Public policy as a means to increase human security in agriculture in a drought-prone area of northern Chile

Alejandro León and Rosa Garay-Flühmann
Department of Environmental Sciences and Renewable Natural Resources,
Faculty of Agricultural Sciences, University of Chile

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Abstract

This paper examines the effectiveness of present Chile[1] long-term irrigation public policies aimed at increasing human security through investment in irrigation infrastructure in the Limarí River basin, a drought-prone area of northern Chile. The Limarí River basin is located in the semi-arid region of Chile, where sixty percent of years receive bellow-normal precipitation. According to precipitation records that span for more than a century, this basin has experienced a decrease in annual rainfall.

Human economic activity and security in the area is related to climate variability and access to water for irrigation, and is being controlled to a great extent by access to capital and technology. As a means of securing agricultural activity, public policies related to the development of irrigation infrastructure (i.e., dams and canals) were put in place in the area in the early 1920s. At the present time no large infrastructure is being built in the basin, but there is a set of so-called economic instruments designed by State agencies aimed at fostering irrigation efficiency and adoption of irrigation technology at the farm level.

In this paper we present preliminary results of a recently conducted research effort aimed at establishing the relationship between public policies in irrigation and agricultural development and poverty alleviation in the Limarí Basin in the Region of Coquimbo in northern Chile during the period 1980-2000. Results show that different categories of farmers (i.e., large, medium and small) have had access to these State sponsored instruments and that they have been a key means in securing agricultural activity thus rising human security in this dryland agricultural area via increase in agricultural production and/or employment .

1. Introduction

The changing climate of semi-arid regions poses several challenges for those depending on agriculture. Such is the case of producers in the Limarí Basin in northern Chile, where large-scale to small-scale and communal agriculture coexist. Larger producers are linked to foreign markets and have access to credits, water rights, and technology, while those who own relatively small (< 5ha) parcels and those depending on open-access resources seldom have access to those resources.

[1] By present Chile we mean the period starting in 1980 to date.

The Region of Coquimbo, where the Limarí River basin is located, is an important producer of different varieties of wine grapes and table grapes that profit from the off-season in the northern hemisphere thanks to its southern hemisphere climate. Most of these products are channelled to foreign markets (such as the U.S., the European Union, and Asia) through a myriad of exporting companies. Linkages to foreign markets have opened commercial opportunities for producers that the local market cannot provide. Therefore, many large, medium, and small-sized private landholders have enjoyed financial profit.

By contrast, this region has traditionally endured the highest levels of poverty in Chile. Most of the poor population lives in the rural sector, and a proportion of the poor families are found among those who own smaller parcels (Schneider 1982; MIDEPLAN 1987, 1990, 1992, 1994, 1998, 2000).

Researchers predict that in all likelihood extreme events will occur in the future once mean climatic conditions undergo significant shifts (Burton 1997, Klein and Maciver 1999, Magistro and Lo 2001). Lenton (2002) suggests that "adaptations and impact mitigation on seasonal to interannual time scales will be critical in adapting to and mitigating the impacts of longer-term climate change as well." Access to resources, income-generating activities, coping strategies, and governmental initiatives constitute some of the elements that shape the capacity of an individual or a group to resist the impacts of drought (Reilly and Schimmelpfennig 1999).

An example of adaptation to climate is provided by the public policies enacted by the Chilean State to secure agricultural production in the Limarí Basin. The area lends itself as a representative case study due to its climatic characteristics, economic activity (primarily agricultural), irrigation water shortages due to prolonged drought episodes, and the active implementation of public policies in irrigation and agricultural development. This paper examines the latter as a coping strategy to increase human security to climate variability and change, and draws from the results of a research project aimed at establishing the relationship between public policies in irrigation and poverty alleviation in two South American dryland basins, the Limarí Basin in the Region of Coquimbo in northern Chile and the Tunuyán Basin in Argentina[2], (Garay-Flühmann *et al.* 2004) and from unpublished results of León's doctoral dissertation (León 2005).

[2] "A Comparative Study of the Modern Irrigation Water Systems and Rural Poverty in the Limarí Basin, Chile and the Tunuyán Basin, Argentina: Institutional and Socio-Economic Aspects". This project contributed to the

2. The Limarí River Basin

Climate

Chile is a long narrow strip of land squeezed between the Andes Mountains and the Pacific Ocean, where extreme intra- and inter-annual climate variations are the rule. The country presents a wide range of climates: from hyper-arid in the northernmost sections to extremely wet and cold in the south. The Limarí River Basin[3], located in the province of Limarí in the Region of Coquimbo, belongs to the semi-arid region. The area's climate records show that extreme events such as prolonged, multi-year droughts or extremely rainy seasons are a common feature (Figure 1). The area has also been described as having a Mediterranean climate because 85.7 percent of

