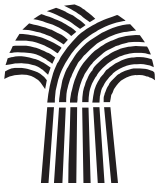
Saskatchewan Watershed Authority

PRAIRIES REGIONAL ADAPTATION COLLABORATIVE
Advancing Climate Change Adaptation in the Prairies



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PRAIRIES REGIONAL ADAPTATION COLLABORATIVE

ADVANCING CLIMATE CHANGE ADAPTATION IN THE PRAIRIES

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Acknowledgements and General Conditions

This report has been prepared by Rescan Environmental Services Ltd. (Rescan) for the Saskatchewan Watershed Authority (SWA) on behalf of the Saskatchewan partners of the Prairies Regional Adaptation Collaborative (PRAC). Funding for this work was provided by Natural Resources Canada. The Rescan team consisted of Jeremy Pittman (lead author and researcher) and Dr. Kent Gustavson (project manager and technical reviewer). Rescan would like to thank all those individuals who were consulted and interviewed as part of this work for their valuable input to the report.

Table of Contents

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PRAIRIES REGIONAL ADAPTATION COLLABORATIVE

ADVANCING CLIMATE CHANGE ADAPTATION IN THE PRAIRIES

Table of Contents

List of Figures

FIGURE **PAGE**

List of Tables

TABLE **PAGE**

Acronyms and Terms

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Acronyms and Terms

AAFC	Agriculture and Agri-Food Canada
AANDC	Aboriginal Affairs and Northern Development Canada
AEW	Alberta Environment and Water
ARD	Agriculture and Rural Development (Alberta)
CCIAD	Climate Change Impacts and Adaptation Division
CCFM	Canadian Council of Forest Ministers
CRCM	Canadian Regional Climate Model
FSB	Forest Services Branch (of the Saskatchewan MOE)
IISD	International Institute for Sustainable Development
LIRA	Landscape and Infrastructure Resiliency Assessment
MAFRI	Manitoba Agriculture, Food and Rural Initiatives
MCWS	Manitoba Conservation and Water Stewardship
MIT	Manitoba Infrastructure and Transportation
MLG	Manitoba Local Government
MOA	Ministry of Agriculture (Saskatchewan)
MOE	Ministry of Environment (Saskatchewan)
NRCan	Natural Resources Canada
OECD	Organisation for Economic Co-operation and Development
PARC	Prairie Adaptation Research Collaborative
PRAC	Prairies Regional Adaptation Collaborative
Prairies Region	The Provinces of Alberta, Manitoba, and Saskatchewan collectively
RAC	Regional Adaptation Collaborative
Rescan	Rescan Environmental Services Ltd.
SWA	Saskatchewan Association of Watersheds
SRC	Saskatchewan Research Council
SRD	Sustainable Resource Development (Alberta)
SWA	Saskatchewan Watershed Authority
VSMB	Versatile Soil Moisture Budget

1. Introduction

1. Introduction

1.1 PRAIRIES REGIONAL ADAPTATION COLLABORATIVE: AN OVERVIEW

The Prairies Regional Adaptation Collaborative (PRAC) is a three-year (2009 to 2012), $6.8 million, cost-shared initiative, designed to support activities that advance decision-making for climate change adaptation in the Prairie Region, which includes the provinces of Alberta, Saskatchewan, and Manitoba. The PRAC is a part of Natural Resources Canada's (NRCan's) National Regional Adaptation Collaborative (RAC) program, which includes six RACs in British Columbia, the Prairies, Ontario, Quebec, the Atlantic, and Northern Territories. NRCan provided approximately $3.5 million of funding support to the PRAC and developed a partnership with provincial government departments, including the Saskatchewan Watershed Authority (SWA), Saskatchewan Research Council (SRC), Alberta Environment and Water (AEW), and Manitoba Conservation and Water Stewardship (MCWS), to deliver PRAC-related initiatives around three themes: Water, Drought and Excessive Moisture, and Terrestrial Ecosystems (Figure 1.1-1). Provincial partners provided an additional $3.3 million of matching funds and further collaborated and partnered with other agencies and stakeholders to deliver activities within each province. The Prairie Adaptation Research Collaborative (PARC) based at the University of Regina was engaged by provincial partners to administer the program in the Prairies Region. The PRAC activities within each theme were coordinated interprovincially, but implemented jurisdictionally, to meet the unique needs, goals, and objectives of the different jurisdictions. Interprovincial collaboration and learning were facilitated through PRAC forums aimed at mainstreaming[1] PRAC findings, projects, and lessons broadly across departments and agencies in the Prairies.

In Alberta, Agriculture and Rural Development (ARD) was the lead on the Drought and Excessive Moisture Theme activities, Sustainable Resource Development (SRD) on the Terrestrial Ecosystems Theme activities, and AEW on the Water Theme activities. These departments worked closely with the PARC on the Water Theme and the SRC on the Terrestrial Ecosystems Theme to advance projects in Alberta. The PARC and SRC also delivered forums in Alberta.

In Saskatchewan, the SWA was the lead on the Drought and Excessive Moisture Theme activities, SRC on the Terrestrial Ecosystems Theme activities, and PARC on the Water Theme and forum activities. These agencies and groups worked collaboratively with a number of other provincial stakeholders, including the Saskatchewan Ministry of Agriculture, Provincial Council of Agriculture Development and Diversification Boards, SaskPower, Saskatchewan Association of Rural Municipalities, Saskatchewan Urban Municipalities Association, Saskatchewan Association of Watersheds, and a number of local watershed stewardship associations to deliver theme-specific activities in Saskatchewan. In addition, collaboration between themes and provinces occurred, when appropriate.

MCWS and Manitoba Agriculture, Food, and Rural Initiatives (MAFRI) shared the lead on the Drought and Excessive Moisture Theme activities in Manitoba. Additionally, MCWS led the Water Theme, forum activities, and the forestry component of the Terrestrial Ecosystems Theme, while MAFRI led the grassland component of the Terrestrial Ecosystems Theme. These departments worked closely with other provincial departments, such as the Manitoba Local Government (MLG), as well as the PARC (on the Water Theme and forums) and SRC (on the Terrestrial Ecosystems Theme) to deliver activities on these themes. Collaboration between themes and provinces also occurred, when appropriate.

[1] Mainstreaming means integrating climate risk, vulnerability, adaptation and resilience into relevant policies, plans, programs, projects, decision-making cycles and processes in systematic and rigourous ways (Klein et al. 2007; OECD 2009; USAID 2009).

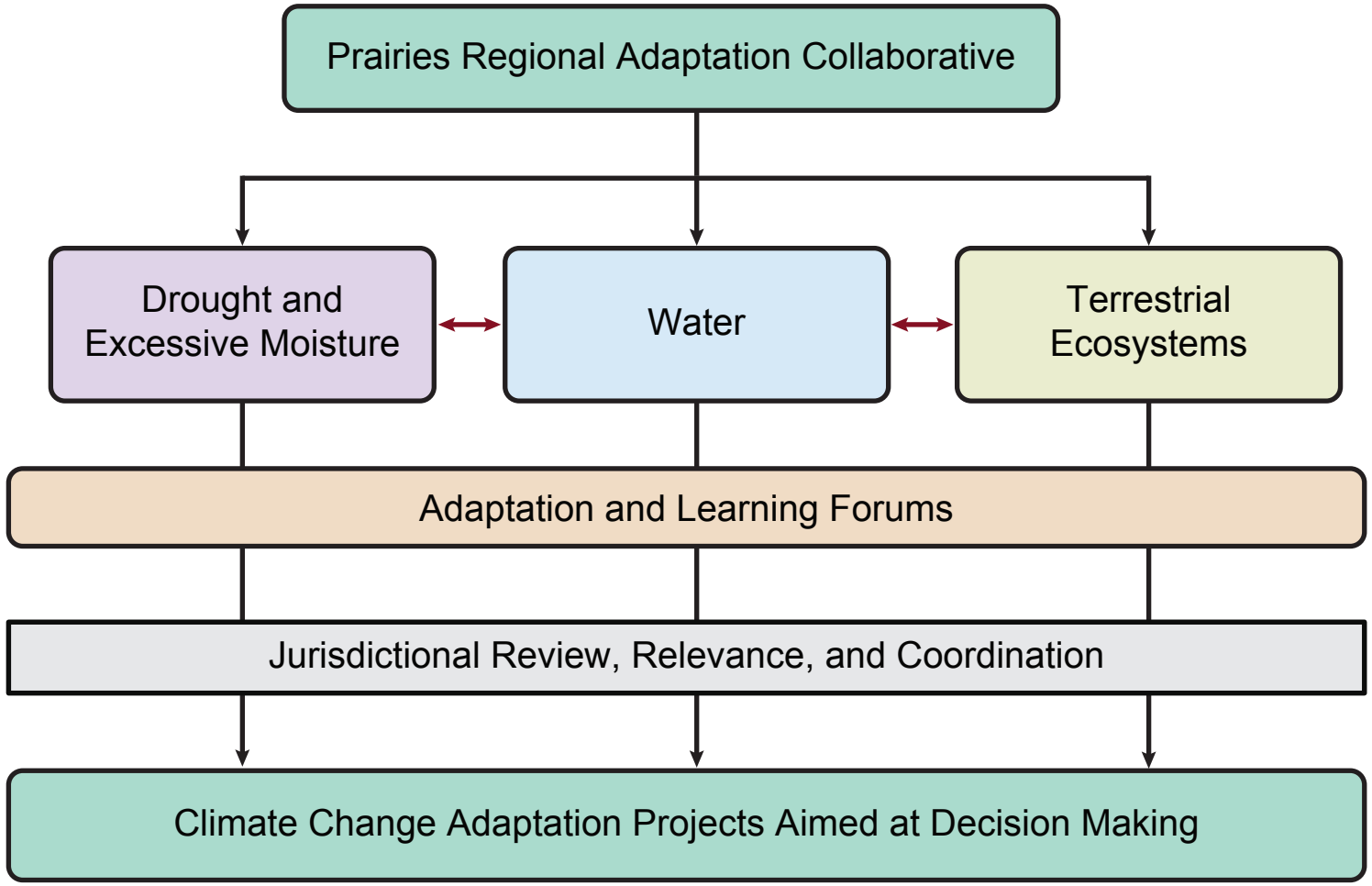

Figure 1.1-1

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Prairies Regional Adaptation Collaborative Themes Overview

Figure 1.1-1

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There were a broad range of projects completed through the PRAC program. Water Theme projects included hydroclimatic variability analysis and projections, water demand analysis and projection, and community-based socio-economic vulnerability assessments. Drought and Excessive Moisture Theme activities included: climate monitoring evaluation, adaptive policy evaluation tool development, program evaluation, model evaluation, in-stream flow needs gap analysis, watershed extreme event preparedness planning, municipal adaptation planning, and extreme climate events characterization. Terrestrial Theme activities included forest and grassland ecosystem vulnerability assessments and identification of adaptation options. A more detailed overview of PRAC projects is provided in Section 3.

