Saskatchewan Watershed Authority

PRAIRIES REGIONAL ADAPTATION COLLABORATIVE
Advancing Climate Change Adaptation in Saskatchewan

Saskatchewan Watershed Authority

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PRAIRIES REGIONAL ADAPTATION COLLABORATIVE

ADVANCING CLIMATE CHANGE ADAPTATION IN SASKATCHEWAN

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PARC

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Acronyms and Abbreviations

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Acronyms and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AAFC	Agriculture and Agri-Food Canada
AESB	Agri-Environment Services Branch
AWSA	Assiniboine Watershed Stewardship Association
ELOHA	Ecological Limits of Hydrologic Alteration
FMP	Forest Management Planning
ICCIAWG	Intergovernmental Climate Change Impacts and Adaptation Working Group
IISD	International Institute for Sustainable Development
LI	Lead Investigator
LIRA	Land and Infrastructure Resiliency Assessment
NSRBC	North Saskatchewan River Basin Council
NRCan	Natural Resources Canada
OECD	Organization for Economic Co-operation and Development
PARC	Prairie Adaptation Research Collaborative
PRAC	Prairies Regional Adaptation Collaborative
Rescan	Rescan Environmental Services Ltd.
SCCWS	Swift Current Creek Watershed Stewardship Association
SMA	Saskatchewan Ministry of Agriculture
SME	Saskatchewan Ministry of Environment
SRC	Saskatchewan Research Council
SWA	Saskatchewan Watershed Authority
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WCEP	Water Conservation, Efficiency, and Productivity

1. Purpose of Report

1. Purpose of Report

The purpose of this report is to provide a draft report on work completed for the Advancing Climate Change Adaptation in Saskatchewan Project related to the Prairies Regional Adaptation Collaborative (PRAC). This report documents the results from: 1) a review of the material produced under the Saskatchewan portion of the PRAC; 2) a synthesis of lessons learned for key policy areas; 3) the identification and prioritization of policies and programs that have the potential to benefit from the identified lessons learned; and 4) the development of recommendations to advance adaptation in Saskatchewan.

2. Methods

2. Methods

2.1 REVIEW AND SUMMARY OF LESSONS LEARNED

All literature produced by Saskatchewan-related PRAC projects that was provided to Rescan by September 2011 was reviewed and summarized. Literature was systematically reviewed in order to document the objectives, methods, results, and conclusions of the various projects. Subsequent analysis of the literature aimed to identify lessons learned for provincial policy in Saskatchewan. Key messages and lessons learned were confirmed through consultation with the Lead Investigators (LIs) for the various PRAC projects, when appropriate. In total, five LIs were consulted via telephone, email, or in-person meetings; the LIs consulted were: Dr. David Sauchyn (Hydroclimatic Variability Analysis and Projections); Dr. Steven Quiring (Evaluation of Monitoring); Dr. Jeff Thorpe (Vulnerability of Prairie Grasslands); Dr. Mark Johnston (Vulnerability of Forest Ecosystems); and Dr. Suren Kulshreshtha (Water Demand Projections). In two cases (i.e., for the Vulnerability of Forest Ecosystems and Water Demand Projections projects), the work was still underway and no reports were available for the review deadline. As such, the consultations served as the primary source of information for these projects.

2.2 POLICY AND PROGRAM IDENTIFICATION AND PRIORITIZATION

Policies and programs were identified and prioritized following the review and summary of lessons learned. Policy areas most relevant to the lessons learned were scoped, and key Saskatchewan policies and programs within these areas identified. Next, key informants working within these policy areas in provincial agencies were identified through consultation with the Saskatchewan Watershed Authority (SWA), and interviews with these individuals were requested. Eighteen individuals were contacted for an interview, and 11 interviews were completed. Interviews were semi-structured; the interview guide is provided in Appendix 2. Interviews were used to help inform the prioritization of policies and programs and recommendations for implementation. Broadly, topics covered in the interview included: the current context for adaptation; priority areas and actions; and implementation. Final prioritization of the policy and programs for advancing adaptation was then completed using the following criteria (Hallegatte 2009; Swanson and Bhadwal 2009):

- potential for benefits given expected climate change impacts;
- potential for benefits given unexpected climate change impacts;
- potential for co-benefits and synergies with other priority areas; and
- potential for benefits without climate change.

Policies and programs were given a qualitative rank for each of the criteria mentioned above, which were then used to give each policy and program an overall qualitative priority ranking (see Section 6.1). For a full description of the ranking rationale for each policy and program, see Appendix 3.

2.3 DEVELOPMENT OF RECOMMENDATIONS

Recommendations to advance adaptation in Saskatchewan were developed based on the lessons learned from PRAC, the policy and program analysis, insights from secondary sources, and the feasibility and potential efficacy of adaptation initiatives.

3. PRAC in Saskatchewan: An Overview

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3. PRAC in Saskatchewan: An Overview

The PRAC is a three-year (2009 to 2012), $6.8 million, cost-sharing initiative, designed to support activities that advance decision-making for climate change adaptation in the Prairies Region, which includes the provinces of Alberta, Saskatchewan, and Manitoba. PRAC is a part of Natural Resources Canada's (NRCan's) National Regional Adaptation Collaborative Program, which includes six Regional Adaptation collaboratives in British Columbia, the Prairies, Ontario, Quebec, the Atlantic provinces, and the Northern territories. NRCan provided approximately $3.5 million of funding support to PRAC and developed a partnership with provincial government departments, including the SWA, Saskatchewan Research Council (SRC), Alberta Environment, and Manitoba Conservation and Water Stewardship, to deliver PRAC-related initiatives based on three themes: Water, Drought and Excessive Moisture, and Terrestrial Ecosystems (Figure 3-1). 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. PRAC activities within each theme were coordinated interprovincially, but implemented jurisdictionally, to meet the unique needs, goals, and objectives related to climate change adaptation of the different jurisdictions. Interprovincial collaboration and learning were facilitated through PRAC forums aimed at mainstreaming PRAC findings, projects, and lessons from other provinces broadly across departments and agencies in the Prairies.

In Saskatchewan, the SWA was the lead on the Drought and Excessive Moisture Theme activities, SRC on the Terrestrial Ecosystem 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 (SMA), 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 occurred, when appropriate.

There was a broad range of projects completed in Saskatchewan through the PRAC program. Water theme projects included a hydroclimatic variability analysis and projections and community-based socioeconomic vulnerability assessments. Drought and Excessive Moisture Theme activities included a climate monitoring evaluation, adaptive policy evaluation tool development, program evaluation, an in-stream flow needs gap analysis, watershed extreme events preparedness planning, extreme climate events characterization, and water demand analysis and projection. Terrestrial theme activities included forest and grassland ecosystem vulnerability assessments. For a more detailed overview of PRAC projects, see Appendix 1.

One of PRAC's main goals was to move decision-makers through a continuum about climate change adaptation—from awareness to the decision point. In Saskatchewan, anecdotal evidence from the interviews completed as part of this synthesis suggests that efforts were largely successful in meeting this objective. As Sections 4 to 7 of this report document, significant learning was undertaken through PRAC, and there are many opportunities for advancing adaptation and strategies for overcoming barriers, as described during the interviews by individuals within provincial agencies. PRAC had a significant role in improving the capacity for adaptation work in Saskatchewan.

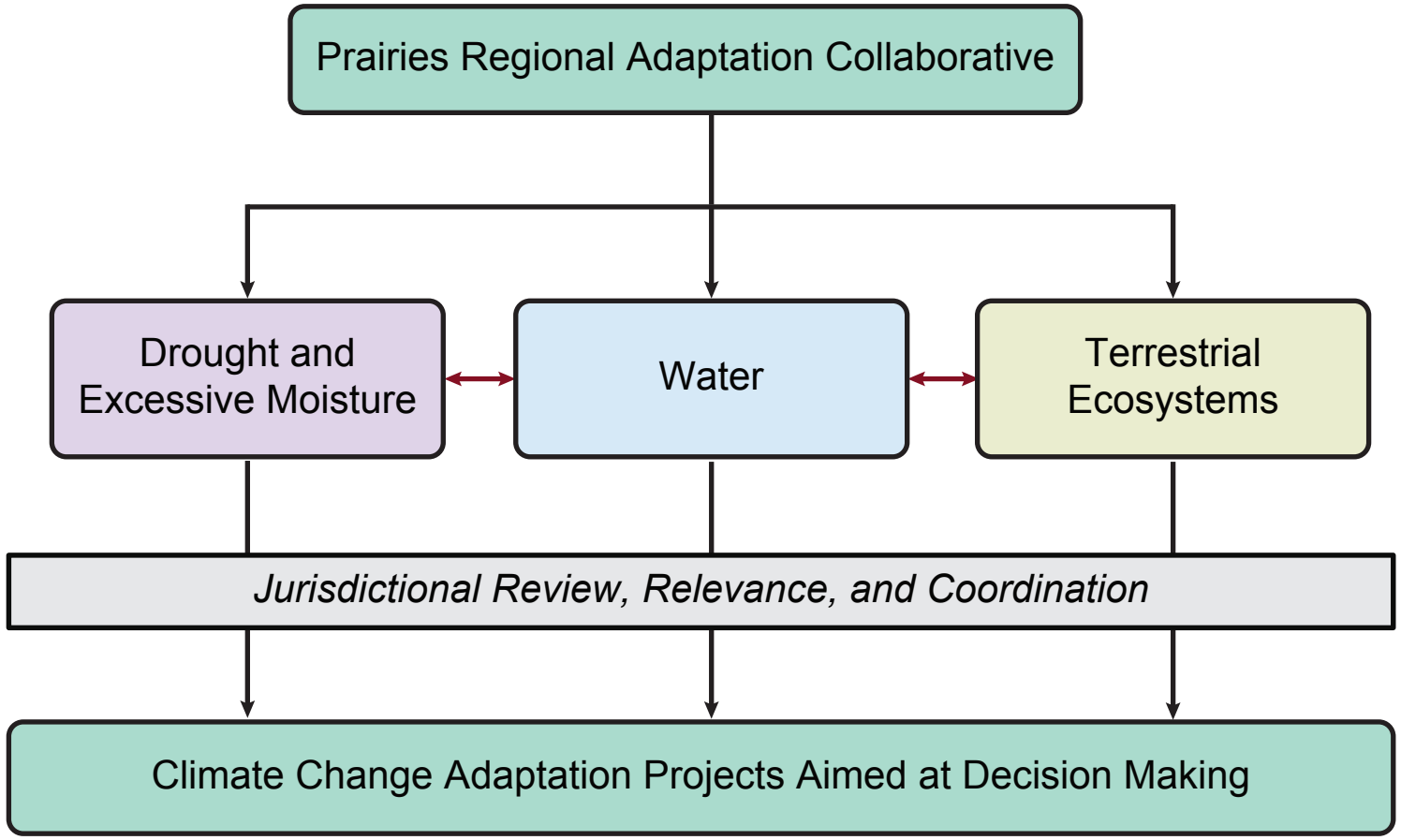

Figure 3-1

Saskatchewan Watershed Authority

Prairies Regional Adaptation Collaborative Themes Overview

Figure 3-1

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4. Summary of Lessons Learned

4. Summary of Lessons Learned

There are a number of important lessons learned for Saskatchewan policy from the PRAC deliverables reviewed (Appendix 1). This section provides an overview of key lessons learned by policy area and an initial identification of specific policies and programs. The key policy areas include water management, climate monitoring, agriculture and grassland ecosystem management, and forest ecosystem management.

4.1 CLIMATE MONITORING

Key Lessons Learned

1. Precipitation minus Potential Evapotranspiration, precipitation deciles/percentiles, and the Standardized Precipitation Index are the most appropriate indices for monitoring agricultural drought and excessive moisture in Saskatchewan (Quiring 2011).
2. Streamflow, reservoir, and lake percentiles and the Standardized Precipitation Index are most appropriate for monitoring hydrological drought and excessive moisture (Quiring 2011).
3. No single indicator, however, can accurately represent all aspects of agricultural or hydrological drought; as such, a multi-index approach to monitoring is recommended (Quiring 2011).
4. A network of networks could be developed to integrate existing and potential future monitoring efforts, which would help address existing limitations (Quiring 2011).
5. For spatial interpolation of data from monitoring networks, Inverse Distance Weighting was recommended for Saskatchewan (Quiring 2011).

Initial Scoping of Policies and Programs

These lessons learned are potentially applicable to the following Saskatchewan policies and programs:

- Climate Monitoring; and
- Climate Information Systems.

4.2 WATER MANAGEMENT

Key Lessons Learned

1. Despite the presence of long-term cycles in the Prairies' hydroclimate, long-term trends are consistent with a warmer climate and the climate change hypothesis (St. Jacques, Sauchyn, and Zhao 2010).
2. 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, Sauchyn, and Barichivich 2009; Lapp et al. 2010; St. Jacques et al. 2011; Wittrock, Wheaton, and Siemens 2011).
3. 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 in Saskatchewan. The severity of expected future droughts, however, is likely to exceed this coping range, as well as the existing water supply planning horizons, warranting adaptation involving fundamental policy and systemic institutional changes (Axelson, Sauchyn, and

Barichivich 2009; Lapp et al. 2010; Rescan 2011; St. Jacques et al. 2011; Wittrock, Wheaton, and Siemens 2011).

4. The threat of long-term hydrologic drought under a changing climate poses increasing risk as water demand increases (Axelson, Sauchyn, and Barichivich 2009; Lapp et al. 2010; Kulshreshtha, pers. comm.).
5. Recognition of various cycles in Saskatchewan's hydroclimate, and the role of the large-scale teleconnection patterns that cause them, can help improve risk management at various timescales and provide the basis for well-informed adaptation (St. Jacques et al. 2011).
6. The SWA recognized the utility of using cycles in Saskatchewan's hydroclimate to inform water management. PRAC hydroclimate variability analyses conducted by PARC helped inform the development of the Emergency Flood Damage Reduction Program in 2011, which was designed to proactively manage excessive moisture risk.
7. Conventional water resource engineering assumes that climate and water supplies fluctuate within known range of variability around an unchanging mean state. Studies of past and future climate and hydrology question this assumption of stationarity, requiring new approaches to estimate the frequencies of extreme events (Axelson, Sauchyn, and Barichivich 2009; Lapp et al. 2010; Lapp et al. 2011; St. Jacques et al. 2011; Wittrock, Wheaton, and Siemens 2011).
8. 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).

Initial Scoping of Policies and Programs

These lessons learned are potentially applicable to the following Saskatchewan policies and programs:

- Water Allocation;
- Water Conservation;
- Source Water Protection;
- Hydrologic Drought Planning;
- Wetland Conservation; and
- Drainage.

