Local Institutions and Adaptation to Climate-Induced Water Problems

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Abstract
In spite of the growing consensus regarding global warming and its impact upon water resources, there is still a limited understanding of the adaptive process of human communities to climate stressors. The IPCC argues that the existence of a regional adaptive capacity—the ability and predisposition to use and develop local and regional resources in the pursuit of adaptation—is fundamental for the sustainability of communities in climate change. This paper discusses the roles that local formal and informal institutions play in fostering the adaptive capacity of a set of rural communities in the semi-arid regions of Canada and Chile. The discussion is based on the initial results of a set of vulnerability assessments of rural communities in northern Chile and western Canada. The results indicate the existence of a community adaptive capacity to climate variability and extreme climate events in both countries. This adaptive capacity, however, is limited given the severity of the expected impacts of climate change.

Introduction

There is no doubt that global warming is already producing significant changes in local conditions, challenging the limits of our adaptive capacity. There is clear evidence that global environmental change is advancing faster that what was expected, with dramatic consequences. The melting of glaciers, polar ice, and the flooding of New Orleans are sad indicators of how fragile human and ecological settings can be to extreme forms of weather. There is also mounting evidence that the impacts of global warming will intensify, producing increasing variations in local weather patterns and water supplies, disturbing ecosystems and soil landscapes and impacting on economic production and social conditions.

The last report of the Intergovernmental Panel on Climate Change (IPCC) indicates that climate change will impact large areas of the Americas. Based on various climate scenarios, the IPCC estimates that by the year 2100, mean regional temperatures will rise between 2°C and 6°C. Important changes in rainfall patterns, and increases in temperatures and the intensity and severity of extreme climate events, have already been observed, with negative impacts for people's livelihoods. Expected impacts involve the displacement of forests, reduction of the extent and volume of glaciers, loss of agricultural soil, biological imbalances and increasing pest intensity, sea-level rise, and water scarcities. Thus, anticipated climate changes will seriously impact regional development, affecting everyone. However, it will disproportionately affect rural communities given their dependency on natural resources, restricted fiscal policies, and exposure to other stressors. Among these, dryland communities tend to be the most vulnerable due to their relative insecurity in terms of access to water resources. Climate change, however, could also bring new opportunities (i.e., expansion of cultivated areas). Expanding our knowledge about climate change impacts and adaptive capacities is essential for an effective management of both threats and opportunities.

Despite the consensus regarding global warming and its impacts, there is a limited understanding of existing vulnerabilities and adaptive capacities of local populations. This information gap is especially important in the context of climate change policies. Most governments have focused on the development of a mitigation policy which will not significantly alter the process of climate change and its impacts. Thus, effective adaptation policies, based

upon sustainability principles and able to deal with opportunities and threats of climate change, are also required to increase the communities' ability to reduce their vulnerability to the adverse impacts of climate change and maximize its benefits.

This paper presents the preliminary results of a comparative international research project focused on the vulnerability of Canadian and Chilean rural communities to climate and climate-related water problems. The first section describes the research project and its objectives. The second section discusses the conceptual and methodological framework of the project as a way to introduce the context for the assessment of the vulnerabilities of the rural communities. The third section outlines the biophysical and social characteristics of the regions where the communities are based, as well as the governance systems that define the management and use of water resources in the regions. Finally, the article discusses some of the results of the community vulnerability assessment and their implications for the adaptive capacities of rural people to present and future climate impacts and water stress.

The IACC Project

The Institutional Adaptation to Climate Change (IACC) project intends to develop a better understanding of the role that local and governance institutions play in the development of an adaptive capacity to climate-related problems. The project, supported by the Social Sciences and Humanities Research Council of Canada, is conducted by an interdisciplinary team of fifteen researchers and research assistants from a variety of disciplines—biology, ecology, engineering, psychology, mathematics, sociology, geography, climatology, economics, history and philosophy. Five Canadian universities and a Chilean university are academic partners in this research initiative. In addition, eleven government agencies and institutes in Canada and Chile have committed resources to the development and implementation of the project (more information is available at: www.parc.ca/mcri).

