Chapter 5
Water Pricing in Chile: Decentralization and Market Reforms

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Abstract The water sector in Chile underwent major changes as a result of decentralization and market reforms. This chapter focuses on recent pricing experiences in the urban residential and rural sectors. Over the last 30 years, the Chilean government has successfully incorporated private participation in the water and sanitation sector and implemented a regulatory framework that has contributed to cost recovery and affordability of the reform. The service offered has greatly improved in quality and coverage reaching, in 2013, 99.9 % of urban population. National coverage of sewage treatment has significantly increased from 17 % in 1999 to 99.8 % in 2013. However, the privatization and decentralization of water utilities is facing new challenges, such as increasing extreme climatic events and a more informed and organized consumer base. In addition, there are concerns with respect to sustainability of groundwater extraction and deterioration of water-dependent ecosystems due to over allocation of water rights. This chapter also presents an overview of Chile's national Rural Potable Water (APR) program, which has reached almost 100 % coverage in semiconcentrated rural areas. Unlike urban service providers, the rural water-supply and sanitation sector has not been subject to regulation like urban services.

Keywords Chile • Water affordability • Urban water and sanitation sector reform • Rural water subsidy • Water markets

5.1 Introduction

A long narrow strip of land, Chile's unique geography provides a variety of climatic conditions and a number of short river valleys running from the Andes to the Pacific Ocean. Two primary mountain ranges, the Andes and the Coastal Mountains, span the length of central Chile and provide the limits to the coastal plain and the central

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valley. Chile's total land area is 743,800 km^2, of which 21.2 % is agricultural land (157,687 km^2) and 21.8 % is forest (162,148 km^2). Arable agricultural land is 1,294,000 hectares (ha), which is 1.7 % of the total land surface. Chile has just over 1 million ha of irrigated agricultural land. Urban area covers approximately 0.06 % of total surface. Currently, the area of wetlands in Chile is about 5 million ha, which is equivalent to 5.9 % of Chile's total land area.

In the last 30 years (1980–2010), Chile's real GDP has grown at an annual rate of 6.2 %. The economy is based mainly on exports concentrated on natural resource production processes that are highly dependent on water, such as mining and agriculture. Chile had a per capita GDP measured in purchasing power parity of US$15.331 in 2013.

Precipitation ranges from near zero in the north to an annual 2,000 mm in the south. Additionally, the spatial distribution of water flows follows the same pattern as rainfall, generating three hydrologic systems: the dry Pacific, central Chile, and southern humid Pacific systems (Fig. 5.1). The characteristics of these systems are the following:

Dry Pacific: In this system water flows reach their peak during the summer months (November–February), which coincide with rainy season of the Bolivian Altiplano. Thus, water flows in these basins are mainly rain driven. Average water flows in this sector are 45 m^3/s.

Central Chile: This system has large snow pack reserves, and water flows are highest during the summer months due to snowmelt. Water flows are significantly greater than those of the dry Pacific system, reaching an average 2.800 m^3/s.

Southern Humid Pacific: Higher rainfall and lower temperatures increase the annual water flow/annual rainfall to values close to 0.9. Rivers in the north of this hydrological system present a mixed regime, snowmelt and rainfall. Toward the south, water flows become more driven by rainfall. This system presents an average water flow of 27.600 m^3/s, the highest water flows of all three systems.

Water withdrawals in Chile average approximately 4,000 m^3/s/year (World Bank 2011). Of this, almost 85 % is used in nonconsumptive hydroelectric generation. Consumptive water use in Chile is dominated by irrigation, with 73 % of consumptive water use. Industrial use of water is 12 % of consumptive withdrawals, and mining and potable water supply account for 9 % and 6 % of total water consumptive water use, respectively. It is interesting to note that all consumptive water uses have increased since 1990; total consumptive water use has increased 13 % since 1990. Industry is the sector with the highest consumptive water-use increase (79 %), followed by potable water and mining (48 % and 46 %, respectively).