4.3 AGRICULTURE AND GRASSLAND ECOSYSTEM MANAGEMENT

Key Lessons Learned

1. A northward shift in vegetation zones is expected due to changing moisture regimes resulting in changes to the existing grassland ecosystem and potential implications for agriculture (Thorpe 2011).
2. Average decreases in grassland production are expected to be slight or moderate; interannual production fluctuations resulting from climate variability and extremes, such as droughts, are likely to be more problematic. Short-term drought produces immediate reductions in growth and productivity, while prolonged, long-term drought can shift grassland composition toward shorter or earlier-growing species. Increased potential for rangeland in formerly forested areas could help compensate for reduced production during long-term drought (Thorpe 2011).

3. Biodiversity will also change as species either adapt to climate change by moving (i.e., shifting ranges) or staying in place (i.e., changing phenology or evolution). Slow-dispersing species requiring specialized habitat are likely to be less adaptable to climate change than species having long-distance dispersal and general habitat requirements. Invasive species, with rapid dispersal rates, use of disturbed habitats, and capacity for relatively rapid evolution are likely to remain highly competitive under climate change, although increasing droughts may help to reduce invasion success by limiting resources available to support invasion (Thorpe 2011).
4. There is a suite of existing programs, policies, and plans (e.g., the Farm and Ranch Water Infrastructure Program, business risk management programs, crop insurance, and Agricultural Drought and Excessive Moisture Monitoring Plan) within the Saskatchewan Ministry of Agriculture that are proactive and aimed at directly addressing potential challenges associated with climate change. 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).
5. A mix of proactive and responsive programming is likely necessary to deal with future climate risks (IISD 2011; Steinley and Mowenchenko 2011; Thomson 2011a, 2011b).

Initial Scoping of Policies and Programs

These lessons learned are potentially applicable to the following Saskatchewan policies and programs:

- Agricultural Drought Management;
- Agricultural Extension and Crop Advisory Services;
- Climate Variability and Extremes Management;[1] and
- Agri-Environmental Programming.[2]

4.4 FOREST ECOSYSTEM MANAGEMENT

Key Lessons Learned

1. The main sensitivities of Saskatchewan's forest ecosystems to climate change include drought, insects, fire, dwarf mistletoe and mountain pine beetle, forest productivity, potential shifts in species, and regeneration potential (M. Johnston and E. Qualtiere, pers. comm.).
2. There is a need to identify priorities for adaptation and opportunities for mainstreaming adaptation in existing policies (M. Johnston and E. Qualtiere, pers. comm.). This will be addressed in the work remaining under the PRAC Terrestrial Ecosystems Theme.

Initial Scoping of Policies and Programs

These lessons learned are potentially applicable to the following Saskatchewan policies and programs:

- Forest Management and Planning;
- Forest Fire Management; and
- Disease and Insect Management.

[1] This includes various programs, including the Drought and Excessive Moisture Monitoring Committee, the Farm and Ranch Water Infrastructure Program, Crop Insurance, and various other relief programs.
[2] This includes various programs, including the Farm Stewardship Program, Agri-Environmental Group Planning, the North American Waterfowl Management Plan, and Environmental Farm Planning.

5. Advancing Adaptation in Saskatchewan

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This section presents a review of various frameworks for implementing adaptation and a recommendation of an integrated framework for application in Saskatchewan. An overview of past and potential future collaboration and partnerships is also provided.

5.1 FRAMEWORKS FOR ADAPTATION IN SASKATCHEWAN

There are three broadly applied frameworks that could be used to advance climate change adaptation in Saskatchewan. These frameworks include a climate change adaptation mainstreaming framework (UNDP 2010), the National Climate Change Adaptation Framework (ICCIAWG 2005) and the Results-based Regulatory Framework in Saskatchewan (Clifton Associates 2009). In light of these frameworks, a fourth framework was developed (see Section 5.1.4), which integrates key elements from the other three frameworks that are most applicable to advancing adaptation in Saskatchewan.

5.1.1 Mainstreaming Framework

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). The benefits of mainstreaming, such as opportunities for synergies and a reduced likelihood of maladaptation, have been documented around the globe (UNDP 2010). Implementing PRAC-generated policy recommendations based on a mainstreaming approach is intended to allow the Saskatchewan to address climate change challenges broadly and in conjunction with other priorities, increasing the likelihood of successful implementation. In addition, many of the PRAC activities and sub-projects undertaken in Saskatchewan have already made progress towards mainstreaming.

Generally, a climate change adaptation mainstreaming framework includes the following components (UNDP 2010):

1. awareness raising;
2. pre-screening risks and vulnerabilities;
3. in-depth risk assessment;
4. identification and formulation of adaptation options;
5. prioritization and selection of adaptation options;
6. implementation of adaptation options; and
7. monitoring and evaluation of outcomes.

5.1.2 National Climate Change Adaptation Framework

The National Climate Change Adaptation Framework was prepared by the Intergovernmental Climate Change Impacts and Adaptation Working Group in 2005. The working group consisted of individuals from federal (NRCan), provincial, and territorial governments in Canada, including representation from Saskatchewan (Ministry of Environment). The intent of the framework is to identify broadly applicable strategies than can improve Canada's capacity to adapt to changing climatic conditions (ICCIAWG 2005).

The framework has six key elements (ICCIAWG 2005):

1. raising awareness of adaptation;
2. facilitating and strengthening capacity for coordinated action on adaptation;
3. incorporating adaptation into policy and operations;
4. promoting and coordinating research on impacts and adaptation;
5. supporting knowledge-sharing networks; and
6. providing methods and tools for adaptation planning.

5.1.3 Results-based Regulatory Framework

The Results-based Regulatory Framework in Saskatchewan is designed to achieve desired environmental outcomes through flexible and adaptive means, allowing regulators and those whose activities are subject to regulation to be responsive to emerging needs, priorities, risks, and hazards. In results-based regulation the role the regulator is to develop and enforce code and standards in relation to specific objectives, while those subject to the regulation are responsible for meeting the objectives. The core principles of results-based regulation include: the establishment of standards aimed at promoting continual improvement, the provision of legal authority for governments to ensure accountability in meeting standards, and transparency through reporting. Results-based regulation is implemented through the following mechanisms (Forino 2006; Clifton Associates 2009):

1. legally enforceable standards based on performance;
2. proportionate regulation;
3. measurement of performance and promotion of continuous improvement;
4. creation of mechanisms, relationships, and institutional structures that build trust; and
5. ongoing adaptation by the regulator, including:
    a. development of a diverse skill-base and adaptive structures,
    b. facilitating and promoting the adaptation of regulatory structures in light of changing needs and priorities, and
    c. incorporating integrated adaptive regulatory strategies.

Results-based regulation can have broad application in a number of priority areas, including climate change adaptation. Linking adaptation priorities in Saskatchewan with the results-based framework will help advance and mainstream adaptation within current environmental governance systems.

5.1.4 Integrated Framework

Suggestions for an integrated framework, drawing on key elements of the Mainstreaming Framework, National Climate Change Adaptation Framework, and Results-based Regulatory Framework (Sections 5.1.1 to 5.1.3), are provided below. It is hoped that by integrating these frameworks an effective approach that allows multiple priorities related to adaptation, mainstreaming, and regulation to be addressed can be developed. The following components are suggested for the integrated framework:

1. definition of standards, goals, and desired outcomes of adaptation;
2. provision and development of tools and procedures for risk and vulnerability assessment, adaptation planning, and prioritizing adaptation options;

3. education and awareness raising;
4. promotion of institutional arrangements that support integrated adaptive management and collaboration;
5. communication and use of climate information and science;
6. integration of adaptation within existing policies and operations;
7. continual monitoring and evaluation of adaptation outcomes based on standard criteria; and
8. continual improvement in the provision and evaluation of climate change scenarios.

5.2 COLLABORATION AND PARTNERSHIPS: PRAC AND BEYOND

5.2.1 Institutional Arrangements

Collaboration and partnership between a wide range of institutions, organizations, and stakeholders will continue to be an important part of advancing adaptation in Saskatchewan. Approaching adaptation cooperatively can be an effective way of utilizing scarce resources and optimizing results.

There are a number of different levels of governance and groups that could be included within collaborative institutional arrangements for adaptation, including federal departments, provincial ministries and agencies, academic and scientific researchers, non-governmental and municipal organizations, First Nations and Métis groups, and public and industry stakeholders. The specific roles of various members within each of these groups vary depending on their mandates and responsibilities.

5.2.2 Federal Collaborators and Partners

Existing Collaborators and Partners

As expected, NRCan was the main federal partner involved with the PRAC, with a role in all PRAC themes. In addition to funding, NRCan provided ongoing support for collaboration and knowledge sharing and a wealth of expertise in climate change impacts and adaptation to provincial partners. NRCan has developed a number of risk management and adaptation planning tools for a variety of stakeholders. In addition, *From Impacts to Adaptation: Canada in a Changing Climate 2007* (Lemmen et al. 2008; Sauchyn and Kulshreshtha 2008), an NRCan initiative to synthesize and summarize current understandings of climate change vulnerability across Canada, provided the knowledge foundations necessary to engage provincial decision-makers in climate change adaptation.

The Agri-Environment Services Branch (AESB) of Agriculture and Agri-Food Canada (AAFC) is currently working extensively on climate adaptation. The AESB plays a key role in adaptation through a number of directorates (e.g., the Agri-Environmental Adaptation and Practice Change Directorate and the Agri-Environmental Knowledge, Innovation, and Technology Directorate) mandated to provide adaptation-related services to the agriculture sector. The AESB has many initiatives that may be relevant to adaptation in Saskatchewan, including the Land and Infrastructure Resiliency Assessment (LIRA), Drought Watch, and the Invitational Drought Tournament.

Environment Canada is another federal department playing a key role in adaptation. Environment Canada is involved in a number of climate change science research initiatives, including adaptation and impacts research. The Canadian Climate Change Scenarios Network is a collaborative effort between Environment Canada research scientists and Canadian universities to provide plausible future climate scenarios that can be used by decision-makers to inform adaptation.

Other Potential Collaborators and Partners

There may also be opportunities to collaborate with other federal departments depending on the focus of PRAC and/or provincial adaptation activities moving forward. For example, Health Canada and Infrastructure Canada would be other relevant federal partners if PRAC or other adaptation activities focused on health or infrastructure in the future. Similarly, Aboriginal Affairs and Northern Development Canada may have a role if future projects involved broader collaboration with First Nations and Métis groups.

5.2.3 Provincial Collaborators and Partners

Existing Collaborators and Partners

The SWA was the provincial lead on the Drought and Excessive Moisture Theme. The SWA coordinated activities under this theme, working in collaboration with the partners. Other provincial partners on the Drought and Excessive Moisture Theme included the SMA and SRC. The interagency Extremes Monitoring Committee of the SMA played a key role in facilitating broad provincial collaboration on this theme. The SRC provided significant expertise in climatology and climate risk analysis, which was used to inform watershed preparedness initiatives.

The SRC[3] was the provincial lead on the Terrestrial Ecosystems Theme for both the grassland and forest ecosystem components. The SRC's extensive expertise in terrestrial ecosystem vulnerability, impacts, and adaptation research provided a solid knowledge base for PRAC activities in this theme. This knowledge was translated and shared with provincial partners through forums and other outreach activities.

Water Theme activities in the province were led by an academic partner (see Section 5.2.5), the PARC. The SWA was the main collaborator on the Water Theme.

Other Potential Collaborators and Partners

The Saskatchewan Ministry of Environment (SME) is officially assigned to deal with adaptation within the provincial government from a broad standpoint. Collaboration and partnership with the SME will be critical to advancing adaptation in Saskatchewan. This Ministry has expertise in the area of climate change adaptation, and many of the current adaptation priorities (Section 6) align well with this ministry's various mandates and responsibilities.

Depending on the direction of adaptation or future PRAC initiatives, there are a number of other potentially relevant provincial partners. These include, but are not necessarily limited to, the following ministries: Highways and Infrastructure, Health, Municipal Affairs, and First Nations and Métis Relations.

5.2.4 Non-governmental and Municipal Collaborators and Partners

Existing Collaborators and Partners

The Saskatchewan Association of Watersheds, along with a number of local watershed stewardship associations, including the Swift Current Creek Watershed Stewardship Association, Wascana Upper Qu'appelle Watersheds Association Taking Responsibility, North Saskatchewan River Basin Council, Upper Souris Watershed Association, Old Wives Watershed Association, Assiniboine Watershed Stewardship Association, and Moose Jaw River Watershed Stewards, were key collaborators and partners with the PRAC. Projects undertaken with these groups were related to drought and excessive moisture preparedness.

[3] The SRC has a unique role as both a provincial organization and an academic and scientific partner.

The Saskatchewan Association of Rural Municipalities and the Saskatchewan Urban Municipalities Association were both partners in the PRAC. These groups play a key role in the province-wide coordination of issues facing municipalities and municipal governance.

Other Potential Collaborators and Partners

Future adaptation projects could pursue collaboration and partnerships with individual municipalities, as appropriate. Municipalities play a key role in the delivery of many services where adaptation is likely to be required. To date, municipalities have been engaged collectively through watershed stewardship associations, the Saskatchewan Association of Rural Municipalities, and the Saskatchewan Urban Municipalities Association. Specific adaptation projects with individual municipalities would have to be suited to local needs and contexts.

The Agricultural Producers Association of Saskatchewan could have a stronger role in future adaptation projects. This association was engaged peripherally through PRAC forums, but engagement could be expanded for a number of projects, potentially related to education and awareness of climate change in rural areas.

There are other non-governmental organizations that could be involved depending on the direction of future PRAC and/or adaptation projects, for example the Saskatchewan Soil Conservation Association, the Saskatchewan Stock Growers Association, and the Saskatchewan Mining Association.

5.2.5 Academic and Scientific Collaborators and Partners

Existing Collaborators and Partners

The PARC, based at the University of Regina, has long been at the forefront of impacts and adaptation research in the Prairies. The PARC was the lead on the Water Theme, implementing provincial theme activities in collaboration with the SWA, and also provided research and scientific expertise on the Drought and Excessive Moisture Theme. In addition, the PARC administered the PRAC program at the prairie-level.

The SRC was another major academic and scientific partner, acting as the lead on the Terrestrial Ecosystems Theme and providing technical support on the Drought and Excessive Moisture Theme. The SRC has long standing expertise in climate change impacts and adaptation research and scientific services for a number of sectors (e.g., forestry and agriculture). Although based in Saskatchewan, the SRC is also quite active in climate change research in other jurisdictions, across Canada, and internationally.

Other Potential Collaborators and Partners

Another research group in the province working extensively on climate change adaptation is the Global Institute for Water Security. Some of the experts at this institute were engaged in PRAC forums or other events. Engagement with the institute could be expanded to meet future research needs, when appropriate.

