Recent and Current Climate Change Impacts and Adaptation Research at PARC – Key Projects, Findings and Future Direction

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Norm Henderson[1]

[1] Prairie Adaptation Research Collaborative (PARC)

Abstract: PARC has recently organised and published important impacts and adaptation research projects, including the "Prairies Chapter" of Natural Resources Canada's National Assessment (From Impacts to Adaptation), the *Climate Scenarios for Saskatchewan* report and the *Saskatchewan's Natural Capital in a Changing Climate: an Assessment of Impacts and Adaptation* report. Key implications for Prairie region adaptation emerge from this body of work. The main biophysical impacts of climate change are seasonal, annual and geographic shifts in the distribution of water resources, and of associated plant and animal species. Extra water will be available in winter and spring, while summers are generally projected to be drier. The longer growing season will favour crop diversification and productivity, but moisture constraints will limit or outweigh these gains. Droughts and extreme weather events are the major threat. The key gap in our knowledge is an understanding of climate variability under conditions of climate change. PARC will engage in further research on climate variability issues, in particular, characterization of drought and drought risk under climate change. Tree species range mapping and policy development and general ecosystems protection policy under climate change will continue to be foci, as will development of a web-based tool to help stakeholders understand and adapt to the climate change impacts challenge on the Prairies. PARC will continue to train new researchers and support scholarship in the impacts and adaptation field, and will continue with an active program of media engagement and information dissemination.

Keywords: climate change, impacts, adaptation, Prairies

1. The Prairies Chapter of the National Assessment

The "Prairies Chapter" of the National Assessment (Sauchyn, *et al.,* 2008) was the chief focus of PARC energies for several years leading up to the Assessment's release in 2008. In the case of the Prairies chapter, the project involved the review and synthesis of hundreds of research papers by a team of 14 authors. Shortly after the release of the Assessment, PARC wrote and released a summary document that highlighted the key findings of this state-of-knowledge study.

The chief findings of the "Prairies Chapter" described below are drawn from the summary document (Henderson and Sauchyn, 2008) based on Sauchyn *et al.* (2008):

Water and Soil Resources

The sustainability and wealth of the Prairie Provinces are intimately linked to the quality and quantity of available water. Water impacts our health and well-being, food production, infrastructure, energy production, forestry, recreation, and communities large and small. Some of the greatest stresses endured in the Prairies have been directly related to hydrologic extremes of drought and flood.

Reduced winter snowfall in the latter half of the twentieth century (Akinremi *et al.*, 1999) contributed to the observed trend of declining streamflows. This is already a critical issue for many rivers in the southern Prairies, such as the Bow, Oldman and Milk, particularly in dry years. Winter warming will reduce snow accumulations in alpine areas (Leung and Ghan, 1999; Lapp *et al.*, 2005) and across the Prairies. This will cause declines in annual streamflow and a shift in streamflow timing to earlier in the year, resulting in lower summer water supplies – unfortunately summer is the season of greatest demand for water.

Continued glacier retreat (Demuth and Pietroniro, 2003) will exacerbate water shortages already apparent in many areas of Alberta and Saskatchewan during drought years. Drier soils result in decreased subsurface recharge, which will lead to a decline in the water table in many regions. Increases in the demand for water will compound issues of declining water supply and quality.

In the Alberta Rockies an increased frequency of landslides, debris flows, rock avalanches and outburst floods is probable, given current and projected future trends that include increased rainfall (especially in winter), rapid snowmelt and shrinking glaciers (Evans and Clague, 1994; 1997). The decay of permafrost could accelerate slope failures at high elevations for many decades (Evans and Clague, 1997).

In the taiga and boreal forest regions, increased drought frequency, including persistent multi-year droughts (Sauchyn *et al.*, 2003), will result in declining soil moisture and increased forest fire extent. During recent extreme droughts, organic soils have dried and burned together with forests, resulting in an almost total loss of vegetation and soil cover. Thereafter runoff becomes instantaneous, resulting in flash floods.