The goal of the project is to develop a comprehensive understanding of the capacities of regional 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. This goal is addressed through a comparative study of river basins at different stages of social and environmental vulnerability: one in western Canada and another in north-central Chile. Both regions have a dry climate adjacent to a major mountain system and landscapes at risk of desertification, as well as an agricultural economy dependent on irrigation water derived from mountain snow and glaciers. As a result of drier conditions and increased climatic uncertainty, it is expected that they will be similarly affected by climate change. In this context, the specific objectives of the project are: (a) to identify the current social and physical vulnerabilities related to water resource scarcity in the two dryland regions; (b) to examine the effects of climate change risks on the identified vulnerabilities; and (c) to foster a dialogue for the development of a strategy of adaptation to climate change.

Given the impossibility of including all regional institutions and human settings existing in the two basins, the project decided to focus on the vulnerabilities of rural communities—considering large urban conglomerates as part of the contextual conditions that define the management of water resources in the rural sector—and those governance institutions, especially those linked to water management, that impact upon those vulnerabilities. Thus, the project seeks to understand the adaptive capacity of rural communities and the roles played by the institutions of governance in the development (or underdevelopment) of the communities' adaptive capacity. It is a policy-oriented project that should contribute to the identification of opportunities to improve the way in which governance institutions manage natural resources, especially water

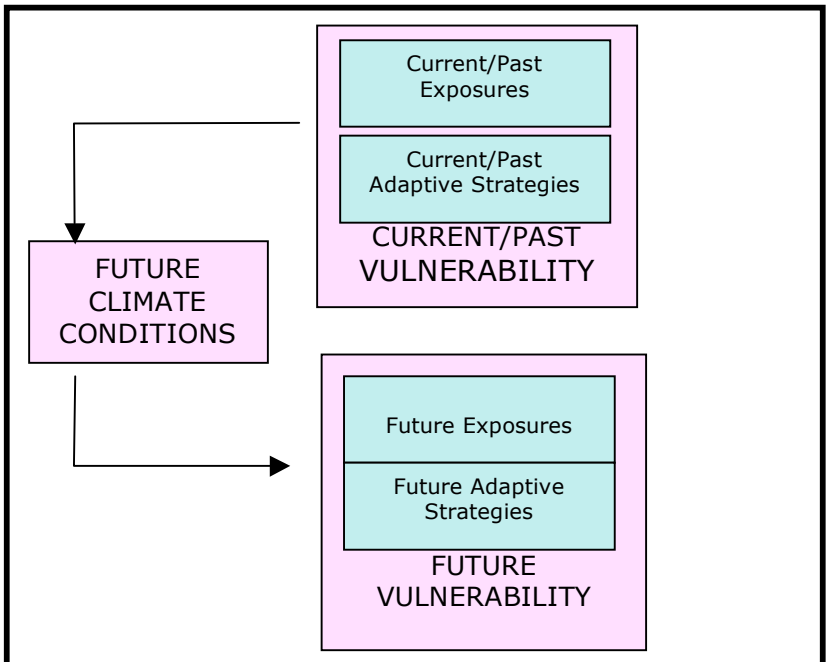
resources, in the context of new climatic conditions, and reduce the vulnerability of the regional rural population.

Vulnerability and Adaptive Capacity

In the global environmental change literature considerable attention has been devoted to the idea of vulnerability as a basic step for effective risk reduction. In general terms, vulnerability is understood as the capacity to be wounded by a perturbation or stress, whether environmental or socioeconomic (Kasperson and Kasperson, 2005). Vulnerability is a concept subjected to many definitions, depending on disciplinary approaches and methodological orientations (Birkmann, 2006). There is, however, an increasing consensus about the need to move from a technocratic paradigm with its hazard-centred interest in geophysical processes into one that emphasizes the mutuality of hazard and social conditions (Hilhorst, 2004). The definition of the IPCC (2001) 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. 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; Smit and Wandel, 2006). Accordingly, the most vulnerable systems are those most likely to be exposed, which are more sensitive to perturbation, and which possess limited capacity for adaptation (Adger and Kelly, 1999; Wisner et al., 2005).

