

Governance Institutions and Community Vulnerabilities to Climate-Induced Water Stress – Case studies in Canada and Chile

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The paper discusses the results of a comparative study of institutional adaptation to climate change and water scarcity in the South Saskatchewan River Basin (SSRB) of western Canada and the Elqui River Basin (ERB) in northern Chile. The study was done in the context of the Institutional Adaptation to Climate Change Project, an interdisciplinary project funded by the Social Science and Humanities Research Council of Canada. The SSRB and the ERB represent two large, regional, dryland water basins with significant irrigated agricultural production but with significantly different governance structures and water management approaches. The Canadian governance situation is characterized as decentralized multi-level governance with assigned water licenses; the Chilean as centralized with privatized water rights.

An important determinant in the ability of rural communities and rural households to adapt to current climate variability and future climate change impacts on water resources in environments like the SSRB and the ERB is the institutional setting surrounding water governance and the degree to which this setting facilitates or hinders the community's adaptive capacity to address climate and other stressors. Based on the definition of vulnerability adopted by the International Panel on Climate Change, the study focuses on governance institutions, and specifically water governance institutions, as one of the main determinants of adaptive capacity of the different rural sectors.

In both countries community vulnerability assessments and water governance assessments to present and past climate variability were carried out based on a comprehensive and interdisciplinary approach. The results of these assessments were analyzed in terms of future climate change scenarios and their potential impacts upon the rural sectors of both basins. In these terms, the project provides significant insights about the weakness and strengths of present adaptive capacity in the context of the expected changes in climate variability. As well, the results of the assessments allow comparing and contrasting the differences in terms of capacity of distinct governance structures to foster adaptive capacity in the rural sector.

Introduction

This paper compares, contrasts, and discusses the institutional adaptive capacities to respond to climate change in Chile and Canada. The study area was the Elqui River Basin (ERB) in northern Chile and in Canada the South Saskatchewan River Basin (SSRB) of western Canada. The SSRB and the ERB are both large, regional, dryland water basins with significant irrigated agricultural production. Both rely on snow pack or glacier run off. In each climate change impacts include changes to seasonal water flows in the river and increased variability predominated by longer dryer conditions (Canadian Integration Report, 2009; Chilean Integration Report, 2009). The governance structure and the associated distribution of water resources, however, are very different. While Canada's governance structure is characterized as decentralized multi-level governance with assigned water licenses; the Chilean governance structure is characterized as highly centralized with privatized water rights.

The Institutional Adaptations to Climate Change (IACC) Project was comprised of several units of study which were undertaken in both the Chile and Canadian study region. One unit comprised of natural scientists studied climate and future climate; another unit studied the communities and their vulnerabilities historically to climate; conflicts were examined in both Chile and Canada surrounding water and water infrastructure; finally water governance and its contribution to the rural communities' vulnerabilities was examined. Reports and papers prepared by each of the units of the project and the integration of these units are available on the project website, www.park.iacc.ca. The study was funded by the Social Science and Humanities Research Council of Canada.

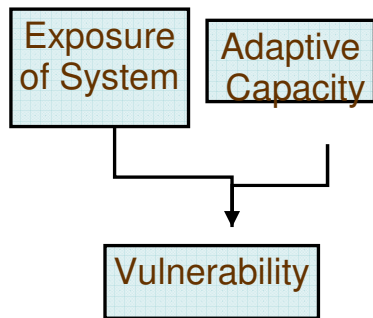
The methodological framework for the governance assessment in the Institutional Adaptation to Climate Change Project was established in a document defining institutions and the main dimension of a governance assessment (Diaz and Rojas, 2006) together with a baseline description of water governance in Canada (Corkal, Inch, and Adkins, 2007) and Chile (Diaz et al., 2005). Interviews were conducted in both Chile and Canada exploring dimensions of water governance facilitating or hindering adaptive capacity. Reports were prepared in Canada and Chile respectively by the separate teams conducting the research (Diaz, Hurlbert, Warren and Corkal, 2009; Reyes, Solas, Schwartz and Espinoza, 2009).

