CHANGING ROLES IN CANADIAN WATER MANAGEMENT DECISIONS AND DATA-SHARING

– A case study of Agriculture and Water in Canada's South Saskatchewan River Basin

Authors:
Darrell R. Corkal, Agriculture and Agri-Food Canada - Agri-Environment Services Branch, Saskatoon,
Harry Diaz, Canadian Plains Research Center, University of Regina.

Executive Summary

Water management decisions and the collection of water data have become increasingly complex in today's world. Competition for water by different sectors, urban-rural pressures, the need for sustainability and environmental protection, the influence of climate change and climate variability, and the pressures of advocacy groups and partisan approaches, all make water management decisions highly politicized. Canadian society is working to engage various viewpoints, and achieving some success with integrated management, yet faces real challenges in water resource management. Canada still needs to gather more water data at all scales. All orders of government are struggling to find ways of making water data more readily available, for effective decision-making.

Canada, like many nations, is beginning to position water management decision-making in the framework of "integrated water resource management" and is increasingly including local stakeholders in management decisions. Roles have evolved where provincial and federal agencies are working together on environmental data collection, drought and extreme event forecasting, and considering how climate change may impact policies and programs and local decision-making. Local stakeholders are forming more established watershed groups. Stakeholders, NGOs, industry, and advocacy and environmental groups are in many cases conducting their own studies and proceeding with gathering data to advance or influence water resource decision-making. Canadian agriculture is beginning to develop its role within water management, both as a water user, and as a steward of water resources.

Key research findings from stakeholder research identify effective water resource management principles in Canada, including:

- Strategic regional and national water planning based on watershed boundaries (i.e. beyond strictly political boundaries). Water resource management has to include a mix of economic, social, and environmental issues.
- Participatory planning where all orders of government empower and engage the viewpoints and wisdom of the various stakeholders with vested interest in water management.
- Strategic yet flexible water frameworks, linked with climate scenarios for a 5 year cycle and a 20 year cycle, to address short and longer-term needs. Such frameworks would help establish a common vision for all orders of government and stakeholders to consider, adopt, implement, and measure success or needed improvements as new information and challenges are discovered.
- Gather more and better water data; facilitate making water data publicly accessible and easily shared by all orders of government and local stakeholders.
- Build on successes that allow the agricultural sector to continue its journey to better understand and adopt agricultural Best Management Practices that safeguard water quality and conserve water resources.

Introduction

Canadian culture is strongly linked to water. While the country is perceived by many to be water-rich, it is increasingly becoming evident that water is a limiting factor in many regions. The perception that Canada is a water-rich country is being challenged as a "myth of water abundance".[1] Selected regions in the country are under increasing pressures of water stress (e.g. competition, full allocation). The 1987 Federal Water Policy was developed in response to Canada's 1985 Federal Water Inquiry[2] and remains Canada's most recent federal policy. The 1987 policy is still recognized as visionary for its day: most of Canada's water issues identified then remain valid today, including integrated water resource management, citizen engagement and climate change. More recent literature identifies Canada's current water management problems to be more related to a lack of implementation of the policy.[3] Increasing demands for water and limited availability have led to moratoriums in selected areas of the country. This growing competition for water, coupled with a greater awareness of the pressures of climate variability, and the potential risks of impacts from a changing climate, have placed governance organizations under pressure for improvements to water management. This is especially the case of those organizations working in the agricultural sector, which due to its essential role in food production, clearly has a critical role in water management. Agriculture consumes water and requires good quality source water as an input in safe food production; agricultural practices also risk impacting natural water sources (water availability and water quality).[4]

After several serious waterborne outbreaks in Canada (Walkerton in 2000, North Battleford in 2001, and Kasheshewan First Nation in 2005), the provincial and federal governments have reviewed and implemented changes to water management strategies to emphasize source water protection and integrated water resource management.[5] These changes are still evolving, and there is a growing body of literature calling for an updated and nationally-developed water strategy in a country where water resources are managed under provincial government authority. Academia, non-government organizations, and Canadian Federal government literature express concerns about the state of water management and knowledge in the country, and call for improvements. In 2008, the western provincial premiers formed the Western Water Stewardship Council to help address cross-boundary and inter-jurisdictional co-ordination of water management decisions (e.g. source water protection, drought preparedness), illustrating a need for increased leadership and collaboration across jurisdictions.[6]

This paper provides insights from a case study of the South Saskatchewan River Basin (SSRB) in Western Canada, the Institutional Adaptations to Climate Change (IACC) project. The study focused on rural community vulnerabilities to climate and climate-induced water stress conditions. Research data was obtained by conducting semi-structured interviews and focus group discussions, with a full spectrum of water users and institutions involved in water management, including all orders of government. The research incorporated a vulnerability assessment model considering past, present and future vulnerabilities as related to climate-induced water stress. Water management challenges were identified, with research recommendations to help build capacity, rural resilience and improved water management and governance in Canada. In order to contextualize the discussion of the case study, this paper presents and overview of Canadian water resources primarily referencing the agricultural sector and the SSRB as a watershed example. While this watershed only spans two western Canadian provinces, its example serves to highlight water management and data challenges in Canada.

A brief overview of Canada's water, focusing on agriculture

Canada is considered to be a water-rich country, but 67% of the water flows northward, while 90% of the population lives in the south where most of the arable land is located[7] (Fig. 1). Canada has about 20% of the world's fresh water stored in lakes, but a distinction must be made between "stored water" and "renewable water supply". The renewable water supply is that portion of water which replenishes lakes and underground aquifers. Canada has about 6.5% of the world's renewable water supply.[8] All of these factors must be considered in water management, in order to balance society's needs and the capacity of the ecosystem to replenish the water that is withdrawn for use. The available water supplies in Canada are particularly challenging to the semi-arid regions such as the Canadian Prairies, where existing water supplies are at, or near, full allocation.

