ANNUAL REPORT
April 1, 2005–April 31, 2006

Institutional Adaptation to Climate Change: Comparative Study of Dryland River Basins In Canada and Chile

A Project of the SSHRC—MCRI Program

July 2006

TABLE OF CONTENTS

I. Introduction

This second annual report of the Institutional Adaptation to Climate Change (IACC) Project discusses the activities that took place during the period April 1, 2005 to April 30, 2006. The IACC project, formally initiated in January 2004 with a grant from the Major Collaborative Research Initiatives (MCRI) program of the Social Sciences and Humanities Research Council of Canada (SSHRC), has been conducted by an interdisciplinary team of fifteen researchers from a variety of disciplines and a group of research assistants (See Appendix 1). Five Canadian universities (the University of Guelph, the University of Saskatchewan, the University of Regina, Athabasca University, and the University of British Columbia) and a Chilean university, the Universidad de La Serena, are academic partners in this interuniversity research initiative. In addition, several government agencies and institutes in Canada and Chile have committed resources to the development and implementation of the project (see Appendix 2).

The second year of the project has been highly productive and fruitful. Research activities have been completed according to schedule, a large number of working documents have been produced, and dissemination activities have been organized and delivered. The implementation of all these project activities has been characterized by an active and continuing integration of team members and research activities. Rather than developing a set of unconnected, parallel studies, the project has continued to emphasize an integration of research activities that promote continuous collaboration within the research team and a common approach.

II. The IACC Project's Objectives.

The goal of the IACC project is to develop a systematic, integrated and 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 two regions: the South Saskatchewan River Basin (SSRB) in western Canada and the Elqui River Basin (ERB) of 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, they will be similarly affected by climate change. In this context, the specific objectives of the project are:

1. to identify the current social and physical vulnerabilities related to water resource scarcity in the two dryland regions;
2. to examine the effects of climate change risks on the identified vulnerabilities; and
3. to assess the technical and social adaptive capacities of the regional institutions to address the vulnerabilities to current water scarcity and climate change risks.

Given the impossibility of including all regional institutions and human settings existing in the two basins, the project has focused 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 that affect those vulnerabilities. Thus, the project seeks to understand the adaptive capacity of rural communities and the roles played by the organizations of governance in the development (or underdevelopment) of their adaptive capacity.

From a policy perspective, we expect that the attainment of these objectives will allow for the identification of opportunities to improve the way in which institutions manage natural resources, especially water resources, in the context of new climatic conditions and reduce the vulnerability of the regional rural population.

III. Accomplishments of the Project

The IACC Project is a significant effort to understand the issue of climate change and its impact on dry lands from a social science perspective, a critical and timely issue of national and international significance. It involves leading edge, collaborative research in an area that according to the Canadian Senate's report, "is still in its infancy" ("Climate Change: We Are at Risk," November 2003). In these terms, this project is one of the first large-scale empirical studies in Canada aimed at understanding the issues of vulnerability and adaptation in an institutional context, bringing together social and natural scientists, universities, stakeholders and government agencies. It is expected that the contributions of the project will be relevant to (a) the scholarly community by providing an improved understanding of the role of institutions in reducing or increasing the vulnerability of sectors of civil society to global change and (b) the policy community by providing valuable policy-oriented information for the design and implementation of adaptation strategies that are critical for the sustainable development of dryland regions.

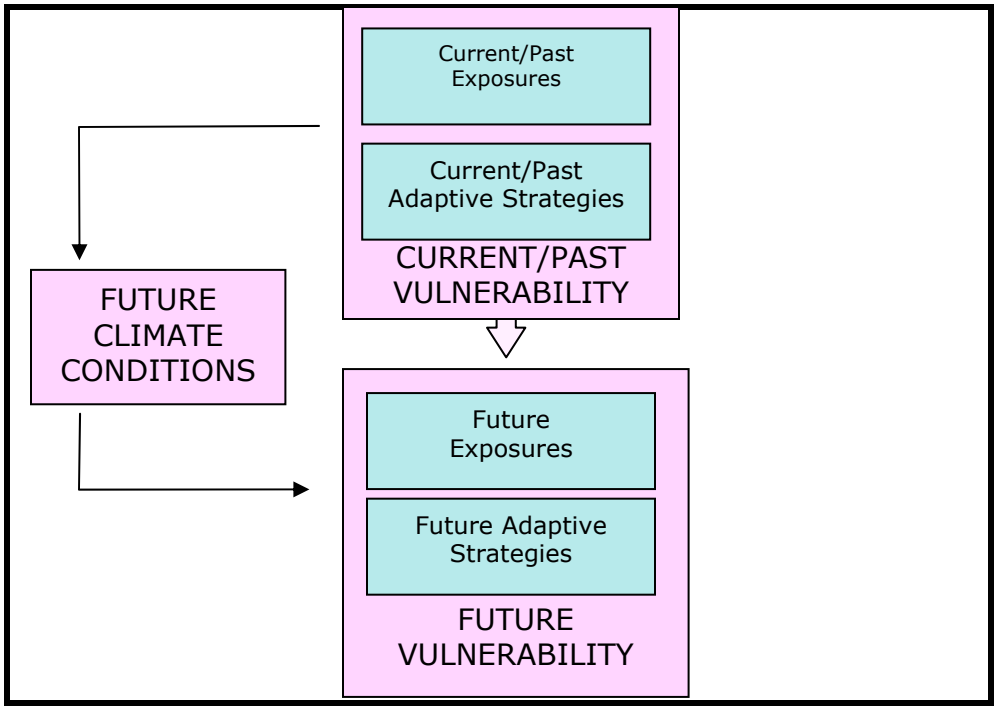
The first two years of the project show a positive progress of the project's activities in terms of attaining these contributions. Some of the accomplishments of the IACC project are:

a. a high level of exchange and integration of its research activities and among the members of the research team, ensuring a real interdisciplinary process;
b. a high level of collaboration with some of the partners, ensuring the possibility of a significant influence upon the policy community;
c. a significant experience for a group of students as members of a large, interdisciplinary international project; and
d. significant efforts to disseminate the project and its potential contributions among stakeholders.

IV. The Conceptual and Methodological Model of the IACC Project

A fundamental element in the process of integration of the project activities has been the development of a common conceptual and methodological framework that ensure a successful integration of the tasks and permanent exchange of knowledge and experiences, avoiding the problem of having multiple parallel projects.

Figure 1. The Vulnerability Assessment Approach



A central decision in the process of developing and strengthening this common framework has been the adoption of the vulnerability assessment 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.

Key elements in this model are the concepts of "vulnerability" and "adaptive capacity" Vulnerability is understood 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. In these terms, the most vulnerable systems are those which are most likely to be exposed to perturbation and possess limited capacity for adaptation. Thus, vulnerability is characterized as a function of the exposure of a system—a household, a community, an ecosystem, and so on—to climate change and its adaptive capacity. Generally, a system that is more exposed to a climate stimulus will be more vulnerable, and a system that has more "adaptive capacity" will tend to be less vulnerable due to its ability to cope with the exposure. "Adaptive capacity" is the property of the system to adjust itself in order to expand its coping range under existing or future climate conditions. A central component of adaptive capacity is the existence of an institutional framework that contributes to strengthening the adaptive capacity of a system, reducing its vulnerability.

The IACC project focuses on the vulnerabilities of rural communities and the role that some specific governance institutions play in reducing this vulnerability. It assesses the present vulnerabilities of rural communities to climate variability and water-related problems and evaluates this current state of vulnerability in the context of future climate conditions. Figure 2 shows the different research activities of the IACC project organized around the vulnerability methodological model. In the context of this model, the activities of the project are organized relative to three clusters of activities:

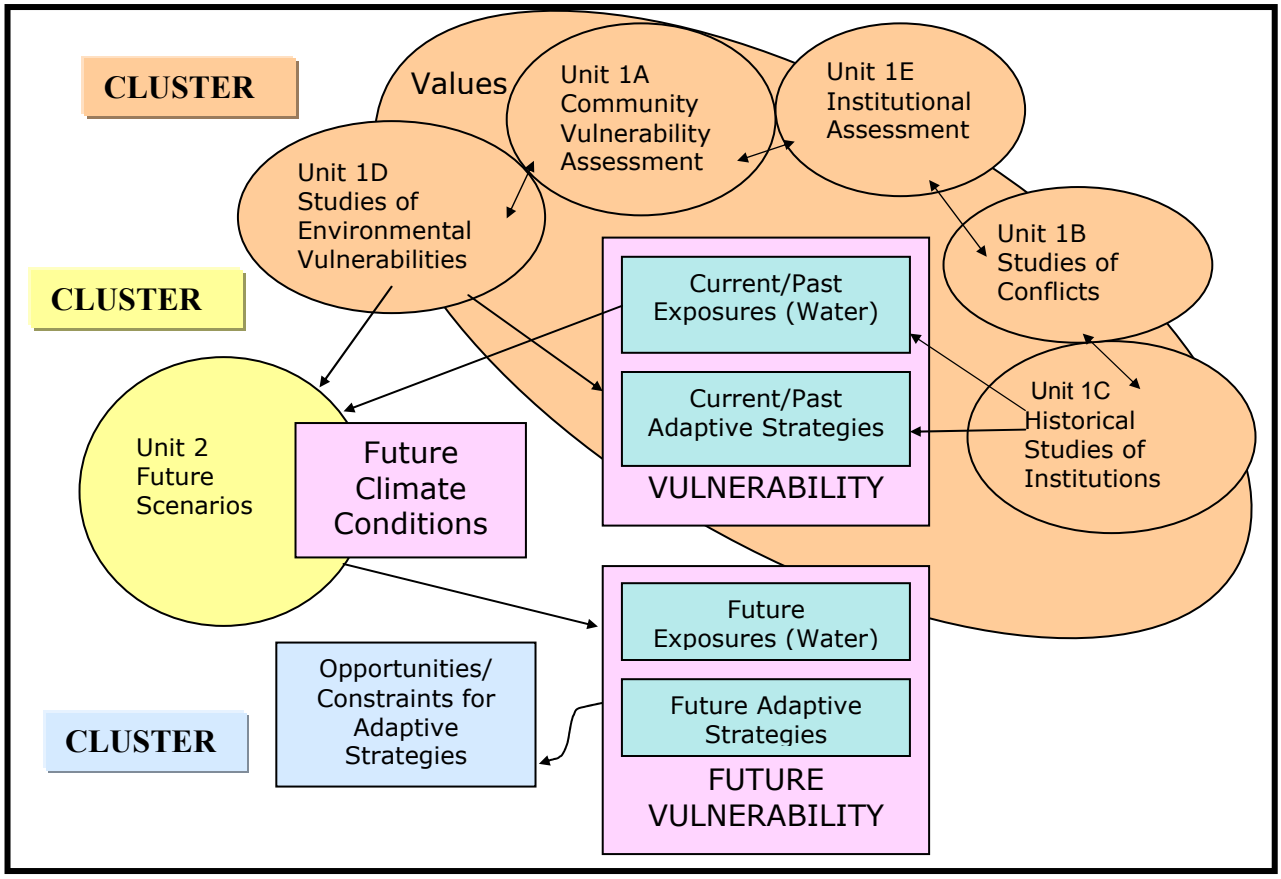
Cluster 1: This cluster involves an analysis of the current vulnerabilities of rural communities and households in the basins. This cluster involves several research projects: (a) an assessment of the current vulnerabilities of a group of communities in the two basins (Unit 1A); (b) an analysis of the role of institutions in the resolution of a group of recent conflicts related to water scarcity (Unit 1B); (c) a historical study of institutional adaptation in periods characterized by water scarcities (Unit 1C); (d) an analysis of environmental vulnerabilities identified by stakeholders (Unit 1D); and (e) an assessment of the capacities of governance institutions to reduce the vulnerabilities of rural communities (Unit 1E). These research activities facilitate the attainment of Objectives 1 and 3.

