



Evaluating Economic Policy Instruments for
Sustainable Water Management in Europe

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The Chilean Water Allocation Mechanism, established in its Water Code of 1981

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Executive Summary

Definition of the analysed EPI and purpose

The Water Code (WC) of 1981 established that water user rights (wur) are transferable in order to facilitate wur markets as an allocation mechanism. "The objective of the governmental action in this field was to create solid water use rights in order to facilitate the proper operation of the market as an allocation mechanism" (Buchi, 1993, pp 85-87). Thus the WC 1981 was designed to protect traditional and customary wur and to foster economically beneficial reallocation through market transfers (Bauer, 2004; Buchi, 1993; Hearne and Donoso, 2005).

Introduction

The WC 1981 specifies rights consumptive wur for both surface and groundwater, and non-consumptive wur for surface waters. Non-consumptive use rights allow the owner to divert water from a river with the obligation to return the same water unaltered to its original channel. Consumptive use rights do not require that the water be returned once it has been used. Consumptive and non-consumptive wur are, by law specified as a volume per unit of time. However, given that river flows are highly variable in most basins, these wur are recognized in times of scarcity as shares of water flows. This characteristic of wur, which combines volumetric maximum amounts per unit time in times of plenty, with shares in times of scarcity has proven to be appropriate, since the use of a system of use rights defined as pure shares precludes any excess water use for other uses such as environmental objectives since it would lead to full use of water by the current holders of wur (World Bank, 2011). The WC 1981 allowed for freedom in the use of water to which an agent has wur; thus, wur are not sector specific. Additionally, wur do not expire and do not consider a "use it or lose it" clause.

Legislative setting and economic background

The first Chilean text to regulate the use of water is an 1819 Executive Decree which defined the dimensions of an irrigating system, form of sale, and responsibility for water intakes. The 1855 Civil Code was the first instrument to define how "the rivers and all waters running within natural channels are national goods of public use". In addition, it establishes that access to water is obtained by means of water-use rights "granted by the competent authority". The concept of "Water-Use Right" was further developed in the 1930 and 1951 Water Codes. The latter code defines water use rights (wur) as follows: "The water right is an actual right that falls on publicly owned waters and which consists in the use, possession and disposal of such waters fulfilling the requirements and in accordance with the rules prescribed herein." (Hearne and Donoso, 2005). It is





important to note that granted wur do not constitute a transfer of ownership of the water.

The 1967 Water Code, implemented in a more centralized political context, reinforces the concept of water as being within the public domain and changed the legal nature of wur, stressing that these were administrative rights where the State grants the use of the waters, subject to public regulation. During this period, land and water-use rights were expropriated without compensation, and water was to be reallocated in accordance with state planning (Bauer, 1998). However, it is important to point out that the 1967 Water Code was not fully implemented due to lack of institutional capacity and resources during the Allende government (1970–1973).

Following the military coup in 1973, the government introduced neo-liberal economic policies which supported private property rights and free markets. The first step towards the new WC 1981 occurs in 1979 with the Executive Decree 2.603 which recognized customary and historical wur. This decree strengthened the security of private ownership of wur, separating wur from land ownership. The WC 1981 maintained water as “national property for public use,” but granted permanent, transferable water-use rights to individuals so as to reach an efficient allocation of the resource through market transactions of wur.

Brief description of results and impacts of the proposed EPI

Until the 90's, environmental and water management policies did not pay much attention to meeting water requirements for environmental purposes and thus, evidence shows that the totality of river flows was allocated. This has led to the deterioration of aquatic ecosystems in semiarid and arid regions of Chile. This gradually changed with the introduction and continuous improvement of the System of Environmental Impact Assessment (SEIA) in 1994 and with the WC 1981 reform in 2005 which imposed the obligation to establish a minimum ecological flow.

The WC 1981 did not pay much attention to the sustainable management of groundwater because at that time, groundwater extraction was marginal. Recognizing the need to improve groundwater management regulation due to increased groundwater pumping, the 2005 amendment of the WC 1981 introduced procedures to reach a sustainable management of underground water resources. World Bank (2011) concludes that these groundwater regulations have not been fully implemented over time and thus, there exist various problems associated with groundwater management.

Jouralev (2005), based on a survey of the literature on wur markets in Chile concludes that these markets have helped to (i) facilitate the reallocation of water use from lower to higher value users (*e.g.* from traditional agriculture to export-oriented





agriculture and other sectors such as water supply and mining), (ii) mitigate the impact of droughts by allowing for temporal transfers from lower value annual crops to higher valued perennial fruit and other tree crops, and (iii) provide lower cost access to water resources than alternative sources such as desalination.

Studies have shown active trading for wur in the Limarí Valley, where water is scarce with a high economic value, especially for the emerging agricultural sector (Hearne and Easter, 1997; Donoso, *et al.*, 2001; Hadjigeorgalis, 2004; Zegarra, 2002). Inter-sectoral trading has transferred water to growing urban areas in the Elqui Valley (Hearne and Easter, 1997) and the upper Mapocho watershed, where water companies and real estate developers are continuously buying water and account for 76% of the rights traded during the 1993-1999 period (Donoso *et al.*, 2001). Other studies have shown limited trading in the Bío Bío, Aconcagua, and Cachapoal Valleys (Bauer, 1998; Hadjigeorgalis and Riquelme, 2002). In all of these studies some permanent transactions of water-use rights have occurred. During the 2000s, the market was more active than in the previous two decades, 1980's and 1990's.

