

The City of Kawartha Lakes Climate Change Strategy

Climate Science Report



Table of Contents

<i>Executive Summary</i>	1
Key Findings	2
Implications for Adaptation Planning	3
<i>Glossary of Terms</i>	4
<i>Climate Variable</i>	7
Hot Temperature	7
Cold Temperature.....	8
Agricultural Indices	8
Precipitation.....	9
Extreme Weather.....	9
<i>Introduction</i>	10
<i>What Causes Climate Change</i>	11
<i>Data Collection and Reporting</i>	11
<i>Climate Change Modelling and Downscaling</i>	11
<i>Greenhouse Gas Emissions Scenarios</i>	12
SSP Scenarios - IPCC Sixth Assessment Report (AR6)	12
Time Periods.....	14
Uncertainty	15
<i>Climate Projections</i>	16
Temperature.....	16
Hot Weather	18
Heat Waves	22
Cold Weather	25
Agricultural Indices	32
Precipitation.....	36
Extreme Weather Events.....	39
<i>Conclusion</i>	48
<i>Reference List</i>	49

Executive Summary

The effects of a warming and more variable climate are already being experienced in Kawartha Lakes. Along with slower onset changes in temperature and precipitation that affect our natural, built and socioeconomic systems, more dramatic changes are also noticeable. These include an increasing frequency, severity, and compounding nature of climate related hazards in the region. For example, the ice storm and spring flooding in March 2025, extreme heat, drought and wildfire in June 2025, severe thunderstorms in August 2023, and derecho in 2022. These observed conditions are consistent with broader trends across southern Ontario and signal a continued escalation in climate risks over the coming decades.

This Climate Science Report outlines future projections for temperature, precipitation, extreme weather, and growing-season dynamics in Kawartha Lakes, compared to the municipality's historical baselines. Using an ensemble-based modelling approach that draws on CMIP6 global climate models, the report characterizes the range of plausible climate variable futures at the census subdivision (CSD) spatial scale, through the lens of the 'high emission' SSP5-8.5 scenario and 'middle-of-the-road' SSP2-4.5 scenario. Ensemble percentiles (10th, 50th, 90th) are used to express the range of possible trajectories for each climate variable and account for projection uncertainty.

All key findings in this executive summary reflect the SSP5-8.5 high emissions scenario, whereas projections for SSP2-4.5 can also be found in the tables and charts throughout the rest of the report.

Key Findings

1. Rapid and Persistent Warming

Average annual temperatures in Kawartha Lakes are projected to increase 6.4°C by 2100, relative to the 1971–2000 baseline. Seasonal warming is expected across all months, with the most pronounced increase occurring in winter.

2. Extreme Heat Becoming a Dominant Hazard

Extreme heat indicators project significant increases through the century under the SSP5-8.5 scenario:

- **Hottest day** rises from **32.3°C** to **39.0°C** by 2100.
- **Days above 30°C** increase *tenfold*—from **7 days** historically to **70 days** by 2100.
- Days with humidex >30 increase from 32 to 112 days by 2100.
- **Tropical nights** (minimum temperature >20°C) rise from **1** to **45 nights** per year by 2100.
- **Heat waves** increase from **less than 1 per year** to **6** per year, with total heat wave days per year increasing from a baseline of **less than 1** to **27 days** by 2100.

These shifts pose significant risks to human health, electricity reliability, and critical infrastructure and will require expanded cooling strategies, risk communications, and preparedness planning.

3. Milder Winters with Fewer Cold Extremes

Cold-weather hazards are projected to decline substantially across the municipality. Some strong indicators are:

- **Extreme cold days** (Tmin <-15°C) fall from a baseline of **36 days** per year to **3 days** per year by 2100.
- **Frost days** decrease from **162 days** per year to **91 days** per year by 2100.
- **Ice days** decline from **71** to **20 days** per year by 2100.
- **Freeze-thaw cycles**, which affect pavement and building durability, decline from **77** to **60 days** per year by 2100.

Heating degree days drop sharply indicating reduced winter energy demand but also shifting requirements for building performance and winter operations.

4. Longer, Warmer Growing Seasons With New Agricultural Risks

Kawartha Lake's growing season expands from **137 days** to **199 days** by century's end—a projected increase of nearly **9 weeks**. **Growing degree days (>5°C)** rise from **1,955** to **3,452**, enabling new crop opportunities but amplifying risks related to pests, water stress, heat injury to crops, and late-spring frost damage. Warmer winters may prolong the activity period of pests such as black-legged ticks, though climate variables alone do not reliably predict tick abundance.

5. Increasing Annual Precipitation but Higher Variability

Annual precipitation is projected to increase by **157 mm** per year by 2100 compared to baseline, with the greatest seasonal increases in winter and spring, and to a lesser extent fall. Summer precipitation is projected to increase then return to just above baseline levels by late century, but higher temperatures and longer dry spells elevate drought risk. **Maximum consecutive dry days** remain relatively stable over the century albeit with a slight upward trend.

6. Heavy Rainfall and Stormwater Hazards Intensify

Extreme precipitation indices for the municipality show consistent increases:

- **Wet days ≥ 10 mm: +8 days** per year by 2100 compared to baseline.
- Wet days ≥ 20 mm: +4 days per year by 2100.
- Maximum 1-day precipitation increases from 36 mm to 46 mm by 2100.

Climate-adjusted IDF curves for the Lindsay Filtration Plant station show substantial increases in rainfall intensity for 25-, 50-, and 100-year storms, with more rain falling in shorter periods. These changes heighten flood risk, exceed the design basis of legacy infrastructure, and require integration of climate-scaled IDF values into stormwater planning, as recommended by ECCC and CSA W231:25.

Implications for Adaptation Planning

The climate projections presented here highlight a future characterized by more frequent and severe heat events, fewer cold-weather constraints, shifting agricultural conditions, and heightened risks from intense rainfall. These trends will interact with built, sociocultural, economic, and ecological systems, increasing exposure and amplifying vulnerabilities across Kawartha Lakes.

The findings provide the technical foundation for identifying priority climate risks and for developing sector-specific adaptation actions under the Building Adaptive and Resilient Communities (BARC) framework. They also underscore the importance of considering uncertainty, using ensemble projections, and updating infrastructure design and policy assumptions to reflect a changing climate.

Glossary of Terms

Definitions have been adapted from the Intergovernmental Panel on Climate Change (IPCC) and ClimateData.ca.

Baseline

A climatological baseline is a reference period, typically three decades (or 30 years), that is used to compare fluctuations of climate between one period and another. Baselines can also be called references or reference periods.

Census Subdivision (CSD)

A municipal-level geographic unit defined by Statistics Canada, used here as one of the finer spatial scales available on ClimateData.ca for climate projections. CSDs provide more localized information than larger reporting units such as Health Regions or Watersheds.

Climate Change

A change in the state of the climate, identifiable through changes in the mean and/or variability of climatic properties (e.g., temperature, precipitation) that persists for an extended period, typically decades or longer. Climate change may result from natural processes or from persistent anthropogenic changes in atmospheric composition or land use.

Climate Change Scenario

A climate change scenario is a plausible description of future climate conditions based on assumptions about greenhouse gas emissions and related socioeconomic factors. It represents how the climate may differ from today under specific emission pathways, using scientific models to explore potential future outcomes.

Climate Projections

A projection of the response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols. These projections depend upon the climate change (or emission) scenario used, which are based on assumptions concerning future socioeconomic and technological developments that may or may not be realized and are therefore subject to uncertainty.

Coupled Model Intercomparison Project (CMIP)

An international framework that coordinates standardized climate-model experiments so results from different global climate models can be compared, evaluated, and used in climate-change research. Successive phases—CMIP5 and CMIP6—provide the model outputs that underpin many climate scenarios, including RCPs and SSPs.

Ensemble Approach

An ensemble approach uses the average of global climate models (GCMs) for temperature and precipitation. Research has shown that running many models provides the most realistic projection of annual and seasonal temperature and precipitation than using a single model.

Extreme Weather Event

A meteorological event that is rare at a place and time of year, such as an intense storm, tornado, hail storm, flood, or heatwave, and is beyond the normal range of activity. An extreme weather event would normally occur very rarely or fall into the tenth percentile of probability.

General Circulation Models

Based on physical laws and physically-based empirical relationships and are mathematical representations of the atmosphere, ocean, ice caps and land surface processes. They are therefore the only tools that estimate changes in climate due to increased greenhouse gases for a large number of climate variables in a physically consistent manner.

Greenhouse Gas (GHG) Emissions

Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation, emitted by the Earth's surface, the atmosphere itself, and by clouds. Water vapour (H₂O), carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), ozone (O₃), and chlorofluorocarbons (CFCs) are the six primary greenhouse gases in the Earth's atmosphere in order of abundance.

Heat Warning

A Heat Warning is issued when temperatures are projected to be at least 31°C during the day and overnight temperatures are at least 20°C or Humidex is at least 40. An Extended Heat Warning is issued when these conditions are expected for more than two days. For the purpose of this report, heat warning is synonymous with 'Heat Wave'.

Hot Days

A hot day occurs when temperatures meet or exceed 30°C.

Intensity-Duration-Frequency curve (IDF Curve)

A graphical representation of the probability that a given average rainfall intensity will occur. Rainfall Intensity (mm/hr), Rainfall Duration (how many hours it rained at that intensity) and Rainfall Frequency/Return Period (how often that rainstorm repeats itself) are the parameters that make up the axes of the graph of the IDF curve. An IDF curve is created with long term rainfall records collected at a rainfall monitoring station.

Radiative Forcing

The change in the value of the net radiative flux (i.e. the incoming flux minus the outgoing flux) at the top of the atmosphere in response to some perturbation, in this case, the presence of greenhouse gases.

Representative Concentration Pathways (RCPs)

These are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its fifth Assessment Report (AR5) in 2014. It supersedes the Special Report on Emissions *Scenarios* (SRES) projections published in 2000.

Shared Socio-Economic Pathways (SSPs)

Scenarios used to characterize possible future development pathways for human societies, particularly in relation to its use of fossil fuels and the social and economic factors which drive fossil fuel use.

Temperature Anomaly

A departure from a reference value or long-term average. A positive anomaly indicates that the observed temperature was warmer than the reference value, while a negative anomaly indicates that the observed temperature was cooler than the reference value.

Climate Variable

The climate variables included in this report are listed and defined in the tables below. Each variable is discussed in more detail in their respective sections below.

Hot Temperature

Table 1: Hot Temperature Climate Variables and Derived Indices

Climate Variable	Description	Units
Mean Temperature	The average seasonal (or annual) temperature.	°C
Hottest Day	The warmest daytime temperature in a given year.	°C
Tmax +30 °C Days	Days when the temperature rises to at least +30 °C.	Days
Humidex Days	Days where the humidex is greater than 30.	Days
Tropical Nights	Days when the minimum temperature remains above +20 °C.	Days
Heat Wave Frequency	The average number of heat waves per year, where a heat event is defined as two or more consecutive days with Tmax ≥ 31 °C and Tmin ≤ 20 °C, or humidex > 40.	Number of heat wave events
Heat Wave Duration	The total number of heat wave days, where a heat wave is defined as 2+ consecutive days with Tmax ≥ 31 °C and Tmin ≤ 20 °C, or humidex > 40.	Days
Cooling Degree Days	<i>Cooling degree days</i> (CDDs) give an indication of the amount of space cooling, i.e., air conditioning, that may be required to maintain comfortable conditions in a building during warmer months. When the daily average temperature is hotter than the threshold temperature, CDDs are accumulated (see Degree Days Above). Threshold values may vary, but 18°C is commonly used in Canada. Larger CDD values indicate a greater need for air conditioning.	Cooling Degree Days

Cold Temperature

Table 2: Cold Temperature Climate Variables and Derived Indices

Climate Variable	Description	Units
Coldest Day	The lowest nighttime temperature recorded in a given year.	°C
Days Below Tmin -15°C	Days where daily minimum temperature is below a threshold of -15°C.	Days
Heating Degree Days	<i>Heating degree days</i> (HDDs) give an indication of the amount of space heating (e.g., from a gas boiler/furnace, baseboard electric heating or fireplace) that may be required to maintain comfortable conditions inside a building during cooler months. When the daily average temperature is colder than the threshold temperature, HDDs are accumulated (see <i>Degree Days Below</i>). Threshold values may vary, but 17°C or 18°C are commonly used in Canada. Larger HDD values indicate a greater need for space heating.	Days
Frost Days	Days on which the coldest temperature of the day is lower than 0°C.	Days
Ice Days	Days on which the air temperature does not go above freezing (0°C).	Days
Freeze-Thaw Cycles	Days when the air temperature fluctuates between freezing and non-freezing temperatures.	Days