Cluster 2: An assessment of the future climate scenarios for the two basins—based on different climatic models—and their potential impacts. This cluster will facilitate the attainment of Objective 2.

Cluster 3: An assessment of the capacities of governance institutions to deal with the future vulnerabilities of the rural communities. This final cluster will facilitate the attainment of Objective 3.

Clusters 1 and 2 constitute the core of the research activities during the first four years (2003–2007) of the project. Cluster 3 will involve an intensive process of discussion with stakeholders and it will occur mostly during the final year of the project (2008).

Figure 2: The Research Activities of the IACC Project



V. The Progress of the Project

This section discusses the progress of the project following a plan of activities that was discussed and approved during the first meeting of the project (April 2004). This plan of activities—the Milestone Report—establishes a schedule for the different IACC project activities for the period May 1, 2004–December 31, 2006 and it is available on the website of the project (www.parc.ca/mcri). It divides the activities of the project into seven units (the first one containing five interrelated sub-units). This section provides a succinct, but detailed description of the progress of the project for each of the research units (Units 1 and 2), as well as for those units oriented to support the research activities (Units 3 to 7).

Unit 1: Vulnerabilities to Climate Variability

This unit contains all the research activities that constitute the first cluster and, as such, it is one of the fundamental research components of the project. It involves an assessment of the current vulnerabilities of rural communities to water-related problems and of the capacity of governance institutions to reduce these vulnerabilities, and it is composed of five related projects.

Unit 1.A: Assessment of Vulnerabilities of Rural Communities

The main goal of this specific project is to assess the current vulnerability of a group of rural communities and households in the SSRB and ERB. This involves identifying: (i) climate and related conditions that have or are affecting communities and the adaptive capacities that the communities have used in dealing with those conditions. Six researchers—H. Diaz (Unit Coordinator), D. Gauthier, H. Morales, A. Rojas, S. Salas, and B. Smit—and their assistants are directly involved in this assessment of the rural communities, with the support of four other researchers who provide expertise in different areas relevant to the assessment: D. Corkal and H. Zavala (hydrological issues), S. Kulshreshtha (agricultural issues), and G. Marchildon (health issues). In addition, B. Morito participates in the unit by focusing on the analysis of community values.

The first year of the project was focused on the development of conceptual papers and the selection of a group of rural communities in Chile and Canada for the assessment. In consultation with partners and stakeholder organizations, 17 communities in the SSRB (12 in Alberta and 5 in Saskatchewan) and 9 communities in the ERB were pre-selected as potential research sites. From these initially selected sites 6 communities were selected in Canada—Cabri, Stewart Valley, and Outlook in Saskatchewan, and Taber, Hanna and the Blood Tribe reserve in Alberta—and four in the ERB: Diaguitas, Marquesa, Pisco Elqui and El Molle. As well, a fieldwork guide was developed to assist with the assessment of each community along four lines of inquiry: (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. A resource guide to community vulnerability assessment, which identifies and discusses several ethnographic data-gathering techniques, and a guide to NVivo, a qualitative data analysis software, were also developed to support the community assessment work.

During the second year of the project six communities were assessed: Cabri, Stewart Valley, and the Blood Tribe reserve in Canada, and Pisco Elqui, Diaguitas and Marquesa in Chile. At this time, the analysis of the collected data is being completed and a report for each case is being developed. In addition, one of the researchers, B. Morito, is also in the process of identifying indicators of stakeholder values for the Canadian sites and analyzing them in terms of the categories to which they might belong. In addition, a process of data merging is in progress for the purpose of developing a single report for the unit. The rest of the selected communities—Taber, Outlook, and Hanna in Canada and El Molle in Chile—will be assessed during the third year of the project.

Unit 1.B: Analysis of Water Conflicts and Institutions

This project focuses on the analysis of the role of institutions in water conflicts in both basins. Given the relevance of potential water scarcities in the context of future climate conditions in both basins we are especially interested in analyzing how different institutions react to conflict and their approach to its solution**.** This project involves three researchers—H. Morales, B. Reyes and A. Rojas (Unit Coordinator)—and their assistants. As in the previous unit, this project is supported by researchers with expertise in different areas—D. Corkal, S. Kulshreshtha, and H. Zavala—and by B. Morito in the area of values.

Two case studies for this project—one in each basin—were identified. In the SSRB the selected case study identified was the Oldman River Dam conflict generated by the construction of the dam in Southern Alberta**.** In Chile, after meetings with several key informants and stakeholders, it was decided that the Puclaro Dam and the conflictive situations linked to it would be the central case study of the role of institutions in water conflicts in the basin.

During the second year initial fieldwork was conducted in both basins. In the Canadian case, Rojas' and Magzul's work provided a more complete picture of the significance of the Oldman River Dam conflict for the stakeholders involved and identified important institutional adaptations beginning to take place in the area. In Chile, the work was conducted by B. Reyes and involved the interviewing of local government agencies involved in the design, construction and operations of the dam, as well as several of the local community leaders affected by the construction of the Puclaro Dam. Both case studies tend to reaffirm findings in the literature indicating that the building of large water reservoirs, as a major strategy to achieve water security, often generates new vulnerabilities among the weaker or disempowered groups and inequities in the distribution of water rights. To support the fieldwork a detailed interview guide was written by Alejandro Rojas and tested in the interviews with key informants. Fieldwork will be completed in both basins during the third year of the project.

Two papers were completed during the second year: (a) "Water Blues in Climate Change: The Role of Institutions in Water Conflicts and the Challenges of Climate Change," by A. Rojas, B. Reyes, L. Magzul and H. Morales, provides a conceptual and methodological path for the study of water conflicts in the context of adaptation to climate change; and (b) "A Historical Chronology of the Oldman River Dam Conflict," written by J. Daschuk and G. Marchildon, discusses the historical background for the Canadian case study of the Oldman River Dam conflict (see Rojas, Reyes, Magzul, and Morales, 2006; and Daschuk and Marchildon, 2005, in Appendix 4).

Unit 1.C: The Historical Study of Institutional Adaptation

The main goal of this project is to assess past vulnerabilities of peoples and communities in the SSRB and the ERB and their respective adaptations to past periods of extreme water scarcity. Beyond providing a baseline for contemporary research and analysis, these studies should also highlight the experience and institutional capital that has accumulated over time in both the SSRB and the ERB in response to past crises and difficulties. The project involves G. Marchildon—the coordinator for the sub-unit—with the support of Corkal, Kulshreshtha and Wheaton as advisors on the SSRB portion of study. A Chilean scholar and researcher, Prof. Hernan Cortes of the Universidad de La Serena, was identified in January 2005 as the key participant on the ERB portion of the study with Marchildon acting as an advisor. H. Cortes initiated the Chilean portion of the project in May 2005.

In Canada, during the second year of the project, two comprehensive statistical compendiums, one on agriculture and drought and the other on economic and demographic information, have been completed by province (Alberta, Saskatchewan and Manitoba), annually from 1905 to the present (see Marchildon and Anderson, 2006, in Appendix 4). In Chile an overview of drought in the Coquimbo region during the 1870–1968 period was initiated by H. Cortes.

The project also completed several Canadian historical case studies. A case study of the origins and impact of the Prairie Farm Rehabilitation Administration (PFRA) in response to the drought crisis of the 1930s has been carried out by G. Marchildon and a manuscript based on this study is in the process of being completed. In addition, a case study of Alberta's early drought relocation efforts following the First World War and a case study of the Saskatchewan Relief Commission, 1931–1934, have also been carried out. These two studies have resulted in three

articles: G. Marchildon, "The Great Divide," in G. Marchildon, ed., *The Heavy Hand of History: Interpreting Saskatchewan's Past* (Regina: Canadian Plains Research Center, 2005); G. Marchildon and D. Black, "Henry Black, the Conservative Party and the Politics of Relief," *Saskatchewan History* 4 (2006); and G. Marchildon, "Relocating farmers and reallocating land under the Special Areas Administration of Alberta" (a draft of a paper to be submitted as an article to *Prairie Forum*). Another case study initiated during the second year is being carried out by G. Marchildon, S. Kulshreshtha, E. Wheaton and D. Sauchyn, "Drought, Demographic Migration and Institutional Adaptation in Alberta and Saskatchewan, 1919–1939." Finally, a historical case study of conflict was carried out to support the work done in the project on conflicts. The paper, a historical chronology of the Oldman River Dam conflict, was produced by J. Daschuk, with an introduction by G. Marchildon (see Marchildon, 2006; Marchildon and Black, 2006; and Daschuk and Marchildon, 2005, in Appendix 4).

Unit 1.D: Analysis of Environmental Vulnerabilities

The main goal of this project is to study biophysical vulnerabilities in the SSRB and the ERB, as they are identified by the communities studied in Unit 1A. The participants are J. Cepeda, M. Fiebig, S. Kulshreshtha, D. Sauchyn (Unit Coordinator), E. Wheaton, and V. Wittrock, with the support of D. Corkal and H. Zavala, and research assistants.

