Looking Ahead: Climate Projections for Saskatoon

To paraphrase David Phillips, a senior Climatologist with Environment and Climate Change Canada, our country can expect warmer, wetter and wilder weather today and into the future. This attachment outlines general trends for Saskatoon under changing climate conditions. It is important to note that Saskatoon will continue to experience year-to-year weather variability and not all experienced weather will be "on-trend".

Warmer

GHG Status	Saskatoon Temperature Change
Status Quo	+7^0 C
Moderate Reduction	+3^0 C
Major Reduction	+2^0 C

In Saskatoon, average annual temperature rise is projected to increase by almost 7^0 C by the end of the century under current emissions production rates as compared to the historical baseline from 1976-2005. Under the moderate emissions reduction scenario this increase shrinks to just over 3^0 C. Under the major emissions reduction scenario, the increase in average annual temperature is lowered still to 1.9^0 C above baseline.

Figure 1: Saskatoon's average annual temperature change under status quo emissions, a moderate emissions reduction, and a major emissions reduction with analysis highlights[i]

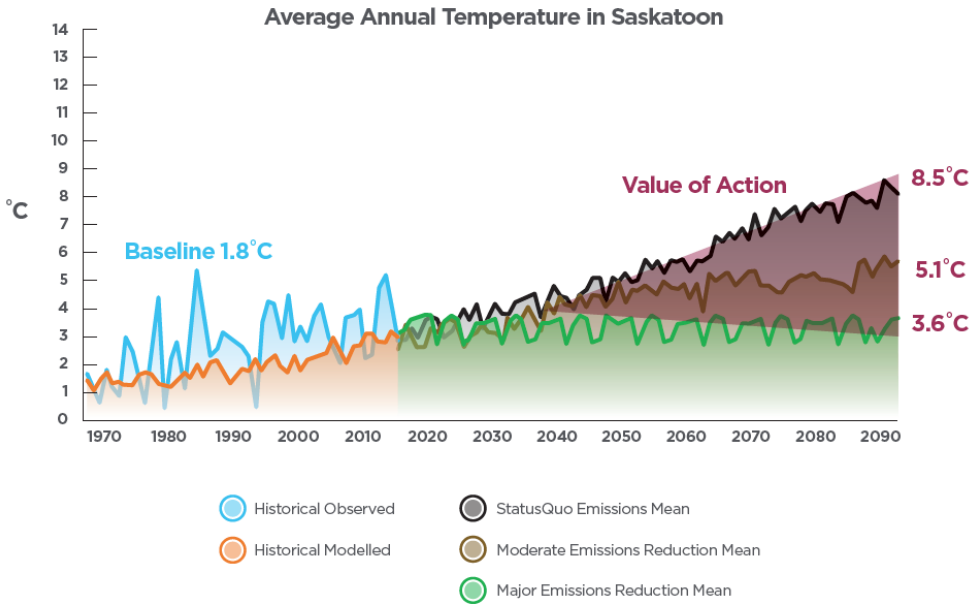


Figure 1 highlights the "value of action". This concept outlines the relationship between emissions rates and adaptation. The higher the emissions rates are, the larger the

increase in average annual temperature will be and, in turn, the larger the increase in cost and magnitude of need for adaptive actions over the long term.

Other "warmer" impacts expected for Saskatoon under current emissions rates by 2100 include:

- A 130% increase in the number of days per year where the temperature reaches above 25^0 C;
- A 511% increase in the number of days per year where the temperature reaches above 30^0 C;
- A 242% increase in the number of growing degree days at base 15^0 C[ii]; and
- A longer frost-free season (47 days per year longer on average).

(% value = [future mean data – baseline data]/baseline data x 100)