Central in the IACC project's approach to the study of institutional adaptation to climate change has been this concept of "vulnerability." Based on this notion of vulnerability, the project adopted a vulnerability assessment methodological model. The model (see Figure 1) emphasizes the need to analyze not only the future vulnerability of systems, but also their vulnerability in the context of current and future climate conditions. The model identifies three sets of interrelated activities: (a) the development of a systematic understanding of the current exposure of a system and its adaptive capacity; (b) the assessment of future climate conditions for the area where the system occurs; and (c) the assessment of future vulnerabilities based on an analysis of how the existing vulnerabilities of the system will be affected by future climate conditions. Accordingly, the model seeks to understand the vulnerabilities of the present in the context of a plausible future climate baseline.

Figure 1. The Vulnerability Assessment Approach



In this conceptual framework the vulnerability of a community is not a function of climate alone, but the result of multiple stressors including environmental, social, economic, and political factors. It is impossible to separate the impacts of climate events on a rural community from the impacts of other factors, such as the price of grain, high levels of regional unemployment, increasing out-migration of young people, or lack of proper basic services. These stressors affect the vulnerability of a community, as much as the biophysical aspects of climate. Moreover, they could act *in tandem* multiplying each other's impacts (or reducing them). Thus, effective analysis of the vulnerability of communities needs to take into consideration those environmental, social, economic and political factors which shape exposures, sensibilities, and adaptive capacities.

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). Thus, adaptation depends on the existing adaptive capacity of the system to cope with the impacts of climate variability and climate change. Adaptive capacity involves both the existence of resources available for adaptation and the ability and predisposition to use these resources "in the pursuit of adaptation" (Burton, 2005). Strengthening this capacity is a necessary condition for the reduction of future vulnerabilities. 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 a set of determinants of adaptive capacity. They "influence the occurrence and nature of adaptation and thereby circumscribe the vulnerability of systems and their residual impacts." These determinants include the existence of economic resources, technology, information and skills (including human capital), infrastructure, equity and "well-developed institutions" (IPCC, 2001: 893) which are the focus of the IACC project. According to the IPCC, established institutions facilitate the management of climate-related risks—such as the existence and availability of insurance mechanisms, water conservation programs, and others—reinforcing the adaptive capacity of the population (IPCC, 2001: 896–97). Accordingly, it is expected that countries or regions with "well-developed institutions" have a greater capacity than countries or region with "less effective institutional arrangements."

There is, however, a significant gap in understanding how institutions could facilitate the development of adaptive capacity. The simple assumption that developed countries—and people in those countries—are less vulnerable because they have a more solid and consolidated institutional system has been challenged by the incapacity of many "advanced" countries to reduce people's exposure to extreme climate events, such as was the case of the impact of Katrina upon the city of New Orleans. The IACC project contributes to fill this gap by focusing on the institutional frameworks of Canada and Chile.

The Regions

As indicated, two basins are the focus of the IACC research effort: the South Saskatchewan River Basin (SSRB) in Canada and the Coquimbo Water Basin (CWB) in Chile. The two basins provide the necessary microcosms that allow for the understanding of the complexities of the impacts of climate change upon society. Both regions cover large geographic areas with natural diversity, involving hundreds of rural communities, middle and large urban centres, different levels of governments—municipalities, regional or provincial, and national governments that impact on the two areas through an array of policies, programs and agencies. In addition, both regions have a vibrant civil society that involves a large number of NGOs, social movements, and local organizations.