Several activities have taken place in the context of the baseline data collection of the biophysical characteristics of the basins. They are: (a) an ongoing review of the current and available literature on the physical geography, climatic and hydrological characteristics, and biological and ecological information about the two basins; (b) development of data bases on biophysical aspects of the SSRB and ERB, which have resulted in a series of thematic maps prepared using geographic information systems; (c) databases on climatic and hydrologic aspects of the SSRB and ERB have been assembled to update the corresponding sections of the working papers; and (d) physical, landscape and human features of the ERB have been photographed to implement a pictorial data base for teaching and dissemination purposes.

As well, several sub-projects were carried out during the second year or are in progress. They are: (a) a study of the vulnerability of two Prairie communities (Cabri and Stewart Valley) to the 2001 and 2002 droughts; (b) an analysis of environmental vulnerabilities in the ERB, focused on precipitation data versus information given by the communities related to precipitation behaviour in the ERB; (c) a study of arthropod outbreaks in the ERB that damage crops as a result of above-average annual environmental temperatures and below-mean precipitation (see V. Wittrock, D. Dery, S. Kulshreshtha and E. Wheaton, 2006, and Cepeda and Pizarro, 2006, in Appendix 4); and (d) preparation of a digital atlas of the ERB focused on environmental vulnerabilities.

Unit 1.E: Assessment of Formal Institutions

The main goal of this sub-unit is to assess the current and future capacity of water governance institutions to reduce the vulnerability of rural communities and households in the SSRB and the ERB. These activities have been carried out by H. Diaz (coordinator), D. Corkal, D. Gauthier, H. Morales, A. Rojas, B. Reyes, and S. Salas.

The project has continued gathering information about the main public and civil society organizations that participate in the governance of water resources in both countries. During the second year, a working paper documenting the case of the water governance institutions in the SSRB was completed by Corkal, Inch, and Adkins, complementing similar work done in Chile by Morales and Espinoza in 2004. Five additional documents were completed and delivered by participants in this unit: (a) a paper, produced by H. Diaz and A. Rojas, focusing on the conceptual and methodological frameworks of the assessment of the governance institutions, was

completed and presented to partners for feedback purposes; (b) a paper on health and climate change, "Climate and Health: Some General Observations for the IACC Project," by G. Marchildon; (c) a paper on "Values Analysis and Institutional Adaptation to Climate Change" by B. Morito; and (d) two papers by Margot Hurberlt on legal frameworks in Canada (see Corkal, Inch, and Adkins, 2006; Diaz and Rojas, 2006; G. Marchildon, 2005; Morito, 2006; and Hurlbert 2006a and 2006b, in Appendix 4).

As part of the work of this unit a workshop was organized in Regina in March 2006 to foster the discussion of the methodological approach to the assessment of the governance institutions. The workshop was attended by PFRA representatives and several of the Canadian researchers. The workshop was focused on the dimensions of the assessment, sampling procedures, and instruments and protocols for the collection of information. The results of this workshop are being used for the development of the instruments to be used during the assessment of the governance institutions.

Unit 2: Climate Change Scenarios

This unit involves Cluster 2 activities. It examines the potential contingent effects of climate change risks on the identified vulnerabilities to water resource scarcity. Achieving this outcome involves: (a) an analysis of a range of climate change model scenarios; and (b) an assessment of how these scenarios could impact the current social and physical vulnerabilities in the regions as determined from Unit 1. Participants in this project are D. Sauchyn (Unit Coordinator) and E. Wheaton (Canada), and J. Cepeda and M. Fiebig (Chile), supported by research assistants and one research associate (V. Wittrock). D. Corkal and H. Zavala are advisors to this project.

During the second year of the project a draft of a working paper that describes the climate and impact scenarios for the SSRB has been developed (see Wittrock, Wheaton, and Kulshreshtha, 2005, in Appendix 4). In addition, since drought is recognized as the most serious climate risk in both basins, two projects have been developed in relation to this phenomenon: (a) The Statistical Characteristics of Drought in the Western Prairies (Sauchyn), an analysis of the long-term statistical characteristics of this severe climate hazard. This long-term perspective complements the work of other team members, such as the impacts of the droughts of 2001–02 (Wheaton, and Kulshreshtha) and the 1920–30s (Marchildon); and (b) Proxy Drought Records for the ERB (Feibig). To enable the statistical analysis of drought in the ERB, it was necessary to collect the type of proxy climate data that already exist for the SSRB. This work is in progress.

During the second year, we have begun to develop climate change and impact scenarios in the SSRB. A paper dealing with these issues—"Climate Change, Ecosystem and Water Resources: Modeling and Impact Scenarios for the South Saskatchewan River Basin, Canada: A Working Paper"—was produced by V. Wittrock, E. Wheaton and S. Kulshreshtha, and published by the Saskatchewan Research Council (see Wittrock, Wheaton and Kulshreshtha, 2005, in Appendix 4). In addition, a research fellow, Suzan Lapp, is developing climate change scenarios under the supervision of Sauchyn and other IACC project researchers (Wheaton and Wittrock). In the case of the ERB we are in the process of starting to develop climate change and impact scenarios. A working paper, "Modelos Climáticos, Escenarios de Emisiones de Gases de Efecto Invernadero y Escenarios Climáticos" (See Pérez, Fiebig, and Cepeda, 2006, in Appendix 4), discusses the existing climate change and impact scenarios and their limitations: the grid size of the GCMs are still too large and in the ERB there are only 8 precipitation time series over 20 years without gaps. At the Department of Geophysics of the University of Chile, a regional climatic model is being validated in order to create impact scenarios of local climate change. In addition, SHETRAN, Hydrologic Model, is being validated, and STEP model, a model for vegetative ecosystems, is being calibrated at the Universidad de La Serena.

Unit 3: Student Training

This unit has as its purpose to increase the students' methodological skills and their knowledge of climate change issues. The Milestone Report emphasizes the development and delivery of climate change, GIS materials, and ethnographic on-line training materials (website), as well as training on the job—acquiring practical skills by being engaged in research activities. The coordinator for this unit is D. Sauchyn.

During the second year, the following training activities took place: (a) delivery of a course (Geography 491/891, University of Regina) focused on the impacts of climate change on biophysical and social systems, and the adjustments to policies and practices that will be required to minimize the negative impacts; and (b) training on the job: several research assistants have been active in the collection of baseline material, the preparation of documents and the elaboration of working papers, and in the organization of seminars, under the direction and supervision of the members of the research team.

Unit 4: Geospatial Data

This unit has as its main purpose the development of a geospatial dataset. Data produced by activities in Units 1, 2, and 6 are organized in a geospatial format using GIS to provide regional context for team members such that the scenarios can be readily applied to regional planning and resource management and used for dissemination purposes. The coordinator for this unit is D. Gauthier, with Technical Assistants Lorena Patino (Canada) and Andres Bodini (Chile).

The search for available digital geospatial data sets, relevant to both the SSRB and ERB, is an ongoing process that also encompasses the re-formatting and updating of tasks when appropriate. Current datasets collected include biophysical, social and economic topics (see Appendix 6). These are made available to all project researchers and assistants. Summary digital datasets for the SSRB and ERB are in development. Maps are updated as required and posted on the IACC web page as photo images in both jpeg format as well as downloadable pfd formats. GIS assistance has been provided in support of the development of a hydrological model for the ERB based on monitoring station data and watershed analysis. In consultation with project researchers, a number of working and final maps have been produced for use during fieldwork as well as for project planning and inclusion in documents. In addition, a collection of digital pictures of the study area has been gathered, organized and posted on the IACC web page for use by all project researchers and assistants. In Chile the GIS team has participated and supported the creation and compilation of an atlas of the ERB.

This unit also contributes to the process of integration of regional context information. The development of a working chart of linkages of information between units according to dimensions of sustainability and exposure/adaptation issues is currently in progress. Information gathered in the ethnographic work in two of the selected communities (Stewart Valley and Cabri) has been used to create a cross-cutting chart template that links identified vulnerabilities, exposures, adaptation strategies, historical components and water conflict issues.

Unit 5: Dissemination of Materials

This unit has as its purpose the development and delivery of materials to stakeholders, partners, academics, policy-makers, and the general public. To maximize access to these audiences during the life of the project, project activities are communicated through annual reports; a website; dissemination meetings (local workshops) involving stakeholders; public presentations; and media information about the project. The coordinator for this unit is D. Gauthier.

During the period covered by this report the following activities were carried out in this unit: (a) preparation and update of a list of stakeholders has been produced—and updated constantly—for dissemination purposes; (b) preparation and delivery of the First Annual Report; (c) update of the website, including the posting of information in both languages—English and Spanish—and the development of new sections; and (c) the organization of stakeholders' meetings in Chile and Canada (see Appendix 5 for a complete list of dissemination materials).

Unit 6: Integration

The purpose of this unit is to promote mechanisms for the development of broadly based collaborative research as the central mode of research activity among the members of the team, as well as between the team and partners. The coordinator is H. Diaz.

During the second year some of the most important activities in this area have been the following: (a) the organization of the annual meetings of the project; and (b) the development of information on integrative frameworks with the use of GIS.

The annual meetings of the project have been the main setting for collective decisions and have been fundamental in establishing and strengthening the development of a common conceptual and methodological approach and a process of increasing integration. During the second year two project meetings took place, the first at the Universidad de La Serena (April 25–29, 2005) and the second at the University of Regina (April 24–28, 2006). The main objectives of these meetings have been: (a) to develop and strengthen collaborative exchanges among the units in order to foster the process of integration of project activities; (b) to review the progress of the project in accordance with the Milestone Report; and (c) the planning of future activities.

Unit 7: Project Administration

The project has established a governance structure that emphasizes a collective discussion and decision process about the direction and implementation of the project's activities. The project is led by Harry Diaz, supported by a Management Committee, composed of D. Gauthier, D. Sauchyn, L. Patino (research fellow), and the Project Manager, Pat Barrett-Deibert. The managerial functions of the management committee involve: (a) the development of general work-plans based on the agreements reached by the team members during the annual project meetings; (b) the monitoring and coordination of project activities; (c) supervision of financial activities; (d) preparation of narrative and financial reports; and (e) organization and chairing of the project's annual meetings. The project's activities in Chile are coordinated by Dr. S. Salas, who is in permanent contact with the Management Committee.

The activities of the project are carried out by different units. Team members participate in these units as researchers or as advisors. The coordinators of the units monitor the activities, providing an annual report to the entire team.