One of the PRAC's main goals was to move decision-makers through a continuum of climate change adaptation, from awareness to the decision point. In the Prairies Region anecdotal evidence from the interviews completed as part of this synthesis suggests that efforts were largely successful in meeting this objective. As this report documents, significant learning was undertaken through the PRAC, and many opportunities for advancing adaptation and strategies for overcoming barriers, as described during the interviews by individuals within provincial and federal departments and agencies, are present. The PRAC had a significant role in improving the capacity for adaptation work in the Prairies Region.

1.2 PURPOSE OF REPORT

The purpose of this report is to provide an accounting of the findings from the PRAC Advancing Climate Change Adaptation in the Prairies Project. This report documents the results from: 1) a synthesis of lessons learned for key policy areas from the PRAC; and 2) identification of the strategic path for advancing adaptation in the Prairies Region.

2. Methods and Approach

2. Methods and Approach

2.1 SYNTHESIS OF LESSONS LEARNED

Rescan reviewed all materials and deliverables provided for the PRAC projects in Manitoba and Saskatchewan. The review focused on the objectives, methods, and main results from the projects. Alberta materials and deliverables were not provided to Rescan and were reviewed by Archibald (2012). Archibald's review was similar in approach to the review work conducted by Rescan.

In many cases, the PRAC projects are ongoing, and materials or deliverables were not available during the drafting of this report. In these cases, project update summaries were produced by project leads, which served as the main source of information on the projects. These projects' reviews were updated as more materials and deliverables were made available.

Lessons learned were synthesized from the review and main PRAC projects' results. Synthesized lessons learned highlight the main findings from the PRAC projects that could be applied or are relevant to policy, programming, and operations. These lessons are focused within and organized around the PRAC themes. Section 3 provides the results of the syntheses.

2.2 IDENTIFYING THE STRATEGIC PATH FORWARD

The strategic path going forward, which includes understanding the current context for adaptation (Section 4), priority areas and actions (Section 5), institutional arrangements (Section 6), barriers and challenges (Section 7), and approaching adaptation effectively (Section 8), was identified through the engagement of key provincial and federal decision-makers (Table 2.2-1). Semi-structured interviewing with key informants was undertaken. Key informants were selected based on their involvement in the PRAC, their known expertise in the field of adaptation, and their known expertise in their work area. These individuals were identified through consultation with PRAC partners and, in some cases, snowball sampling techniques, where interview participants identified other potential key informants. Interviews were conducted until saturation was reached, meaning no additional, novel information was being observed in subsequent interviews. Thirty-five interviews were completed.

Results from interviews conducted for the provincial-level syntheses in Saskatchewan and Alberta were also integrated into the analysis. These interviews were conducted using a similar approach to the one outlined above. As such, an additional 10 interviews from Saskatchewan and three focus group interviews from Alberta were included. The interviews in Alberta were completed by Archibald (2012).

Interview notes were analyzed using qualitative content analysis for each topic of interest. In the case of Alberta, qualitative content analysis was completed on Archibald's (2012) report, which summarized the results of the focus group interviews. Recurring themes in the information for each topic of interest were identified and synthesized into preliminary results and findings. The next steps in the analysis included reviewing preliminary results and findings during breakout sessions with participants at the PRAC Adaptation on the Canadian Prairies Forum (held February 15 and 16, 2012 in Regina, Saskatchewan) and triangulating and complementing the interview and breakout session results with secondary data and other sources.

Table 2.2-1. Institutional Representation of Interview Participants

Jurisdiction	Departments/Agencies/Ministries
Alberta	• Sustainable Resource Development • Agriculture and Rural Development • Environment and Water
Saskatchewan	• Saskatchewan Watershed Authority • Saskatchewan Ministry of Agriculture • Saskatchewan Ministry of Environment • Saskatchewan Ministry of Health • Saskatchewan Ministry of Highways and Infrastructure • Saskatchewan Research Council
Manitoba	• Manitoba Conservation and Water Stewardship • Manitoba Agriculture, Food and Rural Initiatives • Manitoba Infrastructure and Transportation • Manitoba Local Government
Federal	• Aboriginal Affairs and Northern Development Canada • Natural Resources Canada • Agriculture and Agri-Food Canada • Environment Canada
Other RACs	• Fraser Basin Council • OURANOS (Quebec RAC) • Atlantic Climate Change Adaptation Solutions Association

3. Synthesis of Lessons Learned

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3. Synthesis of Lessons Learned

There are a number of important climate change adaptation policy and programming lessons learned from the PRAC for the Prairies Region as a whole, as well as for the provinces of Alberta, Saskatchewan, and Manitoba individually. This section provides an overview of the key lessons learned by policy area. As many PRAC projects are not expected to be completed until March 31, 2012, there are likely more lessons learned to include.

Table 3-1 provides an overview of PRAC projects, their level of review, and area of relevance for policies and programming. As noted in Table 3-1, "full review" refers to a complete review of final reports; "partial review" refers to a review of draft reports or project update summaries the results of which are subject to change as final reports are prepared; "not reviewed" refers to no review undertaken for inclusion in this report; and "Archibald (2012)" refers to a review not undertaken by Rescan.

Table 3-1. PRAC Projects and Level of Review

PRAC Theme	Project	Policy and Program Area	Level of Review
Water Theme	Hydroclimatic Variability: South Saskatchewan River Basin	Water Management	Full review
	Hydro-Climate Modelling – South Saskatchewan Regional Planning	Water Management	Archibald (2012)
	Hydroclimate Data for the Prairies: An Analysis of Possibilities	Water Management	Full review
	GCM Projections for the Pacific Decadal Oscillation under Greenhouse Forcing for the Early 21st Century	Water Management	Full review
	The Effects of Atmosphere-Ocean Climate Oscillations on and Trends in Saskatchewan River Discharges	Water Management	Full review
	Preliminary Probabilistic Analysis of Drought Indices in the Prairies	Water Management	Not reviewed
	Northern Rocky Mountain Streamflow Records Global Warming Trends, Human Impacts or Natural Variability	Water Management	Full review
	Vulnerabilities and Adaptations to Extreme Climatic Variability in the Old Wives Lake Watershed	Water Management and Agriculture and Grassland Ecosystem Management	Full review
	Vulnerabilities and Adaptations to Extreme Climatic Variability in the North Saskatchewan River Watershed	Water Management and Agriculture and Grassland Ecosystem Management	Full review
	Assiniboine River Water Demand Study	Water Management	Partial review
	Assiniboine River Hydrologic Modelling Study	Water Management	Partial review
Drought and Excessive Moisture Theme	Performance Evaluation and Improvement of the Versatile Soil Moisture Budget (VSMB) Model	Climate Monitoring and Information Systems	Full review
	Rural Communities Adaptation to Drought	Water Management and Agriculture and Grassland Ecosystem Management	Not reviewed

(continued)

Table 3-1. PRAC Projects and Level of Review (continued)

PRAC Theme	Project	Policy and Program Area	Level of Review
Drought and Excessive Moisture Theme *(cont'd)*	Drought and Excessive Moisture - Saskatchewan's Nemesis: Characterizations for the Swift Current Creek, North Saskatchewan River, Assiniboine River and Upper Souris River Watersheds	Water Management and Agriculture and Grassland Ecosystem Management	Full review
	Drought and Extreme Moisture – Saskatchewan's Nemesis: Characterizations for the Old Wives Lake, Moose Jaw River, Milk River and Upper Qu'Appelle River Watersheds	Water Management and Agriculture and Grassland Ecosystem Management	Not reviewed
	Drought and Excessive Moisture Preparedness Plans	Water Management and Agriculture and Grassland Ecosystem Management	Partial review
	Analysis and Projection of Water Demands in Selected Watersheds	Water Management	Not reviewed
	Evaluation of Drought and Excessive Moisture Monitoring in Saskatchewan	Climate Monitoring and Information Systems	Full review
	Adaptive Policy Evaluation Tool Report	Agriculture and Grassland Ecosystem Management	Full review
	Evaluation of Drought and Excessive Moisture Preparedness Programming	Agriculture and Grassland Ecosystem Management	Full review
	Ecological Limits of Hydrologic Alteration Implementation Strategy	Water Management	Full review
	Interprovincial Drought Communication Framework	Water Management	Full review
	Mainstreaming Climate Change Adaptation in Key Water Use Across Sectors	Water Management	Not reviewed
	Cost Benefit Analysis of Mainstreaming Adaptation in Water Use	Water Management	Not reviewed
	Low Impact Development Workshop	Municipal and Community Resilience	Not reviewed
	Climate Extremes Workshop	Municipal and Community Resilience	Not reviewed
	Provincial Planning on Adaptation for Excessive Moisture in the Manitoba Interlake Region	Agriculture and Grassland Ecosystem Management and Municipal and Community Resilience	Partial review
	Municipal Adaptation Planning in Southwestern Manitoba Workshop	Municipal and Community Resilience	Partial review
Terrestrial Theme	Vulnerability of Prairie Grasslands to Climate Change	Agriculture and Grassland Ecosystem Management	Full review
	Vulnerability of Grasslands in Southern Manitoba to Climate Change	Agriculture and Grassland Ecosystem Management	Not reviewed
	Manitoba's Agricultural Climate Change Adaptive Planning Workshops	Agriculture and Grassland Ecosystem Management	Partial review
	Upland Grasslands Species Climate Adaptation Workshop	Agriculture and Grassland Ecosystem Management	Not reviewed

