# GOVERNANCE INSTITUTIONS AND COMMUNITY VULNERABILITIES TO CLIMATE-INDUCED WATER STRESS – CASE STUDIES IN CANADA AND CHILE.

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**Abstract**
This paper focuses on water governance and presents a portion of the findings of a larger comparative study of institutional adaptation to climate change or water scarcity in the South Saskatchewan River Basin of western Canada and the Elqui River Basin in northern Chile, two large, regional, dryland water basins with significant irrigated agricultural production. The paper links the community vulnerability paper of Diaz to an assessment of the adaptation capacity of water institutions assessed through primary and secondary research of key representatives from relevant institutions with a water governance mandate.

The goal of the study was to develop a systematic, integrated and comprehensive understanding of the capacities of institutions to formulate and implement strategies of adaptation to climate change risks and the forecasted impacts of climate change on the supply and management of water resources in dryland environments. The objectives of this portion of the study were to identify the role of governance institutions in mediating local-level adaptations to climate and water stress, to assess the capacity of formal institutions to change and make necessary institutional adaptations so that the governance arrangements will be better-equipped to address future vulnerabilities, and to investigate and improve the understanding of the interface among governance institutions in addressing these vulnerabilities.

The methodological approach was based on the concept of vulnerability as a function of both the exposure (or sensitivity) and adaptive capacity of a system to respond to stress from multiple exposures including environmental, social, economic and political factors. Effective tools are thus aimed at addressing all of these factors, also known as "mainstreaming."

Community level vulnerability assessments incorporating both social and natural science insights have been conducted in various contexts in Canada and internationally, but there are few examples of integrating community-level vulnerability assessments into policy in a meaningful way.

Water governance in Chile is defined in the national constitution. A principle driver of water management relates to water rights as a market commodity. This affects the capacity of formal governance institutions to address water conflict and competing demands. In contrast, water is not mentioned in the Canadian constitution. Water management is the mandate of Canadian provinces, but roles are often shared between multiple orders of government (federal-provincial-local). The plethora of government organizations each of which claim to have some role in water management, are not always clear, are sometimes confusing and can be difficult to manage, creating challenges for regional and local decision-makers. While the governance models in Canada and Chile come from different paradigms, future climate-induced water stresses are expected to require future institutional adaptations to address community vulnerabilities. Flexibility, timely decision-making and clarity of roles will be necessary by all orders of government, and will need to recognize increasing efforts towards proactive integrated water resource management approaches.

Based on the research to date, this paper will conclude with its findings of the institutional capacity to adapt to water scarcity or climate change predictions for the area and with policy recommendations for the future to improve adaptive capacity.

**Abstract keywords**: water governance, institutions, integrated water resource management, vulnerability, adaptation, climate change, irrigated agriculture.

## CANADA'S SSRB AND CHILE'S ELQUI RIVER BASIN

Canada's South Saskatchewan River Basin (SSRB) stretches from the Rocky Mountains across southern Alberta and Saskatchewan, covering an area of about 168,000 square kilometres with an estimated population of 2.2 million people reliant on the basin's major river systems. The SSRB is part of the larger 406,000 square kilometer Saskatchewan River Basin which drains from the Canadian Rocky Mountains northeasterly across the expansive Canadian prairies into the Hudson Bay. The SSRB is divided into five major watersheds: Bow, Oldman, Red Deer, South Saskatchewan (in Alberta and in Saskatchewan). The basin is under the jurisdiction of both Alberta and Saskatchewan provincial governments, and there are a large number of local governments (rural municipalities) and approximately 225 rural communities (PFRA, 2007; Sobool and Kulshreshtha, 2003).

The SSRB land use is primarily agricultural. Of the basin's 16.8 million Ha, 15 million Ha is agricultural, accounting for nearly 90% of land in the basin. By far, the largest portion of the basin is dry-land agriculture, solely reliant on precipitation and management of soil moisture and crop type. The SSRB produces commercial crops such as wheat and canola. Livestock production is also a main agricultural activity with large areas left for pasture.

Irrigation is practiced on only 5% of the basin's land but is a major activity, representing close to 80% of the 1 million hectares of irrigated land across Canada. Irrigation accounts for over 90% of consumptive water use in the SSRB, and therefore agriculture is a key player when it comes to water use in the basin. Watershed management is achieved by managing dams, reservoirs, water diversion pipelines and canals and irrigation projects. In southern Alberta, 13 irrigation districts divert water to irrigate about 490,000 hectares (1.2 million acres) of land; an additional 120,000 hectares (296,000 acres) of land are irrigated by private irrigation systems in the SSRB. Approximately 165,000 ha (408,000 acres) of land are irrigated by 25 irrigation districts throughout southern Saskatchewan. Irrigation diversions vary from year to year. Total irrigation diversions in the SSRB are in the order of 2.5 billion cubic metres (Bruneau *et al*, forthcoming). In addition to supplying water for irrigation, the basin is used for recreation, hydro-electricity and is the principal source of household water for 45% of Saskatchewan's population.