Consumptive wur transaction data based on data of the RPA of the DGA, for the period 2005 - 2008 show that there were 24,177 wur transactions of which 92.3% were independent of other property transactions, such as land. The value of wur transactions independent of other property transactions is U.S. \$ 4.8 billion, which on average is U.S. \$ 1.2 billion per year. The average wur price is US \$ 615,623 per wur. Wur prices in the north of the country are greater than in the South, which indicates that the market at least in part reflects the relative scarcity of water.

Increased consumptive wur market activity has generated increased conflicts with downstream users due the existence of wur over return flows. The consumptive wur entitles the holder to totally consume the water taken in any activity. However, in practice, almost all consumptive wur holders generate significant return flows (leakage and seepage water) that are used by downstream customary wur holders. At present it is not known how many regularized or non-regularized customary wur are dependent on return flows. Thus, it is extremely difficult for the DGA to foresee potential third party effects associated with wur transfers that alter return flows.

Despite a legal separation between land and water rights, many Chilean farmers maintain that water and land should not be separated. This traditional integration of land and water has kept many farmers from offering water for sale without also selling the corresponding land.

Conclusions and lessons learnt

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 those valleys where WUAs and infrastructure present assist the transfer of water. In the absence of these conditions trading has been rare and water markets have not become institutionalized in most valleys (Hearne and Donoso, 2005).

The activity of the markets increased over time due to a slow maturation in the public's knowledge concerning the new legislation. In a sense, the 80s represented a preparatory stage in bringing the new Code into full operation, in social, political and economic terms.

The Chilean wur markets are characterized by a large price dispersion for homogeneous wur (Cristi and Poblete, 2010). This large price dispersion is due, in great part, to the lack of reliable public information on wur prices and transactions. Given the lack of reliable information, each wur transaction is the result of a bilateral negotiation between an interested buyer and seller of wur where each agent's information, market experience and negotiating capacity is important in determining the final result (Donoso, Melo and Jordan, 2011).

The problems that water use rights market have not been able to resolve are: water use inefficiency in all sectors, not only in the agricultural sector, environmental problems, and the maintenance of ecological water reserves.

The elements that have hindered wur market effectiveness are the:

- a) Lack of wur and wur market information.
- b) Lack of regularization of customary wur.
- c) Existence of transaction costs
- d) Lack of a rapid, efficient controversy resolution system.

Finally, 13 key lessons learned are elaborated upon.





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1. EPI Background

The first Chilean text to regulate the use of water is an 1819 Executive Decree which defined the dimensions of an irrigating system, form of sale, and responsibility for water intakes. The 1855 Civil Code was the first instrument to define how “the rivers and all waters running within natural channels are national goods of public use”. In addition, it establishes that access to water is obtained by means of water-use rights “granted by the competent authority”. The concept of “Water-Use Right” was further developed in the 1930 and 1951 Water Codes. The latter code defines water use rights (wur) as follows: “*The water right is an actual right that falls on publicly owned waters and which consists in the use, possession and disposal of such waters fulfilling the requirements and in accordance with the rules prescribed herein.*” (Hearne and Donoso, 2005). It is important to note that granted wur do not constitute a transfer of ownership of the water.

The 1967 Water Code, implemented in a more centralized political context, reinforces the concept of water as being within the public domain and changed the legal nature of wur, stressing that these were administrative rights where the State grants the use of the waters, subject to public regulation. These wur could expire, and the process of water reallocation was to be based on regional water-use plans executed by means of studies that determined the rate of rational and beneficial use (Hearne and Donoso, 2005). During this period, land and water-use rights were expropriated without compensation, and water was to be reallocated in accordance with state planning (Bauer, 1998). However, it is important to point out that the 1967 Water Code was not fully implemented due to lack of institutional capacity and resources during the Allende government (1970–1973).

Based on the political changes that occurred in Chile in 1973, where the military coup reversed the “statist” and socialistic tendencies of the previous governments, 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 government thus introduced neo-liberal economic policies which supported private property rights and free markets. The first step towards the new WC 1981 occurs in 1979 with the Executive Decree 2.603 which recognized customary and historical wur. This decree strengthened the security of private ownership of wur, separating wur from land ownership. This is reinforced by Article 19 number 24 of the Constitution of 1980, which distinguishes between constituted and recognized wur. Thus, holders of constituted or recognized wur were granted constitutional protection and security that these rights would not be expropriated without due compensation.

The WC 1981 maintained water as “national property for public use,” but granted permanent, transferable water-use rights to individuals so as to reach an efficient allocation of the resource through market transactions of wur. The WC 1981 allowed





for freedom in the use of water to which an agent has wur; thus, wur are not sector specific. Similarly, the WC 1981 abolishes the water use preferential lists, present in the Water Codes of 1951 and 1967. Additionally, wur do not expire and do not consider a “use it or lose it” clause.

The WC 1981 established that wur are transferable in order to facilitate wur markets as an allocation mechanism. Although private water use rights existed in Chile prior to 1981, the previous water codes restricted the creation and operation of efficient water markets. The framers of the 1981 Water Code sought to achieve the efficiencies of market reallocation of water, "the objective of the governmental action in this field was to create solid water use rights in order to facilitate the proper operation of the market as an allocation mechanism" (Buchi, 1993, pp 85-87). Thus the WC 1981 was designed to protect traditional and customary wur and to foster economically beneficial reallocation through market transfers (Bauer, 2004; Buchi, 1993; Hearne and Donoso, 2005).