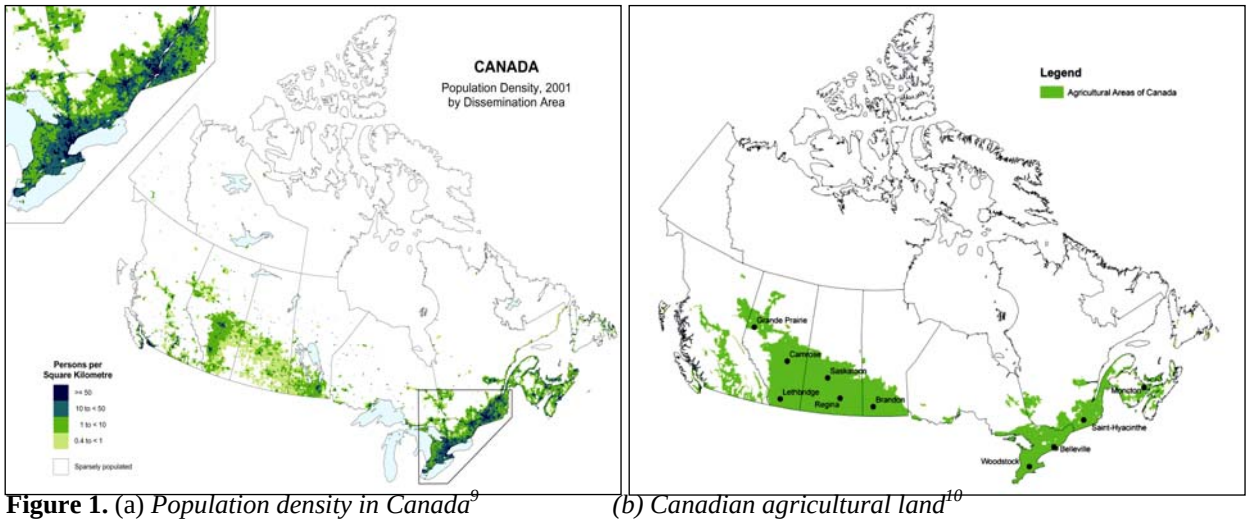

Figure 1. (a) *Population density in Canada*[9] *(b) Canadian agricultural land*[10]

Water management in rural Canada is particularly challenging. Many rural areas are sparsely populated. The agricultural sector and over 4 million rural Canadians (about 13% of Canada) do not have access to the same types of regional water infrastructure as urban Canadians. Most rural citizens rely on private self-managed water supplies. Access to reliable water supplies (sufficient quantity and good quality) can be challenging and costly to rural citizens; water is essential for rural household needs and as an input in the production of safe food. It is estimated that 20 to 40% of rural wells in Canada exceed safe drinking water quality guidelines, and percentages can be much higher in selected regions, affecting water quality for many rural users, including water needs for agricultural purposes and rural homes. Data on water quality for rural users is found in selected studies conducted by provincial, federal or academic institutions; however, there is no provincial or national database summary of rural water quality in these private supplies. On-going research for robust water treatment options for water used by agriculture, and for practices that protect the environment from potential agricultural impacts, are underway and currently being developed in Canada.[11] Private water supplies clearly also pose issues for public health. These supplies are not tested frequently, if at all, and while owners of private systems are fundamentally responsible for their own water, there are calls for local, provincial and federal governments to provide better water information and resources targeted to rural citizens (e.g. enhanced education and awareness programs, better standards, and evidence-based educational, research and training programs for rural water users).[12]

The agricultural sector has a role in water management and use. Agriculture and the agri-food industry in Canada, account for 8.3% of Canada's gross domestic product. Agriculture is practiced on approximately 7% (67.5 million ha) of Canada's land base, with 82% of this occurring on the Canadian Prairie Provinces.[13] Water, as expected, is essential for agriculture's needs, and water

sources are at risk of contamination from agricultural practices and increased water consumption for agricultural water demands.

Agriculture is Canada's largest single sector for water consumption, utilizing about 4.5 billion m^3 of water annually. It is estimated that agriculture consumes 70-80% of the water it diverts (based on 1996 data). About 85% of agricultural water withdrawals are used for irrigation, predominantly in Western Canada, and about 15% of agricultural water withdrawals are utilized for livestock production.[14] Dryland farming relies on timely rains and sufficient soil moisture. Crop types and production on the Canadian Prairies are restricted largely to grains, oilseeds and grasses, due to limited growing days and precipitation. Annual precipitation in southern Saskatchewan amounts to about 300-400 mm.[15] (Fig. 2).

The situation for dryland (or rain fed) agriculture, a large sector on the Prairies, is different. In dryland farming, crop water requirements are provided by precipitation (rain or snow), recharging soil moisture for plant uptake. Dryland crops can only be successfully grown when plants receive timely and adequate moisture. Thus dryland producers have always had to cope with vulnerabilities from climate and associated natural environmental influences, a situation that could be increasingly stressed by climate change impacts. For some areas of the prairies, scientists estimate that future increases in temperatures and precipitation will result in less available plant moisture in summers, due to increasing evaporation and reduced summer precipitation.[16] Such changes will place a greater pressure on the need for more data management and scenario planning to determine agricultural vulnerabilities and water supply availability under different climate scenarios.

