Water Challenge Project

Integrating Governance and Modeling

Integrating Knowledge from Computational Modeling with Multistakeholder Governance Structures: Towards Better and More Secure Livelihoods Through Improved Tools for Integrated River Basin Management

Analysis of Governance Structures for Water Resources Management in the VIIth Region of Chile (Región del Maule)

Heidi Wittmer, Cristian Adasme, Jose Diaz, Regina Birner and Nancy McCarthy

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List of Abbreviations

CNR	Comisión Nacional de Riego
CRR	Comisión Regional de Riego
CRRH	Comisión Regional de Recursos Hídricos
CONAMA	Comisión Nacional del Medioambiente
DGA	Dirección General de Aguas
DOH	Dirección de Obras Hidráulicas
FNDR	Fondo Nacional de Desarrollo Regional
FOSIS	Fondo de Solidaridad e Inversión Social
MA model	Multi-agent model
INH	Instituto Nacional de Hidráulica
INDAP	Instituto Nacional de Desarrollo Agropecuario
PRODESAL	Proyecto de Desarrollo Agrícola Local
PRODECOP	Proyecto de Desarrollo de Comunas Pobre
SAG	Servicio Agrícola y Ganadero

1 Introduction

By making integrated simulation models available as decision-tools in multi-stakeholder governance systems, the project aims to contribute to the overall goal of managing land and water resources in river basins in a manner that is economically efficient, environmentally sustainable and socially acceptable. In order to make the model available to actual decision makers an understanding of governance structures in the water sector, i.e. how and by whom decisions on water issues are made, is essential. This serves two purposes, first it allows to identify who can influence water management and how and second potentially interested users for the model can thus be identified. The model will be adapted to be able to address the questions relevant to the decision makers and stakeholders. This process will take place within a collaborative research and learning framework. The present report constitutes a milestone in this process and consists of nine sections. Section 2 briefly introduces the most important definitions and concepts. Section 3 explains the methodology. Section 4 gives an overview on water legislation and policy as well as the actors and stakeholders involved at the national level. The research region, the VII or Maule Region, as well as the study area are presented in section 5. Section 6 presents the actors and section 7 the programs operating in the VII Region. Finally section 8 presents potentials and problems of water resource management and section 9 concludes.

2 Definitions and Concepts

2.1 Governance Structures

Governance

According to a widely used definition, governance can be understood as "... the exercise of economic, political, and administrative authority to manage a country's affairs at all levels. It comprises mechanisms, processes, and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations, and mediate their differences" (UNDP, 1997). This definition is applied here to a specific subject area - the use and management of water resources, and to a specific geographic area - a river sub-basin.

Institutions and organizations

The term "governance structures" is used here to describe the institutional and organizational dimensions of governance. Governance structures can be considered as the frame conditions that shape policy processes and govern the formulation, adoption and implementation of decisions, in this case related to water resources management. The term "institutions" can be defined as the "humanly devised constraints that structure human interaction. They are made up of formal constraints (rules, laws, constitutions), informal constraints (norms of behaviour, conventions and self-imposed codes of conduct), and their enforcement characteristics (North, 1991). The term formal implies a basis in formal modern law. Informal institutions may be based on customary law. For the purpose of analysis, it is useful to distinguish institutions from organizations. As North (1990) put it, institutions can be considered to be the rules of the game, and organizations the players. Organizations are characterized by

membership and roles assigned to the members. Like institutions, organizations may be formal or customary.

Sectors

For the analysis of governance structures, it is useful to distinguish three sectors: the public sector, the private sector, and a "third sector." The latter sector can also be referred to as a collective action sector, and it includes different types of organizations in civil society (compare Uphoff, 1986). Uphoff (1993) further specifies these three sectors. Governance structures may combine organizations from different sectors, as in case of a committee comprising public sector and third sector organizations.

Table 1: Types of Organizations in the Public, Private and Collective Action Sector

Public sector		**Collective action sector (Third sector)**			**Private sector**	
Government	Public administration	Membership organizations	Co-operatives	Service organizations	Private businesses	Farm households
Orientation of organizations						
political	bureaucratic	self-help (common interests)	self-help (resource pooling)	charitable (non-profit)	profit making	multiple goals (profit and non-profit)
Roles of individuals in relation to different kinds of organizations						
voters and constituents	citizens or subjects	members	members	clients or beneficiaries	customers or employees	family/ household members

Source: modified from Uphoff (1993:613)

Levels

For the analysis of governance structures, it is useful to distinguish different levels. With regard to water resources management, one needs to consider to overlapping classification systems. According to the political-administrative system, one can consider the following levels: the level of individuals, followed by the household and firm level, the community level, different tiers of local government, the regional level, the national level, and the international level. These levels intersect with the levels one can define according to water use and water management criteria: the level of the individual water users, the household level, the community of individuals or households using a joint infrastructure – or subsystem thereof - for drinking water or irrigation, sub-basins of rivers and finally river basins, which may also be internationally shared.

Stakeholders

All individuals and organizations who have an interest – or a stake – in the use and management of water resources can be considered as stakeholders. The terms "actors" or "interst groups" are also used to refer to the stakeholders. These terms, however, imply a certain level of organizaiton or the ability to take actions. The term stakeholder acknowledges that individuals or groups may have an interest in water resources management, but lack the incentives or capacity to organize themselves to pursue these interests.

Coordination Mechanisms

Three major coordination mechanisms – or modes of interaction - can be distinguished in the analysis of governance structures (compare Williamson, 1985):

1) Hierarchical coordination;
2) Market coordination; and
3) Co-operative or collaborative types of coordination.

The hierarchical type of coordination presupposes a power relationship, which may have an economic or a political basis. Organizations in the public sector typically rely on hierarchical coordination mechanisms. Business enterprises and non-profit service organizations usually have an internal hierarchical structure, but may enter into market types of exchange with each other. In membership organizations and cooperatives, co-operative types of coordination are most frequent. Identifying the coordination mechanisms established for the interaction of different types of organizations is an important aspect of analyzing governance. The three types of coordination can be considered as "ideal types". In reality, combinations of the three forms may play an important role.

2.2 Types of Decisions in Water Resources Management

Governance structures are important for decision-making and the implementation of decisions. With regard to water resources management, it is useful to distinguish two major types of decisions: (1) decisions on investment and maintenance of infrastructure, and (2) regulatory decisions regarding water use and water quality.

ad (1): To some extent, water resources can be used individually and without infrastructure investment (e.g., fetching water from rivers and streams). Beyond this level, however, the utilization of water resources – both for drinking water and for irrigation –requires investment in infrastructure – and the maintenance of this infrastructure. The infrastructure for irrigation and drinking water is usually used by groups of households or communities – which involves typical problems of collective action - and requires state or community investment and maintenance. A variety of institutional arrangements can be applied for the financing, provision and maintenance of water-related infrastructure, as the current debate on decentralization, devolution to user groups, contracting out to NGOs and the private sector shows. Hence, decision problems arise regarding the type of infrastructure to be invested in, and to the institutional arrangements regarding financing, provision and maintenance. The analysis of these institutional arrangements is an important aspect of analyzing governance structures for water resources management.

ad (2): The use of water resources involves various externalities, both with regard to water quality and quantity. The typical upstream-downstream problems, which appear at different scales - are an important example. Overuse of water resources may also affect water availability for future generations, thus causing negative externalities for them. Dealing with these externalities requires regulatory decisions. The authority for making these regulatory decisions may rest with different state and/or community organizations. Analyzing the way in which these regulatory decisions are made and implemented is an important dimension in the analysis of water-related governance structures.

2.3 Criteria for Assessing Governance Structures

Governance structures can be analyzed from a positive and a normative perspective. A positive analysis will focus on describing the existing governance structures and explain why water resources management is organized the way it is, considering historical and political factors. A normative analysis will assess the observed governance structures and their outcomes against a set of normative objectives. Selecting these objectives necessarily involves value judgements. Using the generally agreed principles of sustainable development, the following criteria can be considered:

(1) Economic criteria

- Efficiency in water use, taking the cost of infrastructure provision and maintenance into account
- Economic impact of water use

(2) Social criteria

- Distributional aspects – access of different groups of the population – including disadvantaged and marginalized groups; upstream and downstream users; present and future generations – to water for domestic and agricultural use

(3) Environmental criteria

- Sustainability of water use, considering quantity and water quality (pollution, aquatic biodiversity)

The present report focuses on a positive analysis of the water-related governance structures in the research region. Some reflections regarding the normative criteria will be presented. A quantitative analysis of the impact of existing governance structures with regard to these normative criteria is beyond this analysis.

3 Methodology

The methodology involved two general ways of getting the information necessary for the preliminary institutional analysis: the review of secondary sources as well as key informant interviews.

3.1 Review of secondary sources

The most important secondary sources of information that were compiled and analyzed are the following:

1) Reports and data on natural resource management from previous research in Chile were compiled and analyzed listing relevant projects with a brief summary of content

2) A matrix of governance issues containing information on governance problems at actor level and the type of problem (like information asymmetry, failure of coordination, etc.) was set up, which also served to identify relevant interview partners.

3) The process of giving out concessions for building water infrastructure including the legal procedure for the "*Convento Viejo*" Dam and other pilot sites as well as on the stakeholder involvement (official documents and press articles) was analyzed.

4) Plan Director de la Cuenca del Maule: The *Plan Director del Maule* (MOP, 2003) gathers all information related to water resources in the Maule basin, which comprises large parts of the study region (compare section 5). The value of the descriptive information found in the printed version is complemented by the complete GIS database included in the electronic version.

The objective of this plan is to provide the data necessary for planning water use in the basin and states objectives which have been generated from the needs detected in this area. The focus of the information is to support the decisions made in search of the "alleviation of some common needs with regard to the management of water resources, thus facilitating the coordination of efforts in the public and private sector".

Below, an overview of the contents of the *Plan Director* is provided. The *Plan Director* has an extension of approx. 500 pages and is divided into three volumes: Executive summary, Final Study and Addendum.

The Addendum is a complete database for the 12 sections of the main document: Subsequent to an introduction, chapter 2 provides an overview of the recompilation, analysis and synthesis of the technical information. The update of the Hydrologic Operational Simulation Model is at the core of chapter 3, followed by the Hydrogeology study itself. The document focuses on water demands in chapter 5, and on infrastructure and monitoring of water resources as well as water quality in the Rio Maule Basin in chapters 6 and 7, before turning to an evaluation of environmental aspects in chapter 8. The last chapters concentrate on the identification and analysis of policies and plans and provide for an analysis of the water market of the Maule Basin, and draw conclusions.