The five classes of water-consuming activity with the largest share of GDP were manufacturing (12 %); retail, restaurants, and hotels (10 %); mining (8 %); agricul-

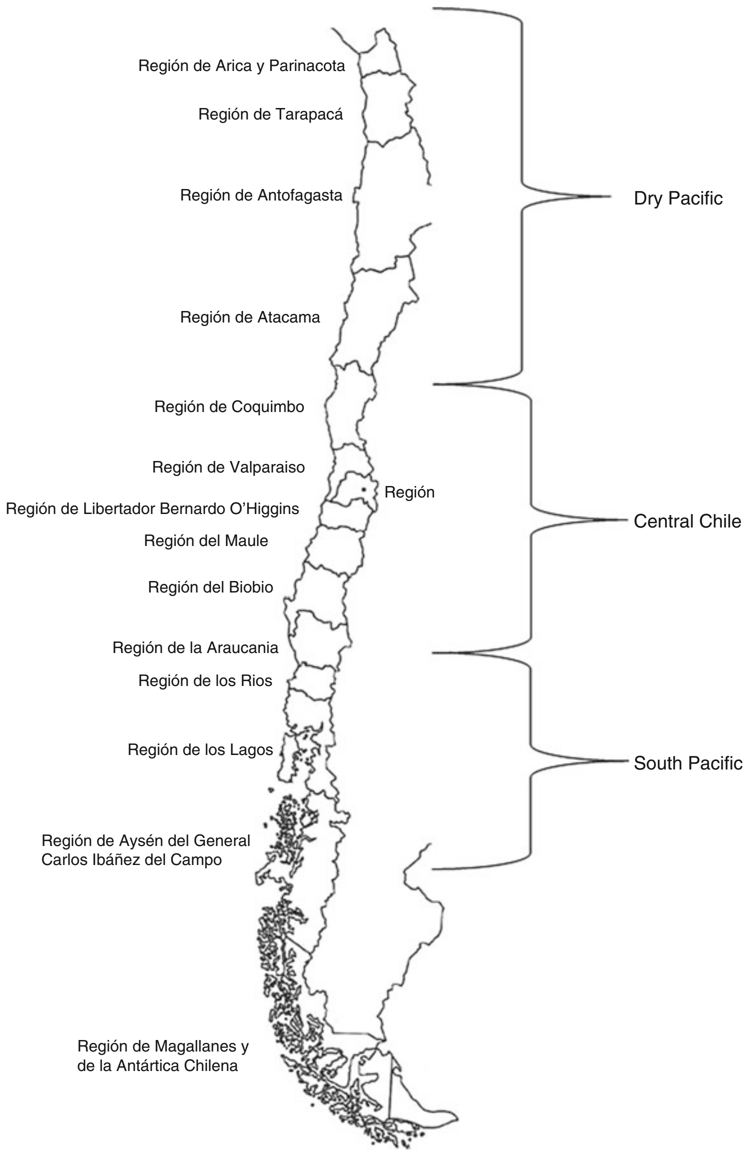

Fig. 5.1 Map of Chile

ture and forestry (4 %); and electricity, gas, and water (3 %). In 2005, the contribution to merchandise exports were mining (57 %); agriculture, forestry, and fishing (7 %); and industrial (31 %) (World Bank 2011).

In the dry Pacific hydrological system, the scarce water resources are divided among Chile's principle mining operations, agriculture toward the south of this system, and a sparse population. The northern portion of the central Chile hydrological system, irrigated agriculture is important and concentrated on fruit crops grown for international markets. Additionally, nearly one-third of the nation's population is located in this system. The southern humid Pacific concentrates Chile's forests, fisheries, and aquaculture industries. A low density of population also characterizes this system.

Chile has a high level of coverage of water, sewerage, and wastewater treatment systems. In 2013, water and sewer coverage reached 99.9 % and 96.3 % of total urban population (SISS 2013), while wastewater treatment coverage was 99.8 % (SISS 2013). On the other hand, only 72 % of the rural population had access to improved potable water (WRI 2003).

During the late 1970s, 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 neoliberal economic policies that supported private property rights and free markets.