5.2.6 Public and Industry Collaborators and Partners

Existing Collaborators and Partners

Broad public and industry collaboration and partnership was not included in the PRAC's design, and is an area that could be expanded in the future. SaskPower was the only industry stakeholder engaged as a collaborator on the PRAC.

Other Potential Collaborators and Partners

There are many potential industry stakeholders that could be engaged in future adaptation activities. In relation to current adaptation opportunities (Section 6), some of the most relevant stakeholders would be in the forestry, agricultural, mining, and oil and gas industries. Future collaboration could include both individual companies and industry organizations.

5.2.7 First Nations and Métis Collaborators and Partners

Existing Collaborators and Partners

In conjunction with PRAC, collaborative projects were pursued with the James Smith Cree Nation, Shoal Lake First Nation, and Red Earth First Nation. These projects focused on vulnerability assessment and preparedness planning for extreme hydroclimate events (e.g., droughts and floods).

Other Potential Collaborators and Partners

Collaboration and partnership with other First Nations and Métis groups could be expanded to include additional First Nations and Métis communities, tribal councils, Métis administrative regions, the Federation of Saskatchewan Indian Nations, and the Métis Nation of Saskatchewan.

6. Current Adaptation Opportunities and Priorities

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6. Current Adaptation Opportunities and Priorities

This section presents an identification and prioritization of current adaptation opportunities with respects to Saskatchewan policies and programs.

6.1 OVERVIEW

An overview of current adaptation opportunities and priorities is provided in Table 6.1-1. The opportunities cover the policy areas of water management, climate monitoring and information systems, agriculture and grassland ecosystem management, and forest ecosystem management. They are prioritized using the prioritization and screening tool presented in Appendix 3. All adaptation opportunities would be useful and beneficial, but they are prioritized to help target the most advantageous initiatives in the context of climate change. Additional priorities may also exist outside the policy areas covered by the PRAC. Additional policy areas, which may have opportunities and priorities not covered in this report, include infrastructure risks and First Nations and Métis collaboration.

Table 6.1-1. Overview of Current Adaptation Opportunities and Priorities

Policy or Program Area	Adaptation Opportunity	Priority
Risk Assessment	Governmental Climate Risk Assessment	Primary
Climate Monitoring and Information Systems	Climate Monitoring	Secondary
	Climate Information Systems	Secondary
Water Management	Water Allocation	Primary
	Hydrologic Drought Planning	Primary
	Water Conservation, Efficiency, and Productivity	Primary
	Water Reuse	Primary
	Watershed Stewardship Planning Protocols and Learning Module	Secondary
	Integrated Landscape and Watershed Resilience (i.e., application of the LIRA tool)	Primary
Agriculture and Grassland Ecosystem Management	Agri-environmental Programming	Primary
	Economic Tools for Producers	Primary
	Adaptation Policy and Programming for Grassland Conservation	Secondary
Forest Ecosystem Management	Community Wildfire Risk Reduction	Primary
	Adaptation of Island Forest Stands	Secondary
	Forest Management Planning	Secondary

Opportunities were identified through engagement of key provincial decision-makers. Through semi-structured interviews, decision-makers were asked to identify the most beneficial next steps regarding climate change adaptation in their work areas, additional information or decision-making tools that would be useful to them, and approaches for mainstreaming adaptation within existing policies and programs. Once identified, opportunities were prioritized by applying a prioritization and screening tool (see Section 2.2 and Appendix 2). Criteria used for prioritization were selected based on accepted

literature (Swanson and Bhadwal 2009; Hallegatte 2009) and included: a) potential for benefits given expected climate change impacts, b) potential for benefits given unexpected climate change impacts, c) potential for co-benefits and synergies with other priority areas, and d) potential for benefits without climate change. Each opportunity was given a ranking of "not likely," "likely," or "highly likely" for criteria a, b, and c, and "yes" or "no" for criteria d. An overall priority of tertiary, secondary, or primary was then assigned as follows:

- tertiary – if the opportunity rated likely two or more times for criteria a, b, and c and yes or no for criteria d;
- secondary – if the opportunity rated likely for one or fewer criteria a, b, and c, at least highly likely for all other criteria a, b, and c, and yes or no for criteria d; and
- primary – if the opportunity rated highly likely for criteria a, b, and c and yes for criteria d.

Opportunities with a primary overall priority have the highest potential benefits for adaptation and are recommended to be included in adaptation programs moving forward. Opportunities with a secondary overall priority have significant potential benefits, but are less beneficial than primary priorities. As such, these opportunities are recommended for inclusion in subsequent adaptation programs only if resources are available following the inclusion of primary priorities. Tertiary priorities are those that would not be recommended at this time due to their limited potential for adaptation benefits. The inclusion of all opportunities in subsequent adaptation programs is done at the discretion of the SWA.

As seen in the previous table, the current adaptation opportunities fell into two priority levels for climate change adaptation (i.e., primary and secondary). This is because based on the selected criteria, which were designed to reflect priorities specifically in terms of adaptation, many of the current opportunities are a relatively high priority. In light of potential program and budgetary constraints, further resolution on the prioritization could be completed in further consultation with key agencies and using economic evaluation tools, such as cost-benefit and/or cost effectiveness analyses.

6.2 GOVERNMENTAL CLIMATE RISK ASSESSMENT

Description

This project would involve the systematic and coordinated assessment of climate risks for various provincial government ministries and agencies and would facilitate adaptation planning and mainstreaming. The PRAC has produced two decision-making tools that could be useful for this process: the International Institute for Sustainable Development's (IISD's) *Adaptive Policy Evaluation Tool* (IISD 2011) and Alberta Sustainable Resource Development's *Climate Change Adaptation Framework Manual* (SRD 2010). Both could be used together or separately, depending on the context. General components of this approach would include vulnerability and risk assessments, identification of adaptation options, strategies for integrating adaptation into existing programs, and prioritization of adaptation options and strategies. This initiative could be recurring in order to promote continued improvement in the management of climate risks.

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of improved collaboration and mainstreaming, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Due to the cross-cutting nature of this initiative, each agency will likely need to have a strong internal coordination role. The SME could likely have a role in inter-ministerial coordination, as this aligns with their mandate.

Collaborators and Partners

All pertinent ministries and agencies would be suitable partners and collaborators, these includes the SWA, SMA, Saskatchewan Ministry of Health, Saskatchewan Ministry of Highways and Infrastructure, Saskatchewan Ministry of Municipal Affairs, Saskatchewan Ministry of First Nations and Métis Relations, SME, and others, as appropriate. From the federal government, NRCan, Health Canada, AAFC, and Environment Canada may be useful collaborators due to their expertise in climate risk assessment. Academic and scientific partners and collaborators, such as the SRC and the PARC, can also provide strong technical expertise for the risk assessment process.

There may be a role for interprovincial collaboration on this initiative, as both Alberta and Manitoba have initiated this process to some degree. Interprovincial collaboration would be most beneficial in terms of sharing lessons learned from the process. Also, IISD's experience and expertise in risk assessment and creating adaptive policies and programs would make them a useful collaborator and partner.

Desired Outcome

The desired outcome of this initiative would be to mainstream climate change considerations into existing policies and programs in a wide range of areas.

Monitoring Success

Monitoring the success of adaptation and mainstreaming is a critical component of this initiative. The monitoring approach and indicators are not presented in this report, however, since they are dependent on the specific adaptation and mainstreaming opportunities identified through the risk assessment and adaptation planning process.

6.3 CLIMATE MONITORING AND INFORMATION SYSTEMS

6.3.1 Climate Monitoring

Description

Based on the recommendations of Quiring (2011), there is the continued need to improve climate monitoring networks to increase network density. Network density is especially important for monitoring short-term extreme events, but it is also desirable when tracking long-term conditions. The development of a network-of-networks, which integrates the information available from a variety of networks, is one of the main recommendations of Quiring's report. The network-of-networks would include stations of a wide range of quality, from World Meteorological Standards stations to volunteer reporting networks. All stations are valuable regardless of their quality.

In addition to network density issues, there are some concerns with the availability of relevant and reliable information from monitoring networks. For example, obtaining snow depth data for decision-making is currently a challenge. These data would be extremely valuable in informing adaptive management of climate risks.

Other opportunities for adaptation within climate monitoring include assessing the feasibility of new and emerging technology. An example would be the use of satellites and other sources of remotely

sensed information for monitoring. It would be beneficial to assess the current state of this technology, its feasibility for application in Saskatchewan, and how strategic investments that lead to optimal benefits could be made to advance the use or application of new technology.

Priority

Secondary: this initiative is highly likely to be beneficial in dealing with climate change, likely to have co-benefits in terms of improved collaboration, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Advancing climate monitoring in Saskatchewan will need to be a collaborative effort, making the identification of a lead agency not possible at this time. The most relevant provincial agencies are the SWA, SMA, and SME. The most relevant federal departments are Environment Canada and AAFC.

Collaborators and Partners

Other potential collaborators and partners for this project include:

- Saskatchewan Ministry of Highways and Infrastructure;
- Saskatchewan Ministry of Health;
- Saskatchewan Crop Insurance Corporation;
- Saskatchewan Research Council;
- Agricultural Producers Association of Saskatchewan; and
- other industry stakeholders (e.g., mining, oil and gas).

Desired Outcome

The desired outcome of this project is to improved climate monitoring to inform effective, efficient, and adaptive climate risk management, as well as to provide high quality, long-term climate records for climate change assessments.

Monitoring Success

The success of this project could be monitored by tracking the spatial density of the monitoring network and progress made on reducing gaps, as well as the quality of the available climate information. Quality can be related to a number of indicators, including timeliness (i.e., is the climate information available when required by decision-makers?), reliability (i.e., does the climate information accurately reflect conditions experienced on-the-ground?), and comprehensiveness (i.e., is information available for all relevant/required aspects of climate?).

6.3.2 Climate Information Systems

Description

A climate information system is a means of linking climate monitoring and other climate information to decision-making for adaptive management and preparedness for problematic events. Climate information systems can also help identify and distribute the most beneficial climate indicators to decision-makers and improve indicator availability. This includes technical translation of the information to make it usable and understandable for decision-makers.

A climate information system can also be used to improve awareness and knowledge of current and future extreme events in relation to long-term variability and change. This includes how these events may relate to short- and long-term drivers of climate, such as the Pacific Decadal Oscillation, the El Niño Southern Oscillation, and the Arctic Oscillation. Information provided to decision-makers could provide an indication of the likelihood of change in the predominant climate and weather patterns, notification when a change occurs, and an analysis of emerging patterns over a variety of timescales. This system could also provide linkages with forecasting weather, projecting climate, and the provision of this information to relevant ministries.

Priority

Secondary: this initiative is highly likely to be beneficial in dealing with climate change, likely to have co-benefits in terms of improved collaboration, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

As with climate monitoring, advancing climate information systems in Saskatchewan will need to be a collaborative effort, making the identification of a lead agency not possible at this time. Again, the most relevant provincial agencies are the SWA, SMA, and SME, and the most relevant federal departments are Environment Canada and AAFC.

Collaborators and Partners

Other potential collaborators and partners for this project include:

- Saskatchewan Ministry of Highways and Infrastructure;
- Saskatchewan Ministry of Health;
- Saskatchewan Crop Insurance Corporation;
- Saskatchewan Research Council;
- Agricultural Producers Association of Saskatchewan; and
- other industry stakeholders (e.g., mining, oil and gas).

Desired Outcome

The desired outcome of this project would be to develop a systematic approach to climate information dissemination and communication that is responsive to user needs and can help increase awareness and understanding of climate risks for effective and adaptive management.

Monitoring Success

There are a number of indicators that could be used to monitor the success of this project. These include availability (i.e., are the required climate indicators and other information available?), accessibility (i.e., is climate information easily accessible to all relevant decision-makers?), relevance (i.e., is the available climate information useful to decisions being made?), understandability (i.e., is available climate information translated into easy-to-understand formats?), connectivity (i.e., are all relevant groups receiving the climate information?), and directionality (i.e., are climate information recipients able to respond to information providers to communicate their information needs?).

6.4 WATER MANAGEMENT

6.4.1 Water Allocation

Description

There is an identified need to update and modernize the Water Allocation Policy for the Province of Saskatchewan. This project will improve capacity to proactively manage water-related risk from climate (e.g., hydrologic drought) and increased demand. This project is both a high priority for adaptation and a high priority broadly within the Saskatchewan Watershed Authority's ongoing activities. This project will provide useful policy tools for water managers in the context of climate and other change.

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of improved capacity to deal with economic development, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Watershed Authority

Collaborators and Partners

Development of this policy is specifically within the mandate of the SWA, limiting the role of collaborators and partners. However, broad consultation with a number of ministries and stakeholders, designed to gather and incorporate feedback on the draft policy, would be beneficial.

Desired Outcome

The desired outcome would be to develop a modern and progressive water allocation policy that ensures the sustainability of the economy, society, and environment.

Monitoring Success

This policy's success could be monitored by tracking the ability of users to access the water they need while meeting environmental flow needs in various watersheds.

6.4.2 Hydrologic Drought Planning

Description

Opportunities currently exist for hydrological drought planning in large systems that are significantly relied upon by a range of provincial sectors (e.g., Lake Diefenbaker and the South Saskatchewan Basin). This project would follow a multi-tiered approach, with the foundation of the plan being developed internally by the SWA. Other tiers would then be engaged, including key provincial agencies and ministries, municipalities, and other stakeholder groups. This project could also provide linkages and be coordinated with the development of the Water Allocation Policy (Section 6.4.1).

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of reduced drought vulnerabilities in a number of sectors, and highly likely to

be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Watershed Authority

Collaborators and Partners

As mentioned earlier, this initiative would likely follow a multi-tiered approach, where the SWA would take the lead on preparing the drought plan followed by the engagement of relevant collaborators and partners. Other relevant collaborators and partners include:

- Saskatchewan Ministry of Environment;
- Saskatchewan Ministry of Health;
- Saskatchewan Ministry of Agriculture;
- Saskatchewan Research Council;
- SaskPower;
- municipalities;
- mining industry;
- other major water users;
- Agriculture and Agri-Food Canada; and
- Natural Resources Canada.

Desired Outcome

The desired outcome of this project is to proactively manage and reduce drought-related risks, sensitivities, and vulnerabilities within heavily used systems.

Monitoring Success

The success of this project could be monitored using indicators related to the impacts avoided. It is assumed more specific indicators would be developed as part of the planning process.

6.4.3 Water Conservation, Efficiency, and Productivity

Description

Water Conservation, Efficiency, and Productivity (WCEP) planning by sector in Saskatchewan would take advantage of synergies between water conservation and climate change adaptation initiatives, and provide a means of mainstreaming both types of initiatives within sector-specific water use policies and practices. The process would engage key water use sectors and work with them through the WCEP planning process and provide them with the capacity to work towards WCEP within their operations (WCEP Team 2007). This work would be intended to build on the initial sector-based WCEP scoping workshops that are currently ongoing under the PRAC in Saskatchewan.

