Climate Projections for the National Capital Region

Executive Summary

June 2020

Executive Summary

Canada’s climate will continue to warm, driven by global greenhouse gas emissions from human activity. Both past and future warming in Canada is, on average, about double the magnitude of warming globally (Canada’s Changing Climate Report, NRCan 2019). This poses risks to all sectors of the economy and Canadians’ quality of life. Action on climate change mitigation and adaptation is required to limit impacts on people, the economy and natural ecosystems.

The National Capital Commission (NCC) and the City of Ottawa (referred to herein as the Project Partners) commissioned CBCL Limited to undertake a comprehensive climate change projection study for the National Capital Region (NCR). The project used a collaborative and impacts-driven approach that involved iterative feedback from the Project Partners and stakeholders such as the Ville de Gatineau and Conservation Authorities. It relied on data and advice from Environment and Climate Change Canada’s (ECCC) Canadian Centre for Climate Services (CCCS). This study complements work being done by the Ville de Gatineau in partnership with Ouranos.

Goals

Climate projections use climate science and modelling to predict future changes in temperature, precipitation, wind and extreme events. Climate projections are used in climate risk assessments and support adaptation and resiliency planning for multiple sectors. The regional approach to developing climate projections encourages consistency across multiple jurisdictions with overlapping climate impacts and adaptation needs. Climate projections from this study (Phase 1) will help decision-makers to understand impacts on communities, infrastructure, economy and the natural environment (Phase 2), and plan for climate resilience and adaptation initiatives (Phase 3). This study builds upon previous studies (Public Services and Procurement Canada, the Ville de Gatineau, and Hydro Ottawa) and is more comprehensive in terms of data coverage and geographical reach, with the intention of reaching the widest user and application base.

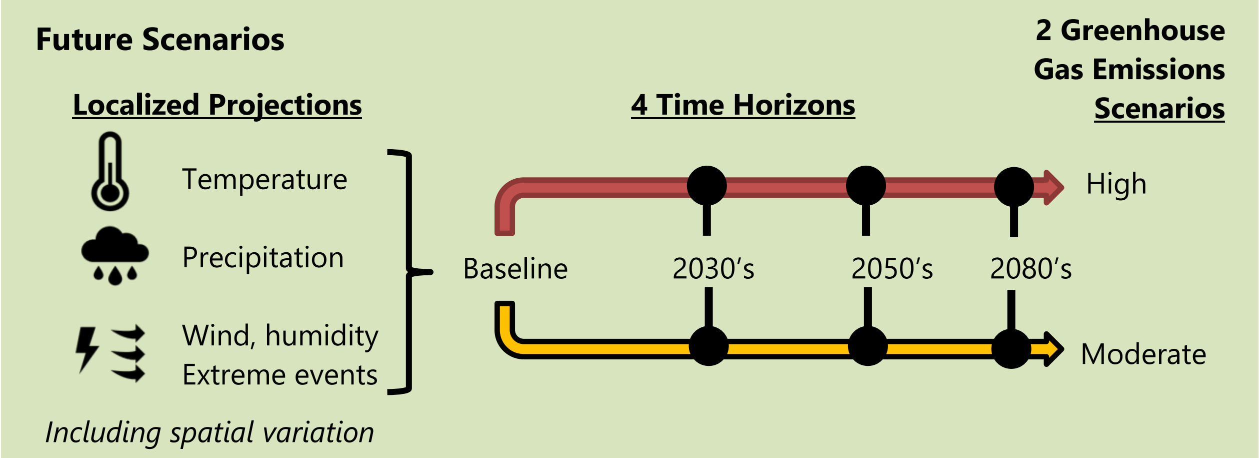
The climate data in this report has been made publicly available to support a common understanding of how the climate in the region is and will continue to change. Stakeholders in the NCR are encouraged to use the results of this climate projections study in climate risk assessments and adaptation planning and projects.

Future Scenarios and Time Horizons

Impact assessment, climate risk management, and policy development today must be informed by a range of emission scenarios, or “Representative Concentration Pathways” (RCPs) used to drive climate models. Scenarios by the Intergovernmental Panel on Climate Change (IPCC Fifth Assessment Report 2013) include low, moderate and high emission scenarios. If global greenhouse gas mitigation objectives from the 2015 Paris Agreement are achieved, the actual emissions will need to fall between the low and moderate scenarios. The rate and magnitude of climate change will depend on future global greenhouse gas emissions; global emissions are currently tracking above the moderate emission scenario.

As the low emission scenario is considered unlikely, this study provides a range of results for the moderate to high emission scenarios (RCP 4.5 and RCP 8.5) for 3 projection horizons, or time slices, when compared to the 1981-2010 baseline:

- **2030s (2021-2050).**
- **2050s (2041-2070).**
- **2080s (2071-2100).**



Climate Projections

The outputs of climate models include parameters like temperature, precipitation, humidity, snow, and wind. Indices, i.e., calculations based on parameters, were selected to provide meaningful projections that can be used by decision-makers.