In agricultural regions, droughts could result in enhanced soil erosion and increased sand dune activity (Wolfe and Nickling, 1997). Slopes and stream channels exposed to less frequent but more intense rainfall will also be vulnerable to increased erosion and shallow slope failures (Sauchyn, 1998; Ashmore and Church, 2001). Erosion will increase stream sediment and nutrient loads in local water systems, leading to eutrophication of water bodies and increased pathogen loading in streams during the summer (Hyland *et al.*, 2003; Johnson *et al.*, 2003; Little *et al.*, 2003). The Millennium Ecosystem Assessment (2005) identified the joint effects of climate change and nutrient overenrichment as the major threat to agro-ecosystems. Phosphorus and nitrogen, while often useful inputs for agricultural production in the Prairies, impinge water quality and encourage eutrophication when run-off events move these nutrients into waterbodies.

Changing the timing of irrigation to after sunset and using more efficient irrigation methods can help offset increasing water demands (Bjornlund *et al.*, 2001). Increasing water recycling or issuing licenses to industries that are based on best water management practices and water recycling standards are other adaptation opportunities (Johnson and Caster, 1999).

Future water scarcity could lead to abandonment or underutilization of major infrastructure (canals, pipelines, dams and reservoirs) worth billions of dollars. Equally, rising water demand combined with a decline in summer runoff in some years will lead to calls for new infrastructure for increased storage and diversion of water. However, reservoirs emit greenhouse gases (St. Louis *et al.*, 2000), and dams and diversions have well-documented negative environmental impacts (Environment Canada, 2001; Mailman *et al.*, 2006).

Ecosystems

Models of vegetation zonation have shown a northward shift of the forest-grassland boundary in the Prairie Provinces with climate change (Hogg and Hurdle, 1995; Vandall *et al.*, 2006). In water-stressed forest regions there will be a general reduction in tree growth, regeneration failure in dry years, a gradual reduction in tree cover, and expansion of grassland patches. Major changes in species representation are projected for the boreal forest, especially at its southern boundary (Herrington *et al.*, 1997; Henderson *et al.*, 2002; Carr *et al.*, 2004). Increased average winter temperatures will lead to greater overwinter survival of pathogens and increased disease severity (Harvell *et al.*, 2002). Drought conditions weaken trees' defences to more virulent pathogens (Saporta *et al.*, 1998). Henderson *et al.* (2002) noted two pathways of forest change: 1) slow and cumulative decline; or 2) catastrophic loss, such as a major fire.

In the aspen parkland there will be shrinking of aspen groves and decreasing shrub cover. Aspen parkland and fescue prairie of the present northern grassland fringe will give way to variants of mixed prairie. The most significant impacts will occur at ecozone boundaries, for example, where grassland meets parkland or forest, or where drier lower-elevation grassland meets moister foothills grassland (Vandall *et al.*, 2006).

Prairie-parkland national parks can expect increases in forest fire frequency and intensity, increased forest disease outbreaks and insect infestations, and loss of boreal forest to grassland and temperate forest (Scott and Suffling, 2000; de Groot *et al.*, 2002). In Alberta's mountain parks, climate change has already caused the treeline to advance to higher elevations, a trend that will accelerate. Isolated island forests will suffer serious challenges to ecosystem integrity. Highly intensive management will likely be necessary to preserve some type of forest cover at these sites (Henderson *et al.*, 2002).

Possible adaptation actions to protect forest systems range from maintaining a diversity of age stands and responding aggressively to pathogen disturbances, to regenerating the forest with alien tree species that are better adapted to new climate parameters. Current policies disfavour alien introductions (e.g., Alberta Reforestation Standards Science Council, 2001; Alberta Sustainable Resource Development, 2005; Manitoba Conservation, 2005). However, western conifers, such as Douglas fir and ponderosa pine, and hardwoods of the southern Prairies, such as Manitoba maple and green ash, may be suited to future climates of the western boreal ecozone (Thorpe *et al.*, 2006).