Chile's Coquimbo Region covers approximately 41,000 square kilometres (5.5 % of Chile), with an estimated population of 605,000 (4% of the national population). Almost four-fifths of this population lives in three large urban centers - La Serena, Coquimbo, and Ovalle. The area has three major watersheds: Elqui, Limarí, and Choapa. Within the Coquimbo Region, the principal study site is the Elqui River Basin covering about 9,800 $km^2$ with a population of about 365,000. At the public institutional level, the area has a regional government with a number of agencies which mirror those existing at the national level (health, environment, economic development, etc.), and fifteen local governments. In addition, the basin has a large number of civil society organizations. A recent research report from the University of La Serena identified approximately 1,400 active local organizations, such as trade unions, neighborhood and women associations, cultural centres, youth organizations, and many others (Morales, Vera, and Jimenez, 2002).

The most important economic activities of the Coquimbo Region in Chile are agriculture and mining, two activities that impose an increasing pressure upon scarce water resources. Most agricultural activities in the region are related to fruit-production, especially grapes for exportation and for the production of a unique brandy known as Pisco. There are also significant pockets of small-scale agriculture that contain most of the poor rural households and subsistence farming in the area. Like the SSRB in Canada, irrigation in Chile is a major water user, accounting for an estimated 84% of the water use (World Resources Institute, 2003).

The two regions in Canada and Chile are characterized by a similar environment - a semi-arid dry climate adjacent to a major river system recharged by mountain runoff from snow and ice, and landscapes at risk of desertification (Grainger et al., 2000; Government of Chile, 2002; Sauchyn *et al.*, 2002a). It is expected that both regions will be similarly affected by future climate variability and climate change that may pose drier conditions, more extreme events, and increasing climatic uncertainty (CONAMA, 1999; Morales-Arnao, 1999; Sauchyn *et al.*, 2002b). The SSRB climate change impacts are expected to impact water resources in terms of quantity and quality (Lapp, 2006). The semi-arid climate of Chile's Coquimbo Region is considered somewhat of a spatial analogue of the possible future climate scenarios for the SSRB and is interesting to compare for its uniquely different institutional governance arrangements.

## VULNERABILITY, INSTITUTIONS AND ADAPTIVE CAPACITY

In general terms, vulnerability is understood as the capacity to be wounded (harmed) from a perturbation or stress, whether environmental or socioeconomic (Kasperson, 2005). The definition of the Intergovernmental Panel on Climate Change (IPCC) follows this consensus understanding vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (Olmos, 2001). Vulnerability, in this definition, is a function of the exposure and sensitivity (the degree to which a system will respond to a change in climatic conditions) and the adaptive capacity of a system to absorb, cope, manage, deal with, adapt, or recover from stress (Liverman, 1994). Multiple social conditions affect vulnerability including social, economic and political factors which cannot be separated from the impacts of climate change.

The impacts of global warming will vary among regions and social groups, depending on specific climate stimuli –including variability and extremes-- and variations in adaptive capacity within social systems (IPCC, 2007). Adaptive capacity refers to a property of a system that involves the "ability to design and implement effective adaptation strategies, or to react to evolving hazards and stresses…" (Burton, 2005). This adaptive capacity, of course, varies among countries, regions, and sectors of the population, making those with a reduced adaptive capacity more vulnerable to the impacts and risks of climate. The Third Report of the IPCC has identified among other factors, "well developed institutions" as facilitative of the management of climate-related risks and thus reinforcing adaptive capacity (IPCC, 2001).

Institutions could be defined as, "a persistent, reasonably predictable arrangement, law, process, custom or organization structuring aspects of the political, social, cultural or economic transactions and relationships in a society" (Henningham, 1985). Water governance is the persistent, reasonably predictable arrangement, process, or structuration of the transactions relating to water and its management in our society. A general description of

the SSRB water governance model is graphically presented in Figure 1. Water governance is a network that integrates communities, to the extent that local governments and members of the communities participate (normally in a subordinated way) in the process of governance. It is constituted by a myriad of organizations, each one of them with their own interests, particular decision-making processes, and resources; instruments (such as legal norms, acts,); and relationships among organizations and instruments, relationships defined by different amounts of political power and competing priorities.