The SSRB stretches from the Rocky Mountains across southern Alberta and Saskatchewan, covering an area of 420,000 square kilometres with an estimated population of 1.5 million. The basin is divided into five major watersheds: Bow, Oldman, Red Deer, South Saskatchewan (Alberta) and South Saskatchewan (Saskatchewan). Approximately 65% of the basin population lives in major urban centres, notably Calgary, Lethbridge, Medicine Hat, Swift Current, and Saskatoon. The basin is under the jurisdiction of two provincial governments, Alberta and Saskatchewan, with a large number of local governments (rural municipalities) and approximately 225 rural communities (Sobool and Kulshreshtha, 2003). The land use is primarily large- and medium-scale agriculture, producing commercial crops such as wheat and canola. Livestock production is also a main agricultural activity with large areas left for pasture. There are numerous dams, reservoirs, diversions and irrigation projects. In southern Alberta, 13 irrigation districts divert about 2.3 billion cubic metres (1.8 million acre-feet) of water to irrigate about 500,000 hectares (1.2 million acres) of land. Approximately 120,000 ha (300,000 acres) of land are irrigated by 25 irrigation districts throughout southern Saskatchewan. 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 (for a more detailed description of the basin see Lac, 2004; Lac and Colan, 2005; and Diaz and Gauthier, 2007).

The ERB is significantly smaller in size. It covers approximately 9,800 square kilometres, with an estimated population of 365,000. Almost four-fifths of this population lives in urban centres—La Serena, Coquimbo, and Vicuna. The Elqui River extends 170 kilometres from the Andean Mountains to the Pacific Ocean. 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 sixteen local municipal governments. The most important economic activities of the area are agriculture, tourism, and mining—three activities that impose an increasing pressure upon scarce water resources. Most agricultural activities in the region are related to fruit production, especially grapes for export and for the production of brandy. This dynamic agriculture benefits from the existence of the large Puclaro Dam, with a water-storage capacity of 220 million cubic metres. There are also significant pockets of small agriculture that contain most of the poor rural households in the area (for a more detailed description of the basin see Bodini and Araya, 1999; and Cabezas, Cepeda, and Bodini, 2007).

Both regions are characterized by a similar environment—a dry climate adjacent to a major mountain system and landscapes at risk of desertification (Grainger et al., 2000; Government of Chile, 2002; Sauchyn and Kulshreshtha, 2008). In the case of the SSRB, the Rocky Mountains to the west impede easy access of moisture-bearing winds from the Pacific. The result is a continental climate, subhumid to semiarid with short hot summers, long cold winters, low levels of precipitation, and high evaporation. Mean annual temperatures in this area range from 1.5°C to 3.5°C. A water deficit is a characteristic of this area, with the presence of high winds accelerating the evaporation of water (Lac, 2004: 8). The ERB is also characterized by a high level of aridity influenced by the desert climate of the north of Chile and the semi-arid climate of north-central Chile. Annual average preciptation in the basin is about 100mm per year, although this value can double and even triple in ENSO (El Niño-Southern Oscillation) years. It is expected that both regions will be similarly affected by climate change with drier conditions, more extreme events, and increasing climatic uncertainty (CONAMA, 1999; Morales-Arnao, 1999; Sauchyn and Kulshreshtha, 2008).

The two basins have a regional economy based mostly on an intensive exploitation of natural resources—mainly agricultural production oriented to national and international markets with a large proportion of their production in cash crops, and relatively large areas dedicated to livestock production. Moreover, in both regions agricultural production is very dependent on