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of reduced drought vulnerabilities in a number of sectors, and highly likely to

be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Watershed Authority

Collaborators and Partners

Potential collaborators and partners for this project include:

- Environment Canada;
- Saskatchewan Ministry of Agriculture;
- Saskatchewan Ministry of Environment;
- other relevant provincial ministries and federal departments, depending on targeted sectors;
- sector-based stakeholders (e.g., irrigation districts, municipalities, First Nations);
- sector associations (e.g., Saskatchewan Irrigation Producers Association, Saskatchewan Association of Rural Municipalities, Saskatchewan Urban Municipalities Association); and
- watershed stewardship associations.

Desired Outcome

The desired outcome of WCEP planning in Saskatchewan would be to improve and advance water conservation, efficiency, and productivity within key water use sectors working collaboratively with local watershed stewardship groups, where and when relevant.

Monitoring Success

As part of the planning process, baselines and goals for WCEP and guidelines for outcomes would be developed. Sector-specific protocols for monitoring success would also be developed as part of this process (WCEP Team 2007).

6.4.4 Water Reuse

Description

This project would assess the feasibility of implementing water reuse projects in Saskatchewan. Standards, procedures, and guidelines for water reuse have been designed by Health Canada and the Canadian Standards Association (CSA 2006; Health Canada 2007, 2010). There is a need to understand ongoing concerns associated with the water reuse systems in order to ensure standards, procedures, and guidelines are effectively employed for proper operation and maintenance. In addition, there is the need to develop a procedure for review and monitoring of system installation, operation and maintenance.

There are linkages between this project and the WCEP Planning Project in Section 6.4.3.

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of reduced drought vulnerabilities in a number of sectors, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Watershed Authority

Collaborators and Partners

Potential collaborators and partners for this project include:

- Environment Canada;
- Health Canada;
- Canadian Standards Association;
- Saskatchewan Ministry of Environment;
- Saskatchewan Ministry of Health (including Regional Health Authorities); and
- Watershed Stewardship Associations.

Desired Outcome

The desired outcome is a reliable assessment of the feasibility of implementing water reuse projects in Saskatchewan.

Monitoring Success

Since this project is a feasibility assessment, monitoring success for continual improvement is not applicable.

6.4.5 Watershed Stewardship Planning Protocols and Learning Module

Description

This initiative would involve mainstreaming climate change adaptation into the Source Water Protection Plan Renewal Process by developing standardized approaches and protocols for risk/vulnerability assessment and adaptation/preparedness planning. It also involves the development of a Climate Change and Variability Learning Theme Module, which can be used by watershed stewardship associations for extension, education, and improving awareness.

Priority

Secondary: this initiative is highly likely to be beneficial in dealing with climate change, likely to have co-benefits in terms of other environmental priorities in watersheds, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Watershed Authority

Collaborators and Partners

Potential collaborators and partners for this project include:

- Saskatchewan Association of Watersheds and its members;
- Saskatchewan Ministry of Environment;
- Saskatchewan Ministry of Agriculture; and
- Agriculture and Agri-Food Canada.

Desired Outcome

The desired outcome for this project would be the successful integration of adaptation to climate change and variability within the Source Water Protection Plan Renewal Process and improved education and awareness of climate change and variability issues.

Monitoring Success

Monitoring the success of this project will include tracking the number of Source Water Protection Plans that consider climate change and variability, as well as tracking the number of individuals exposed to the learning module. It is assumed that the monitoring approach for specific adaptation and preparedness strategies developed through the planning process will be developed as part of the process.

6.4.6 Integrated Landscape and Watershed Resilience

Description

This initiative is focused on excessive moisture preparedness. It would build on the LIRA projects currently ongoing in Saskatchewan and provide the necessary implementation mechanisms to start integrating LIRA within existing planning processes. There would be both on-the-ground and policy components. The on-the-ground component could examine controlled water movement and/or targeted conservation measures on the landscape to facilitate agriculture production, reduce infrastructure impacts, and maintain environment and watershed health. The policy component could explore effective, collaborative institutional arrangements to address excessive moisture issues (i.e., determine the roles for watershed stewardship associations, Agri-environmental Group Plans, provincial agencies, federal departments, and other stakeholders).

There are also many potential synergies with other policy areas, including wetland conservation, low impact development, urban flood protection, and transportation infrastructure protection.

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of other environmental and socio-economic priority areas, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Watershed Authority

Collaborators and Partners

AAFC is a major collaborator and partner for this project. AAFC developed the LIRA process and has expertise in its application. Other potential collaborators and partners include:

- Saskatchewan Ministry of Environment;
- Saskatchewan Ministry of Highways and Infrastructure;
- Saskatchewan Ministry of Agriculture;
- Saskatchewan Association of Watersheds and its members;
- municipalities; and
- Infrastructure Canada.

Desired Outcome

The desired outcome of this project is to improve the capacity of watershed stakeholders and municipalities to deal with the impacts of extreme events on the watershed, landscape, and infrastructure, while managing social, economic, and environmental resilience.

Monitoring Success

Monitoring success from this project could be done using actual and potential avoided economic impacts as well as indicators of environmental and watershed health maintenance.

6.5 AGRICULTURE AND GRASSLAND ECOSYSTEM MANAGEMENT

6.5.1 Agri-environmental Programming

Description

This project builds on PRAC-related program reviews (Steinley and Mowenchenko 2011) as well as the preparation of Drought Preparedness and Water Conservation chapters for the Environmental Farm Plan in Saskatchewan. It would focus on further mainstreaming climate change adaptation into existing programs, such as the Canada-Saskatchewan Farm Stewardship Program, Environmental Farm Plan, Agri-Environmental Group Plan, and Farm and Ranch Water Infrastructure Program. This could be done implicitly through co-benefits to other priority areas (e.g., soil conservation, range health), if necessary. Mainstreaming climate change adaptation within these programs could be targeted at improving flexibility and maintaining options in a wide range of climate situations. The assessment of potential adaptation strategies within this suite of programming could be completed using IISD's Adaptive Policy Evaluation Tool (IISD 2011).

There is the need to continue research and development of beneficial management practices under the Canada-Saskatchewan Farm Stewardship Program for climate variability and other co-benefits (e.g., air quality, water quality, soil conservation, and watershed health). Also, learning modules focused on managing climate variability, and extreme events could be developed for the Agri-Environmental Group plans or further integrated into the Environmental Farm Plan.

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of increased general environmental and agricultural resilience, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Ministry of Agriculture

Collaborators and Partners

Other potential collaborators and partners include:

- Agriculture and Agri-Food Canada;
- Saskatchewan Watershed Authority;
- Saskatchewan Ministry of Environment; and
- Provincial Council of Agriculture Diversification and Development Boards.

Desired Outcome

The desired outcome of this project is improved education and awareness around climate risk in the agriculture industry, as well as the development of effective incentives for adaptive behaviour and practice in agriculture.

Monitoring Success

Success of this project could be monitored by program uptake and impacts avoided due to adaptive behaviours and practices.

6.5.2 Economic Tools for Producers

Description

This project would involve developing economic analysis tools that can provide producers with short- and long-term assessments of costs and benefits associated with various decisions (e.g., planting grass versus cropping given climate variability). These tools would be aimed at the farm-level, but could potentially be scaled up to the policy-level and used to understand and prepare for the impacts of large-scale extended drought (i.e., greater than five years).

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of increased general economic resilience, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Ministry of Agriculture

Collaborators and Partners

Potential collaborators and partners for this project include the SWA, SRC, and AAFC.

Desired Outcome

The desired outcome for this project would be the development of an economic tool that could be used by producers to assess the short- and long-term risks associated with a variety of decisions.

Monitoring Success

Success of this project could be monitored based on economic impacts avoided, benefits realized, and reductions in support payments.

6.5.3 Adaptation Policy and Programming for Grassland Conservation

Description

This project involves the identification of adaptation policy and programming options for grassland conservation in Saskatchewan.

Priority

Secondary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits from mainstreaming within existing programming, and likely to be beneficial for

dealing with climate uncertainties and surprises. It is not no-regrets, since it is most beneficial in dealing with expected climate change impacts. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Research Council

Collaborators and Partners

The most relevant collaborator and partner is the Prairie Conservation Action Plan, which is a collaborative group made up of multiple provincial and federal agencies and departments, non-governmental organizations, and other stakeholders.

Desired Outcome

The desired outcome would be the identification of adaptation policy and program options for grassland conservation.

Monitoring Success

Approaches to monitoring success will have to be developed in relation to the policy and program adaptation options identified.

6.6 FOREST ECOSYSTEM MANAGEMENT

6.6.1 Community Wildfire Risk Reduction

Description

This project would build on the Community Wildfire Risk Assessment Project (Johnson, Maczek, and Fremont 2005) and aim at reducing community risks from wildfires through a variety of means, including increasing participation in the FireSmart program (SME n.d.) and dealing with risks identified in the community profiles (for more information, see SME 2012).

Priority

Primary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits in terms of increased community safety and mainstreaming within existing programming, and highly likely to be beneficial for dealing with climate uncertainties and surprises. It is no-regrets. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Ministry of Environment

Collaborators and Partners

Other potential collaborators and partners include:

- communities and municipalities;
- mining industry;
- forestry industry;
- guide outfitters (including relevant associations);

- First Nations and Métis communities;
- tribal councils and Métis regions; and
- Aboriginal Affairs and Northern Development Canada.

Desired Outcome

The desired outcome is the reduction of community risks from wildfires.

Monitoring Success

Monitoring the success of this project could be linked with the risk assessment framework, and progress made towards the following could be tracked: provision of relevant infrastructure, community preparedness, fire suppression and detection, and structural community characteristics (e.g., participation in FireSmart, distance between houses, and unique house numbers for houses).

6.6.2 Adaptation of Island Forests Stands

Description

This project would address the need to undertake on-the-ground experimentation with adaptive strategies in island forests,[4] which are some of the most vulnerable forests in the province (Henderson et al. 2002). The experiments would examine how changes in site preparation, planting density, seed stock, and possibly other strategies facilitate adaptation. The main opportunity would be to mainstream these adaptation experiments within the forest renewal program for the island forests. Funding is in place for seeds, site preparation and planting, but additional funding is required for the scientific design and monitoring of trial adaptation plots.

Priority

Secondary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits from mainstreaming within existing programming, and likely to be beneficial for dealing with climate uncertainties and surprises. It is not no-regrets, since it is specifically designed for dealing with climate change. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Ministry of Environment

Collaborators and Partners

The main collaborator and partner for this initiative is the SRC.

Desired Outcome

This initiative is aimed at developing and testing adaptive strategies for forest management in the context of climate change. As such, the desired outcome would be the identification of planting strategies that ensure the long-term sustainability of forest stands.

Monitoring Success

It is expected that monitoring the success of this initiative would be built into the experimental design and have a broad focus on the health and productivity of the experimental stands.

[4] Islands forests are “relatively small forests, isolated from other woodlands by intervening grassland” (Henderson et al. 2002).

6.6.3 Forest Management Planning

Description

This project would mainstream climate change adaptation within the Forest Management Planning (FMP) process in Saskatchewan by developing adaptation planning procedures for inclusion in the process and FMP code related to adaptation within the Results-based Regulatory Framework.

Priority

Secondary: this initiative is highly likely to be beneficial in dealing with climate change, highly likely to have co-benefits from mainstreaming within existing programming, and likely to be beneficial for dealing with climate uncertainties and surprises. It is not no-regrets, since it is most beneficial in dealing with expected climate change impacts. For a more detailed explanation, see Appendix 3.

Lead Agency

Saskatchewan Ministry of Environment

Collaborators and Partners

Other potential collaborators and partners for this project include the SRC and forestry industry stakeholders (licensees).

Desired Outcome

The desired outcome of this project is to effectively integrate climate change adaptation considerations within the FMP code and planning manual.

Monitoring Success

The success of this project could be monitored based on the numbers of plans produced that include climate change adaptation, and additionally (and likely more importantly), by the success of adaptive strategies implemented within the plan. These adaptive strategies could be assessed using the same principles already integrated within the planning process. These include (SME 2007):

- ecosystem-based management;
- sustainable forest management;
- collaboration and consultation;
- social and economic sustainability; and
- adaptive management for continual improvement.

Indicators designed to capture progress made towards the principles listed above in the context of climate change could be developed and used to monitor the success of the project.

7. Overcoming Barriers to Adaptation

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7. Overcoming Barriers to Adaptation

There are a number of barriers to advancing adaptation in Saskatchewan, although many of these can be overcome. These barriers are not specific to any of the current adaptation opportunities, but could be faced for any of the opportunities mentioned in Section 6. The most noteworthy barriers are: differences in adaptation and decision-making time horizons, differing public opinions towards climate change; low priority of adaptation relative to policy and program development in other areas; and limited resources.

There is a fundamental mismatch between the time horizons often used in decision-making versus those required for adaptation. Exceptions exist, such as Forest Management Planning, which operates on a 20-year time horizon. However, adaptation time horizons are generally greater in length than those commonly used in decision-making. Also, many policies and programs are framed around responses to conditions; this reactive approach does not align well with the proactive element of adaptation. This can make decisions around adaptation difficult to incorporate within existing governance processes.

Broad public acceptance of anthropogenic climate change has yet to be realized and can be a heated topic of debate, potentially side-tracking projects marketed as "climate change adaptation" although they have broad benefits. Getting trapped in the debate around the cause of climate change can shift the focus within adaptation projects away from the broad benefits the project is aiming to produce and limit the overall success of the project.

Climate change adaptation is usually a lower priority than other ongoing activities within various agencies and ministries, making progress on adaptation less likely when staff and budgets are already stretched. In relation to the low relative priority of adaptation, resourcing challenges, both in terms of staff and program funding, were noted by many of the interviewed stakeholders as to negatively influence adaptation initiatives. The importance of adaptation and the need for long-term strategies is recognized, but short-term priorities and day-to-day operations often consume existing resources, leaving few opportunities to pursue new agendas.

Although these barriers will be challenging, they can be overcome in a number of ways. Mainstreaming and collaboration are two entry points for adaptation in a broad range of projects or decision-making processes. The awareness, education, and decision-making tools provided through mainstreaming can set the stage for incremental progress on climate change adaptation within existing programs, policies, and institutions. Collaboration is important for the development of adaptive governance structures capable of meeting climate change challenges, but can also lead to effective and efficient use of scarce resources.