This chapter focuses on recent pricing experiences in the urban residential and rural sectors. The chapter is structured as follows. The next section presents the market reforms in the water sector. Section 5.3 covers the transformation of the urban water and sanitation sector, while the rural water sector is described in Sect. 5.4. Finally, Sect. 5.5 concludes the paper.

5.2 Market Reforms in the Water Sector

The case of Chile is illustrative of a transition from command and control to market-based water management policy, in which economic incentives play a significant role in water-use rights (WUR) allocations.

The Water Code of 1981 (WC 1981) maintained water as "national property for public use," but granted permanent, transferable water-use rights to individuals to reach an efficient allocation of the resource through market transactions of water-use rights (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. Thus, the WC 1981 was designed to protect traditional and customary WUR and to foster economically beneficial reallocation through market transfers.

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. Inter-sectoral trading has transferred water to growing urban areas in the Elqui Valley 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. Other studies have shown limited trading in the Bío Bío, Aconcagua, and Cachapoal valleys. 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 transaction costs in those valleys where water user associations (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. It should be noted that during the 2000s, the market was more active than in the previous two decades, 1980s and 1990s. This is largely due to a slow maturation in the public's knowledge concerning the new legislation.

The average permanent WUR price is US$215,623 per WUR (Hearne and Donoso 2014). Permanent 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.

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 in which each agent's information, market experience, and negotiating capacity is important in determining the final result.

As a result of the WC 1981 2005 reform, combined with the performance of the Antitrust Commission, the monopolistic distortion due to speculation and nonconsumptive WUR hoarding has been reduced. In turn, 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 nonuse of WUR will continue to reduce in the future, due to the projected increase in the nonuse tariff.

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 WC 1981 did not pay much attention to the sustainable management of groundwater because, at that time, groundwater extraction was marginal during the early 1980s. 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 exists various problems associated with groundwater management. An additional challenge for a sustainable groundwater management is the fact that presently ground and surface waters are managed independently, despite their recognized interrelations. The 2005 amendment of the WC 1981 established that the Juntas de Vigilancia (surface water user associations) must, in the future, integrate groundwater user associations. However, there are only two groundwater user associations, and, thus, there is no conjunctive management of surface and groundwater, which has proven to be an effective adaptation mechanism for climate change.

The literature on WUR markets in Chile indicates that these markets have helped (1) 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); (2) 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 (3) provide lower cost access to water resources than alternative sources, such as desalination.

The analysis of the problems that have been resolved through water-use rights indicates that the use of this allocation mechanism (1) has allowed users to consider water as an economic good, internalizing its scarcity value; (2) constitutes an efficient mechanism that has facilitated the reallocation of granted rights; (3) 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; (4) has solved problems associated with water deficits derived from a significant increase in water demand, caused by significant population growth in the central region of Chile; and (5) solved water-scarcity problems when a quick response was required.

In the Paloma system, for example, a semiarid water basin located in the dry Pacific hydrological system of the country, water is a scarce resource 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 (e.g., during the 1993–1999 period, 6,000 water-use rights were traded). In the Maipo system, in the central region of the country, 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 et al. 2014).

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. Present estimates indicate that 30 % of agricultural operations concentrated in the northern water-scarce regions use water-conservation technologies. 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. Other sectors present a significant increase in water-use efficiency, as a response to the scarcity value signal through WUR prices. The mining sector, for example, has reduced its water footprint from 1.7 m^3/ton of copper ore in 1980s to 0.5 m^3/ton of copper ore in the 2000s.

The problems that water-use rights markets have not been able to resolve are water-use inefficiency in all sectors, not only in the agricultural sector, environmental problems, and maintenance of ecological water flows. Additionally, integrated water resource management has not been implemented, although it has been established as a priority in the 1999 and 2013 National Water Strategy.