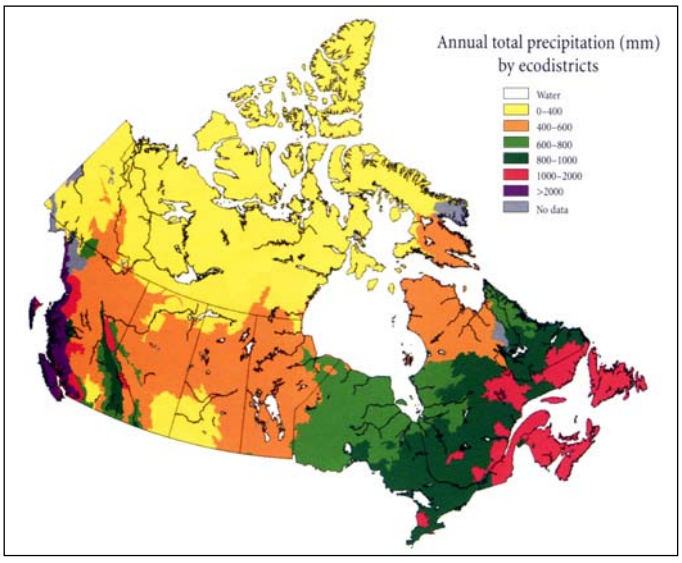

Figure 2. *Annual total precipitation in Canada by ecodistricts.*

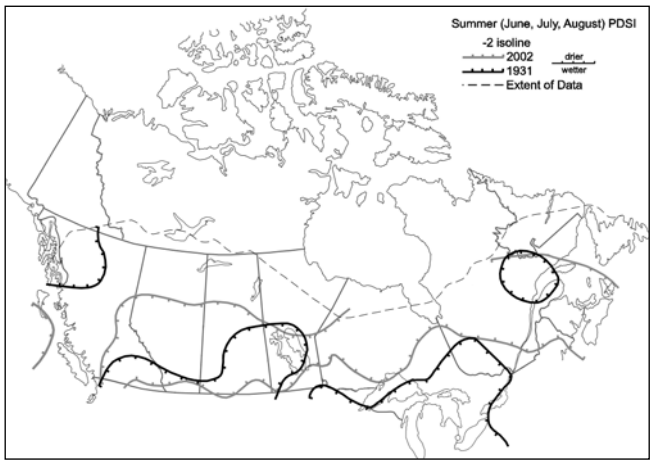

Figure 3. *1931 and 2002 drought extent.*

For Canada, global warming may actually present opportunities for agricultural operations that require warmer temperatures (e.g. increased cropping diversity). To take full advantage of new opportunities from a warmer climate, however, different cropping practices and water management strategies and infrastructure may be required. Global warming and climate change are also expected to increase variability in water supplies and weather (e.g. droughts, floods, storms and extreme weather events). Agricultural production is expected to experience increasing vulnerabilities which could have significant economic impacts. As an example, the drought years of 2001 and 2002 were unique in that they affected large areas across Canada, although the effects were most severe in Alberta and Saskatchewan. The drought was estimated to have caused a $3.6 billion drop in Canadian

agricultural production, a $5.8 billion drop in Canada's Gross Domestic Product, and 41,000 job losses.[17] The 2001-02 drought actually extended over a larger land base than the 1931 drought, which had followed a number of consecutive drought years occurring in the 1920s (Fig. 3).

The Canadian Disaster Database identifies "Prairie Drought" as the number one most costly disaster in Canada, recurring 4 times in the top 5 and 11 times in the top 20 national disasters, for the period from 1900 to 2010.[18] All of the top 20 disasters are climate-related (freezing rain, flood, hurricane, hail, storms). If climate change will cause greater risk and frequency from extreme events, there are clearly implications for increased vulnerabilities to people and communities, infrastructure and agriculture, and water management systems.

Evolving Water Management: Changes and Successes

Established as a nation in 1867, it is fair to say that water development was instrumental in Canada's development. Canadian society is intimately linked with its water resources. The concept of using water resources in nation-building lasted for over a century. Water was seen as essential for society and economic development: water supply development and diversions for communities and industry; transportation canals; water as a source of steam power; hydro-electricity and thermal power; industrial water and wastewater; manufacturing; water for irrigated agriculture and recreation. By the 1980s, global change began to recognize the need for sustainable development, to meet the needs of present society without compromising the needs for future generations. Canada began to adopt environmental protection measures and water management began to consider new forms of water governance, increasing stakeholder participation and integrated water resource management. This became even more evident after recent drinking water disease outbreaks. Provinces have adopted water conservation approaches, and some have established watershed agencies working with local stakeholders to protect water supplies. The federal government advocates integrated water resource management (IWRM) approaches. Agencies are trying to make water databases more publicly accessible for shared use by any stakeholder or citizen.

Sustainable development and IWRM principles are now clearly supported by all Canadian provinces. Two key examples of how provincial water management has evolved to incorporate IWRM principles include:

- Alberta's *Water for Life* strategy, which promotes comprehensive water management strategies affecting all of society. A key focus is management of water by considering the "watershed approach" and participatory planning that is respectful of all stakeholders and the environment, and the recognition that water has economic value.[19]
- Québec's *Water. Our Life. Our Future* Water Policy, which recognizes a need for strategic governance reform, integrated watershed-based management, protection of water quality and aquatic ecosystems, continued clean-up and improved management (including agricultural, industrial and municipal clean-up efforts), and promotion of water-related recreation and tourism.[20]

Increasing awareness exists for environmental risks and the need for protection of source water supplies for threats to water supply and water quality.[21]

The agricultural sector, and Agriculture and Agri-Food Canada (AAFC) have recognized its critical role in water management, both for the sector's needs and risk of environmental contamination from agricultural practices. AAFC, the provinces and the Agricultural sector are conducting research to help the sector with safe water use and conservation, and improved protection of water supplies from risk of agricultural contamination. Federal and provincial environmental farm planning and stewardship programs have promoted the adoption of agricultural beneficial (best) management

practices (BMPs) to help protect water supplies. Water supply expansion programs have helped rural producers gain access to safe, secure water. Pesticide risk reduction programs, national agri-environmental standards and integrated pest management research has been undertaken to help the sector and the environment. Watershed research is being conducted at targeted micro-watersheds across Canada to help increase the understanding the cost and environmental performance of agricultural BMPs. Water conservation research is being conducted to help optimize water use in irrigated agriculture. The sector recognizes these initiatives as beneficial and is striving to adopt good environmental stewardship practices.