This paper provides a brief introduction of vulnerability and adaptive capacity as well as the institution of water governance is provided in Chile and Canada. A discussion of the vulnerabilities found in Chile and Canada follows. Based on this research study's findings, the capacity to foster adaptive capacity in the rural sector between Chile and Canada is compared and contrasted. This paper synthesizes some of the findings of the IACC project's units in respect of community vulnerability and adaptive capacity.

Vulnerability and Adaptation to Climate Change

This paper follows the Intergovernmental Panel on Climate Change (IPCC) defining vulnerability as the degree to which a system, such as a rural community, is susceptible to the adverse effects of climate change, including climate variability and extremes (Diaz et al., 2006; Olmos, 2001). Vulnerability, in this definition, is a function of the exposure/sensitivity and the capacity of a community to adapt to climate stress (Liverman, 1994; Wisner et al., 2005; Handmer et al., 1999; Smit and Wandel, 2006). The most vulnerable communities are those most likely to be exposed to climate change

impacts and are more sensitive to perturbation, with a limited capacity for adaptation (Adger and Kelly, 1999).



In this context the vulnerability of a community is not a function of climate alone, but rather, it is the result of multiple social conditions including environmental, social, economic, and political factors. These environmental, social, economic and political factors are interlaced in the dynamics of community vulnerability and the consequent development of adaptive strategies to reduce vulnerability (Smit et al., 2006). It is the combination of biophysical and social conditions, usually structural conditions (such as access to resources or the existence of social capital) which make people more or less exposed to climatic variability and events. The Third Report of the IPCC has identified a set of determinants of adaptive capacity that “influence the occurrence and nature of adaptation and thereby circumscribe the vulnerability of systems and their residual impacts” (IPCC, 2001, p. 893). These determinants include the existence of economic resources, technology, information and skills (including human capital), infrastructure, equitable social relations, as well as developed institutions such as government bodies, the focus of this article. The IPCC considers that established institutional conditions, such as the existence and availability of insurance mechanisms or water conservation programs, facilitate the management of climate-related risks reinforcing the adaptive

capacity of the population (IPCC, 2001, pp. 896-897). Accordingly, countries with well-developed institutions have a greater capacity than countries with less effective institutional arrangements.

Water governance is an institutional network that can expose people to the phenomena of climate variability and climate change and/or increase their capacity to reduce their negative impacts (IPCC, 2001; IPCC WG2, 2007). Institutions, or conventions, norms and formally sanctioned rules of society (Young, 2008) are central to influencing adaptation as they structure impacts and vulnerability, they mediate between individual and collective responses to climate impacts, and thereby shape outcomes of adaptation, and they act as a means of the delivery of external resources to facilitate adaptation and thus govern access to such resources (Agrawal, 2008).

Water Governance in Chile and Canada

Government systems are radically different in Canada and in Chile. Canada has adopted a federal system, where the federal and provincial governments assume responsibilities in different areas and in different degrees. Chile, on the other side, has a central government, where functions and responsibilities are concentrated in central institutions that organize their work based on provincial agencies.

Stark differences exist in the water governance institutions of Chile and Canada. Canadian water governance institutions are dominated by a government management model, where provincial governments play a central role in the management of water resources within provincial borders. Water rights are allocated predominately based on “first in time first in right” rules. In Alberta, one of the provinces that comprise the SSRB, there is the ability to transfer interests in water under certain circumstances and in

certain situations; however, an active water market is not yet in existence. Although some areas of the study area are fully allocated and have experienced shortages in allocated water interests, this is a relatively rare occurrence. In the event of conflicts or disputes between water rights holders the government can take several measures to attempt to resolve the matter prior to leaving the parties to sort out their interests in a court of law. The Canadian governance situation is characterized as decentralized, multi-level governance with assigned water licenses.