Agricultural Indices

Table 3: Agricultural Climate Variables and Derived Indices

Climate Variable	Description	Units
Frost Free Season	The <i>Frost Free Season</i> is the approximate length of the growing season during which there are no freezing temperatures to kill or damage frost-sensitive plants. This index describes the number of days between the Last Spring Frost and the First Fall Frost.	Days
Growing Degree Days (>5 °C)	A measure of heat available for plant growth, calculated by summing each day's average temperature above +5 °C. Higher totals indicate a longer or warmer growing season.	Degree-Days (cumulative unit)

Precipitation

Table 4: Precipitation Climate Variables and Derived Indices

Climate Variable	Description	Units
Mean Precipitation	The average precipitation for a given time period (e.g., yearly, seasonally).	mm
Maximum Consecutive Dry Days	The maximum number of consecutive days with precipitation below 1mm/day, within a given year.	Days

Extreme Weather

Table 5: Extreme Weather Climate Variables and Derived Indices

Climate Variable	Description	Units
Wet Days (≥ 10 mm)	The number of days where at least 10 mm of precipitation (rain and snow combined) falls during the selected temporal frequency.	Days
Wet Days (≥ 20 mm)	The number of days where at least 20 mm of precipitation (rain and snow combined) falls during the selected temporal frequency.	mm
Max. 1-Day Precipitation	The amount of precipitation that falls on the wettest day of the year.	mm
Rainfall IDF Curves	The annual maximum rainfall intensity for specific durations. Common durations for design applications are: 5-min, 10-min, 15-min, 30-min, 1-hr, 2-hr, 6-hr, 12-hr, and 24-hr.	mm/hr

To view an extended list of climate variables and data projections, see [Appendix A](#).

Introduction

Climate change is imposing increasing pressures at local, regional, and national scales. Canada's climate is becoming warmer, wetter, and more volatile, placing greater stress and strain on the systems our communities depend on to maintain quality of life. These changes manifest across two interconnected dimensions. Slow variables—such as mean annual temperature and precipitation—shift gradually over years to decades and can be difficult for humans to perceive, yet they quietly reshape species distributions, agricultural practices, and infrastructure design thresholds. Extreme weather events, by contrast, tend to gain immediate attention. Recent storms, flooding, extreme heat, and wildfire events serve as reminders of the urgency facing communities as they work to strengthen preparedness for ongoing and intensifying climate-related risks.

Kawartha Lakes has experienced a wide range of weather-related events in the past two years, including an ice storm and spring flooding in March 2025, extreme heat, drought and wildfire in June 2025, severe thunderstorms in August 2023, and derecho in 2022. These events can generate both direct and indirect health effects, place stress on local ecosystems, damage infrastructure, and lead to substantial economic losses. **

**Although there is not an abundance of local insured-loss data for Kawartha Lakes, province-wide analogues from the insurance industry illustrate potential scales of loss. For example, the July 2024 Southern Ontario flash flooding event incurred an estimated \$880.5 million in insured damages, while the December 2022 Eastern Canada bomb cyclone and the December 2021 Eastern Canada windstorm caused \$282.6 million and \$145.4 million in damages respectively. These figures provide a reasonable indication of the magnitude of losses that similar events could impose on communities within Kawartha Lakes.

This report examines baseline and historical climate conditions, along with near-term and long-term projections, with a primary focus on temperature and precipitation. These variables are consistently available across climate-model ensembles and form the foundational drivers of hazards such as extreme heat, drought, and extreme rainfall. The projection results support identification of Kawartha Lakes' key climate vulnerabilities and risks, and provide the analytical basis for the Building Adaptive Resilient Communities (BARC) process — a structured municipal program that guides communities through climate impact assessment and the development of localized adaptation plans to inform subsequent sector-specific action planning.

All climate projections carry inherent uncertainty due to variability in emissions pathways, global climate sensitivity, and model structure. This uncertainty is acknowledged and discussed, along with details on the modelling approach, in subsequent sections. These projections nonetheless offer a robust, evidence-based foundation to inform adaptation planning and to strengthen Kawartha Lakes's long-term resilience.

What Causes Climate Change

Climate change refers to long-term shifts in global weather patterns driven by the accumulation of heat-trapping greenhouse gases (GHGs) in the atmosphere. GHGs warm the planet through the greenhouse effect, a natural process that traps heat near the Earth's surface. The greenhouse effect is essential to life on Earth but the rapid increase of GHGs being released to the atmosphere from human activity since the industrial revolution has increased the concentration of carbon dioxide in the atmosphere by nearly 50% since 1750 ^[1]. This intensification of the greenhouse effect slows heat loss from the Earth to space, resulting in rising temperatures over time—driven primarily by human activity since the 1800s, particularly the burning of fossil fuels.

Data Collection and Reporting

Data for localized climate change projections were primarily collected from [ClimateData.ca](https://climatedata.ca) - an online, publicly available climate change data and scenarios tool. [ClimateData.ca](https://climatedata.ca) is a project undertaken by Environment and Climate Change Canada (ECCC), the Computer Research Institute of Montreal (CRIM), Evolving Web, the Pacific Climate Impacts Consortium (PCIC), ClimateWest, the Prairie Climate Centre, ORCCA, Ouranos and CLIMAtlantic.

More information concerning this online tool is provided in the Glossary. Other information on projected climatic changes in Kawartha Lakes and Ontario was sourced from various academic and government reports. These are identified and cited where applicable.

The scale for the data collected and analyzed was at the census subdivision spatial scale, which provides a consistent and comparable reference point across climate projection datasets and serves as a practical midpoint for what residents of Kawartha Lakes can expect to experience. Reported projection ranges reflect the distribution of an ensemble: unless otherwise specified, the low value corresponds to the 10th percentile, the median represents the 50th percentile (i.e., the median), and the high value reflects the 90th percentile, providing a structured summary of model spread and uncertainty.

Climate Change Modelling and Downscaling

Wherever possible, this report draws on global climate models (GCMs) and emissions scenarios developed for the Intergovernmental Panel on Climate Change's Sixth Assessment Report. Temperature and precipitation projections use data from the Coupled Model Intercomparison Project Phase 6 (CMIP6), the most current coordinated ensemble of global climate models. CMIP6 expands on CMIP5 by incorporating a larger set of modelling centres and simulations, improving representation of key Earth system processes including ocean circulation, land surface dynamics, and the carbon cycle.

Multiple approaches exist for constructing climate change scenarios, but GCMs remain the primary tools for assessing large-scale responses to increasing greenhouse gas concentrations. They use mathematical representations of atmospheric, oceanic, cryospheric, and land-surface

processes to simulate how the climate system may evolve under different emissions pathways. However, because GCMs operate at coarse spatial resolutions — typically 50 to 200 kilometres per grid cell — their outputs must be translated into finer-scale projections before they are meaningful for local planning and infrastructure decisions.

This translation is achieved through statistically downscaling data which applies bias correction and spatial disaggregation techniques to reconcile GCM outputs with observed local conditions and can be accessed through ClimateData.ca. This process adjusts for known model biases and produces projections at resolutions relevant to regional and municipal decision-making.

Wherever possible this report uses an ensemble approach, which refers to a system that runs multiple climate models at once. Research has shown that this provides a more accurate projection of annual and seasonal temperatures and precipitation than a single model would on its own^[2].

Greenhouse Gas Emissions Scenarios

Climate change scenarios are based on models developed by a series of international climate modeling centers. They are socioeconomic storylines used by analysts to make projections about future greenhouse gas emissions and to assess future vulnerability to climate change. Producing scenarios requires estimates of future population levels, economic activity, governance structures, social values, and patterns of technological change. In this report, climate change scenarios from the Fifth and Sixth IPCC Assessments are considered.

SSP Scenarios - IPCC Sixth Assessment Report (AR6)

Shared Socio-economic Pathways (SSPs) are the newest set of climate change scenarios that provide the basis for IPCC's Sixth Assessment Report (AR6). While the Representative Concentration Pathways (RCPs) used in the IPCC's Fifth Assessment Report (AR5) focus on mitigation targets to address physical climate change, the SSPs focus on the underlying socioeconomic contexts which may present challenges to mitigation and/or adaptation policies. The SSPs incorporate socioeconomic characteristics and other human-caused climate drivers (e.g., population growth, education levels, GDP growth, income inequality, use of technology, energy use, political contexts, and land-use change) to derive scenarios that describe differing influences on greenhouse gas emissions and society's ability to adapt. AR6 assesses and compares the RCP and SSP scenarios and incorporates new data, new models, and updated climate research from around the world to allow for a standardized comparison of society's choices and their resulting levels of climate change. The premise is that every radiative forcing pathway (see Glossary) can result from a diverse range of socioeconomic and technological development scenarios. SSP-based scenarios are categorized by their relationship to both adaptation and mitigation challenges, and their approximate total radiative forcing in the year 2100 relative to pre-industrial levels, and are labeled as SSP1 to SSP5.

For this report, projections are shown under SSP2-4.5 and SSP5-8.5, which represent a 'middle of the road', medium challenge to both mitigation and adaptation scenario, and worst-case, 'fossil-

fueled development’ scenario, respectively. SSP5-8.5 assumes a world with high economic growth fueled by fossil fuels, leading to high greenhouse gas emissions and thus making it difficult to reduce them. The high emissions scenario also assumes that with high economic development, societies will have more resources to invest in adapting to the resulting climate impacts, making adaptation easier. Although SSP2-4.5 can be used as a more moderate reference point, SSP5-8.5 was chosen as the primary scenario for this report because it represents a continued high-emissions pathway, has associated projections available from many different climate models, and corresponds with Representative Concentration Pathway (RCP8.5) utilized in the IPCC’s AR5 Report. Additionally, it is important that municipalities, which are generally very risk adverse, be aware of the most dramatic potential effects of climate change should global emissions persist. This report has been designed for adaptation planning purposes only; future infrastructure decisions should review climate projections with updated science of plausible scenarios over the service life of the asset at the time of design. Table 6 provides a bulleted description of SSP scenarios 1, 2, 3, 4, and 5, while Figure 1 illustrates the projected global warming associated with the scenarios. Appendix A also provides a full comparison table for climate variables under SSP5-8.5 and SSP2-4.5.