3.2 Semi-structured interviews with stakeholders

As a first step actors and potential clients of the Challenge Program (CP) project were contacted and informed about the project. Key informants were interviewed to provide information on the governmental as well as on other stakeholders at the different levels (i.e. national, regional local) and mandates. Finally both at the level of water user organizations as well as regional government offices the demand for information and/or scientific support was explored.

Key informants were interviewed in different contexts. The first consisted of two participatory workshops organized by the National Commission of Irrigation (CNR) and assembled almost all national representatives of the Water User Organizations (WUO). This setting provided for an excellent entrance to the field allowing for interactions with an important part of the stakeholders important for the Project. This first round of informal interviews provided a better understanding of the different levels of organizations as well as basic needs and conflicts currently present in the WUOs. (compare Report on Stakeholders' Needs and Priorities milestone June 05)

Based on this understanding a semi-structured interview guideline was developed and at least one directive in almost all second level WUOs in the basin was interviewed. The total number of interviews conducted at this level amounts to eight. A slightly modified guideline was used to interview directives and members of Water Communities (CAs); a total of sixteen interviews were conducted at this level. All interviews were registered in audio and digital media.

The representatives of the Water Users' Organization were asked to provide information along two major lines of questioning.

On the one hand, we collected basic information about the type, size and structure of the diverse organisations working in the region. The number of farmers participating in the programs, the area irrigated, and the amount of water administered were supplemented by an overview on major crops, the type of irrigation system used as well as information on water trade and rights. On the other hand, we directed our interest toward the specific understanding of the water theme – organisational visions, projects planned in irrigation and other areas. To frame the perception of the discourse, we divided it into questions on main problems and conflicts encountered, investment projects received and needed, experiences in modelling and participatory planning. Moreover, representatives were interviewed concerning their experiences with participation and modeling approaches.

3.3 Collaborative Research and Learning Framework for Modeling

In order to reach the project's objective of making the models developed available for stakeholders use a collaborative research and learning framework will be established. Collaborative Research and Learning Framework

The main goal of the research project is to develop a modeling system that is of practical use for decision makers faced with the collective action problems identified above. An important prerequisite for being able to provide decision support in practical planning processes is to reach a state in which the different stakeholders have trust in the model and its simulation results. The Multi-agent Model (MA model) has a distinctive feature that facilitates trust building. Since the model depicts specific agents, it is easier for model users to identify themselves with these agents and the way in which their behavior is modeled than to understand or trust a set of differential equations.

In this project a collaborative research and learning framework is being set up to provide a platform where the MA model can be developed jointly with those interested in using it. This approach is expected to promote ownership and build trust in the model. The joint development has three objectives: (1) to improve the quality of information used to set up and parameterize the model, (2) to ensure that the relevant questions and criteria can be addressed with the model as well as to identify relevant and feasible policy options and (3) to provide decision makers with access to the model which ideally includes training them to use it.

In order to identify the most appropriate counterpart institution for this joint development, an analysis of the existing governance structures involved in irrigated water use and management was conducted as a first step of the research project. Using information from the governance structure analysis, a stakeholder needs and priorities analysis was undertaken, to ensure that the interests of various stakeholders will be captured by the MA model. Additional economic and institutional data required to generate parameters to baseline the model are being collected by means of a household survey, a survey at the level of the leaders of the water user associations, focus group interviews within the communities, and key informant and expert interviews at these and higher levels.

Box 1: Steps in the collaborative research and learning framework

Step 1: **First round contacts, introductions**

Inform stakeholders, contribute to understanding governance structures

Step 2: **Demonstrations of the model**

Elicit feed-back on problems, needs and potential solutions and evaluation criteria (use cases, scenarios); may involve another workshop

Step 3: **Organizing feed-back, esp. regarding front-end**

More workshops and evaluation of workshops, may also involve smaller working groups/interviews

Step 4: **Practical use of the model by stakeholders**

Identification of people who to train, training - training version of the model

Step 5: **Monitoring/evaluating the use of models by stakeholders**

Establishing the use potential of the model

4 Water Resource Policy and Legislation in Chile

Water Regulation in Chile has a history of almost 200 years. After an overview on the historical development, this chapter will present the most important current legislation, the Water Code, which is the legislation that fixes the norms, concepts and procedures on rights of utilization and exploitation of the water. National water policy can be characterized by several programs by which the state subsidizes the construction and maintenance of water infrastructure, some of them specifically oriented towards certain sectors of the population. After presenting these, this chapter will also describe the different actors at the national level.

4.1 Historical Development

In 1819 the first text which regulates the water utilization appeared. It was enacted as a Supreme Decree defining the rights of an irrigator concerning the establishment and management of infrastructure to capture water. The Civil Code came into effect in 1857. It established the first general regulation of water resources. In addition, the rivers and all naturally flowing waters are defined as National Public Goods. We must highlight that this code regulates the access to the water, which must be conceded by the responsible authority. Moreover, it established the water will be rationed and used by turns during dryer periods.

In 1951, Law Nº 9.909, which contains the first Code of Waters, was passed. This code maintains that water is a National Public Good while adding the concept of "Water Exploitation Right" (*Derechos de Aprovechamiento del Agua*), which is conceded at the mercy of the President of Chile.

In this Code, the law defines a list of priorities for water uses according to the political interest of developing the different sectors concerned. The order of priority

was: water for drinking, domestic use, followed by water use for railroads, irrigation, generators of motive force, industry, mills and others. If there was competition in the same category, the pertinent authority chose the company they considered more important based on the criteria of pertinent administrative head in charge.

The Agrarian Reform introduced modifications through the Law Nº 16.640, which ended in a new Code of Waters in 1967. Due to centralizing political context, this Code reinforces the concept of the waters like public domain and it changes the legal nature of the Exploitation Right, giving to this one the character of an Administrative Real Right, where the State grants the use of the National Goods subject to norms of Public Right. In consequence, the State grants use rights for the water, but never confers complete property rights, since the water remains property of the Chilean State. Use rights become rescindable; the respective administration can reallocate them subject to a planning process applying a "rational and beneficial use rate".

In 1979 the Ordinance Law Nº 2.603 was released, and gave faculty to the President to dictate general norms. This Law emphasized the free market, which then provided the base for the Water Code of 1981. The main idea was that the Water Code of 1967 was incompatible with private land markets, as they functioned during this period. This law strengthened the Property Right on water and separated the Water Right from the possession of the land while permitting its free trade (purchase and sale). Also, the Law reestablished the registration system of Water Rights in the "Conservador de Bienes Raíces" registry.

The Constitution of 1980, by means of the article 19 Nº24, established that the granted rights are of the users' property.

4.2 Current Water Legislation

In 1981 the Ordinance with Force of Law Nº1.122 containing the current "Codigo de Aguas" (Water Code) appeared in the Official Newspaper. The Water Code defines the concepts and procedures on rights of utilization, and grants the General Direction of Waters, *Direccion General de Aguas*, DGA all the functions that the code includes specifically to veil that water capture and use procedures stipulated in the law are enforced correctly.

The new norm maintains the character of national good of public use of the waters and it grants the tenants the use right. In addition, the Water Code of 1981 concedes a total and permanent freedom for using water to which someone has a right, enabling the holders of the water rights, among other things: (1) to use them or not, and to dedicate them to the purposes or use types that they want; (2) to transfer them, separate from the land, to use them in any other place; and (3) to trade them through typical negotiations of the market (to sell, to rent, to mortgage, etc.). All concessions are granted with few and weak regulatory norms: (1) the DGA has very limited abilities and is forced to grant rights to new plaintiffs under the condition that the application is legally reasonable, it is established technically that resources of available waters exist and the rights of third persons are not affected; (2) the holders of rights are not forced to use the flows that have been assigned to them, neither to build infrastructure, and they are not subject to any tax, tariffs or collection for the ownership of the right or the use of the waters; (3) there are no priorities nor preferences to assign the use of the water, neither expressed norms on ecological requirements; (4) the transfer, transmission and acquisition or loss of water rights are

regulated by the Civil Code, and (5) the possession of use rights cannot extinguish but for the causes and in the form settled in the common right.

Analyzing the Water code of Chile, Bauer (1995), emphasized the creation of non-consumptive use as a new type of water right, nevertheless, few rules are established on how they might be exercised. It points out that the non-consumptive rights can not harm the existing consumptive rights, but the ambiguity arises when it is necessary to define which of both have priority in case of conflict. Nothing is established regarding the handling of reservoirs of potential multiple use.

These regulations produced a considerable discussion in Chile and after several years the Water Code was reformed by the Law Nº 20.017 of 2005.

The reformation points to that the waters are available for those who have projects to use them. Also to improve the mechanism of assignment of their rights, favouring the competition and eliminating the generation of entrance barriers to new interested parties, a tax can be applied in case water rights are not used. When applying for the assignment of new rights the application has to justify the actually required water flows; the protection of the environment associated to the water resources; the strengthening of the users' organizations and new attributions to the authority to carry out a better administration of the resource.

4.3 National Water Resource Policy

4.3.1 Establishment of a water market; liberalization

The current legislation has established the market as main form of co-ordination mechanism (compare section 2.1). The underlying assumption is that the market efficiently assigns the water and that the system of prices should reflect the scarcity and opportunity cost of this resource. To this end, it is allowed that the rights of water utilization are traded freely between the interested parts; the property of them is assigned to perpetuity; its transfer is neither bound to a specific use, a justification of the request nor requires permission by the respective authority either. Finally, when more than one interested part exists, the law arranges that the water right is available to be bid between both.

In summary water resource policy in Chile assigns water rights to individual users who can trade these freely. The objective of this policy is to establish suitable incentives in order that the market operates freely and leads to the efficient allocation of water. The only restrictions on water use consist in the fact that the utilization of the resource must be done in a sustainable way as well as assuring the protection of the associated environment. Water is considered an economic good and because of that, the juridical and economic system -that regulates its use- must assure that it is used efficiently by the individuals and by Society.

4.3.2 Concessions

A new trend in water resource management is the privatization of large-scale infrastructure development in form of concessions.

According to the Law of Concessions (1991), it is possible to concede the development of large scale infrastructure to private enterprises by means of concessions. The first experience with issuing an invitation to tender for such concessions is the "*Embalse Illapel*" (Illapel Dam or "*El Bato*") in the IV Region of

Chile. The invitation opened in 2001 and the concession was given to a private firm that has, however, due to internal financial problems given it back, so the concession will enter tender again in the near future. This infrastructure is subsidized to 75% by the state, with the aim of lowering the price of each cubic meter calculated by the concession company (Chileriego, 2001). Recently, the process of transferring existing infrastructure to water user groups also gained speed. A pre-requisite to these transfers is the legalization of the *Comunidades de Agua*, which is now extensively being promoted by CNR and DGA. There is no general rule on how to transfer infrastructure and how to share the costs. Depending on the socio-economic circumstances and other externalities, infrastructure can be completely transferred without any cost for the concession holder. In other cases, water user groups are asked to refinance the state-built infrastructure to at least a certain share, which may explain why user groups are often reluctant to these transfers, especially when rather old and poor infrastructure is to be assigned.