In Chile a Water Code established a market for water rights, where water rights are treated as private property, so they could be sold, rented, and transferred to other people. The government has a very limited role in administering water transactions and water conflicts, since they are defined as issues to be resolved between private individuals. Given that in some areas water resources are fully allocated local communities, small, medium or poor farmers may be without water rights and without the means to purchase any water rights (Reyes et al., 2009; Bauer, 1998, p. 67).

Climate and Future Climate in the Study Area

The study regions in Chile and Canada both represent two large, regional, dryland water basins with significant irrigated agricultural production. In Canada, the South Saskatchewan River Basin (SSRB) covers approximately 166,000 square kilometres, encompassing three provinces, with four major rivers and is already experiencing a wide variability of climate, geography and hydrology (Toth et al., 2009). A water deficit is a characteristic of this area and it is Canada's largest dryland watershed and highly dependent on snowmelt runoff from the eastern slopes of the Rocky Mountains. The six rural communities selected for the community vulnerability assessment are all located in

the Palliser Triangle, the driest part of the Canadian Prairies yet highly dependent on agriculture.

Climate change scenarios for the SSRB predict future increases in temperatures and precipitation. Most of the warming is occurring in winter, such that the frost-free growing season is getting longer, although the area is also losing some of the advantages of a cold winter that eliminates many pests and diseases and stores water as snow (the most abundant, reliable and predictable source of water). Most of the extra precipitation is expected in winter and spring and increasingly in the form of rain as the climate warms. This precipitation will be lost during more days of evaporation and transpiration by plants during a longer frost-free growing season. On average there will be longer, warmer and drier summers with lower river flows in summer, the season of greatest demand. While the shift to warmer, wetter winters and drier summers is almost certain, most of the risk from climate change will be related to an increase in year to year variability, included prolonged and more severe and frequent periods of drought and occasionally extreme wet conditions (IACC Canadian Integration Report, 2009; Sauchyn et al., 2007).

The study region in Chile, the Elqui River Basin, is located in the northern most basin of the Coquimbo region in northern Chile comprising almost ten thousand square kilometres and a length of one hundred and fifty kilometres between the coast and the highest mountain range on a straight east to west line. The basin runs from the eastern limits with Argentina and the high Andean mountains down to the Pacific Ocean. This is a semi-arid region with a high inter-annual variation in precipitation and often eight to ten months without precipitation (with the exception of the high mountain areas). A

significant reduction in precipitation over the past century has already been noted close to the coast with a reduction from 150 – 180 mm in the early 1900s to 100 mm average in the last twenty five years (Chilean Integration Report, 2009).

Future climate scenarios showed a trend toward increased higher minimum and maximum temperatures, especially during winter (June to July). The number of hot days is expected to increase, and the number of days with frost decrease. Precipitation is expected to remain close to or lower than that observed. The effect on the water in the rivers is not clear due to sparse high mountain precipitation data and lack of knowledge concerning the cryosphere of the Elqui River Basin (Fiebig et al, 2008).

Comparison and Discussion of Adaptive Capacity

Ability to Foster Adaptive Capacity in the ERB

Institutional adaptation efforts in Chile have been mediated by a structural process of social differentiation among agricultural producers. The agricultural sector has had a significant structural transformation as a result of the neo-liberal policies adopted by the military regime (1973-1989), resulting in the creation of a modern agriculture economy that concentrates high levels of capital and produces mostly for the external market. On the other side, there are a large number of small producers, with limited amounts of capital and with a production oriented to the internal markets. The most dynamic sectors have profited from a large numbers of government institutional support programs, from the availability of credit to access to markets. Small producers, on the other side, have had a very limited support from the government. As a result small producers have diminished their capacity to compete in the markets (Hojman, 1990) resulting in an increasing economic and social vulnerability. In these terms, the

institutional adaptive capacity developed by the government has been unfairly distributed, been mainly oriented to support modern farmers and has resulted in the creation or exacerbation of other producers' vulnerabilities.