Overall, it is projected that **the NCR will become warmer and wetter**. Warming is anticipated in all seasons. An increase in precipitation is anticipated in all seasons, except summer. It is expected that **the timing of seasons will shift** and that periods of extreme heat will become more common. Rainfall is expected to increase, both in volume and intensity. Annually, **less snowfall and a shorter snow season** are projected. Conditions favourable for extreme events such as freezing rain, tornadoes and wildfires are projected to become more common.

Temperatures are projected to be warmer under the high emission scenario. In other words, there is a greater difference between the moderate (RCP 4.5) and high emission (RCP 8.5) scenarios for temperature-based indices. Results are more variable for precipitation indices, and some show a negligible difference between moderate (RCP 4.5) and high (RCP 8.5) emission scenarios or between subsequent time horizons.

Temperature and precipitation are the two most typical climate model parameters; hence, a larger ensemble of climate models is available for these parameters, allowing a better characterization. In each of the following key findings (and in the remainder of the report), the two values quoted (e.g., 5-8°C in the 2030s) are **for moderate (RCP 4.5) and high (RCP 8.5) emission scenarios respectively.** These values represent an "average year" for the time period as they are averaged over 30-year time slices.

In this report, the two values reported for each index (e.g., 5-8°C) are not ranges; they represent the mean values for the moderate (RCP 4.5) and high (RCP 8.5) emission scenarios. When a decrease is projected, such as for the amount of snow, the second value will be lower than the first value.

A simplified summary of projections for the high carbon emission scenario RCP 8.5 is provided in the following table, supported by a more detailed summary in the next sub-sections.

Summary of Future Climate in Canada's Capital Region

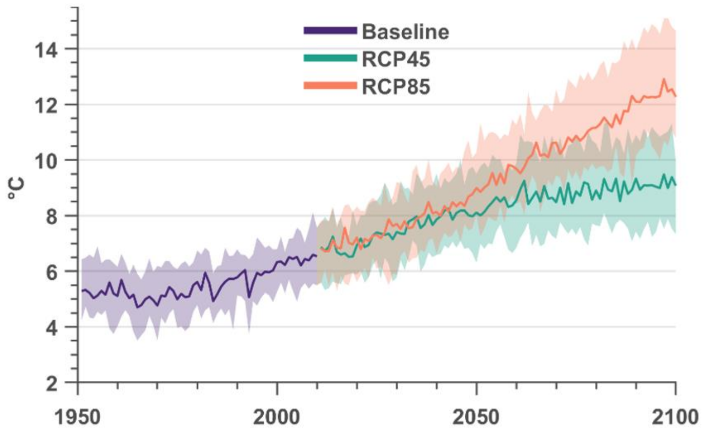
What to expect*	**2030s**	**2050s**	**2080s**
	Temperature		
Average temperature	↑ 1.8°C	↑ 3.2°C	↑ 5.3°C
Very hot days (above 30°C)	2.5 times more	4 times more	6.5 times more
Very cold days (below -10°C)	20% less	35% less	65% less
	Seasons		
Winters shorter by	4 weeks	5 weeks	8 weeks
Springs earlier by	2 weeks	2 weeks	4 weeks
Winter freeze-thaw	↑ 15%	↑ 35%	↑ 55%
	Precipitation		
Fall-winter-spring precipitation	↑ 5%	↑ 8%	↑ 12%
Intense precipitation	↑ 5%	↑ 15%	↑ 20%
Snowfall	↓ 10%	↓ 20%	↓ 45%
	Extreme Events		
	Possible increases in freezing rain		
	Warming favours conditions conducive to storms, wildfires		

More certainty ↓ Less certainty

** For high emission Scenario RCP 8.5*

More certainty → Less certainty

Temperature Projections:



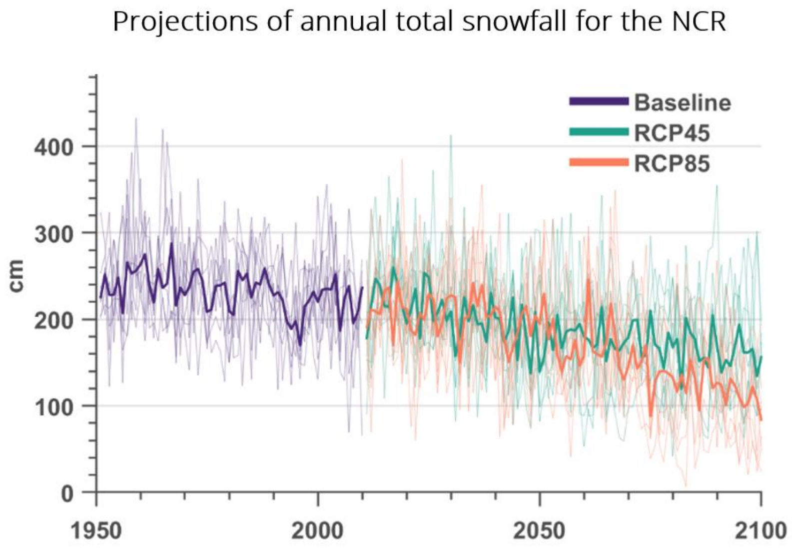
Projections of annual average temperature for the NCR

- **Increase in Average Temperatures (all Seasons)** – The **average annual temperature** is projected to increase from approximately 6.1°C in the baseline to approximately 7.5-7.9°C in the 2030s, 8.2-9.3°C in the 2050s, and 8.8-11.4°C in the 2080s. No single season is projected to warm significantly faster than the others.
- **Less Cold Extremes –** Cold extremes are expected to decrease in intensity and frequency. For example, the number of days per year where the daily minimum temperature is less than -10°C ("**Deep Freeze Events**") is projected to decrease from approximately 71 days in the baseline to approximately 59-57 days in the 2030s, 53-46 days in the 2050s and 48-28 days in the 2080s. Although these projections are for an extreme index, they represent an "average year" since they are averaged over 30-year time slices.
- **More Warm Extremes** – There will be an increase in the frequency and intensity of high-temperature extremes. In the baseline, the NCR experienced approximately 11 days that reached 30°C ("**Hot Days**") per year. Models project an increase to approximately 25-28 days in the 2030s, 32-43 days in the 2050s and 36-72 days in the 2080s. That is twice as many hot days in the 2030s, 3-4 times as many in the 2050s, and 3-6 times as many in the 2080s.
- **Change in Seasonal Characteristics** – The **first day of fall frost** is projected to occur approximately 1-2 weeks later by the 2030s, 2-3 weeks later by the 2050s, and 3-4 weeks later by the 2080s compared to the baseline. The **last day of spring frost** is projected to occur approximately 1-2 weeks earlier in the 2030s and 2050s, and 2-4 weeks earlier in the 2080s.
- **Shift in Freeze-Thaw Cycles** – Models project that winter temperatures will hover around 0°C more frequently in the future. Therefore **winter freeze-thaw cycles** (December–February) are projected to increase, whereas freeze-thaw cycles that occur during spring (March–May) and fall (September–November) are projected to decrease as temperatures warm.

Precipitation Projections:

- **Increase in Total Precipitation (Except Summer)** – The **annual total precipitation** in the NCR (including both rain and snow) is expected to increase from approximately 921 mm/year in the baseline to approximately 949-968 mm in the 2030s, 979-993 mm in the 2050s and 983-1028 mm in the 2080s. Increases will be concentrated in the winter and shoulder seasons with no increases projected for June–September.

- **No change in Frequency of Wet Days** – Although the annual total precipitation is increasing, precipitation is projected to be concentrated within the **same number of wet days** (where precipitation > 1 mm) that occurred in the baseline.
- **More Intense Precipitation** – The **annual maximum precipitation** that falls in one day is expected to increase from approximately 37 mm in the baseline to 39-39 mm in the 2030s, 41-42 mm in the 2050s and 41-44 mm in the 2080s. The increase in precipitation is consistent with a greater amount of total precipitation falling in the same number of wet days (see above). Extreme precipitation (for example the 1 in 100 year event) is projected to increase for multiple durations (sub-daily, daily, and multi-day precipitation events). These projections represent an "average year" (since they are averaged over 30-year time slices), for a 10 km x 10 km area.
- **Decrease in Total Snowfall** – The **annual total snowfall** is projected to decrease from approximately 223 cm in the baseline to 193-201 cm in the 2030s, 184-179 cm in the 2050s and 154-124 cm in the 2080s. This represents a decrease of 31-44% by the 2080s. Due to year-to-year variability, values similar to the baseline are still possible past mid-century.



- **Shorter Snow Season** – The timing of the first snowfall is projected to be later in the year, and the timing of the last snowfall will be earlier. As a result (and due to increasing temperatures), the **number of days with snow cover** is projected to decrease from approximately 115 days in the baseline to approximately 95-94 days in the 2030s, 90-72 days in the 2050s and 78-43 days in the 2080s.
- **High Variability in Extreme Snow** – Projections suggest a decrease in the maximum snow depth and mixed findings for the maximum 1-day snowfall. Average projections suggest that **annual maximum 1-day snowfall** (averaged across the study area) will change from approximately 20 cm in the baseline to 21-20 cm in the 2030s, 22-20 cm in the 2050s and 20-16 cm in the 2080s. There is a decrease by the 2080s for the high emission scenario (RCP 8.5) but not for the moderate emission scenario (RCP 4.5). These projections represent total snow falling over the study area during an "average year" (since they are averaged over 30-year time slices). Due to year-to-year variability, values similar or higher than the baseline are still possible past mid-century.