The water infrastructure privatizations and the concessions program for water treatment services have also captured important inflows from international funds as foreign direct investment in recent years.

(please see: http://www.foreigninvestment.cl/fdi_inchile/fdi_inchile.asp).

4.3.3 Law Nº 19300.94 ("Ley del Medioambiente")

The law for the Basis of the Environment (LBGMA), which is in effect since March 9, 1994, allowed to create the *Comisión Nacional del Medioambiente* (CONAMA), and with it, the environmental institutionalism. The Law 19.300 recognizes the legal and technical competence in the different sectorial services of the government and the need to coordinate the environmental joint management with each of them.

4.3.4 Support programs to improve irrigation infrastructure

Law 18.450 (Ley de Fomento al Riego, Nº 18.450)

The Law Nº 18.450, "Promotion of the Private Investment in Irrigation and Drainage Infrastructure", in effect since 1985, has been administered by the Executive Secretary of the National Commission of Irrigation (CNR) which, under the regulations established in it and its modifications, supervises the development of the Program of minor infrastructure and of irrigation at the field level, in coordination with the rest of the institutions belonging to the water sector.

In 1989, only 2% of the resources in Law Nº 18.450 were assigned to small producers. Today this number comes to 50%, through a strategic alliance between the Executive Secretary of the CNR and the *Instituto Nacional de Desarrollo Agropecuario* (INDAP), benefiting, during the decade 1990-2000, more than 1.600 projects of small farmers, favoring 58.000 rural families (www.indap.cl).

The Ley de fomento al riego, provides funding to the improvement of the irrigation infrastructure. Each year programmes and the amount of funding are defined for certain regions and specific target groups. User organisations or individual users can present projects and can receive up to 75% of the costs in subsidies. The most important programme is administered by the CNR and provided a total amount of US$ 45,000,000 at the national level. Approximately one third of these funds were spent in the seventh, eighth, ninth and tenth regions in 2003 for subsidizing the improvement of irrigation infrastructure (www.odepa.gob.cl/servicios-informacion/Instrumentos/fichas/f-30.html).

4.3.5 Special programs for the poor

Requirements for applying for the above mentioned support programs exclude a considerable amount of agricultural producers who do not hold sufficient land, registered water rights or economic means to finance the counterpart funds. In order to support the economic transformation and the modernization of the small family-run farms the Chilean state has therefore designed specific programs targeting poorer producers and communities. The target population for such programs is defined based on the results of CASEN[1] survey from 2000.

Such programs are financed and carried out through:

- the Institute for Agricultural Development INDAP (Instituto de Desarrollo Agropecuario)
- the office for agrarian studies ODEPA (Oficina de Estudios y Política Agraria),
- specific programs from the National Commission of Irrigation from the Ministry of Agriculture, and
- other programs designed for specific segments of the population (compare FOSIS below).

These programs consider instruments that promote and motivate the implementation and improvement of the irrigation systems in order to increase the irrigated surfaces and thereby to increase the production. Measures supported by these programs include the improvement of the existing infrastructure, the construction of new irrigation and drainage infrastructure, as well as the support of user's organizations to efficiently administer irrigation water use.

CNR Program

The CNR finances all subsidies for the off-farm irrigation infrastructure. It also runs a special Program for Developing Irrigation in Communities with Problems of Unemployment and Poverty: This is a complementary program for developing irrigation in Communities considered to be poor. These communities should accomplish the requirements established by at least one of the following programs.

- Ley de fomento al riego, Nº 18.450;
- Bonificación al Riego del Instituto de Desarrollo Agropecuario, INDAP, and/or
- Comisión Nacional de Desarrollo Indígena, CONADI;

The INDAP programs will be described in more detail in section 6.

CONADI has its own programme by which the indigenous population can apply for support. These programmes include support for irrigation infrastructure. The requirements for application are less strict in terms of minimum land holding, water right registration and the studies that need to be provided in order to apply for support. This kind of program is justified by the fact that a large proportion of indigenous

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[1] CASEN stands for Encuesta de Caracterización Socioeconómica Nacional and is a survey to identify population in need of special assistance it defines poor population by insufficient income to satisfy basic needs, and indigent population by insufficient income to buy food.

(please see: www.chileriego.cl/comunas_pobres.htm)

communities do not qualify to apply for projects through the Ley de Riego. Its target group and requirements are comparable to programmes by Prodecop (compare section 6) which, however does not operate in the entire country.

***Fondo de Inversion Social*, FOSIS** (Fund for social investment)

Additionally to the programs mentioned above programs for poverty alleviation such as FOSIS can support irrigation related projects. FOSIS is a public service, represented in all regions in Chile. It was created in 1990 and administratively depends on the Ministry of Planning and Cooperation, MIDEPLAN. FOSIS finances - entirely or partly - plans, programs, projects and special activities of development that contribute to the alleviation of poverty in Chile. These actions must solve problems of income, improve the quality of life and/or help to strengthen the capacities of the population with the highest unmet needs from communities and territories prioritized based on the high concentration of poverty and/or other indexes of social exclusion. The population eligible to this program has even lower incomes than those targeted by the programs mentioned above and there is no requirement that most of the family income must come from agriculture.

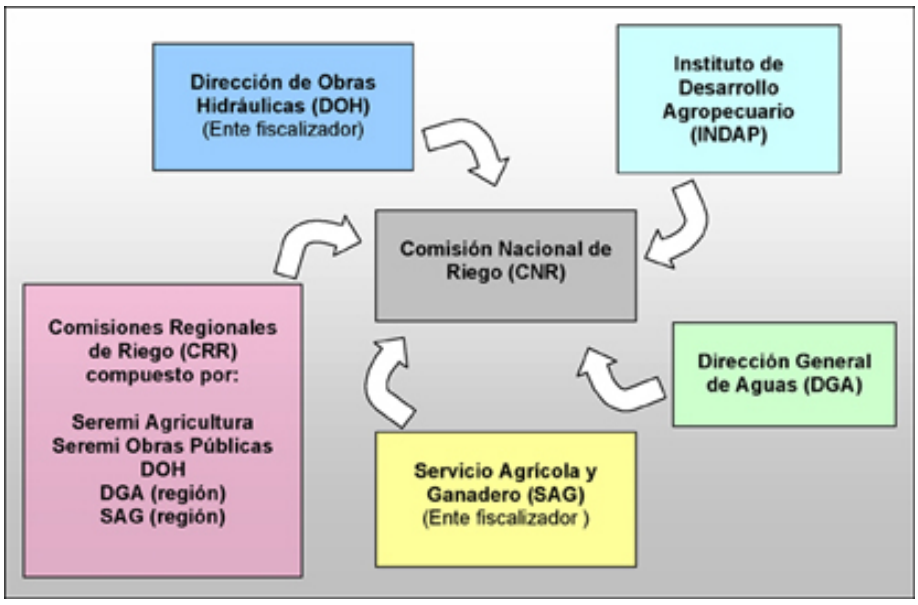
There is no a particular program for irrigation or water resources, but since FOSIS must coordinate with the *Fondo Nacional de Desarrollo Regional* (FNDR, National Fund for Regional Development), it indirectly supports those projects that involve irrigation and drinking water improvement.

4.4 State Organizations at the National Level

4.4.1 Overview

Figure 1 shows that there are several state organizations involved in water policy. At the center stands the National Commission for irrigation (CNR) who coordinates all irrigation related measures. All the other State organizations and their functions are described below.

Figure 1: State organizations in charge of irrigation



4.4.2 National Commission of Irrigation *(CNR)*

The *Comisión Nacional de Riego*, CNR is responsible for coordinating all irrigation related matters and the organizations responsible for them (compare Figure 1). It is a public organization that is related to the Government through the Department of Agriculture, which takes as a mission "to coordinate the formulation and materialization of the national politics of irrigation, for the good utilization of the water resources of the country emphasizing in irrigation and drainage".

At the regional level, the CNR is represented by the representative of the agricultural ministry, who heads the *Comisión Regional de Riego* (CRR) that supervises the application of the irrigation law (*Ley de Riego* 18.450) at the regional level. The state supplies considerable funds to the irrigation sector for infrastructure development through different funding programs (compare above). As a general rule, users contribute 30% of investment costs. In principle, funds in all programs are attributed according to a competition process, which implies that the potential beneficiaries have to present projects to the state agencies in charge. These agencies evaluate the proposals according to the criteria specified for the relevant program. The final decision on these proposals is made by the *Comisión Nacional de Riego* (CNR). The function of CRR is to collect the proposal from the region and to present them to CNR at the national level. With regard to the realization of the projects, the regional CNR representative pays the subsidies once SAG and DOH have received the works. (Compare below and section 5.1).

The CNR is a centralized service that acts by delegation of functions - for the application of the Law of Promotion of Irrigation (Ley de Riego) - to the Direction of Hydrological Works (DOH) in the Ministry of Public Infrastructure (MOP) and to the Agricultural and Cattle Service (SAG) in the Department of Agriculture. Every National Director of these services delegates his faculties to the Regional Directors (in total, they add up to 26 regional offices). Also there exist faculties delegated to the Regional Commissions of Irrigation (13 commissions).

The central level decides on irrigation policies such as a) focusing efforts on the especially vulnerable producers or marginal areas; b) supporting private investment by programs for subsidies and c) evaluate the technical and economic feasibility of irrigation infrastructure.

4.4.3 General Direction of Water (DGA)

Within the public sector (compare figure 2), there are two units belonging to the Ministry of Public Works (*Ministerio de Obras Públicas*) responsible for water management: The *Direccion General de Aguas* (DGA) and the *Dirección de Obras Hidraulicas* (DOH). DGA is in charge of registration of water rights and water user organizations and in charge of operating a measurement system for water flow. The DGA has as functions:

- To register water user rights;
- to plan the development of the water resource in the natural sources, in order to formulate recommendations for its utilization;
- to investigate and to measure the resource and to provide and to publish the corresponding information;

- to coordinate the research programs that corresponds to the entities of the public sector, as well as of the private entities that use public funds for these works;
- to exercise the surveillance of the waters in the natural riverbeds of public use and the surveillance of works in the riverbeds in order to prevent that infrastructure modifying or destroying the natural riverbeds is constructed without the corresponding authorization;
- to monitor the functioning of the *Juntas de Vigilancia* (compare section 5.2.1), in agreement with the Water code.