Table 6: IPCC Sixth Assessment Report Climate Change Scenario Characteristics

Scenario	Description
SSP1-2.6 – Sustainability Taking the Green Road	<ul style="list-style-type: none"> • Low challenges to both mitigation and adaptation • Policy focused on sustainable development • Effective international cooperation • Reduced inequality within and across countries • Low consumption • Low population growth
SSP2-4.5 Middle of the Road	<ul style="list-style-type: none"> • Medium challenges to both mitigation and adaptation • Current development and consumption patterns continue • National and global institutions are slow to achieve sustainable development goals • Environmental systems decline • Slow improvements to inequality • Moderate population growth
SSP3-7.0 Regional Rivalry A Rocky Road	<ul style="list-style-type: none"> • High challenges to mitigation and adaptation • Policy focused on security • Barriers to international trade • High inequality • Slow economic growth • Low population growth in rich countries, high in other countries

Scenario	Description
Scenario 4 SSP4-6.0 Inequality A Road Divided	<ul style="list-style-type: none"> • Policy focused on elite • High consumption • High inequality • Low to medium economic growth • Low population growth in rich countries, high in other countries
SSP5-8.5 – Fossil-fueled Development Taking the Highway	<ul style="list-style-type: none"> • High challenges to mitigation, low challenges to adaptation • Policy focused on free markets • High consumption • Effective international cooperation • Reduced inequality • High economic growth • Low population growth

Global Mean Surface Temperature Change (°C)

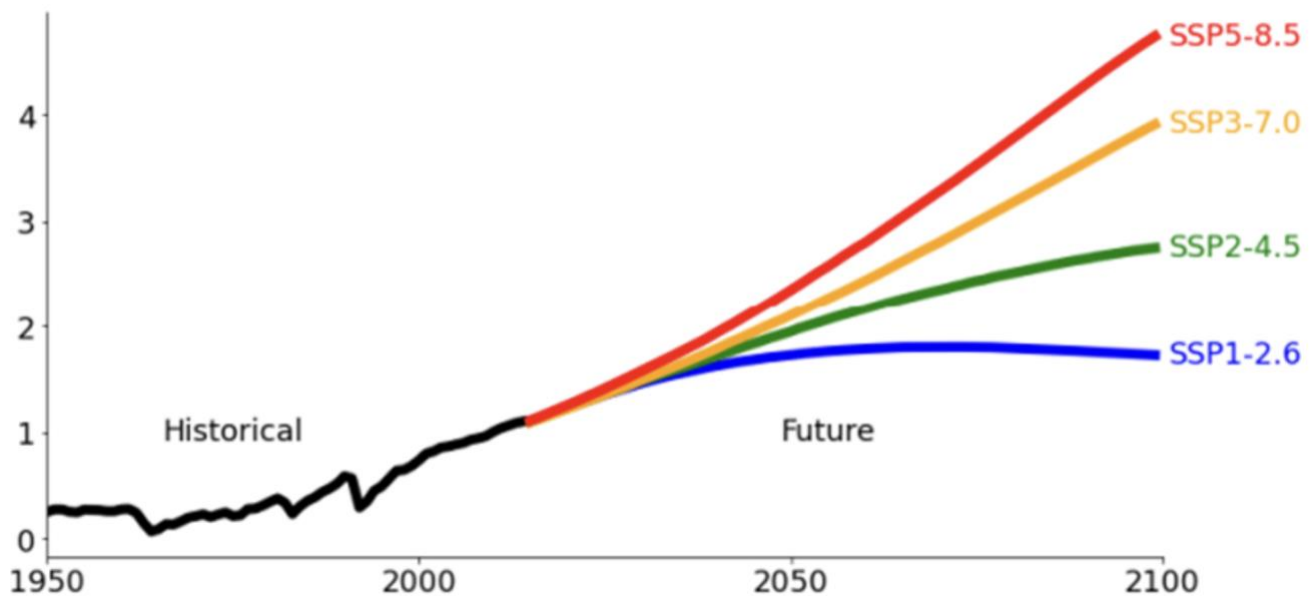


Figure 1: Projected Global Surface Temperature Change for CMIP6 SSP Scenarios

Time Periods

This report establishes a consistent baseline period so that projections can be accurately compared with historical trends. When utilizing data from ClimateData.ca:

- The baseline is 1971–2000.
- The future time periods used for this report are 2011–2040, 2041–2070, and 2071–2100.

Many climate indices are also divided into seasonal periods, defined in Table 7 below.

Table 7: Seasonal timeframes

Season	Months
Spring	March, April, May
Summer	June, July, August
Fall	September, October, November
Winter	December, January, February

Uncertainty

It is important to note that uncertainty is an integral part of the study of climate change. Uncertainty is factored into climate change scenarios, models, and data, and reflects the complex reality of environmental change and the evolving relationship between humans and the planet. Climate change cannot be predicted with absolute certainty in any given case, and all data must be considered with this in mind. While it is not possible to anticipate future climatic changes with absolute certainty, most contemporary climate analyses rely on ensemble modelling—drawing on multiple models or simulations to capture a broader range of plausible futures and minimise model-specific bias, i.e., the influence of any single model’s structural assumptions. Climate change scenarios like SSP2-4.5 and SSP5-8.5 help to create plausible representations of future climate conditions, and these conditions are based on assumptions of future atmospheric composition and on an understanding of the effects of increased atmospheric concentrations of greenhouse gases (GHG), particulates, and other pollutants.

Climate Projections

Temperature

Mean Temperature

Over the last six decades, Canada has become warmer, with average annual temperatures increasing by 1.3°C between 1948 and 2016. This rate of warming is almost double the global average reported over the same period ^[3]. Assuming emissions continue at the current rate of global output, Kawartha Lakes is projected to experience an annual average temperature increase of 6.4°C by the end of the century compared to its baseline. The table below displays the projected annual and seasonal temperature changes in Kawartha Lakes based on the IPCC Sixth Assessment Report (AR6). Climate modelling suggests that these changes will continue, and the climate change associated risks will increase in the future.

Table 8: Annual and Seasonal Mean Temperature (°C) for Kawartha Lakes - SSP5-8.5

Time- Frame	Annual	Winter	Spring	Summer	Fall
Baseline 1971-2000	6.2	-7.3	5.1	18.5	8.1
2011-2040 Low	7.5	-5.7	6.1	19.7	9.3
2011-2040 Median	8	-4.7	6.8	20.2	9.8
2011-2040 High	9	-3.3	7.4	21.2	10.6
2041-2070 Low	9.3	-3.6	8	21.3	10.9
2041-2070 Median	10.2	-2.4	8.8	22.2	11.7
2041-2070 High	11.7	-0.3	9.8	24.1	13.7
2071-2100 Low	11.3	-1.2	9.8	22.8	12.4
2071-2100 Median	12.6	0.1	11.3	24.9	14.3
2071-2100 High	15	2.7	12.4	27.3	17.6

Table 9: Annual and Seasonal Mean Temperature (°C) for Kawartha Lakes - SSP2-4.5

Time- Frame	Annual	Winter	Spring	Summer	Fall
Baseline 1971-2000	6.2	-7.3	5.1	18.5	8.1
2011-2040 Low	7.6	-5.8	6.4	19.6	9.3
2011-2040 Median	7.9	-5.2	6.8	20.1	9.8
2011-2040 High	9.1	-3.9	7.4	21.1	11.2
2041-2070 Low	8.5	-4.5	7.3	20.5	10.2
2041-2070 Median	9.3	-3.8	8	21.3	10.9
2041-2070 High	10.4	-2	8.8	22.6	12.4
2071-2100 Low	9.3	-3.5	7.9	21	10.9
2071-2100 Median	10.1	-2.6	8.7	22.3	11.7
2071-2100 High	11.8	-0.2	10.1	24	13.5

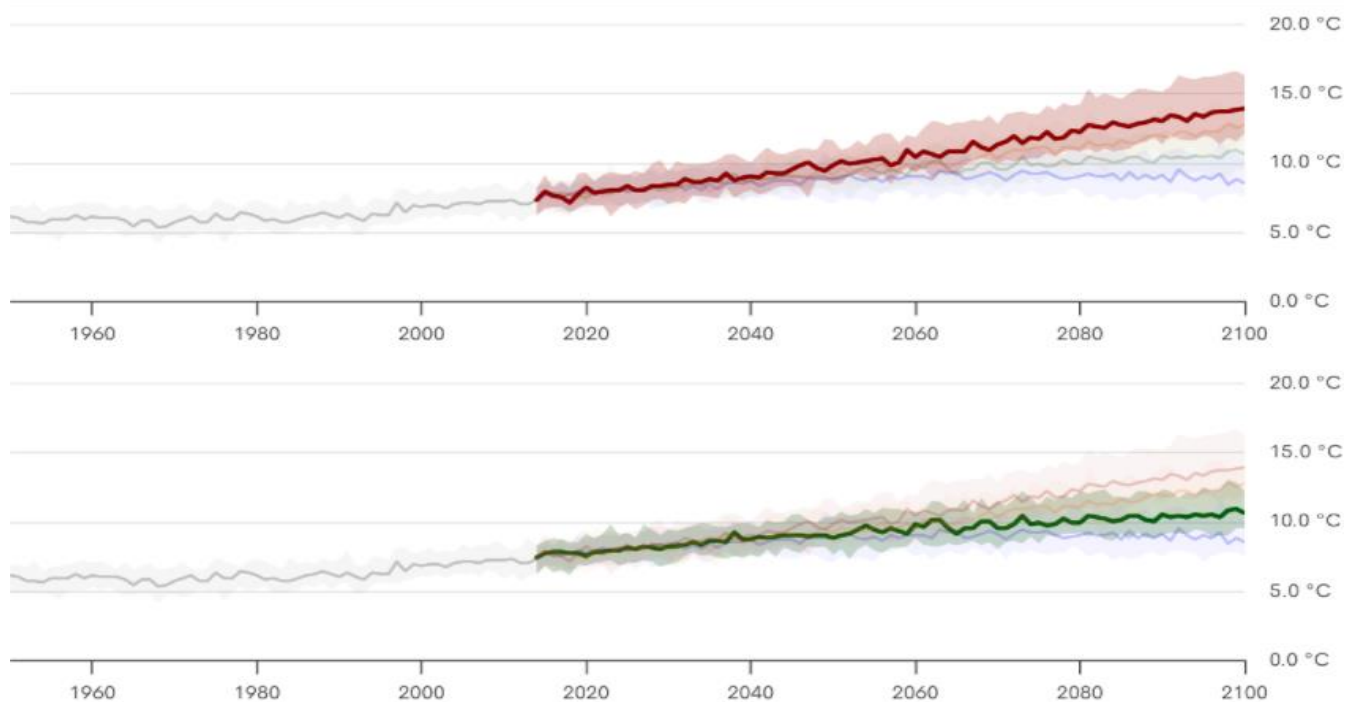


Figure 2: Projected Mean Annual Temperature Change for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Hot Weather

Extreme heat is the best-documented natural hazard associated with health consequences and increased all-cause mortality. Still, the thresholds and duration of extreme heat days and events vary across the country ^[4]. Examples of the health risks associated with extreme heat include heat rash, heat cramps (muscle cramps), heat edema (swelling of hands, feet, ankles), heat syncope (fainting), heat exhaustion, and heat stroke. Health Canada outlines the following at-risk groups for extreme heat event: older adults, infants and young children, people with chronic illnesses (like breathing problems, mental illness and heart problems), people who are unable to keep their living space cool, people who work in the heat (indoors or outdoors), people who exercise in the heat (indoors or outdoors), people experiencing homelessness, and people with low incomes ^[5]. Moreover, while higher summer temperatures increase electricity demand for cooling, extreme temperatures can also reduce the capacity of transmission lines to carry electricity, potentially leading to reliability issues during heat waves ^[6]. High temperatures determine if plants and animals can thrive; they limit or enable outdoor activities, define how we design our public realm, buildings and vehicles, and shape our transportation and energy use.

Hottest Day and Extreme Heat

Under the SSP5-8.5 scenario, the hottest day in Kawartha Lakes is projected to increase by 6.7 °C, from a baseline of 32.3 °C to 39.0 °C, by 2100 and the number of Tmax >30 °C days in Kawartha Lakes will increase from a baseline of 7 days to 70 days by 2100.