The Directorate General of Water (*Dirección General de Aguas, DGA*), part of the Ministry of Public Works (MOP), is responsible for monitoring and enforcing wur. With its 15 regional offices, it collects and maintains hydrological data and Public Registry of Wur (*Registro Público de Agua, RPA*). As the leading government agency in water resources management it develops and enforces national water policy. In this role it has: led efforts to amend the 1981 Water Code and developed a National Water Policy. In general, the DGA has maintained a limited role in accordance with the paradigm of limited state interference on which the WC 1981 is inspired.

The WC 1981 establishes that water use right owners are responsible for water management. User management has existed in Chile since the colonial era, and currently there are more than 4000 Water User Associations (WUAs) (Dourojeanni and Jouravlev, 1999). Three types of WUAs exist in Chile and are recognized by the WC 1981: water communities, canal user associations, and vigilance committees. Water communities are any formal group of users that share a common source of water. Canal user associations are formal associations with legal status that can enter into contracts. Vigilance committees are comprised of all the users and canal associations on any river, river section, or stream; they are responsible for administering water and allocating water to different canals. Some vigilance committees and canal user associations manage reservoirs for irrigation water storage and finance their operations with small hydroelectric plants.

Many of these WUAs have professional management (Hearne and Donoso, 2005). The effectiveness of some of these institutions in managing irrigation systems and reducing transactions costs for water market transactions has been noted (Hearne and Easter, 1995, 1997). However, according to the DGA and the Directorate of Water Works (DOH), a large percentage of these institutions have not updated their capacity to meet new challenges. Many managers of these user organizations do not have technical capacity and do not effectively communicate with their members. Additionally, Bauer (1998) points out that vigilance committees have not been effective in resolving intersectoral conflicts. To address some of these concerns, the





DOH and DGA have implemented programs to train WUA managers and directors (Peña, 2000; Puig, 1998).

The following sections describe the different types, characteristics of wur under the WC 1981, and the regulation of transfers of wur.

1.1. Recognized customary water use rights

Article 79 of D.L. 2603 recognizes customary wur that were conceded previous to the WC 1981. A water user shall be the owner of a customary water use right once their use over a certain amount of time is proven and ensuring that no third party effects or conflicts exist associated to this use. The specific details of this recognition are specified in in the transitory second article of the WC 1981.

Thus customary wur exist and the ownership is guaranteed by the 1980 Constitution, even though they are not formally registered; the lack of formal registration does not imply lack ownership security. The transitory second article of the WC 1981 also establishes the regulatization procedure for these customary wur. However, it is important to note that after 30 years of the WC 1981, the majority of wur today are still customary non-recognized wur.

1.2. Regularization procedure for customary water use rights

The transitory second article of the WC 1981 establishes the procedure to inscribe these customary wur in the Real Estate Registry (*Conservador de Bienes Raíces, CBR*). The regularization procedure has two stages: an administrative stage where the DGA publishes and informs other water users of the regularization request, and a judicial stage where the water user must legally demonstrate the existence of the customary water use right. The regularization of the customary water use right is finalized when the water use right is inscribed in the RPA and in the CBR, under the specifications established in the WC 1981.

Since the promulgation of the WC 1981, efforts have been made to regularize, register wur and grant title for wur in order to resolve overlapping claims to water. This is especially important for wur that were redistributed under the Agrarian Reform and might be contested by previous owners. Estimates of wur that are not registered range from 90% to 60% (Dourojeanni and Jouravlev, 1999). This can be in part explained by the fact that courts have protected unregistered rights, and thus undermined the registration requirement (Bauer, 1998).

Rhodos (2010) documents legitimate uses in different water basins that have been recognized for decades by WUAs which have not been regularized; his findings are presented in Table N° 1. In the northern basins, the water flow associated with recognized but undocumented (or in process of regularization) wur are small. However, the contrary is true for southern water basins where there are many legitimate recognized wur which have not been regularized.

Table N° 1: Water flow (l/s) of regularized and un-regularized wur

Water Basins	Regularized wur flows (l/s)	Un-regularized wur flows



		(l/s)
Río Salado	397	1
Salar de Atacama	2.740	8
Estero Pupío	437	128
Estero Quilimarí	346	65
Río Petorca	2.355	1.622
Río La Ligua	3.531	2.738
Río Maipo	82.473	34.247
Río Bio-Bio	62.236	38.852

Source: Rhodos, 2010, World Bank (2011).

Thus the regularization procedure has not been effective. This lack of regularization and registration can be explained by the following reasons (World Bank, 2011):

- a) The lack of incentives and penalties for holders of wur to regularize and register their customary wur. In particular, the second transitory article of the WC 1981 does oblige users to regulate their wur and there are no impediments to exercise their rights even though the wur are unregistered;
- b) Regularization procedures are complex and lengthy, due to the complexity and rigurocity of the verification process. However, it is also due to an excessive judicialization of proceedings. Of the customary wur that have been certified by the DGA since 1981, between 40 and 65% are still awaiting a court ruling (World Bank, 2011).