5.3 Urban Water and Sanitation Sector

During the 1980s, the sector was dominated by governmental water-supply utilities, which supplied water and sanitation (WSS) services to most of Chile. The inclusion of private operators began in 1988. The urban water-supply coverage in 1993 was 97.6 %, and the service was provided mainly by state-owned water-supply operators (see Fig. 5.2). Furthermore, only 85.9 % of urban population had access to sewer collection, and only 13 % of wastewater was treated. The driver of this situation was the low investment in infrastructure; the estimated investment cost deficit for the 1993–2000 period was $2.4 billion, and 63 % of the deficit was in wastewater treatment. Before 1993, the average annual investment of the state-owned operators was $150 million.

During 1994, several of the 13 state-owned WSS operators presented losses; for example, Essat presented −4.1 % and Emssa −3.2 %. This was, in part, due to a 30 % increase in average costs between 1990 and 1994. Administrative costs increased during this period; ESVAL increased its administrative costs by 140 %, while EMOS increased by 40 %. Furthermore, nonrevenue water varied between 24 % and 43 %.

The actual legal framework of the WSS sector established in 1988 presented the following objectives that water and sanitation tariffs must satisfy:

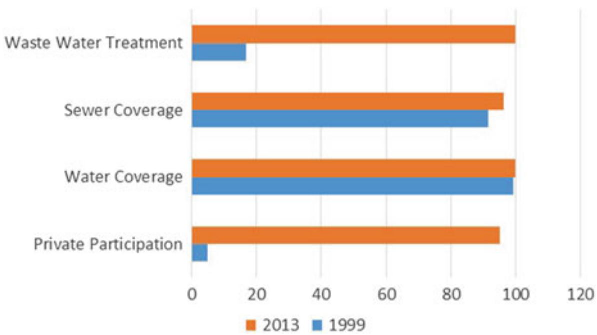

Fig. 5.2 Growth and evolution of regulated water and sanitation sector (Own elaboration based on SISS 2013)

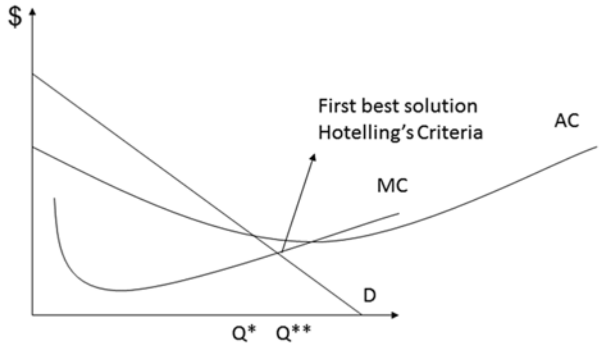

Fig. 5.3 Tariff setting principles

(a) Full recovery of operation and maintenance costs
(b) Funding of necessary infrastructure reposition and development plan investment
(c) Tariff reductions when operators increase efficiency
(d) Operational margins that are consistent with the opportunity cost of capital

The legal framework of the Chilean water and sanitation tariff system establishes that tariffs must satisfy the principles of (1) economic efficiency, (2) water-conservation incentives, (3) equity, and (4) affordability (Chavez 2002).

In order to comply with economic efficiency, the WSS tariffs are based on a two-part tariff, following Coase's solution: a variable and fixed tariff. The variable tariff is set following Hotelling's principle; thus, variable water tariff is consistent with the first best solution where marginal benefits are equal to long-run marginal costs[1] (MC) and social welfare is maximized (Fig. 5.3). However, this variable tariff set at MC does not cover the operator's average costs; that is, the WSS providers operate with losses. In order to satisfy the full cost recovery principle, a fixed tariff is included to cover the natural monopoly's losses at the first best solution.

The Executive Decree 453 of the 1988 Law N° 70, of the Ministry of Public Works (*Ministerio de Obras Públicas*, MOP) establishes a variable tariff that is set for periods of high demand, during summer months (peak variable tariff $\$/m^3$), and for nonpeak periods (nonpeak variable tariff $\$/m^3$). The peak and nonpeak tariffs are considered to internalize changes in seasonal demand and, thus, cover differences in the provision costs of the service. As previously indicated, the current tariff structure also considers a fixed charge per customer (connection), which depends on the diameter of the connection.