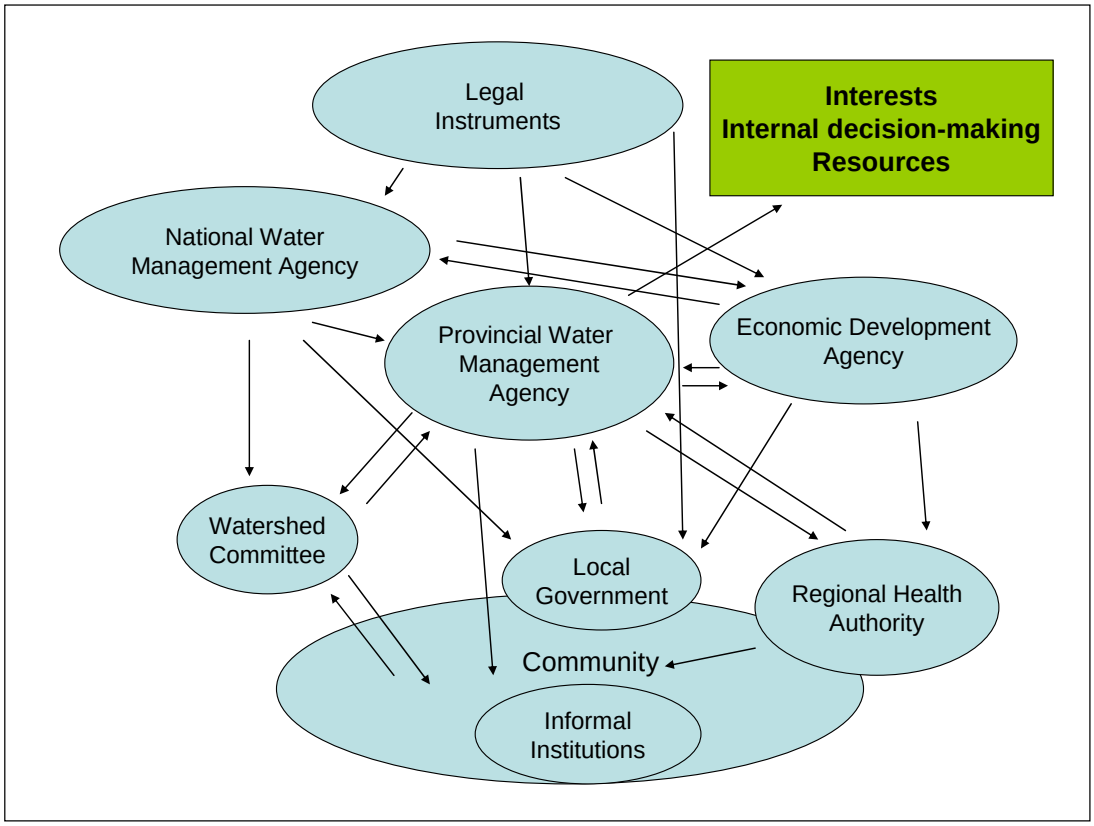


**FIGURE 1 – General description of Governance Model**

In the context of adaptive capacity, governance requires flexibility of institutions to deal with the unanticipated conditions that may result from the impacts of climate change. The role of institutions includes implementing an enabling environment that allows civil society to deal successfully with the challenges of climate change and applying specific policies (resource mobilization and allocation and incentives and disincentives). Adaptive capacity, to be successful, must allow for the identification and resolution of communities' problems and the satisfaction of their needs in a fair, efficient and sustainable manner. Thus, the fundamental contribution of governance to reducing the vulnerabilities of rural people rests on its ability to anticipate problems and to manage risk and challenges in a way that balances social, economic, and natural interests. In other words, proper adaptive capacity overlaps with sustainable development (IPCC, 2007).

## THE SSRB WATER GOVERNANCE INSTITUTIONAL SETTING

A complex institutional cluster is involved in water governance in the SSRB, involving federal and provincial agencies, local governments, civil society groups, and NGOs. This complex structure is partly a result of the historical development of water governance in Canada. Water management was not specifically dealt with in the Constitution of Canada. The topic of water spans several heads of legislative power assigned to the federal and provincial governments. Thus each level of government has a role to play. Water is managed by shared jurisdiction and there is a complicated overlapping of jurisdiction considering water and water-related activities such as environmental protection and agricultural production. The result is that a multitude of political actors at the municipal, provincial and federal levels each have some role or responsibility in water. This makes it difficult to identify issues and to balance interests at all levels or orders of government.

Canadian water law has been formed through an interesting mixture of British and Canadian history, development of the South Saskatchewan River Basin and local and provincial politics. This history also results in a complex field of legal study. Canadian water rights are based on two common law theories, the ***English riparian doctrine*** (a set of usufructuary rights for sharing water as a common good) and the ***American prior appropriation doctrine*** ("first in time, first in right" for granting ownership or use of water to the *first water user in time*); these law theories have been modified as required by both Alberta and Saskatchewan. The SSRB watershed and its water resources are defined by geographic boundaries, but it is separated by artificial provincial and municipal boundaries representing different legal norms, rules and laws, or legal instruments.

Challenges created by this institutional setting with a multitude of actors have been mitigated in several ways. The following is a description of the main organizations involved in water governance in the SSRB. (See Table 1 which lists key provincial and federal institutions (after Corkal *et al*, 2007).