This is also the case in relation to crop insurance, a significant form of adaptation to climate extreme events. Medium and large farmers have benefited from commercial crop insurance; meanwhile small farmers have had a more restricted access to insurance. The Chilean Ministry of Agriculture developed a program to integrate small farmers to insurance services by covering up to 50% of the costs. However, only a small number can afford to pay (GORE, 2008). Government support programs such as these are not always timely and often do not cover the full economic impact of climatic phenomena (Salas et al., 2009).

This pattern of distribution of adaptive capacity is also found in the ERB. Between 1915 and 2003 there were eleven years of extreme drought (less than 30mm of precipitation) and sixteen years of moderate drought (30-60 mm of annual precipitation) in the ERB and there has been a steady decrease in precipitation during the last half of the twentieth century (Carrasco et al, cited in Fiebig et al, 2009). Adaptation has occurred in the form of water infrastructure and irrigation schemes which started early in the nineteenth century aimed at regulating river flows and water shortages. The La Laguna Dam was built in 1941 and the Puclaro in the late 1990s with the technical support and initial managerial support of the Department of Hydraulic Works – DOH of the Ministry of Public Works. Three irrigation districts manage the irrigation systems and are now fairly autonomous and well structured social organizations (Salas et al, 2009). Irrigation is considered a key component to expand agricultural productivity and place Chile among

the top ten agricultural exporting countries (Reyes et al., 2009). These efforts have reduced the risks associated with drought, enhancing water security and the adaptive capacity of large and medium farmers. These initiatives have resulted in an increased global trade of crops produced through irrigation and benefits to the modern farmers who have been able to secure water rights (which includes all irrigation farmers). Meanwhile those without rights have experienced reduced adaptive capacity

Other rural producers in the ERB, such as goat herders, a traditional component of the subsistence economy of the area, have been reduced in numbers by 43 percent in the last seventeen years as a result of an absence of government programs that could facilitate their adaptation to increasing aridity and deforestation (Salas et al, 2009). This would demonstrate a lack of interest in the part of the Chilean government for supporting this economy.

The dams associated with irrigation in the study area have resulted in the relocation of the town of Gualliguaica and three hamlets onto nearby lands. Social conflicts resulted and interviewees stated the compensation packages eventually negotiated did not replace the social capital lost nor traditional orchards and river habitats. Today these communities are located next to the dam but cannot extract water for irrigation nor use it to develop income generating activities associated with tourism (Rojas et al., 2009) as they do not have water rights.

Mudslides are a recurrent feature affecting some of the rural communities in the ERB, especially those located at the foothills close to the river and ravines, a location that render them particularly vulnerable. Also, floods are a common feature in the basin: 373 occurrences of flood have been registered in the study area from 1900 to 1981 (Chilean

Integration Committee, 2009). In nineteen ninety seven the ERB experienced large mudslides and floods which killed two people and produced much economic damage (Chilean Integration Committee, 2009). Floods and mudslides such as these exacerbate the problems associated with mining activities and unmanaged tailings sites. Tailing sites during mudslides and floods contaminate soil and water sources (Salas et al., 2009). There is weak support programs and coordination for disaster relief in these communities (Salas et al., 2009, p. 19). Communities often can't identify the roles and competence of public institutions and can't find ways to reach the institutions. Poor coordination and communication exists between the community and local and regional authorities.

To improve access to drinking water in rural areas, community controlled drinking water systems became a goal for the Chilean government in the early 1990s. More than 500 community neighbourhood associations manage and operate drinking water systems to over one million people in Chile's rural areas. An extended system of social capital associated with these groups is a significant development of adaptive capacity. As well, effort has been made to address rural sanitation. However the poor coordination among government agencies has left water quality control and sanitation in critical condition. Close to half a million isolated and dispersed rural dwellers rely on trucked in water or their own wells or makeshift systems (Reyes et al., 2009). Some communities are without water rights and without water (Barrioneuvo, 2009).

The centralized decision making of the Chilean government limits the activities of regional water agencies and local governments. Regional agencies have limited discretionary power to change water policies and resourcing such that centralization is a recurrent complaint among regional agencies associated with water (Reyes et al., 2009).