irrigation water derived from snow and glaciers in the adjacent mountains. In recent years, this critical water source has been declining in both regions. Current research (Schindler and Donahue, 2006; Sauchyn, 2007; Sauchyn and Kulshreshtha, 2008) suggests that agricultural production in the western Canadian plains will be seriously impacted in this century by reduced soil moisture, more frequent drought, and reduced stream flows from the Rocky Mountains. Similar problems already exist in the CWB of Chile, where most precipitation occurs in winter, with positive anomalies recorded during El Niño events. This variability strongly influences the local economy (Compagnucci, 2000; CONAMA, 2002; Fiebig et al., 2003; Chile Sustentable, 2004). Andean glaciers have receded dramatically or disappeared completely (Borquez et al., 2006) causing declining stream flows (Morales-Arnao, 1999), and snow cover is less extensive and more variable. Watersheds in dry environments, such as the semiarid CWB and the subhumid SSRB, are especially sensitive because annual runoff already is highly variable and drought is historically common (Sauchyn and Skinner, 2001). Thus, given that in both regions agriculture plays a critical economic role and water resources are important to agriculture, the issue of the sustainability of water resources is fundamental in any analysis of the effects of climate change upon these regions.

Similarities exist in terms of the institutional geography of both countries. Both national governments are relatively stable and have in place policies and programs that reflect concern about the effects of climate change on water. There are, however, relevant differences in terms of institutional frameworks that define the process of governance of water.

The neo-liberal economic principle of the free market has been central to the Chilean strategy of development since the late 1970s. Under Pinochet's government Chile adopted and pursued a model of market liberalization, which led to a radical opening to external trade, attraction of foreign capital, and the liberalization of domestic prices, union laws, and the financial system. The democratic governments that replaced the military regime maintained a milder approach by adopting a more active role in regulating business and the markets, as well as in terms of providing basic welfare. The free market doctrine has impacted the management of water resources in two areas: water resource allocation and the resolution of conflicts around water issues. Water allocation has become a market issue, allowing the existence of private water rights and their free transaction in the market. As Bauer indicates, the Chilean model of water market is different than the market model followed by other countries. Rather than using the market as a policy instrument, Chile has subordinated water management to the market. This has reduced the capacity of public institutions to manage water resources and, especially, their capacity to provide rules and conditions for the resolution of water conflicts (Bauer, 2004; Galaz, 2003; OECD, 2005). Water resources are still defined as public property, but the state can grant private rights to use. Once water rights are granted, they are fully protected as private property rights under the Chilean constitution and they can be freely sold, bought, transferred, or inherited as any tradable commodity. Given that water rights have constitutional protection means that they cannot be appropriated by the state without specific legislation and compensation (Bauer, 2004; Mentor, 2001).

Water governance is not only characterized by a legal framework that ensures private rights to water resources, but also by a centralization of the decision-making process and management of the resources. The Chilean public institutional system is characterized by a high centrality of the decisions, with a central office in Santiago, the national capital, and regional administrative secretariats that implement the decisions of the central office. According to the Programa Chile Sustentable, only 10% of the decisions regarding public spending are taken in the regions. The rest are taken by central agencies in Santiago (2003: 122). In the case of water governance a central role is played by the General Water Directorate, a branch of the Ministry of Public

Works, which is responsible for surface and ground water resource management, including water quality control and the granting and registering of water rights. Other government agencies play minor roles in areas related to water health, environment, and others. Civil society organizations play no formal role in water governance (OECD, 2005: 64; Pizarro et al., 2002). This significant centralization has, of course, implications for the regional and local management of water resources and an efficient management of water problems.

The Canadian public institutional system, on the other hand, is organized around a federal structure composed of a central government, provincial governments, and local or municipal governments. In this political structure, different levels of government have different functions and responsibilities and some degree of autonomy. The management of natural resources in Canada is formally a government responsibility. The Constitution requires that responsibilities for the management of natural resources be shared between the federal and provincial governments. In this sense, the power of the federal government is somewhat limited in those areas where the provincial or local governments have control over the decision-making process. Although the management of natural resources is politically decentralized in most cases, the federal government has the power to intervene if necessary. As a result of this multi-layered public institutional structure there is a strong need for cooperation between the different levels of government in all aspects. As Dwivedi et al. explain: "federal-provincial coordination has become a vital and necessary part of the governmental response to environmental problems" (2001: 69).

