problem, since it fails to resolve certain specific situations, such as when *campesinos* with traditional rights invest in improving the efficiency of their irrigation systems, thus adversely affecting downstream water users.

Uncertainty regarding availability of water.

In the Maipo River basin, water rights are established in a manner proportional to the discharge that passes through the supply point. In the ISmaipo, the supply point is the Maipo River, whose discharge varies greatly during the year and from one year to the next, making it impossible to predict, for users, water volumes that will be available during the season, since these are, by definition, irregular and unpredictable. For this reason there is more hoarding of water than is necessary on the part of farmers who have no exact way of anticipating the available water supply, thus hindering the functioning of the market.

In the lower sections of the basin, little is known of the variations in discharge in the canals where the rights are taken out. Thus, there is no way of gauging equivalence in a meaningful way that can be used to analyze the costs and benefits of possessing these rights. Moreover, there is no means of quantification for the entire section, making the rights for different canals non-comparable and therefore non-tradable. This latter situation does not apply to the ISmaipo, where the equivalence of the water shares is widely known, primarily among the water users of the region. However, in the ISmapocho, the value of the water shares is unknown, due primarily to the fact that an obsolete method of quantification is used - one that does not take account of the changes in

water demand that have occurred for the river basin. This system differentiates between two types of rights: irrigation rights and drinking water rights. Irrigation rights are associated with a distribution of water volume throughout the year, with variations similar to the variation in irrigation needs for a typical crop. Drinking water rights, on the other hand, are distributed continuously throughout the year. This distinction does not make sense in the current environment, given that agricultural demand is practically nil.

However, efforts are being undertaken to solve this problem in an institutional manner. The creation of Public Water Registry Regulations, requiring rights holders to define the basic features of the rights, addresses this issue. It is hoped that, in the future, such impediments to the water market will not exist.

In the Paloma System, the situation regarding quantification of rights is different. There, the rights are also proportional in nature, based not on a variable flow, but rather on the volume stored in the Paloma, Cogotí and Recoleta reservoirs. This volume can be determined prior to the start of the agricultural season. The Paloma System is much like a water bank in which the users maintain current accounts, with the ability to carry out the same activities as in a common, everyday bank. Among various possible transactions, water withdrawals from (or charges to) the account may be made; one can request loans of water from the bank, to be returned in the following period; or deposits of water may be made from one user to the account of another user. The fact that reservoirs provide the capacity for regulation increases the security of water availability, clarifying supply and allowing users to make rational decisions regarding the marginal use of their water.

Problems related to market allocation

In studies related to the water rights system, certain problems have been identified - problems such as the lack of adequate and timely information; the difference between nominal and *in rem* rights; conflicts arising between users due to the sale of traditional rights; avoidable transaction costs; and the hoarding of non-consumptive rights.

Lack of adequate and timely information.

There is a general lack of information (or incomplete information) on use rights holdings. This is due, on the one hand, to the fact that, currently, the User Registry is not in use and, on the other, to the fact that many rights are not recorded in any registry. This makes it difficult for those interested in effecting transfers of water to easily find a counterpart, since they do not know how much water can be transferred, how much volume is represented by each share, and whether it will be a dry or rainy year.

Studies carried out by INECON (1995) indicate serious difficulties in finding information of all types regarding the water market. Thus, not only is it difficult for sellers and buyers to form contracts, but it is also hard to obtain information regarding water rights in the country, with such information scattered and disaggregated. Moreover, the little information that does exist is processed poorly or not at all, with major problems in quality and reliability.

As a result of these problems with information, the decisions of use rights holders do not take account of social benefit and economic efficiency, since without knowing the economic, hydrologic and fundamental characteristics of their rights, they are unable to determine their value, tending, rather, to undervalue or overvalue them, with the repercussions this implies.

Many of the problems related to information are independent of the allocation system, since any such system requires a minimum of information in order to function properly. Nevertheless, the rights market system presents a greater problem. One basic factor is that potential buyers and sellers need to be able to have information on transaction prices. To the extent that there is no mechanism for revealing such prices - allowing owners to verify the value of their rights - transactions become more difficult, since only a perceived value exists, without actual evidence of such value.

Incompatibility between nominal and in rem rights. One of the problems identified in the literature regarding water rights markets relates to the difference between nominal and

in rem rights. There are different cases in which *in rem* rights do not coincide with what the holder defines as his nominal property rights. This situation occurs primarily in the case of traditional rights or, in some cases, ground water rights. In the latter case, there is a distortion between estimated rates of potential extraction and actual available resources.