At the regional and national level, multi-agency coordination and planning is weak (Salas et al., 2009, p. 19). Planning is reactive, not proactive (ibid., 2009). Local governments are first responders for climatic events, but lack the capacity to respond to water contamination or other management issues and are left with trucking in water. Local governments also could pass environmental by-laws but apparently fail to have the capacity to do so (Integration Report, 2009).

The “Water Dialogues” are a pilot project for integrated watershed management attempting to include a diverse set of institutions and multiple stakeholders in developing a common regional water agenda (GORE, 2007). However this process is just commencing and its ability to address the issues of coordination and poor local capacity to manage water issues has yet to be seen. It may be several years before a watershed authority in the study region is established as only three pilot projects are currently commencing in Chile. Integration of information and meaningful participation of different stakeholders will be a challenge. Climate change concerns still do not permeate government water policy concerns and it is too premature to know if these concerns will be raised in this process.

Water quality, quantity and climatic data gaps exist which affect modeling capacities able to analyze future climate scenarios and even make projections on how ground reservoirs and glaciers will be affected. This inhibits the medium and long term planning capacities of the water governance institutions, both regionally and nationally (Chilean Integration Committee, 2009).

Chile has an adaptive capacity to respond to climatic variability. It is uncertain if this capacity will be great enough to respond adequately to anticipated climate change

conditions which include more severe drought and variability. What adaptive capacity Chile does have is not distributed evenly amongst its rural people and communities. The poor farmers and communities without water rights have greater vulnerability than the large and irrigated farmers. Proactive planning and policy development to build adaptive capacity especially for the most vulnerable people is required.

Ability to Foster Adaptive Capacity in Canada

The SSRB is characterized by a water deficit and highly dependent on snowmelt runoff from the eastern slopes of the Rocky Mountains. This affects supply of water to the regional population as well as farming activity in the region. The most recent significant drought was in 2001 and 2002 causing net farm income to be negative in the province of Saskatchewan and zero in Alberta with production losses reaching over two billion dollars in the two provinces (Wittrock et al., 2007). The upper reaches of the SSRB (southern Alberta) also experience too much precipitation and flooding. Three of the six communities assessed by the IACC project experienced three severe floods from 1995 onwards (Magzul and Rojas, 2006). A range of threats relating to quality and quantity of surface and groundwater exist due to nutrient contamination from such things as agricultural and industrial activities. Increasing water demand is a problem and some areas of the study region have water fully allocated. Non climate sources of stress also exist in these rural communities which are heavily dependent on agriculture just as in Chile. These stresses include rural out-migration, changes in rural infrastructure, health care and education and to a large extent a product of the transformations in the global agricultural market (Jones and Schmeiser, 2005; Stirling, 2004).

Many adaptive practices, processes, systems and infrastructure have been tried and adopted by communities and households to reduce risk. Relocation, diversifying of income sources and crops, adopting new technologies, building irrigation and flood control infrastructure are just a few. Past crises have revealed vulnerabilities and exposed institutional weaknesses forcing institutional innovations to address these. The Prairie Farm Rehabilitation Administration (PFRA) was a significant institutional adaptation to address the historic droughts in the Depression surrounding the 1930s helping with water infrastructure, knowledge and capacity building. This institution continues as a branch of the federal department of Agriculture and Agri-Food Canada and has been re-named Agri-Environment Services Branch. As well the Prairie Provinces Water Board was established in 1948 to formally manage the apportionment of water amongst the three prairie provinces of Manitoba, Saskatchewan and Alberta (Canadian Integration Report, 2009).

Significant investment in irrigation infrastructure and technology has occurred in the SSRB. Saskatchewan has approximately 11% and Alberta well over 60% of Canada's irrigated land. Safety net programs to manage unpredictable weather conditions are offered by both the Federal and provincial governments albeit there s some dissatisfactions amongst interviewees with the high costs of the services.