(continued)

Table 3-1. PRAC Projects and Level of Review (completed)

PRAC Theme	Project	Policy and Program Area	Level of Review
Terrestrial Theme *(cont'd)*	Increasing Resiliency of Manitoba's Grassland Ecosystems to Climate Change Impacts: Final Technical Report	Agriculture and Grassland Ecosystem Management	Not reviewed
	Adaptation to Climate Change in Management of Prairie Grasslands	Agriculture and Grassland Ecosystem Management	Not reviewed
	Climate Change Adaptation Framework Manual	Agriculture and Grassland Ecosystem Management and Forest Ecosystem Management	Archibald (2012)
	Impacts of Climate Change on the Western Canadian Southern Boreal Forest Fringe	Forest Ecosystem Management	Archibald (2012)
	Climate Change Vulnerability of the Sandilands Provincial Forest	Forest Ecosystem Management	Partial review
	Climate Change Vulnerability Assessment and Adaptation Options for the Island Forests of Central Saskatchewan	Forest Ecosystem Management	Not reviewed

3.1 CLIMATE MONITORING AND INFORMATION SYSTEMS

Key Lessons Learned for Alberta

There are a number of lessons learned for Alberta in terms of soil moisture modelling as part of ongoing climate monitoring and information systems. These lessons are based on Hayashi et al.'s (2012) evaluation of the Versatile Soil Moisture Budget (VSMB) model as part of the Drought and Excessive Moisture Theme.

Hayashi et al. (2012) found that the VSMB simulated evapotranspiration and soil moisture acceptably well when tested in a barley field in 2009, but performed worse in the same field during the excessively wet summer of 2011. Using the adjusted winter process algorithm, the VSMB performed acceptably well in pasture sites during the winters of 2006-2007, 2007-2008, and 2008-2009. Improved performance could be achieved by adjusting the crop root extraction coefficient, drying curve function, and pedo-transfer function, although this would require significant primary research, data collection, analysis, and testing.

Key Lessons Learned for Saskatchewan

There are a number of lessons learned for Saskatchewan in terms of climate monitoring and information systems for adaptation. These are related to most appropriate indicators and approaches for monitoring extreme conditions, developing network capacity, and interpolating station data. These lessons are based on Quring's (2011) study of monitoring undertaken as part of the Drought and Excessive Moisture Theme.

A major lesson was the recognized need to take a multi-indicator approach to monitoring climate extremes. No single indicator can accurately represent all aspects of agricultural or hydrological drought or excessive moisture. Using multiple indicators can help provide a more accurate depiction of existing conditions, as the inaccuracies associated with each individual indicator can be identified and interpreted in the decision-making process by comparing it to other indicators. Of the indicators currently available, precipitation minus potential evapotranspiration (P–PET), precipitation deciles/ percentiles, and the Standardized Precipitation Index were recommended for monitoring agricultural

drought and excessive moisture in Saskatchewan, while streamflow, reservoir, and lake percentiles, and the Standardized Precipitation Index were recommended for monitoring hydrological drought and excessive moisture (Quiring 2011).

In terms of monitoring network adequacy, a network of networks was recommended to be developed in Saskatchewan to integrate existing and potential future monitoring efforts. There are a number of networks of different quality currently operating in the province, which provide acceptable spatial coverage when all networks are considered in unison. Information from these networks, however, is currently not integrated, leaving significant gaps in the spatial coverage of any one network. A solution to this issue is improved integration via a network of networks (Quiring 2011).

Even if a network of networks was developed, data from climate stations would still need to be interpolated to provide information for all areas across the province. Various techniques for spatial interpolation were tested and Inverse Distance Weighting was recommended for Saskatchewan, given its simplicity in application yet relative accuracy when interpolating climate conditions (Quiring 2011).

3.2 WATER MANAGEMENT

Key Lessons Learned for the Prairies Region

There are a number of lessons learned for the Prairies Region in terms of adaptation in water management. These are related to hydroclimatic cycles, drought risks, and assumptions of stationarity. These lessons are based largely on the work of the Prairie Adaptation Research Collaborative (Axelson, Sauchyn, and Barichivich 2009; Lapp et al. 2010; Lapp et al. 2011; St. Jacques et al. 2010; St. Jacques et al. 2011), as well as other research teams at the Saskatchewan Research Council (Wittrock, Wheaton, and Siemens 2011, 2012) and University of Saskatchewan (S. Kulshreshtha, pers. comm.).

A number of cycles can be detected through long-term observations of Prairie hydroclimate occurring at various timescales. These cycles are not perfect oscillations, but are often referred to as “quasi-oscillations,” meaning that they are somewhat oscillatory in nature but have variations in their periodicity. In the Prairies hydroclimate, the following quasi-oscillations are apparent: the El Niño Southern Oscillation at intra-annual timescales, the North Atlantic Oscillation or the Arctic Oscillation at typically decadal timescales, and the Pacific Decadal Oscillation at multi-decadal timescales. Despite the presence of long-term cycles in the Prairies' hydroclimate, such as the Pacific Decadal Oscillation, long-term trends are consistent with a warmer climate and the climate change hypothesis. Recognition of various cycles in the hydroclimate and the role of the large-scale teleconnection patterns that cause them can help improve risk management at various timescales and provide the base for well-informed adaptation (St. Jacques et al. 2010).

The risk of droughts more severe than those experienced by current water management institutions is apparent from the paleo-climate record, simulations of future climate and variability under climate change, and the analysis of long-term climate cycles (Axelson et al. 2009; Lapp et al. 2010; St. Jacques et al. 2011; Wittrock, Wheaton, and Siemens 2011). In addition, risks associated with long-term hydrologic drought under a changing climate could increase as water demand increases (S. Kulshreshtha, pers. comm.). Current water management institutions are capable of coping with experienced inter-annual variability and the short wet/dry cycles driven in part by the El Niño Southern Oscillation. The severity of droughts expected in the future, however, is likely to exceed this coping range, as well as existing water supply planning horizons, warranting adaptation involving fundamental policy and systemic institutional changes (Axelson et al. 2009; Lapp et al. 2010; St. Jacques et al. 2011; Wittrock et al. 2011; Rescan 2011).

Finally, PRAC Water Theme work showed water management can no longer rely on assumptions of hydroclimate stationarity. Conventional water resource engineering assumes that climate and water supplies fluctuate within a known range of variability around an unchanging mean state. Studies of past and future climate and hydrology question this assumption of a stationary mean, requiring new approaches to estimating the frequencies of extreme events (Milly et al. 2008; Axelson et al. 2009; Lapp et al. 2010; Lapp et al. 2011; St. Jacques et al. 2011; Wittrock, Wheaton, and Siemens 2011).

Key Lessons Learned for Alberta

The main lessons learned specifically for Alberta are based on preliminary findings from hydrological scenarios. These scenarios indicate that annual stream flows in the South Saskatchewan River Planning Area are expected to change +5 to -30% due to climate change, with an additional reduction of 25% or more in dry years. These lessons can be used to inform adaptation planning initiatives within the South Saskatchewan River Planning Area.

Key Lessons Learned for Saskatchewan

Recognizing cycles in Saskatchewan hydroclimate can effectively help manage risks. PRAC hydroclimate variability analyses conducted by the PARC helped inform the development of the Emergency Flood Damage Reduction Program in 2011, which was designed to proactively manage excessive moisture risk.

Key Lessons Learned for Manitoba

The main lessons learned specifically for Manitoba resulted from their modelling work using the MIKE-SHE model and the Canadian Regional Climate Model (CRCM), as well as their work on water demand projections. They found that the MIKE-SHE model is representative of the Assiniboine River watershed hydrology for scientific or exploratory purposes, but operational applications will require refinement of the modelling technique. CRCM output (e.g., temperature, precipitation, and evapotranspiration) is biased when compared to historical records, and bias correction techniques should be developed. Hydrologic projections for the Assiniboine River watershed using the MIKE-SHE model ran with CRCM output indicate no significant changes to the magnitude or variability of streamflow, but there is a high degree of uncertainty associated with these projections since only one scenario of future climate was used.

In terms of water demand, municipal and irrigation water use is expected to increase in the future. These increases are expected to be even greater in the context of climate change. Other water uses, such as industrial, recreational, and the La Salle Diversion, are expected to remain relatively similar to existing levels (Stantec and Genivar 2012).

3.3 AGRICULTURE AND GRASSLAND ECOSYSTEM MANAGEMENT

Key Lessons Learned for the Prairies Region

There are a number of lessons learned for the Prairies Region in terms of adaptation in agriculture and grassland ecosystem management. These are related to shifting vegetation zones as well as changes in production, biodiversity, and wetlands. These lessons are based on Thorpe's (2011) study of grassland vulnerability undertaken as part of the Terrestrial Ecosystems Theme.

A northward shift in vegetation zones is expected due to changing moisture regimes resulting in changes to existing grassland ecosystem and potential implications for agriculture. It is likely that this shift will lag behind changes in climate based on vegetation response time, making it difficult to predict exact vegetation changes. It is expected that southern forest fringe areas will be replaced by aspen parkland and grassland. In addition, current Canadian grassland types found in the region are

expected to be replaced by types currently found in the Great Plains Region of the United States (Thorpe 2011).

In terms of grassland production, long-term average decreases are expected to be slight or moderate. Interannual fluctuations in production resulting from climate variability and extremes (e.g., droughts) are likely to be much more severe and problematic. The duration of drought will be important in determining specific impacts to grasslands. The effects of short-term drought are more acute, producing immediate reductions in growth and productivity only for the duration of the drought. Long-term drought, however, can shift grassland composition toward shorter or earlier-growing species (Thorpe 2011).

Biodiversity will also change as species respond to climate change by moving (i.e., shifting ranges) or staying in place (i.e., changing phenology or evolving). Slow-dispersing species requiring specialized habitat are likely to be less adaptable to climate change than species having long-distance dispersal and less specific habitat requirements. Invasive species with rapid dispersal rates that can use disturbed habitats and have capacity for relatively rapid evolution are likely to remain highly competitive under climate change. Increasing droughts, however, may help to reduce invasion success by limiting resources available to support invasion (Thorpe 2011).