While this problem should not be viewed as intrinsic to the market system, since it is the result, rather, of poorly defined rights, given the market allocation system involving transferability this problem becomes a hindrance to transactions: owners who sell will want to transfer their nominal rights, while the buyer will not be willing to pay for rights that do not include a flow of the real resource. This problem, then, becomes evident when attempting to transfer rights and, therefore, presents an obstacle to the transaction.

Conflicts between users resulting from the sale of traditional rights. A problem frequently occurs when the owners of traditional rights seek to sell more than they actually possess, since titles do not clearly establish volumes, whether the rights are consumptive, whether they are permanent or contingent, and whether they are continuous or discontinuous (Vergara, 1998). This situation creates conflicts between those who wish to transfer these rights and potential buyers, since the former overvalue the rights they wish to sell, while the latter (if they are well informed) will not accept the selling price.

There are also conflicts between users of consumptive and non-consumptive rights. These occur when there is no specification of how long the hydroelectric plants shall retain the water in their reservoirs. The Code clearly establishes that non-consumptive users may not produce adverse effects on consumptive users by delays in delivering water; however, as explained by Bauer (1998), the 1981 Water Code definition of non-consumptive use rights did not specify the timing of use which led to conflicts between irrigators and the electricity generators.

Avoidable transaction costs. Avoidable transaction costs concern disbursements related to the investigation of offers and

requests that sellers and buyers must carry out, the corresponding negotiation, and compliance with contracts, as well as the legal certification of ownership of water rights, legalization of the contract, and obtaining permission from the authorities necessary to transfer the water. High transaction costs may prevent an initial allocation – found to be less than ideal – from being corrected naturally.

These costs include registration, DGA inspection, and permits to user organizations. This does not include the cost - often significant - of investigating supplies of water offered on the market.

There are no quantitative and empirical studies to gauge the real magnitude of these costs at a national level. One exception is a study conducted by Hearne and Easter (1995), who established the total net earnings associated with the transfer of water rights and, thus, established the estimated transaction costs. However, this analysis was conducted only for the Elqui and Limarí River basins. The study determined that, in these basins, significant net earnings were achieved; hence, the benefits obtained from the transactions were considerably greater than the cost incurred.

A particular cost occurs when there is asymmetry of information between buyers and sellers of a good. In this case, there is a theorem that shows that there is no exchange that is totally efficient and, therefore, the initial distribution of rights affects the efficiency of the ultimate allocation of resources (Gómez-Lobo and Paredes, 2001).

The existence of transaction costs is equivalent to imposing a tax on rights transactions. If these are high, they can hinder the development of the market and prevent the re-allocation of original rights. The transaction costs act as a fixed cost that limits the minimum volume of each transaction, i.e., small transactions will not occur, thus creating a situation similar to that in which small farmers find themselves (Gómez-Lobo and Paredes, 2001).

Speculation and hoarding of non-consumptive rights. One of the criticisms leveled at the water rights market relates to the fact that the

law makes it possible for large discharges from rivers still untouched by industrial or irrigation demand to be requested by individuals who do not use the resource. According to Jaeger (1999) these market imperfections are mainly due to the initial water allocation of water use rights free of charge without considering medium and long term impacts. The main problems are: 1. Market imperfections originated by the hoarding of non-consumptive water use rights. This is a strategic action aimed at entrepreneurial development, rather than a matter of speculation, per se. Since water is a basic factor in their productive process, hydroelectric plants can not afford to expose themselves to the risk of future supply shortages, or of having to buy at high prices, which would diminish the profitability of the project. Based on evidences of monopolistic behavior, endorsed by the antimonopoly commission, has refused to grant new water use rights. In fact, the Constitutional Court has established that the State can impose additional conditionalities to grant new water use rights by reformulating the Water Code. 2. Third party effects due to speculative behavior. These impacts are generated when large discharges from rivers still untouched by industry or irrigation are requested by individuals who do not intend to use all of the water.

There is little concern about unused consumptive rights for water, given that, under a system of proportional use, all water is eventually distributed to users. Dourojeanni and Jouravlev (1999) estimate the percentage of consumptive use rights that are unused to be less than one percent of the total. However there are concerns about the rapid allocation of non-consumptive use rights to hydroelectric concerns and to speculators. DGA data indicates that at present non-consumptive use rights have been constituted for approximately $13000 \text{ m}^3\text{-sec}^{-1}$, while only $2500 \text{ m}^3\text{-sec}^{-1}$ are actually used in hydroelectric generation (Hearne and Donoso, 2005).