4.4.4 Direction of Hydrologic Works (DOH)

The *Direccion de Obras Hydraulicas* DOH is the technical counterpart in charge of the development of hydrological infrastructure and of the maintenance of large-scale infrastructure such as reservoirs and bridges. Both entities, DGA and DOH, form part of the *Comisión Nacional de Riego* (CNR). The Ministry of Public Infrastructure (MOP) plans and constructs irrigation infrastructure. DOH is the technical unit of the ministry with regard to irrigation. Its main functions are:

The study, projection, construction, repairing and development of works of irrigation that are done by fiscal funds, in accordance with the dispositions of the Decree-Law N° 1.123/81.

4.4.5 National Hydrological Institute (IHN)

The *Instituto Nacional Hydraulico*, INH is an organization in charge of applied hydrological research. This organization gives directions to the National level about knowledge and requirements for optimizing the use of water resources. In the future, the IHN must become the organization where the public and private sector can address any type of consultation related to water resource and to the development of hydrologic infrastructure. In this sense, this organization is a technical institution in charge of information management on hydrologic, marine, and sanitary works, obtaining and centralizing information useful for future hydrological projects. Equally the responsibility for calibrating instruments and hydrological machines lies with IHN and they act as referee or expert in hydrological matters.

4.4.6 Institute of Agricultural Development (INDAP)

The Instituto Nacional de Desarrollo Agropecuario, INDAP, was created in 1962 and its principal objective is to foment and to promote the development of the small agriculture. It is a public decentralized organism, of indefinite duration, with juridical personality and own patrimony, with full aptitude to acquire, to exercise rights and to control obligations, under the surveillance of the President of the Republic, through the Ministry of Agriculture.

INDAP supports peasant irrigation through specific programs that will be presented in more detail in section 7.

4.4.7 Agriculture and Livestock Service (SAG)

The *Servicio Agrícola y Ganadero*, SAG, contributes to the productive development and to the improvement of the competitiveness of the national agricultural, livestock and forest sector, through the policies of sanitary regulations, animal health, renewable natural resources and food quality. SAG receives the irrigation infrastructure subsidized by the state from the contractors and checks its technical quality. They also certify water quality, which is necessary to fulfil 'Good agricultural practise' a set of quality standards required for export to EU and US markets.

4.4.8 Nacional Forestry Corporation (CONAF)

The function of the *Corporación nacional forestal,* CONAF, follows two lines of action:

- To achieve that peasants and farmers see the forest activity as a productive profitable option, to optimize the marketing and industrialization of maximum value added for the forest sector.
- To recover and to protect the natural patrimony of Chile, minimizing the deterioration of the forest ecosystems.

CONAF is in charge of assuring water capture in the upper watersheds. To this end it develops conservation plans including erosion control. These plans involve technical measures such as dikes, and ditches but also protective forest plantations along riverbeds. With regard to wetlands CONAF veils that they are not deteriorated by human actions.

4.4.9 National Corporation for the Environment (CONAMA)

CONAMA, *Comision nacional del medio ambiente,* is the public institution whose mission is to promote the environmental sustainability of the development process and to coordinate the actions derived from the policies and strategies defined by the government in environmental matters. With regard to water CONAMA has three functions: It revises the environmental impact assessment that needs to be made for every new industrial project, especially concerning potential emision of industrial residuals. If residuals are detected, CONAMA can fine the respective company in extreme cases it can shut the factory down. The second function consists in monitoring the quality of wastewater and if it surpasses the legal limits CONAMA is in charge of taking the pertinent legal actions. The third function refers to the diffuse emissions from agricultural or forest activities, where again CONAMA is in charge of taking legal actions should the quality of water returning from agriculture to the natural water system not comply with the legal quality standards.

4.5 Private Sector Organizations at the national level

4.5.1 Water Users' Organisations

The highest level of water user association in Chile is the Federation of Chanelists, *Federación de canalistas de Chile*, unites all higher level water users associations such as *Juntas de Vigilancias* and *Asociaciones de Canalistas* (compare below). It does, however, not have any weight or lobby power in public decisions. In fact, they were excluded from the last meetings in relation to the modification to the Water Code. At the subnational level there are up to three further levels of organizations, the *Juntas de Vigilancia* (Watch Committees), the *Asociación de Canalistas* (Canal Associations) and at the lowest local level individual users are organized in

Comunidades de Agua (Water Communities). These organizations will be described in more detail in section 6.2.

4.5.2 Hydro-power plants

Chile's electricity generation relies mainly on hydropower and natural gas imported from Argentina. Starting in 1978 the state of Chile began privatizing its electricity generation, transmission and distribution. Currently 86% of power generation is privatized and 14% comes from Colbún, the main company remaining in the state sector. Colbún generates hydropower from two dams located in the 7th Region (compare section 5.3 and 6.3.1).

National policy gives priority to hydropower generation, and since its use in non-consumptive it is not considered to create problems for irrigation. The main conflict between hydropower generation and irrigation, however, occurs in the summer months February and March, when hydropower companies want to maintain high levels in the dams and release the water constantly whereas downstream irrigation users need higher water quantities due to increased plant water demand in last part of the growing season.

In the process of privatization of hydropower generation, the private companies have negotiated water flow securities that in some areas have led to closing irrigation channels using and thus deviating water upstream of the dams. The state has partially tried to compensate these disadvantages by subsidizing infrastructure development as described in section 4.3.4 ff.

Both increasing demand for electricity by different industrial sectors and recent announcements by Argentina a mayor supplier of natural gas to reduce these supplies due to increases in domestic demand have increased the necessity to increase hydropower generation as well as the lobbying power of the electricity industry.

4.5.3 Consultancies

Consultants operate as individuals and/or firms to develop projects regarding irrigation improvement and repairing of infrastructure. In the system of state subsidized programs, private consultancies play an important role because they formulate the technical dimension of the proposed projects. There are just a few companies in the region specialized in irrigation, most of the consultants work on irrigation projects in addition to agricultural production extension.

Usually, the firms that work with other than small projects correspond to small construction companies that operate with specialized professionals who are registered in the CNR and/or INDAP directory. The registration is a prerequisite for operating funds from the Ley de Riego. The fact that all consultants need to be registered and all projects need to be approved by SAG and/or DOH seems to assure quality control and competitive prices since companies can loose not only their reputation but also their registration should irregularities occur.

4.5.4 Non-Governmental Organizations

Most of the NGOs created in the period of the 70 and 80's, working with foreign funds, have become consultants for using public funds. As any other consultant, they have to be registered in a directory of service providers in the respective institution,

There is currently no NGO specialized in the field of water use, irrigation is a complementary service. One of the NGOs interviewed (SUR Ltda.) appears in the INDAP directory just like any other consultant, with a broad set of services offered for small agriculture.

4.5.5 Donor Organisations and Development Projects

When democracy was recovered at the beginning of the 90s, most of the international donors stopped their funding activities in the country. A considerable amount of large scale water infrastructure is financed by World Bank loans, channelled through the Ministerio de Obras Públicas (MOP). These loans do not imply that the World Bank is involved in national water policy.

5 Profile of the Maule Region

The Maule Region (VII Region) is bounded to the North by the Sixth Region, del Libertador General Bernardo O'Higgins, to the South by the Eighth Region, del Biobío, to the East by Argentina, and to the West by the Pacific Ocean. The extension of this region is between 34º 41' and 36º 33' southern latitude, and from 70º 20' western longitude to the Pacific Ocean. The total area comprises 30,296.1 km^2.

5.1 The Political Administration of the VIIth Región

The Region is divided into four Provinces with subdivisions of a total of 30 communities. The regional capital is the City of Talca. Shown below is the general distribution of the communities in the Provinces: Curicó (capital: Curicó) with nine communities, Talca (capital: Talca) with ten communities, Linares (capital: Linares) with eight communities, and Cauquenes (capital: Cauquenes) with three communities. (Also compare mapa politico below).

The study area of this project includes the eight communities from Linares province (i.e. Yerbas Buenas, Longaví, Retiro, Parral, Colbún, San Javier, Linares y Villa Alegre).

5.2 Geography

In the Maule Region, four geographical zones are defined:

1) *Andes Mountains*: The average height of this mountain system in the region is around 2.500 m. although some mountains reach more than 4.000 meters above sea level, i.e. the Peteroa Volcano (4.101), and the Planchón (4.023 m).

2) *Central Valley*: Located between the Andes and the Coastal Mountains, it is a smooth valley consisting of ancient volcano stones, molded by glacial and fluvial activity.

3) *The Coastal Mountains*: This mountain chain extends from the Sixth Region with heights of up to 900 m.

4) *Coastal Plains*: Characteristic of the regional coast, the plains were produced by the penetrations of the Coastal Mountains. (Also compare map below).

5.3 Hydrology

The Maule Region is characterized by two big basins: The Mataquito river basin to the North (6,200 km^2), and the Maule river basin (20,600 km^2), which gives the name to the region. In both basins rivers originate in the Andes and discharge into the Pacific Ocean after running for approximately 250 km.

The Maule basin contains eight hydropower plants and two dams that constitute the Colbún system.

5.4 Climate

The predominant climate in the Region is of the dry Mediterranean type, with variation depending on latitude and longitude. Hence, four types of climate can be defined:

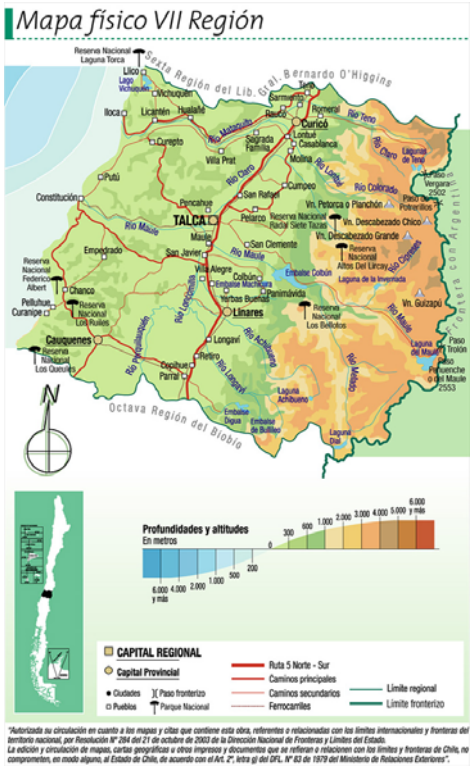
The Eastern Region, corresponding to the heights of the Andes Mountains, has heavy snow in the winter and abundant precipitations (1,700 to 1,800 mm).

The pre-mountain Region has a temperate climate, warmer than the Eastern Region, with five months of drought. Precipitations are less than in the Eastern Region and the winter and spring freeze limit agricultural activity.