Table 10: Hottest Day (°C) for Kawartha Lakes – SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 32.3 °C			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	33.1	34.1	35.6
SSP5-8.5 (2041-2070)	34.8	36.2	39.4
SSP5-8.5 (2071-2100)	36.7	39.0	43.5
SSP2-4.5 (2011-2040)	33.3	34.0	35.4
SSP2-4.5 (2041-2070)	34.3	35.4	37.3
SSP2-4.5 (2071-2100)	34.9	36.4	39.3

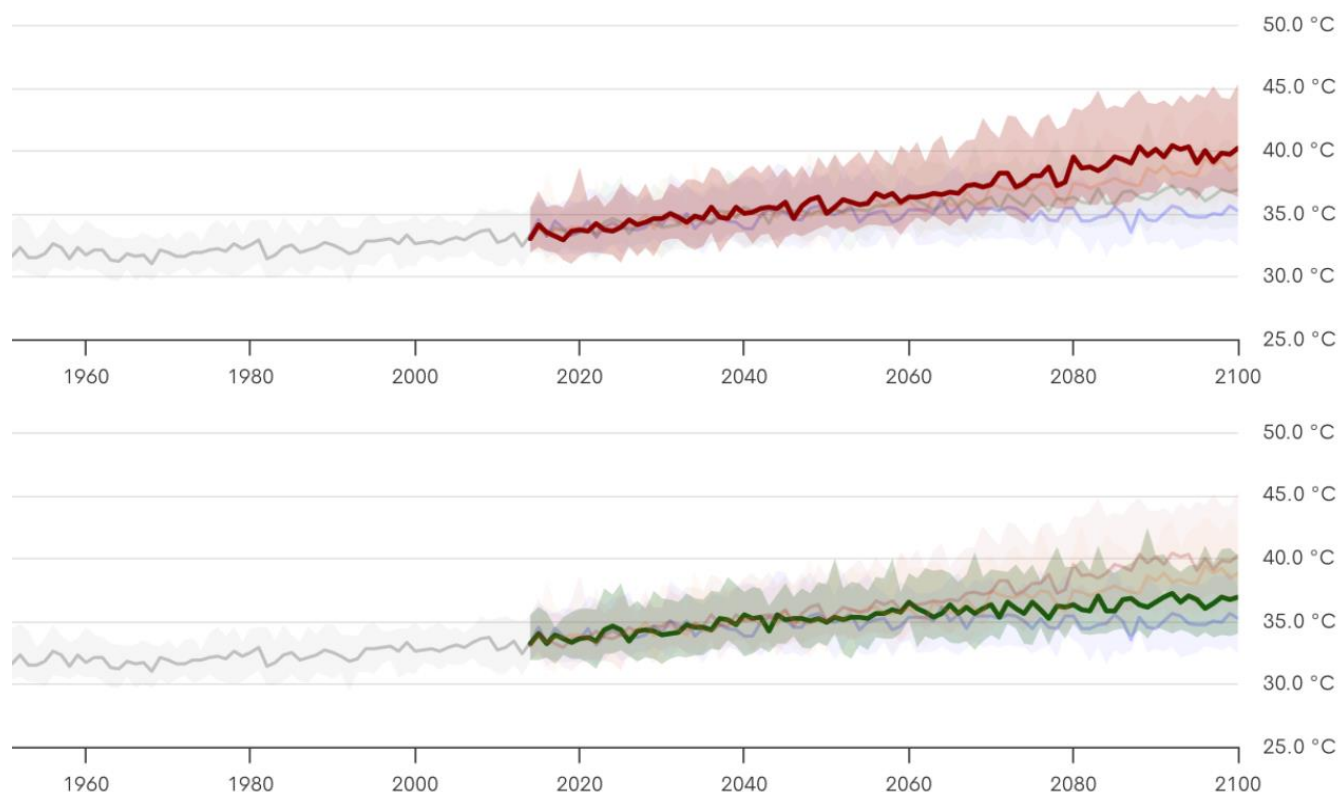


Figure 3: Projected Hottest Day for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Table 11: Number of days above Tmax 30°C for Kawartha Lakes – SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 7			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	12	17	27
SSP5-8.5 (2041-2070)	25	38	63
SSP5-8.5 (2071-2100)	45	70	106
SSP2-4.5 (2011-2040)	13	17	25
SSP2-4.5 (2041-2070)	19	28	46
SSP2-4.5 (2071-2100)	2	32	52

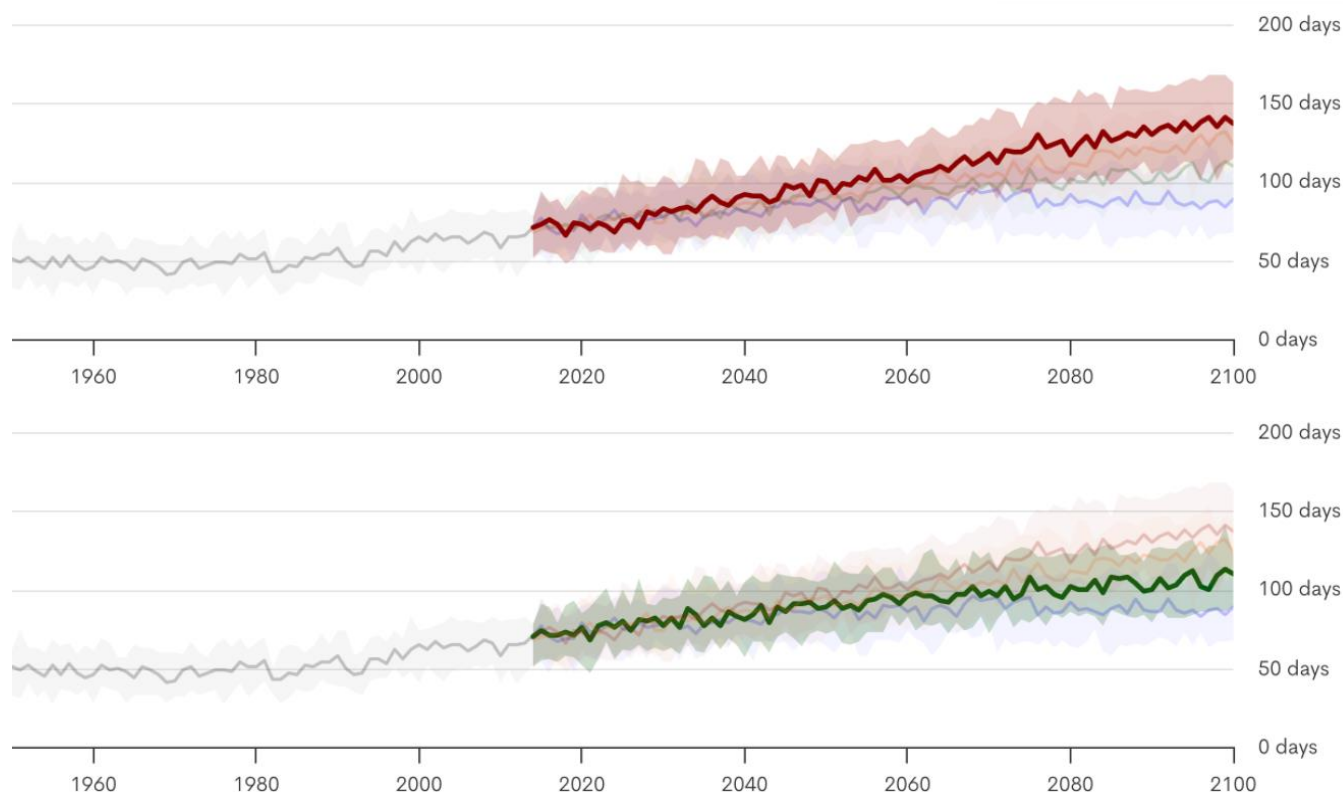


Figure 4: Projected Days Above $T_{max} > 30^{\circ}C$ for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

The humidex days variable provides the number of days where the humidex is greater than 30 ($Hx > 30$). The humidex index was developed by the Meteorological Service of Canada to describe how hot and humid the weather *feels* to the average person. In Canada, it is recommended that outdoor activities be limited or modified when the humidex exceeds 30, and that all unnecessary physical activities be reduced when it passes 40 ^[7]. The number of $Hx > 30$ days is projected to increase from a baseline average of 32 days to 112 days by 2100 under the SSP5-8.5 scenario.

Table 12: Number of Days With Humidex > 30 for Kawartha Lakes – SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 32			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	47	52	64
SSP5-8.5 (2041-2070)	71	82	92
SSP5-8.5 (2071-2100)	89	112	131
SSP2-4.5 (2011-2040)	47	51	59
SSP2-4.5 (2041-2070)	59	68	81
SSP2-4.5 (2071-2100)	68	82	100

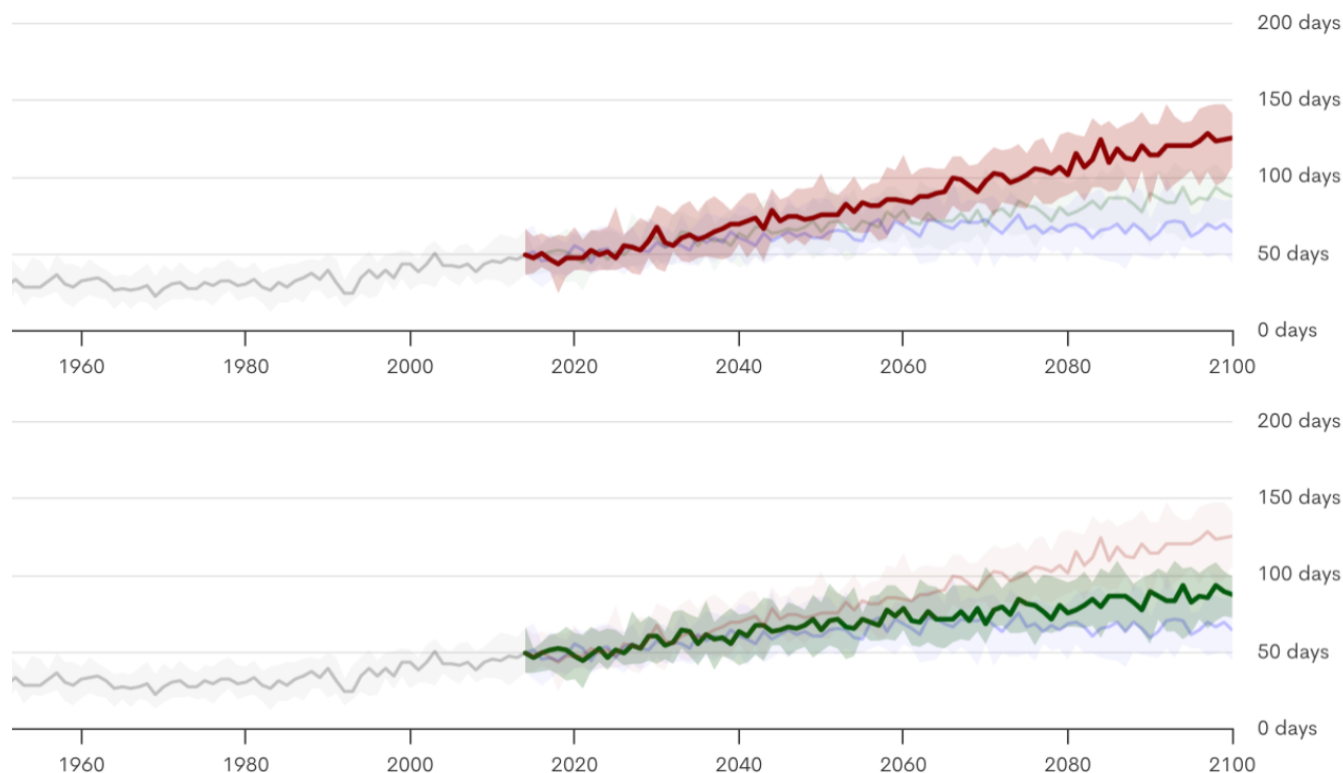


Figure 5: Projected Number of Humidex Days >30 for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Tropical Nights

Tropical nights—days when the minimum temperature remains above 20 °C—are a key indicator of prolonged heat exposure because they limit overnight cooling and reduce recovery time for people, infrastructure, and ecosystems. Projections for Kawartha Lakes show a clear increase in the frequency of tropical nights, consistent with regional warming and more persistent heat events. From its baseline of 1 day per year, the number of tropical nights is projected to rise to 45 days per year by 2100 across the municipality under the SSP5-8.5 scenario. This projection illustrates that the number of tropical nights are expected to more than double from one thirty-year period to the next.