In order to estimate the variable charge, the Chilean tariff law introduced the concept of an incremental development cost, which is defined as the value applied to the incremental forecasted demand that generates the necessary revenues to cover

[1] Long-term infrastructure investment costs are included in the water and sanitation services tariff rates.

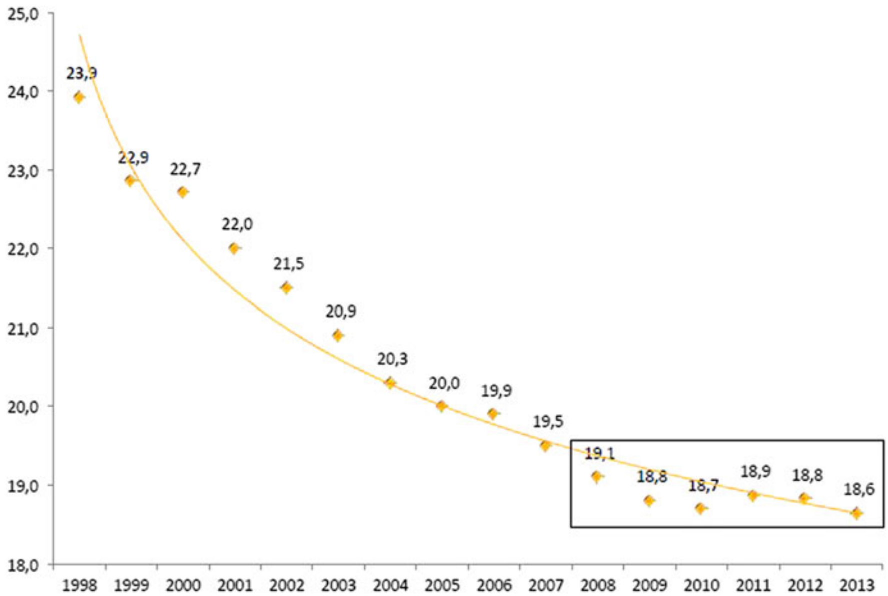

Fig. 5.4 Average monthly household water consumption (m^3/household/month) (SISS 2013)

incremental operation efficient costs, and the required investment for an optimized expansion project of the WSS firm. The incremental development cost is determined such that the net present value of the optimized expansion project is equal to zero (D.F.L. No 70/1988).

The variable tariff also considers the value of water so that consumers consider the scarcity of water in their water usage decisions.[2] This generates correct incentives to conserve water in resource-scarce areas. For example, average variable non-peak and peak tariffs in the dry Pacific arid system are \$1.3/m^3 and \$2.2/m^3. In the southern humid Pacific system, on the other hand, they are \$0.88/m^3 and \$1.3/m^3, respectively. Fixed tariffs also vary according to water scarcity, representing \$1.9/ m^3 and \$0.8/ m^3 in the dry and southern humid Pacific systems, respectively (SISS 2013). Additionally, evidence that tariffs send the right signals to consumers is that average monthly household consumption has significantly fallen since 1998, from approximately 25 to 18.6 m^3/household/month in 2013 (Fig. 5.4).

The affordability criteria is met by the provision of subsidies directly to the most vulnerable households. Households are classified based on an annual survey (*Encuesta Casen*), which estimates household per capita income. In order to qualify for the subsidy, households must not have payment arrears with the service provider. The central government transfers the block subsidy to the municipalities; the latter use this to pay a share of each of the eligible household's water bill; the payment share ranges from 15 to 85 % of the water bill, with the poorest families get-

[2] The value of water for each WSS provider is determined by market prices of traded WUR.

ting the highest share. The subsidy covers a consumption of up to 20 m^3. The Social Development Ministry (*Ministerio de Desarrollo Social*, MDS) uses the household survey information for each region of Chile to determine the size of the block subsidy that needs to be transferred to the municipalities. The WSS providers bill the benefiting households for the net of the subsidy amount, indicating the full consumption cost, and then charge the municipality for the subsidies granted.[3] The municipality will be charged interest for late payment, and the WSS provider can discontinue service to benefiting households if there is nonpayment by the municipality. In 2011, 15 % of WSS provider customers benefited (6 % of total sales), at a cost of $80 million and an average monthly subsidy per household of $10.