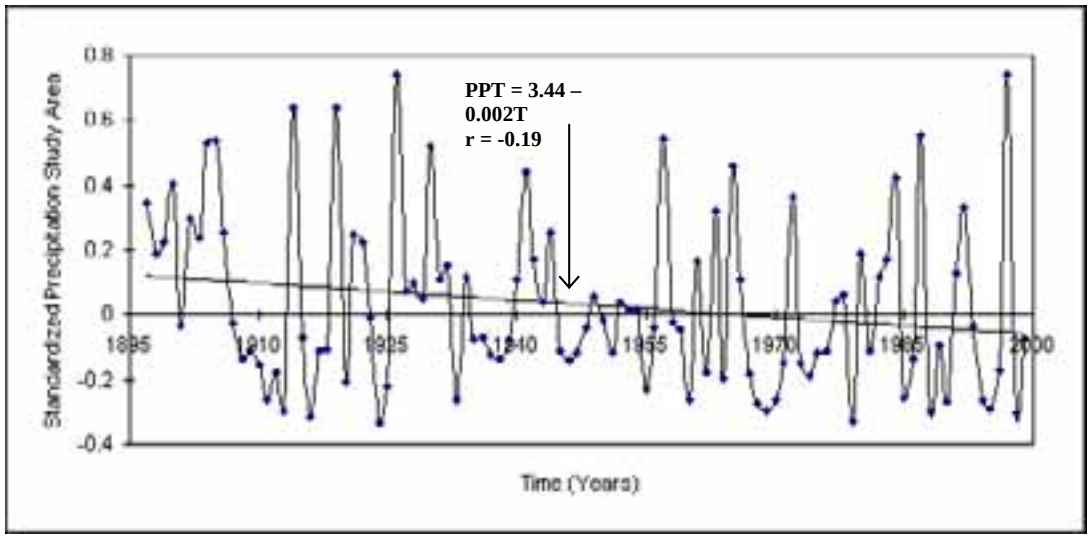


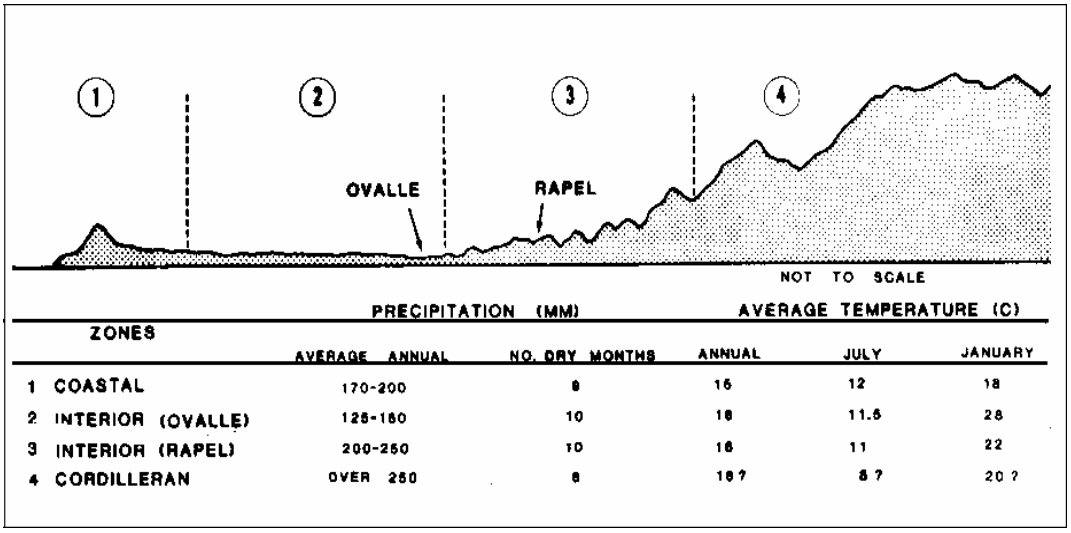
Figure 1. Precipitation patterns in the study area (1896-1999)

Source: Oficina Meteorológica de Chile

the average annual precipitation is concentrated in the winter months (May-August) while the summer is dry (Borgel 1973, Montecinos *et al.* 2000). Within this region, average annual rainfall ranges from less than 75 mm in the north coastal areas to more than 350 mm in southern portions of the region (Bahre 1979). Rainfall also increases from west to east, as shown in figure 2.

Comprehensive Assessment of Water Management in Agriculture and was funded by the governments of the Netherlands and Switzerland.

[3] 30° 45'S; 70°30'W–30° 45'S; 71°30'W



ZONES	PRECIPITATION (MM)		AVERAGE TEMPERATURE (C)		
	AVERAGE ANNUAL	NO. DRY MONTHS	ANNUAL	JULY	JANUARY
1 COASTAL	170-200	8	15	12	18
2 INTERIOR (OVALLE)	125-150	10	16	11.5	28
3 INTERIOR (RAPEL)	200-250	10	16	11	22
4 CORDILLERAN	OVER 250	8	10 ?	8 ?	20 ?