The prairie pothole region of central North America is the most productive habitat for waterfowl in the world (Clair *et al.*, 1998). Increasing aridity and habitat loss in the prairie grasslands is likely to negatively impact migratory waterfowl populations (Poiani and Johnson, 1993; Bethke and Nudds, 1995).

Aquatic ecosystems will be stressed by warmer and drier conditions. A large number of prairie aquatic species are at risk of extirpation (James *et al.*, 2001). Many fish species and amphibians are sensitive to small changes in temperature, turbidity, salinity or oxygen regimes. The size of the massive algae blooms in Lake Winnipeg correlates with higher summer temperatures (McCullough *et al.*, 2006). Larger algal blooms, accelerated eutrophication, and serious impacts on fish species are expected, due to a combination of climate change, increasing nutrient runoff, and increasing human use pressures on natural water systems (Schindler and Donahue, 2006; Xenopoulos *et al.*, 2005).

Actions to increase connectivity between protected areas to facilitate migration of species populations is commonly proposed as one method of coping with climate change (Malcolm and Markham, 2000; James *et al.*, 2001; Joyce *et al.*, 2001). Although some species may be able to migrate, others will be threatened by the arrival of new competitors or by the pathogens that increased connectivity supports. Thus, increased connectivity may also hasten the decline of some ecosystems by favouring alien invasions.

Conservation management that aims simply to retain existing flora and fauna, or to restore historical vegetation distributions, will fail as the climate moves farther away from recent and current norms. Biodiversity protection planning may need to build resilience into ecosystems, rather than seeking stability (Halpin, 1997). Selection of protected areas may need to focus on site heterogeneity and habitat diversity (as these provide some buffer against climate change) rather than on representativeness (Henderson *et al.*, 2002).

Climate change means ecosystem change is inevitable. Therefore, biodiversity managers must become less practitioners of preservation and more stewards of new and unprecedented ecosystems and landscapes.

Agriculture

Higher levels of atmospheric CO_2 improve water-use efficiency of photosynthesis, and may increase some crop yields (particularly for plants using the C3 carbon-fixation pathway, like wheat and canola). However, the picture is complex, since weeds may also be more vigorous under a carbon-enriched atmosphere. Warmer and longer growing seasons could be positive for crop growth and yield. Shorter and milder winters may put less stress on livestock. Potential negative impacts include changes in the timing of precipitation, more intense precipitation events, the emergence of new pests, and, especially, the increased frequency and intensity of droughts.

Manitoba, the least water-deficient province, has been projected to benefit from warming as producers shift to higher value crops (Mooney and Arthur, 1990). By contrast, the more arid mixed grassland ecoregion of southern Alberta and Saskatchewan, an area of approximately 200,000 km^2, is at risk of desertification.

Historically, federal and provincial governments have responded to drought with safety net programs to offset negative socioeconomic impacts (Wittrock and Koshida, 2005) and, more recently, through development of drought management plans. More intense and longer droughts will be expensive challenges to safety net programs.

Grassland production is limited by moisture supply. Although a drier climate would suggest declining production and grazing capacity, actual changes in grassland production are likely to be modest, given a longer growing season, reduced competition from shrubs and trees, and increases in warm-season grasses that have higher water-use efficiency (Thorpe *et al.*, 2004).

Soil conservation and irrigation are major agricultural adaptations to annual soil water deficits. Soil conservation is a prime example of a 'no regrets' strategy, since preventing soil loss is beneficial whether or not impacts of climate change occur exactly as projected. The Permanent Cover Program (Vaisy *et al.*, 1996) has reduced sensitivity to climate over a large area. The move in recent decades to more efficient irrigation techniques has dramatically increased on-farm irrigation efficiencies. However, the continued loss of water from irrigation reservoirs and open-channel delivery systems due to evaporation, leakage and other factors indicates the need for further improvement in the management of limited water resources.