Water Management and Data Collection: Roles and Challenges

In spite of new developments and trends towards sustainability and integrated water resource management, water governance in Canada is still complex and faces significant challenges. Water management in Canada is the primary responsibility of provincial governments. However, in reality, water management involves all orders of government and includes local government and a variety of agencies. Therefore, water management in Canada is stated to involve the shared jurisdictions of provincial, local and federal agencies. Table 1 is a simplification of the key water agencies within the South Saskatchewan River Basin.[22] As noted earlier, this case study watershed in western Canada is representative of institutional arrangements for most Canadian regions.

The principal water management agencies are normally the provincial Ministries of the Environment, although in Saskatchewan it is the Saskatchewan Watershed Authority. Water rights are granted by the Ministry of Environment in Alberta and the Saskatchewan Watershed Authority in Saskatchewan. Environmental ministries have a key responsibility for collection of environmental water quality and flow data, environmental protection enforcement, and water research studies. These roles are shared between provincial and federal environmental ministries.

Municipal drinking water is treated by the local communities, tested at approved laboratories (usually the provincial health laboratory or a commercial lab), and corrective actions are enforced by the provincial Ministries of the Environment; in the case of risk to human health, the provincial Ministries of Health will enforce immediate actions to protect citizens from risk of waterborne disease outbreak.

Federal agencies, however, also play key roles in regional water management. Environment Canada plays an instrumental role in water research (quantity, quality, environmental research). Natural Resources Canada collects water data and maps ground water aquifers. The Department of Fisheries and Oceans is concerned with healthy aquatic ecosystems and fish habitat. Indian and Northern Affairs Canada is responsible for constructing water and wastewater infrastructure at First Nations Communities, which then take operational responsibility of these systems. The monitoring and testing of drinking water at First Nations communities is conducted by approved laboratories, with data reporting and corrective guidance provided by Health Canada. Parks Canada is concerned with water resources on national parks. Agriculture and Agri-Food Canada is concerned with agriculture and its interactions with water resources, as noted in the previous section.

Some unique agencies have been created to help with trans-boundary water flows, which is essentially the mandate of the federal Government (Environment Canada, Department of Foreign Affairs and International Trade). The International Joint Commission oversees the 1909 International Boundary Water Treaty Act governing water flow across international boundaries of United States and Canada. The Prairie Provinces Water Board is a unique board that involves the federal government working in partnership with three provincial governments. The PPWB administers the 1969 *Master Agreement on Flow Apportionment* for the Prairie Provinces.[23] The board includes sub-

committees responsible for water flow apportionment, water quality, and groundwater; it has successfully administered the shared provincial water resources since it was created in 1948.

Table 1: Key Water Agencies in the South Saskatchewan River Basin – Year 2009

Orders of Government	**Key Ministries/ Water Managers**	**Other Principal Ministries with major water responsibilities**					
Alberta	Alberta Environment (AB Env.)	Health	Agriculture	-	Transportation & Utilities	Alberta Research	Other ministries; Watershed groups
Saskatchewan	Saskatchewan Watershed Authority (SWA)	Health	Agriculture	Environment	Sask Water	SK Research Council	Other ministries; Watershed Groups
Local Municipalities	Utilities	Utilities: water and wastewater treatment. Environmental protection from development and land use; local and regional public health protection;					
Canada	Environment	Health	Agriculture	Natural Resources Canada	Fisheries & Oceans	National Water Research Institute	Other ministries & agencies
Simplified Summary of Key Water Responsibilities	Alberta Env.; SWA	Authority for provincial water management: water allocations, licensing, water use and apportionment, hydrology, planning, source water protection					
	Environment: environmental protection & research ; weather & climate change science *Health:* public health protection (drinking water, wastewater); Regional Health District support *Agriculture:* Agricultural programs & research; promotion of adoption of Agricultural Best Management Practices to protect the environment from potential agricultural contamination *Provincial Utilities:* municipal water supply, distribution, hydroelectricity, energy *Research:* water, environmental monitoring, contamination & protection, land use *Natural Resources:* ground water mapping, forestry, energy, minerals, climate change adaptation *Watershed groups/ river basin councils:* watershed planning and source water protection						
Selected key agencies with inter-jurisdictional water responsibilities in the SSRB							
Inter-governmental	International Joint Commission	The IJC represents the Governments of Canada and the United States. The IJC addresses water use and quality of boundary waters affecting both nations. With respect to the SSRB, the Boundary Water Treaty includes clauses for water flow in the St. Mary and Milk Rivers, and the inter-basin transfer of water from the St. Mary to the Milk. This agreement affects Montana (USA) and Alberta, Saskatchewan, and Manitoba (Canada).					
	Prairie Provinces Water Board	Federal-Provincial Board (Environment Canada, Agriculture and Agri-Food Canada-PFRA/AESB, Alberta Environment, Saskatchewan Watershed Authority, Manitoba Water Stewardship). The PPWB administers, monitors, and reports on inter-provincial water flows and allocations, and water quality, on rivers crossing the Prairie Provinces of Alberta, Saskatchewan, and Manitoba.					
Unique federal pan-prairie agency	Prairie Farm Rehabilitation Administration-Agri-Environment Services Branch	The Federal government created PFRA, a branch of Agriculture and Agri-Food Canada, in 1935 as an emergency response to address soil & water issues from catastrophic multi-year prairie droughts. The agency's mandate included applied research leading to agricultural adaptations for better soil and water conservation practices, improved rural water supplies for agriculture (water supply, water quality, irrigation), and improved agricultural adaptations to cope with climate and drought impacts. In 2009, PFRA became Agri-Environment Services Branch, evolving its prairie base to a national mandate focused on advancing agri-environmental sustainability and innovation.					

A fundamental issue in water governance in Canada and the provinces is the process of data-gathering, data-management and data dissemination. There are clearly many different local, provincial and federal agencies with shared interests and roles in water management and data collection. The datasets are not standardized, and while there is a general interest in transparency and public accountability for water data, it is no small task to develop datasets that are interchangeable and shareable by all concerned agencies.