Based on evidences of market imperfections and monopolistic behavior, endorsed by the antimonopoly commission, the Water Code was modified and additional conditionalities to grant new water use rights and non-use fees were incorporated.

Conflict resolution. The transferability of rights is significantly reduced when conflict resolution is limited.

According to the 1981 Water Code, the judicial system must resolve conflicts between consumptive and non-consumptive users, when neither the user associations nor the General Directorate of Water has been able to resolve them. This has been the case with many conflicts between *campesinos* and hydroelectric companies, which have ultimately been resolved in the courts. However, many others have failed to be resolved satisfactorily by the judicial system.

Often, when conflicts are transferred to the courts, the culpable party is not punished, given the slow pace at which the courts proceed, thus prolonging the existing situation rather than exploring possible solutions. Chilean attorneys and judges are rarely knowledgeable about issues related to water rights, and even less so on matters related to the different uses of water. Water rights law is not ordinarily taught in law schools, and since it is not a lucrative area of practice, private attorneys have had little interest in it. When there are trials to resolve these conflicts, the judges must resort to calling upon the DGA to obtain more information (Bauer, 1995, 1997a, b).

It should be more feasible for private organizations to resolve conflicts that arise between different users, since such organizations have easier access to the information needed to investigate the cases. Despite this fact, these institutions continue to have problems resolving such disputes. According to a number of authors, water user associations are poorly equipped to resolve intersectoral problems, and they lack the coordination necessary to ensure sustainable intersectoral development, particularly given the interdependence between different types of rights (Bauer, 1997a and Hearne and Easter, 1995).

The Water Code establishes the existence of boards of control, which include all river basin users, whether consumptive or non-consumptive, and each water share such users possess is entitled to one vote on the corresponding board of control, without distinction as to what

type of user is involved. This has given rise to a disproportionately high participation on the part of non-consumptive users, adversely affecting the vote of consumptive users. Since non-consumptive rights may be granted at many points in the river basin (Ríos and Quiroz, 1995), this leads to a situation in which non-consumptive rights holders are not invited to attend meetings held to resolve such conflicts.

These conflicts arise as a result of the lack of proper legal regulation regarding the coordination of multiple water uses (Bauer, 1995). Thus, for example, the Water Code has not established what type of right has priority in case of a conflict in use. Nor has it properly defined non-consumptive rights, since often these involve a degree of consumption, as is the case with hydroelectric companies filling reservoirs to ensure proper functioning, thus altering the time during which consumptive users have access to the resource. This problem arises due to the fact that the definition of the rights does not specify the maximum time during which water may be captured.

These conflicts can be minimized by defining clearly the ownership rights over the different types of use rights (Vergara, 1998). A better defined institutional system also needs to be established - one that is suitable for resolving conflicts and that takes into account the political factors that such changes may entail, given that major restrictions are involved. Thus, clauses contained in the bill sent to the parliament in December 1992 include provisions for creation of Hydrographic Basin Administrators, which encompass both public and private entities. This provision has not been approved by the *campesinos*, since it would involve a potential increase in the government's administrative interference in water distribution.

In conclusion, it should be noted that the water market creates conflicts between users from different sectors. The Water Code does not provide a clear means of resolving such disputes: it does not provide an adequate definition of non-consumptive rights - the source of the conflict - nor establish appropriate powers for the responsible institutions to effectively resolve these problems.

Lessons learned

The Water Code of 1981 shows that the allocation system based on the water rights market has significant economic benefits because it considers water as an economic good, internalizing its scarcity value. However, the adequate application of this system requires strengthening the institutional framework to achieve the integrated management and sustainable use of water.

The main conditions to establish a market system based on water rights are: 1. Relative water scarcity, 2. Secure water use rights, 3. Clearly defined water use rights, 4. Well regulated water use rights market, 5. Adequate inventory of water resources, and 6. Efficient conflict resolution system.

Additionally, one can conclude that the performance of the water use rights market in Chile has been variable. The variability in performance of the market can be explained by problems both related to and independent of the allocation system. Problems independent of the allocation system affect the efficient allocation of the resource but are not considered to be related to the free transferability of water rights. In other words, the existence of a rights market neither creates nor aggravates the problem. Furthermore, the problem represents an impediment to reallocating of the resource under any allocation system. At the same time, problems related to the allocation system affect the efficiency in allocating water resources and are related to the water market system.