The regularization procedures have generated an important proportion of the current water use conflicts that must be settled by the DGA and the judicial courts. Given that the regularization procedures were established 20 years ago, the difficulty of verifying the validity of the customary water use has significantly increased (World Bank, 2011). According to Rhodos (2010), who studied unregistered rights that were submitted to the regularization procedure in several water basins, the regularization procedure has lent itself for many abuses. For example, several wur that were being regularized are not recorded in the cadaster of water users that was conducted by the DGA between 1981 and 1987 for surface water and in 1976 for groundwater.

1.3. Specification of new water use rights

The WC 1981 specifies rights consumptive wur for both surface and groundwater, and non-consumptive wur for surface waters. Non-consumptive use rights allow the owner to divert water from a river with the obligation to return the same water unaltered to its original channel. Consumptive use rights do not require that the water be returned once it has been used. Consumptive and non-consumptive wur are, by law specified as a volume per unit of time. However, given that river flows are highly variable in most basins, these wur are recognized in times of scarcity as shares of water flows. This characteristic of wur, which combines volumetric maximum amounts per unit time in times of plenty, with shares in times of scarcity





has proven to be appropriate, since the use of a system of use rights defined as pure shares precludes any excess water use for other uses such as environmental objectives since it would lead to full use of water by the current holders of wur (World Bank, 2011).

In addition, consumptive and non-consumptive rights can be exercised in a permanent or contingent manner and in a continuous, discontinuous or alternating mode. Permanent use rights are rights specified as a volume per unit of time, unless there is water scarcity in which these wur are recognized as shares of water flows. Contingent rights are specified as a volume per unit of time and only authorize the user to extract water once permanent rights have extracted their rights. Continuous rights are those use rights that allow users to extract water continually over time. On the other hand discontinuous rights are those that only permit water to be used at given time periods. Finally, alternating rights are those in which the use of water is distributed among two or more persons who use the water successively.

1.4. Allocation of new water use rights

Initially, new water-use rights are obtained free of charge, and the procedure for acquiring a new right started with an application that had to meet the following requirements:

- (a) Identification of the water source from which the water is to be extracted, specifying whether the source is surface water or ground water;
- (b) Definition of the quantity of water to be extracted, expressed in liters per second;
- (c) Yield and depth must be specified in the case of groundwur;
- (d) Specification of the water extraction points and the method of extraction; and
- (e) Definition 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*, in a daily Santiago newspaper, and in a regional newspaper, where applicable. Previous to the WC 1981 reform of 2005, the DGA could not refuse to grant new water rights without infringing a constitutional guarantee, provided there was technical evidence of the availability of water resources and that the new use would not harm existent rights holders¹. If there is competition for solicited water rights, they are to be allocated through an auction with an award to the highest bidder. This allocation rule between competing wur petitioners allows water to be allocated to its highest use value. The allocated water use right is registered in the DGA's Water Use Rights Registry.

Peña (2004) and Bitran and Saez (1994) point out that the absence of an obligation to use wur led to a proliferation of wur requests for speculation and

¹ But, the DGA can declare certain aquifers to be fully exploited and refuse to grant new groundwater use rights.



hoarding² purposes. Speculation and wur hoarding led to non-real water shortages which created obstacles to the development of new investment projects due to the impossibility of acquiring new wur. This was particularly evident in the case of non-consumptive wur where entry barriers were created for new hydroelectric plants, discouraging competition in hydroelectric power generation. In fact, Riestra (2008) points out that of the 15,000 m³/s granted non-consumptive uses, rights only 2,800 m³/s were being effectively used. However, 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 (Hearne and Donoso, 2005). Dourojeanni and Jouravlev (1999) estimate the percentage of consumptive use rights that are unused to be less than one percent of the total.

The State, concerned about monopolistic behavior and supported by the antimonopoly commission, refused to grant new non-consumptive rights. In fact, the Constitutional Court established that the State could impose additional conditions on petitions for new water-use rights by reformulating the Water Code. This led to an amendment of the dispositions of the WC 1981 in 2005. The Law N^o. 20,017 of 2005 amended the procedure to grant new wur of the WC 1981 and introduced a non-use tariff (*patente de no-uso*). The amended water use right granting procedure for the DGA is as follows:

- (a) The petitioner must justify the water flow that is petitioned and to clearly indicate the use that will be given to the water;
- (b) Wur are only granted in accordance with the requirements of the use for which the wur is solicited for;
- (c) The DGA can limit the flow of an application for wur if there is no equivalence between the amount of water requested and the use invoked by the petitioner;
- (d) The DGA awards wur to the petitioner if water is available and does not affect rights of other wur holders, taking into account the relationships between surface water and groundwater;
- (e) In the case of non-consumptive wur, the withdrawal and restitution of the waters must not affect rights of other wur holders over the same water source with respect to water quantity, quality, and temporality of use;
- (f) The DGA has the obligation to establish minimum ecological flows, which can only affect new petitions of wur, but not those granted previous to 2005; and
- (g) The introduction of a non-use tariff.
- (h) The DGA has the obligation to establish a minimum ecological flow, which may only affect the new wur.

² This is a strategic entrepreneurial action, rather than a matter of speculation, *per se*.





1.5. Non-Use Tariff

As was pointed out, the State's concern about the significant proportion of wur without an effective use, led to the introduction of a non-use tariff in 2005. Due to the difficulties of monitoring the effective use of all wur, the non-use tariff is applied to all consumptive wur that do not count with water intake infrastructure and to all non-consumptive wur that do not have water intake and return infrastructure (Law N°. 20,017 of 2005, art. 129 bis 4-6).