The project is also served by an Advisory Board that provides advice and guidance to the Project Director and Management Team in particular, and the research team in general, on all matters that are relevant to the research project (see Appendix 3). During the second year of the Project Dr. Fernando Santibanez—a well known Chilean scholar in the area of climate change—replaced Dr. Horacio Larrain, who resigned from the Board as a result health problems.

VI. Schedule for Completion

During the last meeting of the project a detailed work plan for the last thirty months of the project (July 1, 2006–December 31, 2008) was discussed. The following table indicates the specific times assigned for the implementation of each of these clusters. Clusters 1 and 2 constitute the core of the research activities during the first four years (2003–2007) of the project. Cluster 3 will occur during the final year of the project (2008), involving (a) an integration of the results of the research activities in Units 1 and 2 (an analysis of current vulnerabilities in the context of the future climate scenarios) and (b) a process of discussion with communities and governance institutions to discuss both the results of the research and potential strategies for strengthening the adaptive capacity in both basins. A more detailed schedule of completion is found in the website.

Project Activities	**Year 1 (2004)**	**Year 2 (2005)**	**Year 3 (2006)**	**Year 4 (2007)**	**Year 5 (2008)**
CLUSTER 1. Assessment of present vulnerabilities of communities (Unit 1A)	X	X	X		
Assessment of the role of institutions in water-related conflicts (Unit 1B)	X	X	X		
Assessment of the history of institutional adaptive capacities (Unit 1C)	X	X	X	X	
Identification of current physical vulnerabilities (Unit 1D)	X	X	X	X	
Assessment of current institutional adaptive capacity (Unit 1E).	X	X	X	X	
CLUSTER 2. Identification of future climate scenarios	X	X	X	X	
CLUSTER 3. Assessment of governance institutions—Integration of Units 1 and 2				X	X
Assessment of governance institutions—Stakeholder Discussion					X

VII. Partners and Stakeholders

The project has been defined as policy-oriented and as such it makes a special effort to be in contact with partners and stakeholders. In the context of the project, stakeholders are organizations and individuals with an interest in the governance of water resources and the sustainability of rural communities in the two basins. The identification of stakeholders is an ongoing activity in the project. To facilitate an easy access to stakeholders we have developed a list of stakeholders for communication purposes (electronic mail) and ensured that team members are active in regional meetings for the purpose of introducing the project and presenting initial results (Appendix 5 lists all the presentations to stakeholders).

Partners are a group of organizations that encouraged and supported the development of the proposal (see Appendix 2 for a list of the partners). We have established close links with several of these partners that have provided mutual benefits to both parties (the research team and the partners). In Canada a special partner has been PFRA, a federal agency that focuses on land and water resources, and promotes sustainable agricultural development and the adoption of farming practices that protect the environment. This agency has the majority of its staff complement in the Western Canadian prairies, as a direct federal government response to severe climate change impacts caused by severe prairie droughts in the 1930s. PFRA has provided

important technical expertise to the project: GIS data, SSRB watershed maps, water and climate data, and Radarsat data for correlating drought index data with soil moisture (collected in collaboration with Environment Canada and the Canadian Space Agency). PFRA has supported the research with its own human resource contributions; a member of PFRA, D. Corkal, is a permanent collaborator of the project; while other PFRA staff have supported project initiatives in Saskatchewan and Alberta where their unique expertise and local knowledge is beneficial. PFRA has participated in the annual meetings, provided advice on methodological issues, provided context and content on climate and water issues facing rural communities, and organized stakeholder meetings in the SSRB. In Chile CONAMA has become a special partner as the result of its recent interest in developing an adaptive strategy in the context of the national policy on climate change. CONAMA and the IACC project have organized two workshops (December 2005 and May 2006) to discuss the project's activities and approaches. Other partners that have also contributed significantly to the project are Prairie Adaptation Research Collaborative (PARC) (providing data, hosting and supporting research fellows, and developing and maintaining the project's website) and the Centro de Estudios Regionales (CER) in Chile (housing the project activities in the Universidad de La Serena and providing secretarial and technical support).

Members of the project have also had a strong participation in the Government of Canada's National Assessment of Climate Change. The co-lead authors of the Prairie Chapter (Sauchyn and Kulshreshtha) and two contributing authors (Diaz and Wheaton) are investigators in our IACC project.

VIII. Students

The work of researchers and collaborators has been supported by many assistants. Assistants are normally graduate students who are integrated into the project as Research Assistants or Research Fellows. Research assistants participate in the project by doing specific work in the area of research and/or dissemination. They are paid on an hourly basis and are not requested to participate in the project beyond their specific work.

Research Fellows are graduate students with a higher level of integration into the project. For all purposes they are considered members of the research team and as such they participate in the meetings of the project, both in Chile and Canada, which provides them with the opportunity of participating in the processes of planning and delivery of research activities and making contributions to the development of the project. Research fellows, as part of the team, have co-authored several project papers and documents and participated in the conceptualization, planning, and implementation of research activities. To facilitate their experience of working as research assistants these students receive training and all the resources that may be necessary to carry out their activities (office space, secretarial support, computer, etc.). In exchange, and to strength their participation in the project, they are required to produce related graduate theses.

The project has encouraged the establishment of contacts among the research fellows, providing them with the time to get together during the annual meetings, and to expand their experiences by working in the other country. Thus, Gwen Young spent several months in Chile participating in one of the community assessments, while C. Perez Valdivia was invited to obtain a graduate degree at the University of Regina and to participate in the project activities in Canada.

For further information about the report and/or the project please contact any of the following persons:

Dr. Harry Diaz, (306) 585-4758, harry.diaz@uregina.ca
Dr. David A. Gauthier, (306) 337-3130, david.gauthier@uregina.ca
Dr. David Sauchyn, (306) 337-2299, david.sauchyn@uregina.ca
Ms. Pat Barrett-Deibert (306) 585-4788, pat.barrett-deibert@uregina.ca

For free copies of the report see the IACC website: http://www.parc.ca/mcri

APPENDIX 1: PROJECT TEAM MEMBERS

The project team consists of fourteen researchers from five Canadian universities and two Chilean universities and four collaborating partners. The project team members are as follows:

Researchers:

- Dr. Jorge Cepeda-Pizarro (Ecology, Biology, University of La Serena, Chile)
- Dr. Harry Diaz (Sociology, University of Regina, and Director, Canadian Plains Research Center, Canada)
- Dr. Melitta Fiebig (Mathematics, Universidad de La Serena, Chile)
- Dr. David Gauthier (Geography, Associate Vice-President Research, University of Regina, Canada)
- Dr. Suren Kulshreshtha (Agricultural Economics, University of Saskatchewan, Canada)
- Dr. Gregory P. Marchildon (Economic and Regional Development, Administration, University of Regina, Canada)
- Dr. Bruce Morito (Philosophy, Athabasca University, Canada)
- Dr. Héctor Luís Morales (Administration/Tourism, Universidad de La Serena, Chile)
- Bernardo Reyes (Environment and Sustainability, Universidad ARCIS and Universidad de Chile, Chile)
- Dr. Alejandro Rojas (Faculty of Land and Food Systems, University of British Columbia, Canada)
- Dr. Sonia Salas (Psychology, Universidad de La Serena, Chile)
- Dr. David Sauchyn (Geography, Arts, University of Regina, and Research Coordinator, Prairie Adaptation Research Collaborative, Canada)
- Dr. Barry Smit (Geography, Global Environmental Change, University of Guelph, Canada)
- Elaine Wheaton (Climatology, University of Saskatchewan and Saskatchewan Research Council, Canada)

Collaborators:

- Hernan Cortes (History, Universidad de La Serena, Chile)
- Margot Hurlbert (Sociology/Justice Studies, University of Regina, Canada)
- Darrell Corkal (Water Quality, Prairie Farm Rehabilitation Administration, Canada)
- Humberto Zavala (Engineering, Universidad de La Serena, Chile)

The students who have participated in the activities of the project during the second year, both as research assistants and research fellows, are the following (team members acting as supervisors are identified within brackets):

Research Assistants

- Anderson, Carl: PFRA, Master student, History, University of Regina (G. Marchildon and D. Corkal)
- Cabezas, Ricardo C.: Licenciate student, GIS and Remote Sensing, Universidad de La Serena (J. Cepeda)
- Duthier, Katherine: Master student, Philosophy, University of Alberta (B. Morito)
- Knuttila, Erin: Master candidate, Sociology, University of Regina (H. Diaz)
- Lexier, Roberta: PhD student, History, University of Alberta (G. Marchildon)
- López, Francisco C.: Licenciate student, Biology, Universidad de La Serena (J. Cepeda).
- Munizaga, Ivan: Licenciate student, Engineering, Universidad de La Serena (H. Zavala)
- Pizarro, Jaime A.: Licenciate student, Biology, Universidad de La Serena (J. Cepeda)
- Richer, Liska: PhD candidate, Agricultural Sciences, University of British Columbia (A. Rojas)
- Robles, Marcela I.: MS Student, Geography, Universidad de La Serena (J. Cepeda)

- Schwartz, Enrique: Licenciate student, Universidad ARCIS (B. Reyes)
- Trigos, Hernaldo: Licenciate student, Engineering, Universidad de La Serena (H. Zavala)

Research Fellows
- Espinoza, Roxana: Licensed in Management and Commercial Engineering Sciences, Universidad de La Serena (H. Morales)
- Jeanes, Stephanie: MA student, Sociology, University of Regina (H. Diaz)
- Jimenez, Elizabeth: MA candidate, Center for Latin American Studies, Universidad de La Serena (S. Salas)
- Lapp, Suzan: PhD candidate, Geography, University of Regina (D. Sauchyn)
- Lazo, Emilio: Master student, Environmental Engineering, Universidad de La Serena (M. Fiebig)
- Magzul, Lorenzo: PhD candidate, Agricultural Studies, University of British Columbia (A. Rojas)
- Patino, Lorena: PhD candidate, Geography, University of Regina (D. Gauthier)
- Perez, Cesar: Master student, Universidad de La Serena (D. Sauchyn)
- Prado, Susana: Master student, Social Work, University of Regina (H. Diaz)
- Wandel, Johanna: PhD candidate, Geography, University of Guelph (B. Smit)
- Young, Gwen: Master candidate, Geography, University of Guelph (B. Smit)

Finally, the project has been supported by the work of a group of research associates, technicians and administrative assistants. They are:

Research Associates and Technicians:
- Bodini, Andrés: GIS, Universidad de La Serena (J. Cepeda, S. Salas)
- Daschuk, James: research associate, University of Regina (G. Marchildon)
- Pittman, Jeremy: Website, Prairie Adaptation Research Collaborative (D. Sauchyn, H. Diaz, D. Gauthier)
- Wittrock, Virginia: Data, Saskatchewan Research Council (E. Wheaton and S. Kulshreshtha)

Administrative Assistants:
- Barrett-Deibert, Pat: Project Administrative Assistant, Canadian Plains Research Center, University of Regina
- Araya, Solange: Project Administrative Assistant, Universidad de La Serena, Chile

APPENDIX 2: PROJECT PARTNERS

- Alberta Environment, Canada
- Athabasca University, Canada
- Canadian Plains Research Center (CPRC), Canada
- Centro del Agua para Zonas Áridas y Semiáridas de América Latina y el Caribe, Chile
- Centro de Estudios Regionales, Chile
- Comisión Nacional del Medio Ambiente, Chile
- Instituto de Ecología Política, Chile
- Meteorological Services of Canada, Environment Canada
- National Water Research Institute, Canada
- Prairie Adaptation Research Collaborative (PARC), Canada
- Prairie Farm Rehabilitation Administration (PFRA), Agriculture and Agri-Food Canada
- Saskatchewan Research Council, Canada
- Saskatchewan Watershed Authority, Canada
- University of British Columbia, Canada
- University of Guelph, Canada
- University of La Serena, Chile
- University of Regina, Canada
- University of Saskatchewan, Canada

APPENDIX 3: THE ADVISORY BOARD

The Advisory Board offers advice and guidance to the Director of the Project and the Management Team in particular and the research team in general on all matters relevant to the project. Its members meet formally once a year, at the same time and location as the annual project team meeting.

The Advisory Board of the IACC project has three members. They are:

- Phil Adkins. Mr. Adkins is the Acting Director of the Agricultural Water Directorate, Agriculture and Agri-Food Canada (AAFC) PFRA, and was recently the Acting Manager of the Prairie Agroclimate Unit. He is a civil engineer with considerable experience in the management of water supplies and engineering of water control structures. This includes participation in CIDA missions in Ethiopia and Indonesia and work as a CIDA consultant to the UN Food and Agriculture Organization.
- Fernando Santibanez. Dr. Santibanez is an Agronomist Engineer. He is a professor of agroclimatology at the College of Agriculture and Academic Director of the PhD Program on Agricultural, Forestry and Veterinarian Sciences of the Universidad de Chile, as well as Director of AGRIMED, an agricultural and environmental center based at the same university. Dr. Santibanez is one of the most well known Chilean scholars in the area of climate change.
- Martin Mujica. Dr. Mujica is a former professor of Sociology at the Université de Moncton (Canada) and a research fellow of the Interdisciplinary Research Group on Environmental Management of the Université de Québec à Montréal. He has significant experience in international research, having worked with CIDA and IDRC for several years in the areas of sustainable development.

P. Adkins and M. Mujica became members of the Advisory Board in March 2004. F. Santibanez joined the Board in December 2005, replacing Dr. Horacio Larrain. The three members of the Board have agreed to serve for the duration of the project.

APPENDIX 4: WORKING PAPERS

The documents described in this appendix are those that were produced during the period April 1, 2005–May 31, 2006. Each entry provides the author(s), year in which the paper was delivered, title, the language of the document, an abstract, and the website address where the document can be found. The papers are in either English or Spanish.

Bischoff-Gauß, I., N. Kalthoff and M. Fiebig-Wittmaack, 2006, "The Influence of a Storage Lake in the Arid Elqui Valley in Chile on Local Climate" (English) (published on-line, Theoretical and Applied Climatology http://www.springerlink.com) Abstract: High-resolution model simulations were performed with the quadruple-nested version of the mesoscale model KAMM to investigate the impact of the new storage lake "Embalse Puclaro" on the arid environment. The storage lake covers an area of 1 to 2 km in width and about 7 km in length. Model simulations were performed for a summer and a winter day. Due to a change in the surface properties, the installation of the storage lake resulted in a modification of the energy balance. Above the lake area, a stable stratified atmosphere is established during the day and unstable stratification during the night. During the day, the latent heat flux is similar to that of the replaced cultivated ground, but is higher at night. The influence of the storage lake on temperature and humidity can be seen to a height of about 300m above ground level. During the night, water vapour accumulation results in relative humidity values of 100%, as a result a greater number of days with fog above the storage lake is likely when compared to the surrounding area. The storage lake does not produce its own lake breeze during the day, because the larger-scale up-valley wind is too dominant. However, a significant modification of the nocturnal down-valley wind above the lake area can be observed, especially in summer. As a consequence of the larger-scale valley wind system, the influence of the storage lake on the temperature, humidity, and wind field can be identified up to about 4 km on the downwind side.

Cepeda, Jorge and Jaime Pizarro, 2006, "Analysis of Environmental Vulnerabilities identified by stakeholders in the Elqui River Valley, with Focus on Arthropods of Economic Importance" (Spanish). Abstract: Literature review showed a lack of relevant studies/publications on climate change effects on arthropod populations. Most of the information is too generalist or presumptive to get sound conclusions. In the case of this work, the present study sets a baseline upon which future trends may be envisioned. Locally, the thermal and moisture variability found in the arthropods' habitat can apparently favor the outbreak of some species, such as has been shown by Fuentes and Campusano (1985) and Cepeda-Pizarro et al. (in peer review). (www.parc.ca/mcri/elqrb.php)

Corkal, Darrell, Bruce Inch and Phil Adkins, 2006, "The Case of Canada—Institutions and Water in the South Saskatchewan River Basin" (English). Abstract: Canadian society and culture are intricately linked to water. This paper provides an overview of the key institutions with some degree of interest in water resource management in Canada, and principally within the South Saskatchewan River Basin in Alberta and Saskatchewan. To better understand Canadian water institutions and their roles in water resource management, three factors are identified as key institutional drivers: (a) decentralization and shared jurisdictions; (b) sustainable development and integrated water resource management; and (c) governance and the need for leadership and clearly focused federal, provincial and local roles. The paper argues that water governance remains a challenge. Water and the environment are cross-cutting issues involving interdisciplinary approaches, and the active participation of many institutional actors. All orders of government will need to find new ways of working together, within and between their own hierarchies. All orders of government will need to engage and empower all stakeholders, including citizens, industry and academia, with desired goals of making efficient and timely water resource management decisions, and of finding improved capacity to deal with water conflict and competing interests in water resources.

Federal, provincial, and local roles and responsibilities for water resource management will need to become more clearly defined and focused, in order to truly achieve sustainable integrated water resource management. (www.parc.ca/mcri/papers.php)

Daschuk, James and Gregory P. Marchildon, 2005, "Historical Chronology of the Oldman River Dam Conflict" (English). Abstract: Responsible for about 30% of the total water flow in the SSRB, the Oldman River is important to Aboriginal people, particularly the Peigan First Nation, and farmers in southwest Alberta. This working paper provides a chronology of the various conflicts that have arisen over the diversion and use of the river over the past century, including: 1) the historical background to water management in Alberta, including irrigation that drew upon the Oldman River, from the late 19th century until the 1970s; 2) the opposition to the construction of a dam on the Oldman River by the Peigan First Nation and environmentalists since the 1970s; and 3) conflict since the dam's construction in 1991–92. (www.parc.ca/mcri/papers.php)

Diaz, H. and D. Gauthier, 2005, "Adaptive Capacity for the South Saskatchewan River Basin" (English) (to be published in E. Wall et al. (eds.), "Climate Change and Canadian Agriculture: Understanding Impacts and Capacity," UBC Press, Vancouver). Abstract: This article focuses on the role of public institutions as a component of the adaptive capacity of rural communities and rural households for dealing with risks from changing climate conditions and resource scarcities. The discussion is intended to contribute to the understanding of the term "adaptive capacity" by discussing conceptual and methodological issues related to institutional adaptation to climate change. Research underway in the SSRB is used for illustrative purposes. (www.parc.ca/mcri/papers.php)

Diaz, Harry and Alejandro Rojas, 2006, "Methodological Framework for the Assessment of Governance Institutions" (English). Abstract: This document was prepared to facilitate the methodological discussion of institutional assessment. Its purpose is to provide suggestions for a methodological framework for assessing governance institutions that operate in the area of management of water resources. It discusses the concept of institution, the nature of the formal institutions to be assessed, and the main dimensions of the assessment. (www.parc.ca/mcri/papers.php)

Hurlbert, Margot A., 2006a, "Water Law in the South Saskatchewan River Basin (Alberta/Saskatchewan)" (English). Abstract: The South Saskatchewan River Basin ("SSRB") travels from the foothills of the Rockies in Alberta through Saskatchewan and back into southern Alberta. As a result, the water law relating to water quality and water allocation amongst competing users is a mixture of Alberta (within the Alberta boundaries) and Saskatchewan (within the Saskatchewan boundaries) and a smattering of federal law in respect of federal lands and issues. This paper will review some of the pertinent legal rules respecting water allocation and quality in respect of the SSRB and conclude with a discussion of the most salient issues raised by this review. (www.parc.ca/mcri/papers.php)

Hurlbert, Margot, 2006b, "Inter-jurisdictional Water Law—SSRB" (English). Abstract: Canada's water law evolves from many different sources and influences. It commenced with the riparian water laws of Britain, where laws developed on a case-by-case basis in a land of relative water abundance. This law was adopted in Canada but then modified by statute in respect of western Canada, first by the Canadian government and later the provincial governments after the formation of the provinces of Alberta and Saskatchewan and the Natural Resource Transfer Agreements of 1930. In the aftermath, Alberta and Saskatchewan water law and policy have diverged, yet in some federal lands in the provinces federal water law and policy remains intact. Now a complex web of federal and provincial laws, institutions and policies apply to the South Saskatchewan River Basin running through

Alberta and Saskatchewan along with interprovincial agreements and co-management institutions. Although the South Saskatchewan River is one continuous body of water, laws differ between Alberta and Saskatchewan. This is further complicated when laws relating both to quantity and also quality of water are examined. Although quantity and quality of water issues are interrelated ecologically and scientifically, the laws in relation to quantity and quality have very few connections. This paper will outline the constitutional framework of water law and provincial, federal and inter-provincial water institutions relating to both water quantity and quality. This review includes provincial statutes relating to water quantity and quality and principles of constitutional paramountcy and jurisdiction. Thereafter issues, discrepancies and conflicts will be identified and discussed as well as a plan for the future. (www.parc.ca/mcri/papers.php)

Kalthoff, N., M. Fiebig-Wittmaack, C. Meißner, M. Kohler, M. Uriarte, I. Bischoff-Gaux and E. Gonzales, 2006, "The Energy Balance, Evapo-transpiration and Nocturnal Dew Deposition of an Arid Valley in the Andes" (English) (published in the *Journal of Arid Environments*, No. 65, 2006, 420–443). Abstract: The arid Elqui valley, part of the Norte Chico of Chile between 271S and 331S latitude, is located south of the hyper-arid Atacama desert. The region is characterized by complex terrain and great differences of the surface properties, the latter due to cultivated and irrigated areas along the valley floor and sparse vegetation in the arid surrounding area. Here the energy balance of the valley has been investigated to compare the evapo-transpiration of the cultivated area with that of the natural vegetation, and to estimate the dew deposition, which proves to be an important water resource in arid areas. Analyses are based on two Bowen ratio and two eddy covariance stations, operated in the Elqui valley from 2000 to 2002 and in November 2004, respectively. The Bowen ratio of the natural vegetation is about ß11, but much lower in the cultivated and temporally irrigated area along the valley floor. A typical value of the Bowen ratio of a field covered by potatoes is ß2:5 after harvesting or during dry periods and is ß0:7 to 1 after irrigation events or precipitation.