In order to obtain the necessary investment funds to improve its performance, the WSS sector instituted during the period 1989–1999, a model in which the regulatory and supervisory functions were separated from the investment, production, and sale of service functions. The new regulatory regime, which considered concessions to establish, build, and operate water and sanitation services by private providers, led to an increase in private participation in the provision of WSS services from 5 % in 1999 to 95.5 % in 2013. This process also led to a significant increase in average annual investments from $200 million to $500 million in 1999 and 2013, respectively (Fig. 5.2). This is mainly due to the increased rate of return on capital, due to increases in tariff rates. Tariff rates are determined so that investors receive a low-risk return of at least 7 % on capital expenditures, and therefore, private WSS providers have the incentive to invest in water provision, wastewater collection, and treatment (Hearne and Donoso 2005). For example, sewage treatment coverage increased from 17 % in 1999 to 99.8 % in 2013 (Fig. 5.2).

This reform period coincided with the era of high economic growth (6.2 % per year) with real incomes rising significantly. Williams and Carriger (2006) proposed that the transformation of the WSS sector would not have been so successful without these high rates of growth. The level of investment needed to attain this coverage could not have been reached if the Chilean government were responsible for investment. With tariffs set centrally for water and sanitation, efficiency incentives exist for the companies to increase returns on investment. This has happened and these companies perform well on the Chilean stock exchange (Bitran and Arellano 2005).

Currently there are 53 water and sanitation service providers operating in the urban areas of Chile. They function as private companies, although the state investment company, ECONSSA, still owns a considerable number of shares in most companies (Hearne and Donoso 2005). Five of Chile's 13 regional water companies were fully privatized with partial sale to multinationals in 1998.

The WSS providers service more than 4.5 million clients[4]; 94.4 % of clients are domestic, 4.7 % commercial, 0.2 % industrial, and 0.7 % other. Additionally, 95 %

[3] This practice does not distort the price signals.

[4] A client is determined by the property, rather than the individual, that receives services and is billed for these (more than one person may live in the same property, benefiting from the services).

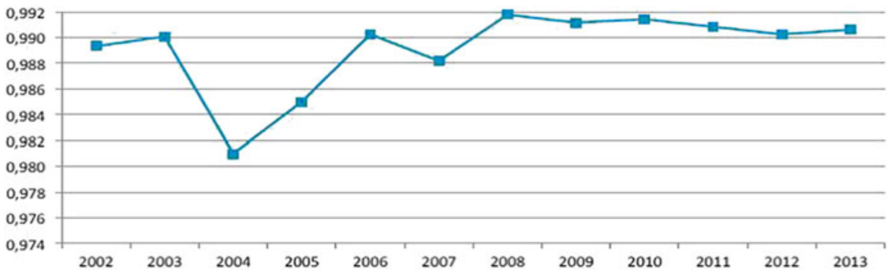

Fig. 5.5 Water service quality (SISS 2013)

of all clients have both drinking water and wastewater connections. The other 5 % have either one or the other, with most having only drinking water connections.

The large and medium service providers (8 of the 53) serve 84.2 % of all clients. It is interesting to note that a municipality (SRMPA of the Maipu municipality) owns one of them. Private providers service 95.5 % of all clients.

With respect to the service quality, Fig. 5.5 shows that customer satisfaction levels since 2008 are over 99 %. WSS clients were quite satisfied with the service, rating it with a 5.3 on a scale of 1–7 (GWI 2013).

Therefore, the new regulatory scheme in the Chilean WSS sector has provided the right economic signals for an efficient allocation of resources. It has also led to meeting the set goals for service coverage. Additionally, the transformation of the WSS sector has led to an:

(a) Improvement in quality of service
(b) Increase in WSS provision coverage, despite rapidly increasing urban populations
(c) Increase in water conservation by customers

In summary, Chile's policy of providing water-supply and sanitation (WSS) services through privatized regional and local water companies has been a notable success.