Table 13: Tropical Nights for Kawartha Lakes – SSP5-8.5 and SSP2-4.5

Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	3	6	9
SSP5-8.5 (2041-2070)	11	17	28
SSP5-8.5 (2071-2100)	25	45	71
SSP2-4.5 (2011-2040)	4	5	8
SSP2-4.5 (2041-2070)	8	11	17
SSP2-4.5 (2071-2100)	11	16	28

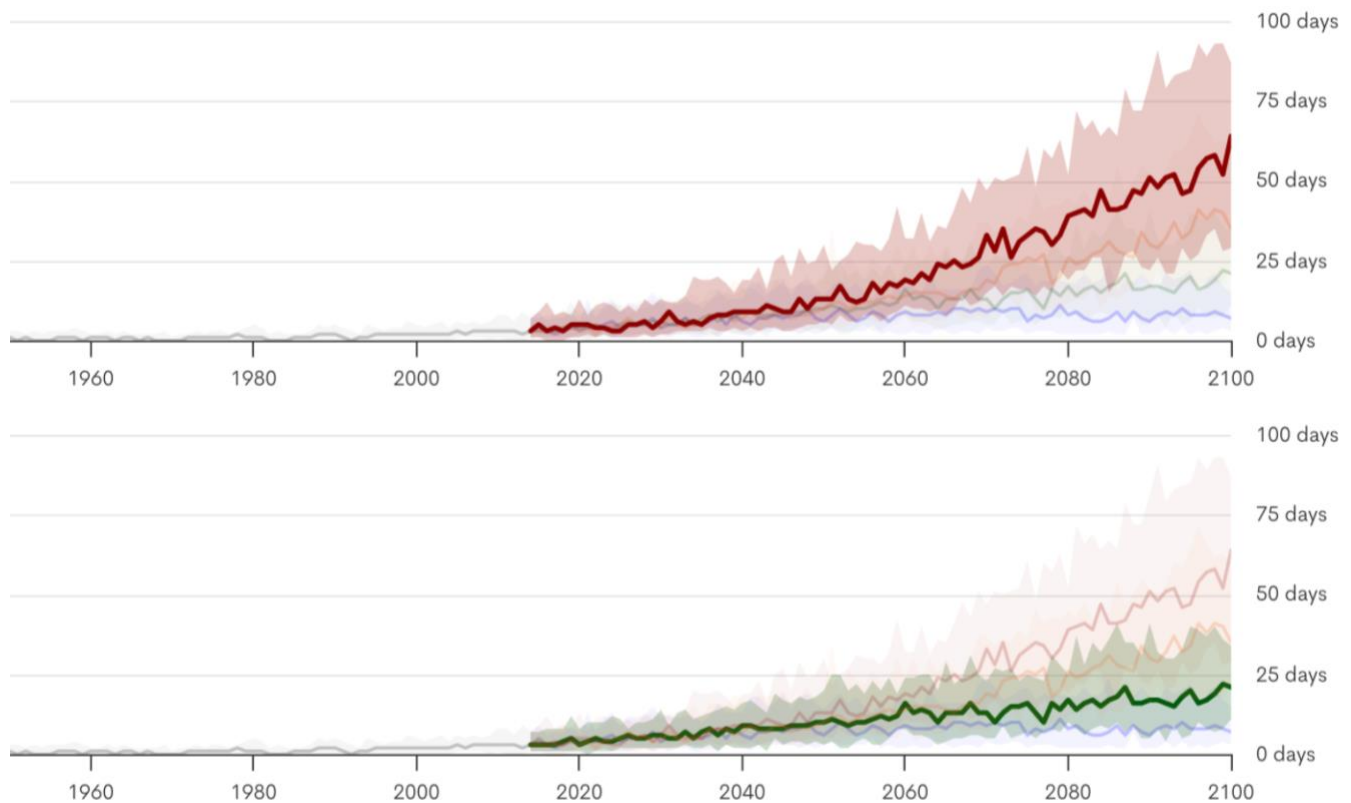


Figure 6: Projected Tropical Nights for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Heat Waves

Environment and Climate Change Canada (ECCC) issues a heat warning when ‘daytime highs’ are forecast to reach at least 31 °C ($T_{max} > 31^{\circ}\text{C}$) and ‘nightly lows’ are forecast to fall no lower than 20 °C ($T_{min} > 20^{\circ}\text{C}$), or when the Humidex is projected to reach 40, for two consecutive days. An extended heat warning applies when these conditions persist for three days or more. Public-health agencies integrate temperature, humidity, and nighttime cooling into warning thresholds to capture acute human-health risk.

Heat Wave Frequency

Heat wave frequency refers to how often heat waves occur in a specific area over a given period. As shown in the table below, the baseline frequency of heat waves in Kawartha Lakes is less than 1 heat wave per year. Kawartha Lakes is projected to experience 0.3 heat waves per year by 2040; 2.2 heat waves per year by 2070, and 6.2 heat waves per year by 2100 under the SSP5-8.5 scenario.

Table 14: Number of Heat Waves per year for Kawartha Lakes – SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 0			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	0	0.3	1.9
SSP5-8.5 (2041-2070)	0.4	2.2	4.9
SSP5-8.5 (2071-2100)	2.8	6.2	9.7
SSP2-4.5 (2011-2040)	0	0.2	1.6
SSP2-4.5 (2041-2070)	0.1	1.3	3.4
SSP2-4.5 (2071-2100)	0.3	2.2	5.1

Heat Wave Duration

Heat wave duration is a climate variable that totals the number of days per year that a heat event meets the thresholds of Tmax 31 °C and Tmin 20 °C, or humidex >40 for two or more days. For Kawartha Lakes, the baseline duration is less than 1 day per year. There is a significant upward trend toward the end of the century, however, with 1 heat event day per year projected by 2040; 7 heat event days per year by 2070; and 27 heat event days per year by 2100.

Table 15: Heat Wave Duration (total days) for Kawartha Lakes – SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 0			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	0	1	5
SSP5-8.5 (2041-2070)	1	7	19
SSP5-8.5 (2071-2100)	9	27	56
SSP2-4.5 (2011-2040)	0	0	4
SSP2-4.5 (2041-2070)	0	4	11
SSP2-4.5 (2071-2100)	1	6	19

Overall, more heat wave events and total heat wave days per year are projected to occur toward the end of the century. Sustained over several days at a time, extreme heat poses a significant risk to the health of individuals in Kawartha Lakes – heat illnesses can manifest quickly, and lead to long-term health problems and even death. Overexposure to extreme heat is especially dangerous for children and elderly adults, and those who work outside or are physically active outdoors ^[8]. Beyond human health, extended extreme heat events can cause accelerated wear and tear to built infrastructure, overwhelm the energy grid due to higher energy demand, and negatively impact regional ecosystems, wildlife and agriculture.

Cooling Degree Days

As extreme heat becomes more frequent and persistent, measures of cumulative heat exposure provide more insight into how temperature changes translate into impacts on buildings, energy use, and community well-being. Cooling degree days (CDD)—the sum of degrees by which daily mean temperature exceeds 18 °C per year—offer a way to assess how often and by how much conditions drive the need for mechanical cooling (air conditioning). Rising CDD values across Kawartha Lakes reflect both higher average temperatures and a greater number of days exceeding comfort thresholds. Incorporating CDD into the assessment of extreme heat helps illustrate how warming translates into increased cooling demand, with implications for electricity planning, building design, and vulnerability to heat-related stress.

Table 16: Cooling Degree Days for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 171			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	250	304	388
SSP5-8.5 (2041-2070)	406	492	708
SSP5-8.5 (2071-2100)	591	846	1182
SSP2-4.5 (2011-2040)	249	291	378
SSP2-4.5 (2041-2070)	333	403	552
SSP2-4.5 (2071-2100)	388	511	680

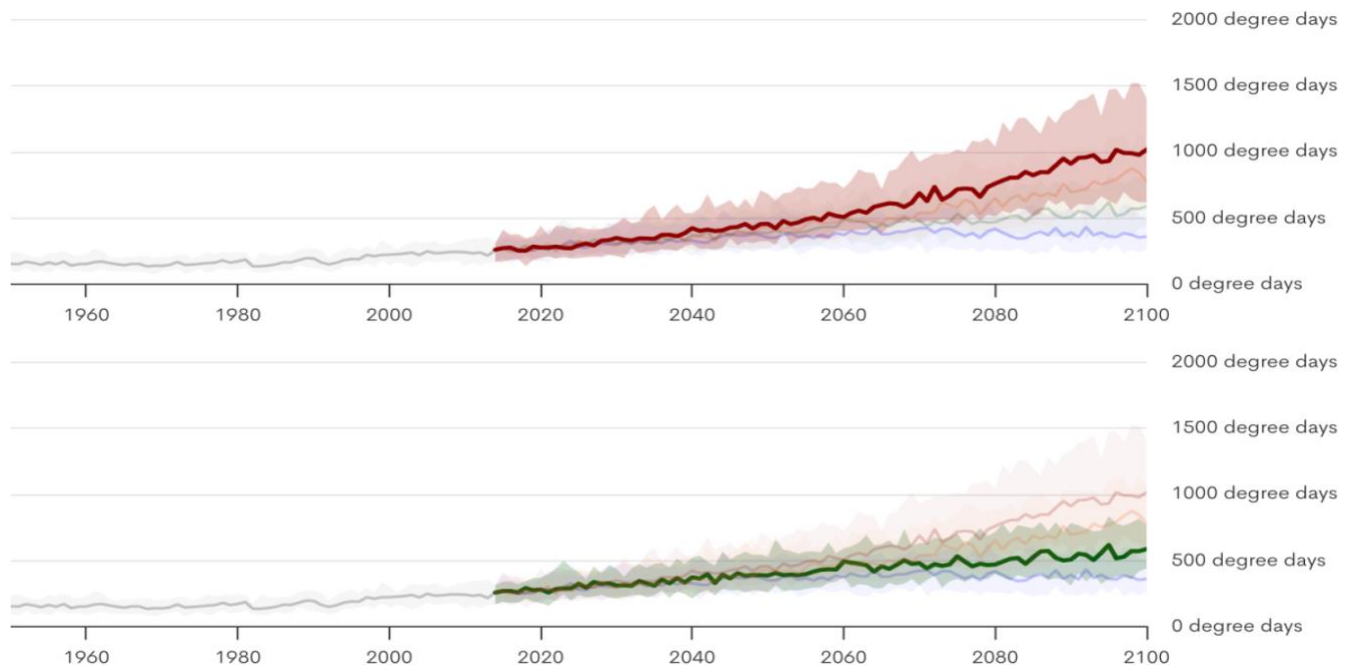


Figure 7: Projected Cooling Degree Days for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Cold Weather

Cold weather is an important aspect of life in Canada and many places in Canada are well adapted to very cold winters. Overall, the frequency and severity of cold days is decreasing across the country, and in Kawartha Lakes, the trend is no different. It is important to consider how cold weather temperatures will change in the future as these have implications for health and safety, factor into the feasibility of growing plants and raising animals, can limit or enable outdoor activities, define how we design our public realm, buildings and vehicles, and shape our transportation and energy use.

Coldest Day and Extreme Cold

The coldest day describes the lowest nighttime temperature in the selected time period. In general, the coldest day of the year occurs during the winter months. Given the warming of annual temperatures, the coldest day in Kawartha Lakes is projected to become warmer, from a baseline of -30°C to -26.5°C by 2040, to -21.9°C by 2070 and -16.9°C by 2100.

Table 17: Coldest Day (°C) for Kawartha Lakes – SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): -30 °C			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	-27.9	-26.5	-23.4
SSP5-8.5 (2041-2070)	-24.4	-21.9	-17.3
SSP5-8.5 (2071-2100)	-19.6	-16.9	-11.2
SSP2-4.5 (2011-2040)	-28.2	-27.0	-23.3
SSP2-4.5 (2041-2070)	-26.0	-23.8	-19.8
SSP2-4.5 (2071-2100)	-24.0	-22.4	-16.4