The Intermediate Region enjoys a temperate climate with a long warm season lasting for more than six months, with the possibility of freezing during the winter time. Precipitations are caused by rainfall and occur principally from June to August.

The Coastal Region (as well as the west part of the Coastal chain), has a warm climate with homogenous temperatures due to the influence of the Pacific Ocean. Although the dry season is long, there is high relative moisture (more than 80%) due to the same maritime effect that decreases the stress to the vegetation.

Figure 2: Physical and Administrative Maps of the VII Region



5.5 Population

Table 2 shows the percentages of the population below the lines of poverty and indigency as defined by the CASEN study. Poverty in Chile is defined by the costs to meet basic needs. If income is not enough to meet basic needs a person is considered poor; if the income is not enough to buy sufficient food[2] a person is considered indigent. The table contains the communities with the highest poverty levels in the 7th Region. The total proportion of 25.3% the population living in poverty in the 7th region is higher than the national average of 20.6%. Within in the region the province of Linares, which comprises in the study region, has one of the highest indices of poverty with 29.1 Poverty in concentrated especially in the communities of Parral and Retiro. The other communities in the table show the most extreme examples of poverty in the 7th region. From first survey results at the level of the presidents of the comunidades de agua in the Rio Longavi basin, it becomes clear that a considerable amount of the rural population (in a little less than half of the comunidades de agua an average of approximately one third of the families) do not possess land and water rights to cultivate apart from the plots their houses are build on. Many of these families work as seasonal labourers in agriculture.

The study area, the province of Linares, is one of the poorest provinces with total poverty levels

Table 2: Population and Poverty in the 7th Region: Communities with the highest levels of Poverty

REGION, PROVINCE, *AND COMMUNITY*	***Indigent***		***Poor not indigent***		***Total Poor***		***Not Poor***		***Total***	
	#	***%***	***#***	***%***	***#***	***%***	***#***	***%***	***#***	***%***
VII REGION	***60.303***	***6,7***	***167.175***	***18,6***	***227.478***	***25,3***	***671.394***	***74,7***	***898.872***	***100,***
SAN CLEMENTE	*5.074*	*13,7*	*9.510*	*25,7*	*14.584*	*39,4*	*22.430*	*60,6*	*37.014*	*100,*
EMPEDRADO	*483*	*10,8*	*1.729*	*38,6*	*2.213*	*49,4*	*2.264*	*50,6*	*4.476*	*100,*
CONSTITUCION	*3.441*	*7,3*	*13.254*	*28,1*	*16.695*	*35,4*	*30.503*	*64,6*	*47.198*	*100,*
CUREPTO	*1.454*	*12,5*	*2.624*	*22,6*	*4.078*	*35,1*	*7.536*	*64,9*	*11.615*	*100,*
PROVINCE OF LINARES	***24.470***	***9,4***	***51.238***	***19,7***	***75.708***	***29,1***	***184.866***	***70,9***	***260.574***	***100,***
PARRAL	*3.141*	*7,9*	*11.089*	*27,9*	*14.229*	*35,9*	*25.457*	*64,1*	*39.687*	*100,*
RETIRO	*2.093*	*10,7*	*5.226*	*26,6*	*7.319*	*37,3*	*12.296*	*62,7*	*19.615*	*100,*

Source: Adapted from CNR 2003, with data from MIDEPLAN, División Social, Departamento de Información Social, Encuesta CASEN 2000.

[2] According to caloric requirements defined by CEPAL (Comision Economica para

5.6 Land Use and Agricultural Production

Agriculture and forestry make a significant economic contribution in the region as they account for 32% of the gross regional product. Electricity generation is another important sector. Within agriculture annual crops are the most important with wheat followed by corn, beans, rice and sugar beets. The value per hectare is highest in fruit and horticultural production the most common being raspberries, vineyards and apple orchards. All these crops require irrigation at least part of the growing season. (For more detail compare Annex).

5.7 Water Resources and Water Use

The main water uses for both basins mentioned in section 5.3 above are as follows:

Type of water uses	Activities
In situ	a) Aquiculture b) Fishing sport
Extraction	a) Irrigation b) Drinking water c) Production of Electric Energy d) Industrial Activities e) Mining industry
Biodiversity	Protection and conservation of aquatic population
Ancestral uses	Water used by Indigenous population

Source: Author elaboration with the information of *Plan Director*, 2005.

6 Stakeholder Organizations in the VII Region

6.1 State Organizations

6.1.1 Comisión Nacional de Riego/Comisión Regional de Riego

CNR is represented in the VII Region by the regional branch which is known as the Regional Irrigation Commission, the *Comisión Regional de Riego*, CRR. The main objective of this institution is to promote the *Ley de Riego*, and to support water users when submitting projects to the different available financing agencies. They receive all the proposals from the region and submit them to the CNR who decides on funding. The CRR operates below the regional representative (SEREMI) of the Ministry of Public Works. The CRR is responsible for the distribution and administration of all public funds used in the irrigation sector.

6.1.2 Direccion General de Aguas

The regional direction of the DGA, the general water directory (DGA-VII Region) is in charge of making effective the delegation of functions as described above.

6.1.3 Direccion de Obras Hidraulicas

As well as the DGA, the regional branch of the directory for hydrological works, DOH (DOH-VII Region) is in charge of the study and supervision of projects of irrigation infrastructure and drinking water for rural communities in the region.

6.1.4 Instituto Nacional de Desarrollo Agropecuario

Poorer user groups may apply for state funds of the *Instituto Nacional de Desarrollo Agropecuario* (INDAP) and through regional and municipal institutions. However, in highly politicized procedures, municipalities and other authorities sometimes provide financing before or close to elections.

Through the Irrigation Department, the regional branch of INDAP supports small projects of irrigation with funds coming from the Ley de Riego. INDAP has irrigation specialists in its regional offices who support farmers in preparing the proposals to be presented for funding. The programs offered by INDAP will be described in section 7.2.

6.1.5 Comisión Regional de Recursos Hídricos (CRRH)

A Regional Commission of Water Resources *Comisión Regional de Recursos Hídricos* (CRRH) consisting of the main stakeholders from the public and the private sector in the 7th Region, was created on December 24, 2003, through a Resolution (Nº J-649) from the Intendencia of the Maule Region. According to section 9.4.1 of the Plan Director the objective of the commission is to coordinate water uses and users at the regional level; and the majority stakeholders of both surface and groundwater are included. In its concept for the basin, the principal objective of the CRRH is to coordinate and integrate institutionally the public services linked to the use, development and conservation of the surface and underground water resources incorporating the participation of the private sector and social actors for the achievement of a better use of all waters within the frame of sustainability.

The CRRH is composed of the following institutions/persons, from the public and private sectors. The governor of the VII Region (*Sr. Intendente Regional*) is the president of the commission and the regional ministerial representative (Seremi) from the publics works ministry is the executive secretary. Other participants from the public sector include the Governors of the four Provinces, the Seremi for Agriculture, Seremi Economy, Seremi Finance, Seremi Planning and Coordination, Seremi de Bienes Nacionales, Seremi Health, the president and the executive secretary of the *Comisión Regional de Riego* (CRR), the regional directors of: DOH, DGA, CONAMA, INDAP, SAG, CONAF, SERNAPESCA, SSM y OREMI and the president of the Association of Municipalities.

The private sector is to be represented by three representatives from the functioning *Juntas de Vigilancia*, three representatives from local universities, the president of the Development Corporation, the president of the Chamber of Commerce, and the president of the Association of Industrials from the central parts (*Asociación de Industriales del Centro*).

When forming the commission there was a modification from this original composition since the presidency of the commission corresponds to the regional representative of the Ministry for Agriculture (SEREMI Agricultura) and the secretary is the regional director of DGA. Other stakeholders such as hydropower generation have also been included. The commission has not met after the constituting session and the participants do not seem to be aware of being part of a commission that is not working. Nevertheless in the interviews the president and the secretary of the CRRH voiced their interest in working together with the project and considered that the adaptation of the model could serve not only their mission but also create an occasion for actually beginning this task.

6.1.6 Servicio Agrícola y Ganadero

This section lists the main functions of the Agriculture and Livestock Service, SAG for irrigation at the regional level. They consist of:

1.- To check the hydrological infrastructure when they are in construction. This can be carried out together with or separately from DOH Regional, according to the requirements of CRR (*Comisión Regional de Riego*). Furthermore, SAG and DOH carry out the final inspection of the hydrological works and both institutions can approve the completion of the entire work, part of this work or not accept the hydrological work.

2.- On request of the DOH, to verify the real investments used on built projects.

3.- To register the transfer of the property rights in those cases where there are installed elements and equipments of mechanical irrigation systems acquired with subsidy and susceptible of being transferred to other persons.

4.- To authorize the temporary moves of the acquired goods with the subsidy, outside of the field or irrigation system.

5.- To undertake periodic inspections of the hydrological works constructed on the fields or in the irrigation systems, of equipment and elements of mechanical irrigation system and in cases of violation, SAG must formulate the accusations to the competent tribunal.

6.- Report to the CNR when the irrigation projects or drainage can produce any type of environmental impact. Moreover, SAG will make a declaration on the compliance with the laws and related decrees to the conservation of native species and other natural resources.

7.- Relate to the CNR all the information for the execution of the Law and their regulation.

8.- Supervise the irrigation or drainage project proposals which are submitted, and later to visit the fields to confirm their technical viability. The information is sent to the CNR.

9.- To make an inventory the equipments and elements of mechanical irrigation system that are acquired and installed by the projects during the last 10 years.

6.2 Water User Organizations in the 7th Region

Within the water sector, water user groups are organized as follows:

6.2.1 Juntas de Vigilancia

Juntas de Vigilancia (Watch Committees) are in charge of water distribution from a stream or reservoir to the primary channels. In the Region there is a total of five *Juntas de Vigilancia*. They correspond to the Río Mataquito, the Río Maule, the Río Achibueno, the Río Ancoa, and the Río Longaví. The last three *Juntas de Vigilancia* are in the study area and manage the irrigation infrastructure at the level of the rivers.

Some of the *Juntas de Vigilancia* have begun to set up GIS of their sub basins. These JdV were very interested in collaborating with the project and using the model since they are quite aware of the additional possibilities they gain through the model and of how much effort it would take them to do it on their own. The other *Juntas de*

Vigilancia were also interested but their actual work so far does not use sophisticated data management techniques.