**Table 1: Key Provincial and Federal Government Agencies with Water Mandates in the South Saskatchewan River Basin:**

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| **PROVINCE OF ALBERTA:**<br>**Key guidance documents: Water for Life Strategy http://www.waterforlife.gov.ab.ca/ and associated documents** | |
| Alberta Environment | Water allocations; licensing; oversees municipal treatment of drinking water and wastewater; watershed management in partnership with watershed groups, planning, monitoring and protection of water quantity and quality in surface and ground water systems the environment. |
| Alberta Health | Protection of public health (e.g. drinking water, wastewater management); decentralized authority to Regional Health Authorities. |
| Alberta Agriculture | Irrigation, drought management, encourages adoption of Agricultural BMPS to protect water supplies from agricultural contamination, assistance for on-farm agricultural and domestic water supplies. |
| **PROVINCE OF SASKATCHEWAN**<br>**Key guidance documents include:**<br>**Safe Drinking Water Strategy (Environment), and Saskatchewan Watershed Authority performance plans, source water protection plans, and State of the Watershed assessments, such as:**<br>**(http://www.swa.ca/AboutUs/PerformancePlans.asp )**<br>**http://www.swa.ca/Stewardship/WatershedPlanning/Default.asp**<br>**http://www.swa.ca/StateOfTheWatershed/Default.asp** | |
| Saskatchewan Watershed Authority | Water allocations, licensing, and watershed management in partnership with watershed groups. |
| Saskatchewan Health | Protection of public health (e.g. drinking water, wastewater management). Conducts water quality testing services at the Saskatchewan Provincial Laboratory<br>Decentralized authority to Regional Health Authorities. |

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| Saskatchewan Environment | Oversees municipal treatment of drinking water and wastewater; monitoring and protection of water quantity and quality in surface and ground water systems the environment. |
| Saskatchewan Agriculture | Irrigation, drought management, encourages adoption of Agricultural Beneficial Management Practices to protect water supplies from agricultural contamination. |
| SaskWater Corporation | Provincial fee-for-service crown corporation which provides services for water supply sourcing and treatment of water and wastewater for interested Saskatchewan communities. |
| **GOVERNMENT OF CANADA**<br>**Key guidance documents: http://www.ec.gc.ca/Water/en/info/pubs/fedpol/e_fedpol.htm Federal Water Policy, 1987 (informational purposes, dated but issues remain valid)**<br>**Current documents on water issues are available for each department on-line, such as http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/tap-source-robinet/protection_e.html: From source to tap – The Multi-Barrier Approach to Safe Drinking Water** | |
| Environment Canada | Surveys and monitors water quality and quantity, trans-boundary flow regulation, enforcement and protection of the aquatic environment, water and climate research. Environment Canada and provincial ministers of the environment set the *Canadian Environmental Quality Guidelines*. (Guidelines pertinent to water include limits established for the protection of aquatic ecosystems, municipal uses of water (community supplies), recreational uses of water, and agricultural uses of water (Canadian Council of Ministers of the Environment, or CCME).<br>Leads the Prairie Provinces Water Board. |
| Health Canada | Sets Guidelines for Canadian Drinking Water in partnership with provinces.<br>Sets health-based standards for materials in contact with drinking water, assists First Nations with drinking water safety on their lands, and provides drinking water guidance to other departments, governments and citizens.<br>Regulates the manufacture and sale of pesticides in the *Pest Control Products Act.*<br>Co-leads the *Canadian Environmental Protection Act* with Environment Canada. |
| Agriculture Canada | Encourages adoption of agricultural BMPs to protect water from agricultural contamination; PFRA responsible for applied research and rural water management (water supply/quality, irrigation, climate, drought adaptations). |
| Natural Resources Canada | Ground water mapping and monitoring, water and climate research. Responsible for climate programs and activities with Environment Canada (e.g. lead for Canada's now defunct *Climate Change Secretariat*.) |
| Fisheries and Oceans | Responsible for the protections, management and control of inland and marine fisheries, conservation, protection and restoration of fish and fish habitat, prevention and response to pollution, and navigation. |
| **CO-ORDINATING WATER MANAGEMENT INSTITUTIONS** | |
| Prairie Provinces Water Board | Federal-Provincial Board to manage inter-jurisdictional water issues in the Prairie Provinces (Alberta, Saskatchewan, and Manitoba). Environment Canada, Agriculture Canada – PFRA, Alberta Environment, Saskatchewan Watershed Authority, Manitoba Water Stewardship. The board address issues related to inter-provincial water issues (allocations, flows, water quantity and water quality) |
| Watershed Advisory Councils and Boards | A variety of watershed councils and groups exist in each province. The key basis is water management by landscape boundary (defined as a watershed for surface water and an aquifer for ground water). Watershed groups involve all water users, local government, provincial and federal government, each working to identify and address water management issues unique to each watershed. |
| Irrigation Districts | Irrigation Districts in the SSRB manage water for irrigated agriculture for scale field crops. Because these are large water users, the districts play a key role in water management in the SSRB, and work in concert with provincial agencies. Irrigation in the SSRB accounts for 90% of the consumptive water used in the SSRB. |
| International Joint Commission | The IJC represents the Governments of Canada and the United States. The IJC addresses water use and quality of boundary waters affecting both nations. With respect to the SSRB, the Boundary Water Treaty includes clauses for water flow in the St. Mary and Milk Rivers, and the inter-basin transfer of water from the St. Mary to the Milk. This agreement affects Montana (USA) and Alberta, Saskatchewan, and Manitoba (Canada). |

In both provinces there are also several users' organizations that play a role in the local management of water resources involved in irrigation and pipelines. In addition, there are many civil society organizations throughout Saskatchewan and Alberta participating in decisions relating to specific watersheds. A bi-national agency involved in the SSRB is the International Joint Commission, representing Canada and the United States. The commission is designed to prevent and resolve disputes between the two nations, making rulings in accordance to the 1909 *Boundary Waters Treaty*.