Addressing climate change challenges involves dealing with numerous other ongoing challenges (e.g., environmental, economic, and social) that have yet to be resolved. There are many programs that can be implicitly related to climate change adaptation, but are not marketed explicitly as such. Approaching adaptation implicitly can be beneficial in some cases, as non-constructive arguments around the cause of climate change can be avoided. This leaves the focus on the goals, objectives, and benefits the programs are aiming to meet and provide. There is a need to effectively address the underlying issues causing challenges and manage adaptation for broad goals, objectives, and benefits regardless of explicit messaging around climate change.

8. Summary

8. Summary

The PRAC has significantly advanced adaptation in Saskatchewan. PRAC-related projects produced a number of lessons for key policy areas in the province, including: water management, climate monitoring and information systems, agriculture and grassland ecosystem management, and forest ecosystem management. A common theme from the lessons is the need to proactively manage climate risks through adaptation and apply effective adaptive management to deal with increasingly difficult and uncertain decision-making arenas.

It is suggested that broadly advancing adaptation in Saskatchewan be implemented following a framework that integrates key adaptation-related elements from mainstreaming (UNDP 2010), the National Climate Change Adaptation Framework (ICCIAWG 2005), and the Results-based Regulatory Framework (Clifton Associates 2009). The key elements of the integrated framework (see Section 5.1.4) include: the definition of standards, goals, and desired outcomes of adaptation; provision and development of tools and procedures for risk and vulnerability assessment, adaptation planning, and prioritizing adaptation options; education and awareness raising; promotion of institutional arrangements that support integrated adaptive management and collaboration; communication and use of climate information and science; integration of adaptation within existing policies and operations; continual monitoring and evaluation of adaptation outcomes based on standard criteria; and continual improvement in the provision and evaluation of climate change scenarios.

In relation to the PRAC, decision-makers are approaching the decision point in terms of adaptation in the province and many opportunities to develop adaptation initiatives currently exist. Within the policy areas explored by the PRAC, some of the primary priorities are: modernizing the water allocation policy; conducting hydrologic drought planning in major systems; water conservation, efficiency, and productivity; water reuse; integrated landscape and watershed resilience (i.e., application of the LIRA tool); mainstreaming adaptation into agri-environmental programming; developing economic decision-making tools for producers; and reducing community risks from wildfire.

Although PRAC significantly advanced adaptation in a number of key policy areas, there are other areas that should be explored for future adaptation work. These include improved collaboration with First Nations and Métis groups and communities to address adaptation concerns and developing an improved understanding of risks and adaptation options for infrastructure throughout the province.

Overcoming many barriers and challenges for adaptation in the province will likely involve expanding the collaboration fostered under the PRAC and continued mainstreaming. These two approaches will help deal with resourcing challenges and barriers related to the low relative priority of adaptation within mandates. Repositioning and reframing adaptation work to focus on the goals, objectives, and desired outcomes in relation to other provincial institution priorities will also help broaden participation in adaptation initiatives and improve the effectiveness of projects.

References

References

Definitions of the acronyms and abbreviations used in this reference list can be found in the Acronyms and Abbreviations section.

AWSA. 2011. *Drought and Excessive Moisture Preparedness Plan*. Prepared for the Saskatchewan Watershed Authority by the Assiniboine Watershed Stewardship Association: Moose Jaw, SK.

Axelson, J. N., D. J. Sauchyn, and J. Barichivich. 2009. New reconstructions of streamflow variability in the South Saskatchewan River Basin from a network of tree ring chronologies, Alberta, Canada. *Water Resources Research*, 45, W09422, DOI: 10.1029/2008WR007639.

Clifton Associates. 2009. *Toward a Results-Based Regulatory System*. Prepared for the Saskatchewan Ministry of Environment by Clifton Associates Ltd.: Regina, SK.

CSA. 2006. *Design and Installation of Non-Potable Water Systems/Maintenance and Field Testing of Non-Potable Water Systems*. CAN/CSA-B128.1-06/B128.2-06 (R2011). http://shop.csa.ca/en/canada/plumbing-products-and-materials/cancsa-b1281-06b1282-06-r2011/invt/27024892006/ (accessed January 2012).

Forino, D. 2006. *The New Environmental Regulation*. Cambridge, MA: MIT Press.

Hallegatte, S. 2009. Strategies to adapt to an uncertain climate change. *Global Environmental Change*, 19 (2): 240-47.

Health Canada. 2007. *Canadian Guidelines for Household Reclaimed Water for Use in Toilet and Urinal Flushing*. http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/consult/_2007/reclaim-recycle/reclaim-recycle-eng.pdf (accessed January 2012).

Health Canada. 2010. *Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing*. http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/reclaimed_water-eaux_recyclees/reclaimed_water-eaux_recyclees-eng.pdf (accessed January 2012).

Henderson, N., E. Hogg, E. Barrow, and B. Dolter. 2002. *Climate Change Impacts on the Island Forests of the Great Plains and the Implications for Nature Conservation Policy*. http://www.parc.ca/pdf/research_publications/forestry1.pdf (accessed January 2012).

ICCIAWG. 2005. *National Climate Change Adaptation Framework*. Prepared by the Intergovernmental Climate Change Impacts and Adaptation Working Group. http://www.nickeldistrict.ca/ndca/images/uploaded_files/documents/climate_change/adaptationframework2006.pdf (accessed January 2012).

IISD. 2011. *Adaptive Policy Evaluation Tool Report*. Prepared for the Saskatchewan Watershed Authority by the International Institute for Sustainable Development: Moose Jaw, SK.

Johnson, K., P. Maczek, and L. Fremont. 2005. *Saskatchewan Community Wildfire Risk Assessment Project: Final Report*. http://www.environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID=a9861404-d8df-4d98-8120-27d831c839d4&MediaID=1714&Filename=Community+Wildfire+Risk+Assessment+Report.pdf&l=English (accessed January 2012).

Klein, R. J. T., S. E. H. Eriksen, L. O. Næss, A. Hammill, T. M. Tanner, C. Robledo, and K. L. O'Brien. 2007. Portfolio screening to support the mainstreaming of adaptation to climate change into development assistance. *Climatic Change*, 84 (1): 23-44.

Lapp, S., J. St. Jacques, E. Barrow, and D. Sauchyn. 2011. GCM projections for the Pacific Decadal Oscillation under greenhouse forcing for the early 21st century. *International Journal of Climatology*, DOI: 10.1002/joc.2364.

Lapp, S., J. St. Jacques, Y. Zhao, and D. Sauchyn. 2010. *Early 21st Century Projected Southern Alberta River Discharges*. Prairie Adaptation Research Collaborative: Regina, SK.

Lemmen, D. S., F. J. Warren, J. Lacroix, and E. Bush. (eds). 2008. *From Impacts to Adaptation: Canada in a Changing Climate 2007*. Ottawa, ON: Government of Canada. http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca.earth-sciences/files/pdf/assess/2007/pdf/full-complet_e.pdf (accessed January 2012).

NSRBC. 2011. *Drought and Excessive Moisture Preparedness Plan*. Prepared for the Saskatchewan Watershed Authority by North Saskatchewan River Basin Council: Moose Jaw, SK.

OECD. 2009. *Policy Guidance on Integrating Climate Change Adaptation into Development Co-operation*. http://www.oecd.org/dataoecd/26/34/42747370.pdf (accessed January 2012).

Quiring, S. 2011. *Evaluation of Drought and Excessive Moisture Monitoring in Saskatchewan*. Prepared for the Saskatchewan Watershed Authority: Moose Jaw, SK.

Rescan. 2011. *ELOHA Implementation Strategy*. Prepared for the Saskatchewan Watershed Authority by Rescan Environmental Services Ltd.: Saskatoon, SK.

Sauchyn, D. and S. Kulshreshtha. 2008. Prairies. In *From Impacts to Adaptation: Canada in a Changing Climate 2007*. Eds. D. S. Lemmen, F. J. Warren, J. Lacroix, and E. Bush. Ottawa, ON: Government of Canada. http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca.earth-sciences/files/pdf/assess/2007/pdf/ch7_e.pdf (accessed January 2012).

SCCWS. 2011. *Drought and Excessive Moisture Preparedness Plan*. Prepared for the Saskatchewan Watershed Authority by the Swift Current Creek Watershed Stewardship Association: Moose Jaw, SK.

SME. 2007. *Forest Management Planning Document*. http://www.environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID=891,897,878,862,244,94,88,Documents&MediaID=1093&Filename=Forest+Management+Planning+Document+2007.pdf&l=English (accessed January 2012).

SME. 2012. *Wildfire Risk Assessment*. http://www.environment.gov.sk.ca/Default.aspx?DN=548bb226-240e-4bde-a71c-1461e72b78a6 (accessed January 2012).

SME. n.d. *FireSmart: Protecting your home from wildfire*. http://www.environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID=06a3f068-7ce0-4d45-aa2b-76ecd1e0c923&MediaID=344&Filename=Firesmart+Booklet.pdf&l=English (accessed January 2012).

SRD. 2010. *Climate Change Adaptation Framework Manual*. http://www.srd.alberta.ca/MapsPhotosPublications/Publications/documents/ClimateChangeAdaptationFrameworkManual-April%202010.pdf (accessed January 2012).

St. Jacques, J., Y. Huang, Y. Zhao, S. Lapp, and D. Sauchyn. 2011. *The Effects of Atmosphere-Ocean Climate Oscillations on and Trends in Saskatchewan River Discharges*. Prepared for the Saskatchewan Watershed Authority: Moose Jaw, SK.

St. Jacques, J., D. Sauchyn, and Y. Zhao. 2010. Southern Alberta streamflow records: global warming trends, human impacts or natural variability? *Geophysical Research Letters*, 37, L06407, DOI: 10.1029/2009GL042045.

Steinley, D. and J. Mowenchenko. 2011. *Evaluation of Drought and Excessive Moisture Preparedness Programming*. Prepared for the Saskatchewan Watershed Authority: Moose Jaw, SK.

Swanson, D. and S. Bhadwal, eds. 2009. *Creating Adaptive Policies: A Guide for Policy-making in an Uncertain World*. New Delhi, India and Ottawa, ON: Sage Publications and IDRC.

Thomson, L. 2011a. *Vulnerabilities and Adaptations to Extreme Climatic Variability: North Saskatchewan River Watershed*. Prepared for the Saskatchewan Watershed Authority: Moose Jaw, SK.

Thomson, L. 2011b. *Vulnerabilities and Adaptations to Extreme Climatic Variability: Old Wives Lake Watershed*. Prepared for the Saskatchewan Watershed Authority: Moose Jaw, SK.

Thorpe, J. 2011. *Vulnerability of Prairie Grasslands to Climate Change*. Prepared for the Prairies Regional Adaptation Collaborative: Regina, SK.

UNDP. 2010. *Screening Tools and Guidelines to Support the Mainstreaming of Climate Change Adaptation into Development Assistance: A Stocktaking Report*. http://www.beta.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/climate-change/stocktaking-of-tools-and-guidelines-to-mainstream-climate-change-adaptation/UNDP%20Stocktaking%20Report%20CC%20mainstreaming%20tools.pdf (accessed January 2012).

USAID. 2009. *Adapting to Coastal Climate Change: A Guidebook for Development Planners*. http://pdf.usaid.gov/pdf_docs/PNADO614.pdf (accessed January 2012).

WCEP Team. 2007. *Water Conservation, Efficiency and Productivity: Principles, Definitions, Performance Measures and Environmental Indicators, Final Report*. Prepared by the Water Conservation, Efficiency and Productivity Definitions Project Team for the Alberta Water Council. http://www.albertawatercouncil.ca/Portals/0/pdfs/CEP_Definitions_Final_Report.pdf (accessed January 2012).

Wittrock, V., E. Wheaton, and E. Siemens. 2011. *Drought and Excessive Moisture - Saskatchewan's Nemesis: Characterizations for the Swift Current Creek, North Saskatchewan River, Assiniboine River and Upper Souris River Watersheds*. Prepared for the Saskatchewan Watershed Authority: Moose Jaw, SK.

Personal Communications

Anonymous: 002-002. 2011. Personal communication via telephone: November 21, 2011.

Anonymous: 002-005. 2011. Personal Communication via Telephone: November 14, 2011.

Anonymous: 002-009. 2011. Personal communication via Telephone: November 24, 2011.

Anonymous: 002-010. 2011. Personal Communication via Telephone: November 25, 2011.

Funk, D. 2011. Senior Water Conservation Coordinator, Saskatchewan Watershed Authority. Personal Communication via Telephone: November 10, 2011.

Jessop, D. 2011. Director, Wildfire Support Section, Saskatchewan Ministry of Environment. Personal Communication via Telephone: November 21, 2011.

Johnston, M. and Qualtiere, E. 2011. Researchers, Saskatchewan Research Council. In-person Meeting: June 16, 2011.

Kulshreshtha, S. 2011. Professor, University of Saskatchewan. Personal Communication via Email: September 29, 2011.

Mackasey, P. 2011. Forest Management Planning Coordinator, Saskatchewan Ministry of Environment. Personal Communication via Telephone: December 9, 2011.

Neil, G. 2011. Manager, Planning and Lands Management, Saskatchewan Watershed Authority. Personal Communication via Telephone: November 17, 2011.

Soulodre, E. 2011. Senior Agrologist, Saskatchewan Watershed Authority. In-person Meeting: November 23, 2011.

Waggoner, J. 2011. Director, Licensing and Water Use, Saskatchewan Watershed Authority. Personal Communication via Telephone: November 14, 2011.

Wynes, B. 2011. Executive Director, Forest Service, Saskatchewan Ministry of Environment. Personal Communication via Telephone: November 21, 2011.

Appendix 1

Review of PRAC Projects

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Appendix 1. Review of PRAC Projects

1.1 SASKATCHEWAN PROJECTS SCOPE

The PRAC-related projects reviewed for Saskatchewan are provided in Table A1.1-1. As is indicated in the table, some projects were reviewed in their entirety, while for others only the progress to September 1, 2011 was available for review because the projects were yet to be completed. In addition, there were projects in their early stages that were not reviewed; information gathered on these projects was done through engagement of the respective Principal Investigators.

Table A1.1-1. PRAC-Related Projects Reviewed for Saskatchewan

PRAC Project	Reviewed
Hydroclimatic Variability Analysis and Projections	Yes
Evaluation of Monitoring	Yes
Adaptive Policy Evaluation Tool	Yes
Evaluation of Farm Stewardship Program, Farm and Ranch Water Infrastructure Program, Environmental Farm Planning and Agri-Environment Group Planning Programming	Yes
In-stream Flow Needs and Climate Change Adaptation Gap Analysis	Yes
Vulnerability of Prairie Grasslands	Yes
Vulnerability of Forest Ecosystems	No as project still ongoing. Worked with Principal Investigator to confirm assumptions around key finding and to identify lessons learned.
Watershed Drought and Excessive Moisture Preparedness Plans	Study components for Swift Current Creek, North Saskatchewan River, and Assiniboine River Watersheds
Drought and Excessive Moisture Characterization	Study components for Swift Current Creek, North Saskatchewan River, and Assiniboine River Watersheds
Community-Based Socioeconomic Vulnerability Assessment	Yes
Analysis and Projections of Water Demands in Selected Watersheds	No as project still ongoing. Worked with Principal Investigator to confirm assumptions around key finding and to identify lessons learned.