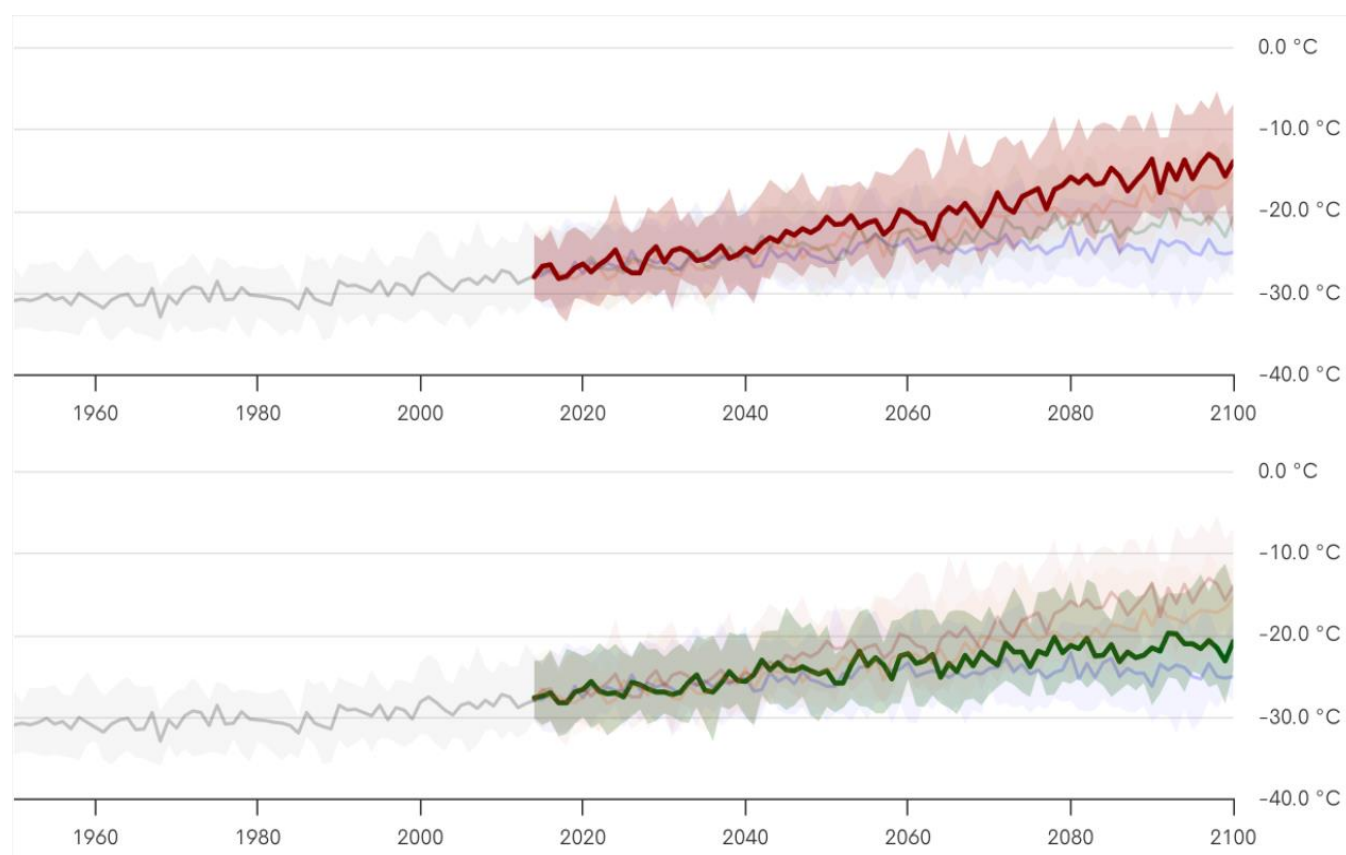


Figure 8: Projected Coldest Day for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Extreme cold days, defined as a day where the temperature drops to at least -15°C , are projected to decrease significantly in Kawartha Lakes from a baseline of 36 days to 23 days per year by 2040; further decreasing to 11 days per year by 2070; down to 3 days by 2100.

Table 18: Days with $T_{\min} < -15^{\circ}\text{C}$ for Kawartha Lakes – SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 36			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	14	23	28
SSP5-8.5 (2041-2070)	4	11	17
SSP5-8.5 (2071-2100)	0	3	7
SSP2-4.5 (2011-2040)	18	25	27
SSP2-4.5 (2041-2070)	8	18	22
SSP2-4.5 (2071-2100)	3	12	16

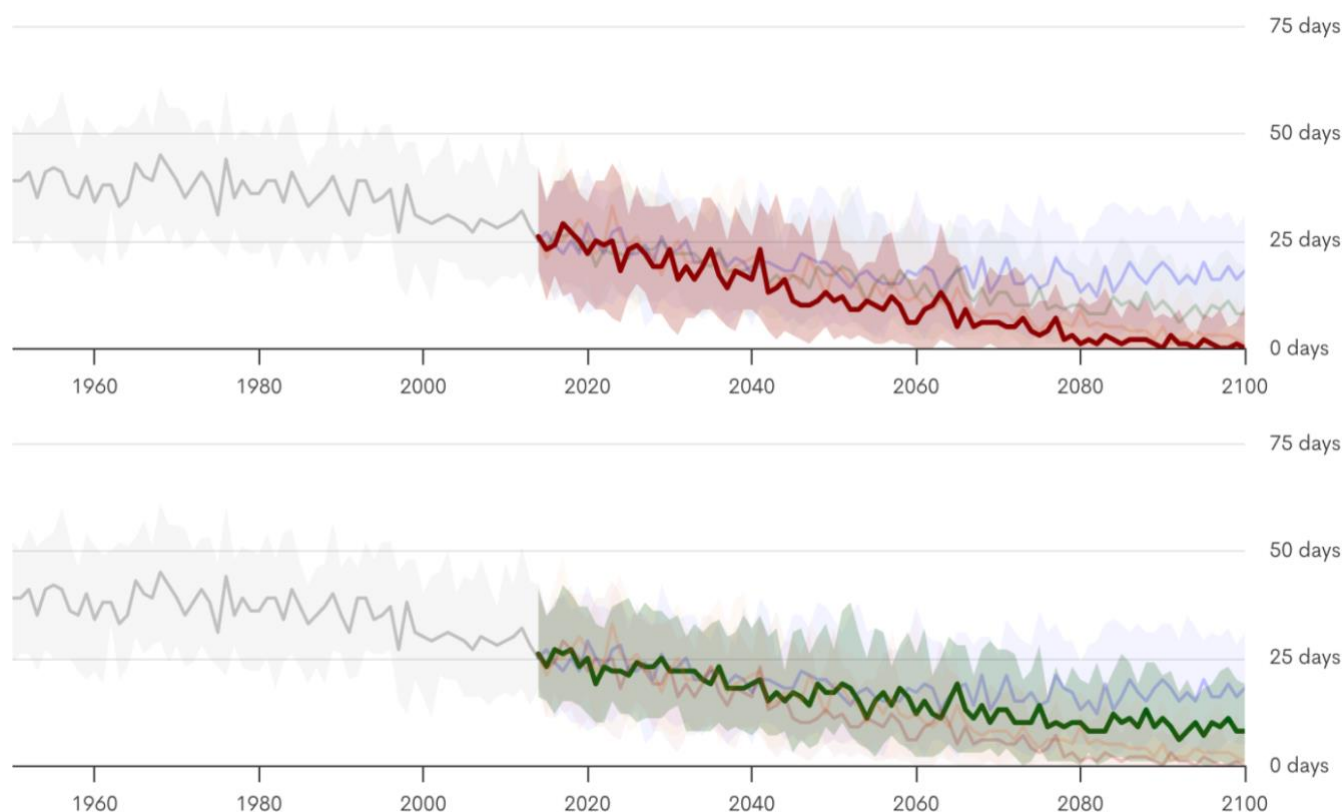


Figure 9: Projected Days with $T_{\min} < -15^{\circ}\text{C}$ for Kawartha Lakes – SSP5-8.5 (above); SSP2-4.5 (below)

Heating Degree Days

Heating degree days (HDD) provide a measure of cumulative cold-season (heating) energy demand by summing the number of degrees for which daily mean temperatures fall below 18°C over a year. HDD values decrease as regional temperatures warm, indicating fewer days where indoor heating is required or where heating loads are substantial. Tracking changes in HDD helps illustrate how winter warming translates into shifting energy needs, building performance demands, and potential changes to seasonal operating costs. As evidenced in the table below, HDDs are expected to decrease over the coming century.

Table 19: Heating Degree Days for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 4490			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	3626	3931	4085
SSP5-8.5 (2041-2070)	2968	3344	3593
SSP5-8.5 (2071-2100)	2317	2765	3003
SSP2-4.5 (2011-2040)	3639	3966	4093
SSP2-4.5 (2041-2070)	3305	3624	3805
SSP2-4.5 (2071-2100)	2913	3409	3618

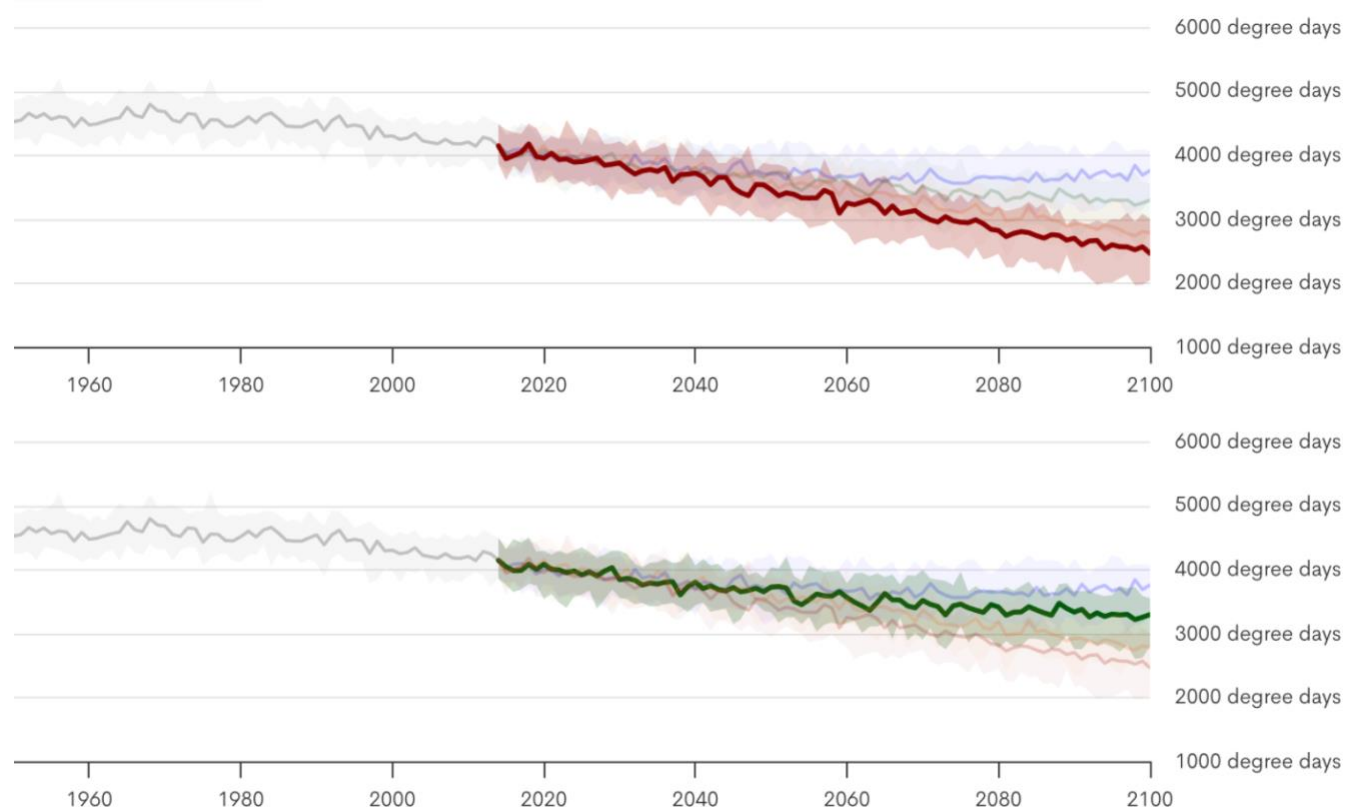


Figure 10: Projected Heating Degree Days for Kawartha Lakes - SSP5-8.5

Frost Days and Ice Days

Other indicators of cold temperatures are frost days and icing days, which can help to understand freeze and thaw patterns throughout the municipality, and are correlated to risks relating to injury and mortality from traffic accidents, damage to roads and infrastructure, facility closures and more. A frost day is a day in which the minimum temperature is below 0°C. From a baseline of 162 days, frost days in Kawartha Lakes are projected to decrease by 21 days per year by 2040; by 42 days per year by 2070; and by 71 days per year by 2100.