There has been strong criticism that more and better water data is necessary. For example, in 2005, a Government of Canada Senate Report, Water in the West: Under Pressure[24] recommended that the Government of Canada:

1. map all of Canada's major aquifers by 2010
2. work with industry and all orders of government to develop a standard methodology for collection and reporting of water-related data
3. restore funding for latitudinal (national) water research studies
4. bolster support for national institutes with regional relevance in water (National Water Research Institute, Prairie Farm Rehabilitation Administration)
5. create a National Water Council, comprised of industry, research institutes and all orders of government, to identify key water issues and needed strategies

A Closer Look at the Case Study of the South Saskatchewan River Basin (SSRB)

The South Saskatchewan River Basin spans the provinces of Alberta and Saskatchewan, covering 173,000 km^2, with a highly variable geography and climate. Its major rivers are mountain-fed, and the region is characterized principally as semi-arid, with the majority of the region receiving less than 345 mm of annual precipitation.[25] (Fig 4)

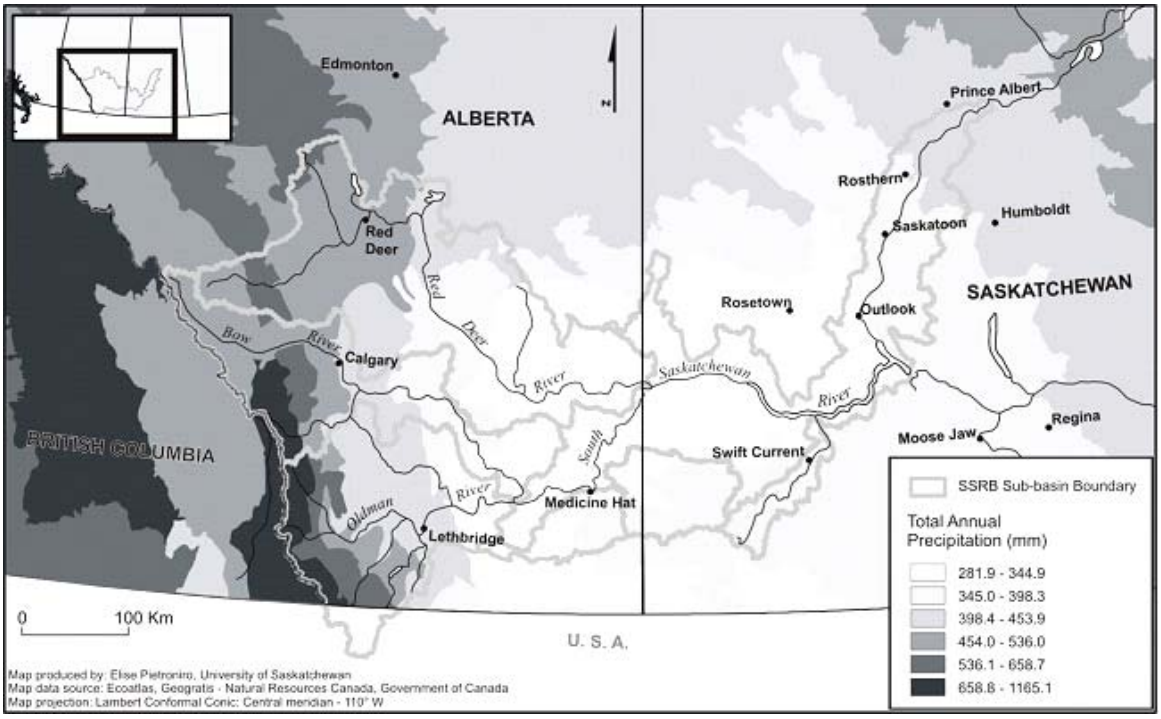

Figure 4 - Major Rivers and Annual Precipitation in the South Saskatchewan River Basin

Agriculture in the South Saskatchewan River Basin is characterized by extensive farming, principally dryland field crops producing grains and oilseeds, with rangeland supporting livestock production.[26] (See Table 2).

TABLE 2: Farm Types, Land Use, and Livestock Production in the SSRB, 2001

	SSRB - Alberta	SSRB - SK	SSRB Total
Number of Farms[1]	**19,600**	**9,000**	**28,600**
Primarily Livestock	53%	24%	44%
Primarily Grains	47%	76%	56%
Livestock (million head)			
Cattle (includes dairy cows)	2.83	0.45	3.28
Density (head per ha)[2]	0.596	0.297	0.524
Hogs	6.06	1.12	7.18
Density (head per ha)	1.277	0.737	1.146
Poultry	1.27	0.23	1.50
Density (head per ha)	0.268	0.152	0.240
Land Use on Farms (million Ha)	**9.89**	**5.34**	**15.23**
Cropping[3]	42%	53%	46%
Pasture	48%	28%	41%
Fallow and Other Use	10%	19%	13%

1 Number of farms includes all operations with annual receipts greater than $2,499.
2 Density based on hectares of land allocated to pasture.
3 As a % of land allocated to farms. (Total SSRB area is 16.78 million Ha)
Source: Statistics Canada Census of Agriculture, 2001.

The SSRB is located within the Canadian Prairies, a region that was severely affected by multi-year droughts of the 1920s and 30s, which caused serious economic impact and forced abandonment of many settled farming areas. Today the region supports a vibrant and diverse economy, and accounts for the vast majority of Canadian grains, oilseeds and livestock production. This was achieved by adapting to the highly variable climate within the region. Successful adaptations included:

- Improved institutional responses: the creation of Alberta's *Special Areas Boards*, and Canada's *Prairie Farm Rehabilitation Administration* to assist in land use, and soil and water conservation.
- Scientific advances in sustainable agricultural practices: reduced soil tillage to conserve soil structure and water-bearing capacity, management of marginal lands (e.g. converting sensitive lands from cultivated tillage to permanent community pasture for sustainable grazing by cattle, and enhancing biodiversity), promotion of tree planting in shelterbelts that serve as windbreaks and trap snow for moisture.
- Construction of water development projects for better regional water management for communities and agriculture: dams and reservoirs, regional water distribution pipelines and canals, more secure on-farm water supplies (wells and dugouts), and regional irrigation projects to enhance water security for agricultural production.
- Preservation of wetlands and lakes: increased recognition is occurring to ensure preservation of natural wetlands and lakes.