1.2 HYDROCLIMATIC VARIABILITY ANALYSIS AND PROJECTIONS

1.2.1 Objectives

There were multiple objectives of this work:

- to examine long-term hydroclimate variability in the South Saskatchewan River Basin;
- to understand the drivers of internal hydroclimate variability and how these drivers will be influenced by climate change;
- to understand the implications of climate change for future internal hydroclimate variability;
- to examine high-resolution climate change scenarios produced by Regional Climate Models for the Prairie Provinces; and
- to understand the prospects for creating probabilistic climate change scenarios for the Prairies.

1.2.2 Method

The methods used in the deliverables from the Hydroclimatic Variability Analysis and Projections work are summarized in Table A1.2-1.

Table A1.2-1. Summary of Methods from Hydroclimatic Variability Analysis and Projections Deliverables

Paper/Report	Citation	Methods
The Effects of Atmosphere-Ocean Climate Oscillations on and Trends in Saskatchewan River Discharges	St. Jacques et al. (2011)	Part I: Composite analysis of annual average mean daily streamflow and climate oscillation indices (PDO, ENSO, PNA, and AO). Streamflows were composited into two classes corresponding to strong positive and negative cycles of the corresponding climate oscillation. The differences in averages streamflow between the two classes was then assessed using Monte Carlo permutation *t*-tests. Part II: Non-parametric Mann-Kendall statistical trends tests completed on annual average mean daily streamflow using a variance correction approach.
Hydroclimate Data for the Prairies: An Analysis of Possibilities	Barrow (2010)	Hydroclimatic indices (e.g., PET, P-PET) calculated from available GCM and RCM output for the Prairie Provinces.
New Reconstructions of Streamflow Variability in the South Saskatchewan River Basin from a Network of Tree-Ring Chronologies	Axelson et al. (2009)	Dendrochronological reconstruction of historic streamflow in the South Saskatchewan River using multiple linear regression to estimate streamflow from a set of tree ring predictors, index chronologies and principal components of tree ring indices, for the growth year and at forward lags of 1, 2 and 3 years.
Northern Rocky Mountain Streamflow Records: Global Warming Trends, Human Impacts or Natural Variability?	St. Jacques et al. (2010)	Generalized Least Squares (GLS) analysis of annual average mean daily flows with linear trends, as well as PDO, SOI and NAO indices at various lags, used as predictors.
Projected Southern Alberta River Discharges: 2010-2050	Lapp et al. (2010)	GLS analysis of annual average mean daily flows with linear trends, as well as PDO, SOI and NAO indices at various lags, used as predictors. Future PDO, SOI and NAO indices were calculated using GCM output and used to drive the GLS models.
GCM Projections for the Pacific Decadal Oscillation under Greenhouse Forcing for the Early 21st Century	Lapp et al. (2011)	A PDO index was calculated from gridded datasets of sea-surface temperature (SST) for the period from 1900 to 2008 and from GCM output for the period from 1900 to 2050. The two sets of indices were compared over the historical period in order to assess the ability of the GCMs to model observed PDO variability; from this analysis, the most appropriate GCMs to use for future projections were chosen. Output from GCMs that were best able to model observed conditions was then analyzed for projected PDO conditions to 2050.

1.2.3 Results

There are numerous implications for water resource management in Saskatchewan from this work. It helps identify the various temporal scales of variability in regional hydroclimate and characterize the role of the El Niño Southern Oscillation (ENSO), Pacifica Decadal Oscillation (PDO) and Arctic Oscillation (AO) on local climates. Recognizing and understanding quasi-oscillations in hydroclimatic variability can support the proactive management of corresponding risks associated with the various phases of the underlying climate phenomenon. This work also shows that, despite the presence of influence of PDO, ENSO and AO, long-term trends in water levels are consistent with the climate change hypothesis (St. Jacques et al. 2011).

The results of the dendrochronological streamflow reconstructions were based on 14 new moisture-sensitive tree ring chronologies. These chronologies were used to reconstruct average water year (October to September) flow for the Oldman and South Saskatchewan rivers from 1618–2004 and 1400–2004, respectively. The tree ring models tended to underestimate high flows; as such, there is more confidence in the timing and duration of drought and periods of low flows reconstructed by the models. There were many periods in the reconstructed models that were much dryer than those experienced since the Euro-Canadian settlement of the Prairies. In addition, both reconstructions exhibited highly significant multi-decadal (~65 years) and interannual (2-6 years) components of variability, possibly related to the large-scale teleconnection patterns of the Pacific Decadal Oscillation (PDO) and the El Nino-Southern Oscillation (ENSO), respectively (Axelson et al. 2009).

The South Saskatchewan River reconstructions showed extreme drought (lowest 10th percentile) in the 1560s, with the earliest extreme drought spanning both reconstructions occurring from 1717-1721. The most severe drought in memory for western North America, the 1930s, does not appear as an extreme drought in either reconstruction (Axelson et al. 2009).

The work completed under the hydrologic variability analysis and projections project of the PRAC Water Theme provides significant lessons learned for water management in Saskatchewan.

1.3 EVALUATION OF DROUGHT AND EXCESSIVE MOISTURE MONITORING

1.3.1 Objectives

The objectives of this work were to provide an overview of commonly used indicators for drought and excessive moisture monitoring, review the indicators and recommend those that are the most suitable for use in Saskatchewan, and determine any inadequacies in the spatial or temporal distribution of existing monitoring networks and recommend the most appropriate spatial interpolation technique for mapping.

This work was vetted through the interagency Drought and Excessive Moisture Monitoring Committee that was spearheaded by the Saskatchewan Ministry of Agriculture, and provided scientific content and opportunities for learning at many of the committee's meetings. This project was completed by Dr. Steven Quiring from Texas A&M.

1.3.2 Method

Indices were classified based on their applicability to agricultural or hydrological drought. Next, the indices were evaluated using a qualitative approach, where each index was given a score for each of six criteria (Table A1.3-1). Weighted average scores were then calculated and used to rank the indices.

Table A1.3-1. Criteria for the Evaluation of Indices from Evaluation of Drought and Excessive Moisture Monitoring Deliverables

Criteria	Description	Weight
Robustness	The ability of an index to remain reliable over a wide range of climatic conditions, as well as be comparable over time and space.	30%
Tractability	The ability of an index to be easily calculated with readily available data that is applicable at local scales.	25%
Sophistication	The ability of an index to accurately represent the physical characteristics of existing conditions in a scientifically defensible and rigorous way.	10%

(continued)

Table A1.3-1. Criteria for the Evaluation of Indices from Evaluation of Drought and Excessive Moisture Monitoring Deliverables (completed)

Criteria	Description	Weight
Extendability	The ability of an index to be calculated over a historical period and not just in the present. Extendibility is usually dependent on the availability of relevant data over time.	10%
Transparency	The ability of an index to be clear, rational and easy to understand by the end user groups.	15%
Dimensionality	The ability of an index to be expressed in units that have physical meaning.	10%

1.3.3 Results

Quiring (2010) found that P–PET, precipitation deciles/percentiles, and SPI are the most appropriate indices for monitoring agricultural drought and excessive moisture in Saskatchewan, while streamflow, reservoir and lake percentiles, and SPI are most appropriate for hydrological drought. No single index, however, can accurately represent all aspects of agricultural or hydrological drought; as such, Quiring (2010) recommend a multi-index approach to monitoring.

In terms of existing network adequacy, the main challenge in Saskatchewan is not a lack of stations but a lack of integration of existing stations (Quiring 2010). Developing a network of networks would help address current limitations (Quiring 2010). Accurate monitoring in Saskatchewan will require a network, or network of networks, containing at least 500 stations (Quiring 2010). For spatial interpolation of data from monitoring networks, Inverse Distance Weighting (IDW) was recommended (Quiring 2010).

The main conclusions from Quiring (2010) are the need for a network of networks within Saskatchewan and the use of multiple indices for drought and excessive moisture monitoring.

1.4 ADAPTIVE POLICY EVALUATION TOOL

1.4.1 Objectives

The objective of this work was to produce a tool to assess the influence of a suite of programs and policies on the adaptive capacity of relevant stakeholders. The tool was developed by the International Institute for Sustainable Development (IISD) and builds on earlier adaptive policy work completed by this group.

1.4.2 Method

The tool steps decision-makers through a process for assessing adaptive policies. These steps include (IISD 2011):

1. Determine the geographic scope of the evaluation and the suite of policies to be evaluated.
2. Conduct a vulnerability analysis of relevant sectors to existing conditions and develop a list of potential adaptations required under changing conditions.
3. Evaluate the ability of each program or policy to support planned adaptation for anticipated impacts and autonomous adaptation for impacts that cannot be anticipated.
4. Synthesize the results of the analysis into an aggregate score for each policy/program and for the suite of policies/programs to identify gaps causing deficits in adaptive capacity.

1.4.3 Results

The Adaptive Policy Evaluation Tool was applied to the suite of programs under the North American Waterfowl Management Plan (NAWMP) as a test case. The results show that NAWMP contributes significantly to autonomous adaptation, but marginally to planned adaptation (IISD 2011).

The Adaptive Policy Evaluation Tool can be useful for review of the influence of specific or multiple policies and programs on vulnerability and adaptive capacity across sectors or watersheds. This tool can be applied within various agencies in Saskatchewan to determine how current suites of policies and programs can influence adaptive capacity and identify ways of mainstreaming adaptation within existing policies and programs.

1.5 EVALUATION OF AGRICULTURAL DROUGHT AND EXCESSIVE MOISTURE PREPAREDNESS PROGRAMS

1.5.1 Objectives

The objective of this work was to evaluate existing agri-environmental programming for its influence on the adaptive capacity of subscribers to the programs. The programs selected include the Farm and Ranch Water Infrastructure Program (FRWIP), the Canada-Saskatchewan Farm Stewardship Program (CSFSP), the Environmental Farm Plan (EFP) program, and the Agri-Environmental Group Plan (AEGP) program.

1.5.2 Method

Desk-based and consultative research methods were used for this project. Key informant interviews with experts within provincial and federal agencies, local non-governmental organizations (NGOs), and academia were conducted. Key informants were chosen based on their knowledge of the programs evaluated. An extensive review of relevant literature was conducted in order to verify the information in the interviews, as well as the scientific basis for the influence of various beneficial management practices (BMPs) and adaptive strategies for drought and excessive moisture preparedness. This project was completed by private contractors in close consultation with Saskatchewan Watershed Authority (SWA) staff and researchers at the University of Regina.

1.5.3 Results

The FRWIP was specifically designed to encourage drought preparedness, reducing vulnerability to water stress and related exposures. In addition, the urgent needs of producers already facing water shortages was integrated into program design, facilitating quick turnaround times for approvals by eliminating regulatory and technical review requirements. In this manner, and in certain situations, FRWIP almost improves response capacity in addition to preparedness (Steinley and Mowenchenko 2011).

A potential co-benefit from FRWIP is improved range management. FRWIP helps producers meet their livestock watering goals, potentially allowing for effective rotational grazing and, subsequently, improved range health, increased production, decreased erosion risk, and improved soil moisture conservation. The program was originally targeted at Southwest Saskatchewan, but has since become available to producers, Rural Municipalities (RMs), and First Nations across Saskatchewan (Steinley and Mowenchenko 2011).

The CSFSP was not specifically designed to encourage drought or excessive moisture preparedness, but preparedness is a co-benefit of many BMPs funded through the program. The program aims to reduce environmental risk by funding a number of BMPs that improve storage of farm inputs and waste, improve water quality, reduce soil erosion, and increase fertilizer and pesticide efficiency. Only

projects undertaken with the intent of improving environmental conditions are funded – those deemed as expansion projects are not eligible (Steinley and Mowenchenko 2011).

The AEGP and EFP programs both focus on providing agri-environmental education and awareness among producers, with the AEGP addressing geographic or sector-specific concerns (usually at the watershed-scale) and the EFP addressing individual, on-farm concerns. These programs are closely tied with the CSFSP, as producers who participate in the AEGPs or the EFP are eligible to apply for funding to the CSFSP (Steinley and Mowenchenko 2011).

Both programs are proactive and focus on awareness and education. Recent additions of water conservation and drought preparedness chapters to the EFP program have improved the potential influences this program could have on extreme events preparedness, although these new additions will only reach new program participants. AEGPs, on the other hand, have additional flexibility and can continually engage producers, allowing them the ability to respond to emerging issues, such as adaptation to climate variability, and adjust as necessary. Opportunities to develop social networks also exist within both programs. Learning is encouraged through workshops and field days. A particular emphasis is place on the interconnectedness of producers within a specific geographic area and opportunities to address agri-environmental issues collectively (Steinley and Mowenchenko 2011).

1.6 WATERSHED DROUGHT AND EXCESSIVE MOISTURE PREPAREDNESS

1.6.1 Objectives

The objective of the Watershed Drought and Excessive Moisture Preparedness project was to increase the adaptive capacity of watershed stakeholders by facilitating preparedness planning at the watershed level. This project was completed by the Saskatchewan Watershed Authority (SWA) in partnership with local watershed stewardship groups. The plans for the Assiniboine Watershed Stewardship Association (AWSA), Swift Current Creek Watershed Stewards (SCCWS) and North Saskatchewan River Basin Council (NSRBC) were reviewed[1].

1.6.2 Method

The watershed drought and excessive moisture preparedness plans were developed using the following participatory approach:

- kick-start workshops;
- vulnerability assessment;
  - participatory mapping,
  - timeline construction,
  - scenario planning,
  - information requirements;
- adaptation planning and actions.

1.6.3 Results

The results from this work are instructive to local and provincial preparedness initiatives. High priority adaptation options from the preparedness plans are summarized in Table A1.6-1.

[1] As is noted, in Table 3.1-1, other plans were ongoing but not available for review at the time of report writing.