Table 20: Frost Days for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 162			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	136	141	148
SSP5-8.5 (2041-2070)	103	120	128
SSP5-8.5 (2071-2100)	59	91	106
SSP2-4.5 (2011-2040)	134	144	147
SSP2-4.5 (2041-2070)	119	129	136
SSP2-4.5 (2071-2100)	101	121	128

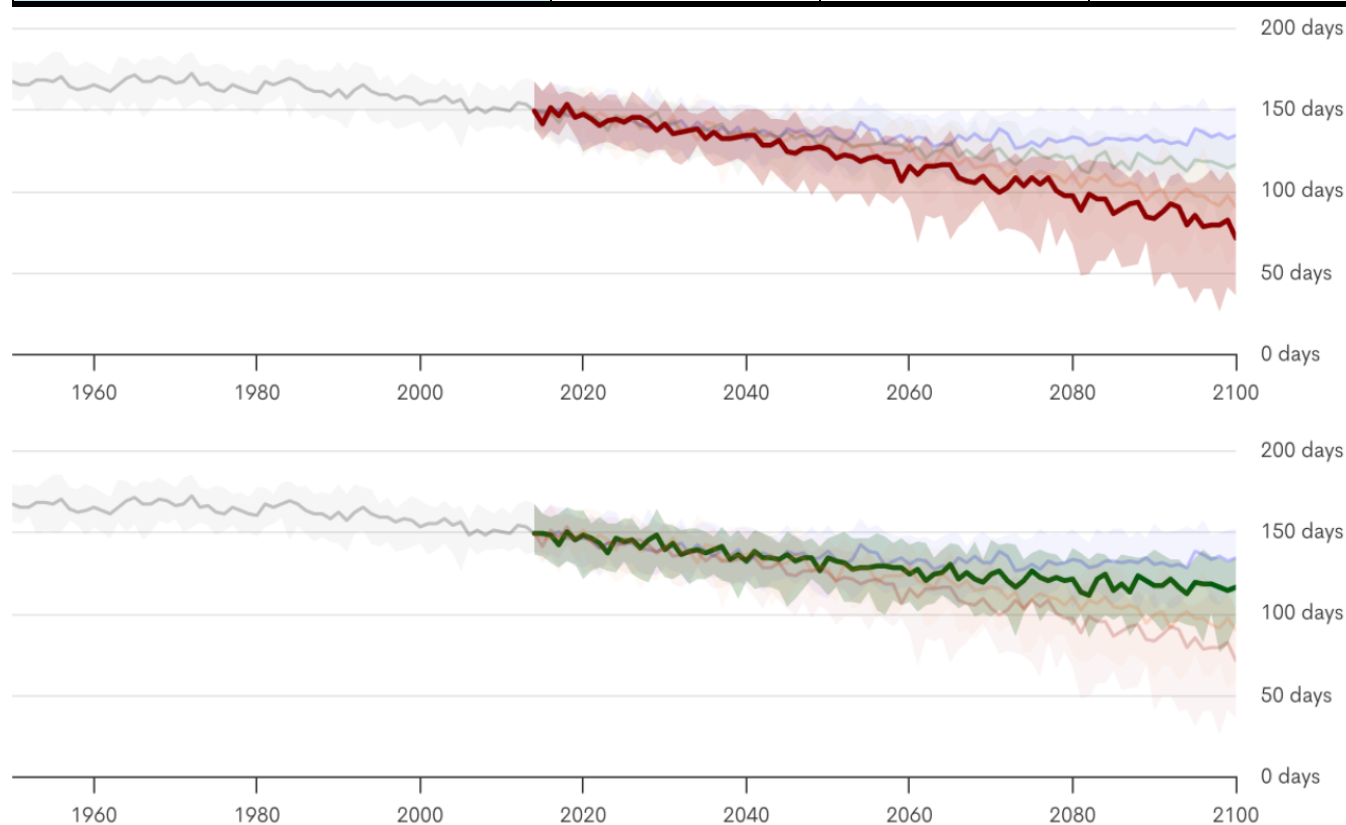


Figure 11: Projected Frost Days for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Similarly, the number of ice days are projected to decrease in Kawartha Lakes. Ice days are the total number of days when the daily maximum temperature is at or below 0°C. Ice days are projected to decrease from a baseline of 71 days to 53 days by 2040; to 37 days by 2070; down to 20 days by 2100.

Table 21: Ice Days for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 71			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	43	53	61
SSP5-8.5 (2041-2070)	23	37	46
SSP5-8.5 (2071-2100)	7	20	27
SSP2-4.5 (2011-2040)	47	56	61
SSP2-4.5 (2041-2070)	33	47	53
SSP2-4.5 (2071-2100)	20	38	48

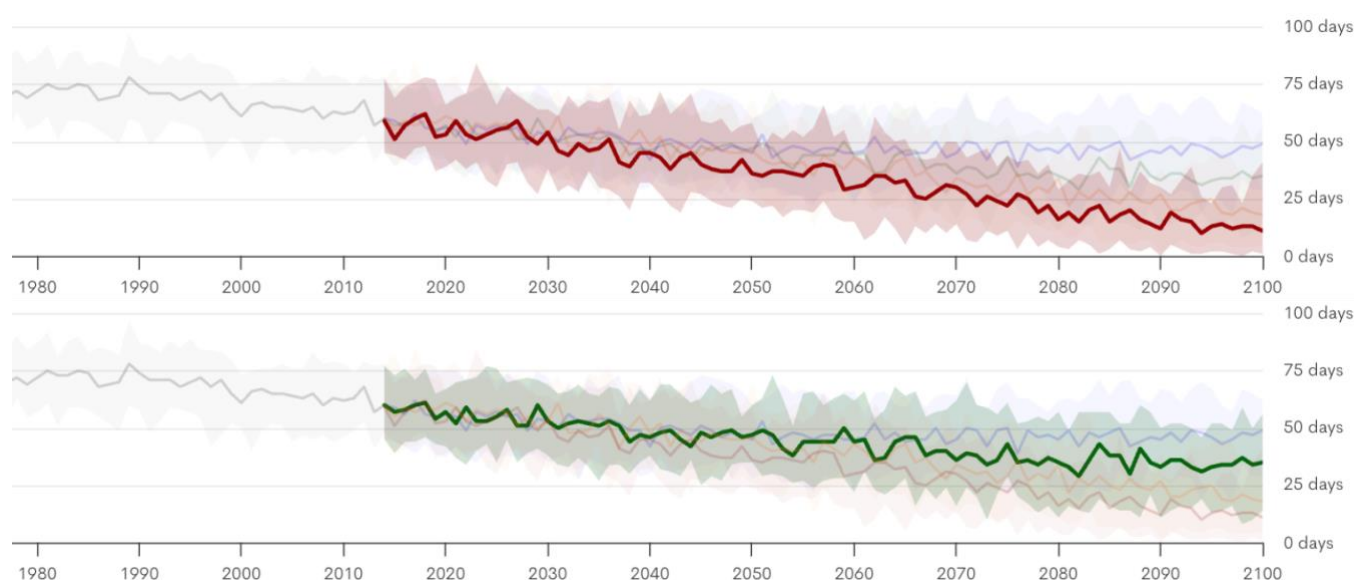


Figure 12: Projected Ice Days for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Freeze-Thaw

A freeze-thaw cycle is any day where the minimum temperature is below 0°C and the maximum temperature is above 0°C. Freeze-thaw cycles are projected to decrease due to overall warmer temperatures. This projection is likely due to the fact that days are getting warmer and Kawartha Lakes is expected to experience fewer days per year that reach a minimum temperature below 0°C.

Freeze-thaw cycles can have major impacts on infrastructure. During these cycles, surface water transitions between liquid and frozen states within a single 24-hour period. Because water expands when it freezes, the repeated freezing, melting, and re-freezing of water causes

cumulative damage to roadways, sidewalks, and other outdoor structures — potholes that form during the spring, or during mid-winter melts, are a familiar example of this process in action.

Beyond infrastructure, freeze-thaw dynamics also affect cultural and economic activities across the region. Increasing mid-winter thaw events and reduced snow cover could shorten seasons for ice fishing and snowmobiling, degrading trail quality and raising safety concerns for winter recreation. Maple syrup producers may similarly face less predictable and potentially shorter sugaring seasons, as the traditional late-winter pattern of freezing nights and warming days that enables sap flow continues to shift.

As shown in the table below, freeze-thaw cycles are projected to decrease from a baseline of 77 days per year to 74 days per year by 2040; to 68 days per year by 2070; down to 60 days per year by 2100.

Table 22: Annual Freeze-Thaw Cycles for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 77			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	70	74	78
SSP5-8.5 (2041-2070)	58	68	75
SSP5-8.5 (2071-2100)	39	60	69
SSP2-4.5 (2011-2040)	68	73	77
SSP2-4.5 (2041-2070)	61	70	76
SSP2-4.5 (2071-2100)	59	68	75

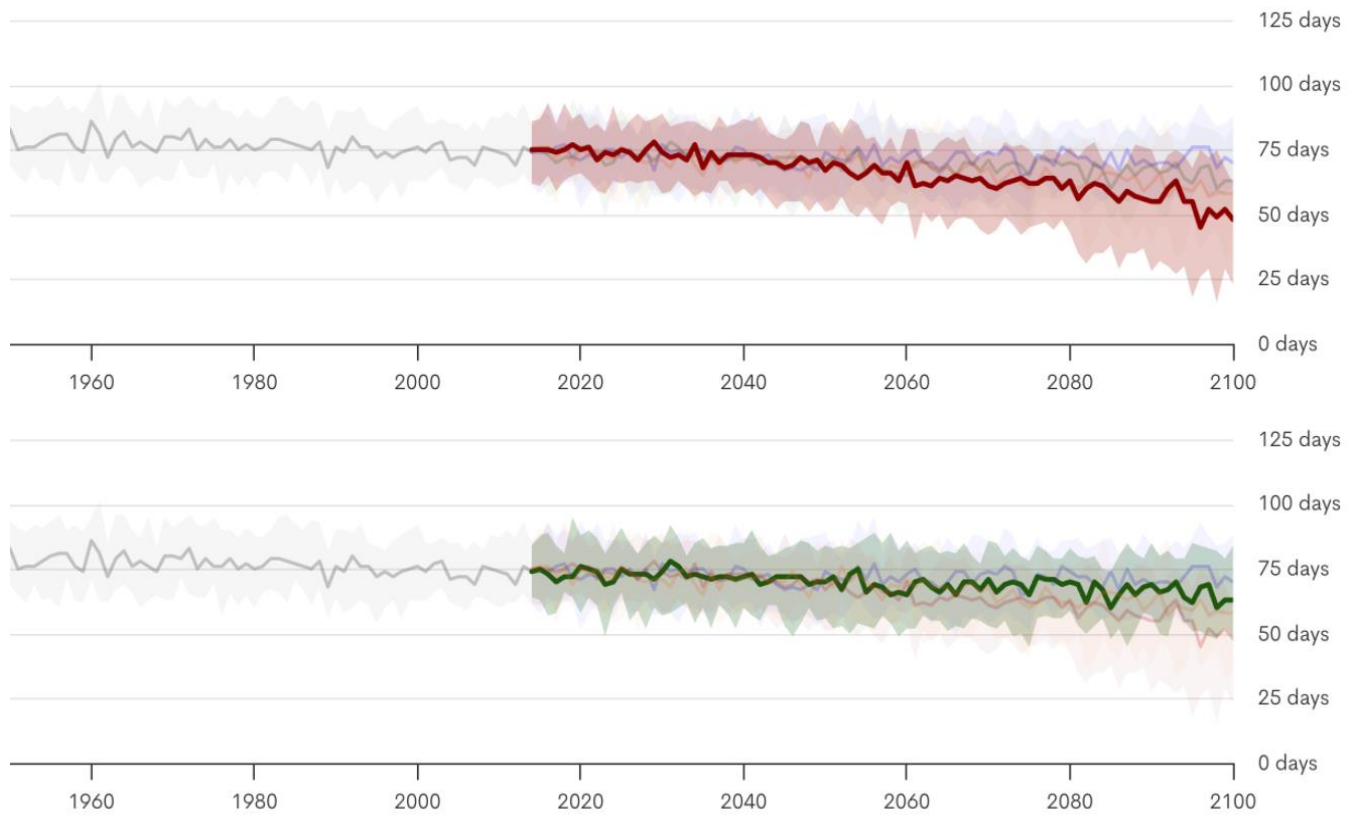


Figure 13: Projected Freeze-Thaw Cycles for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Agricultural Indices

Growing-Season Dynamics and Heat Availability

Climate change is altering seasonal temperature patterns, precipitation regimes, and the overall length of the growing season in Ontario, with direct implications for agriculture and related ecosystems in Kawartha Lakes. Longer frost-free periods and warmer average temperatures may expand the range of crops that can be grown, but these potential benefits are also offset by increasing risks. Higher temperatures can elevate the likelihood of drought, reduce water availability for irrigation, disrupt pollination processes, and create more favourable conditions for certain pests and pathogens. For example, warmer winters are extending the activity period of black-legged ticks—typically active in spring and fall¹. Managing increased agricultural productivity and working to reduce risks under climate change will require careful consideration of changing weather and climate conditions, as well as key landscape and soil characteristics, crop suitability, farm management options, and policy and program support ^[9].