Wetter

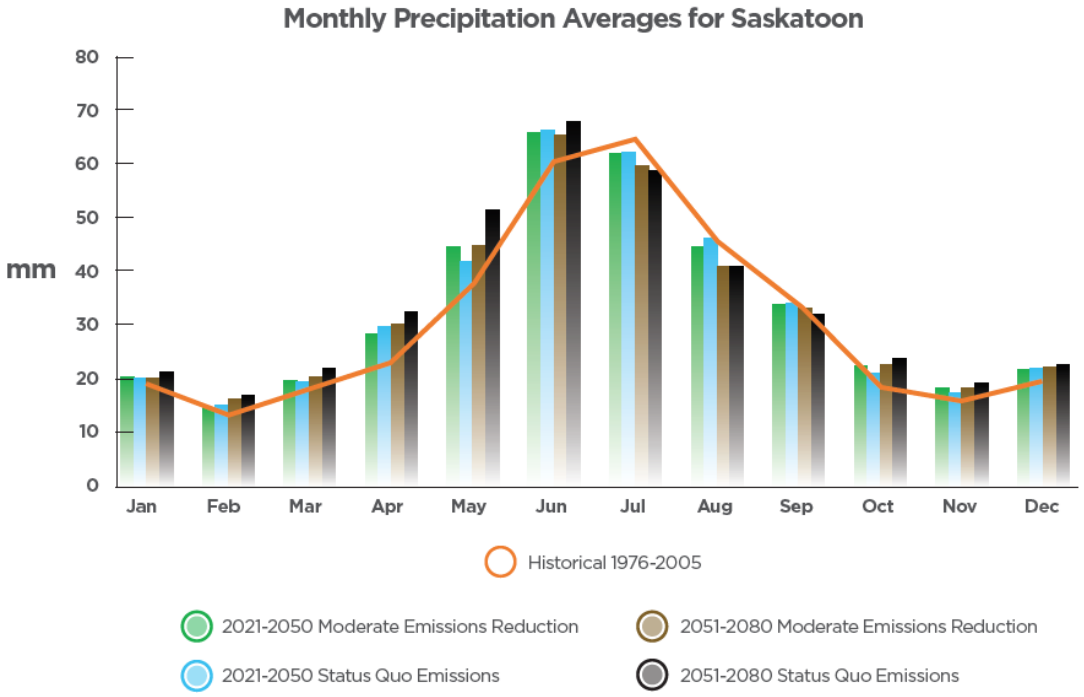
GHG Status	Saskatoon Average Annual Rainfall Change by 2100
Status Quo	+12%
Moderate Reduction	+7%
Major Reduction	+6%

Average Annual Rainfall

As an arid province, Saskatchewan will generally see smaller increases in average annual precipitation compared to other regions in Canada, even under changing climate conditions. Under current emissions rates, the projected increase in average annual precipitation in Saskatoon is approximately 12% by 2100[iii]. Under the moderate emissions reduction scenario, the increase shrinks to 7.5% by 2100. Under the major emissions reduction scenario the increase 6%[iv].

In similar seasonal trends observed at the national level, Saskatoon will see a general shift in the timing of the majority of precipitation. Today is generally highest during the late spring and summer months. Under both current emissions rates and moderate reduction scenarios precipitation timing changes to earlier in the year[v].

Figure 2: Saskatoon's average monthly precipitation change under status quo emissions and a moderate emissions reductions[vi]



Analysis of Figure 2 results in the following statements:

- Under current emissions rates total precipitation from March to June will increase by roughly 24% by 2100.
- Under the moderate reduction scenario total precipitation from March to June increases by 16% by 2100.

Precipitation changes expected for the July, August, and September season by 2100 are as follows:

- 8% reduction under current emissions rates; and
- 7% reduction under moderate emissions rates.

Seasonal shifts in precipitation combined with generally warmer temperatures and more hot days will likely increase the risk of drought conditions for Saskatoon.

Heavy Rainfall Events

Under current emissions scenarios, rainfall projections for Saskatoon call for slight increases in heavy precipitation days (totalling 10 mm or 20 mm over 24 hours)[iii]. Storm water system performance issues are generally due to the intensity of rain events. While 20 mm over 24 hours is not likely to cause flooding, 20 mm over 30 minutes will likely cause flooding issues. The likelihood of 1-in-10 year rain events (36.5 mm over 1 hour) is expected to increase by 13.4% from 2041 to 2070[vii]. The City of Saskatoon's (City) storm water infrastructure design standards for new neighbourhoods, adopted in 1989, include streets as part of the "major system" which effectively handle run-off for up to a 1-in-100 year rain event. Storm water infrastructure in older neighbourhoods, however, was not developed to the same standards, and some neighbourhoods are

subject to flooding during lower intensity rain events. A Flood Control Strategy was approved in 2018 to add storm water capacity in ten areas that are subject to frequent flooding.

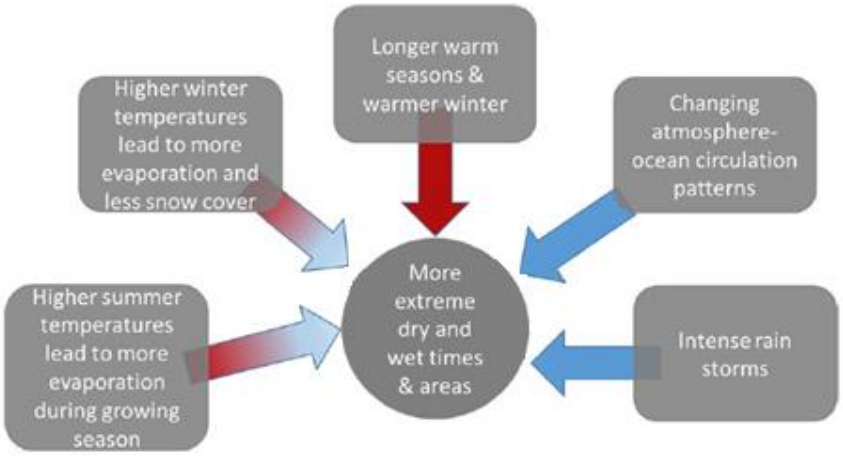
Saskatoon Water also has begun a project to refine climate projections regarding the intensity, duration, and frequency of rainfall events in Saskatoon. This action is one of the most common recommendations in municipal climate adaptation plans. The IDF Curve project will update current intensity, duration, and frequency information and explore the potential impacts to storm water design standards moving forward. The project is a joint venture between the City, the University of Saskatchewan, and Concordia University. Final results from the project are expected in 2020.