The two most significant agricultural adaptations were improved tillage practices (conservation tillage helps manage water-bearing capacity within the prairie soils), and irrigation, which augments water

supplies on irrigated land during periods when runoff and rain are insufficient for field crops during dry years. Irrigation in the SSRB is only practiced on about 5% of the land base, but it accounts for roughly 18% of the Agricultural Gross Domestic Product within the basin.[27] (See Fig 5).

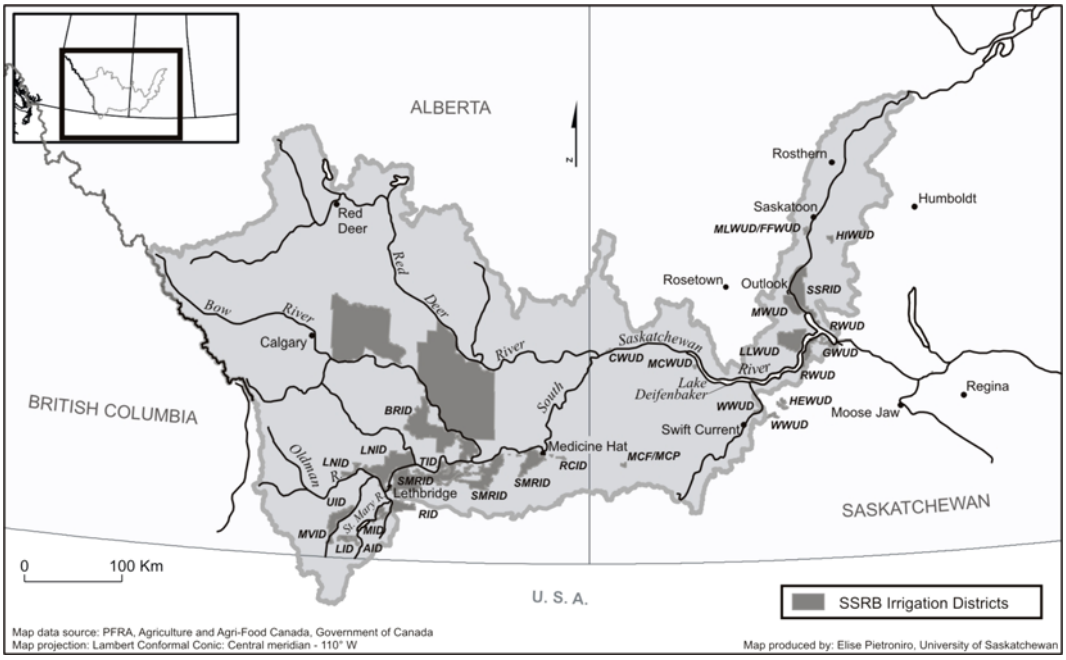

Figure 5: Irrigation districts in the SSRB

Irrigation is, by far the largest "consumer" of water in the basin, accounting for over 90% of all water consumptive uses.[28] (See Table 3) Water supplies are fully allocated in the Alberta portion of the basin, but water remains available for further allocations in the Saskatchewan portion. Irrigators and agricultural producers are presently advocating for additional irrigation expansion in Saskatchewan, which has potential to expand its irrigated land from 81,000 ha to 400,000 ha.[29] However, environmental groups express concern about construction of new dams, reservoirs, increased water pressures, and advocate water conservation before further development.[30]

Alberta has adopted water conservation objectives (target values) but Saskatchewan has not yet done so. However, it is recognized that more environmental research is needed with more water data (quality, quantity) to establish scientific principles for in-stream flow needs to sustain aquatic ecosystems. This need exists across Canada.

Climate change scenarios for the South Saskatchewan River Basin suggest two key problems for agriculture:

1. Warmer temperatures and changes in annual precipitation distribution affecting crop production and water availability for dryland crops. Winters are expected to be warmer and wetter, and summers are expected to be hotter and drier. Climate variability may increase with greater risk for droughts, floods, and extreme events and storms. These factors are expected to increase risks from disease and pests affecting crops and plants.
2. Reductions in annual river flows of the major river systems, affecting available water for irrigated agriculture.[31] (see Figure 6).

TABLE 3: Water Diversions, Return Flow and Consumption in the SSRB

	Water Diversions		Return Flow		Consumption	
	Million dam^3	**Share of Natural Flow**	**Million dam^3**	**Share of Total Diversions**	**Million dam^3**	**Share of Natural Flow**
Non-irrigation Demand[1]	**0.51**	**5.9%**	**0.36**	**71%**	**0.16**	**1.8%**
Municipal	0.31	3.5%	0.24	77%	0.07	0.8%
Livestock	0.07	0.8%	0.02	28%	0.05	0.5%
Industrial	0.05	0.6%	0.02	40%	0.03	0.3%
Thermal Hydro	0.09	1.0%	0.08	88%	0.01	0.1%
Irrigation Demand[2]	**2.52**	**29.1%**	**0.59**	**23%**	**1.93**	**22.3%**
Total Supply[3]	8.67				8.67	

1. Based on 1996 data which is the last year in which comprehensive demand data was collected.
2. The Alberta portion of the SSRB contains approximately 79% of the irrigated land in the SSRB (600,000 ha).
3. Total supply in million cubic decameters is based on estimated average natural flow from 1961-1990.[32] One cubic decameter is a volume of 10 m x 10m x 10m; 1 dam^3 equals 1,000 m^3.

