Features of Climate Extremes in Two Key Watersheds in the Canadian Prairies - the Swift Current Creek and Oldman River Watersheds: A VACEA Fact Sheet

People, plants and animals are challenged with wide ranges of temperatures, precipitation and other climatic conditions in the prairie region. This fact sheet introduces some main features of climate extremes for the Swift Current Creek Watershed (SCC) in Saskatchewan and Oldman River Watershed (OM) in Alberta. Associations of drought and excessive moisture with wheat yields are also referenced to initiate the discussion of impacts, vulnerability and adaptation. When identifying climate extremes, it is always best to have the longest record possible, however, the climate stations started and ended collecting data at different times, so these dates are included.

Temperature: what and where are the record extremes, where is the greatest variability?

Very high and extreme low temperatures have been recorded. A record low of **-45.6°C** (Beaver Mines, OM, Jan 1943), and extreme high of **43.3°C** (Maple Creek, Aug 1961, SCC), demonstrate that these watersheds can experience a range of almost 90°C in temperature variations. The record begins in 1912 for Beaver Mines and 1921 for Maple Creek. The OM is warmer in the winter and cooler in the summer than the SCC, on average for January and July. Day to day temperature changes are greater in winter as compared to summer in both watersheds.

The climate record shows that warmer conditions are becoming more frequent. Winter in recent years generally has fewer extreme low temperatures and is becoming shorter when compared with earlier decades. The growing season is now longer on average than it used to be in the past but still can vary a lot from year to year.

Precipitation: what are the extreme daily rainfalls and snowfalls?

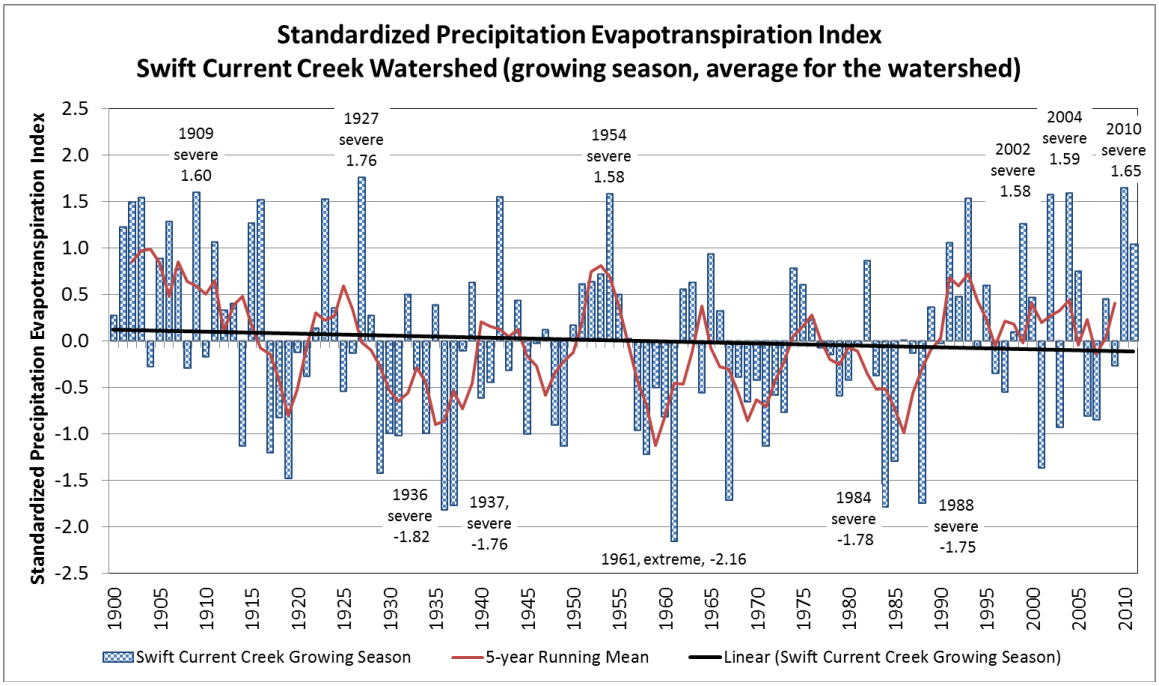
Large year to year and even decade to decade differences in precipitation amounts are characteristic to both watersheds: **160.5 mm** is the highest recorded daily rainfall (High River, OM, June 1926), much greater than the record for SCC at 65.8 mm (Swift Current, June 1966). The highest daily snowfall amount is **76.2 cm** for the OM (High River, OM April 1920), more than double that for SCC at 33.5 cm (Swift Current, March 1951). The record begins in 1902 for High River and 1895 for Swift Current.