Wilder

Climate models are not yet able to reliably project changes in the occurrence rates for extreme weather events. As a result, formal extreme weather projections for Saskatoon are not present in this attachment. Instead, the discussion in this section focuses on observed trends and future risk projections.

Many climate scientists agree that warmer and wetter settings increase the likelihood of severe and extreme weather events, as the conditions that generate large and intense storms are present more frequently. Figure 3 outlines how relationship changing temperature and precipitation patterns can impact flooding and drought events.

Figure 3: Wet times become wetter and dry times become drier (used as adapted from Wheaton, Bonsal, and Wittrock, 2013[viii] in Wittrock et al. 2018[ix])



Extreme weather events (or natural hazards) such as drought, wildfire and flooding are part of Saskatchewan's history and can play a significant role in the economic prosperity of the region.

- The 2001-2002 drought caused a reduction in agricultural production of more than $1.6 billion[ix].
- The forest fires in Saskatchewan in 2015 cost in excess of $100 million, destroyed over 1.7 million hectares, and forced more than 10,000 people to evacuate their homes in northern communities[ix].

- Saskatchewan's Provincial Disaster Assistance Program (PDAP) expenditures have been rising since 2002 with costs ranging from $10.4M to more than $157M over the last ten years[x].
- In 2010, $4.5M of PDAP assistance was paid to residents and businesses with flooding damages in Saskatoon alone[xi].

A 2018 report from the Saskatchewan Research Council completes a province-wide risk analysis of natural hazards in Saskatchewan[ix]. Results from the report suggest changing climate conditions will slightly increase the risk of experiencing natural hazards throughout the province.

The insurance industry has additional evidence on wilder weather in Canada. Since 2008, the Insurance Bureau of Canada has reported an increase in annual claims related to extreme weather events of approximately 150% ($400M to $1B)[xii]. Many local and national insurance providers started offering overland flooding protection products in 2015. New product availability is contributing to the increase in annual claims and total cost of claims nationally. New flood protection products are often "add-ons" for an additional cost which will increase the total amount of household and organization budget spent on insurance.

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[i] Data used in Figure 1 is from Climate Atlas of Canada for "current emissions production rates" and "moderate reduction in emissions" scenarios; Data from Canadian Centre for Climate Services for the "major reduction in emissions" scenario.
[ii] Many insects and pests begin to thrive at this temperature.
[iii] Projection data from the Climate Atlas of Canada.
[iv] Projection data from the Canadian Centre for Climate Services.
[v] Monthly precipitation projection data was not available from consulted sources for the "major reductions emissions scenario" therefore it is not included within this analysis.
[vi] Data used for Figure 2 from the Climate Atlas of Canada. No "major emissions reduction" scenario data was available at the monthly rate from consulted sources at the time of reporting.
[vii] As cited in Saskatoon Water's Flood Control Strategy: Hazards and Return on Investment. Increase in 1-in-10 Year daily extreme rainfall in Saskatoon at 25 km by 25 km scale is 13.4% from 2041 to 2070 based on an average from 21 Global Climate Models and Representative Concentration Pathway (RCP) 8.5 which assumes emissions continue to rise throughout the 21st century.
[viii] Wheaton, E., Bonsal, B., and Wittrock, V. (2013). Possible future dry and wet extremes in Saskatchewan, Canada. Prepared for the Water Security Agency, Saskatchewan. Saskatchewan Research Council Publication No. 13462-1E13. Saskatoon, SK.
[ix] Wittrock, V., Halliday, R. A, Corkal, D. R., Johnston, M., Wheaton, E., Lettvenuk, J., Stewart, I., Bonsal, B., and Geremia, M. (2018, December). Saskatchewan flood and natural hazard risk assessment. Prepared for Saskatchewan Ministry of Government Relations. Saskatchewan Research Council Publication No. 14113-2E18. Saskatoon, SK.
[x] As cited in Prebble, P., Asmuss, M., Coxworth, A., and Halliday, B. (2018). "Prairie Resilience" is not enough. Retrieved from http://environmentalsociety.ca/wp-content/uploads/2018/12/Prairie-Resilience-Is-Not-Enough-Full-Report-Final.pdf PDAP statistics citation #48.
[xi] Saskatoon Water. (2018). Flood control strategy: Hazards and return on investment.
[xii] Hodgson, G. (2018, May 15). The costs of climate change are rising. Retrieved from https://www.theglobeandmail.com/business/commentary/article-the-costs-of-climate-change-are-rising/