Figure 2. Climate zoning on an East-West transect along the Limarí River basin
Source: Bahre 1979

Population

The study area has experienced an increase in population over the past twenty years (Table 1). This increase is partly related to the growth in agricultural activity since the 1980s.

Table 1. Population and population density of study area 1982-2002

	Population			**Population density (hab/Km^2)**		
	1982	**1992**	**2002**	**1982**	**1992**	**2002**
Region of Coquimbo	419,956	504,387	603,210	10.3	12.4	14.8
Prov. Limarí	126,437	141,551	156,158	9.3	10.4	11.5

Source: INE 1982, 1992, 2002

However, the Region of Coquimbo as well as the Province of Limarí (with a territorial extent of approximately 13,461 Km^2, almost that of the Limarí River Basin itself) have been signaled as one of the poorest zones in the country. Mean poverty indexes show that during the 1990s almost one third (31%) of the population was below the poverty level (Table 2). But since 1998 non indigent poverty indexes have decreased partly due to employment programs launched by the public sector and growth in agricultural activity.

Table 2. Population distribution by income, Province of Limarí, 1994 – 2000

	Non poor population (% of total population)	Poor population (% of total population)	
		Non indigent	Indigent
1994	67.7	22.7	9.6.
1998	67.3	25.7	7.1
2000	73.2	19.1	7.1

Source: Mideplan (*CASEN* survey) 1994, 1998, and 2000

Land tenure

The Province of Limarí contains about 36% of the regional private lands, 40% of communal lands, and 73% of the total count of agricultural communities. In this province both private and communal lands are held primarily in units larger than 2,000 ha. There are, however, a significant number of farmers who own private properties smaller than 10 ha (Table 3).

Table 3. Number and size of holdings by land tenure regime and location

	Private Property				Agricultural Communities			
	Region of Coquimbo		Province of Limarí		Region of Coquimbo		Province of Limarí	
Type of Size	*Number*	*Area*	*Number*	*Area*	*Number*	*Area*	*Number*	*Area*
less than 1 ha	4,445	1,997	2,317	1,031	0	0	0	0
1 to <5 ha	6,492	14,760	3,374	7,428	0	0	0	0
5 to <10 ha	2,399	16,625	1,050	7,144	0	0	0	0
10 to <20 ha	1,749	23,448	767	10,309	0	0	0	0
20 to <50 ha	1,084	32,673	589	17,819	0	0	0	0
50 to <100 ha	365	25,120	193	13,516	0	0	0	0
100 to <200 ha	155	21,594	77	10,552	3	494	1	141
200 to < 500	104	34,070	56	18,588	5	1,876	4	1,446
500 to < 1000 ha	67	47,780	21	14,886	25	18,383	19	14,223
1000 to < 2000	64	91,260	34	50,859	48	70,218	42	61,967
2000 +	178	2,497,365	71	862,222	91	866,478	50	305,489
Total	**17,102**	**2,806,691**	**8,549**	**1,014,354**	**172**	**957,449**	**116**	**383,266**

Source: INE 1997

Economic activity

Chile's production and exports is primarily based on the exploitation of natural resources (Meller *et al.* 1996). Such is the case in the Region of Coquimbo, where mining and agriculture are currently the two main economic activities, and their output is traded internationally. Between 1990 and 1997, the average contribution of mining to the Gross Regional Product (GRP) was 22 percent, and that of agriculture was 21 percent; the agricultural GRP almost tripled between 1985

and 1996 due mainly to fresh fruit exports (INDAP *et al*. 2001). Irrigated agriculture is the foremost employment opportunity in the study area (Soto 2000).

3. Irrigation Policies

An Overview of macroeconomic policies

In order to contextualize the irrigation policies during the 1980-2000 period we need to understand the broader socioeconomic and political background shaping Chile's approach to agriculture and water use starting from the historical and political framework. The period from 1973-80 was the staring point of neo-liberal reforms, where the State assured the macroeconomic equilibrium and the market assigned the resources. The macroeconomic policies reform of this period meant, among other factors, that the exchange rate was no longer fixed but free; tariffs decreased over time to reach an average of 2% in 2005; provision of goods and services was transferred to the private sector; public expenditure was reduced, while the social security system, the financial market and the labor legislation were reformed. As a result, the GNP increased steadily during the last two decades of the XX century, and the annual inflation rate decreased to an average of 2-3% in the 2000s. The State's intervention occurred when market failures arouse or the private sector did not participate (Baytelman *et al.* 1999).