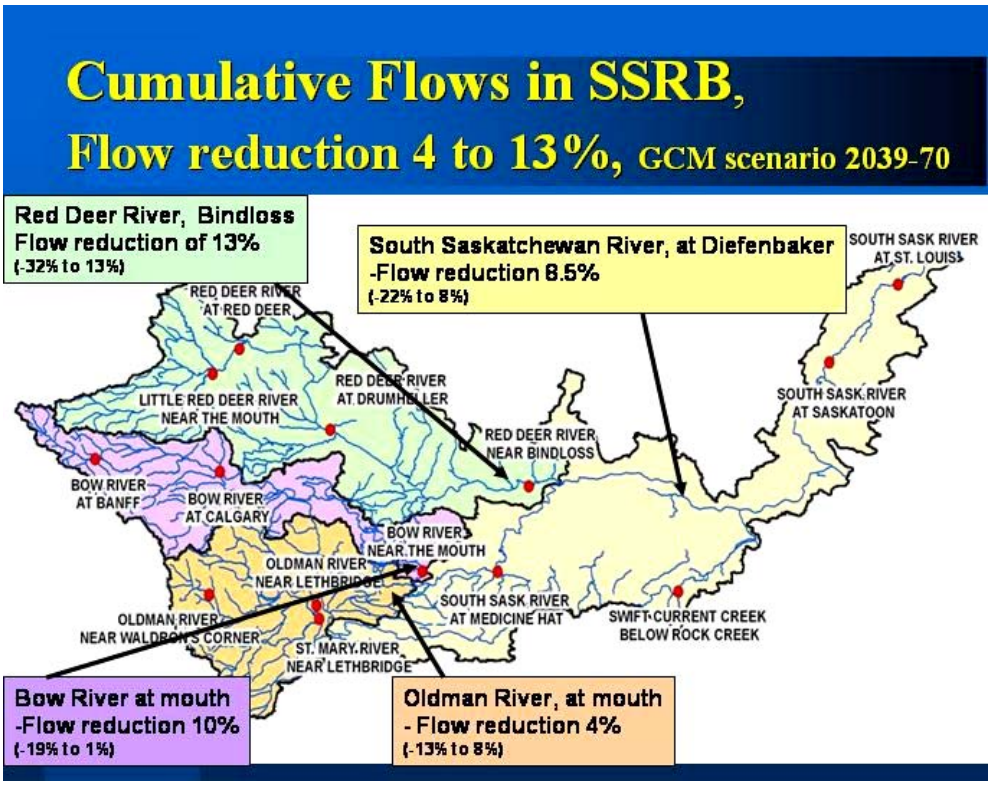

Figure 6 – River Flows SSRB – Global Climate Model scenario 2039-70

Stakeholder and Water Governance Research: The IACC Findings

Methodology: The Institutional Adaptation to Climate Change study in the South Saskatchewan River Basin, conducted research on the vulnerabilities of rural communities to climate-induced water stress. During the years 2004 to 2009, data was obtained by conducting semi-structured interviews and focus group discussions, involving all water users and institutions involved in water management, including all orders of government. The research incorporated a vulnerability assessment model considering past, present and future vulnerabilities as related to climate-induced water stress. Water and climate data was reviewed both from historic and present knowledge. Future climate scenarios were linked to water and community vulnerability impacts. The research blended a mix of inter-disciplinary sciences, combining research results from physical scientists (e.g. climate scenarios; water use) and social scientists (qualitative data with stakeholders identifying vulnerabilities and adaptations).

In this context, the IACC project's main goal was to assess the capacities of regional water governance institutions to reduce the vulnerabilities of rural livelihoods and rural communities to climate and climate-induced water stress. Six rural communities were studied in Alberta and Saskatchewan, and interviews were conducted with a full spectrum of governance institutions. In Saskatchewan alone, over 60 interviews were conducted with water users, user groups and associations, watershed and basin councils, environmental groups, community representatives, and experts from local , provincial and federal government agencies.[33]

The key challenges identified by the research are listed as follows:

- *Uneven distribution of adaptive capacity:* Rural communities and the Ag Sector are most vulnerable to climate-induced water stress.
- *Policy analysis*: Rural communities and stakeholders are seeking provincial and federal policies that have more relevance for local conditions and ecology, and they desire greater trust with senior levels of government.
- *Water data:* Simply put, there is a need for more water data and for better quality of data, in formats that are readily accessible by local stakeholders, to help guide water management decisions.
- *Long-term adaptation planning:* A stable and clear vision for water planning is required; concerns exist over frequent changes resulting from differing policies, often implemented by political or governance changes.
- *Watershed advisory groups:* While significant advances have been made with respect to increased citizen engagement in watershed and basin councils, a real challenge exists in sustaining and empowering these groups, so that decisions and actions can be made for effective local adaptations and rural water management.
- *Operational challenges:* The water governance arrangements and number of institutions with a vested interest in water management is considered too complex for both stakeholders and government agencies. There is a need to clearly identify roles and responsibilities and simplify decision-making for effective water management.
- *The lack of central resources for water and climate stress:* There is a challenge in co-ordinating responses that are locally-relevant, and/or have targeted support for rural water needs, particularly at times of increased stress (droughts, floods, storms).

Nine key recommendations to address the above challenges are identified as follows[34]:

1. **Develop long-term climate and water plans.** Proactive drought preparedness (and extreme event preparedness) planning should be undertaken, considering a baseline planning vision for a period of 10 to 20 years. Anticipatory water resource planning needs to consider climate scenarios, extending from 5 to 20 years. Water, environmental and agricultural

programming should consider climate, climate stress, natural climate variability and climate change impact scenarios.