6.2.2 Asociaciones de Canalistas

The *Asociación de Canalistas* (Canal Associations) is at the intermediate level and comprises all those lower level WUO that receive their water from one irrigation channel. They are responsible for the maintenance of this canal and distributing the water to the secondary canals that provide the water to the lower level organisations. If smaller canals receive their water directly from a river or stream there is no intermediate level of an *Asociación de Canalistas*. According to the registers of CNR and DGA, six *Asociaciones de Canalistas* can be found in the Region. They are: *Asociación Canalistas Maule Norte, Asociación canalistas Maule Sur, Asociación Canalistas SORPAM, Asociación Canal Melado, Asociación Canalistas Putagán,* and *Asociación Canalistas Digua*. The last three *asociaciones de canalistas* are included in the study area.

6.2.3 Comunidades de Agua

At the lowest local, administrative level, users are organized in *Comunidades de Agua* (Water Communities); these groups are responsible for water distribution to users' plots, maintenance of tertiary and secondary irrigation channels, and the collection of fees for higher level organizations. The table below is taken from the *Plan Director de la Cuenca del Maule* and gives an overview on total number of *Comunidades de Agua* and water shares registered in the DGA records[3]. It has to be noted, however, that information from the interviews to the *Asociaciones de Canalistas* and the *Juntas de Vigilancia* have provided different numbers. The following table shows the number of *Comunidades de Agua* in the study region according to their present state of registration.

[3]detailed information can be obtained from Anexo 9-6: *Comunidades de Aguas Cuenca del Río Maule,* in the *Plan Director*.

Table 3: *Comunidades de Aguas* (CdA) in the study area by registration step

Community	Nº de CdA registered	Nº de CdA in registration	Nº de CdA No not registered	Total
Parral	4	2	1	7
Retiro	4	3	3	10
Longaví	40	2	28	70
Linares	95	-	102	197
Yerbas Buenas	1	1	27	29
Colbún	6	-	26	32
Villa Alegre	13	-	9	22
San Javier	3	-	-	3
Total	166	8	196	370

Fuente: own elaboration based on dates provided by DGA, 2005

6.3 Other private Sector Organizations

6.3.1 Colbún

The hydropower company resulting from the privatization of the public institution ENDESA is the biggest non-consumptive user of water from the Maule River.

Hydropower is generated using water from the Maule River at two dams with generators: Colbún and Machicura. From this last dam, the water is returned to the river downstream where the water enters back into the irrigation system Colbun can store up to 1,700 million cubic meters of water, and Machicura 50 million.

There is a longstanding conflict between the irrigators from Maule Sur and the hydropower company due to the fact, that water for irrigation is mainly needed at certain peak times (February and March) whereas hydropower generation requires constant water flows year round.

6.3.2 Aguas del Nuevo Sur

Aguas del Nuevo Sur is the company in charge of the extraction management (underground water) and distribution of the drinking water in most of the cities of the region. Aguas del Nuevo Sur operates based on a concession from the Chilean government to the international holding Thames Waters for a period of 30 years. This company is also in charge of the projects for sewage water treatment in the City of Talca, the capital of the region.

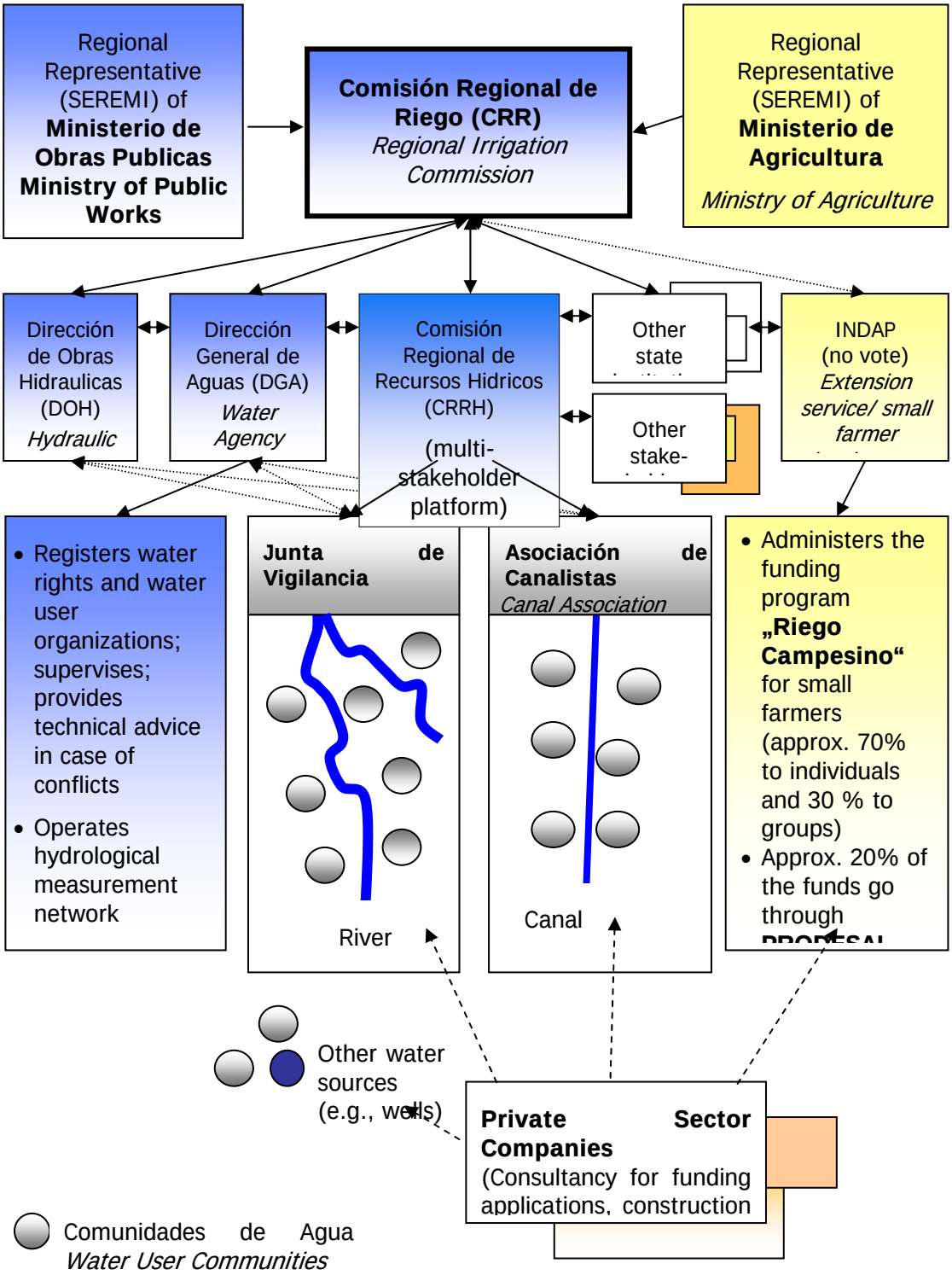
6.4 Others

The only non-governmental organization identified in the region that works with water resources is the *Corporación* para la Defensa de la Flora y la Fauna (CODEFF). They do not work in any line directly with water resources affected by irrigation activities, but they have included the wetlands protection in their plans.

6.5 Overview of Actors in Irrigation Water Management in the 7th Region

Figure 4 illustrates the different actors described above and how they interrelate.

Figure 4: Actors Participating in Irrigation Water in the 7th Region



7 Government Programs for Irrigation in the VIIth Region

7.1 Projects financed through the *Ley de Riego*

In order to apply for subsidies through the Ley de Riego the applicant has to have land rights, or be a registered water user organization or a WUO in the process of registration. There were no exact figures available on the amount of subsidies paid through this mechanism, apart from the fact that approx. one third of the national allocation (compare section 4.3.4) goes to the 7th 8th 9th and 10th regions.

7.2 INDAP Irrigation Projects for Campesinos

The irrigation program of INDAP (Programa de riego campesino) gives benefits to small farmers for the construction of small hydrological works and/or drainage which seek to:

- improve the efficiency of water application to the field,
- capture water and incorporate a new irrigation area,
- improve, extend and widen the actual irrigation systems and drainages.

The funds of the irrigation program are provided to construct and repair hydrological infrastructure, purchase equipments (e.g. water pumps, piping), install technical irrigation infrastructure, to pay labour required for constructing the infrastructure and to pay for initial water rights regulations.

The irrigation program of INDAP gives a bonus of up to 100 Unidades de Fomento (approximately US$ 3,308)[4] to an individual irrigation project and up to US$ 46,729 to collective irrigation programs.

The hydrological infrastructure support is focused on:

- Hydrological infrastructure for poor small farmers
- Small farmers working on non-irrigated land (secano)
- Hydrological infrastructure to support the productive development

Entitled applicants to this bonus are:

- The small farmers, who are users of INDAP and have not received benefits from irrigation programs during the last 2 years or who received a subsidy not exceeding 100 Unidades de Fomento.
- The users located in communities or localities which are considered areas with so called agricultural emergencies, which are mainly drought prone regions. Here the bonus is needed to capture new water sources or improve the existing hydrological infrastructure by constructing and improving the water

[4] The so called Support Unit *Unidad de Fomento* is an amount of money which is constantly adjusted according to the variation of the Consumer price index.

- conduction, as well as for complementary investments to improve or maintain existing infrastructure.

On the other hand, the funds described above are part of the Development Investment Program (*Programa de desarrollo para inversiones*) which has assigned US$ 1,557,009 for the development of investments for both agriculture and irrigation in the VIIth Region during this year. In relation to the last point, it is necessary to highlight that US$ 570,093 are generally assigned to improve field infrastructure (e.g. irrigation systems), while US$ 252,336 are assigned to infrastructure outside the field (for example small channels, irrigation ditches, conduction systems etc). According to INDAP, 204 new hectares with irrigation will be included this year.

7.3 PRODESAL Projects with an Irrigation Component

PRODESAL (*Programa de Desarrollo Local*) is a joint program of INDAP and the Municipalities of the Region that gives technical support to poor small farmers. The Municipalities carry out an ongoing survey of all families in rural communities (the CASEN) and accordingly select those families with highest economic necessities. INDAP provides a technical inspection of these farms and manages the application procedure.

Successful applicants to this program have to meet two essential requirements: a) to have a maximum of 3 hectares of *riego basico* (basic irrigation land[5]) and b) the main proportion of their income must be earned by agricultural activities. Presently, PRODESAL has 59 operational units in the VIIth Region, consisting of approximately 120 small farmers each. So, a total of 6.446 poor families gain assistance through this program. Additionally, small farmers belonging to the PRODESAL program can apply for funds from the Development Investment Program, to purchase farm materials, small hydrological works and irrigation systems.