Ever since drinking water disease outbreaks in Walkerton, Ontario (2000), North Battleford, Saskatchewan (2001) and Kashechewan First Nation, Ontario (2005), provincial, federal and local water policies have changed in Canada (Corkal *et al*, 2007). Current models utilize the watershed as the unit of water management and authorities are increasingly involving citizens in water management decisions. Water agencies are attempting to operate in a participatory manner involving all water stakeholders from water users to water managers. In the SSRB, this is achieved by active involvement of watershed advisory committees and councils (civil society organizations recently created in Alberta and Saskatchewan for citizen engagement) which have the potential to coordinate issues of local development and water planning decisions.

## ASSESSING WATER GOVERNANCE IN THE SSRB

Several semi-structured interviews and focus groups with community members of the SSRB and representatives of governance organizations in both Alberta and Saskatchewan have been conducted to assess water governance capacity. This section discussed some of the initial insights about the strengths and weaknesses of governance.

### The need for a comprehensive climate change policy

Fostering adaptive capacity to climate change requires, as a first step, a proper consideration of climate in the governance agenda. There have been significant developments in this area since 2000. Canada's efforts are focused on climate change impacts (with efforts to mitigate greenhouse gas concentrations) and adaptation (to build adaptive capacity) (Environment Canada, 2008, Natural Resources Canada, 2004a, 2008).

Alberta has developed overarching policies which have implications for adaptation to climate change and water governance. Saskatchewan's new government (elected 2007) retained mitigation targets from the previous government's climate change plan and is now developing a new plan. While these overarching policies represent an increasing level of awareness and concern about climate change, they have not been translated into a comprehensive long-term approach to climate change and adaptation, an approach able to manage the risks and opportunities of new climate conditions. A limited consideration to the development of stronger adaptive capacity is evident on the climate change agenda of both provinces. Most of the attention has been given to mitigation issues, while attention to adaptation is still in its infancy. The government of Alberta is currently in consultation respecting a climate change plan; the previous Saskatchewan government had a climate change plan which focused mainly on mitigation of carbon dioxide emissions and contained only a statement of intent to develop an adaptation strategy in the future. It is clear that more emphasis on adaptation and on the interrelationship with development decisions, in light of both economics and climate change predictions, is required. Federally, Canada signed on to the Kyoto Protocol, adopting a 6% reduction from 1990 emission levels by 2012; this amounts to a 26% reduction and the country has a major challenge to achieve this (Natural Resources Canada, 2004b). Federal approaches currently are working to better understand climate change and adaptation. In 2008, Natural Resources Canada published a national assessment report, *From Impacts to Adaptation – Canada in a Changing Climate* (Natural

Resources Canada, 2008). Canada is working towards national and international adaptations to address climate change impacts.

The absence of a comprehensive governance approach to climate change translates into a lack of homogeneity within governance agencies regarding climate change relevance and its proper integration into action agendas. Lack of proper resources has been a significant obstacle in transforming issues of climate awareness into programs and organizational practices. Other agencies express a concern with climate change, but they are reluctant to integrate the issue into their agendas claiming that scenarios of climate change are plagued with uncertainty and, consequently, that they cannot yet be considered. This requirement for certainty in climate change predictions is problematic in strengthening adaptive capacity to a range of climate conditions, where changes, surprises, and uncertainty are part of the nature of the problem. There is a need to more concretely integrate the variable climate of the region into the governance agenda, especially for decisions that will have long-term impact. The SSRB in Canada is by nature prone to a wide range of climate variability from drought to floods. In the last 100 years, at least 40 droughts have been recorded in the prairies, some of which had significant impact to the environment, the economy, and Canadian society (Marchildon *et al*, 2007).

**The need for integrating civil society in water governance**

No less relevant for strengthening water governance is the need for full inclusiveness, where the complete range of stakeholders are involved in defining problems and solutions, identifying local needs and problems, balancing interests, and executing and implementing solutions. There is no doubt that we have had important and exciting developments in the engagement of civil society in water governance in both Alberta and Saskatchewan. Local organizations have been formed to assist in water planning in both provinces. The full implementation of this approach will contribute to a better management of the risks and opportunities associated with climate change and accordingly, to develop proper adaptive capacities within the rural population of the SSRB. These groups are largely advisory in nature, lack adequate funding and currently have either limited sources or no sources of revenue.

**The need to simplify the complex nature of water governance**

Governance coordination complexity has also been a concern for rural people. Most of their concerns could be summarized in the statement of one elder farmer, who stated there was “too much water governance, yet not enough water governance,” an expression that clearly reflects one of the shortcomings of existing governance. The statement captures issues related to the confusion over the number of agencies involved with all orders of government, and the disconnection between governance institutions and processes and local watershed issues.

They expressed this as a disconnection between the local community and the provincial and federal levels of government. Politicians and government agencies are viewed to be both far away in physical presence and unavailable because of time pressures. Because of this, local concerns, challenges and issues were not understood by these distant, non-local levels of government.