With drinking water disease outbreaks that have occurred in the last decade in Canada, a renewed focus on water governance has occurred. Provincial governments have created or revisited water policy and legislation improving the management of water resources in respect of drinking water and also creating local watershed groups tasked with source water protection. Only several watersheds have yet to finish these plans.

Although these organizations could play a significant role in increasing adaptive capacity in both provinces, the future of these organizations, their funding and mandate has yet to be fully determined.

Interviews with participants, focus groups, and studies of water related conflicts all confirmed that crisis results in institutional innovations, but also that adaptive capacity is not distributed evenly. Of the study communities the Kanai Blood Reserve was the most vulnerable due to particular conditions characterizing First Nation communities. Other communities also were highly sensitive due to lack of access to irrigation and small and aging populations. Communities with well-established water infrastructure (storage reservoirs and distribution networks) and who utilize irrigation in period of low precipitation were the most resilient. Further harm to communal identity and stability, people's sense of heritage, cultural integrity, informal systems of governance and trust-based relationships often are not part of policy and focus by water governance institutions. Preserving this social capital, new styles of policy building and development relating to ecosystem and environmental preservation are often neglected by institutions but would assist in building local and rural resilience.

Many water data collection issues were reported by interviewees. Identified gaps in the data pool (water quality, quantity and use, and climate data) were identified. Uncertainty exists about what data is available, what can be accessed by whom and who is responsible for collecting and sharing (Diaz et al., 2009, p. 53). If the status of the water resource is currently uncertain it is difficult to make determinations about resilience and adaptation in the face of climate change.

Information about climate is essential in order to effectively respond. Most research into climate change has focused on general trends and average conditions, but climate's biggest impacts on humanity have been a result of extreme events. The present notion of variability in climate change scenarios is based on past events and this assumption may be flawed under future conditions where climate is influenced by increasing global warming. A better understanding of climate variability now and under various climate change scenarios is needed. This is a significant contributor to not being able to translate comprehensive climate change policy into a comprehensive action plan to address climate change issues, to manage the risks and opportunities of new climate conditions. There have been significant increases in the institutional research capacity in the area of climate change and water resources at universities, within the Prairie Provinces and the federal government. (Agriculture and Agri-Food Canada, 2008). Ongoing funding will still be required.

Challenges surrounding data availability have contributed to an inability and a deficit in long term planning. No concerted and collaborative effort exists in respect of future climate change and often planning is limited by the election cycle. No drought plan exists in Saskatchewan (Hurlbert et al., 2009) and Alberta's plan focuses on short term coping strategies at the producer level. There is a need for a plan addressing the larger picture of water allocation during times of surface water shortage (Wandel, 2009). Addressing issues beyond provincial borders and an appropriate federal water policy and plan is lacking.

A multitude of water organizations exist at the provincial and municipal level making interagency coordination an issue. Complexity creates confusion even amongst

government officials themselves, let alone stakeholders and the general public. A need to establish clear roles and coordinate water activities was discovered in participant interviews and focus groups. A further constraint of first in time first in right licensing exists. Although water transfers are allowed in Alberta, the construction of further irrigation and rural residents (including some municipalities) are constrained by this system.

Currently most water supply and infrastructure challenges in Saskatchewan are met by municipal governments, and individual farm operators. The government agencies with experience and capacity to deliver rural water programming solutions to water stressed communities and farmsteads are facing uncertain futures due to institutional rearrangements. If the two institutions of the Agri-Environment Services Branch and SaskWater were to disappear a deficit in capacity and a major vulnerability would result. Alberta faces similar challenges with the threat to long time Alberta Environment and Alberta Agriculture employees who may eventually retire or be replaced with people of lesser knowledge.

The stability of Canadian politics (in comparison to Chile) in combination with the historic climatic variability in the study region has allowed significant institutional adaptation since the beginning of the twentieth century. These institutions still have an ability to respond to future climate change albeit somewhat reduced given program cuts and neoliberal policies. It is doubtful these governance institutions could effectively respond to an extended period of drought greater than three years. Greater focus on adaptation in planning, policy and decision making taking into account predictions of future climate is required.