7.4 PRODECOP - Programa de Desarrollo de Comunas Pobres

PRODECOP (Development programme for poor communities) is a program of INDAP concentrating on non-irrigated land use (secano) of the VII Region. This program attempts to help poor families who earn most of their income from agriculture. Currently, within the 7th region only the communities of Cauquenes and Empedrado, both located in the coastal zone outside the study area of the project participate in this program, and received subsidies for irrigation, agriculture, forestry, the recovery of natural resources, and farmers training. The total amount spent on per year in the past three years amounts to approximately 200.000 US$. The total number of small farmers funded through this program is composed of 160 small farmers from the Empedrado Community and 186 small farmers from the Cauquenes Community. From 2003 to 2005 a total number of 113 irrigation systems have been established in both communities[6].

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[5] Land with a productive potential equivalent to 1 hectare of irrigated land in the Valle del Maipo, close to Santiago. It is used as an equivalence measure for the rest of the country and was defined by the Law of Agrarian Reform Nº16.640.

[6] Personal interview of PRODECOP representative for the VII Región.

8 Potentials and Problems of Water Resources Management

The potentials and problems of water resources management in the study area will be discussed under three different perspectives. The first concerns the views of the stakeholders as obtained from the stakeholder needs assessment through interviews, secondary documents and the participation in stakeholder workshops treating these topics (for more detail also compare Report on Stakeholders' Needs and Priorities milestone June 2005). The second gives a rough assessment of the potential for poverty alleviation and the third identifies areas were a multi-agent model can be used to support the identification and planning of projects to improve water resource management.

8.1 Potentials and Problems according to the stakeholders

According to the stakeholder needs assessment the main problem in the area is the need to improve irrigation infrastructure. Potentials for improvement lie in the improvement respectively modernization of current infrastructure as well as in constructing additional infrastructure for retaining additional water quantities. The most important surface water use besides agriculture in the 7th Region of Chile is hydropower generation. Currently there is no hydropower generation facility in the four micro-basins falling within the study area; however, concerns about the security of supply of natural gas from Argentina have increased the pressure to consider new hydropower projects. Conflicts between hydropower generation and irrigation mainly concern the timing of water release. Recreational use of water reservoirs currently occurs to a minor extent, but this may increase, especially in response to increased regional tourism. Another issue of increasing importance is water quality. The main concerns are poorly purified sewage water and contamination with agro-chemicals. These issues are important also in the implementation of 'good agricultural practices' (EU-determined quality standards for high-value export crops) also has implications for both farming practices and water use and management. The certification of these standards is a prerequisite for export to EU and US markets from 2002 onwards.

Even though trade in water is one of the theoretical advantages of Chile's liberalized water system, only one of the canal associations in the region (Digua system) has so far developed the capacity to make this trade possible on a significant and regular basis. In all other *Juntas de Vigilancia* and *Asociaciones de Canalistas* interviewed water trade occurs only very occasionally and on a very limited scale, which comprises one or two cases in several years. The reasons for this limited implementation seem to be technical and organizational. The technical limitations concern the canals that are built for a certain water flow volume, both reducing and increasing this volume results in water losses that are in many cases prohibitive. The organizational limitations concern the security of water rental markets. So far only selling water rights can be institutionally secured. Rental arrangements are short term and contracts are not enforceable which means that users are not only unwilling to assume the high transaction costs but would also incur considerable risks.

In summary this means there are four basic issues from the stakeholders' point of view that can be addressed to improve water utilization: (1) The improvement of existing infrastructure, (2) the construction of new water retention infrastructure either for irrigation or for hydroelectricity generation, (3) monitoring and achieving water quality requirements, and (4) improving the viability of water trade.

8.2 Potentials and Problems with Focus on Poverty Alleviation

The proportion of irrigation water users that is poor in the study area could not be obtained yet. This will be one of the results of the household survey. One important poverty relevant implication has been identified with regard to the rural labor market. Most of the rural population that does not own sufficient land and water to obtain sufficient income from own farm production provides labor for agricultural production, especially in fruit orchards and vineyards. Therefore a considerable potential for poverty alleviation lies in the increase of labor demand if irrigation can be assured, which is especially important for the high value and at the same time high labor intensity products such as fruits and vegetables.

Once the data from the household survey is incorporated in the Multi-agent model, the model will be able to estimate the effect of different policy options as for instance those described below on income distribution between different groups of users and thus also on poverty alleviation.

8.3 Assessment of Possibilities to Use Multi-agent Model

Simulation models especially when based on multiple agents can help to identify and quantify trade-offs that may arise in the short run, between the goals of economic growth, reduced vulnerability and food insecurity, environmental sustainability and equity. Simulation modeling can be used to examine long run impacts of predicted changes in climate and to evaluate alternative policies under different climate scenarios. They can also help to identify technical, economic and institutional options that increase water productivity and reduce vulnerability to shocks. Here we will outline how the multi-agent simulation model can be used to address and inform on policy-relevant research questions identified in section 8.1. The four policy relevant research questions are the development of small-scale and large-scale infrastructure, water quality issues, and trading water rights. This does not imply that the application of the model will be limited to these questions. Further questions will be identified jointly with the stakeholders in the corresponding workshops (compare sections 8.3.3 and 3.3).

8.3.1 Development of small-scale infrastructure

Investment into and maintenance of small-scale infrastructure is a typical case of collective action problems at the lowest level of user organizations, the C*omunidades de Agua*. Water users have to make individual contributions to jointly-used infrastructure; if a critical mass of users cannot be reached, jointly-used facilities are never set up. Additionally, without effective collective action, existing facilities collapse because of lack of maintenance. Examples are canal maintenance and improvement, monitoring of individual water uptake and installment of measurement equipment, joint investments such as overnight storage, deep wells, and small-scale hydropower. This again poses a number of user and policy-relevant research questions:

- What are the incentives for individuals to participate, given the extent of participation by others?
- What factors affect individual incentives, and what policies/mechanisms could be used to changes these incentives when they inhibit collective action? How are incentives to participate in one activity affected by collective action in other spheres?

- What factors at the water user association level appear to help or hinder collective action in any sphere? (e.g. heterogeneous interests, trust amongst community members, historical experiences)

Investing in water distribution monitoring equipment provides information on actual quantities of water used by each member; such information provides a pure public good even in the absence of water trading. The discrete decision to invest in storage facilities has similar characteristics to the decision to invest in water monitoring equipment.

Additionally, most irrigation investments require periodic maintenance at both the household and community level. Water users must make agreements on maintenance activities, assign responsibilities, and monitor and enforce these agreements. Monitoring maintenance contributions may well be more costly than ensuring everyone contributes their share to a specific investment. In the case of discrete investments, as long as net gains to the investment are positive, then there are no incentives to free-ride (in fact, there are "negative incentives"), and no incentives to not be taken advantage of. In the case of maintenance, where each additional unit of labor or money has a marginal impact on the condition of the canal, there are likely to be both incentives to free-ride, and incentives not to be taken advantage of, even when there are net gains to all if all contribute their share.

The MA model can be used to generate the payoff matrices that characterize the maintenance and investment environment for the individual users, the distributional consequences of existing investment and maintenance activities, the change in net benefits due to changes in the external environment, and thus the types of policies and/or institutional mechanisms that can be used to alter incentives that currently hinder maintenance and investment.

8.3.2 Development of large-scale infrastructure

Planning of large-scale infrastructure projects such as new multi-purpose dams (Ancoa reservoir, Longaví reservoir) involve interactions at higher levels of water user organizations. It is also not clear how the new market-oriented approach of giving out private concessions to building water infrastructure will affect holders of existing water rights versus new holders of additionally assigned water rights. Here questions become relevant like, e.g. what the capacity of local user organizations is to manage interactions with higher-level organizations and with government agencies? And during the planning process, what is the impact of information asymmetries on the concentration of assets such as land resources?

In case of large-scale infrastructure, such as large reservoirs, the investment will affect a much larger group of users than those comprising a water user association and it will often affect users other than farmers, such as hydro-electric power plants, industry, tourists, and municipal authorities. Large-scale infrastructure projects often generate positive externalities, such as a less fluctuation in water flow and new tourism potential, but may also generate negative externalities, such as reduction of biological diversity. Reconciling different water demands will be a much more difficult task, and will require some type of institutional structure within which negotiation and bargaining can take place.

The provision of large-scale infrastructure also involves a number of other problems. For example, the relation between established political decision-making processes and platforms, some created specifically to increase involvement of "all" stakeholders,

needs to be clarified in order to capture the distribution of bargaining power and capacity of different stakeholders to shape certain institutional rules. As discussed in sections 2 and 3, privatization is an option high on the current political agenda. The privatization of large-scale infrastructure provision, based on a concession system, creates additional challenges for decision-making, and for ensuring that public interests are assured.

The MA model can be used to simulate the effects of different types of institutional arrangements for provision and management of large-scale infrastructure. For example, MA model can be used for assessing the effects on all users of giving seasonal priority to hydropower. The MA model can also show the incentives for a private firm to invest in the provision of large scale infrastructure such as reservoirs to increase the amount of water stored. The MA model can also generate different shadow prices for water, thus showing were new water rights might receive the highest prices as well as calculate the distributional effects among the different users. Thus, the effects of different terms of concession contracts can be simulated.

8.3.3 Water quality issues

At the present state it is not yet clear, what types of questions with regard to water quality are relevant for the stakeholders and whether and how it will be possible to adapt the model accordingly, this will be one question to address at the Stakeholder workshop in November. At this workshop (compare section 3.3) a first presentation of a model, actually running, will illustrate the potentials of the model and a process of determining what other variables and parameters would be of interest to the users will be initiated.

8.3.4 Trade in water user rights

With regard to the trade of water user rights the following questions arise and could be addressed by the Model:

- What explains the differences across user associations in number of permanent and temporary transactions of water rights? Is trade hampered by poor infrastructure and monitoring facilities? Or are there only small potential gains from trade because of minor differences in water shadow prices of individual users?
- If there are indeed potential gains from trading of water rights, what are the most binding factors for exploiting them more fully? Currently, short-term informal rental contracts are the most frequent form of water trading. What would be the implications of institutional innovations such as secured long-term rental arrangements?
- What is the nature and extent of externalities arising from trade of water rights, and what are the distributional consequences of increased trade in water rights, particularly impacts on smallholders and farm laborers?

An important condition for the emergence of trading in water rights is that the purchasers of these rights are assured that they will indeed receive the water in accordance with the rights purchased. In cases where water flows from all primary, secondary and tertiary canals are monitored using sophisticated water flow measurement equipment, the development of water trading rests on the enforcement of water rights using the information collected; the technology provides the information needed for enforcement and there is little need for collective action. Even under this system, however, negative asymmetric externalities may be generated

which affect those not party to the trading itself. For instance, if there is a concentration of a significant number of users renting out their rights in some part of the system, this may alter the flow of water throughout the system thereby affecting other users (see Section 3). Avoiding this type of negative externality requires an understanding of the entire irrigation system, and thus a forum where different users can acquire this information and negotiate new rules regarding transfers.