The most important problems independent of the water allocation mechanism are those arising as a result of unavoidable transaction costs, externalities due to inadequate definition of use rights in the Water Code, and uncertainty regarding the availability of water.

Likewise, certain problems related to the allocation system have been identified - problems such as the lack of adequate and timely information; the difference between nominal and *in rem* rights; conflicts arising between users due to the sale of traditional

rights; avoidable transaction costs; and the hoarding of non-consumptive rights.

In general, one can conclude that the allocation framework based on a market allocation system established by the Water Code in 1981 has been efficient from an investment point of view, mainly due to the water use rights security granted by the legislation. This is evidenced by significant investments that have been undertaken by several economic sectors to improve water use efficiency and to increase the availability of groundwater through exploration.

Likewise, the free transaction of water use rights, even though in many areas water use rights markets have not been very active, constitutes an efficient reallocation mechanism which has facilitated the reallocation of granted rights. However, it is not clear whether this reallocation of water use rights has occurred from low value to high value users, due to the lack of empirical evidence and information. It is thus necessary to develop a reliable data base in order to correctly evaluate the performance of the Chilean water use rights markets.

It is important to highlight, however, that the regulatory framework and the heterogeneity of water use rights has allowed for strategic and monopolistic behavior on the part of water use rights holders, thus generating an inefficient allocation from a social point of view. Part of this problem involves the hoarding of non-consumptive rights. This is a strategic action aimed at entrepreneurial development, rather than a matter of speculation, *per se*. Since water is a basic factor in their productive process, hydroelectric plants can not afford to expose themselves to the risk of future supply shortages, or of having to buy at high prices, which would diminish the profitability of the project.

In summary, water use rights markets represent a useful allocation mechanism for water resources. However, it is necessary to reformulate the regulatory framework of this mechanism so as to reduce the existence of conditioning factors that have limited the efficiency and sustainability and replicability of this allocation mechanism.

Resumen

El presente trabajo tuvo como objetivo fundamental desarrollar un estudio de caso del mercado de derechos de aprovechamiento establecido en el Código de Aguas de Chile de 1981, como mecanismo asignador del recurso hídrico. Con este fin, se analizó la formulación, desarrollo, puesta en marcha y evaluación de los resultados obtenidos con la operación del mercado de derechos de aprovechamiento establecido en el Código de Aguas de Chile de 1981. En general, del análisis del desempeño del mercado de los derechos de aprovechamiento de aguas se concluyó que este marco jurídico-económico en la práctica se ha mostrado eficiente desde el punto de vista del fomento a la inversión en proyectos productivos asociados a la explotación de los recursos naturales, lo cual se explicaría principalmente por la gran seguridad jurídica que otorga la legislación a los derechos de los particulares sobre los derechos de aprovechamiento de aguas. Diversos estudios han concluido que el desempeño del mercado de derechos de aprovechamiento en Chile ha sido variable. No obstante estas diferencias, existe consenso que la escasez relativa es sin lugar a dudas el principal factor que motiva el funcionamiento del mercado. Este desempeño variable se puede explicar en función de problemas independientes y dependientes del sistema de mercado de derechos de aprovechamiento. Los principales problemas independientes son los que se originan debido a los costos de transacción inevitables, a externalidades por una inadecuada definición de los derechos de aprovechamientos en el Código de Aguas y a la incertidumbre frente a la disponibilidad de agua. Por otro lado, se han detectado problemas dependiente tales como la falta de información adecuada y oportuna; la diferencia entre los derechos nominales y los reales; los conflictos generados entre usuarios por ventas de derechos consuetudinarios; costos de transacción evitables y el acaparamiento de los derechos no consuntivos. En términos de las principales lecciones, la experiencia con el Código de Aguas de 1981 demuestra que el sistema de asignación basado en el mercado de derechos de aprovechamiento presenta beneficios económicos significativos, debido a que considera el agua como un bien económico

internalizando su precio de escasez. Sin embargo, la aplicación adecuada de este sistema requiere del fortalecimiento institucional que permita reducir la incidencia de factores condicionantes que han limitado su eficiencia, sustentabilidad y replicabilidad.

Palabras clave: Chile, manejo de recursos hídricos, mercado del agua, políticas del agua.

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