Forestry

Generally, net primary forest productivity is expected to increase under warmer temperatures and longer growing seasons, if water and nutrients are not limiting (Norby *et al.*, 2005). Increased photosynthetic activity for much of Canada during the period 1981–1991 has been attributed to a longer growing season (Myneni *et al.*, 1997).

Free-air CO_2 enrichment experiments found trees respond to increased CO_2 concentrations more than other vegetation, with biomass production increasing an average of about 20 to 25% (Long *et al.*, 2004; Norby *et al.*, 2005). Higher levels of atmospheric CO_2 improve water-use efficiency (WUE); that is, less water is lost for a given unit of CO_2 uptake (Long *et al.*, 2004) – particularly important for water-limited sites. Johnston and Williamson (2005) found that, even under severe drought conditions, increased WUE under a high CO_2 future would result in an increase in productivity relative to current conditions. Simulated future drought reduced productivity of white spruce in Saskatchewan by about 20% on sites with low available water-holding capacity (Johnston and Williamson, 2005).

Insect outbreaks are expected to be more frequent and severe (Volney and Fleming, 2000). Of particular concern is the mountain pine beetle, currently in a major outbreak phase in the interior of British Columbia. It is now beginning to spread east, with approximately 2.8 million trees affected in Alberta as of spring 2007 (Alberta Sustainable Resource Development, 2007). The beetle is limited by the occurrence of –40°C winter temperatures; with warming, this limiting temperature is likely to occur farther to the north and east, allowing the beetle to spread into jack pine in the Prairie Provinces.

Forest fires are expected to be more frequent (Bergeron *et al.*, 2004), of higher intensity (Parisien *et al.*, 2004), and to burn over larger areas (Flannigan *et al.*, 2005). Increased forest fire activity will likely favour hardwood species (e.g. aspen) over some conifers (e.g. white spruce), as aspen recovers quickly after fire. Increased tree mortality in the southern margin of the boreal forest is projected as a result of the interaction of insects, drought and fire (Hogg and Bernier, 2005; Volney and Hirsch, 2005).

In areas where winter operations are important, a shorter period of frozen ground conditions will limit operations and affect scheduling of harvesting equipment. Potential adaptation measures for dealing with climate change impacts include managing forests to reduce fuel loads and fire loss potential; assisting the migration of commercial tree species; thinning forests to enhance growth and insect / disease resistance; and maintaining connectivity (Spittlehouse and Stewart, 2003). Forest loss could be irreversible if adaptation is slow or only reactive.

Transportation

Increased frequencies of extreme precipitation events (Kharin and Zwiers, 2000) and increased inter-annual climate variability are likely to result in increased damage to roads, railways and other structures as a result of flooding, erosion and landslides. Asphalt surfaces, particularly those with significant heavy truck traffic, are especially susceptible to damage during heat waves, which are expected to increase in frequency.

Winter roads, that is, those that use frozen lakes and muskeg, have experienced significant negative impacts. Manitoba Transportation and Government Services has reported decreased ice thickness, poor ice texture and density, delayed winter road seasons, problematic muskeg areas and decreased load limits. The average length of the winter road season in Manitoba is expected to decrease by 8 days in the 2020s, 15 days in the 2050s and 21 days in the 2080s (Prentice and Thomson, 2003).

The longer ice-free season in Hudson Bay and northern channels resulting from continued climate warming (Arctic Climate Impact Assessment, 2005) will increase opportunities for ocean-going vessels to use the Port of Churchill terminus for grain and other bulk commodities. But northern railways passing through areas of permafrost, as does the rail line serving Churchill, will require frequent repair, if not replacement, as a result of continued permafrost degradation (Nelson *et al.*, 2002). Additionally, some paved roads in northern areas are stabilized by frozen substrates during winter and may be compromised by warmer winter temperatures.