Where information on distribution is not monitored with equipment, collective action and coordination activities become more important. Consider first trading of rights within the same water user organization. If everyone with rights believes that the distribution system functions well enough in the sense that they indeed receive their share of water, then it may be a simple matter to trade water rights. Even in this case, however, community members as a whole must "support" this trade in the sense that, with traded rights, members do not change their behavior compared to the no-trade (or less trade) situation. If the current "no-trade" system functions because near-neighbors monitor each other's use, then a downstream user considering the purchase of an upstream user's water allocation must be assured that the *seller* will still monitor his/her neighbors' use. Yet, the incentives for the seller to provide monitoring, particularly if payment is made at the beginning of the season, are reduced vis-à-vis the situation where monitoring is necessary to ensure that one's own allocation is received. This monitoring problem can be expected to be reduced to the extent that a seller wants to have the option to rent out rights in the future as well. However, the larger the distance between the purchaser and the seller, the greater are the chances that others not involved in the contract become tempted to take a little bit more, since more water is flowing through. To offset this, someone – most likely the purchaser – will have to increase monitoring.

The monitoring and enforcement problems become even more severe when trading occurs across different communities of water users. Though representatives of community water user associations can attend meetings at the next higher level of aggregation (*Asociación de Canalistas* or *Junta de Vigilancia*), there is often no formal framework for negotiating trades.

9 Conclusions and Outlook

For the purpose of making an MA model available to actual decision makers the identification and analysis of the governance structures for water resource management were important for two reasons: to understand the types of decisions that are made and who makes them and secondly to identify potential users for the model.

This will be jointly discussed in this final section. The decisions that can be supported by MA modeling have been identified and described in section 8. The analysis of the institutional context in sections 4, 6 and 7 helps to identify who might make use of what kind of information and also what stakeholders have the technical potential to use MA modeling.

With regard to the technical potential the state organizations and the higher levels of water user organizations are to be considered. The Comisión Regional de Recursos Hídricos was identified as the forum for presenting the model and further specifying potential policy relevant research questions. It unites state and private sector actors concerned with water management and although it is hardly institutionalized and far

to big to actually manage a model it is a good entry point of potentially interested users with relevant mandates within the decision making structures. It can serve to later identify the certainly much smaller group of actual model users.

The questions identified so far concerned three main decision arenas, infrastructure development, water trade as a form of increasing efficiency of water use via the market, and water quality issues. Each of these will be discussed with regard to the relevant actors here.

Investment decisions for the improvement or extension of irrigation infrastructure are relevant for state actors since there are several state funded programs for subsidizing infrastructure development (described in sections 4.3 and 7). The model can help to identify in which areas such investments have the highest pay offs. It can also simulate the impact of such decisions on poverty alleviation. This type of information has two potential users: the state agencies in charge of the support programs and the water user organizations. The state actors can use it in two directions: to make inform decisions on which projects to prioritize and to formulate specific support programs i.e. for poverty alleviation. With regard to Water User Asociations one needs to differentiate the different levels, since managing a model is not feasible at the lower levels such as C*omunidades de agua* due to the required qualifications and organizational capacity. At the level of the *Juntas de Vigilancia*, however, this capacity seems to be available. The interviews also showed that at least some of the *Juntas de Vigilancia* are interested in becoming increasingly involved in supporting their *Comunidades de agua* beyond the mere provision of water.

With regard to water trade the model can help to identify constraints that limit the extent of the current water market. Depending on the constraints identified, and this will depend on the results, the relevant level of decision maker then needs to be identified. To date it is unclear whether constraints are more of a technical (infrastructure, monitoring) or of an institutional nature (monitoring, security of contracts).

Questions of water quality concern the commission for the environment and the water user organizations, again at the higher levels. In case the model can be adapted to process relevant information these two groups would constitute the main users.

The next step in the collaborative research and learning framework after this First round contacts and introductions to the projects objectives consists in demonstrating the model to the decision makers and potential users. This step is scheduled for November and will elicit feed-back on the problems, needs and potential solutions identified so far and reported here and further specify them. At the same time the workshop will provide evaluation criteria, further use cases and scenarios.

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Annex

Land use in (Ha) in the 7th Region

ESTRUCTURA DEL USO DEL SUELO EN LA AGRICULTURA SEPTIMA (VII) REGION DEL MAULE HECTAREAS								
Categorías de uso	1989/90	1990/91	1991/92	1992/93	1993/94	1995/96	1996/97	1997/98
USO INTENSIVO								
Cultivos Anuales	152.220	165.810	156.730	139.780	153.540	134.921	155.181	147.698
Frutales y Viñas	47.810	48.660	50.800	51.910	54.470	57.839	60.053	69.435
Hortalizas y Flores	8.510	11.530	11.260	10.580	11.160	13.273	15.615	17.047
Empastadas Artificiales	36.120	48.980	45.210	39.800	41.030	49.676	50.213	62.115
Barbechos	53.630	39.220	46.070	37.760	27.480	27.459	13.880	34.414
Total uso Intensivo (A)	298.290	314.200	310.070	279.830	287.680	283.168	294.942	330.709
USO EXTENSIVO								
Praderas Mejoradas	149.550	29.360	17.820	57.320	102.920	75.600	50.385	29.115
Praderas Naturales	563.200	753.390	688.710	720.710	702.740	626.008	683.402	581.216
Total praderas (B)	712.750	782.750	706.530	778.030	805.660	701.608	733.787	610.331
Otros suelos, incluido forestal (**)	618.800	533.050	602.500	549.490	506.710	609.257	602.192	689.282
Forestal 1_/ (C)	261.125	289.218	300.033	313.150	324.523	341.970	342.822	359.310
Total uso Extensivo (B+C)	973.875	1.071.968	1.006.563	1.091.180	1.130.183	1.043.578	1.076.609	969.641
TOTAL (A+B+C)	1.272.165	1.386.168	1.316.633	1.371.010	1.417.863	1.326.746	1.371.551	1.300.350
FUENTE : Elaborado por ODEPA con información INE e INFOR - CORFO.								
NOTA : 1_/ Plantaciones forestales, pino radiata y eucalipto desde la Tercera a la Décima Región. NOTA : (**) ITEM NO INCLUIDO EN SUMATORIA (A+B+C).								

Annual crops grown (Ha) in the 7th Region

SÉPTIMA REGIÓN (VII) CULTIVOS ANUALES : SUPERFICIE SEMBRADA TEMPORADA 1989/90, 1995/96 - 2003/04 HECTÁREAS										
CULTIVOS	1989 / 90	1995 / 96	1996 / 97	1997 / 98	1998 / 99	1999 / 00	2000 / 01	2001 / 02	2002 / 03	2003 / 04
TRIGO	84.600	56.910	64.364	62.717	35.123	53.470	60.830	60.690	61.860	62.200
AVENA	2.640	2.136	3.166	1.712	1.630	2.461	1.510	1.590	1.330	1.500
CEBADA	6.010	4.017	4.003	2.491	2.152	2.368	1.390	1.050	570	600
CENTENO	86	37	356	9	-	-	450	1	-	-
MAIZ	18.000	16.406	17.388	22.255	9.073	11.848	15.810	14.070	23.530	25.000
ARROZ	20.470	19.438	20.255	19.981	10.739	16.975	20.000	20.070	21.340	19.000
POROTO	26.070	18.242	14.161	19.885	14.283	15.327	17.350	13.890	14.040	14.700
LENTEJA	1.500	1.557	857	446	537	343	320	240	210	220
GARBANZO	2.890	3.196	3.054	1.538	999	569	1.700	1.520	1.410	1.550
ARVEJA	830	907	286	486	369	75	360	171	350	-
CHICHARO	1.195	864	875	426	45	776	230	198	240	-
PAPA	5.970	4.942	6.496	5.540	2.114	2.282	4.880	4.170	3.850	3.800
MARAVILLA	3.740	1.118	467	1.670	235	424	610	640	350	760
RAPS	450	130	113	151	110	-	-	-	-	130
REMOLACHA	19.075	23.342	17.863	20.741	17.100	16.520	16.000	17.570	9.660	10.340
LUPINO	-	-	4	-	-	-	-	-	-	-
TABACO	1.462	1.447	1.709	1.810	1.800	1.359	1.080	810	960	1.160
TOTAL	194.988	154.689	155.417	161.858	96.309	124.797	142.520	136.680	139.700	140.960
FUENTE : Elaborado por ODEPA con información de INE, IANSA y CCT										
Nota : Año 1996/97 cifras del VI censo nacional agropecuario.										

Production of annual crops (t) in the 7th Region

SÉPTIMA REGIÓN (VII) CULTIVOS ANUALES : PRODUCCIÓN TEMPORADA 1989/90, 1995/96 - 2003/04 TONELADAS										
CULTIVOS	1989 / 90	1995 / 96	1996 / 97	1997 / 98	1998 / 99	1999 / 00	2000 / 01	2001 / 02	2002 / 03	2003 / 04
TRIGO	257.755	211.476	242.505	239.216	131.768	220.774	264.274	261.400	253.150	266.838
AVENA	5.700	5.308	9.103	4.143	3.674	5.414	3.571	7.813	3.708	4.500
CEBADA	22.054	17.017	14.948	12.746	9.063	11.063	5.831	5.581	3.019	3.210
CENTENO	211	41	784	6	-	-	450	-	-	-
MAIZ	98.823	110.552	108.590	131.581	35.077	68.860	115.691	123.324	189.407	228.000
ARROZ	85.322	93.124	85.515	75.715	47.532	87.219	96.354	94.877	100.948	87.020
POROTO	38.860	28.618	18.165	33.234	15.646	25.519	28.304	23.828	28.204	28.665
LENTEJA	1.109	1.658	507	447	419	232	353	243	169	165
GARBANZO	1.658	2.569	1.627	1.116	628	248	1.276	1.027	1.204	1.225
ARVEJA	1.381	1.938	365	185	331	90	555	152	256	-
CHICHARO	697	969	595	494	24	580	199	160	191	-
PAPA	124.089	91.900	83.444	86.707	17.375	32.254	71.274	62.219	57.217	57.190
MARAVILLA	8.173	2.208	937	1.540	378	477	1.325	962	567	1.277
RAPS	478	283	343	436	153	-	-	-	-	486
REMOLACHA	1.170.738	1.499.459	1.007.892	1.111.922	967.147	1.083.382	944.000	1.189.681	676.200	832.370
LUPINO	-	-	4	-	-	-	-	-	-	-
TABACO	4.853	5.311	5.345	5.357	5.238	4.199	3.644	2.500	2.660	3.677
FUENTE : Elaborado por ODEPA con información de INE, IANSA y CCT										