The governance of water in Canada follows this pattern of management of natural resources. The *Canada Water Act* defines the arrangement for federal and provincial roles in water resources management, where provincial governments have proprietary rights over water resources. The federal government retains rights for research and planning and implementation of programs related to conservation, development and utilization of water resources, usually under joint federal-provincial agreements. In addition, it retains proprietary rights of water resources on all federal and First Nations lands. The federal parliament also has the "power to legislate for peace, order and good government" which could enable local water resources to be under federal authority if it is in the national interest. Finally, the federal government also has the responsibility to deal with water where international arrangements are necessary, such as cross-boundary water issues (Corkal, Inch, and Adkins, 2006). Provincial governments' powers relate to water because of their jurisdiction over natural resources, providing provinces with a leading role in the regulation of water. This jurisdiction relates to regulating water quality and water quantity on provincial lands. Municipalities' authority on water resources derives from delegated provincial legislation. Therefore, municipalities can have no greater authority to manage environmental matters than the provinces, and only in respect of matters or issues specifically delegated or provided for in the acts establishing the municipalities. Thus, they are only responsible for community drinking water supplies, water quality and wastewater treatment.

Challenges to management of water in Canada are clearly an issue of governance and not a result of market conditions, as in the Chilean case. As a result of the shared management of the resource there is a complicated overlapping of jurisdictions over water and related activities. The result is that a multitude of political actors at the municipal, provincial and federal levels each has some role or responsibility in water. Numerous organizations, government departments and other agencies or entities, sometimes with confusing or unclear mandates, make it difficult to identify issues and to coordinate and integrate efforts at all levels of government (Corkal, Diaz, and Hurlbert, forthcoming).

The Community Vulnerability Assessment

As indicated before, one of the main objectives of the IACC research project has been to assess the current vulnerability of a group of rural communities and households in the SSRB and ERB. This community assessment was complemented by other studies dealing with conflicts, past events, cases, and biophysical vulnerabilities, and an assessment of governance's capacities to reduce the vulnerabilities of communities.

The protocol for the community vulnerability assessment was organized around four sections: (a) the conditions (exposures or stresses) faced by the community; (b) how the community has dealt with those conditions (institutionally and individually); (c) the assessment of the community of external institutions that have constrained or facilitated the community's ability to deal with those conditions; and (d) the assessment of the capacity of communities to deal with possible changes in the future. These lines of inquiry follow the concept of vulnerability discussed in the second section, emphasizing those aspects related to the exposure and adaptive capacity of community members.

Given the localized character of climate impacts and the variability of social conditions among and within communities, the assessment required an ethnographic approach where researchers spent several weeks living in the communities. While actual tasks varied, the ethnographic approach followed general steps: (a) a period of familiarization with the community, including "mapping" exercises and collection of historical and statistical data, which allowed the interviewers to fully understand the context of how the community sees and uses water; (b) the establishment of contact with key informants to obtain information about the social organization of the community and to establish contacts with the various groups present in the community; (c) in-depth interviews were completed with individuals representing the different groups; and (d) focus groups were held to both confirm preliminary findings and serve as group data collection exercises. In addition, specific studies about climate conditions affecting the communities have been carried out and several participative workshops with civil society stakeholders and public organizations have been organized in both countries, both for the dissemination of knowledge and as data collection venues.

In consultation with partners and stakeholder organizations, six communities in the SSRB (3 in each of two provinces: Alberta and Saskatchewan) and four communities in the ERB were selected as research sites. The communities are Cabri, Stewart Valley, and Outlook in Saskatchewan; Taber, Hanna and the Blood Tribe reservation in Alberta, while in Chile the communities are Diaguitas, Marquesa, Pisco Elqui and El Molle. Communities were selected to cover broad geographic representation, including both biophysical and socio-economic diversity. Six community assessments were conducted in 2005 and the rest in 2006. All the community reports (Salas and Jimenez, 2006 and 2007; Morales et al., 2006; Salas et al., 2006; Young, 2006; Magzul and Rojas, 2007; Matlock, 2007; Pittman, 2008; Young and Wandel, 2008; Prado, 2008. See also Wittrock et al., 2006 and 2007) are available at www.parc.ca/mcri/unit1a.php.