Non-use tariff (τ) for consumptive and non-consumptive wur is calculated as $\tau = \gamma Q f$ and $\tau = \gamma Q H f$, respectively, where γ is a constant that takes the value of 0.1 for all regions between Magallanes and Los Lagos, 0.2 for regions between O'Higgins and Araucanía, and 1.6 for all regions north of the Metropolitana³, Q represents the average water flow that is not used measured in m³/sec., f is a temporal factor that increases the non-use tariff if the water use right remains without use ($f = 1$ for years 1 to 5, $f = 2$ for years 6 to 10, and $f = 4$ for over 11 years without effective use), and H , only applied to non-consumptive wur, is the difference between the water intake level and the level where the water is returned with a minimum value of 10 meters ($H \geq 10$).

1.6. Obligation to establish minimum ecological flows

At present there are two mechanisms for the establishment of ecological flows in the Chilean legislation:

- a. The SEIA proposes the establishment of an ecological flow as a mitigation measure, mainly for the construction of dams and
- b. Setting minimum ecological flows in the act establishing new wur by the DGA.

A major source of conflict between water users and the DGA is the diversity of criteria and methodologies under which minimum ecological flows are established (Vergara, 2010). The, Law N°. 20,417 of 2010 that created the Ministry of the Environment (*Ministerio de Medio Ambiente MMA*), requires the Ministers of the Environment and Public Works to identify criteria by which to establish minimum ecological flows. This new regulation has not yet been approved.

1.7. Regulation of transfers of Water use rights

The main regulatory measure established in the WC 1981 to control potential negative effects on third parties and / or the environment due to the transfer of wur between water users is when the transfer implies a change of water intake location, the transfer must be authorized by the DGA.

³ The coefficient γ increases for regions located further north to reflect increased water scarcity.





The analysis of potential third party or environmental effects associated with wur transfers between water users is conducted by the DGA and is complemented by reporting process towards the committee. Transfer requests, as well as new wur petitions, are broadcast three times and published in a newspaper at the national and provincial levels. Additionally, the Environmental Impact Assessment Study System (*Sistema de Estudio de Impacto Ambiental, SEIA*) introduced in 1994 by the Law 19,300 requires water users to mitigate or compensate environmental damages that may result from the transfer of wur.

It is important to note that transfers of wur that do not require a change in water intake location are not regulated.

2. Assessment Criteria

2.1. Environmental outcomes

Water extraction from rivers alters the natural river dynamics and the aquatic ecosystem. In order to protect aquatic ecosystems, the concept of minimum ecological flow was designed to preserve the basic properties that maintain aquatic ecosystems. The WC 1981 did not consider regulation to establish minimum ecological flows.

Until the 90's, environmental and water management policies did not pay much attention to meeting water requirements for environmental purposes and thus, evidence shows that the totality of river flows was allocated. This has led to the deterioration of aquatic ecosystems in semiarid and arid regions of Chile. This gradually changed with the introduction and continuous improvement of the System of Environmental Impact Assessment (SEIA) in 1994 and with the WC 1981 reform in 2005 which imposed the obligation to establish a minimum ecological flow.

2.2. Economic Assessment Criteria

Wur markets have received wide attention, both in Chile and internationally. Although market reallocation of water has not been common throughout most of Chile, the existence of water markets has been documented. Studies have shown active trading for wur in the Limarí Valley, where water is scarce with a high economic value, especially for the emerging agricultural sector (Hearne and Easter, 1997; Donoso, *et al.*, 2001; Hadjigeorgalis, 2004; Zegarra, 2002). Inter-sectoral trading has transferred water to growing urban areas in the Elqui Valley (Hearne and Easter, 1997) and the upper Mapocho watershed, where water companies and real estate developers are continuously buying water and account for 76% of the rights traded during the 1993-1999 period (Donoso *et al.*, 2001). Other studies have shown limited trading in the Bío Bío, Aconcagua, and Cachapoal Valleys (Bauer, 1998; Hadjigeorgalis and Riquelme, 2002). In all of these studies some permanent transactions of water-use rights have occurred.



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 those valleys where WUAs and infrastructure present assist the transfer of water. In the absence of these conditions trading has been rare and water markets have not become institutionalized in most valleys (Hearne and Donoso, 2005). Although market transactions are still rare they are becoming more frequent in areas subject to economic growth and increased water scarcity. A lesson of these studies is that the operation of the wur markets is variable across the country, and they depend significantly on the relative scarcity of water resources, the distribution infrastructure and water storage capacity, and the proper functioning of WUAs. It should be noted that during the 2000s, the market was more active than in the previous two decades, 1980's and 1990's. This is largely due to a slow maturation in the public's knowledge concerning the new legislation. In a sense, the 80s represented a preparatory stage in bringing the new Code into full operation, in social, political and economic terms.

Table N° 2 presents consumptive wur transaction data based on data of the RPA of the DGA, for the period 2005 - 2008⁴. The results for this four-year period show that there were 24,177 wur transactions of which 92.3% were independent of other property transactions, such as land. The value of wur transactions independent of other property transactions is U.S. \$ 4.8 billion, which on average is U.S. \$ 1.2 billion per year.

