Long Range Climate Outlook: Semi-arid?

Dave Sauchyn

Prairie Adaptation Research Collaborative, University of Regina, 150 - 10 Research Drive, Regina, SK S4S 7J7; ***Email***: sauchyn@uregina.ca

Introduction

This paper presents scenarios of the future climate of the Prairie Provinces and summarizes the scientific understanding of the current and potential impacts of these climate changes. Global warming is now very well documented. Increases in temperature over the past several decades can be simulated only by models that include the forcing of climate by human-caused increases in the concentration of greenhouse gases. The impacts of climate change can be avoided only with significant reductions in emissions of greenhouse gases. Because human activities already have modified the climate, and the full response of temperature lags by decades behind the forcing of change, significant global warming will occur before new technology, legislation and voluntary actions can control emissions of greenhouse gases. Therefore some, and possibly substantial, adaptation will be necessary to prevent the adverse impacts of climate change. There are significant opportunities for adaptation, any adjustment to management practices, infrastructure, engineering design, and public policy that increases the resilience of communities and economic sectors and lowers vulnerability to climate change and variability. Adaptation also is the means of taking advantage of a warmer climate.

Pattern of Global Warming

The pattern of global warming projected by most climate models, and observed in recent years, shows that the largest increase in mean annual temperature occurs in the high latitudes of the Northern Hemisphere. This zone of maximum heating dips to lower latitudes over the continental interiors, which in Canada includes the Prairie Provinces (Lemmen and Warren, 2004). Scenarios of the mid 21st century climate of this region suggest median annual increases of 2 to 5 degrees in temperature and 2 to 12% in precipitation

(CCSN, 2006). With the exception of a few scenarios for the 2020s (2010-2039), all models project climates that are outside the current range of natural variability. Much of the change will occur in winter and spring with increases of close to 4 degrees in temperature and 15% in precipitation (CCSN, 2006).

Consistent with these climate projections, temperature records from this region show significant positive trends, especially since the 1970s (**Figure 1**). The favourable consequences of this temperature trend are a warmer and longer growing season. The productivity of forests, crops and grassland should rise with more heat and higher concentrations of CO_2, provided there is adequate soil moisture. Unfortunately, another common climate change scenario is a summertime drying of the earth's mid-continental regions (Lemmen and Warren, 2004). This elevated aridity has major implications for the Prairie Provinces, the driest major region of Canada, where moisture deficits are the most serious climate risk. Seasonal water deficits occur in all regions of Canada, but only in the Prairie Provinces can surface water disappear over large areas for many months, seriously impacting the economy and environment and putting landscapes at risk of desertification.

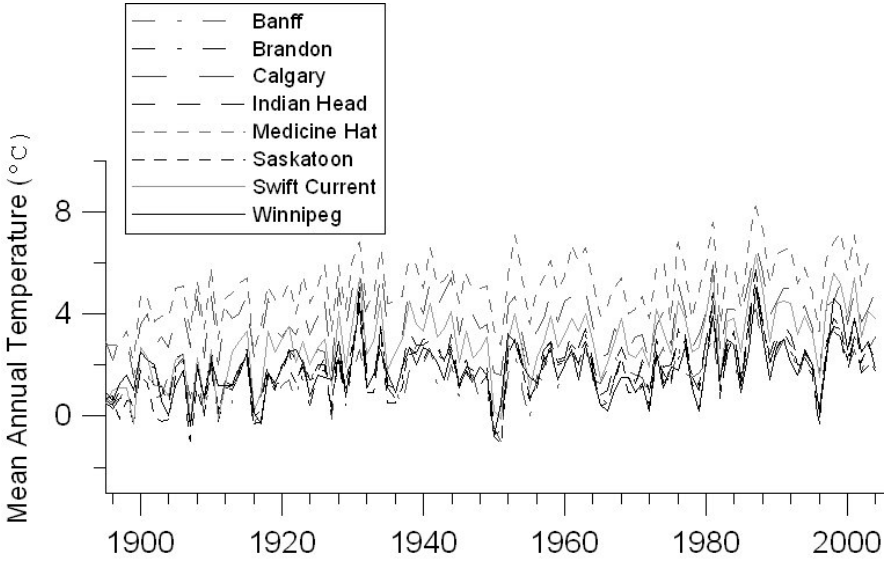

Figure 1. Trends in mean annual temperature since 1895 for 12 climate stations located across the Prairie Provinces. (Source: Adjusted Historical Canadian Climate Data - *www.cccma.bc.ec.gc.ca/hccd/)*

The communities and institutions of the Prairies Provinces have considerable capacity to take advantage of higher temperatures and minimize the adverse impacts of climate change. There are, however, socioeconomic and environmental characterises that underlie vulnerabilities to climate change:

- Canada's major dryland, with social and natural systems that are sensitive to periodic drought
- More than 80% of Canada's farmland
- The reliance of agricultural production in southern Alberta and south-western Saskatchewan on irrigation water from the receding glaciers and waning snow packs of the Rocky Mountains
- Headwaters of the longest rivers in western North America: the Mackenzie, Saskatchewan-Nelson and Missouri Rivers
- Climates of the recent past and near future that were, and very likely will be, less favourable than the climate of the 20th century
- The climatically-sensitive ecological transition from grassland to forest
- The water required for processing Canada's largest reserves of oil and gas
- Canada's fastest growing cites and economies
- The most concentrated aboriginal population in Canada outside the northern territories

Considering these and other characteristics of the Prairie Provinces, exposure to the forecasted climate changes presents the following risks and opportunities.

Changes in the Availability of Water Resources

Recent trends in water resources and future projections include lower summer stream flows, falling lake levels and retreating glaciers. Most climate impact scenarios also show increasing soil and surface water deficits as more water is lost by evaporation and transpired from plants than is gained by the extra precipitation expected with global warming (Lemmen and Warren, 2004). A trend of increased aridity most likely will occur with droughts of longer duration and greater frequency. With greater climate variability, there also could be unusually wet periods and flooding.

Shifts in Bioclimate and the Distribution of Ecosystems

Shifts in bioclimate and the distribution of ecosystems will result in new ecosystems (*e.g.* shortgrass prairie), changed disturbance regimes (insects and fire), stressed aquatic habitats, fewer native species and the introduction of previously non-native plants and animals (Lemmen and Warren, 2004).

Impacts will be most visible at strong ecological gradients: mountain ecosystems, isolated forests and forest fringe areas. There are major implication for livelihoods (*e.g*. aboriginal) and economies (*e.g*. agriculture, forestry) that depend on natural resources. Adjustments to ecosystem management will be required to enable or prevent ecological responses to climate change.

The Prairies are Losing the Advantages of a Cold Winter

There will be less frozen ground to support winter transportation and resource extraction, and new pests and disease vectors likely will survive warmer winters. Most importantly, however, more precipitation will fall as rain, a less reliable and predictable source of water than snow and ice.

Sensitivity of Resources and Communities to Climate Variability

The prairies have one the world's most variable climates. This variability has been costly. For example, the drought of 2001-02 caused a drop in agricultural production in the prairies of about $3.6 billion (Wheaton *et al*., 2005). Most adaptation to climate risks has occurred in response to droughts. The impacts of climate are necessarily adverse when resource management practices assume a stationary climatic and hydrological regime.

The Major Risk

Among these risks and opportunities, changes in the availability of water resources represent the most serous risk imposed by climate change. Higher forest, grassland and crop productivity from increased heat and CO_2 could ultimately be limited by available soil moisture. An expanded range of year to year departures from climate norms may represent a greater risk to the prairie economy than simply a shift in mean conditions. Climatic extremes, especially droughts, can limit opportunities provided by a warmer climate and require adaptation strategies that are different than those that address the impacts of climate change. Water scarcity could constrain the rapid economic and population growth in Alberta.

The sources of water supplies are upland watersheds, primarily in the eastern slopes of the Rocky Mountains, the water towers of the prairies. Growth of prairie communities and economies during the 20th century (and especially since the 1930s) occurred while mountains glaciers were rapidly melting and droughts were of relatively short duration. Records of past climate and models of future climate both show climate extremes (*i.e*. prolonged droughts) that were lacking in the 20th century (**Figure 2**). Resulting perceptions of abundant and consistent water supplies have influenced water use, policy and management.