Communities

Prairie cities may find existing water storage and drainage systems inadequate to handle projected changes in precipitation intensity and snowmelt. Increasing drought frequency and severity will require water efficiency initiatives. The City of Regina has developed drought contingency plans, including water conservation programs and expansion of water treatment and delivery capacity (Cecil *et al.*, 2005). Other Prairie cities do not have such contingency plans in place (Wittrock *et al.*, 2001). More frequent heat and drought events can place urban vegetation and wildlife under extreme stress. For example, the City of Edmonton (2007) estimated the loss of approximately 23,000 trees to drought since 2002.

In general, rural communities are more sensitive to climate change impacts than cities, due to their more direct natural-resource dependency and lack of economic diversification. Drought is of particular concern, as small communities are largely dependent on well water or smaller reservoirs. Of greatest concern for agricultural communities are extreme weather events, droughts and ecosystem shifts. Rural residents may be more skeptical than urbanites about climate change (Neudoerffer, 2005), which may hinder adaptation initiatives.

Many Aboriginal communities are partly dependent on subsistence for their livelihood. Declines or uncertainties in the availability of moose, caribou, deer, fish and wild rice will increase dependence on imported foods. Unsuitable snow and ground conditions greatly hamper travel to trap lines, hunting grounds and fishing areas. At the February 2004 Prince Albert Grand Council Elders' Forum, elders reported more frequent extreme weather events, deterioration in water quantity and quality, changes in species distributions, changes in plant life, and decreasing quality of animal pelts. Traditional knowledge and land management systems served as a source of resiliency in the past, and could play an important role in strengthening adaptive capacity in the future.

Health

Prairies residents may experience increasing negative health burdens from air pollution, food-borne pathogens, heat-related illnesses, particulate matter, water-borne pathogens and vector-borne diseases (Seguin, 2008). Subpopulations most at risk are children, the elderly, Aboriginal peoples, the poor, the homeless, and people with underlying health conditions.

An increased frequency of wildfires may result in increases in respiratory ailments, hospital visits and mortality (Bowman and Johnston, 2005). Warmer temperatures decrease the number of cold-related deaths, but also enhance the production of secondary pollutants, including ground level ozone (Last *et al.*, 1998; Bernard *et al.*, 2001). Drought may increase concentrations of pathogens and toxins in domestic water supplies (Charron *et al.*, 2003; World Health Organization, 2003). Outbreaks of water-borne disease have been linked to intense precipitation, flooding and runoff from agricultural livestock areas (Millson *et al.,* 1991; Bridgeman *et al.*, 1995; Charron *et al.*, 2003, 2004; Schuster *et al.*, 2005). Hantaviruses may increase, as well as West Nile virus. Other potential health threats are western equine encephalitis, rabies, influenza, brucellosis, tuberculosis and plague (Charron *et al.*, 2003).

Energy

Increasing water scarcity and water supply variability are the major climate change risks to energy industries. Production of oil, and even some natural gas, relies on significant quantities of water (Bruce, 2006). Tar sands production is already putting pressure on Athabasca River water; climate change and expanding production will worsen this problem (Bruce, 2006). Drought periods will reduce the supply of cooling water to power plants.

Approximately 95% of the electricity generated in Manitoba comes from renewable water energy (Manitoba Science, Technology, Energy and Mines, 2007). Future hydro generation will be impacted by decreasing water flows from the western portion of the Prairies due to glacial ice decline (Demuth and Pietroniro, 2003) and lower snow accumulations (Leung and Ghan, 1999; Lapp *et al.*, 2005).

Warming is already causing substantial permafrost degradation in many parts of the north (Majorowicz *et al.*, 2005; Pearce, 2005), which will lead to land instability, soil collapse and slope failures. Together with an increased frequency of extreme climate events, this will create problems for foundations and roads. There will be pipeline ruptures and costs to reroute existing pipelines to more stable locales (Huang *et al.*, 2005).

Tourism and Recreation

Lower lake and stream levels, particularly in mid- to late summer, may reduce opportunities for water-based recreation: swimming, fishing, boating, canoe-tripping and whitewater activities. Hunting and fishing could decline with decreasing waterfowl and game fish populations. The island forest parks (Henderson *et al.*, 2002) and small recreation areas of the southern Prairies, where water and trees draw visitors, are particularly sensitive to changing climate. Banff's ski industry may be negatively affected by less snowfall (Scott and Jones, 2005). Less snow cover and a shorter season will also impact cross-country skiing, snowshoeing and snowmobiling (Nicholls and Scott, in press).