The results of the community vulnerability assessments show the most significant exposures are related to climate extremes. In all cases normal climate variability—having a colder winter or more rain than expected—is not a significant issue for community members. Rather, extreme climate events constitute the main concern for communities. As expected, in both basins droughts—and associated problems such as infestations—have been historically problematic for Canadian and Chilean communities. However, it was not just the existence of dry conditions that has been problematic. Other climate extreme events also affect many of the communities. Heavy spring rains, for example, have created significant flooding events in those rural communities closer to the Rocky mountains (Magzul and Rojas, 2007; Prado, 2008). In Chile, ENSO, the global climatic phenomenon, is also problematic. During El Niño years, abundant and intensive

rains, which can triple the annual average amount of rain, create not only flooding but also contribute to the occurrence of mudslides. Communities settled in areas close to the mountain slopes are prone to the destructive effects of mudslides, which are the product of not only the physical landscape but also of human actions, which have made slopes more susceptible to intensive rains (Young, 2006; Salas and Jimenez, 2006 and 2007; Morales et al., 2006).

The results also indicate that vulnerability to climate stressors compounds vulnerability to other stressors. Climate is not the single, or even the most important determinant of the communities' vulnerability. They are also exposed to other events, such as the upheaval of market conditions, political conditions, unemployment, and others. In both Canada and Chile, climate and water stresses are part of a suite of stresses that individuals and communities must manage in their everyday life. In Chile an intensive transformation of agriculture has led to the coexistence of agribusiness—large farms specialized in the production of high value crops—and a small unstable agriculture that produces for local markets. This transformation has created significant changes in regional labour markets—reduction of the number of permanent jobs, predominance of seasonal occupations—and increasing income differences. Economic instability is, in all Chilean communities, the most significant form of exposure. Other stressors related to the presence of agribusiness, such as the contamination of water sources by pesticides—are also high in the list of concerns expressed by people (Salas and Jimenez, 2006 and 2007; Morales et al., 2006; Salas et al., 2006). In most of the Canadian cases we found a similar pattern although in a less drastic form. Changes in government policies and the process of economic globalization have led to a continuous farm crisis that has also led to increasing differentiation between large and small farms (Matlock, 2007; Pittman, 2008, Young and Wandel, 2008; Prado, 2008). In this context, rural communities have been impacted by a reduction of spending power, decline of basic services, and a continuous out-migration of young people. Exposure to climate-related events compounds these economic problems, making the sustainability of communities even more precarious.

Communities in both countries already have a variety of adaptation strategies in place. An accumulated historical experience has resulted in the adoption of many coping mechanisms to reduce exposure to climate and other stressors, mechanisms that allow local people to deal with the expected changes in climate variability and some extreme events. In the case of drought these capacities include establishing local water conservation programs to control water demand, simple household water management techniques such as the use of barrels for saving water, irrigation techniques, farm water management strategies such as changing cropping practices or filling dugouts, community solidarity networks that contribute to reducing the impacts of water scarcities, and diversifying crop varieties and income sources. In the case of economic stressors the diversification of household incomes is a coping mechanism that is used in both countries. In Chile, for example, there is an increasing integration of children and women into seasonal employment, especially during harvest time. Similar trends are observed in Canada, where double incomes are necessary to maintain family farms. Informal and formal institutions play a role in the development and adoption of these coping mechanisms. Kinship and friendship networks, local government, regional government organizations, the social capital of local organizations, and others institutional forms contribute with knowledge, contacts, and resources that could be used to reduce the exposure to a variety of stressors. Many of these adaptive strategies are reactionary: they react to existing or impending events rather than dealing with the sources of problems (Salas and Jimenez, 2006 and 2007; Morales et al., 2006; Salas et al., 2006; Young, 2006; Matlock, 2007; Pittman, 2008, Young and Wandel, 2008; Prado, 2008).