When water is scarce there exist incentives to participate in wur markets in order to achieve a reallocation of the scarce resource. In the Paloma System, for example, a semiarid water basin located in the northern region of the country, water is a scarce good with a high economic value (especially for the export oriented agricultural sector). This scarcity generates strong competition for water between users, which in turn causes the temporary and permanent water market to be very active; during the 1993-1999 period, 6000 water use rights were traded. In the Maipo system, in the central region of the country, on the other hand, water supply is greater and demands from the agricultural sector lower. In the first section of this river basin only 793 wur were traded in the period 1993-1999 (Donoso, 2006).

Table 2: Consumptive Wur transactions and prices for the period 2005-2008

Region	Total transacciones of wur	Transacciones of wur independant of other godos such as land	Wur transaction values (only wur transctions independent of other goods) (10 ⁶ US\$)	Average wur transaction price (US\$)
I	568	564	20	36,121
II	153	131	216	1,652,519
III	16	15	8	530,933
IV	3.489	3.448	550	159,615
V	3.191	2,839	517	182,029

⁴ The RPA of the DGA has data only for the period 2005-2009. However, the data for the year 2009 is incomplete.





RM	4.804	4.226	2.312	547,095
VI	2.315	2.010	509	253,361
VII	6.518	6.159	622	101,059
VIII	2.330	2.162	29	13,432
IX	494	487	8	16,805
X	225	223	23	103,390
XI	68	68	0	2,588
XII	6	6	0	80,667
Total	24,177	22,338	4,817	215,623

Source: World Bank, 2011.

The average wur price is US \$ 615,623 per wur. Wur prices in the north of the country are greater than in the South, which indicates that the market at least in part reflects the relative scarcity of water. Wur prices present a standard deviation of US \$ 100,460,800 per wur; price dispersion is lower in the more active wur markets. Thus, Chilean wur markets are characterized by a large price dispersion for homogeneous wur (Cristi and Poblete, 2010).

This large price dispersion is due, in great part, to the lack of reliable public information on wur prices and transactions. Given the lack of reliable information, each wur transaction is the result of a bilateral negotiation between an interested buyer and seller of wur where each agent's information, market experience and negotiating capacity is important in determining the final result (Donoso, Melo and Jordan, 2011). Bjornlund (2002) in a study of water rights markets in the Goulburn-Murray Irrigation District in South Australia, found similar results, where factors that influence the negotiating process and the agent's negotiating power influence significantly wur prices. In first place, Bjornlund (2002) found that the agent's awareness of prevailing market prices is a significant factor that explains water rights price; hence, an important variable that influences the negotiating process is each agent's expected price, which is based on previous traded water rights prices. In second place, Bjornlund (2002) concludes that a major determinant of water rights prices is the bargaining strength of the water rights buyers and sellers.

According to Peña (2010), as a result of the WC 1981 2005 reform, combined with the performance of the Antitrust Commission, the monopolistic distortion due to speculation and non-consumptive wur hoarding has been reduced. In turn, Jouravlev (2010) notes that as a result of the reform of 2005 (together with other measures), wur that still are not used are generally no longer a major obstacle to the development of the water basin, and it is likely that non-use of wur will continue to reduce in the future due to the projected increase in the non-use tariff. Along the same lines, Valenzuela (2009) notes that the non-use tariff has operated as an incentive for the return of wur; an equivalent of 65 m³/s has been returned, which represents 1% of both the total wur affected by the non-use tariff. However, Cristi (2010), states that the effect of the non-use tariff has been limited, based on evidence that during the year 2009 only 2.08% of the wur subject to the non-use tariff were returned or began to be used. Thus, further research is required to determine the effectiveness of the non-use tariff.





It is important to point out the major flaws with respect to the design of the non-use tariff:

- a) The non-use tariff is only applied to wur for which the water intake infrastructure has not been constructed. However, the mere existence of water intake infrastructure does not necessarily ensure that waters are used in practice;
- b) It can be applied only to the registered wur and regularized customary wur that are contained in the records of the RPA. As was already mentioned, the majority of wur are not registered;
- c) The calculation formulas are defined in the WC 1981, which makes it difficult to change, in particular to reflect the increased economic value of water over time. It is foreseeable that the economic value of water will increase significantly in the near future;
- d) The non-use tariff for consumptive wur is associated to the opportunity cost of agriculture, which does not represent the real opportunity cost of water for all economic sectors and thus will not act as an incentive when the sector's opportunity cost is greater to that of agriculture.

Despite a legal separation between land and water rights, many Chilean farmers maintain that water and land should not be separated. This traditional integration of land and water has kept many farmers from offering water for sale without also selling the corresponding land. Also, the agricultural sector in Chile has continued to grow, often at a rate greater than the rest of the Chilean economy (World Bank, 2003; ODEPA, 2004). Because of this growth, the value of water in irrigation has remained high and farmers have little incentive to sell water. Many farmers maintain surplus water rights in order to mitigate the risk of drought. And given that there are no taxes on water rights, there is no penalty for maintaining surplus rights.

A major challenge of the wur markets in Chile is how to ensure optimal water use without compromising the sustainability of rivers and aquifers. The sustainability of northern rivers and aquifers is compromised due to the over-provision of wur related to the practice of allocating wur based on foreseeable use. The foreseeable use considers the probable effective water extraction of different sectors. For example, an agricultural wur does not extract water in winter months, whereas a mining wur extracts water all year round. In this case, the authority would consider a lower pressure on water resources of an agricultural right with respect to the pressure of a mining wur. This practice commits the mistake of not considering the transferable nature of wur. Thus, when water scarcity increases and inter-sectoral wur transactions increase, water resources will be overexploited and unsustainable.