The period 1980-89 was characterized by a continuous growth in export goods. Macroeconomic policies emphasized economic stability via privatizations of public services and increasing import taxes (Morandé 1993). This increase in tariffs was temporary and was a response to the 1982 economic crisis. During this decade the export of non-traditional goods (i.e., goods different from copper) such as fresh fruit, was stimulated. This is how between 1980-86 and 1987-2000, fruit orchards grew at an annual mean rate of 10% and 8%, respectively. While in 1974 Chile participated with only 6% of the Southern Hemisphere exports of fruit (such as table grapes, apples, pears, and peaches), by 1991 it represented more than 47% of the hemisphere's exports and had also diversified in its produces (adding, for example, citrus fruit, avocados, chirimoyas). The industry of processed horticultural products (i.e., frozen products, juices) expanded during this period too.

The period from 1989-2000 was characterized by significant changes in public policies as democracy replaced the military regime: the free market economy was combined with more active state intervention. Thus, keeping the macroeconomic balance from the former period, economic progress concentrates in the growth of medium- and small-enterprises, the

improvement of the public educational system, and the participation of women in labor. The Corporation for Productive Incentive (*Corporación de Fomento Productivo*, CORFO), a public agency, developed and implemented a series of export-oriented programs directed to medium-sized producers. During this period there is also an increase in tax payments: enterprises' tax rate increased from 10% to 15% (Muñoz and Celedón 1999).

Long term Irrigation Policies

In 1887, under the government of Manuel Balmaceda (1886-1991), the Ministry of Industry and Public Works was created with the purpose of planning State-sponsored works. This included infrastructure to distribute water for irrigation. Thus the first dam was built in Huasco (in the neighboring region of Atacama) in 1889. Due to the increase in number of hydraulic related works, in 1906 the General Hydraulic Inspection Office was created and in 1914 four large-scale irrigation systems were started. Between 1914 and 1973, the State-sponsored irrigation infrastructure projects numbered approximately 70.

During 1973-89 two main reforms to the irrigation policy were implemented: i) decrease public investment in irrigation. During 1965-73 the annual average public investment was approximately US$ 60 million, whereas during 1973-89 this amount was reduced to US$ 20 million (ODEPA 2004). This change responded to macroeconomic reforms resulting from the shift from a centralized economic system to a liberal one. During this period, the State funded projects that showed that social benefits were larger than the private ones; in addition, the private sector was responsible of small-scale infrastructure construction and administration *(*República de Chile 1983-1989, cited by ODEPA 1994). Consequently, no large- or medium-sized infrastructure was built during this period; and ii) the second reform had to do with public agencies: the National Commission for Irrigation (*Comisión Nacional de Riego*, CNR, in Spanish) was created in 1975. Its functions were to evaluate the needs of irrigation infrastructure in the country and was entitled to utilize State funds to develop projects related to irrigation, and to coordinate the private and public efforts in this matter. In 1981 the Directorate for Irrigation (*Dirección de Riego*; later, in 1997, re-named *Dirección de Obras Hidráulicas*, *DOH*, the Directorate for Hydraulic Works), was in charge of improving existing and building new infrastructure (Anguita 1998).

Perhaps the turning point to present agricultural activity in the study area, as well as in the nation, was the passing of Law 1,122 in 1981, which created a new Water Code and thus changed

the water tenure system. Until that time, water resources were State owned. Under the new Water Code it was possible to trade water property rights in the market. In 1985 a newly enacted Law 18,450 allowed for new incentives aimed at promoting irrigation at the farm level. The new laws, together with the macroeconomic framework, had positive implications for the Chilean large- and medium-scale agriculture, as it will be shown in the next section with data on the study area.

The period 1989-00 put into action a series of programs aimed at the construction of new on-farm irrigation systems, with a special emphasis on small-sized projects, and the improvement of old infrastructure. The existing legal body allowed for the continuity of the benefits derived by Law 18,450 and the inclusion of medium- and small-producers. In addition, existing institutions related to socio-economic development joined irrigation efforts: one exemplar case is the National Institute for Agricultural Development (*Instituto Nacional de Desarrollo Agropecuario, INDAP, in Spanish*) which has played an important role in assisting smaller producers with credit. This agency is in charge of the administration of some of the economic instruments related to irrigation, as it will be explained below.

Thus, the existence of the National Commission for Irrigation (CNR), the Directorate for Hydraulic Works (DOH), the Water Code, and the economic instruments arising from the body of public policies dealing with irrigation decrease farmers' insecurity to water scarcity resulting from climate variability and change.