5.4 Rural Water Sector

In 1960, only 6 % of the rural population had an adequate supply system of water. During this period, there was no public agency in Chile responsible for supplying drinking water in rural communities. As of 1964, the government adopted the Rural Sanitation Master Plan, which appointed the National Health Service, as the executing agency of the first stage of the National Rural Drinking Water Program. The Inter-American Development Bank (IDB) funded the program to supply drinking water to 199 concentrated rural localities.

In 1975, the responsibility for the program was transferred to the MOP, through the Directorate of Water Works, later National Sanitation Service (SENDOS). In 1977, a second contract was signed with the IDB, called the second stage of the program, benefiting 142 rural localities. Between 1981 and 1985, the third stage was implemented, benefiting 233 villages. The fourth stage of the program was established between 1986 and 1991, supplying drinking water to 240 villages.

Since 1991 the Chilean state funds the Rural Drinking Water Program (*Programa de Agua Potable Rural*, *APR*), which provides infrastructure for water provision in rural areas. The program is directed to rural communities living in concentrated towns[5] and semiconcentrated towns[6] that lack WSS or have a WSS service that needs to be expanded or improved. The state subsidizes the installation of infrastructure, and rural water user committees (RWC) manage water provision in their areas, supervised by Chile's Department of Health. Additionally, tariff setting is the responsibility of the RWC. Evidence shows that these committees have not set tariffs at the correct levels in order to fully recover costs. The evaluation of the APR Program conducted by the Budget Directorate of the Ministry of Finance (Dirección de Presupuestos, Ministerio de Hacienda Dirección de Presupuestos, Ministerio de Hacienda 2007) shows that only 57 % of the total rural water-supply installations have been maintained or improved. This is mainly due to tariffs that, in general, only cover operating costs. The majority of the RWCs have not set tariffs that allow for recovery of maintenance costs. Moreover, the RWCs have not been able to finance the required investments to attend growing demands. This explains the deterioration of the systems over time, requiring further subsidies to recuperate the systems.

More importantly, these RWCs set the tariffs without a supervising regulatory agency. During Bachelet's first presidential administration (2006–2010), the government submitted a bill to the Chilean congress to give this sector a new institutional framework in the form of a specialized agency. However, to date no changes have been implemented, and this agency still has not been created.

Thus, the APR program subsidy has been effective in installing water-supply infrastructure in concentrated and semiconcentrated rural towns. However, due to funding problems, these water-supply installations are precarious and vulnerable. For example, the dry Pacific and northern portion of the central Chile hydrological systems have suffered a severe drought during the past 7 years. Due to this drought, the majority of the rural water-supply installations have not been able to supply water to their clients, and the state has had to supply water with cistern trucks. On the other hand, all of the regulated urban water service providers have been able to satisfy water demands.

[5]Towns with over 300 inhabitants and a minimum density of 15 households per km.

[6]Towns have at least 80 people and a minimum density of 8 homes per km.

5.5 Conclusions

The water sector in Chile underwent major changes as a result of decentralization and market reforms. Over the last 30 years, the Chilean government has successfully incorporated private participation in the urban water and sanitation sector and implemented a regulatory framework that has contributed to cost recovery and affordability of the reform. The service offered has greatly improved in quality and coverage, reaching in 2013, 99.9 % of urban population. National coverage of sewage treatment has significantly increased from 17 % in 1999 to 99.8 % in 2013. Thus, Chile's policy of providing water-supply and sanitation (WSS) services through privatized regional and local water companies has been a notable success.

Unlike urban service providers, the rural water-supply and sanitation sector has not been subject to regulation like urban services. This has led to tariffs that do not allow for full cost recovery. More importantly, tariffs have not allowed for adequate funding and maintenance to satisfy growing demand. Thus, rural WSS systems are precarious and vulnerable.

There is no irrigation water pricing in Chile. However, agricultural producers face the opportunity cost of water through markets for WUR. This has led to significant increases in the adoption of water-conservation technologies. Average irrigation efficiencies have increased to levels above 50 % in all three hydrological systems (Comisión Nacional de Riego 2010).

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