Marchildon, Gregory, 2005, "Climate and Health: Some General Observations for the IACC Project" (English). Abstract: Because human communities and individuals are part of both local and global ecosystems, health conditions within them are influenced to a significant degree by climatic fluctuation. Changes in microbial ecosystems, the source of disease among human and animal populations, are often the direct result of variability of water. This paper considers three aspects of the interaction between water, disease, and human populations. The three aspects are temperature (in particular the significant warming of the past decades), drought, and overabundance of water. The three variables are intimately related and, as with any other aspects of ecosystems, cannot be easily separated from one another. (www.parc.ca/mcri/papers.php)

Marchildon, Gregory, 2006, "The Great Divide" (published in G.P. Marchildon (editor), *The Heavy Hand of History: Interpreting Saskatchewan's Past*. Regina: Canadian Plains Research Center, pp. 51–66) (English). Abstract: This document analyses the enormous impact of the droughts and economic depression of the 1930s in terms of: 1) the economic development of Saskatchewan and the decline of the primacy of wheat growing; 2) the impact of depopulation of rural Saskatchewan; 3) the political platforms and programs of successive Saskatchewan governments after the 1930s; and 4) the collective psychology of Saskatchewan residents relative to Alberta residents today. (www.parc.ca/mcri/papers.php)

Marchildon, Gregory and Carl Anderson, 2006, "Data Time Series for Alberta, Saskatchewan and Manitoba: 1) Economy and Demography; and 2) Agriculture" (English). Abstract: Annual data are collated so that comparisons can be made in terms of the demographic, economic and agricultural characteristics of each of the three prairie province over the last 100 years (1905–2005). Manitoba is used as a test case for changes in Alberta and Saskatchewan where the SSRB is located. (www.parc.ca/mcri/papers.php)

Marchildon, Gregory and David Black, 2006, "Henry Black, the Conservative Party and the Politics of Relief" (published in *Saskatchewan History*, Vol. 58, no. 1 (2006), pp. 4–17). Abstract: This article analyses the organization and management of the Saskatchewan Relief Commission, one of the most important institutional adaptations to the great droughts of the 1930s. In particular, the article highlights the sometimes dysfunctional relationship between the federal and provincial governments, both of which were Conservative, but both of which were attempting to limit their respective fiscal exposure in a human crisis without parallel in Canada in the 20th century. (www.parc.ca/mcri/papers.php)

Morito, Bruce, 2006, "Values Analysis and Institutional Adaptation to Climate Change" (English). Abstract: This paper develops a value analytical approach to identifying and assessing institutional capacities to adapt to climate change in light of stakeholder vulnerabilities. It is written as a companion paper to the paper of H. Diaz and A. Rojas, "Methodological Framework for the Assessment of Governance Institutions" (March 2006). The open-ended and empirical approach for which the paper argues identifies two major sources of information regarding (formal) institutional values: 1) documentation (internal and external) such as mandates, mission statements and to some extent, policies; and 2) practices of the institutions and their agents. It proceeds on the assumption that differences between stakeholder and institutional values analysis are marked by: 1) more explicit and well-defined value and ethical commitments for institutions, owing to the documentation and publicly identifiable practices; and 2) role differentiated responsibilities of institutional agents that limit what values they are free to exercise. Evaluation of institutional adaptive capacity from the perspective of values analysis is to be based on: 1) an examination of consistency between an institution's avowed or explicit value commitments and stakeholder value profiles; and 2) an institution's explicit and implicit (as reflected in its practices) value commitments. At a broader level, it is suggested that three arguably near-universal normative principles can be invoked to provide a second-order values analysis: 1) the harm principle; 2) giving what is due; and 3) principles revolving around the virtues of honesty and trustworthiness. (www.parc.ca/mcri/papers.php)

Pérez Valdivia, Cesar, Melitta Fiebig-Wittmaack, and Jorge Cepeda, 2006, "Modelos Climáticos, Escenarios de Emisiones de Gases de Efecto Invernadero y Escenarios Climáticos" (Spanish). Abstract: This working document contributes to the development of scenarios of climate change in Chile. It provides information about the "state of art" of climate models and their roles in producing future scenarios of climate change, and discusses the studies and instruments used in Chile to analyze the local impacts of climate change scenarios, with an emphasis on the impacts on the hydrological resources in the Elqui basin. (www.parc.ca/mcri/papers.php)

Rojas, Alejandro, B. Reyes, L. Magzul and H.L. Morales, 2006, "Water Blues in Climate Change: The Role of Institutions in Water Conflicts and the Challenges Presented by Climate Change" (English). Abstract: This paper explores the significance of studying water conflicts and the way institutions deal with them, as an important link to understanding community vulnerabilities to climate change. The study of the role of institutions in the resolution or management of (or failure to resolve or manage) water conflicts provides insights to understanding possible and actual institutional learning and needed adaptations to confront climate-change-induced water insecurities. The authors argue that the key aspect

revealed by the examination of conflicts is the realization that power differentials in conflict resolution within communities and between communities and political organizations involved in water governance, may have hampered the adaptive capacity of all stakeholders. The institutions whose role is more relevant here are those involved in water governance. Their role in water conflicts and what they and the communities involved learn from conflicts provides the focus of the study. We also argue that conflict resolution can be adaptive or destructive. Paradoxically, in some conflicts elements of both types of outcomes can coexist and there will be winners and losers, who still may derive important lessons from the experience of conflict. In the case of water conflicts, the communities more directly exposed to hazardous conditions may experience internal strife and fragmentation and/or enter into conflict with some of the institutions involved in water governance. Institutions involved in water governance are those which most directly influence decision making and in the case of water governance, these are the government organizations responsible for water management and allocation, and the ample range of water users and beneficiaries and other civil society organizations that influence water use. Water conflicts are considered here within the wider stream of studies of *environmental* conflict resolution. Since water is an essential element to sustain life, many of the difficulties we encounter in maintaining the integrity of ecosystems and the wise use of natural resources are reproduced in the case of water, where interests are difficult to reconcile, particularly under conditions of water insecurity. Thus, we will often refer to water conflicts as a type of environmental conflict. (www.parc.ca/mcri/papers.php)

Smit, Barry and Johanna Wandel, 2006, "Adaptation, Adaptive Capacity and Vulnerability" (English) (to be published in *Global Environmental Change)*. Abstract: This paper reviews the concept of adaptation of human communities to global changes, especially climate change, in the context of adaptive capacity and vulnerability. It focuses on scholarship that contributes to practical implementation of adaptations at the community scale. In numerous social science fields, adaptations are considered as responses to risks associated with the interaction of environmental hazards and human vulnerability or adaptive capacity. In the climate change field, adaptation analyses have been undertaken for several distinct purposes. Impact assessments assume adaptations to estimate damages to longer-term climate scenarios with and without adjustments. Evaluations of specified adaptation options aim to identify preferred measures. Vulnerability indices seek to provide relative vulnerability scores for countries, regions or communities. The main purpose of participatory vulnerability assessments is to identify adaptation strategies that are feasible and practical in communities. The distinctive features of adaptation analyses with this purpose are outlined, and common elements of this approach are described. Practical adaptation initiatives tend to focus on risks that are already problematic, climate is considered together with other environmental and social stresses, and adaptations are mostly integrated or mainstreamed into other resource management, disaster preparedness and sustainable development programs. (www.parc.ca/mcri/papers.php)

Wittrock, V., E. Wheaton and S. Kulshreshtha, 2005, "Climate Change, Ecosystem and Water Resources: Modeling and Impact Scenarios for the South Saskatchewan River Basin, Canada: A Working Paper" (published by the Saskatchewan Research Council (SRC Publication No. 11899-1E05)). Abstract: The purpose of the paper is to describe the climate modeling used to develop climate change scenarios and to describe the ecosystem modeling used to develop ecosystem impact scenarios. The paper has three main subjects. First, selected climate change models and their resulting impact scenarios are reviewed. Second, several main ecosystem models and their scenarios are described with emphasis on water and vegetation issues. Finally, water use models are reviewed. The method to achieve these objectives is through a critical literature review with emphasis on the last five years of published information. The climate change sections include descriptions of emission scenarios, criteria for climate change scenarios, types of climate scenarios, the uncertainties

of emission and climate scenarios and how well they work. The various types of scaling were also discussed. (www.parc.ca/mcri/papers.php)

Wittrock, V., D. Dery, S. Kulshreshtha and E. Wheaton, 2006 (draft), "Vulnerability of Prairie Communities Water Supply during the 2001 and 2002 Droughts: A Case Study of Cabri and Stewart Valley, Saskatchewan" (Saskatchewan Research Council (SRC), Saskatoon, Saskatchewan. SRC Publication No. 11899-2E06). Abstract: The major objective of this study was to investigate the impact of 2001 and 2002 droughts on the rural communities of Cabri and Stewart Valley in Saskatchewan with emphasis on water resources. These impacts were studied in the context of the communities, as well as in the context of the larger region—Rural Municipality of Riverside (No. 168 housing the community of Cabri) and Rural Municipality of Saskatchewan Landing (No. 167 housing the community of Stewart Valley). Drought impacts were assessed in terms of bio-physical changes as well as economic changes that were observed during the drought years.
(www.parc.ca/mcri/papers.php)