4. State Economic Instruments in the Limarí River Basin

Public Investment in Irrigation Infrastructure: An Overview

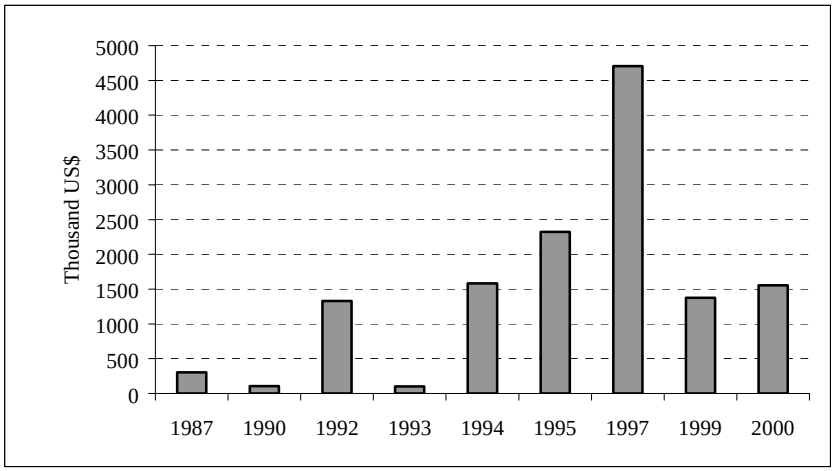
As a result of the public effort initiated in the late XIX Century, a system of three large and interconnected reservoirs was built in the study area over the years. In 1934, the first one, the *Recoleta*, was built. It was followed by the *Cogotí*, finished in 1945 and the *Paloma* in 1967 (MOP 1978). Together they form the Paloma System. The full amount of this investment, according to public records, was US$160 millions approximately (Note: all monetary figures appear in US dollars, and in year 2000 value). However, and according to local experts, this sum could have been US$300 millions (Jorge Romero, former director DOH Region of Coquimbo, personal communication, February 2004).

The Recoleta Reservoir has a full capacity of 1,000 Hm and irrigates 15,000 ha. Its construction was finished in 1934 while the main canals were built between 1944 and 1947 (MOP 1978). The total cost of the project is estimated in US$17.9 millions (present value, year

2000); this cost includes acquisition of land, and technical supervision. The cost of the canal network was US$21.7 millions (Personal Communication, Recoleta Reservoir Irrigators Association Manager, August 2004). The Cogotí Reservoir has a full capacity is 150 Hm and irrigates 12,000 ha. The total cost of the project, including canals, was US$23.6 millions (present value, year 2000) (Personal communication, Cogotí Reservoir Irrigators Association Manager, August 2004). The Paloma Reservoir, the largest of all three, allows for interannual regulation. It complements irrigation security on lands covered by the other two reservoirs, and other 15,000 ha in the Punitaqui County, which had no irrigation previously. Its full capacity is 750 Hm and was built between 1959 and 1967 (MOP 1978), with a total investment of US$117.8 millions (MOP 1961).

More recently, in 1992, Chile's government received a loan from the World Bank to fund the Rehabilitation and Construction of Middle- and Small-size Irrigation Works (PROMM, in Spanish). The Bank provided $45 millions while the government contributed with $73 millions (ODEPA 1994). This program, administered by the DOH, fostered a new wave of investment in irrigation throughout the country. Within the study area, initiatives such as the construction of new canals and improvement of old ones, and improvement of the Cogotí dam were funded through this program. Figure 4 shows public investment in irrigation infrastructure in the Limarí River basin during this period.

Figure 4. DOH's investment in irrigation infrastructure within the Study Area 1987-2000 (in Thousand US Dollars)



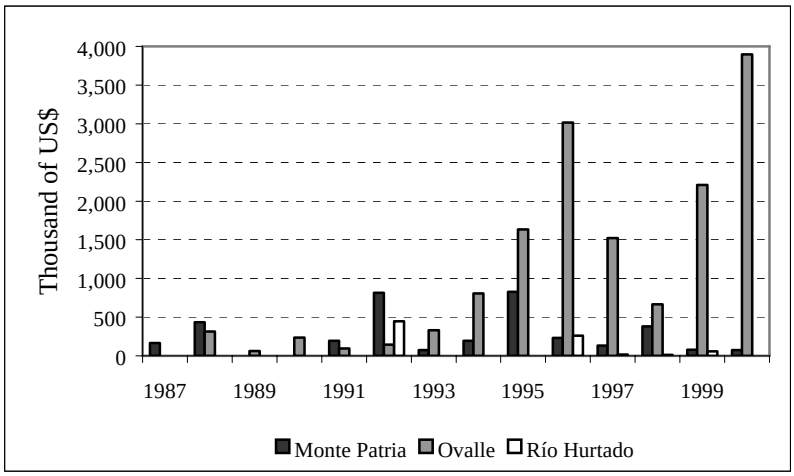
Source: Elaborated by the authors, based on the Region of Coquimbo's DOH Annual Reports

Law N° 18.450: Subsidies to Private Investment in Small-scale Irrigation and Drainage projects, administered by the National Commission for Irrigation (CNR).

This law was passed in 1986. It is aimed at increasing the area under irrigation and improving technical efficiency of water utilization and drainage. It also fosters connectivity of off-farm projects (ODEPA 2004). This instrument subsidizes up to 75 % of the total cost of irrigation projects. However, the total cost of individual projects may not exceed US$ 360.000 and for joint projects (two or more farmers) project costs may not exceed US$ 720.000 (Anguita, 1998).