As expected, adaptive capacity varies considerably among communities and within communities. Access to resources and the quality of these varies from one community to another

and among households. Variations in social conditions, institutional arrangements, financial resources, and technological knowledge facilitate the adoption and implementation of different forms of adaptation. For example, communities with access to irrigation infrastructure, such as Taber in Alberta and Outlook in Saskatchewan, have a better adaptive capacity to droughts than dryland communities, where the infrastructure is nonexistent (Matlock, 2007; Pittman, 2008; Young and Wandel, 2008; Prado, 2008). Similarly, economic differences among community members play a role in exposure and adaptive capacity to climate-related events. This is particularly relevant in Chile, where the differences between rich and poor farmers in relation to financial capital, resources, and information play a fundamental role in the farmers' coping abilities. This differential access is sometimes problematic since it creates the conditions for a process of concentration of resources, where the strong become stronger. An example of this is the trading of water rights, where rich farmers buy the rights of poor peasants, leaving them without a resource that is vital for the sustainability of production (Salas and Jimenez, 2006 and 2007; Morales et al., 2006; Salas et al., 2006). The poorest and more marginalized communities, such as the case of the Blood Tribe community in Canada, faces even more dramatic socio-economic challenges that certainly impinge upon the development of an adaptive capacity, such as drug and alcohol abuse, addictions, community and family violence, unemployment, lack of skills, and shortage of housing (Magzul and Rojas, 2007).

The capacity of these communities to adapt to a more severe global environmental change is, however, problematic. The community vulnerability assessments show that the existing adaptive capacity could be at its limits in dealing with more intense and prolonged climate events, such as multi-year droughts. Even those communities with access to irrigation face serious problems in dealing with severe forms of water scarcities, as was the case in the 2001 and 2002 droughts in Canada. These existing coping mechanisms could be even more limited to the extent that there is a reduction of the resources available to communities. An example of this is the decline in social capital that is observed in all communities. Social capital—participation in formal and informal networks and organizations—has played an important role in both Canadian and Chilean communities, especially in terms of dealing with the negative impacts of extreme weather events and water management at a regional level, as well as the crisis produced by other stressors. All communities, however, face a decline of this important resource. As a result of economic and cultural processes, Chilean communities are characterized by loss of social cohesion and a decline in participation in organizations, resulting in a reduced level of intra-community solidarity. Canadian communities, on the other hand, face increased aging and continuous reduction of their populations, which translates into a decline in participation in organizations and networks. No less significant is the increasing marginalization of rural communities from the political mainstream, which is expressed in a loss of legitimacy of governance institutions and political leaders among community members. In spite of the fact that many community members recognize the relevance of a variety of government programs in reducing their exposure to climate and other stressors, there is a generalized sentiment that regional and national governments are "too distant," unreliable, and unable to understand the specific challenges of local communities. Community members expressed concerns about the lack of clear policies and priorities on water use and water management, lack of available information about government roles and responsibilities, the existence of programs unable to resolve the problems of communities, lack of long-term planning, and others.

There is undoubtedly significant work to be done in terms of improving the existing adaptive capacity of communities. A significant effort should be done to develop and strengthen a policy process that emphasizes the links between adaptation and development priorities integrating ecosystem management, disaster reduction, and social and economic development measures

(IISD, 2006). No less relevant is the need to improve communication between communities and government agencies in order to facilitate the implementation of policies and programs oriented to improve local and regional capacities and inter-community coordination around common issues. All these measures would not only provide rural communities with the instruments to become more sustainable, but they would also contribute to a more effective strategy to reduce the risks of climate change.

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