2. **Integrate government and community adaptation activities.** Rural and agricultural adaptations need to be linked with sustainable development principles. Stakeholders and institutions should plan and act across traditional sectors (i.e. multi- and inter-disciplinary), and include environmental management, disaster reduction, social and economic development activities in water resource planning and adaptation responses.
3. **Participatory Planning:** Water resource planning and management decisions will be more effective in building capacity and resilience to stressors if governments increase engagement and empowerment of citizens and stakeholders to support decision-making. Such participatory planning adds a different degree of complexity and uncertainty in water governance, but is expected to lead to improved decisions, actions and adaptations, as stakeholders bring ownership to implementing solutions and locally relevant adaptations.
4. **Improved linkages between governments and rural communities/ Ag Sector stakeholders.** Increased two-way communication and dialogue between governments and rural communities will enhance local relevance and buy-in to solutions, and development of policies that are flexible and suited to local conditions. Improved dialogue will help mobilize knowledge and program implementation at a local watershed scale, leading to activities that will better target local vulnerabilities.
5. **Focus on local and regional coping capacity**. Local training and capacity building will help rural stakeholders implement appropriate activities in water management responses. Rural water climate monitoring and programming (e.g. decision-support tools) can help strengthen knowledge and local capacity. Targeted training can be extended between communities and inter-provincially / regionally. Building local and regional capacity will help administrative and political jurisdictions make more effective water management decisions by incorporating water management at a more appropriate planning scale in recognition of their role within the watershed.
6. **Prepare for water conflict and plan for adaptive conflict resolution.** Be ready for increasing water conflict and water scarcity (whether from natural variability or climate change impacts). Establish plans to address issues of conflict. Use multiple stakeholder participation to resolve issues, with structured adaptive conflict resolutions techniques, akin to the principles of "integrated water resource management" where all stakeholders' perspectives are sought for joint decisions and actions.
7. **Acquire more and better water data.** Effective water management relies on having knowledge of water data. Invest in collecting water data (surface water, ground water, water supply and water quality) at all scales (local, provincial, regional, national). Factor climate data, climate variability data (historic/present) and climate change impact data on water resources. Water management will improve with better data and better awareness of the potential effects of climate impacts. Make data available to all stakeholders and share data in user-friendly formats.
8. **Incorporate inter-disciplinary teams in water management.** Water management can no longer rely solely on the decisions of single departments or experts in a few disciplines. Effective water management and effective adaptation to climate-induced water stress requires broader societal responses. It is critical to integrate social sciences with physical sciences, and work across traditional expertise. Inter-disciplinary teams are needed for water and climate research, for academic and government investigations and information-gathering, for governance institutions involved in water management, and for stakeholders implementing watershed management activities.
9. **Simplify water governance.** Find ways to help implement water management decisions in spite of the existing complexity of agencies involved. Improve the clarity and role of all orders of government. Seek to achieve more efficient, timely, and more effective decision-

making. Use regional approaches, and extend similar and common approaches across and beyond provincial boundaries.

The IACC research shows that water data issues present a challenge which must be overcome to help increase adaptive strength and resilience to water stress. Community and governance assessments identify a need for more co-ordinated data collection and data management, particularly with respect to ground water and climate monitoring. In the Saskatchewan context, respondents indicated a need for comprehensive ground water data mapping (this need mimics the finding from the previously cited Banks and Cochrane Senate report for Canadian ground water mapping).

Considerable water data exists, but a lack of comprehensive water resource data is challenging for those hoping to assess the status of the resource in conjunction with the development of strategies for adapting to climate change. Planners are uncertain of the extent of the water resource and its resilience. Respondents stated there is no province-wide sense of what sustainable levels of extraction are, or even whether some aquifers are already in an overdraft situation. Respondents also described gaps in surface water quantity and use monitoring within Saskatchewan. They claimed that considerable data was available for municipal and industrial use. However, the picture is somewhat incomplete because not all municipalities collect usage data. In addition, the measures employed to calculate water use by irrigators were seen as insufficient. While estimates could be made by surrogate measures such as pumping capacity, the estimates did not reflect actual use or provide data that might inform more efficient water use strategies. In the same vein, there is no overall coordination of data management with respect to water or climate for Saskatchewan. This lack of coordination is in part reflected by the reality that electronic data management systems may not always be compatible between agencies, a common problem for many areas of the world.

Data collection and data management problems for water are clearly related to climate change and adaptation, and the need for short-term and long-term planning strategies. Without scenario-planning and longer-term vision linking water and climate, it becomes very difficult to address the operational challenges of water management under increasing competition for water, and the challenges posed by climate change and climate variability. Moreover, the complexity of water governance, the need for greater clarity of roles and responsibilities, greater horizontal and vertical coordination, improved integration of stakeholders, and other factors, limit the capacity to standardize data collection and monitoring systems, and to share the information.

Data collection and data management systems are not only an indicator of a healthy institutional system. They are also the fundamental components of *informational capital*, which is an important determinant of adaptive capacity. As relevant as other forms of capital (e.g. economic, social, human, natural/environmental, etc.) informational capital contributes to a better knowledge of the existing resources, and facilitates their management in situations of uncertainty and surprise. The existence of a solid accumulation and good use of information capital is a must in ensuring the sustainability of rural livelihoods and the agricultural sector.

Conclusions:

The case of water management in the South Saskatchewan River Basin is insightful for the challenges across Canada. The Institutional Adaptations to Climate Change project recommendations are beneficial for all of Canada. Longer-term water planning, increased involvement of civil society in water management decisions, and simplified, proactive water governance arrangements will provide better capacity to manage existing water resources, and help build resilience to climate-induced water stress. Successful adaptations to natural climate variability and future climate stress will be more effectively attained if more widespread and inter-disciplinary approaches are adopted. Water

management in Canada is clearly evolving and the move to integrated water resource management is becoming more common. This is also challenging as more stakeholders and agencies are involved in water management decisions. However, if Canada's water institutions continue to be flexible and adaptive themselves, they will gain improved capacity, and have a greater likelihood for successful coping. In turn, adaptive and flexible institutions will be better equipped to help others strengthen their resiliency, and be more capable of finding new and more effective water management opportunities that value environmental, economic and social principles.

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