Table A1.6-1. High Priority Adaptation Options from the Watershed Preparedness Plans

High Priority Adaptation Options	Plan(s)
Research and extension regarding cumulative impacts of agricultural drainage and municipal trenching. Develop guidelines or best practices for dealing with issues associated with local drainage and trenching.	NSRBC
Research and extension regarding the value of local water storage, such as wetlands. Develop guidelines or best practices for dealing with issues associated with local water storage.	NSRBC
Prepare for flooding and excessive moisture through planning (using technical tools, such as the Landscape and Infrastructure Resiliency Assessment) and strategic investment in infrastructure, identification of high risk areas, assessment of existing channel capacity, and zoning.	NSRBC, SCCWS, AWSA
Promote the expansion of agricultural water supplies before droughts occur.	NSRBC
Promote the development of regional agreements between municipalities (rural and urban) regarding: options for redirecting flow during flood events; sharing of various equipment for preparedness or emergency response situations; and coordination of emergency response plans to incorporate downstream municipalities and land owners.	SCCWS, AWSA
Improve information pathways and enhance information availability for: the efficient use of rain water in rural, urban and agricultural applications; available preparedness programs and recommended beneficial management practices (BMPs); school program and curriculum development; public health information regarding risks associated with aquifer contamination; and options for dealing with sedimentation and debris.	NSRBC, SCCWS, AWSA
Review compensation packages for producers impacted by drought and excessive moisture events and engage key stakeholder groups in identifying adaptation options.	NSRBC
Provide funding for long-term preparedness-related infrastructure and agricultural programming.	NSRBC
Expand meteorologic, hydrometric, and ground water monitoring networks in high risk areas.	NSRBC, SCCWS
Ensure emergency management plans are in place (including regular assessment of conditions, maintenance of infrastructure, and confirmed availability of key resources) and emergency response personnel are properly trained.	SCCWS, AWSA
Define drought and excessive moisture thresholds by watershed and undergo water supply planning.	SCCWS

Sources: AWSA (2011), SCCWS (2011), and NSRBC (2011)

1.7 DROUGHT AND EXCESSIVE MOISTURE CHARACTERIZATION

1.7.1 Objectives

The object of this work was to provide a historical comparison of extreme hydroclimate events at the watershed level using two main indicators – SPI and PDSI. The characterizations were then presented to stakeholders at watershed preparedness workshops and used to frame discussions.

1.7.2 Method

SPI, PDSI, and PDSI Z-values were calculated by Meinert et al. (2010) from a gridded climate dataset of monthly temperature and precipitation produced using the ANUSPLIN technique. The indices covered the time period from 1901 to 2005 – it should be noted that the extremely wet year of 2010 was excluded from the analysis. Data were then extracted for each watershed and ranked from wettest to driest years based on the indices.

1.7.3 Results

Drought and excessive moisture patterns vary significantly over space and time, and within and between watersheds. This analysis showed that it was not uncommon for portions of a watershed to experience extreme conditions while other portions were experiencing near normal conditions. There were, however, two hydroclimate events that influenced all watersheds – the excessive moisture event of 1954 and the drought of 1961. Wittrock et al. (2011) also suggest that 2010 was another widespread event, although not included in this analysis.

The main conclusions drawn from this work are as follows:

- the hydroclimate in Saskatchewan varies significantly by watershed and each watershed has experienced severe dry or wet conditions, although the frequency and magnitudes are different; and
- analyses of historic conditions can provide valuable information to planning processes.

1.8 SOCIOECONOMIC VULNERABILITY ASSESSMENT

1.8.1 Objectives

The objectives of this project were to investigate agricultural vulnerability to extreme climate conditions in Old Wives Lake Watershed (OWLW) and North Saskatchewan River Basin (NSRB). These two regions were selected due to their differing climates and the ongoing adaptation planning processes occurring with watershed stewardship groups (see Section 3.6). The vulnerability assessments can be used to identify adaptation options and inform adaptation planning processes.

1.8.2 Method

Bottom-up vulnerability assessments were conducted through engagement of key watershed stakeholders, including grain farmers, ranchers, and other land stewards. Semi-structure interviewing techniques were used to first understand stakeholders' experiences with climate and to understand exposure, sensitivity, and adaptation capacity. There were 60 interviews conducted in the OWLW and 40 in the NSRB. Information from the interviews was then further contextualized with Census data, watershed reports, and other relevant literature.

1.8.3 Results

Generally, this study found agricultural adaptive capacity in both the OWLW and NSRB to be high. Production methods and technological innovations helped producers manage risks associated with climate variability in the past, although many producers find it difficult to conceptualize further measures that could be taken in this respect. Potential options referenced during the interviews included the development of new crop varieties that can tolerate future climate variability and increasing large-scale water supply infrastructure. Neither of these potential adaptation strategies could be implemented on-farm, and would have to be broader, public initiatives (Thompson 2011a, 2011b).

The availability of program support is relatively high. Relief programs in response to extreme climatic events have, for the most part, enabled producers to maintain their livelihood, although reliance on these programs is often unfavourable. Proactive programming, such as the Farm and Ranch Water Infrastructure Program, was also viewed as being beneficial in coping with drought (Thompson 2011a, 2011b).

Respondents noted that during periods of climatic stress, on-farm decision-making focuses on short-term sustainability. Short-term options include herd reduction, summer fallowing land (in excessive moisture events), and overgrazing land. It was widely acknowledged that these options undertaken to manage short-term risks can sometimes have implications for long-term farm sustainability (Thompson 2011a, 2011b).

Social networks are an important part of agricultural resilience. Access to technical assistance and funding are often greater for those who are involved with agricultural stewardship groups or other social organizations. Participation in social networks can also be a means of facilitating learning and innovation (Thompson 2011a, 2011b).

1.9 IN-STREAM FLOW NEEDS (ELOHA IMPLEMENTATION STRATEGY)

1.9.1 Objectives

The objective of this project was to outline a strategy for implementing the Ecological Limits of Hydrologic Alteration (ELOHA) framework in the South Saskatchewan/Qu'Appelle systems. The ELOHA framework takes a regional approach to assessing in-stream (a.k.a. environmental) flow needs, and was designed to address the issues regarding scientific rigour and resource constraints of previously applied frameworks. The ELOHA framework, including the scientific basis for the regional approach and the practical guidelines for its application, was developed by an international group of scientists. To date, the ELOHA framework has been applied in Australian, Chinese, and American river systems. The review of the ELOHA framework and development of the implementation strategy was completed by Rescan Environmental Services Ltd. (Rescan 2011).

1.9.2 Method

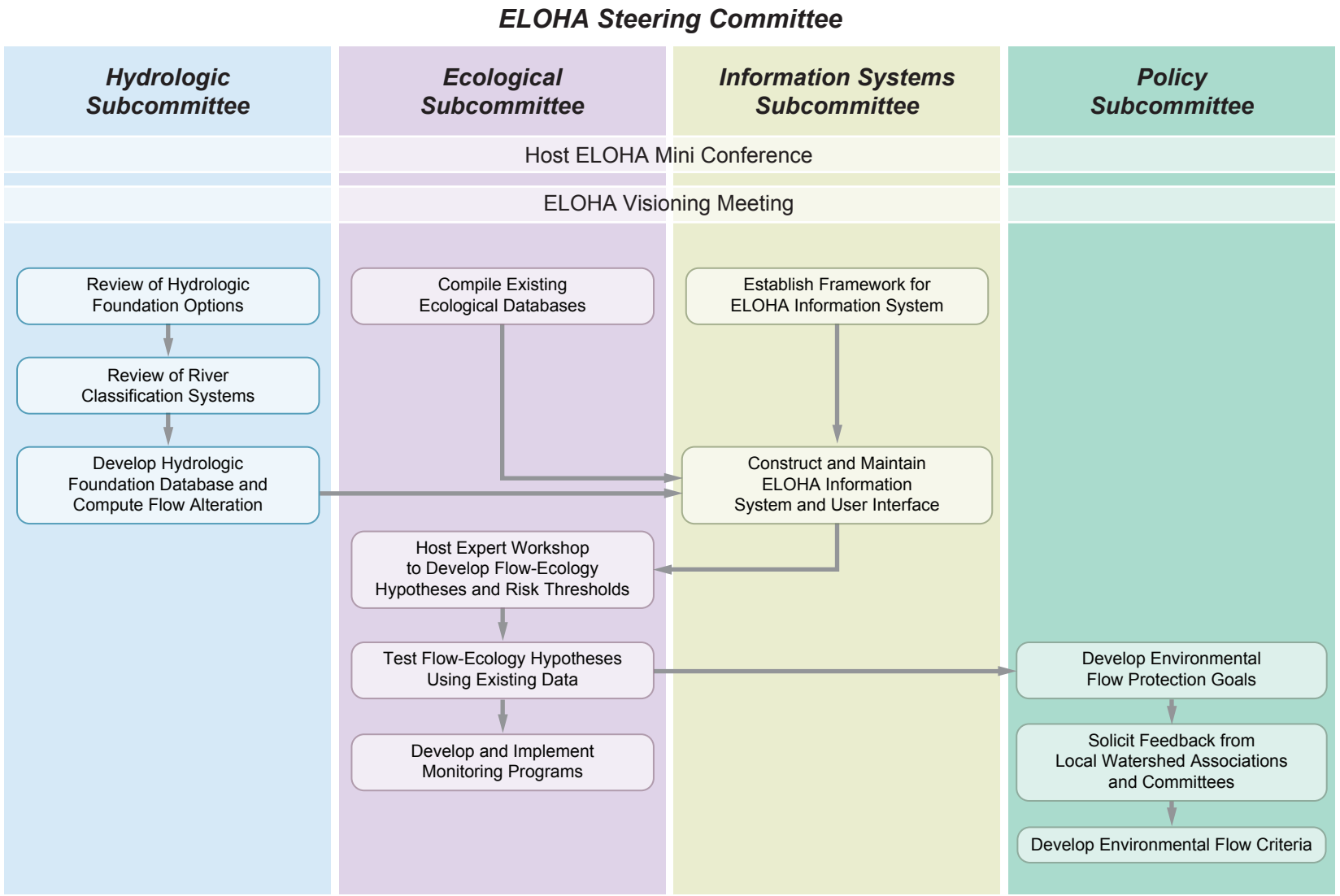
Rescan (2011) used desk and consultation-based research to compile and review relevant information regarding the implementation of the ELOHA framework in the selected systems. This included a general review of the ELOHA framework, development of a strategy for implementing this framework, insights into incorporating climate change adaptation within the framework, and documentation of existing data sources to support framework implementation.

1.9.3 Results

The implementation strategy developed as part of this project can be found in Figure 3.9-1. The implementation strategy involves the formation of an ELOHA Steering Committee, as well as relevant subcommittees (i.e., Hydrologic, Ecological, Information Systems, and Policy), to guide the implementation process. It was proposed that implementation be commenced with two workshops (Rescan 2011):

- an ELOHA Mini-Conference to introduce the ELOHA concept and provide a common ground on the path forward; and
- an ELOHA Visioning Meeting to provide direction for the path forward regarding spatial and temporal scales for project, data sources, and potential tools.

Following these meetings, the specific actions required by each subcommittee could occur, as outlined in Figure A1.9-1.



Source: Rescan 2011

Figure A1.9-1

Saskatchewan Watershed Authority

ELOHA Implementation Flow Chart

Figure A1.9-1

Rescan Engineers & Scientists

Opportunities to integrate climate change information were identified during the development of the hydrologic foundation and flow-ecology hypotheses. Scenarios for each of these could be built based on climate model projections from Global Circulation Models (GCMs). These scenarios could be used to inform strategies and to identify potential adaptation strategies.

1.10 VULNERABILITY OF PRAIRIE GRASSLANDS TO CLIMATE CHANGE

1.10.1 Objectives

The broad objective of this work was to assess the vulnerability of native grasslands and other natural ecosystems in the Prairie Ecozone of Alberta, Saskatchewan, and Manitoba to climate change. This work was completed by the Saskatchewan Research Council.

1.10.2 Method

The method for this work consisted of the following:

1. Characterizing baseline (1961 to 1990) climates using an interpolated dataset and future climates (2020s, 2050s, and 2080s) using GCM output representative of a range of conditions.
2. Modelling climate change impacts to vegetation zonation by relating the distribution of current vegetation zones to climatic variables and then driving the model with future climate scenarios.
3. Modelling climate change impacts to grassland production by relating observed production to average climate and then driving the model with climate change scenarios.
4. Modelling the influence of drought on grassland production by relating forage-year precipitation to observed production.
5. Documenting the potential impacts of climate change on biodiversity via literature review.
6. Documenting the impacts of climate change on rangeland and cropland via literature review.
7. Synthesizing the impacts.

1.10.3 Results

The following general trends for Canadian grasslands in the coming century are indicated (Thorpe 2011):

- reduced tree and shrub cover;
- reduced woody species invasion of grassland;
- increased areas of open vegetation suitable for livestock grazing;
- decreased (increased) populations of animal species dependent on woody cover (grassland);
- structural change of grasslands (decrease of midgrasses and increase of shortgrasses);
- decrease (increase) in cool-season (warm-season) grasses;
- migration of plant and animal species north from the U.S.;
- emerging community types resulting from differing rates of species northward migration;
- increases in invasion by exotic plants;
- reduced wetland coverage and shifts towards temporary wetlands; and
- slight to moderate decreases in average grassland production and grazing capacity.

Climate change is expected to have major impacts within the Prairie Ecozone of Alberta, Manitoba and Saskatchewan, resulting from changes in temperature and precipitation. A northward shift in vegetation zones is expected, as forest is replaced by aspen parkland and grassland. In more southerly regions, current Canadian grassland types are expected to be replaced by those found in the U.S. Great Plains (Thorpe 2011).

Slight to moderate decreases in average annual grassland production are expected, decreasing sustainable stocking rates. More problematic, however, are interannual production shortages resulting from climate variability and extremes, such as droughts. Short-term drought produces immediate reductions in growth and productivity, while prolonged, long-term drought can shifts grassland composition toward shorter or earlier-growing species. Increased potential for rangeland in formerly forested areas could help compensate for reduced production (Thorpe 2011).

Implications for overall biodiversity are also expected, as species respond to climate change differently, either by moving (i.e., shifting ranges) or adapting in place (changing phenology or evolution). Slow-dispersing species requiring specialized habitat are likely to be less adaptable to climate change than species having long-distance dispersal and general habitat requirements. Invasive species, with rapid dispersal rates, use of disturbed habitats, and capacity for rapid evolution, are likely to remain highly competitive under climate change, although increasing droughts may help to reduce invasion success by limiting resources available for invasion (Thorpe 2011).

Wetlands are likely to reduce in number and area under expected climate change, resulting in losses to duck 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).

1.11 VULNERABILITY OF FOREST ECOSYSTEMS IN THE PRAIRIE PROVINCES TO CLIMATE CHANGE

1.11.1 Objectives

A vulnerability assessment of the forestry sector will be conducted, focused on the impacts of drought and associated factors on the southern boreal forest across the prairie region. Specifically, this work will address the following questions (Johnston and Qualtiere, pers. comm.):

1. How does climate change affect wood supply in the future?
2. How do we incorporate climate change into management plans?
3. Are all changes going to be negative? What about a positive change? Will some areas be converted from wetland into forest?
4. What tools are available for forest managers to use in adaptation?
5. Is it possible to apply fire future scenarios and its impact on future wood production? What are different techniques that can be used to decrease fire susceptibility?