2. Other Key Research Reports

Climate Scenarios for Saskatchewan

In 2009 PARC published a new set of climate scenarios (Barrow, 2009) for Saskatchewan based on the latest available GCM outputs. Since changes to moisture balance represent the most serious impact to both Saskatchewan's forest and grassland regions, scenarios were selected on the basis of an annual moisture index, i.e. on the combined effect of both temperature and precipitation changes. Moisture balance is a key issue in the health of Saskatchewan ecosystems and in the success of key industries such as agriculture. It also affects water supply to industry, cities and towns, and hydropower generation. The results for specific Saskatchewan towns are summarised in Figure 1, and show a future of increased aridity for Saskatchewan, even under the most optimistic of scenarios.

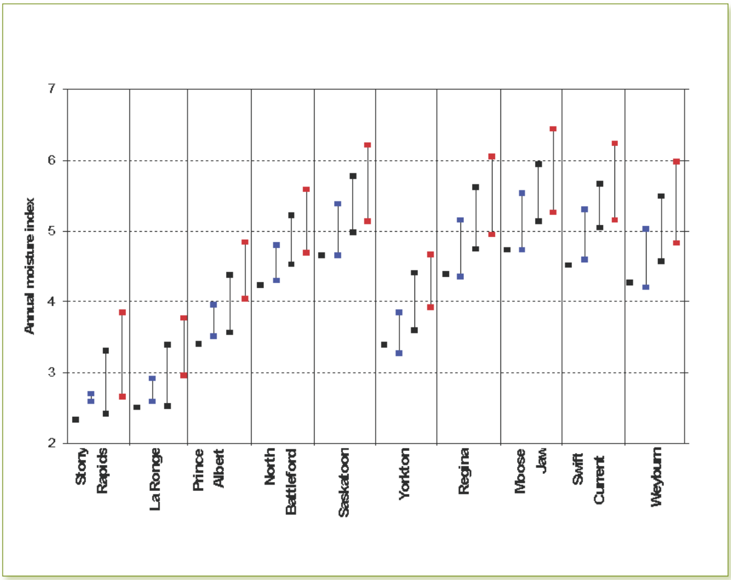

Figure 1 | Annual moisture index for the forest and grassland sites in Saskatchewan. At each site there are four blocks of data: 1961-1990 baseline (black square), and the scenario ranges for the 2020s (blue high-low lines), the 2050s (black high-low lines) and the 2080s (red high-low lines). Higher numbers indicate more arid conditions.

Across a range of global climate models and greenhouse gas emission scenarios, there is a consistently-predicted increase in future annual temperature and precipitation throughout Saskatchewan. These climate changes impact many activities, especially agriculture. When, within the year, extra heat and water will be available is an important question. Most of the warming is occurring in winter. The frost-free growing season is getting longer. However, some of the advantages of a cold winter are being lost that enables transportation over ice and frozen ground in northern Saskatchewan, prevents many pests and diseases, and stores water as snow – the most abundant, reliable and predictable source of water. Most of the extra precipitation is expected in winter and spring and increasingly in the form of rain as the climate warms. Scenarios of summer precipitation are less consistent but many include decreased summer precipitation falling in fewer and more intense storms. Thus, on average, the mid to later stages of longer warmer summers will tend be drier, possibly much drier.