Communities find it difficult to engage in long term planning because of the high turn-over in the political system. Provincial and federal elections sometimes result in policies that change on a frequent or short term basis, yet water and climate issues require long-term planning and significant long-term focus to achieve results that reflect the actual environmental exposures and vulnerabilities. Community members expressed a preference for their local governments who they believed were more aware of the local conditions and needs; they noted an interest in giving more emphasis to local authorities in the decision-making process of managing local water resources.

Citizens are genuinely interested and are willingly participating in watershed management. But they are interested in more than talk. They are interested in action and implementation. Meetings to increase awareness are necessary, but some stakeholders noted that they are tired of frequently meeting and not doing anything. Whatever improvements can be developed in simplifying the maze of water governance, it will be imperative to sustain and support citizen engagement. Finding mechanisms that lead to implementing constructive changes, by undertaking actual activities that result from the contributions of citizen engagement, will be a necessary piece of the water governance puzzle.

## ELQUI RIVER BASIN WATER GOVERNANCE INSTITUTIONAL SETTING

Water governance in Chile is defined in the national constitution. The Chilean Water Code has seen significant historical change since first established in 1855. The 1981 Water Code established a neo-liberal economic water market designed to promote agricultural development and economic efficiency. Essentially, water rights were privatized, deemed to be public property, and could be freely sold, bought, transferred, inherited or traded as a marketable commodity. The water rights are not tied to the land. This code was designed for expanded irrigation and agricultural development. Seventeen years later, revisions were made for environmental protection and improved equity. The governance of water in Chile is significantly affected by market drivers. Not all water is fully allocated. Shortages may be managed by large operators purchasing the rights from small water consumers (Diaz et al, 2005).

As in Canada, water in Chile is deemed to be a public good. In contrast to Canada, water rights in Chile are a marketable commodity. Chile's approach to water management is unique in the world, and has become the focus of research and study by countries and academics around the globe. Positions and viewpoints vary, as can be seen from the following quotations:

- "…Chile has become the world's leading example of the free-market approach to water law and water resources management, the textbook case of treating water rights not merely as private property but also as a fully marketable commodity" (Bauer, 2004).
- "[Chile's water]…system has resulted in speculation, hoarding, and impaired water management to the detriment of water sources." (Solanes and Gonzalez-Real, 1999)

Chile's Water Code was designed to promote the country's natural strengths of access to water and its warm climate. Agriculture has boomed with significant investment by agri-business in large-scale high-value irrigated crops (fruits, vegetables, table grapes, and grapes for wine, Pisco [a unique brandy], and other value-added processing). Agriculture in Chile has evolved remarkable since the implementation of the Water Code. The United Nations Food and Agriculture Organization has reported on "The Positive Externalities of Chilean

Agriculture" at the Roles of Agriculture International Conference (FAO, 2003a). Agricultural growth and export markets have had a significantly positive effect in Chile, with reductions in poverty, increases in value-added per worker, increasing employment and household income, among other benefits. Agricultural growth has played a larger role in reducing poverty than other sectors – "a 4.5% increase in agricultural output…leads to poverty reductions in the range of 6.7% to 9.9%" (FA0, 2003b). When perceptions of the environmental role of Chilean agriculture were studied in the IV Region (where the Elqui Valley is located), respondents stated they believe that "a clear definition of water rights has been a very important driver" (FAO, 2003c). Other water-related externalities are also credited for agricultural growth, the most notable being the application of drip irrigation technology, and investment in dams and irrigation projects – "The significant improvement in availability of water and in irrigation has been critical for agricultural development in the IV Region" (FAO,2003c). In addition to the economic activity of growing avocado, the plantations on mountain slopes (practiced in the Elqui Valley) is considered a positive buffer against soil erosion, as well as providing a scenic landscape in the semi-arid climate. Avocado plantations are also considered a strong sink for carbon and nitrogen, reducing concentrations of carbon dioxide (FAO, 2003d). Agricultural growth can have negative impacts if not properly mitigated. The rapid growth of agriculture has led to increased pesticide use, a potential health and environmental risk. Environmental exposure is not well understood. Ground water pollution from nitrates (likely from agriculture and septic systems) has been recorded in the Aconcagua basin. This basin also experiences surface water pollution from mining, agriculture and human sewage (FAO, 2003d).

It is evident that a principle driver of water management relates to water rights as a market commodity. This affects the capacity of formal governance institutions to address water conflict and competing demands. Business is heavily involved in water development, which is approved by the state. A user-pay mentality has developed and appears to have been accepted throughout the country. Chileans are exposed to full-cost pricing for water in a water market. Chile and Canada both do not regard water as a human right; however as earlier noted, in spite of different governance both countries do regard water as a public good.