Wetlands are likely to reduce in number and area under expected climate change, resulting in losses to waterfowl production and other wetland biodiversity. These impacts, however, are also highly dependent on changes in land use, which could be more immediately important (Thorpe 2011).

Key Lessons Learned for Saskatchewan

There is a suite of existing programs, policies, and plans currently being implemented by the Saskatchewan Ministry of Agriculture that are proactive and aimed directly at addressing potential challenges associated with climate change (e.g., the Farm and Ranch Water Infrastructure Program). Other programs (e.g., the Canada-Saskatchewan Farm Stewardship Program, Environmental Farm Plan, and Agri-environmental Group Plan) were not designed to directly deal with climate change-related challenges, but do have co-benefits related to successful adaptation (AWSA 2011; IISD 2011; NSRBC 2011; SCCWS 2011; Steinley and Mowenchenko 2011). Given the complexity of climate change risks, a mix of proactive and responsive programming is likely necessary to deal with future climates (IISD 2011; Steinley and Mowenchenko 2011; Thompson 2011a, 2011b).

Key Lessons Learned for Manitoba

In Manitoba, it was determined that effectively managing excessive moisture in the Interlake Region requires a number of short-, medium-, and long-term strategies. Short-term strategies aimed at developing policies and programs attuned to regional hydrology and flood frequencies, which ensure appropriate land use; ongoing drainage infrastructure maintenance and development; and adequate disaster relief are required. In the medium-term, strategies aimed at documenting, reviewing, and evaluating existing and historical policies and programs; discontinuing ineffective programs; and developing integrated strategies for risk management would be beneficial. And in the long-term, strategies aimed at promoting water conservation, pursuing policy and program innovation, and ensuring adequate and ongoing flexibility in programming will likely be required (MMM 2012).

Vulnerability to climate change for both cattle and forage production is expected to be high, with a number of high risks expected from extreme events and disease outbreaks leading to reduced economic stability and coping capacity. In order to deal with the identified vulnerabilities and risks, a number of adaptation options were developed. These options were generally not specific to either the cattle or forage industries and could be organized into the following themes or categories: maintenance of

water quantity and quality, conservation of native grassland, prevention and planning for disease outbreaks, maintenance and restoration of wetlands, prevention and mitigation of flooding, maintenance and improvement of community pastures and Crown lands, expansion of the existing soil survey, and development of new cattle breeds and breeding programs (MAFRI and MCWS 2012).

3.4 FOREST ECOSYSTEM MANAGEMENT

Key Lessons Learned for the Prairies Region

There are a number of lessons learned for the Prairies Region in terms of adaptation in forest ecosystem management. These are related to vulnerability/risk assessment and adaptation planning. The lessons are based on SRC's work of forest vulnerability and identification of adaptation options undertaken as part of the Terrestrial Ecosystems Theme (Qualtiere 2011; M. Johnston and E. Qualtiere, pers. comm.).

The PRAC identified a number of high concern vulnerabilities: drought, reduced timber supply, increased pest damage, increased forest fire activity, decreased regeneration potential, and decreased revenue for the forest industry. Vulnerabilities of medium concern included forest ecosystems shifts, habitat loss and fragmentation, loss of genetic resources, and reduced carbon storage potential (Qualtiere 2011; M. Johnston and E. Qualtiere, pers. comm.).

Adaptive management in the context of climate change will likely require managing not only for existing or historical vegetation and ecosystems, but new vegetation and ecosystems as climate change increases in magnitude. This includes maintaining a diversity of age classes, dealing with pests and pathogens, and actively regenerating forest stands with species properly adapted to new climates, either native or exotic (Henderson et al. 2002; Lemmen et al. 2008).

Key Lessons Learned for Alberta

High priority risks from climate change to Alberta's forest sector include drought, reduced timber supply, increased damage from pests and fires, and decreased regeneration potential. Medium priority risks include forest ecosystems shifts, habitat loss and fragmentation, reduced genetic resources across (and within) species, and reduced carbon storage. Effective management of climate change risks in the forestry sector will require proactive adaptation, a broad acceptance of uncertainty, and the ongoing monitoring and evaluation of outcomes from the implementation of adaptation strategies. The Climate Change Adaptation Framework is a useful tool that agencies can apply to identify vulnerabilities, prioritize risks, and develop a suite of adaptation options (Qualtiere 2011).

3.5 MUNICIPAL AND COMMUNITY RESILIENCE

Key Lessons Learned for Manitoba

A number of lessons for municipal and community resilience were identified in Manitoba. These were largely the result of the Municipal Adaptation Planning Workshop held on November 2, 2011. The adaptive strategies identified at this workshop included:

- promoting stakeholder awareness of climate change issues;
- pursuing integrated vulnerability and risk assessment and management;
- effectively valuing ecological goods and services;
- assessing infrastructure risks and developing long-term (10-year) development plans;

- developing regulations, protocols, standards, codes, land use plans, and zoning aimed at improving infrastructure resilience;
- conserving and restore natural areas (e.g., wetlands and watersheds);
- coordinating land-use and watershed management plans and planning initiatives;
- increasing housing density to manage urban growth;
- developing long-term flood and drought preparedness and management plans;
- regionalizing water management services and technology development;
- developing monitoring programs for land, water, and infrastructure use;
- enhancing stakeholder collaboration; and
- developing an integrated financial planning and budgeting system.

3.6 PRAIRIES REGIONAL ADAPTATION COLLABORATIVE FORUMS

Throughout the duration of the PRAC, a number of decision-making forums were held for multiple purposes. The forums brought collaborators with broad backgrounds together from different provinces to discuss their progress, key findings, lessons, and challenges with respect to implementing the PRAC. The forums helped foster collaborative networks both intra and interprovincially and significantly contributed to the success of the PRAC. An overview of forum activities is found in Table 3.6-1.

Table 3.6-1. Prairies Regional Adaptation Collaborative Workshops, Forums, and Conferences

Name	Organizer	Location	Date
Living with a Changing Climate Conference	Prairie Adaptation Research Collaborative	Calgary, AB	February 2010
Terrestrial Ecosystems Theme Forum	Saskatchewan Research Council	Saskatoon, SK	March 2011
Water and Drought and Excessive Moisture Themes Forum	Manitoba Conservation and Water Stewardship	Winnipeg, MB	September 2011
Adaptation to Climate Change on the Canadian Prairies Forum	Prairie Adaptation Research Collaborative	Regina, SK	February 2012

The specific lessons from the previous forums were discussed at the Adaptation to Climate Change on the Prairies Forum held February 2012 in Regina, Saskatchewan. There were over 65 participants at this forum, representing provincial and federal governments, non-governmental organizations, academic and research groups, and other stakeholders in the Prairies Region. These participants identified some of the successes and lessons learned from the forums and the challenges associated with or ways of improving the forums.

According to participants, the forums helped integrate and advance adaptation between different groups who had different views on what adaptation means and how this could or should be approached within work areas. They helped identify common ground from which collaborative PRAC projects could be built. The forums also helped leverage some additional funds from provincial governments to support collaboration, but resource availability, especially for interprovincial travel, was still a major challenge. The importance of framing adaptation was also highlighted by participants; the forums helped do this in a way that increased the PRAC's effectiveness, but there is still an identified need to re-frame adaptation to improve the impact of adaptation programming. The importance of framing is

discussed further is Section 8.3. Forums also facilitated the sharing of frameworks, approaches, and other decision-making tools for adaptation between provinces and/or sectors. This sharing of tools was supported formally by presentations or discussion activities, but also informally through non-structured networking that occurred at the forums (Klumper and McLeod 2012).

Differing regulatory environments and governance structures in the provinces lead to some challenges to integration at the forums. In some cases, provincial jurisdictions have very different needs in terms of adaptation, limiting the effectiveness of interprovincial information sharing. Some participants would have liked to see detailed examinations of provincial policies and identification of potential adaptation-related synergies occurring at the forums. This would also help target forums on specific adaptation-related issues for specific sectors, potentially improving outcomes. The timing of the forums was another concern; the amount of time between forums potentially limited their effectiveness, because each forum required significant time upfront working on broad issues as opposed to focused, in-depth progress on specific issues.

4. Current Context

4. Current Context

This section describes the current context for adaptation in the Prairies Region. It contains an overview of adaptation initiatives already underway or planned in a number of departments and agencies. The results in this section are based on information from interviews, which was triangulated with publically available sources. This section is organized by governance level and includes an overview of activities in each of the Prairie Provinces as well as at the federal level.

4.1 ALBERTA

Three Alberta ministries were included in this study: AEW, Alberta SRD, and Alberta ARD. Each of these ministries was engaged in the PRAC. In addition, the ministries have also been involved with or have led a number of other adaptation-related initiatives in the past. Most current and past adaptation-related activities in Alberta have been undertaken in support of the development of a comprehensive provincial adaptation strategy. A description of these activities for each ministry can be found below.

AEW is responsible for ensuring water and environmental stewardship to maintain a high quality of life for all Albertans. Within Alberta's provincial government, AEW manages climate change activities, including adaptation, and leads the development of the provincial adaptation strategy; there is also a broad agenda to coordinate adaptation across ministries. As such, AEW played a key role in coordinating and implementing the PRAC in Alberta. In addition to PRAC-related adaptation projects, AEW is also facilitating grassroots adaptation in water management through regional planning and other initiatives, as well as collaborating internationally with the State of Montana on adaptation through the International Joint Commission.

Alberta SRD is responsible for ensuring balanced and responsible resource use in the province and has made significant progress towards adaptation. There is an internal adaptation team within the ministry that leads and coordinates adaptation between divisions. A Climate Change Adaptation Framework has been developed for Alberta SRD to help the ministry identify vulnerabilities and risks to its core business areas and identify and prioritize corresponding adaptive strategies. Alberta SRD has also produced a manual that can guide decision-makers through the vulnerability/risk assessment and adaptation planning process (SRD 2010). This manual has been made publically available and was used to guide projects in a number of PRAC's Terrestrial Ecology Theme activities (SRD 2010; Archibald 2012).