Adaptive capacity in Canada is not equally distributed. Communities without access to water infrastructure and irrigation are significantly disadvantaged in terms of adaptive capacity. Some First Nations communities are particularly disadvantaged in regards to adaptive capacity. Special considerations for each community will be required in order to improve adaptive capacity. Policies and mechanisms appropriate to a rural community may not be transferable and appropriate for a First Nation community. Specific planning for adaptation to climate is required at all levels of government and community (Hurlbert et al., n.d.).

Comparison of Adaptive Capacity and Vulnerability – Canada and Chile

Many similarities in vulnerability exist between Canada and Chile, which is surprising given the significantly different governance structure surrounding water.

These similarities can be characterized in four categories:

1. Structural Water Governance Issues

Both Chile and Canada have similar issues surrounding water governance. In spite of the different levels of centralization of the government systems in these two countries, their water governance is characterized by the multiplicity of water governance actors and coordination issues between all of these actors. This is partly due to the fact that water affects many different government departments and institutional mandates. It is also in part due to the reduction of government occurring in the last forty years and fewer government personnel accessible in rural communities. In this context rural households and communities are uncertain which institution is responsible for which water function.

Election cycles in both countries make long term planning in relation to water an issue. Climate change science is generally very long term, from twenty to fifty year time

frames, yet governments rarely set binding legislation and policy with a planning time frame further than a few years into the future. These time frame disparities make it very difficult for effective policies, plans, legislation and regulations to be prepared and adopted in response to anticipated climate change. Large investments in water infrastructure required to adapt to future droughts anticipated by climate change are costly and hard to implement for political parties interested in re-election in a few years especially in difficult economic times.

2. Data Issues

Both Chile and Canada have gaps in climate and water quantity and quality data. Coordination of data bases and knowledge gaps of what data exists are issues. Funding of programs, collecting, storing and sharing this data have been cut in past years contributing to this issue and not remedying the issue. This lack of information is detrimental to the development of policies able to foster adaptive capacity to climate variability and climate change

3. Emergence of Civil Society Watershed Groups

Integrated watershed management has emerged for consideration in both countries which is consistent with its adoption as a best practice (GWP, 2009). Canada is significantly more advanced than Chile in this regard and Chile is really only in the pilot project stage. This may be in part due to the strong centralized nature of Chile's water governance and the more decentralized nature of Canada's. Decentralization is more in keeping with local groups managing local water. Even with Canada's greater experience with watershed groups and integrated watershed management planning of several years, firm conclusions on the longevity and success of this initiative would be premature.

4. Unequal Distribution of Vulnerability and Adaptive Capacity

Both Chile and Canada have certain communities and groups of individuals who are more vulnerable and have less adaptive capacity than others. As such adaptive capacity is distributed unevenly. Some households and communities will be affected more severely by future climate change than others. Government programs of income stability appear unequally accessible to individual; households. Some communities and individuals have better access to water, water infrastructure, and economic capital fostering resilience than others. Groups with high adaptive capacity in both Chile and Canada tend to be larger more well off farmers especially those with irrigation. Vulnerable peoples and communities tend to be poorer, and not have the same access to resources including water infrastructure. This will affect negatively the health and livelihood of these people in both study regions.

The differences in the vulnerabilities and adaptive capacities between Chile and Canada do relate to the different governance structures of each country. While Chile has a strong central governance regime it lacks regional discretion and presence. This leaves rural communities especially vulnerable in times of disasters such as mudslides and with water programs (crop insurance and drinking water or sanitation) that have not been particularly effective. While Canada has a strong decentralized water governance structure residing in its provinces it lacks a current federal water policy and strategy,. Some communities studied in the SSRB were more vulnerable than others but without same degree of lack of access to and benefit from water for drinking and sanitation. Although crop insurance and water infrastructure programs were complained about as expensive and unsatisfactory, they were not characterized as completely unavailable.