APPENDIX 5: DISSEMINATION ACTIVITIES

Public Presentations

- Sauchyn, D., What's With the Weather? The Controversy of Climate Change, QUEST: North Conference, Winnipeg, Manitoba, March 4–5, 2005.
- Diaz, H., D. Gauthier and D. Sauchyn. (Presenter: D. Sauchyn). Presentation at the Conference Adapting to Climate Change in Canada 2005: Understanding Risks and Building Capacity, Montréal, Québec, May 4–7, 2005.
- Marchildon, G. Adaptation to Drought and Climate Change in Saskatchewan and Alberta, 1919–39. Seminar, Department of Agricultural Economics, University of Saskatchewan, October 21, 2005.
- Morito, B. Value and Ethical Analysis in Vulnerability to Climate Change: Establishing an Analytic Framework for Identifying, Classifying and Evaluating Vulnerability Issues. Presentation at Environmental Studies Association, Canada, Congress of the Humanities and Social Sciences meetings, University of Western Ontario, London, Ontario, June 4, 2005.
- Sauchyn, D.J. What If? … What Then? …What Now? The Problem with Climate Change. Annual Meeting of the Canadian Association of Geographers—Prairie Division, Winnipeg, Manitoba, September 24–25, 2005. Keynote Speaker.
- Sauchyn, Dave, Jodi Axelson, Antoine Beriault and Ge Yu. Using Tree-Rings to Establish the Probability of Drought in the Western Interior. Special Session, Drought in Western Canada: Proxies, paleoclimate observations and human interactions, Biennial meeting of the Canadian Quaternary Association, University of Manitoba, Winnipeg, June 5–8, 2005. Invited.
- Sauchyn, D.J. Tree-ring Records of Prolonged Drought from Canada's Western Interior. "Predicting Drought on Seasonal to Decadal Time Scales," University of Maryland, Adelphi, MD. May 17–19, 2005. Invited.
- Sauchyn, Dave; Jodi Axelson and Antoine Beriault. A Network of Moisture-Sensitive Tree-Ring Chronologies from the Western Interior. CAG / ACG 2005 Annual Meeting, May 31 to June 4, 2005. The University of Western Ontario, London, Ontario. Invited.
- Sauchyn, D.J. Adaptation to the Impacts of Climate Change on Water Resources: South Saskatchewan River Basin, Canada; Elqui River Basin, Northern Chile. Reflections on Our Future: A New Century of Water Stewardship, 58th Annual CWRA National Conference. Banff, Alberta, June 14–17, 2005. Invited.
- Smit, B. State of the Art: Adaptation. International Human Dimensions of Global Change Open Meeting, Bonn, November 2005.
- Smit, B. Where From and Where To: Climate Change Impacts and Adaptation Research and Practice. Climate Change and Society: Social Science Research Issues and Opportunities Symposium, London, Ontario, June 2005.
- Smit, B. Climate Change, Impacts, Adaptations, Vulnerabilities. Plenary Presentation at Adapting to Climate Change in Canada 2005: Understanding Risks and Building Capacity, Montreal, 2005.
- Smit, B. Presentation on Adaptive Capacity, Adaptation and Vulnerability at the International Human Dimensions Open Meeting, Bonn, 2005.
- Wandel, J. The "Vulnerability Approach" to Climate Change Research. Climate Change and Society: Social Science Research Issues and Opportunities Symposium, London, Ontario, June 2005.
- Fiebig-Wittmaack, M., S. Montecinos, C. Pérez and N. Kalthoff. Study of Water Cycle Components at an Arid Andean Valley at 30° S in Chile. Symposium on Climate Change: Organizing the Science for the American Cordillera (CONCORD), Mendoza, Argentina, April 4–6, 2006.

- Smit, B. Stormy Weather: The Turbulent Science, Economics and Politics of Climate Change. Presented to The Alliance for Capitalizing on Change, Calgary and Edmonton, February 8 and 10, 2006.
- Smit, B. Climate Change, Adaptation and Development. Presentation for students in the University of Guelph's International Development Program, February 2006.
- Sauchyn, D. Los Fundamentos del Cambio Climatico. Universidad de La Serena, May 23, 2006.

Presentations to Stakeholders

- Fiebig-Wittmaack, M. "La influencia del embalse Puclaro sobre el clima local", Instituto de Investigaciones Agropecuarias, La Serena, June 2005.
- Reyes, B. Presentation to the "National Seminar on Disasters and Climate Change: Global Climate Change Citizenship," organized by CONAMA, Universidad Bolivariana, Universidad C. Silva Enriquez, April 2005.
- Reyes, B. Presentation to regional seminar "Global Climate Change and Local Renewable Resources," Ovalle, region de Coquimbo, Chile, May 6, 2005. Organized by Ovalle City Council, May 2005.
- Reyes, B. Presentation of Overview of the SSHRC MCRI Project on Institutional Adaptations to Climate Change on the "National Self-evaluation and Consultative Workshop for the Second National Communication on Climate Change," organized by the national Commission on Climate Change and UNDP, September 2005.
- Salas, S. "Vulnerabilidad, Cambio Climatico y Desertificación," Seminario Cambio Climatico, Ovalle, Chile, May 6 and 7, 2005.
- Sauchyn, Dave, Harry Diaz, Jorge Cepeda and Melita Fiebig. "Comparing Human-Climate Interactions between Dryland River Basins in Western Canada and Northern Chile." 2nd Southern Deserts Conference, Human-Environment Interactions in Southern Hemisphere Deserts: Past, Present and Future, Arica, Chile, October 10–14, 2005.
- Sauchyn, D.J. "Water, Drought and Climate Change: The Long View." International Waters Association, Watershed Conference 2005, September 13–15, 2005, Calgary, Alberta. Keynote Speaker.
- Sauchyn, D.J. Alberta Vulnerability Assessment Project— Climate and Biophysical Scenario Overview. Vulnerability Assessment—Social/Economic Workshop, University of Alberta, May 26, 2005. Invited.
- Fiebig-Wittmaack, M. Oscilaciones Climáticas y Cambio Climático en la Cuenca del Rio Elqui. Seminario-taller "Adaptación institucional al cambio climático: oportunidades y desafíos para Chile"; CONAMA/PNUD/IACC, Santiago, Chile, Mayo 29–30, 2006.
- Diaz, H. and A. Rojas. "Methodological Framework for the Assessment of Governance Institutions." Workshop on Institutional Adaptations to Climate Change. Prairie Farm Rehabilitation Administration (PFRA) Regina, March 17, 2006.
- Sauchyn, D. and P. Diaz. "Cambio Climatico y sus Impactos Sobre la Agricultura," Ministerio de Agricultura, Santiago, May 18, 2006.
- Gauthier, D. "El Estado del Arte en la Investigación Científica Asociada al Cambio Climático en Canadá y su Diálogo con los Tomadores de Decisiones. Seminario-taller "Adaptación institucional al cambio climático: oportunidades y desafíos para Chile"; CONAMA/PNUD/IACC, Santiago, Chile, Mayo 29–30, 2006.
- Salas, S. "Adaptación Institucional al Cambio Climático: Estudio Comparativo de Cuencas en Canadá y Chile. Una Mirada Interdisciplinaria en torno a la Vulnerabilidad y Adaptación institucional. Seminario-taller "Adaptación institucional al cambio climático: oportunidades y desafíos para Chile"; CONAMA/PNUD/IACC, Santiago, Chile, Mayo 29–30, 2006.
- Diaz, H. "El Desarrollo de la Capacidad Adaptativa al Cambio Climático: el Rol de las Instituciones." Seminario-taller "Adaptación institucional al cambio climático: oportunidades y desafíos para Chile"; CONAMA/PNUD/IACC, Santiago, Chile, Mayo 29–30, 2006.

- Corkal, D. "Agricultura y Clima en el Oeste de Canada." Seminario-taller "Adaptación institucional al cambio climático: oportunidades y desafíos para Chile"; CONAMA/PNUD/IACC, Santiago, Chile, Mayo 29–30, 2006.
- Corkal, D., H. Diaz and D. Gauthier. "Governance and Adaptation: The Cases of Chile and Canada," PFSRB Conference. Climate Change and Water in the Prairies, Saskatchewan, June 22, 2006.

Media Releases

- Diaz, H., Radio Interview—CJTR Community Radio, July 11, 2005.
- Patino, L., Faculty of Arts, the University of Regina. Autumn 2005. Researching climate change: students groomed for leadership. *Art Beats Newsletter* 3 (1): 6. www.uregina.ca/arts
- Sauchyn, D., Contributed to "Fire and Ice" (Extreme Weather documentary), CBC Newsworld, broadcast several times during October 2005.
- Sauchyn, D., Commentary on climate change impacts on water supplies, CBC Radio International, November 18, 2005.
- Smit, B., radio interview, CBC Radio "The Current," June 20, 2005.
- Smit, B., radio interview, The Weather Network (television), May 6, 2005.
- Smit, B., radio interview, CBC "The National" (television), December 1, 2005.
- Smit, B., press interview, featured in Guelph *Mercury*, December 7, 2005.

Stakeholders Workshops

- Workshop "Cambio Climático. Desastres y Adaptación. Perspectivas Ciudadanas Hacia la Décima Conferencia de las Partes de la Convención Sobre Cambio Climático," a CONAMA/IACC Workshop (with the participation of B. Reyes, S. Salas, and M. Fiebig), Santiago, December 1–2, 2004.
- Workshop "Climate Change and Water Resources," IEP/Municipality of Ovalle/IACC (with the participation of B. Reyes and S. Salas), May 6 and 7, 2005.
- Workshop on Institutional Research, a PFRA/IACC workshop (with the participation of H. Diaz, D. Gauthier, B. Morito, A. Rojas, B. Smit and J. Wandel), Regina, Friday, March 17, 2006.
- Workshop with representatives of rural communities in the ERB. Organized by the Centro de Estudios Regionales, Universidad de La Serena (with the participation of S. Salas, M. Fiebig, H.L Morales, E. Jiménez y R. Espinoza, La Serena, May 15–16, 2006.
- Workshop "Adaptación Institucional al Cambio Climático: Oportunidades y Desafíos para Chile," a CONAMA/PNUD/IACC workshop (with the participation of B. Reyes, M. Fiebig, S. Salas, D. Gauthier, D. Corkal, and H. Diaz), Santiago, May 29–30, 2006.