In addition, the Forestry Division of Alberta SRD has been involved with ongoing adaptation initiatives through the Canadian Council of Forest Ministers (CCFM). The CCFM has initiated a number of climate adaptation and mitigation initiatives, providing Canadian forest managers with valuable tools, frameworks, and other materials to address climate change issues. The CCFM provides a forum for broad collaboration, as it includes membership from provincial, territorial, and federal governments (Archibald 2012).

Alberta ARD is responsible for delivering services to Alberta's agriculture and rural sector aimed at promoting and enhance sustainability and facilitating risk management. As such, many of their programs and services are directly related to adaptation and provide entry points for mainstreaming in the context of climate change. Alberta ARD was the provincial lead on Alberta's Agriculture Drought Risk Management Plan. The ministry has also developed an extensive climate monitoring network (i.e., Alberta's AgroClimate Information Service) and numerous tools, supporting adaptive decision-making of agricultural producers. These tools and services are delivered through a number of means and are incorporated in ARD's website, Ropin' the Web, providing producers with a one-stop-shop for information.

4.2 SASKATCHEWAN

Saskatchewan agencies currently undertaking adaptation-related work were engaged in interviews: the Saskatchewan Ministry of Environment (MOE), SWA, Saskatchewan Association of Watersheds (SAW) and its partners, Saskatchewan Ministry of Agriculture (MOA), and SRC. A description of their activities can be found below.

The Saskatchewan MOE is officially responsible for climate change mitigation and adaptation in the provincial government. Most of the climate change-related work completed to date by the MOE has been on climate change mitigation. Moving forward, however, the ministry will continue to develop a provincial adaptation framework through collaboration with other relevant ministries, agencies, and stakeholders. Internally, the Forest Services Branch (FSB) is in the process of developing a draft climate change response strategy for their operations. The FSB has also been collaborating on adaptation through the CCFM Climate Change Task Force.

The SWA was the Government of Saskatchewan lead on delivering the PRAC. The SWA has an ongoing and substantive role in conducting scientific hydroclimate risk assessments and the governance of hydroclimate risks. Currently, the SWA is developing a water allocation strategy to effectively manage future climate risks and economic growth and has recently developed flood mitigation and damage reduction programs (e.g., Emergency Flood Damage Reduction Program 2011). The proactive nature of these programs was based in part on the PARC's hydroclimate variability work. The PARC's work on hydroclimate cycles was used to justify early action with regards to flood mitigation, given the expected conditions based on dominant hydroclimatic phases. In addition, the SWA has been involved in broad collaborative adaptation efforts through the Prairie Provinces Water Board Committee on Hydrology aimed at testing the resilience of the Master Apportionment Agreement.

The SAW and its partners have undertaken a number of adaptation initiatives through the PRAC in partnership with the SWA. Watershed Drought and Excessive Moisture Preparedness plans have been developed for six of Saskatchewan's watersheds. In addition, a number of held workshops aimed at watershed and municipal decision-makers provided exposure to climate change science, as well as vulnerability and risk assessment and adaption planning techniques. These initiatives helped foster multi-level collaboration and learning on adaptation between municipal, watershed, provincial, and federal stakeholders.

The Saskatchewan MOA, through development and implementation of their Agricultural Drought and Excessive Moisture Monitoring Plan, have been engaged in a number of adaptation-related initiatives. The extremes of moisture monitoring committee developed as part of the plan, which includes representation from the MOA, SWA, Agriculture and Agri-Food Canada (AAFC), and Saskatchewan Crop Insurance Corporation, provided direction to many PRAC projects under the Drought and Excessive Moisture Theme. In addition, this committee plays a key role in providing accurate information for adaptation decision-making regarding climate extremes in Saskatchewan's agricultural sector.

The SRC has well-developed expertise in climate change impacts and adaptation research. The SRC has continued their role in adaptation by leading the PRAC's Terrestrial Ecosystems Theme and contributing significantly to the Drought and Excessive Moisture Theme. Their PRAC work included assessing the vulnerability of and identifying adaptation options for forest and grassland ecosystem management in the Prairies Region, as well as conducting extreme hydroclimate events' characterization in support of preparedness planning. The SRC also operates climate reference monitoring stations in the province. In addition, the SRC is involved in a number of ongoing climate change adaptation projects with broad collaborative scopes, such as the CCFM climate change initiatives.

4.3 MANITOBA

Within Manitoba, the PRAC has been one of largest adaptation projects to date. The PRAC has helped departments to become coordinated on adaptation and identify collaboration opportunities. It has also helped raise the profile and priority for adaptation work and facilitated proactive adaptation by providing the necessary resources. Specific adaptation initiatives within the MCWS, Manitoba Infrastructure and Transportation (MIT), MAFRI, and the MLG are identified below.

The MCWS is the provincial lead on all impacts and adaptation work in Manitoba, including the delivery of the PRAC. As such, this department has an evolving and emerging role in broad provincial coordination of adaptation, which may include the potential development of a climate change adaptation roadmap for Manitoba. The MCWS also is responsible for sustainable resource management, which includes jurisdiction over water and forest resource management. In this respect, the MCWS has been involved in a number of adaptation-related initiatives, mostly related to the PRAC. The MCWS has led the vulnerability assessment in the Sandilands Provincial Forest, the Assiniboine River watershed hydrologic modelling, water demand projections, and other PRAC projects. The MCWS has also been involved in inter-jurisdictional collaboration for climate information sharing and coordinating best practice in modelling.

Most of MAFRI's adaptation work to date has been related to the PRAC. MAFRI recently hosted two workshops—one for government staff and the other for a range of industry stakeholders—aimed at conducting vulnerability and risk assessment and adaptation planning for the beef and forage industries. MAFRI also led the excessive moisture case study in the Interlake Region undertaken, through the PRAC, and was involved in the grasslands adaptation planning under the Terrestrial Ecosystems Theme. MAFRI is currently in the process of developing a departmental adaptation strategy and is also working with International Institute for Sustainable Development (IISD) to assess the adaptive capacity provided by six MAFRI-administered agriculture programs.

The involvement of the MLG and MIT in adaptation projects to date has been exclusively through the PRAC. The MLG recently hosted a workshop aimed at facilitating adaptation planning with municipal decision-makers. The MLG is also leading an ongoing feasibility assessment of applying the Landscape and Infrastructure Resiliency Assessment (LIRA) process in Manitoba. MIT has provided expertise on the Water and Drought and Excessive Moisture PRAC themes. MIT is interested in developing flood forecast and risk assessment techniques in the context of climate change and non-stationarity.

4.4 FEDERAL

Many federal departments have well-developed and established adaptation programs. This includes programs within Environment Canada, NRCan, AAFC, and Aboriginal Affairs and Northern Development Canada (AANDC).

Environment Canada is the official federal policy lead on climate change and has a mandate towards climate change adaptation and impacts. Environment Canada is involved in the coordination of adaptation activities across federal departments and participates in the development of federal adaptation initiatives. Environment Canada is also the lead federal department conducting climate science research and oversees the federal government's climate monitoring network.

The Climate Change Impacts and Adaptation Division (CCIAD) of NRCan has a long-standing mandate to facilitate and promote climate change adaptation. CCIAD programs have funded many impacts and adaptation research projects and helped created a number of adaptation decision support tools. The development of *From Impacts to Adaptation: Canada in a Changing Climate 2007* (Lemmen et al. 2008), a Canada-wide assessment of vulnerability, impacts, and adaptation in a number of sectors, was

led and coordinated by CCIAD. In addition, CCIAD has helped foster broad collaborative networks and bridge multiple groups for adaptation across Canada. This is exemplified through their most recent program, the RAC program. Moving forward, CCIAD will be applying lessons learned from the RAC experience to advance adaptation through the development of the Adaptation Platform Program.

AAFC has a broad mandate towards multifaceted aspects of adaptation in the agriculture sector. Parts of AAFC are rooted in the Prairie Farm Rehabilitation Administration, an agency almost fully devoted to and well known for its climate adaptation efforts (Marchildon et al. 2008; Marchildon 2009). Both water and climate change are priorities for AAFC. To address these priorities, AAFC provides a broad range of services to support adaptation, for example, watershed delineation, developing hydrologic frequency curves, modelling crop growth and evapotranspiration, water use efficiency, water storage and infrastructure, sustainable stocking rates, and riparian area restoration. Climate information services and decision support systems are also provided through AAFC's National Agro-Climate Information Service, such as Drought Watch (AAFC 2012). The Climate Decision Support and Adaptation Unit of the National Agro-Climate Information Service is well-known for providing decision support tools for adaptation. A number of the unit's initiatives were also integrated into PRAC projects, such as the LIRA and the Drought Preparedness Partnership. There has also been significant interest from the PRAC partners in the Invitational Drought Tournament.

In addition, AANDC has successfully initiated the Climate Change Adaptation Program with First Nation and Métis communities in Canada. The program aims to support adaptive capacity and resilience in Aboriginal and northern communities through a number of means, including vulnerability and risk assessment and adaptation planning. AANDC is also conducting an internal departmental climate risk and vulnerability assessment to identify opportunities to integrate adaptation into ongoing program areas following a mainstreaming approach.

5. Institutional Arrangements

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5. Institutional Arrangements

This section describes the mandates and potential roles of various departments in adaptation. It also outlines existing and potential partnerships and collaborations, as well as discusses effective governance for adaptation.

5.1 POTENTIAL ROLES IN ADAPTATION

5.1.1 Alberta

Table 5.1-1 shows the potential roles and relevant mandates of the Alberta ministries engaged in this study.