Some believe not having a federal water policy is a disadvantage especially in relation to preventing the privatization of water and ensuring the human right to water for all (Barlow, 2007).

Irrigation has been a significant government policy in Chile in recent decades. In Canada irrigation was developed some time ago and new irrigation projects have been less predominant in recent decades than in Chile. This is a significant adaptation to climate change and Chile's export agricultural industry has expanded considerably. Opportunity for irrigation expansion exists only in Saskatchewan in the study region and no current federal or provincial government plans to support this infrastructure exists. In Canada this may be another disadvantage of not having a centralized government involved in water governance to a greater degree. More involvement arguably would lead to more funding of large infrastructure programs such as those required for the building of irrigation.

Both countries will increasingly face water shortages and potential conflicts amongst current water rights holders. Neither country has well established institutions to respond to these conflicts. Chile will predominately rely on the court system and legal action and the provinces of Saskatchewan and Alberta, civil society and water bureaucrats. Not planning for increased conflict as a result of water shortages due to climate change increases vulnerability leading to further reductions in adaptive capacity (Rojas et al., 2009).

The study in Chile concluded that a significant threat was the loss of the social capital associated with community drinking water committees while in Saskatchewan a significant threat was the loss of institutional knowledge on water adaptation at

SaskWater the community drinking water institution and the federal government department of Agri-Environment Services Branch (formerly PFRA). The former institutions, SaskWater is the institution with knowledge and skill in providing drinking water solutions to people and communities; the latter institutions PFRA is an institution with the knowledge and skills to provide assistance to farmers in managing and responding to dry conditions including with infrastructure needs, crop needs and other informational needs. The threatened loss of the institutional capacity may be a result in both countries of a failure to plan for climate change adaptation.

The differences between Chile and Canada may be a result of the very different water governance regimes, cultural and historic background of these two countries. The striking similarities in vulnerability and adaptive capacity are noteworthy. These similarities could in part be due to the predominant influence of a global market economy on water governance institutions. This economic social structure has contributed to unequal distribution of economic resources and adaptive capacities in both countries. Government deficit and spending reductions associated with a global market economy has also contributed to reduced government safety programs, data collection and monitoring, and local presence. A counter influence has been the creation of local watershed groups and integrated water management (albeit only in a pilot experimental stage in Chile). However the sustainability of these groups is highly questionable into the future in both countries. Perhaps the mandate of these groups is too focused on water and not focused enough on community social capital building. Individuals and households suffering impacts of climate change which will include health and economic

repercussions may have little time and receive little assistance from one group focused on only water.

Conclusion

Both study regions in Chile and Canada face risk and future uncertainty surrounding climate. This will have real impact on communities and people's livelihoods. This changing climate will also bring certain opportunities and lessons can be learned from both the Chilean and Canadian case study on the reduction of vulnerabilities and the improvement of resiliency in the future.

Global economic forces appear to affect both countries resulting in vulnerability for lower socio economic people and people without access to water and water infrastructure. Adaptive capacity is unequally distributed in both countries. It is by far the lower socio economic communities and individuals with higher vulnerability and more risk to their livelihoods as a result of climate change. Both countries face uncertainty about the resolution of water conflicts between water rights holders in a future with more constrained water availability, data availability challenges, and risk of loss of institutional capacity.

Water governance and policy choices can make significant differences in improving adaptive capacity and resiliency, or alternatively increasing vulnerability, regardless of global economic forces. Often the choice of policy initiatives will have disparate effects improving adaptive capacity for some, and reducing it for others. As such a number of different policy initiatives aimed at different communities and people will be required. The same policy or program may not be universally beneficial. Recent governance changes improving civil society participation and drinking water are cause

for optimism. However, more needs to be considered. Momentum needs to continue in exploring new technologies, new farming and environmental practices, expanding irrigation, and safety net programs for the most vulnerable to climate change. More research on adaptation, its barriers and limitations would provide solid grounding for difficult future decisions. The breadth and depth of adaptation is daunting, but continued dialogue, research and planning is a requisite.

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