The DGA and a number of experts believe that this allocation practice likely the main cause of the over-allocation of wur, and in many cases of over-exploitation of various aquifers in the country. The allocation of new wur based on foreseeable use for nearly 15 years has led to an underestimation of the actual use of water of the conceded wur, causing a considerable impediment to reach the sustainability of





water resources and associated ecosystems. Additionally, the over-provision of wur gave rise to increased water insecurity as wur are transferred to users with a more intensive water use.

On the other hand, increased consumptive wur market activity has generated increased conflicts with downstream users due the existence of wur over return flows. The consumptive wur entitles the holder to totally consume the water taken in any activity. However, in practice, almost all consumptive wur holders generate significant return flows (leakage and seepage water) that are used by downstream customary wur holders. At present it is not known how many regularized or non-regularized customary wur are dependent on return flows. Thus, it is extremely difficult for the DGA to foresee potential third party effects associated with wur transfers that alter return flows. For this reason, in those rivers with a large return flows, such as the Elqui and Aconcagua rivers, located north of Santiago, there have been cases where the JDV have tried to prohibit the transfer of wur from agricultural users to non-agricultural users in earlier sections of these rivers, in order to protect users who depend return flows (Rosegrant and Gazmuri, 1994).

The WC 1981 did not pay much attention to the sustainable management of groundwater because at that time, groundwater extraction was marginal. Recognizing the need to improve groundwater management regulation due to increased groundwater pumping, the 2005 amendment of the WC 1981 introduced procedures to reach a sustainable management of underground water resources. The main provisions are: (a) extraction restrictions when third parties are affected, (b) the authorization for the DGA to impose the installation of extraction measurement equipment in order to monitor effective extractions, (c) the establishment of areas subject to extraction prohibitions and restrictions, and (d) consider the interaction between surface water and groundwater when analyzing the petition of new surface or groundwater wur.

World Bank (2011) concludes that these groundwater regulations have not been fully implemented over time and thus, there exist various problems associated with groundwater management. A major concern is the general lack of information about groundwater and insufficient knowledge about its dynamics, in particular its interaction with surface waters. There are significant gaps in the registry of wells, extraction and quality measurements, recharge balances, and identification of pollution sources. In general, information systems are not linked to the measurement and monitoring of aquifers to estimate groundwater withdrawals. An effective information system is a prerequisite to be able to control and sustainably manage an aquifer.

An additional challenge for a sustainable groundwater management is the fact that at present ground and surface waters are managed independently despite their recognized interrelations. This implies that there is no conjunctive management of surface and groundwater, which has proven to be an effective adaptation mechanism for climate change.

There are, in general, no WUAs that manage groundwater user rights; the only exception is in some sections of the over-exploited Copiapo aquifer. There should





exist a groundwater WUA at least for all aquifers that have a restriction or prohibition declaration by the DGA. The fact that users have not yet organized themselves in groundwater WUAs to take over the management of groundwater may reflect the lack of understanding of a large proportion of users of the long term effects that uncontrolled exploitation of aquifers may cause. In the absence of groundwater WUAs, the WC 1981 establishes that the DGA is responsible for controlling and monitoring groundwater withdrawals. Evidence has shown that the DGA does not have the necessary resources (human, technical, and financial) to monitor all groundwater extractions

There is an incentive for the adoption of water saving technologies by farmers (Law N°. 18,450). This program subsidizes small scale, private irrigation investments. It has supported much of the installation of drip irrigation systems in the dry north and spray systems in the humid south. However, there has been no assessment of the impacts of this incentive instrument on groundwater recharge and sustainability. Hence, it is essential to strengthen the coordination between sectoral policies and water management policies.

Jouralev (2005), based on a survey of the literature on water markets in Chile concludes that these markets have helped to (i) facilitate the reallocation of water use from lower to higher value users (*e.g.* from traditional agriculture to export-oriented agriculture and other sectors such as water supply and mining), (ii) mitigate the impact of droughts by allowing for temporal transfers from lower value annual crops to higher valued perennial fruit and other tree crops, and (iii) provide lower cost access to water resources than alternative sources such as desalination.

The analysis of the problems have been resolved through the market of water use rights, indicates that the use of this allocation mechanism has allowed users to consider water as an economic good, internalizing its scarcity value; constitutes an efficient reallocation mechanism which has facilitated the reallocation of granted rights; has permitted the development of mining in areas in the semiarid northern region of Chile where this resource is scarce, by buying water rights from agriculture; the solution of problems associated to water deficits derived from a significant increase of water demand, caused by the significant population growth in the central region of Chile; and the solution of water scarcity problems when a quick response has been required (Donoso, 2006).

The problems that water use rights market have not been able to resolve are: water use inefficiency in all sectors, not only in the agricultural sector, environmental problems, and the maintenance of ecological water reserves.

The elements that have hindered water market effectiveness are the:

- e) Lack of water and water market information.
- f) Lack of regularization of customary water.
- g) Existence of transaction costs
- h) Lack of a rapid, efficient controversy resolution system.