Table 5.1-1. Potential Roles and Mandates of Alberta Ministries in Adaptation

Ministry/Agency	Relevant Mandates	Potential Role(s) in Adaptation
AEW	Ensures stewardship of Alberta's environmental and water resources to sustain a high quality of life.	• Provincial lead on adaptation • Interpreting and contextualizing impacts and adaptation needs of water resources and water management
SRD	Promotes balanced and responsible natural resource use in Alberta by applying leading management practices, science, and stewardship.	• Involvement in climate change policy and regulation development • Facilitating adaptation in industry • Ongoing land and resource stewardship in collaboration with land and resource users • Providing and interpreting climate change information
ARD	Provides the frameworks and services necessary for Alberta's agriculture and food sector to excel and enable resilient rural communities.	• Facilitating adaptation and providing extension for the agriculture industry • Coordinating adaptation-related research • Innovation in product and market development

5.1.2 Saskatchewan

Table 5.1-2 shows the potential roles and relevant mandates of the Saskatchewan ministries and agencies engaged in this study.

Table 5.1-2. Potential Roles and Mandates of Saskatchewan Ministries and Agencies in Adaptation

Ministry/Agency	Relevant Mandates	Potential Role(s) in Adaptation
MOE	Ensures sustainable natural resource use and management in the Province of Saskatchewan. Officially mandated with coordinating provincial climate change adaptation.	• Provincial lead on climate change adaptation • Education and awareness of climate change issues • Develop risk management capacity with partners • Enhance and protect forest and wildlife resources in a changing climate • Balancing short-term economic benefits from industry with long-term sustainability goals
MOA	Ensuring the success and competitiveness of Saskatchewan's agriculture industry.	• Coordinating and facilitating adaptation in Saskatchewan's agriculture industry

(continued)

Table 5.1-2. Potential Roles and Mandates of Saskatchewan Ministries and Agencies in Adaptation (completed)

Ministry/Agency	Relevant Mandates	Potential Role(s) in Adaptation
SWA	Responsible for sustainable water management and stewardship in Saskatchewan.	• Developing long-term drought and flood mitigation strategies • Managing water allocation and licensing in the context of change • Applying cutting edge climate science research to real world problems in water management • Conducting hydroclimate trend analysis and understanding the implications for water management • Promoting watershed stewardship and resilience
MHI	Responsible for developing and advancing major highways and infrastructure projects in Saskatchewan.	• Developing/implementing adaptation strategies, protocols, standards, etc. to deal with flooding, wet/dry cycles, and other climate impacts
Ministry of Health	Supporting Saskatchewan's residents in achieving optimal health and well-being.	• Managing climate change impacts to health • Defining standards and protocols for water reuse projects
SRC	Providing scientific and applied research services in broad areas to communities, industry, and government.	• Plays a major role in bridging gaps between the scientific and academic community and the on-the-ground, practical users of technologies, and innovation • Applying ecosystems science (ecological knowledge) in broad range of contexts, working with a broad range of groups (industry, communities, etc.) • Technical service provider (i.e., identify and screen adaptation options)

5.1.3 Manitoba

Table 5.1-3 shows the potential roles and relevant mandates of the Manitoba departments engaged in this study.

Table 5.1-3. Potential Roles and Mandates of Manitoba Departments in Adaptation

Department/Agency	Relevant Mandates	Potential Role(s) in Adaptation
MCWS	Ensures the sustainable use of Manitoba's natural resources, including water. Coordinates, enables, and delivers on Manitoba's climate change programs.	• Coordination and secretariat role in adaptation • Sharing climate change information and communication • Continuing the provision of hydrological expertise within the province for various policies, programs, projects, and planning initiatives • Ongoing hydrometric monitoring and water supply planning • Terrestrial ecosystem management in a changing climate
MAFRI	Accelerating greater prosperity and productivity in Manitoba's agriculture industry.	• Working on-farm and with industry towards adaptation • Leading provincial understanding of what climate change means for production • Developing recommendations for beneficial adaptation options in Manitoba's agriculture sector • Developing MAFRI's adaptation strategy • Assessing risks of various agriculture sectors through focus groups

(continued)

Table 5.1-3. Potential Roles and Mandates of Manitoba Departments in Adaptation (completed)

Department/Agency	Relevant Mandates	Potential Role(s) in Adaptation
MIT	Establishing and management Manitoba's highways and transportation infrastructure.	• Effectively managing climate risks to infrastructure
MLG	Improving the economic, social, and environmental well-being of Manitoba's communities.	• Developing policies and programs to advance adaptation in Manitoba's municipal sector • Working collaboratively with municipalities to manage climate risks

5.1.4 Federal

Table 5.1-4 shows the potential roles and relevant mandates of the Federal departments engaged in this study.

Table 5.1-4. Potential Roles and Mandates of Federal Departments in Adaptation

Department/Agency	Mandate	Potential Role in Adaptation
AAFC	"Provides information, research and technology, and policies and programs to achieve an environmentally sustainable agriculture, agri-food and agri-based products sector, a competitive agriculture, agri-food and agri-based products sector that proactively manages risk, and an innovative agriculture, agri-food and agri-based products sector" (AAFC 2011). Agri-Environment Services Branch promotes adoption of solutions to priority issues, such as water and climate change.	• Continuing mandate of supporting agriculture industry adaptation • Demonstrating leading edge technology and practice • Continuing ongoing role in industry competitiveness • Mainstreaming adaptation where relevant • Providing climate information and decision support tools • Enabling and bridging scientific knowledge and innovation with practice
AANDC	Supports Aboriginal and northern peoples to improve social well-being, economic prosperity, community sustainability, and participation in Canada's development.	• Continuing the Climate Change Adaptation Program • Mainstreaming adaptation into ongoing programming • Providing climate change adaptation expertise (internally and externally)
NRCan	Promotes the sustainable development of Canada's natural resources while protecting well-being. Climate Change Impacts and Adaptation Division facilitates effective adaptation actions with regions and sectors in Canada.	• Overall facilitator with broad ownership of federal collaborative adaptation projects • Continued role as broad champion • Climate change assessment activities • Widening context for adaptation collaboration
Environment Canada	Preserving and enhancing the quality of Canada's natural resources, conserving renewable resources, and forecasting and providing information on weather conditions and warnings.	• Coordination role • Federal policy lead (horizontal) • Developing Federal Adaptation Policy Framework • Climate and weather monitoring, forecasting, and information provision • Climatology and meteorology research

5.2 COLLABORATION AND PARTNERSHIPS

This section provides an overview of horizontal collaboration within each jurisdiction and identifies opportunities for external collaboration, including inter-jurisdictional collaboration.

5.2.1 Alberta

Broad collaboration on adaptation within the Government of Alberta has been facilitated by the Alberta Climate Change Adaptation Team. PRAC-related collaboration in Alberta on adaptation has been mainly between the three ministries engaged in the PRAC: AEW, SRD, and ARD. These agencies also took part in the PRAC forums and worked with the SRC and PARC on a number of projects. There is a recognized need to broaden collaboration on adaptation in the province both horizontally within government and vertically with municipal, community, and industry stakeholder groups (Archibald 2012).

5.2.2 Saskatchewan

Within Saskatchewan, it is recognized that collaboration on adaptation is essential to the success of projects. To date, most collaboration related to adaptation has occurred through the PRAC, and further collaboration will likely be necessary to effectively manage climate change. The main provincial ministries, agencies, and groups involved with the PRAC were PARC, SWA, MOA, and SRC. Further collaboration was facilitated through the MOA's extremes of moisture monitoring committee (see Section 4.2). In addition, there were a number of PRAC projects undertaken in collaboration with SAW and its partners, but there are still opportunities to expand collaboration with external stakeholders (e.g., municipalities, communities, First Nation and Métis groups, and industry).

Through implementation of the PRAC program, ground work has been completed for broadening the collaborative network within the province. Also, collaborations with the scientific and academic community, such as PARC and SRC, were seen as beneficial, and further collaboration with these groups would be useful in the future.

5.2.3 Manitoba

In Manitoba, the PRAC has been the main catalyst for collaboration on adaptation in the province. The main departments involved with the PRAC include the MCWS, MIT, MLG, and MAFRI. The need to further develop collaboration across government and with external stakeholders, such as communities, municipalities, First Nation and Métis groups, conservation districts, planning districts, industries and academics/researchers, is recognized.

5.2.4 Interprovincial

Interprovincial collaboration on adaptation has facilitated the implementation of the PRAC, building on previous initiatives (e.g., Drought Research Initiatives and the Western Water Stewardship Council) to help ensure success. Policy and management approaches differ by jurisdiction, limiting opportunities for collaboration in some cases. The PRAC forums were viewed as a tool for promoting and fostering interprovincial collaboration. Interprovincial collaboration is most effective in the following areas:

- knowledge, practice, and information sharing;
- collaborative research projects and research extension (e.g., forums);
- sharing lessons learned from various studies (e.g., excessive moisture in the Interlake Region case study);
- sharing manuals and approaches to vulnerability and risk assessment and adaptation planning (e.g., SRD's *Climate Change Adaptation Framework Manual*); and
- developing shared monitoring, planning and education and awareness programs.

In some cases, such as with forestry, it may be beneficial to expand interprovincial collaboration beyond the Prairies Region and integrate lessons learned on adaptation from other jurisdictions

(such as British Columbia). In addition, interprovincial collaboration can be more effective when it is built out of an existing management structure, such as the Prairie Provinces Water Board, Mackenzie River Basin Board, or International Souris River Board.

5.2.5 Federal

The federal departments involved with adaptation have a longstanding track record of broad collaboration on adaptation, internally and externally. Moving forward, expanding collaboration will be a priority in the next generation of federal adaptation programming, including within NRCan's emerging Adaptation Platform. The Adaptation Platform aims to build on lessons learned and collaborative networks formed during the RAC program to continue progress on adaptation.

5.3 EFFECTIVE GOVERNANCE OF ADAPTATION

A common theme identified through the interviews was the need to expand engagement of communities, municipalities, and industry to advance adaptation. This would include not only working directly with community, municipality, and industry stakeholders, but also improving engagement of sector associations and regional authorities. This includes, but is not necessarily limited to conservation districts, watershed stewardship associations, planning districts, municipal associations (e.g., Association of Manitoba Municipalities), non-governmental organizations, and industry associations (e.g., Saskatchewan Institute of Agrologists and Agricultural Research and Extension Council of Alberta). Many of these groups currently lack the resources and capacity to effectively tackle the challenge of adaptation on their own, and collaboration with all levels of government will be required.