The law was been amended in the mid 1990's so to keep the benefits to smaller farmers until 2009. To date, this subsidy has funded more than 600 projects in the Region of Coquimbo, and is considered as one of the most relevant instruments. Figure 5 shows the total investment through Law N° 18.450 in the study area since 1986.

Figure 5. Total investment through Law No. 18.450 by county within the Study Area, 1987-2000



Source: Elaborated by the authors based on non published National Commission for Irrigation data

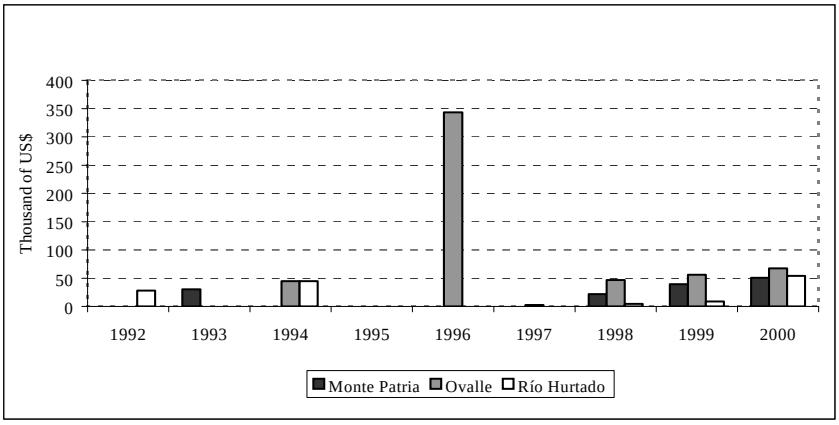
Peasant irrigation program (Programa Bono de Riego Campesino), administered by INDAP

This program is aimed at irrigating and draining new areas, and increasing irrigation security in areas irrigated by small projects that belong to peasants who own small parcels. It is a subsidy that can be used to acquire new and replace old equipment, and to build new and enlarge existing projects. It exists since 1991 and it focuses on small land-owners and projects under US$28,000 (INDAP 2003).

In 1997 this subsidy was modified to benefit individual and joint projects. In the latter case, the program subsidizes up to US$61,000 if it is an off-farm project exclusively, while it also

provides $4,600 per individual. If a project combines on- and off-farm elements, payments can total US$60,000 and $4,500 per individual for those off-farm components and $3,140 for on-farm elements (ODEPA, 2004). Figure 6 shows the total amounts invested through this program in the study area during 1992-2000.

Figure 6. Total investment in the Study Area, by county through the *Peasant Irrigation Program*, 1992-2000

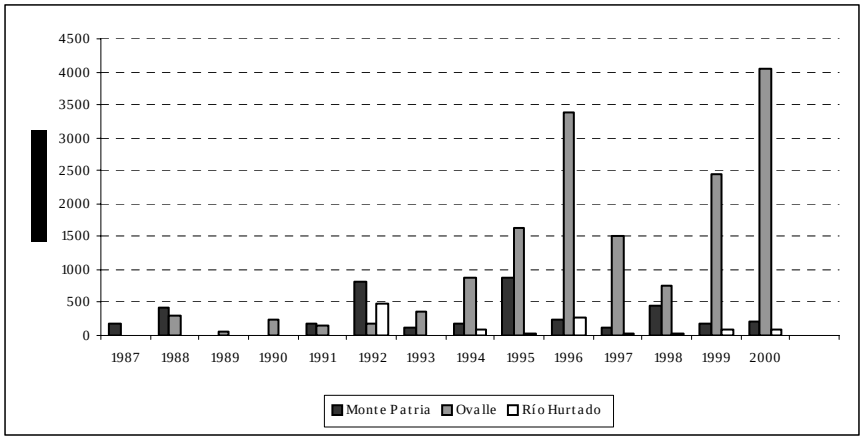


Source: Elaborated by the authors based on non published *INDAP* data

No projects were funded in the study area during 1995. The value for 1996 in the Ovalle County is high because 140 projects to build small reservoirs were funded. In 1997 all funds were diverted to mitigate drought impacts.

Total investment in the study area by the State during 1987-2000 through the different instruments is $21 millions, of which $16 million were used in Ovalle county, $4 million in Monte Patria, and $1million in Río Hurtado (Figure 7).

Figure 7. Total public investment in irrigation projects in Study Area, by county (1987-2000)



Source: Elaborated by the authors, based on Chile's government data

Public investment in technology transfer in the Limarí River basin

Regarding technology transfer, the National Institute for Agricultural Research (*Instituto Nacional de Investigación Agropecuaria, INIA*) has played a central role. Created in 1964, its main objective was the generation of technology. By 1975, this Institute handled 90% of the funds that the State provided for this issue, and acquired a network of experiment stations located throughout the country. Up to 1973, INIA transferred technology at no cost for the user. Since then, and due to neo-liberal reforms, private companies were supposed to be directly responsible for the technology they needed, and INIA received funding only for those areas where the private sector was considered not to be competitive. By 1989 public funding had been reduced to 40 % of the annual budget of previous years, which forced INIA to sell technology to the users.