1.11.2 Method

Case studies in the Island Forest Region will be conducted, building on adaptation planning guidelines produced in Alberta as a part of PRAC. Landscape modeling, more specifically the LANDIS-II model, will be used to simulate landscape dynamics, including succession, disturbance, seed dispersal, forest management, and climate change effects. Information provided by the model will be used in the identification of adaptation options and throughout the adaptation planning process (Johnston and Qualtiere, pers. comm.).

1.11.3 Results

This work is ongoing and results will be updated as they are made available.

1.12 WATER DEMAND

1.12.1 Objectives

The objective of the water demand project is to characterize future water demand in key Saskatchewan watersheds (Kulshreshtha, pers. comm.).

1.12.2 Method

More details on the method will be added as they are made available.

1.12.3 Results

Although final results are not yet available, there are a number of insights from this work that can be provided at this time (Kulshreshtha, pers. comm.):

- water demand in the South Saskatchewan and Qu'Appelle systems is likely to increase in the future from irrigation and potash production;
- future trends in water demand in other areas of Saskatchewan (i.e., more rural areas) will vary depending on population trends, the development of potential oil sands projects, and uranium production;
- climate change is likely to increase water demand; and
- the threat of long-term hydrologic drought under a changing climate poses increasing risk as water demand increases.

This work is ongoing; results presented in this report should be used with caution. This section will be updated as further results are made available.

Appendix 2
Interview Guide

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Appendix 2. Interview Guide

SK Synthesis and Next Steps

Interview Guide

General Information

Name(s): _____

Position(s): _____

Agency: _____

Date interviewed: _____

Interviewed by: _____

Method: Telephone _____

Current Context for Adaptation

What is the mandate of your department (e.g., policies, programs, operations)?

_____

_____

_____

_____

In your area, what types of programs or activities come to mind in terms of climate change adaptation?

_____

_____

_____

_____

Are you currently working on climate change adaptation in any capacity? If so, please describe.

Are you aware of PRAC?

Did PRAC support or facilitate any adaptation (or other) activities in your organization?

Do you have any ongoing projects or initiatives that could have been facilitated by PRAC? Please explain.

Priority Areas and Actions

Within your mandate (i.e., policies, programs, operations), where is there the most additional work required in order to meet the challenges associated with existing climate (i.e., long-term conditions, variability and/or extremes)? Please explain.

Within your mandate (i.e., policies, programs, operations), where is there the most additional work required in order to meet the challenges associated with a changing climate (i.e., long-term trends towards warmer/drier climates and increasing uncertainty and risk from climate variability and extremes)? Please explain.

Within your mandate, how would you prioritize additional work related to adaptation? Please explain.

Do you have any ongoing or planned projects or initiatives that could be facilitated by a second round of PRAC funding, or funding from a similar program, that fit within your priorities for adaptation? Please explain.

Implementation

How do you see climate change adaptation being incorporated within your existing mandate (i.e., programs, policies and operations)?

What do you think the next steps are in terms of incorporating climate change adaptation within your existing mandate (i.e., programs, policies and operations)?

What additional information or tools would you need to help incorporate climate change adaptation within your mandate (i.e., programs, policies and operations)?

Are there other agencies (municipal, (inter)provincial or federal) you believe it would be beneficial to collaborate with in advancing climate change adaptation? Please describe the nature of the potential collaborations.

From your perspective, what are the barriers to advancing adaptation in Saskatchewan?

From your perspective, what are the opportunities for advancing adaptation in Saskatchewan?

Other comments

Are there additional topics related to adaptation that you would like to speak about today?

Do you have any final comments?

Appendix 3

Prioritization and Screening Tool

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Appendix 3. Prioritization and Screening Tool

Table A.3-1. Policy and Program Prioritization and Screening Tool

Policy or Program	Given expected climate change impacts, is working on this policy or program beneficial?		Given potential opportunities from mainstreaming and co-benefits, is working on this policy or program beneficial?		Given climate uncertainty and surprises, is working on this policy or program beneficial?		Is working on this policy no-regrets?		Overall priority	
	Answer	Explanation	Answer	Explanation	Answer	Explanation	Answer	Explanation	Priority	Explanation
Water Allocation	Highly Likely	Modernizing the Water Allocation Policy improves capacity to proactively manage risks associated with long-term hydrological droughts and changes to the timing, quality and quantity of water supplies.	Highly Likely	Modernizing the Water Allocation Policy improves capacity to manage potential growth in various industries (e.g., mining, oil and gas) will increase demand for water supplies.	Highly Likely	Formal yet flexible policy regarding water allocation can reduce reliance on *ad hoc* strategies when dealing with extreme events and improve management efficiency.	Yes	This initiative will likely be beneficial to water management in the context of expected economic growth with or without climate change.	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Hydrologic Drought Planning	Highly Likely	This initiative directly improves capacity to deal with Increases in the frequency, magnitude and/or duration of drought events.	Highly Likely	Reduction of vulnerabilities across sectors and regions	Highly Likely	This initiative helps increase preparedness for unforeseen and difficult to predict events.	Yes	Droughts are a natural part of the climate making drought planning beneficial with or without climate change.	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Climate Monitoring	Highly Likely	This initiative allows for changes in key climatic indices to be more accurately tracked and could improve monitoring of extreme events.	Likely	Improved monitoring has co-benefits for a wide range of industries, sectors, agencies and ministries (e.g., insurance, transportation, fire management, water management, agriculture, mining, oil and gas), but some of these benefits are already realized to a certain extent from existing monitoring systems.	Highly Likely	Accurate monitoring is beneficial for adaptive management of risk/opportunities associated with climate extremes, variability and changes in variability.	Yes	Improved monitoring leads to enhanced understanding and management of extreme climate events and variability regardless of climate change.	**Secondary**	Rates 'likely' in one criterion.

Policy or Program	Given expected climate change impacts, is working on this policy or program beneficial?		Given potential opportunities from mainstreaming and co-benefits, is working on this policy or program beneficial?		Given climate uncertainty and surprises, is working on this policy or program beneficial?		Is working on this policy no-regrets?		Overall priority	
	Answer	**Explanation**	**Answer**	**Explanation**	**Answer**	**Explanation**	**Answer**	**Explanation**	**Priority**	**Explanation**
Climate Information Systems	Highly Likely	This initiative improves climate risk management capabilities by spreading awareness and promoting learning about climate science and also by providing decision makers with the climate information required to make sound decisions.	Likely	Once developed and implemented, there may be opportunities to promote learning in other topic areas using the same system.	Highly Likely	Accessible and understandable climate information is beneficial for adaptive management of risk/opportunities associated with climate extremes, variability and changes in variability.	Yes	Improved climate information systems lead to enhanced understanding and management of extreme climate events and variability regardless of climate change.	**Secondary**	Rates 'likely' in one criterion.
Water Conservation, Efficiency and Productivity	Highly Likely	This initiative proactively reduces sensitivity to expected climate change impacts (e.g. long-term droughts).	Highly Likely	This initiative has co-benefits to a number of priority areas (e.g., health, ecosystem and/or watershed health) and it promotes government and industry/sector collaboration.	Highly Likely	This initiative will proactively reduce sensitivity to unexpected events impacting water availability.	Yes	The benefits from this initiative are not dependent on climate change occurring.	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Water Reuse	Highly Likely	This initiative proactively reduces sensitivity to expected climate change impacts (e.g. long-term droughts).	Highly Likely	This initiative has co-benefits to a number of priority areas (e.g., health, ecosystem and/or watershed health) and it promotes collaboration between agencies.	Highly Likely	This initiative could improve general resilience by reducing sensitivity to unexpected events impacting water availability.	Yes	The benefits from this initiative are not dependent on climate change occurring.	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Watershed Stewardship Planning Protocols and Learning Module	Highly Likely	This initiative would broaden awareness and promote learning of climate (change) science.	Likely	Linkages and opportunities for integration with other priority learning areas could be identified.	Highly Likely	This initiative would broaden awareness and promote learning around climate preparedness, including ways of managing uncertainty.	Yes	This initiative would be beneficial to deal with existing climate variability and extremes regardless of climate change.	**Secondary**	Rates 'likely' in one criterion.

Policy or Program	Given expected climate change impacts, is working on this policy or program beneficial?		Given potential opportunities from mainstreaming and co-benefits, is working on this policy or program beneficial?		Given climate uncertainty and surprises, is working on this policy or program beneficial?		Is working on this policy no-regrets?		Overall priority	
	Answer	**Explanation**	**Answer**	**Explanation**	**Answer**	**Explanation**	**Answer**	**Explanation**	**Priority**	**Explanation**
Integrated Landscape and Watershed Resilience (i.e. application of LIRA tool)	Highly Likely	This initiative would be focused directly on dealing with a broad range of climate (change) risks.	Highly Likely	There are numerous co-benefits to other priority areas from this initiative (e.g., soil conservation, water quality, air quality).	Highly Likely	This initiative directly increases preparedness capacity and reduces sensitivity to unexpected events.	Yes	The benefits from this initiative are not dependent on climate change occurring.	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Agri-environmental Programming	Highly Likely	This initiative would help raise awareness and promote learning of climate science in the agricultural community as well as provide incentives for pursuing sound adaptation.	Highly Likely	There are numerous co-benefits to other priority areas from this initiative (e.g., soil conservation, water quality, air quality).	Highly Likely	Programming designed to increase flexibility and the options available to producers will improve capacity to deal with unexpected climate events.	Yes	The benefits from this initiative are not dependent on climate change occurring.	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Economic Tools for Producers	Highly Likely	This tool would help producers understand the short- and long-term economic implications of adaptation decisions on their farms.	Highly Likely	The enhanced understanding of short- and long-term economic implications of adaptation decisions could also be applied for other priority areas (e.g., biodiversity, grassland conservation, permanent cover, watershed health).	Highly Likely	This tool would improve preparedness and capacity to deal with unexpected events by allowing for adaptation options to be assessed prior to the event occurring.	Yes	This tool could aid decision making in existing climate variability as well as in the context of climate change.	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Adaptation Policy and Programming for Grassland Conservation	Highly Likely	It is assumed this initiative would be specifically designed to deal with climate change risks within Grassland Conservation Programming.	Highly Likely	This initiative could provide benefits to other priority areas (e.g., species at risk, biodiversity, soil conservation).	Likely	Depending on the design and implementation of adaptive strategies, this initiative would likely improve capacity to deal with unforeseen climate risks.	No	This initiative focuses on integrating climate change considerations that may or may not be beneficial without climate change.	**Secondary**	Rates 'likely' in one criterion.

Policy or Program	Given expected climate change impacts, is working on this policy or program beneficial?		Given potential opportunities from mainstreaming and co-benefits, is working on this policy or program beneficial?		Given climate uncertainty and surprises, is working on this policy or program beneficial?		Is working on this policy no-regrets?		Overall priority	
	Answer	**Explanation**	**Answer**	**Explanation**	**Answer**	**Explanation**	**Answer**	**Explanation**	**Priority**	**Explanation**
Community Wildfire Risk Reduction	Highly Likely	This initiative directly reduces sensitivity to potential wildfire risks associated with climate change.	Highly Likely	This initiative would build upon and integrate within ongoing programming (e.g., FireSmart) used to reduce fire risk. Also, there are co-benefits to numerous other priority areas (e.g., infrastructure, health).	Highly Likely	This initiative directly reduces sensitivity to unexpected and unpredictable wildfire risks.	Yes	This initiative reduces wildfire risks with or without climate change.	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Adaptation of Island Forest Stands	Highly Likely	This initiative would promote experimentation and learning to deal with climate change risks.	Highly Likely	This initiative would improve the understanding of forest ecology in island forests on the Prairies and integrate adaptation into ongoing programming.	Likely	This initiative would promote experimentation and learning to deal with unexpected climate risks, however designing the experiments to encompass unexpected risk is difficult.	No	This initiative is specifically designed to deal with climate change.	**Secondary**	Rates 'likely' in one criterion.
Forest Management Planning	Highly Likely	It is assumed this initiative would be specifically designed to deal with climate change risks in the Forest Management Planning process.	Highly Likely	This initiative builds upon and integrates within ongoing programming.	Likely	Depending on the design and implementation of adaptive strategies, this initiative would likely improve capacity to deal with unforeseen climate risks.	No	This initiative focuses on integrating climate change considerations that may or may not be beneficial without climate change.	**Secondary**	Rates 'likely' in one criterion.
Governmental Climate Risk Assessment	Highly Likely	This initiative would help proactively assess and manage risks from climate change.	Highly Likely	This initiative may provide the basis for broader collaboration on and mainstreaming within other priority areas.	Highly Likely	This initiative may help identify general vulnerabilities to unexpected or unpredictable events.	Yes	This initiative would also be beneficial to deal with existing climate risks regardless of climate change.	**Primary**	Rates 'likely' in two or more criteria.

Table A.3-2. Policy and Program Prioritization and Screening Tool Ranking and Rating Explanation

Rating or Ranking	Given expected climate change impacts, is working on this policy or program beneficial?	Given potential opportunities from mainstreaming and co-benefits, is working on this policy or program beneficial?	Given climate uncertainty and surprises, is working on this policy or program beneficial?	Is working on this policy no-regrets?	Overall priority	
					Ranking	Explanation
Highly Likely	Focus on this policy will directly reduce vulnerability or increase resilience to expected climate change impacts.	Has significant opportunities for mainstreaming and co-benefits with other priority areas.	Substantially improves general adaptive capacity and resilience.	n/a	**Primary**	Rates 'highly likely' for all criteria and is no-regrets.
Likely	Focus on this policy will indirectly reduce vulnerability or increase resilience to expected climate change impacts.	Existing but limited opportunities for mainstreaming and co-benefits with other priority areas.	Moderately improves general adaptive capacity and resilience.	n/a	**Secondary**	Rates likely for one or fewer criteria and all other criteria at least 'highly likely'. May or may not be no-regrets.
Not Likely	Focus on this policy will not reduce vulnerability or increase resilience to expected climate change impacts.	No opportunities for mainstreaming or co-benefits with other priority areas.	Does not improve or limits and/or constrains adaptive capacity and resilience.	n/a	**Tertiary**	Rates 'likely' in two or more criteria. May or may not be no-regrets.
Yes	n/a	n/a	n/a	Makes sense without climate change and can be considered 'no-regrets' in this respect.		
No	n/a	n/a	n/a	Does not make sense without climate change and cannot be considered 'no-regrets' in this respect.		