The Organisation for Economic Co-operation and Development (OECD) has developed a number of guiding principles for good practice in multi-level climate governance. These include (Corfee-Morlot et al. 2009):

- ensuring participatory governance and strategic planning at relevant scales;
- providing analytical foundations for short- and long-term planning;
- pursuing cost-effectiveness and economic efficiency;
- encouraging experimentation and innovation;
- addressing distributional vulnerabilities and procedural equity;
- establishing appropriate planning horizons;
- delivering policy coherence; and
- monitoring, reporting, and evaluating adaptation outcomes.

6. Priority Areas and Actions

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6. Priority Areas and Actions

This section provides an overview of key priority areas and actions within each jurisdiction, as identified through the interviews. This includes priorities within the main focal areas of PRAC activities to date (i.e., climate monitoring and information systems, water management, agriculture and grasslands ecosystem management, and forest ecosystem management) but also opportunities for expanding efforts beyond these focal areas. Opportunities for expanding priorities are discussed for the following areas: improved collaboration with First Nations and Métis groups, infrastructure risks and resilience, municipal and community resilience, health risks and adaptation, economic tools for adaptation, and broad governmental climate risk assessment.

6.1 CLIMATE MONITORING AND INFORMATION SYSTEMS

6.1.1 Saskatchewan

Current priorities for climate monitoring and information systems in Saskatchewan include:

- improving the monitoring network;
- providing broad access to data and information on climate; and
- documenting information requirements of different stakeholder groups.

6.2 WATER MANAGEMENT

6.2.1 Alberta

AEW identified the following priorities (Archibald 2012):

- conducting an integrated review of the risks associated with extremes and variability in water supply and identifying adaptation options;
- developing a better understanding of the risks and adaptation options for emergency management;
- fostering broad awareness and engagement beyond the department and government; and
- completing and translating baseline assessments of potential future climatic conditions for use in water management models.

6.2.2 Saskatchewan

The SWA identified the following priorities:

- developing water allocation policy that is effective in the context of climate change and economic development;
- developing hydrologic drought plans for major systems;
- improving the monitoring and reporting of water use;
- increasing awareness and exposure to leading science on the key drivers of hydroclimate variability and implications for operations;
- analyzing hydrometric records to detect change;

- developing water conservation policy and programs;
- further developing and pursuing risk assessments and preparedness and mitigation options;
- reviewing and evaluating methods and techniques for dealing with non-stationarity in hydrology; and
- conducting water supply analysis on key systems.

6.2.3 Manitoba

The MCWS and MIT identified the following priorities:

- improving integration of climate change information into forecasting, which would include a review of procedures and tools for forecasting extreme events in the context of climate change;
- mainstreaming adaptation into the Red River Floodway operation;
- reviewing water supply using hydroclimate scenarios and understanding implications for water management (e.g., is changing rule curves required?);
- enhancing shoreline protection and flood control; and
- developing an improved understanding of infrastructure options for managing extremes.

6.3 AGRICULTURE AND GRASSLAND ECOSYSTEM MANAGEMENT

6.3.1 Alberta

The Government of Alberta identified the following priorities (Archibald 2012):

- developing rangeland management policies and programs that improve capacity to deal with climate extremes and variability;
- continuing development of the climate science base to support ongoing operational policy;
- developing an improved understanding of the social and economic implications of climate change impacts and adaptation;
- preparing for hydroclimatic extremes;
- developing tools to identify and evaluate adaptation options in agriculture, including an economic assessment (e.g., cost-benefit analysis);
- increasing integrated modelling capacity; and
- developing information systems to support adaptation.

6.3.2 Saskatchewan

The SRC identified the following priorities:

- identifying short-, medium- and long-term adaptation options;
- promoting long-term land use changes to support resilience;
- maintaining connections between native grasslands; and
- integrating economics into adaptation options.

6.3.3 Manitoba

There were a number of priorities related to agriculture and grassland ecosystem management that were identified by MAFRI. A major priority at the moment is completing the MAFRI adaptation strategy, which would be supported by:

- assessing agriculture sector vulnerability;
- identifying high risks related to climate change;
- developing adaptation options to address risks and vulnerabilities; and
- selecting and applying frameworks and tools for evaluating adaptation options.

Other priorities include:

- evaluating current programs and identifying opportunities for mainstreaming;
- developing scenarios of potential climate change impacts to agro-ecosystems;
- developing policy strategies that improve adaptive capacity;
- improving business risk management programming;
- developing pasture management strategies for drought and excessive moisture risks;
- increasing research and capacity for forage agronomy and forage variety testing; and
- identifying no-regrets beneficial management practices with a focus on co-benefits.

6.3.4 Federal

AAFC identified the following priorities:

- developing knowledge and information tools for adaptation that can be applied in the agriculture industry;
- developing and evaluating beneficial management practices for adaptation to extremes and variability;
- integrating climate change into long-term economic projections for the agriculture industry;
- promoting economically driven and sustainable practice change and adaptation;
- continuing information service provisions; and
- continuing development of adaptation decision support tools.

6.4 FOREST ECOSYSTEM MANAGEMENT

6.4.1 Alberta

SRD identified the following high priority work areas (Archibald 2012):

- mountain pine beetle and fire management;
- changing disturbance regimes;
- integrated modelling and identifying linkages with policy and operations; and
- strategic regional land use planning and analysis.

6.4.2 Saskatchewan

The FSB of the Saskatchewan MOE is currently developing an internal climate change adaptation strategy. As such, current priorities are to:

- complete draft strategy;
- receive buy-in from different units within the FSB; and
- implement the strategy throughout the FSB.

6.4.3 Manitoba

The Forestry Branch of the MCWS identified the following priorities:

- expansion of their carbon budget modelling assessments throughout the boreal forest;
- completion of the vulnerability assessment in the Sandilands Provincial Forest and development of an approach for expanding vulnerability assessments into other forest regions;
- development of an assisted migration plan; and
- development of climate-sensitive growth models for use in planning and management.

6.5 OTHER THEMES AND EXPANDING PRIORITIES

To date, the PRAC themes have focused on water resources, extreme hydro-climate events, and terrestrial ecosystems. A number of additional themes where future efforts could be directed were highlighted during interviews.

6.5.1 Improved Collaboration on Adaptation with First Nations and Métis

Adaptation work undertaken in collaboration with First Nations and Métis in the Prairies Region has been somewhat limited to date, and there is a need to better engage First Nations and Métis in adaptation. AANDC has been the main department working on adaptation in First Nations and Métis communities in the Prairies Region through its Climate Change Adaptation Program. A recent AANDC risk assessment highlighted infrastructure, land management, and emergency response as priority areas for adaptation within its operations.

6.5.2 Infrastructure Risks and Resilience

Infrastructure risks and resilience were highlighted as a priority, especially in Saskatchewan and Manitoba in relation to recent flood conditions. Integrating adaptation into design and construction standards and guidelines is one potential starting point to address the issues. The Transportation Association of Canada and Engineers Canada have recently initiated projects aimed at identifying practical and effective approaches for mainstreaming adaptation.

The LIRA developed by AAFC is one emerging tool for adaptation planning around infrastructure risks. Currently, the PRAC initiatives in Saskatchewan and Manitoba have focused on piloting and scoping LIRA projects, but LIRA projects could be expanded within both provinces. AAFC's next steps regarding the LIRA process are developing macroeconomic tools to identify constraints on adaptation options and defining standards and protocols to apply the process.

Investing in infrastructure was seen as one way of approaching long-term adaptation that is currently underdeveloped. Tools for effective decision-making on infrastructure investments in the context of uncertainty would be beneficial.

6.5.3 Municipal and Community Resilience

Municipal and community resilience was identified as an additional theme or priority area for future work. Jurisdictions are at different stages in engaging municipalities in adaptation. Priorities for future adaptation work have been identified in Manitoba. Current priorities for the MLG include:

- developing broad policy and legislation related to adaptation;
- mainstreaming adaptation into existing programs;
- developing information resources and guidelines for municipalities;
- modifying existing tools related to adaptation for application in Manitoba;
- clearly articulating and defining what adaptation means for Manitoba's municipalities; and
- continuing and expanding the projects developed under the PRAC (PRAC projects provide case studies that can be used to communicate adaptation with decision-makers).

6.5.4 Health Risks and Adaptation

Projects related to health risks and adaptation options were a gap in PRAC activities and an area where future work could be conducted. In Saskatchewan, one potential entry point for collaboration with the Ministry of Health is on understanding the ongoing issues around maintenance of water reuse projects and identifying lessons learned from other jurisdictions that could be applied in Saskatchewan.

6.5.5 Economic Tools for Adaptation

Tools that can be practically applied to assess the economic risks, costs, benefits, and efficiencies of adaptation options would be useful for decision-making in a number of priority areas. The LIRA process incorporates integrated economic analysis (e.g., cost-benefit analysis) within its approach to adaptation planning. It is likely that innovative economic tools will be required to provide effective information for decision support in the context of deep uncertainty.

6.5.6 Broad Government Climate Risk Assessment

Conducting broad government climate risk assessments was also an expanding area of interest. The risk assessment process would help governments take an integrated approach to managing climate change and help identify opportunities for collaboration. It was suggested that the risk assessment process could use the following approach: develop "perfect storm" risk scenarios, conduct a stress test, assess capacity to cope, and identify adaptation options to address gaps in capacity. Effectively applying this approach would likely require improved coordination on adaptation between departments in all jurisdictions (May and Plummer 2011; T. Hanley, pers. comm.).

7. Barriers and Challenges

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7. Barriers and Challenges

This section provides an overview of the main barriers and challenges to adaptation as highlighted by interview participants. An overview of barriers and challenges in each province is provided below. There are a number of similarities between provinces. Adaptation is typically a lower priority than other work within institutions. As such, adequate resources (i.e., staff and funding) to pursue adaptation are typically lacking. Other common barriers included a lack of coordination within provincial governments on adaptation and a misunderstanding or lack of awareness of adaptation within high-level decision-making arenas.

7.1 ALBERTA

The main barriers and challenges for advancing adaptation in Alberta include (Archibald 2012):

- low relative priority of climate change adaptation within departments;
- differing stages of progress on adaptation between departments;
- limited staff and budget resources for adaptation work;
- misunderstanding of adaptation in high-level decision-making;
- a lack of senior-level leadership on adaptation;
- a lack of political support for adaptation; and
- limited cooperation across departments.