Lack of wur and wur market information

The wide dispersion of prices documented by Donoso (2006) and Cristi and Poblete (2010) is an indication of the limited information that buyers and sellers have access to on wur transactions and prices. Wur markets have lacked transparency.

A centerpiece of the information system on wur is the RPA. This provides the DGA with the necessary information on wur to enable it to effectively fulfill their functions, and water users with the required data for an efficient water management and planning, as well as wur market information. However, as discussed previously, the RPA is incomplete; only 20% of all wur and 50% of market transaction cases are registered (World Bank, 2011).

The main reason why the RPA is incomplete is that only regularized and formally inscribed wur can be registered. Moreover, the record is not updated because the CBR and users rarely transmit to the DGA market transaction data, even though the 2005 amendment of the WC 1981 requires all CBR to inform wur market transaction data.

Lack of regularization of customary wur.

Only registered rights can be bought, sold, and mortgaged, and thus, the fact that most rights remain unregistered impedes the transfer of water. However, most WUAs maintain their own registries in order to effectively distribute water to rights owners. These do not imply legal title. The DGA is also responsible for maintaining the RPA which contains information on all water-use rights that are granted by the DGA. This RPA also contains hydrological and water-quality data, information on WUAs and water withdrawals, and all transactions. However, this registry does not imply legal title, and often is incomplete.

Existence of transaction costs.

Transaction costs associated with the wur market have increased due to the difficult process of finding potentially suitable buyers or sellers. Due to the lack of public information on water transactions, water rights prices and water rights market activity, in general, interested water rights buyers usually contact water user associations or lawyers specialized in water law for information on potential water rights sellers. It is also common for individuals or companies with wur to hire consulting services to assess and value their rights.

Additionally, there is no wur price revealing mechanism. An initiative to reduce transaction costs is the research project-“Development of an electronic market for water in Chile” that is developed in collaboration with the DGA, academic institutions and CORFO.

Lack of a rapid, efficient controversy resolution system.

The WC 1981 establishes that any conflicts that may arise among water users, must be solved by the board of directors of the WUAs that arbitrate and decide –in their capacity as arbitrating arbitrator– and such decisions may be enforced with the assistance of the public force. However, WUAs have problems solving controversies





since they have weak, inappropriate capacities to solve problems (Bauer, 1998). Thus, the majority of conflicts have ended in the judicial system.

However, Chilean lawyers and judges are not always formally educated on wur law. The legislation on wur is not, in general, taught in the Schools of Law. When proceedings are carried out to solve these conflicts, the judges must resort to the DGA to obtain further information (Bauer, 1998). Therefore, a major challenge to improve water allocation through wur markets is to increase the conflict resolution capacity.

3. Conclusions

3.1. Lessons learned

This review of Chile's wur markets and WC 1981 regulations leads to the identification of lessons that must be considered in order to establish an effective water allocation mechanism based on a wur market. The main lessons are the following:

- a. A cultural context of the society consistent with the economic paradigm of solving inefficiencies of free access goods based on the establishment of property rights (wur); society's acceptance is a prerequisite for a successful wur market;
- b. The existence of water scarcity; when water is not scarce, there is no need to reallocate wur;
- c. It is essential that wur be clearly specified, ownership secure, and formally registered;
- d. The period during which the water can be used; the lack of this definition has caused conflicts in between consumptive and non-consumptive users;
- e. It is important that regulations and conditions for wur trade and transfers be explicit, and designed to accommodate transfers quickly and at low cost; this also requires that there exists an effective conflict resolution mechanism;
- f. The issues of total resource use, unused entitlements, and environmental and in-stream needs should be addressed prior to the introduction of trade; otherwise, the authority will probably not be able to satisfy minimum ecological flows;
- g. The need to consider the issue of unused water. Failure to address this issue with adequate regulatory mechanisms can lead to inefficient and unsustainable water uses and opens up for speculation and monopolistic behavior and negative economic impacts, as was the case of the WC 1981 which did not consider these issues;
- h. Adequate regulations that address externalities and potential damage to third parties due to wur transactions. As Bjornlund and McKay (2002) point out, a balance between private market forces and government regulation to protect third party interests, including environmental concerns must be found;
- i. A complete registry of wur holders;





- j. An efficient information system that considers an efficient flow of market information such as data on transactions and a price revealing mechanism; this is important in many countries where the ability of well-informed and well-financed buyers to benefit from ill-informed and poor sellers is present;
- k. Detailed information and models of both surface and groundwater resource availabilities;
- l. Efforts should be made to remove obstacles to the spatially free movement of water. For example, a flexible infrastructure that allows for the transfer of water at low costs;
- m. Strengthening and capacity building of WUAs; successful WUAs have proven that to be instrumental in facilitating water markets.

3.2. Enabling / Disabling Factors

- Keeping in mind the transferability of the EPI, what were the key enabling factors that allowed the EPI to succeed?
- What were the key disabling factors that prevented the EPI from achieving its objectives?

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1 Data Sources

This section identifies and outlines the general data sets used in the assessment. Provide source and data sets names as given by the source, as well as valid links (URL).

2 Annexes

The annexes can be used to provide any relevant background information that the assessor considers relevant for further explaining the results of the assessment. Annexes should be linked with the specific section of the main report of the case study following the table of contents used in this review (e.g. further info about transaction costs outside what it is asked to provide in the main body of the report should be put in the annexes under the heading Annex 3.2 Transaction costs)