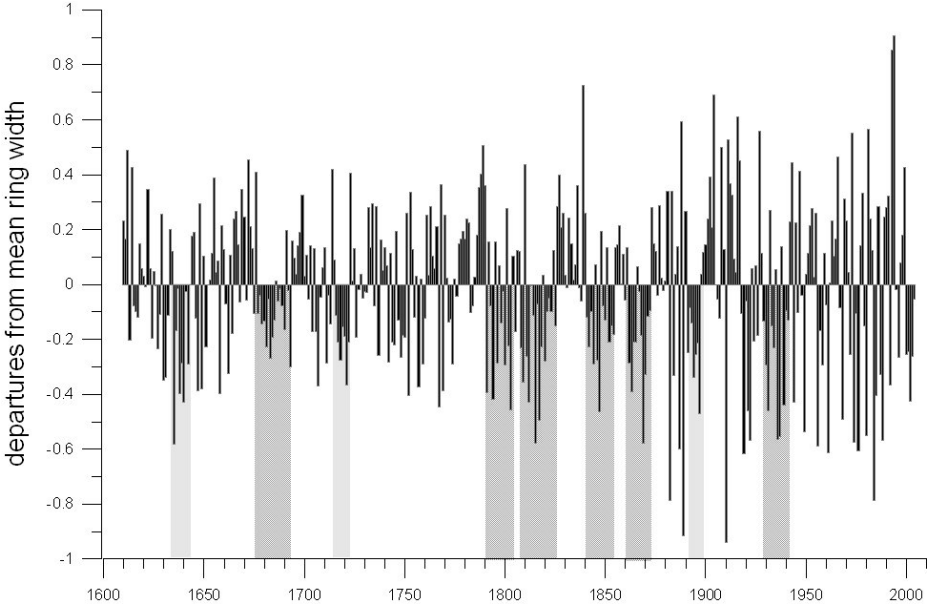

Figure 2. Departures from mean standardized tree-ring width from 1611 to 2004 for Douglas Fir from the Wildcat Hills near Cochrane, Alberta. Positive departures represent years of above average soil moisture. Negative departures represent years of below average soil moisture. Sustained dry periods are highlighted to illustrate that the 1930s dust bowl was not a rare event. The dark grey shading highlights periods when most years had below average soil moisture. The lighter shading marks droughts that were of shorter duration but severe in terms of many consecutive years of below average moisture conditions.

■ Preparing for the Future

In the Prairie Provinces, there is a large potential for adapting to climate change. The necessary resources exist in terms of social and natural capital, technologies, infrastructure and institutions. Also, there is a history of adaptive management in forestry and agriculture. Recent adaptations (*e.g.* minimum tillage practices and crop diversification in the agriculture sector, water policy in Alberta, reengineering of the Red River floodway, municipal infrastructure and water conservation programs) have enhanced resilience and reduced vulnerability to climate change.

The adaptive capacity of all communities and sectors of the economy will be challenged by a projected increase in climatic variability (*e.g.* drought) and frequency of extreme events. Also, levels of adaptive capacity are uneven

geographically (*e.g*. rural communities generally have lesser resources and emergency response capacity) and among populations; elderly, aboriginal and immigrant populations are the fastest growing and most vulnerable to the health impacts of climate change. There likely will be further migration from rural to urban communities and to regions with the most resources.

Water management and conservation have been and will continue to be important strategies of adaptation to climate change and variability. This includes adaptive technologies for improved water use efficiency and water pricing regimes to more accurately reflect the real costs of water treatment and supply and to ensure that an increasingly scarce resource is properly allocated. Policy and practices must be adjusted to manage a hydrological cycle that may be increasingly sensitive to the timing and frequency of rainfall events with less of a buffer from ice and snow. Current sensitivity to drought suggests that our communities and institutions are not adequately adapted to climate variability even in the absence of climate change that could produce shifts in the magnitude and frequency of departures from an average climate (that is, severity of drought).

■ Conclusion

Many of the recently observed trends in climate and hydrology are consistent with scenarios of future climate and the consequences for the Prairie Provinces. The greatest risk imposed by global warming is changes to the amount, quality and distribution of water supplies. A scenario of greater summer dryness and increased climate variability will be a challenge for sustainable economic development unless, without further delay, there is a concerted effort to control the greenhouse gas emissions and develop and implement polices and programs to enable individuals, communities and corporations to adapt to a warmer and drier climate.

A high adaptive capacity could mitigate much of the potential impact of climate change but it is not clear how this capacity will be applied. Capacity is only potential – government agencies and local institutions will play a key role in mobilizing adaptive capacity. Since adaptation is the process of adjusting policies, practices (*e.g*. soil and water management) and processes, the main role of individuals will be to work collectively to influence public policy and the delivery of programs and services such that the impact of climate change on our lifestyles and economies can be constrained. We must demand that government and industry take action to minimize the risks and capitalize on the opportunities. Policy must enable individuals and small businesses (*e.g*. farms) to manage financial and natural resources to build resilience to climate change and variability.

References

CCSN (Climate Change Scenarios Network). 2006. *http://www.ccsn.ca/* (Accessed October 8, 2006)

Lemmen, D. and F. Warren (editors). 2004. Climate Change Impacts and Adaptation: A Canadian Perspective. Government of Canada Climate Change Impacts and Adaptation Program, Ottawa, ON. (Available at *http://adaptation.nrcan.gc.ca/perspective_e.asp*)

Wheaton E., V. Wittrock, S. Kulshreshtha, G. Koshida, C. Grant, A. Chipanshi, and B. Bonsal. 2005. Lessons Learned from the Canadian Droughts Years of 2001 and 2002: Synthesis Report. SRC Publication No. 11602-46E03. Saskatoon: Saskatchewan Research Council. (Available at www.*rural-gc.agr.ca/pfra/drought/info/11602-46E03.pdf*)