Another technology transfer program was executed by the *INDAP*, focusing on smaller farmers. This program's objective was to promote technical and productive development through subsidies aimed at increasing farm production and productivity, and therefore income (INDAP 2003).

The following table shows the technology transfer programs in the Limarí River basin for 1993-2000 (table 8).

Table 8. Technology Transfer Programs in the Limarí River basin

Program	**Funding**	**Amount (Thousand US$)**	**Time frame**
Technology Validation and Transfer System, and Irrigated Productive Systems(applied in different regions of Chile)	Ministry of Agriculture	420	1993-1997
Technology Validation and Transfer System, and Irrigated Productive Systems on irrigated lands (applied in different regions of Chile)	Regional Government and National Commission for Irrigation	1.065	1997-2002
Irrigation Technology Transfer and Productive Options for the Río Hurtado and Punitaqui counties	Regional Government	345	1998-1999
Intra-farm Irrigation Systems Transfer Program	National Commission for Irrigation	196	1999-2001
Technical Assistance Program for Intra-farm Irrigation Projects	INDAP	27	2000

Source: Elaborated by the authors based on data provided by Dr Leoncio Martínez, Researcher at INIA Intihuasi, Region of Coquimbo

5. Agricultural activity in the Limarí River Basin

In order to illustrate the case of public policies as a key determinant of human security under climate variability/change conditions, this section shows the evolution of agricultural production in the drought-prone study area. As mentioned above, the rapid growth of private agriculture can be considered as the result of the structural adjustment programs starting in 1973 that included the implementation of open-market policies, the existence of water for irrigation and the provision of subsidies by the State.

Grapes (table, pisco[4], and wine) are the most important produce of the Limarí region. Of the regional fruit-producing hectareage, 47.0 % was planted with table grapes, 44.3 % with pisco grapes, and 8.6 % with wine grapes in 2000 (Table 9).

Table 9. Vineyard hectareage and number of holdings by grape type and location

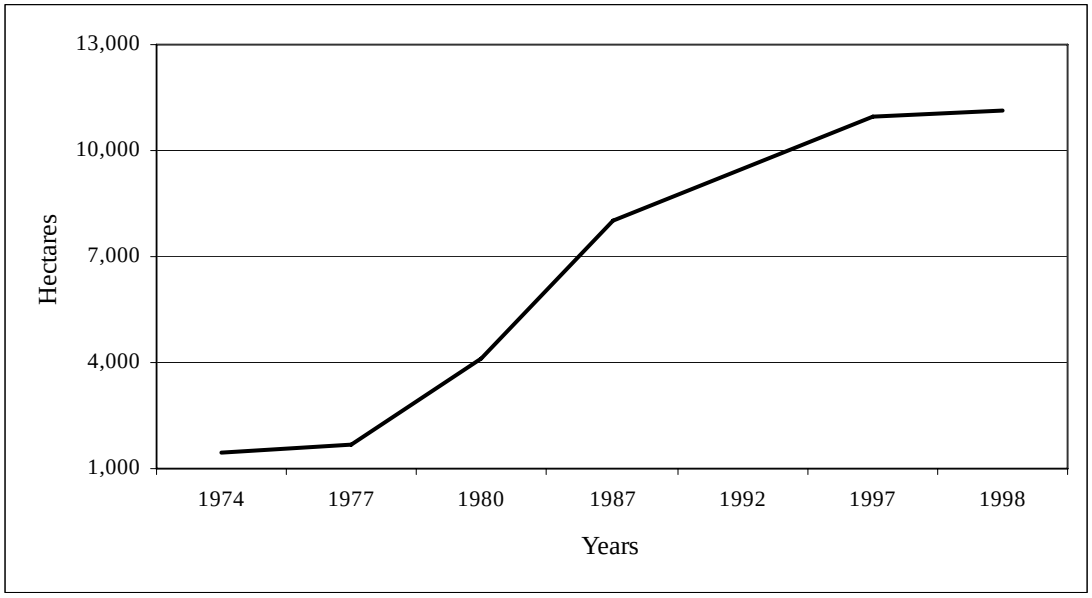
	Table Grapes (ha)	**No. holdings**	**Wine Grapes (ha)**	**No. holdings**	**Pisco Grapes (ha)**	**No. holdings**
Chile	50,818	n.a.	103,876	n.a.	10,016	n.a.
Region of Coquimbo	9,864	n.a.	1,804	n.a.	9,279	n.a.
Province of Limarí	7,041	550	1,340	172	5,875	1,486

n.a.: not available
Source: SAG, 2000.