Publications and Reports

- Beriault, A. and D.J. Sauchyn. Submitted. Tree-ring reconstructions of streamflow in the Churchill River basin, northern Saskatchewan. Submitted to the *Canadian Water Resources Journal*.
- Bischoff-Gauß, I., N. Kalthoff, and M. Fiebig-Wittmaack, The influence of a storage lake in the Arid Elqui Valley in Chile on local climate, published on-line, Theoretical and Applied Climatology, 2006, http://www.springerlink.com
- Diaz, H. and M. Nelson, "Social Capital and Adaptation to Climate Change," *Prairie Forum* (Special Issue) Vol. 30, No. 2, Fall 2005.
- Diaz, H., D. Gauthier and D. Sauchyn, Social Dimensions of the Impact of Climate Change on Water Supply and Use in the City of Regina, a research report prepared for the Center for Sustainable Communities (with B. Cecil and J. Piwowar, as co-authors).
- Diaz, H. and D. Gauthier (forthcoming), "Adaptive Capacity for the South Saskatchewan River Basin," in E. Wall et al. (eds.), *Climate Change and Canadian Agriculture: Understanding Impacts and Capacity* (UBC Press, Vancouver).

- Ermine, Willie, Ralph Nilson, Dave Sauchyn, Ernest Sauve and Robin Smith, 2005. Isi Askiwan—The State of the Land: Prince Albert Grand Council Elder's Forum on Climate Change. PARC Summary Document No. 05-05. Prairie Adaptation Research Collaborative, Regina, 8 pp.
- Gauthier, D.A. and H. Diaz (editors). Rural Adaptation and Social Cohesion on the Prairies. *Prairie Forum* (Special Issue) Fall 2005. Canadian Plains Research Center, University of Regina, Saskatchewan.
- Gauthier, D.A. and H. Diaz. 2005. Rural Adaptation and Social Cohesion for Sustainable Development of the Prairies. Pp. iii–xviii in: D.A. Gauthier and H. Diaz (editors), *Prairie Forum* (Special Issue), Fall 2005. Canadian Plains Research Center, University of Regina, Saskatchewan.
- Gauthier, D.A. and S. Weiss. 2005. Assessing Performance: Indicators, Social Cohesion and Community Sustainability. Pp. 313–328 in: D.A. Gauthier and H. Diaz (editors), *Prairie Forum* (Special Issue), Fall 2005. Canadian Plains Research Center, University of Regina, Saskatchewan.
- Kalthoff, N., M. Fiebig-Wittmaack, C. Meißner, M. Kohler, M. Uriarte, I. Bischoff-Gauß and E. Gonzales, 2006, "The energy balance, evapo-transpiration and nocturnal dew deposition of an arid valley in the Andes," *The Journal of Arid Environments*, No. 65, 420–443.
- Marchildon, Gregory, 2005, "The Great Divide," in G.P. Marchildon (editor), *The Heavy Hand of History: Interpreting Saskatchewan's Past*. Regina: Canadian Plains Research Center, pp. 51–66.
- Marchildon, Gregory and David Black, 2006, "Henry Black, the Conservative Party and the Politics of Relief." *Saskatchewan History*, Vol. 58, no. 1, pp. 4–17.
- Sauchyn, D.J. (forthcoming). The Impacts of Climate Change on Prairie Agriculture. Chapter 4 in E. Wall et al. (eds.), *Climate Change and Canadian Agriculture: Understanding Impacts and Capacity* (UBC Press, Vancouver).
- Sauchyn, D.J. (forthcoming). Saskatchewan's Changing Climate. In M. Lewry et al. (eds.), *The Geography of Saskatchewan* (Canadian Plains Research Center, Regina).
- Sauchyn, D.J. and S.D. Kennedy. The Potential for Land Degradation under Climate Change in the Vicinity of Six Rural Communities in Saskatchewan. Pp. 173–186 in: D.A. Gauthier and H. Diaz (editors), *Prairie Forum* (Special Issue), Fall 2005. Canadian Plains Research Center, University of Regina, Saskatchewan.
- Sauchyn, D.J., M. Khandekar and E.R. Garnett (eds.). 2005. *The Science, Impacts and Monitoring of Drought in Western Canada: Proceedings for the Canadian Prairie Drought Workshop, Calgary, Alberta, May 26–28, 2004*. Canadian Plains Research Center, University of Regina.
- Sauchyn, D.J. 2005. A 250-Year Climate and Human History of Prairie Drought. Pp. 27–30 in: D.J. Sauchyn, M. Khandekar and E.R. Garnett (eds.), *The Science, Impacts and Monitoring of Drought in Western Canada: Proceedings for the Canadian Prairie Drought Workshop, Calgary, Alberta, May 26–28, 2004*, Canadian Plains Research Center, University of Regina.
- Smit, B. and J. Wandel. 2005. Submitted paper, "Adaptation, Adaptive Capacity and Vulnerability" to *Global Environmental Change* (under review).
- Smit, B., E. Wall and J. Wandel. 2005. *Climate Change and Canadian Agriculture: Understanding Impacts and Capacity* (co-editing book in progress).
- Wittrock, V., E. Wheaton and S. Kulshreshtha. 2005. "Climate Change, Ecosystem and Water Resources: Modeling and Impact Scenarios for the South Saskatchewan River Basin, Canada: A Working Paper." Saskatchewan Research Council (SRC), Saskatoon, Saskatchewan. SRC Publication No.11899-1E05. 61 pp.
- Wittrock, V., D. Dery, S. Kulshreshtha and E. Wheaton. 2006 (draft). "Vulnerability of Prairie Communities Water Supply during the 2001 and 2002 Droughts: A Case Study of Cabri and Stewart Valley, Saskatchewan." Saskatchewan Research Council, Saskatoon, Saskatchewan. SRC Publication No. 11899-2E06.

APPENDIX 6: LISTS OF GEOSPATIAL DATA

List of Geospatial Data Layers for the South Saskatchewan River Basin (SSRB).

Layer	Source
South Saskatchewan River Basin and Sub-basins	Downloaded for Saskatchewan and Alberta – Geogratis (2004) (1:1000000)
Rivers	ESRI
SSRB sub-basins and watersheds, The SSRB boundaries have been defined according to Richard J. Rickwood in terms of its sub-basin boundaries.	The Prairie Farm Rehabilitation Administration (2004), Richard Rickwood the Prairie Farm Rehabilitation Administration personal communication (1:50000) Includes the sub-basins of Big Stick Lake, Bow River, Oldman River, Red Deer River, Seven Persons Creek, South Saskatchewan River and Swift Current Creek.
Aridity Index (P/PET)	ECOATLAS series available free of charge – Geogratis (2004) (1:2000000) Include PET calculated from Penman Method annual wind speed (km/hr) and soil texture.
Agriculture land use (for Alberta and Saskatchewan)	From the vmap_zero_r4 series – Geogratis (2004) (1:1000000).
Available water capacity less or equal to 150 mm in the upper soil (upper 120 cm in the dominant soil landscape)	The Soil Landscapes of Canada – the Canadian Soil Information System (2004) (1:1000000).(http://sis.agr.gc.ca/cansis/nsdb/slc/v2.2/intro.html)
Mean annual air temperature	From the ECOATLAS series available from Geogratis (2004) (1:2000000)
Total annual precipitation	ECOATLAS series available from Geogratis (2004) (1:2000000)
Maximum elevation	ECOATLAS series available from Geogratis (2004) (1:2000000)
Annual potential evapotranspiration	ECOATLAS series available from Geogratis (2004) (1:2000000)
Ecological Regions (ecozones, ecoregions, ecodistricts)	ECOATLAS series available from Geogratis (2004) (1:2000000)
District numbers	ECOATLAS series at Geogratis.
Geo-referenced census data (e.g. RM population)	Statistics Canada— Data Liberation Initiative program, University of Regina
Health districts and population	Saskatchewan Health, 2005. Alberta Health and Wellness, 2005.
Health care facilities	Alberta Health and Wellness, 2005. Saskatchewan Health, 2005.
Land cover type	Source: PFRA. 2001. PFRA Generalized Landcover for the Canadian Prairies. Time Period: 1993-05-01 to 1995-07. http://www.agr.gc.ca/pfra/gis/lcv_e.htm
1919 to 1939 Palmer Drought Severity Index (PDSI)	Source: Environment Canada. Provided on January 9, 2006.
Wind erosion risk for unprotected soils in areas sensitive to climatic change	Source: Wolfe, S.A. and W.G. Nickling. 1997. Sensitivity of Eolian Processes to Climate Change in Canada. Geological Survey of Canada Bulletin 421. Ottawa: Natural Resources Canada.
1900–1999 Prairie Monthly Palmer Drought Index (PDI)	Source: Environment Canada. Format: PDI derived from gridded climate data.

List of Geospatial Data Layers for the Elqui River Basin (ERB).

Layer	Source
Elqui River Basin boundary	
Census District Divisions	Time period: 1992
Census District Divisions 2002	Time period: 2000
Hydrology network	Instituto Geografico Militar, Chile (1:50000)
Hydrology network	Instituto Geografico Militar, Chile (1:250000)
Roads	Instituto Geografico Militar, Chile (1:50000)
Roads	Instituto Geografico Militar, Chile (1:250000)
Population centres	Instituto Geografico Militar, Chile (1:50000)
Population centres	Instituto Geografico Militar, Chile (1:250000)
Elevation contours	Instituto Geografico Militar, Chile (1:50000)
Elevation contours	Instituto Geografico Militar, Chile (1:50000)
Pluviometric stations	Direccion General de Aguas
Pluviometric stations	CEAZA
Panchromatic aerial photography (portion of ERB)	
Digital elevation model	Resolution: 100x100 pixels
Facet/aspect	Resolution: 100x100 pixels
Slope	Resolution: 100x100 pixels
Shadow	Resolution: 100x100 pixels
Avalanche risk	Resolution: 100x100 pixels
Landsat image, Thematic Mapper,	Thematic Mapper Image. Resolution: 28x28 mts. Approx.
Population centres, Census 1992	Time period: 1992
Channel network of the Elqui River.	
Land use	Corporacion de Fomento Fabril
Geomorphology	
Chilean native vegetation	