A summary of the key government and non-government water management agencies in Chile is listed in Table 2 (after Diaz, 2005; and, WWW links):

**Table 2: Key Government and non-government agencies with interests in Water:**

| **GOVERNMENT OF CHILE:**<br>**Key guidance documents: Water Code (constitutionally-enshrined); General Directorate of Water www.dga.cl**<br>**Modifications to the Water Code:**<br>**http://www.dga.cl/index.php?option=content&task=section&id=45&Itemid=384** | |
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| **General Directorate of Water**, **DGA** - Dirección General de Agua, part of the Ministry of Public Works (**MOP** – Ministerio de Obras Públicas) | Plans the development of water resources, manages surface and ground water resources, reviews and authorized construction of large dams, oversees water user groups. Responsible for water rights and allocations. The DGA grants rights if water is physically and legally available. If insufficient water is available to meet requests, auctions are held and rights are sold to the highest bidder. Amendments in 2005 to the 1981 Water Code now grant more power to the DGA to address ecological needs and prevent hoarding. www.dga.ca and www.mop.cl |
| **Superintendency of Sanitary Services**, **SSIS** – Superintendencia de Servisios Sanitarios, MOP | Oversees the services of private companies providing potable water (quality and quantity) and the companies that treat wastewater; monitors operations, norms and regulations, sets and oversees water rates, etc. http://www.mop.cl/oirs/ and www.sisss.cl<br>http://www.siss.cl/siss2/article-3784.html |
| **Hydraulic Works Authority**, **DOH**- Dirección de Obras Hidraúlicas, part of | Is responsible for planning, design, construction, operation and maintenance of water (hydraulic) infrastructure (e.g. large-scale, medium-scale irrigation works, flood protection and drainage, water resource development for rural potable water, dams, |

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| MOP | reservoirs, and major water resource projects). |
| **National Water Institute INH –** Instituto Nacional Hydraúlica, MOP | Responsible for hydraulic engineering (studies, research, and various hydraulic projects) http://www.mop.cl/oirs/ |
| **Ministry of Health** (Salud) | Responsible for disease prevention in the delivery of potable water and safeguarding with wastewater systems; sets policy, norms and regulations for environmental health (e.g. air, water, etc). http://www.redsalud.gov.cl/conozcanos/dipolp3.html http://www.minsal.cl/ www.redsalud.cl |
| **National Commission of the Environment CONAMA** – Comisión Naciónal del Medio Ambiente | Inter-ministerial commission with responsibilities to protect the environment, and safeguard water resources from contamination www.conama.cl develops standards and controls for protection of water quality in the natural environment and for the protection of natural ecosystems http://www.conama.cl/portal/1301/article-33945.html Responsible for the development of a **National Strategy for Integrated Watershed Management** (approved by the Ministries of Public Works, Agriculture, Mining, Energy, Housing and Urban Development, Defense, Economy, Foreign Affairs, Planning, Health; promulgated December, 2007) http://www.conama.cl/portal/1301/article-42435.html |
| National Irrigation Commission CNR – Comisión Naciónal del Riego, Ministry of Agriculture: MINAGRI | Responsible to develop, enhance and improve irrigation development in Chile. Sets national irrigation policy, seeks to improve irrigation efficiency and production, promotes irrigation and drainage to assist vulnerable regions, conducts technical and economic research into irrigation feasibility and profitability, www.cnr.cl Part of the Ministry of Agriculture www.minagri.cl |
| Office of Agrarian Studies and Policy **OEDEPA** – Oficina de Estudios y Políticas Agrarias, MINAGRI | Conducts agri-sector research and establishes programs and policy for agriculture and agricultural development. Part of the Ministry of Agriculture. http://www.odepa.gob.cl/odepa |
| **Agriculture and Livestock Service SAG** – Servicio Agrícola y Ganadero, MINAGRI | Responsible to promote agriculture, livestock and forestry development in a sustainable manner. Promotes responsible production practices and management to sustain healthy natural resources and renewable natural resources. www.sag.cl |
| **National Forest Corporation CONAF** – Corporación Naciónal Forestal, MINAGRI | Contributes to the development of the country by conserving forests and forest ecosystems. Optimizes use of forest reserves (protection, conservation, reforestation, national parks and the environment). www.conaf.gob.cl |
| **Maritime and Merchant Marine Directorate – DIRECTEMAR –** Dirección General del Territorio Marítimo y de Marina Mercante | Monitors and protects Chile's 4.300 north-south coastal marine environment. Carries out national research, monitoring and protection of the aquatic marine environment. www.directemar.cl |
| **ASSOCIATIONS (historical long-term civil society groups – part of a "water culture")** | |
| **Rural Potable Water – APR** Comítes de Agua Potable Rural | Citizen stakeholder committees and co-operatives that support and develop Rural Potable Water systems (operation, maintenance, improvement, monitoring, fees) http://www.aprchile.cl/ |
| **Canal Associations** – Associación de Canalístas | Oversees dams and irrigation canal withdrawals; the Canalístas administer the use and distribution of the water in the main network of constructed canals or sets of canals within a basin. |
| **Vigilance Associations** – Juntas de Vigilancia | Oversees the natural course of water and surface water extractions and diversions at the basin or "basin-section" level (smaller-scale extractions). |
| **Water Communities** – Comunidades de Agua | Water user groups or communities with interests in water management at the rural scale. |
| **Drainage Communities** – Comunidades de Drenaje | Drainage communities with interests in drainage at the rural scale. |
| **PRIVATE COMPANIES** | |
| **Potable Water Treatment; and Wastewater Treatment** | Private sector companies are heavily involved in water and wastewater treatment, normally providing services for municipalities. The companies are overseen by the Superintendency of Sanitary Services. (smaller systems tend to be operated by the local governments) |
| **Agri-businesses** | Agri-business is heavily involved in high-value agricultural development reliant on state-of-the-art irrigation usually for export crops and highly diversified and value-added agriculture. There acquisition of water rights makes these companies key players in water use and water extraction. |
| **Mining** | Mineral and mining companies require water rights and access to water for |