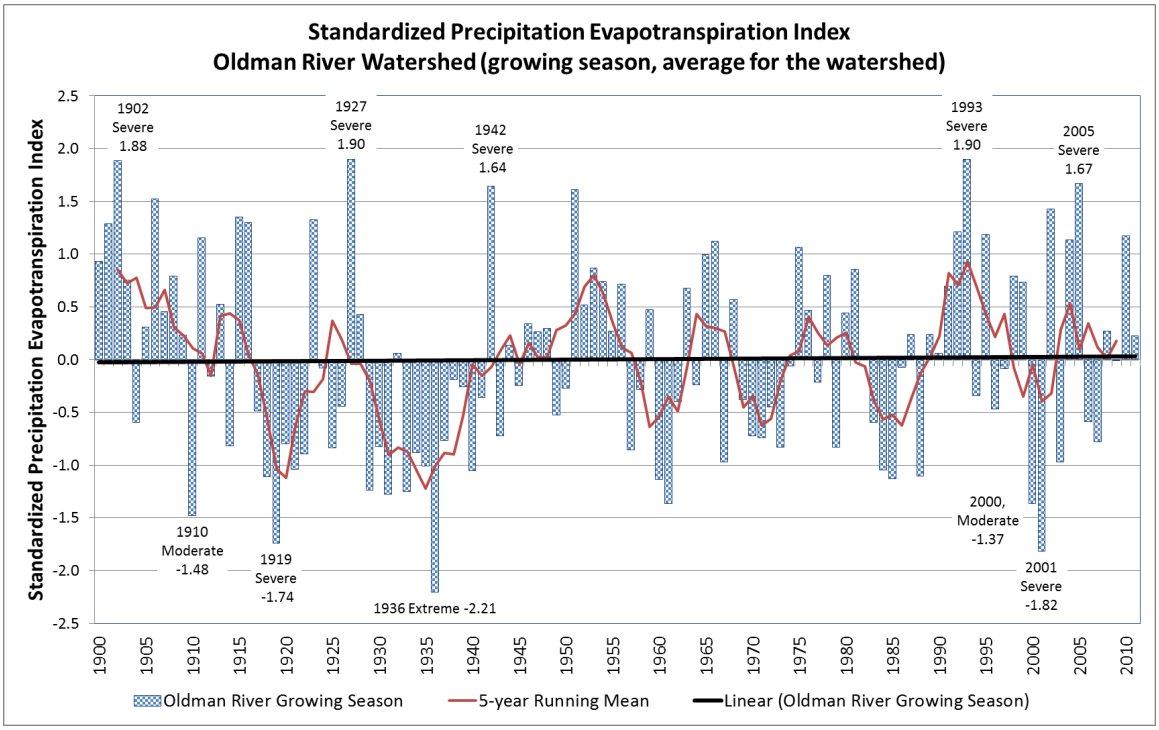
Extreme droughts and wet periods according to a water budget index (1900-2011)

As with precipitation, the two watersheds show large year to year and decade to decade differences in dry and wet conditions. Abrupt shifts from dry to wet periods and vice versa can also occur. The water budget concept takes into account water gains through precipitation falling on the ground, and water losses by evaporation, as influenced by temperature. This concept is a useful way of measuring dry and wet periods and has been used for many years. One water budget index, known as the Standardized Precipitation and Evapotranspiration Index (SPEI) was used to measure dry and wet periods during 1900 to 2011 (Figures, next page). SPEI values less than -0.5 indicate droughts and values greater than 0.5 indicate excessive moisture conditions. The top five extreme wet and dry growing seasons are given in order of severity, with the wettest or driest first. The growing season is defined here as May to August.

VACEA

April 2015


Standardized Precipitation Evapotranspiration Index
Swift Current Creek Watershed (growing season, average for the watershed)
Standardized Precipitation Evapotranspiration Index
1909 severe 1.60
1927 severe 1.76
1954 severe 1.58
2002 severe 1.58
2004 severe 1.59
2010 severe 1.65
1936 severe -1.82
1937, severe -1.76
1961, extreme, -2.16
1984 severe -1.78
1988 severe -1.75
Swift Current Creek Growing Season
5-year Running Mean
Linear (Swift Current Creek Growing Season)


Standardized Precipitation Evapotranspiration Index
Oldman River Watershed (growing season, average for the watershed)
Standardized Precipitation Evapotranspiration Index
1902 Severe 1.88
1927 Severe 1.90
1942 Severe 1.64
1993 Severe 1.90
2005 Severe 1.67
1910 Moderate -1.48
1919 Severe -1.74
1936 Extreme -2.21
2000, Moderate -1.37
2001 Severe -1.82
Oldman River Growing Season
5-year Running Mean
Linear (Oldman River Growing Season)

Top five droughts (using SPEI)

1961, 1936, 1984, 1937, 1988 are the strongest droughts in the growing season (May to August) for the SCC. The more recent drought of 2001, although falling short of the top five, is also among the top ten most severe droughts.

1936, 2001, 1919, 1910, 2000 are the strongest droughts in the growing season for the OM. As 2003 was also a drought, 2000-2003 was a significant multi-year drought.