The surface planted with table, wine, and pisco vineyards increased from around 1,500 ha in 1974 up to a maximum of 11,000 ha in 1997, at an average growth rate of about 400 ha per year. In 1998 the planted surface remained almost the same to that of 1997 (Figure 8). These figures correspond to the counties of Ovalle and Monte Patria, where most of the commercial agriculture takes place in the study area.

[4] A local brandy made of a mixture of specific grape cultivars.

Figure 3. Evolution of table, wine, and pisco vineyards in the municipalities of Ovalle and Monte Patria (in ha)



Source: modified from Bahamondes et al. (1994) and unpublished data provided to the author by Ricardo Vilches, from the SAG, Region of Coquimbo

The size of holdings that belong to producers of table grapes and pisco (data for wine producers was not available) tend to be rather small, especially among the pisco producers. For example, pisco grape producing farms tend to be very small, since 60 % of the holdings are 0-1 ha, as compared to 19% for table grapes growers. On the other hand, 4% of pisco holdings are larger than 20 ha, as compared to 13% among the table grape growers (calculated from Table 10).

Table 10. Number of grape growers by size (hectares) in the Region of Coquimbo

	Size of plot in hectares						
	0 - 1	**1.1 - 5**	**5.1 – 10**	**10.1 - 20**	**20.1 – 50**	**> 50**	**Total**
No. of Pisco Growers	215	70	35	19	9	6	354
No. of Table Grapes Growers	177	386	130	94	79	39	905

Source: SAG 2000.

The evolution of the grape-producing industry in the study area is important for several reasons. First, numerous producers are smallholders, especially those producing pisco grapes. These growers depend on the reliability of the system that provides them with irrigation water, and they would certainly not have planted unless they had a high degree of confidence on the

irrigation system in the basin. Moreover, due to the existence of the reservoirs in the study area, planting of new vineyards continued even during multi-year drought, as those occurred in 1973-74, 1988-90, and 1993-96.

Second, access to subsidies provided by the State has had a positive impact on this industry, which is the primary source of employment in the area (as stated by Schneider in 1982 and later by Soto in 2000). Subsidies have increased the technical and economic efficiency of water utilization, as they have allowed off- and on-farm small scale irrigation systems.

6. Land-owners' evaluation of public investment

A questionnaire was applied to large, medium, and small land-owners in three counties of the study area: Ovalle and Monte Patria, and Rio Hurtado, where agriculture is not so oriented to foreign markets as the two former counties. Among other issues, their perception regarding the effectiveness of public investment through different economic instruments was inquired.

Results show that 90.7% of the surveyed farmers declared to have improved the irrigation infrastructure in his property. Of these, 65.3% did it based exclusively on funding provided by the state, and 18.7% with a combination of their own and state funding. These figures are relatively similar when size of holding is considered. Hence, the public programs are equally distributed among different type of growers, and can therefore considered to be "democratically" distributed.

The public programs designed by the State to subsidize irrigation projects are generally well known by all type of producers (89.5% of producers knows at least one program). Likewise, 100% of the farmers have been a beneficiary of at least one of the programs outlined above. By contrast, only 46% know at least one technology transfer program. This shows that the State has given a high priority to irrigation, but not to training.

Producers were asked about changes in their economic condition between the 1980s and the present time. 74.4% is "better now than in the past." This percentage holds for different types of land holders. When asked if this improvement could be related to the existence of the dams, 63.8% answered yes. However, only 52% of the small holders answered positively, which can be explained because 27.5% of them does not have surface water rights and therefore have no relation to large irrigation infrastructure. 92% of the medium and large size farmers believe economic achievement is linked to the existence of the reservoirs.

An 80.4% of all farmers relate their own economic success to State initiatives promoting irrigation. Most of these respondents correspond to small- and large-scale farmers. The medium-scale farmers believe, however, that the State initiatives favour the other segments, especially the larger producers. The medium-scale producers tend to operate directly with private banks to obtain credits, because they are easier and faster to obtain.

7. Conclusions

In an area that is highly dependent on irrigated agriculture and is subject to recurrent droughts, and where precipitation has decreased over the last century, long-term irrigation policies have had an impact on society, increasing security of, possibly, all households depending on agriculture.

In present neo-liberal Chile, the State has played a central role in providing financial assistance to all type of individual producers (i.e. large, medium, small). In this sense, access to economic instruments that promote farm-level irrigation has been highly democratic. Moreover, financial resources transferred to the private sector represent a significant amount for the local economy, and democratic regimes, starting in 1990, have ensured access to subsidies to smaller producers.

The water-rights market may have decreased security of some families. These have been forced to sell the entirety or part of the water they were entitled to by their economic situation. Consequently, they now depend on the wage labor market for their subsistence.

Producers are highly satisfied with the role that the Chilean state has played in promoting irrigation, and they see it as related to their own economic success. This seems not to be so clear when it comes to technology transfer. Hence, there is still a gap to fill in terms of technology transfer and training.

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