Humidity, Wind, Extreme Events and Other Phenomena

No trends in average winds and humidity were detected; however, the occurrence of high wind chill is expected to decrease, whereas the number of days with high humidex is expected to increase. Although uncertainty remains high, the occurrence of conditions favourable to extreme weather (such as freezing rain, tornadoes, lightning, hurricanes, and wildfires) is projected to increase.

Prominent Climate Impacts on Key Sectors

This study did not examine specific risks and vulnerabilities, as this will occur in phase 2; however, potential impacts are generally known and can be summarized as follows.

Health and Safety – A warmer and wetter climate conducive to extreme events will have wide-ranging repercussions for public health and safety. For example, flooding, heat waves, and wildfires and extended power outages can have great impacts on those directly affected and put an added strain on emergency services. Wildfires increase the concentration of airborne particulate matter, impacting air quality. Conditions that are favourable for transmission of vector-borne illnesses, such as Lyme disease and West Nile virus, will be more common.

Water Services – More intense precipitation, including winter rain, will increase risks of flooding, erosion, combined sewer overflows and leachate generation at landfills. High winds may increase power outages to water services, requiring back-up power systems. Summer low flows may increase the risk of odours in the wastewater collection system.

Buildings, Real Estate and Planning – Energy demands are expected to shift seasonally, with heating requirements decreasing in the winter months and cooling demands increasing during the summer months. The roof and foundation drainage systems of buildings will be impacted by increases in the frequency and intensity of extreme precipitation events. For new construction, climate change will influence future editions of the National Building Code of Canada. Municipal planning must account for climate impacts, including future flood risks.

Transportation – Climate change will impact both transportation infrastructure (such as life expectancy of roads and flooding) and operations (such as power outages and travel delays). A changing climate could also bring potential opportunities to the transportation sector such as longer construction seasons or reduced winter snow clearing.

Natural Assets, Tourism and Recreation – Shorter winters with less snow, thinner ice and rain-on-snow will negatively impact popular activities such as cross-country skiing in Gatineau Park or skating on the Rideau Canal. Drier and warmer summers may impact plant and animal species, potentially favouring invasive species and agriculture, although variable precipitation may cause additional challenges. Shifting seasons will impact the preferred timing for the tulip festival.

Riverine Flooding – Riverine flooding can occur on all rivers in the NCR, most notably along the Gatineau, Rideau and Ottawa rivers. The NCR has experienced significant flooding along these rivers, including in the springs of 2017 and 2019. There are many factors that contribute to flooding or flood risk, most of which are outside the scope of this study. Spring freshet flooding, for example, is affected by precipitation and snowmelt in the entire Ottawa River watershed, which extends far beyond the present study area.

Managing Uncertainty

Sources of uncertainty in the projections include **natural variability**, **scenario uncertainty,** and **model uncertainty.** The respective significance of the sources of uncertainty changes with the expected remaining useful life of the policy, program, or asset in question. Uncertainty related to natural variability is relatively more significant in the short term whereas predictions associated with each emission scenario diverge over the long term. Strategies for managing uncertainty include:

- Climate Projections (this report) - Using an **ensemble of climate models** and a **range of scenarios.**
- Incorporating the implications of uncertainty into **climate risk assessments** (i.e., Phase 2)
- For planning and adaptation (i.e., Phase 3), where practical to do so, using a **low-regret approach** that accounts for the full range of climate projections can make a project more resilient to future climate and weather extremes, as follows:
    - ✓ Planning/designing for **most probable climate conditions** over the intended lifetime.
    - ✓ **Including flexibility** and/or additional safety factors for alternative courses of action should climate conditions deviate from planning and/or design assumptions.
    - ✓ **Monitoring climate** conditions and project performance over time.
    - ✓ Opting for adaptations that provide a clear **financial or social benefit** regardless of how climate changes in the future.
    - ✓ Implementing design and construction **modifications** in response to observed changes.

Applying the Climate Projections

The climate data in this report can support a wide variety of risk assessments and adaptation planning that build the resilience of people, assets and services to future climate conditions.

In the future, when new models are published, it is worthwhile to monitor new projections and compare them to the results presented within the report on a case by case basis. Risk and impact assessments should not be automatically presumed to be outdated when data becomes available, as new data may not change the outcome of the assessment.