When droughts occur, they tend to affect larger areas in comparison to the areas impacted during years that have extreme surplus moisture. Droughts impact both watersheds at the same time more frequently than excessive moisture events, which seem to be more localized.

Top five wet periods (using SPEI)

1927, 2010, 1909, 2004, 1954 are the wettest single-year wet growing seasons for the SCC. Another recent year, 2002, ranks sixth.

1927, 1993, 1902, 2005, 1942 are the five wettest growing seasons for the OM. Another recent year, 2002, ranks eighth.

Other extremes cause damage: examples of storms, wind, heat waves

Tornados and strong winds, e.g., 2008 (15 July near Vulcan, AB)
Extreme multi-day rainfall events, e.g., 8-11 June 2002 centered on the area from Lethbridge, Alberta to near Regina, Saskatchewan
Extended heat waves, e.g., June 1988, especially in SCC (can be related to droughts)
Hails storms, many occurrences
Blizzards are becoming less common.

What do these extremes mean for agriculture?

These identified extremes, and in particular, the prolonged droughts and wet periods, have many adverse social, environmental and economic effects. One of the most significant effects is on agriculture, and some examples of these effects on crop production are provided below for 1956 to 2011.

Year to year changes in our climate directly affect annual variations in crop yields. In fact, more than a third of the variation in spring wheat yields is associated with variations in climatic conditions (represented by SPEI). The rest is related to other factors, including soils and agricultural management. However, there are numerous examples in both watersheds where crops fail in the most severe drought years. For example, the drought years of **1961, 1985, and 1988** had the lowest average spring wheat yields for SCC. The highest yield occurred during the recent wet year of 2011.

The drought years of **1960-1962 and 1984-1985** had the lowest average spring wheat yields for the OM. The highest yields were during the recent wet years of 2004, 2008, and 2010. The study period is 1956 to 2011.

Droughts can cause low yields and crop failures even with the more advanced technologies and management of recent years. This indicates the need for even more improved adaptation. Flooding can reduce yields, but the effects are usually more localized than those of drought. Consecutive drought and wet years that affect large areas often cause the greatest challenge for adaptation and require the most improved adaptation measures and planning. Such information about the occurrence, changes, and year to year variability of past droughts and floods is needed help improve adaptation to future extremes which are expected to become more severe.

For further information

Fact Sheet Authors: E. Wheaton, B. Bonsal, V. Wittrock, J. Vanstone. August 20, 2014. Prepared for VACEA (Vulnerability and Adaptation to Extremes in the Americas Project), Prairie Adaptation Research Collaborative, Regina, SK. The work is based on:

Environment Canada. 2014 August. Historic Data. climate.weather.gc.ca/advanceSearch/searchHistoricData_e.html accessed 5 August 2014.

Wittrock, V, E. Wheaton, B. Bonsal, J. Vanstone. 2014 July. *Characterization of Past Drought and Excessive Moisture Extremes using the Standardized Precipitation and Evapotranspiration Index (SPEI): Case Studies of the Oldman River and Swift Current Creek Watersheds.* Technical report prepared for the Vulnerability and Adaptation to Climate Extremes in the Americas (VACEA) of the Prairie Adaptation Research Collaborative (PARC), Regina, SK. SRC 13224-3E13. Saskatchewan Research Council, Saskatoon, SK.

Wittrock, V, E. Wheaton, B. Bonsal, J. Vanstone. 2014 Oct. *Connecting Climate and Crop Yields: Case Studies of the Swift Current Creek and Oldman River Watersheds*. Prepared for VACEA, PARC, Regina, SK. Saskatchewan Research Council, Saskatoon, SK.

Wittrock, V. 2012 Jan. *Characterizing the Climates of the Swift Current Creek and Oldman River Watersheds.* Technical report prepared for VACEA. SRC 13224-1E12. Saskatchewan Research Council, Saskatoon, SK. 112 pp.

For even more information, including video, photos, and reports, refer to the VACEA website at: www.parc.ca/vacea/ (9 February 2015).

Acknowledgments

The Vulnerability and Adaptation to Climate Extremes in the Americas (VACEA) program is led by Drs. D. Sauchyn and F. Santibañez. Funding for the VACEA program is provided by the International Research Initiative on Adaptation to Climate Change, a joint initiative between IDRC, NSERC and SSHRC. We thank Shannon Frank and Arlene Unvoas, Executive Directors of the Oldman Watershed Council and the Swift Current Creek Watershed Stewards, and Darrell Corkal, Water Quality Engineer, for their comments. The tornado information came from: CTV News. Tornado touches down during wild Alberta Storm: http://www.ctvnews.ca/tornado-touches-down-during-wild-alberta-storm-1.309074 accessed 23 July 2014.
Photo Credits: Bruno Hernani, 2012 – Landowners' hands with drawing of landscape (bottom row, third from right). Jessica Vanstone, 2012 for all other photos.