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| | their operations. Competition for water is occurring particularly in areas where water is scarce. |
| **ENDESA – hydro-electricity** Empresa Naciónal de Electricidad | Created in 1943, Endesa operated for 42 years developing hydroelectricity (and irrigation) throughout the country, as a state company subsidiary of CORFO (Corporación de Fomento de Producción Corporation for Development of Production). The company was privatized in 1987 and now operates 53 plants in Latin America. Chile is heavily reliant on hydroelectricity for its energy. With increased water competition, it is expected there will be challenges to manage hydroelectric and irrigation demands.<br>www.endesa.cl |

## ASSESSING WATER GOVERNANCE IN THE ELQUI RIVER BASIN

Some have characterized the Chilean water market as the "law of the jungle", where the powerful can do what they want with the water rights of the small. Conflict is left to be resolved between the affected parties or by the courts. While the judicial system may be accessed, it is slow, costly, and unpredictable (Galaz, 2003). Review of water governance in Chile indicates potential for conflict between consumptive and non-consumptive water users (e.g. agriculture and hydro-electrical users). After inception of the Water Code in 1981, the market resulted in cases of hoarding and speculation of unused water rights. These actions perpetuate the belief that there is "stealing from the poor." The Water Code limited the capacity of the state to regulate water.

Chile's water markets are very unique and have been intensely studied around the globe. However, Carl Bauer states that "…it is essential to not lose sight of the water management issues that have received much less research attention. The two most important issues are the impacts of the Water Code on social equity, especially on peasant farmers and the rural poor, and the performance of the institutional framework in coordinating multiple water uses, managing river basins, resolving water conflicts, and protecting river ecosystems and instream flows….both issues demonstrate serious weaknesses of the Chilean model…these issues are at the heart of integrated water resources management." (Bauer, 2003)

The 1981 Water Code was finally revised in 2005 after 12 years of effort. In part, the Code's revisions are meant to address issues related to water hoarding and the need to retain a percentage of water for ecological needs of aquatic ecosystems. The revisions now give additional power to the state agencies. The Global Water Partnership states that Chile is making progress on the "3 E's" of integrated water resources management: economic efficiency, social equity and environmental sustainability (Global Water Partnership, 2007). Three lessons from Chile are identified as:

- water resource planning must be linked to national sustainable development
- water reform must be gradual, and tailored to economic, social and political conditions
- water strategies must be adaptable, allowing flexibility for decision-makers to address problems

Chile's Water Code Reform of 2005 is meant to correct limitations and problems in the 1981 Water Code: water hoarding, social equity, and environmental sustainability (e.g. ecological flows and sustainable aquifer management). Time will tell how successful these improvements will be.

The Chilean communities and rural stakeholders participating in the Institutional Adaptations to Climate Change project have a well-established and historic water culture and water awareness. The stakeholders are concerned about their vulnerability to climate, water scarcity, the risk of avalanches, drought and market pressures affecting their survival, personal well-being and their environment. Rural community stakeholders and agri-businesses express concern about water contamination and sustainable development. Some agri-businesses have drought plans in place and fear the current rates of development, stating many water users are not planning for shortages and are taking access to water for granted. The reality is that water supplies are variable, and shortages for large and small water users are expected from time to time. Further concern exists about reductions in annual precipitation and the potential for a changing climate. Recent variable weather (a severe winter with plant-killing frost) followed by drought and warmer than normal summer temperatures have placed stress on the agricultural economy and the small farmers and subsistence farmers. Agri-businesses continue to adapt to environmental and market pressures. The rural stakeholders continue to express concern about access to water and water equity. Virtually all water stakeholders are worried about water quality and a variety of contamination sources. They desire more knowledge on the condition and health of surface and ground water supplies. Similar to Canada, rural stakeholders feel that government is too distant and not as connected to their water-related problems as is needed for local adaptations to be effective. The notion of citizen engagement and participatory planning in water management decision-making is desired by local stakeholders striving to care for their environment and livelihood.

## CONCLUSIONS

Water governance models in Canada and Chile are uniquely different. Canada's water is essentially managed by provinces and the role of the federal government is one of shared jurisdiction with the provinces. Chile's water is managed by a strong national centralized approach, whereby much of the power has been relegated to private interests with the Water Code and private water rights. Both countries are adopting integrated water resource management principles. Interestingly, in spite of the variant models, rural communities and stakeholders in both countries express similar concerns. Stakeholders desire more active participation in water management, and flexible strategies that are suited to the local problems and needs. Water scarcity and water quality are topmost concerns for rural citizens and agri-businesses. Livelihood, a healthy environment and sustainable development are seen as essential for society's well-being and market viability. Governments will be challenged to address stakeholders concerns as water resources continue to be placed under increasing pressures of climate variability. Finding the balance for addressing climate-induced water stress will require adaptive institutions working together with civil society.

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