7.2 SASKATCHEWAN

The main barriers and challenges for advancing adaptation in Saskatchewan include:

- adaptation usually being a low priority relative to other issues;
- most resources being consumed by immediate risks and needs;
- securing adequate funding and resources to advance adaptation;
- unwillingness to work on adaptation or negative attitudes towards adaptation;
- misunderstanding or not taking the potential impacts of climate change seriously;
- adaptation being confused with mitigation;
- potential lack of immediate payoffs or benefits from adaptation;
- adaptation prevention because some policies assume a static future;
- communication between government and stakeholders not always being effective;
- end users expecting climate change information that goes beyond defendable science;
- a lack of translation of climate information for end users;
- a lack of effective risk communication in the context of climate change;
- unavailability or inaccessibility of data and information; and
- uncertainty in forecasts and projections.

7.3 MANITOBA

The main barriers and challenges for advancing adaptation in Manitoba include:

- relatively low (but climbing due to recent flooding) priority for adaptation;
- immediate risks and issues overshadowing long-term risks and issues;
- a lack of strategic direction from high-level decision-makers;
- a lack of awareness regarding the importance of research on adaptation;
- a culture of crisis- versus proactive-management and decision-making structures;
- limited resources available to pursue proactive adaptation;
- needing a better understanding of the risks and implications of climate change for ecosystems;
- available funding usually being short-term;
- a need to better integrate science into policy;
- a lack of coordination between departments;
- limited resources available to maintain collaborative networks;
- the need for improved intra and interdepartmental communication regarding adaptation initiatives;
- limited time and resources available to develop funding proposals or to find matching funds; and
- limited time and resources to develop and maintain collaborative networks.

7.4 FEDERAL

The main barriers and challenges for advancing adaptation include:

- limited resource availability and a lack of resource coordination between departments;
- uncertainty in climate change projections; and
- difficulty prioritizing proactive adaptation relative to current issues.

8. Advancing Adaptation

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8. Advancing Adaptation

Based on the lessons learned (Section 3), interview results (Sections 4 to 7), and a review of relevant secondary sources, a number themes or strategies related to advancing adaptation in the Prairies have been identified. These strategies include: exploiting opportunities for mainstreaming, broadening engagement at multiple levels; framing adaptation more effectively; targeting, setting goals for, and monitoring adaptation; mobilizing resources for adaptation; streamlining collaboration; and continuing progress on adaptation. This section provides an overview of these themes and strategies.

8.1 OPPORTUNITIES FOR MAINSTREAMING

Mainstreaming is one of the most effective and efficient ways of approaching adaptation to climate change. Mainstreaming means integrating climate risk, vulnerability, adaptation, and resilience into relevant policies, plans, programs, projects, decision-making cycles and processes in systematic and rigorous ways (Klein et al. 2007; OECD 2009; USAID 2009). Numerous opportunities for mainstreaming were identified by interview participants including integrating climate change adaptation into departmental business lines, existing policies and programs, and ongoing operations related to climate risk management. It is likely that effective mainstreaming would require improved political support and broad departmental buy-in on adaptation.

Existing planning processes are one of the main entry points for adaptation mainstreaming. Planning is intrinsically forward-looking and typically process-based, making it well-suited for mainstreaming and adaptation. There is a wide range of ongoing planning processes where adaptation could be mainstreamed. Planning processes noted during the interviews include forest management planning, source water protection planning, and watershed management planning.

8.2 BROADENING ENGAGEMENT AT MULTIPLE LEVELS

Interview participants highlighted three main groups with whom improved engagement would be beneficial: high-level decision-makers, industry stakeholders, and community stakeholders. The benefits of improved engagement with these groups were identified in each jurisdiction. It is hoped that improved engagement and, importantly, participation would help obtain political support and raise the relative priority for adaptation within existing work areas. Expanded engagement of high-level decision-makers could also help to develop a clear direction on adaptation within ministries. Engagement with industries and communities is at different stages depending on the jurisdiction within the Prairies Region. Broadly, however, the need for government to provide the policies, programs, services, and frameworks to facilitate and encourage autonomous and planned adaptation within industries and communities was recognized.

8.3 FRAMING ADAPTATION

Framing adaptation refers to the social process of constructing and representing the meaning of adaptation (Goffman 1974; Gray 2003); it is a critical and unavoidable part of public communication and policy discourse (Nisbet 2009). Within the policy discourse, the framing of adaptation occurs at multiple levels, including the operational, conceptual, and political, by defining the language used to describe adaptation (e.g., as a problem or opportunity), the groups who are expected and permitted to make qualifying statements regarding adaptation (e.g., scientists, politicians, and stakeholders), and the relevant and important issues in managing climate change (e.g., impacts, uncertainty, vulnerability; de Boer et al. 2010; Fünfgeld and McEvoy 2011).

The existing framing of adaptation can be problematic and, in some cases, simply using the term "climate change adaptation" can create barriers for projects as it invokes non-constructive frames. Possible alternative frames were identified by interview participants. These frames are described below and could potentially help remove barriers to adaptation when working with some groups, although their efficacy in this respect has not been tested and will likely require further study.

Framing adaptation as general increases in efficiency, progress towards shared goals, or as innovation in practices and operations was one noted approach. This could help remove some of the ambiguity in adaptation and potentially provide cognitive linkages between adaptation and existing operations or activities. It also focuses on the positive outcomes of adaptation and moves away from previously used "doom-and-gloom" messaging to communicate the need for adaptation.

Towards the same end, framing adaptation as mainstreaming could help advance it within institutions. As noted in Section 7, one major barrier to adaptation is limited resources available to pursue adaptation. This is possibly related to the fact that adaptation has been typically framed as additional work or separate from existing activities (i.e., as "something new" to work on). By framing adaptation around mainstreaming, the linkages and synergies for resource allocation between existing activities and those required for adaptation could be identified. This framing allows decision-makers to be empowered in managing adaptation within their work areas and areas of expertise. It also allows adaptation to be connected and integrated within existing priority areas.

Similarly, the need to communicate adaptation specifically in relation to the expected or desired results and outcomes was identified. This can help conceptualize the benefits of adaptation. Also, highlighting how making investments now can reduce economic impacts later and lead to net economic benefits could be an effective means of framing adaptation.

8.4 TARGETING, SETTING GOALS, AND MONITORING

Targeting areas for adaptation, setting goals and objectives related to adaptation, and monitoring and evaluating the outcomes of implemented adaptive strategies will become increasingly important as adaptation is advanced in policy and operations. Interview participants identified a number of ways to target areas for adaptation. These include linking adaptation priorities with ongoing and emerging issues and risks and integrating risk and vulnerability assessment into operations.

Setting goals and objectives for adaptation is also important and can be challenging, given the complexity of the issue. Strategies identified by interview participants include: starting with identifying goals and objectives to manage current vulnerabilities and adjusting as necessary; leveraging other existing priority issues (including climate change mitigation) and working towards co-benefits;[2] working towards general resilience and adaptive capacity for a broad range of issues, impacts, and stressors; developing goals and objectives that are achievable in the short-term (at least in part) and also provide long-term benefits; promoting the value of long-term, proactive strategies and "preparedness thinking" but ensuring that action and progress occur in the short-term; and engaging stakeholders in the ongoing definition of goals and objectives.

Monitoring and evaluating the outcomes of implemented adaptation strategies will be critical to informing the adaptive management of climate change risks. Monitoring and evaluation also contributes to effective targeting, and goal setting for adaptation in an ongoing process. In some cases, there are existing sustainability indicators and criteria that could be used or modified to evaluate adaptation

[2] An overview of some of these priorities can be found in Section 6. A more detailed description specifically for Saskatchewan can be found in Rescan (2012).

outcomes (e.g., sustainability indicators for the forestry sector). In other cases, the evaluation approach will likely need to be developed.

8.5 MOBILIZING RESOURCES FOR ADAPTATION

Collaboration has and will continue to facilitate effective resource mobilization for climate change adaptation. The PRAC has played a key role in leveraging resources to date and has allowed jurisdictions to foster and develop collaborative networks. The future application of scarce financial resources for adaptation will require efforts to continue, maintain, and expand collaboration. Collaboration can also be a means of realizing greater benefits by sharing resources. As documented in this report, resources to pursue adaptation initiatives are typically inadequate within departmental budgets. Effective collaboration can help address these challenges.

8.6 STREAMLINING COLLABORATION

In the context of expanding collaboration to mobilize scarce resources, it is also important to ensure that collaboration is approached effectively and efficiently. Ineffective collaboration can lead to inefficient resource use and limit the success of outcomes. In cases where resources are already scarce, ineffective collaboration becomes even more problematic and the need for streamlining more apparent. Some guiding principles of effective collaboration include ensuring a clearly defined purpose for collaboration; ensuring each collaborator can realize clear benefits from the collaboration; identifying and addressing potential barriers to collaboration early in the process; and building inclusive and diverse collaborative networks, but avoiding over-collaborating (Hansen 2009; All Collaboration 2012).

8.7 CONTINUING PROGRESS ON ADAPTATION

PRAC has facilitated progress on adaptation within the Prairies Region, but adaptation is an ongoing and continuous activity that will require further progress to effectively manage climate risks. Interview participants identified a number of strategies for continuing progress on adaptation within their work areas.

There are opportunities to use ongoing short-term climate risk management as an entry point for longer-term adaptation. This could be beneficial for a number of reasons, but could mainly help raise the priority for adaptation work, address resourcing issues, and ensure further progress on adaptation is made. In addition, this approach would ensure that adaptation is effective for both current and future vulnerabilities.

There is also an underlying need to foster a broad acceptance of and build capacity to proactively manage uncertainty. Focusing on no-regrets and robust adaptation strategies are possible means of meeting this need. Generally, ensuring flexibility in institutions and avoiding path-dependent decisions can help manage unforeseen and unpredictable risks and vulnerabilities (Hallegatte 2009; Swanson and Bhadwal 2009).

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