The report (Barrow, 2009) notes that while most scenarios generate information on projected changes to mean climate, in Saskatchewan it is climate variability that is the key concern. Variability is the degree and frequency of variations from the mean climate, the climate normals. It is changes in variability which are likely to have the largest effect on the frequency and magnitude of extreme climate events. Extreme events on the Prairies include tornadoes, plow winds, hail, severe thunderstorms, blizzards, droughts, rain-flood events, and ice events. These extreme events in turn tend to have a large impact on our environment, economy and infrastructure. Understanding or defining changes in climate variability as well as changes in mean climate is not a trivial task. Statistical techniques (such as stochastic weather generators) exist which allow the perturbation of observed time series by both changes in means and variability. These techniques are best applied at the site scale, so one option would be to focus on specific locations, such as those in Figure 1.

Saskatchewan's Natural Capital in a Changing Climate

In 2009 PARC published a major report (Sauchyn *et al.,* 2009) identifying the main impacts and adaptation options for Saskatchewan's natural systems, based on the latest climate scenarios. The report draws on the expertise of top climate change researchers and a large body of previous work to create a state-of-knowledge synthesis of key biophysical impacts and adaptation options. The focus is on Saskatchewan's ecosystems and water resources and the sectors of the economy, agriculture and forestry, which are most dependent on these natural resources. The report documents the expected impacts of climate change on Saskatchewan's natural resources and dependent industries, and outlines options for adaptation of resource management practices, policies and infrastructure to minimize the risks associated with the impacts of climate change and to take advantage of opportunities provided by a warming climate. Key conclusions include:

- The major biophysical impacts of climate change in Saskatchewan are seasonal, annual and geographic shifts in the distribution of water resources and plant and animal species.
- One of the most certain projections is that extra water will be available in winter and spring but summers generally will be drier as the result of earlier spring runoff, and a longer warmer summer season of water loss by evapotranspiration. Much of the observed and projected warming in Saskatchewan is during winter and spring, such that the frost-free growing season is getting longer and expected to get significantly longer as the climate warms.

- A longer warmer growing season will favour diversification of prairie agriculture and higher crop, pasture and forest productivity. However, higher productivity will be limited by the availability of soil moisture.
- The impacts of climate change tend to be adverse because Saskatchewan communities and resource economies are sensitive to fluctuations in the quantity and quality of natural capital and they are not adapted to the projected larger range of climate conditions.
- The net impacts of climate change depend heavily on rates of climate change and the effectiveness of adaptation measures. South of the Churchill River, nearly all of Saskatchewan's ecosystems and water resources are managed. Most impact assessment has assumed no adaptation or made simple assumptions about adaptation. This reflects a lack of understanding of adaptation processes and the difficulty of predicting changes in public policy and socio-economic factors.
- Planned adaptation is a component of adaptive resource management and sustainable economic development. There is a gap in our understanding of the extent to which existing management practices and public policies either encourage or discourage the implementation of adaptive strategies. There is also a need to determine the relative importance of adaptive responses versus other priorities, and to develop approaches that incorporate climate change considerations into existing policy instruments.
- The major threats are understood with the least certainty. The recurring impacts of drought in Saskatchewan suggest that the severity and duration of future droughts will determine much of the impact of climate change. Droughts, and to a lesser extent flooding, could limit opportunities provided by a warmer climate and will challenge capacity to adapt to changing conditions. Nearly all climate change assessments are based on climate change scenarios that give shifts in mean conditions between decades.
- A key finding of this impact assessment, therefore, is that the gap in our knowledge of climate variability is problematic for evaluating impacts and developing appropriate adaptation strategies.

3. PARC's Future Priorities

Water issues and climate change are the key challenge to the Prairie Provinces and PARC will continue to engage in research and collaboration in this area. Climate variability, in particular the risk of drought, is the key risk, and efforts are under way to try and model and understand variability under climate change. Tree species range mapping and policy development and general ecosystems protection policy under climate change will continue to be foci, as will development of a web-based tool to help stakeholders understand and adapt to the climate change impacts challenge on the Prairies. PARC will continue to train new researchers and support scholarship in the impacts and adaptation field, and will continue with an active program of media engagement and information dissemination. Prominent amongst these efforts is the June 2010 launch of **www.SaskAdapt.ca**. This new website summarises key PARC research in an accessible way for a wide range of stakeholders.

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