¹ Whereas warmer temperatures can be attributed to greater black-legged tick activity, no single climate variable provides a reliable proxy for tick abundance or Lyme disease risk.

Frost Free Season (Growing Season)

The frost free season is the approximate length of the growing season during which there are no freezing temperatures to kill or damage frost-sensitive plants. This index describes the number of days between the Last Spring Frost and the First Fall Frost. Compared to a baseline of 137 days, the frost free season is projected to increase by 18 days per year by 2040; 39 days by 2070; and by 62 days by 2100. In other words, the annual frost free season is projected to increase by nearly 9 weeks within a century. To illustrate this another way, the last spring frost is projected to occur earlier in the year—on April 16 from a baseline of May 13—and the first fall frost is expected to occur later in the year—on November 3 from a baseline of September 29.

Table 23: Frost Free Season Length for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 137			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	143	155	166
SSP5-8.5 (2041-2070)	161	176	195
SSP5-8.5 (2071-2100)	185	199	230
SSP2-4.5 (2011-2040)	140	154	169
SSP2-4.5 (2041-2070)	155	169	182
SSP2-4.5 (2071-2100)	159	178	199

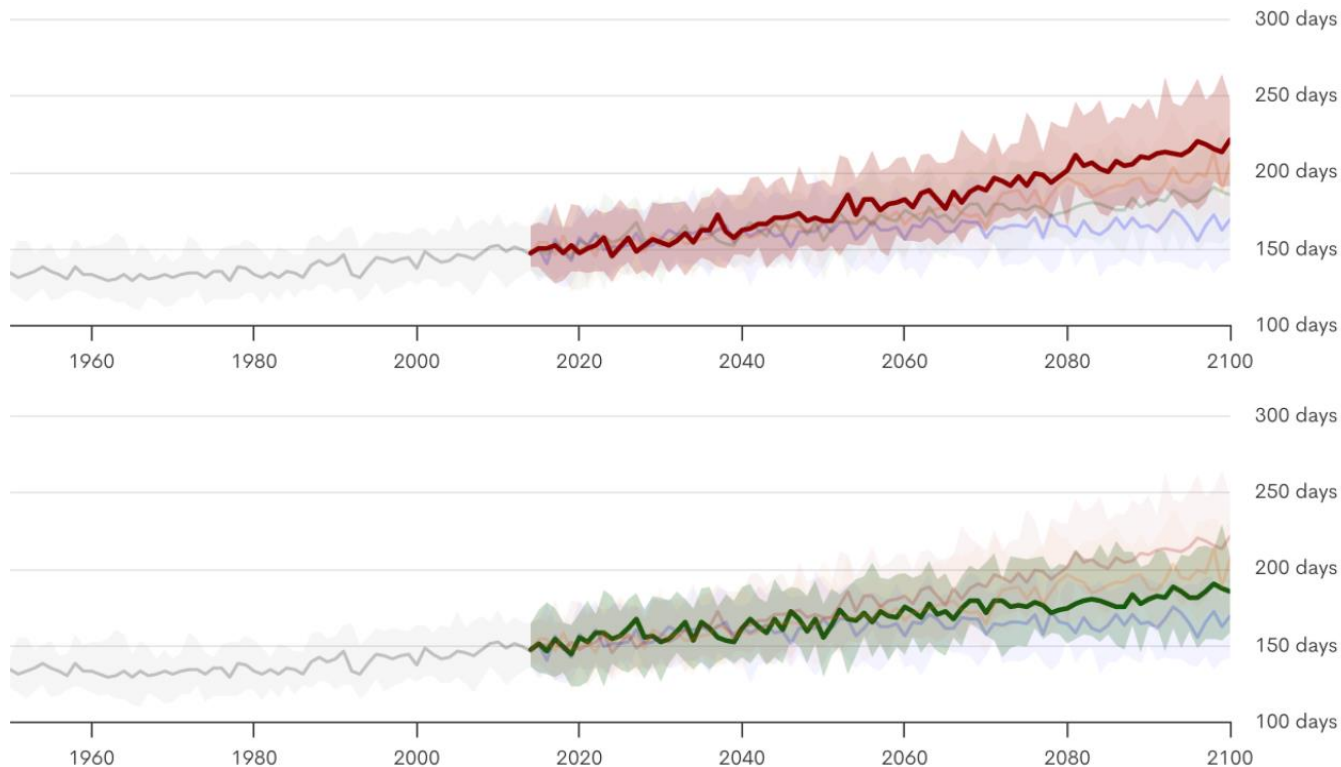


Figure 14: Projected Growing Season Length for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Growing Degree Days

Plant and insect development rates depend largely on the amount of heat they receive throughout the growing season, from planting to harvest. This heat accumulation is quantified using growing degree days (GDD). GDD measures the difference between the average daily temperature and a specific base temperature, which varies for different species ^[10]. Each plant species has a unique base temperature, below which its growth is limited. To account for varying heat requirements, different base temperatures are used for different organisms: +5°C GDDs are typically used for canola and forage crops; +10°C GDDs are more suitable for crops like corn and beans; and +15°C GDDs are often applied to assess the growth and development of insects and pests. This approach helps in understanding and predicting the growth patterns and developmental stages of various species based on their specific thermal needs ^[11].

Climate change is increasing the number of GDDs, which can both extend growing seasons and shift agricultural and ecological dynamics, introducing new opportunities and risks. With more GDDs, crops may mature earlier in the season, potentially producing more food and growing different types of crops. However, this warming trend also brings challenges, such as increased water stress, more favourable conditions for pests and diseases, and altered timing for key events like pollination. Additionally, more variability in spring and fall temperatures can stress fruit trees causing blossom loss due to late frosts ^[12].

In Kawartha Lakes, growing degree days are projected to increase from the baseline of 1955 degree-days per year to 2292 degree days by 2040; 2729 by 2070; and 3452 by 2100. This trend indicates longer and potentially more productive growing seasons but also highlights the need for adaptation strategies in agricultural management to address the impacts of climate change.

Table 24: Growing Degree Days (>5°C) for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 1995			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	2176	2292	2496
SSP5-8.5 (2041-2070)	2580	2729	3087
SSP5-8.5 (2071-2100)	2909	3452	3990
SSP2-4.5 (2011-2040)	2205	2278	2514
SSP2-4.5 (2041-2070)	2384	2549	2794
SSP2-4.5 (2071-2100)	2534	2771	3102

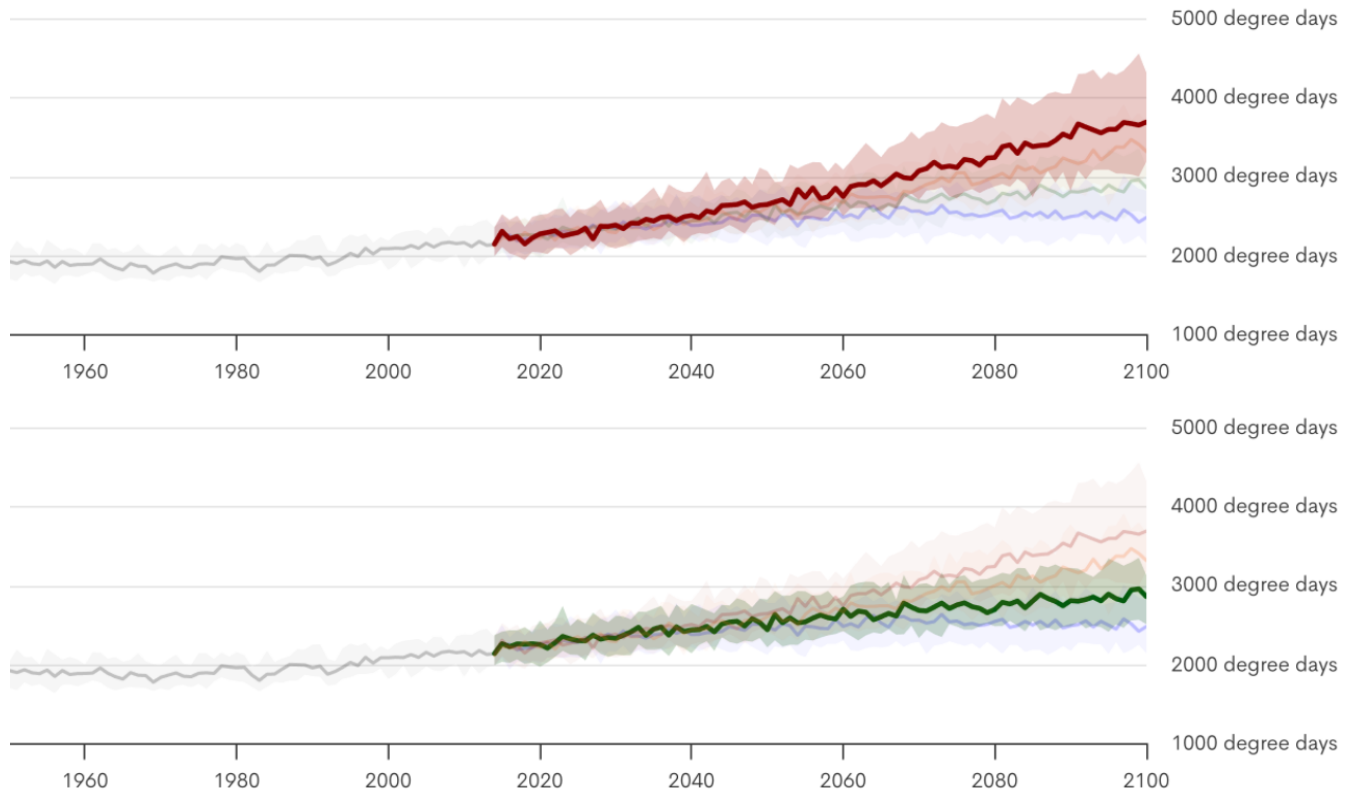


Figure 15: Projected Growing Degree Days for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Precipitation

Canada has become wetter over the past several decades, with increases in average annual precipitation in many regions. Some parts of the country are projected to see a significant percentage increase in precipitation, particularly in Northern Canada. Projections for Kawartha Lakes show somewhat less dramatic but still significant changes to precipitation patterns.

Mean Precipitation

For Kawartha Lakes, the baseline average annual precipitation is 952 mm. Under a high emission scenario, the municipality is projected to experience an average annual precipitation increase of 63mm by 2040; of 97mm by 2070; up to an increase of 157mm by 2100. You can find the precipitation accumulation projections for Kawartha Lakes under both SSP5-8.5 and SSP2-4.5 scenarios in the tables below. Likewise, Figure 16 presents the precipitation accumulation projections for Kawartha Lakes based on both scenarios.

On a seasonal basis, Kawartha Lake's spring, winter and fall precipitation accumulations are projected to increase by the end of the century. Projected summer precipitation is also projected to increase but to a lesser degree and returns to levels just above baseline by 2100 under the SSP5-8.5 scenario. These seasonal trends, including relatively stable summer rainfall amounts, paired with the projected increases in summer temperatures and heatwave lengths may lead to increased instances of drought.

Table 25: Annual and Seasonal Precipitation (mm) for Kawartha Lakes - SSP5-8.5

Time- Frame	Annual	Winter	Spring	Summer	Fall
Baseline 1971-2000	952	233	224	235	264
2011-2040 Low	963	238	223	216	252
2011-2040 Median	1015	256	240	246	274
2011-2040 High	1051	274	256	261	297
2041-2070 Low	1023	259	234	213	264
2041-2070 Median	1049	273	260	238	285
2041-2070 High	1093	293	283	257	297
2071-2100 Low	1043	283	251	196	270
2071-2100 Median	1109	301	278	239	292
2071-2100 High	1170	338	304	267	323

Table 26: Annual and Seasonal Precipitation (mm) for Kawartha Lakes - SSP2-4.5

Time- Frame	Annual	Winter	Spring	Summer	Fall
Baseline 1971-2000	952	233	224	235	264
2011-2040 Low	968	239	227	224	255
2011-2040 Median	1007	253	242	241	273
2011-2040 High	1044	269	253	256	294
2041-2070 Low	1001	249	233	217	269
2041-2070 Median	1050	266	256	245	282
2041-2070 High	1084	280	264	261	312
2071-2100 Low	1019	254	245	215	258
2071-2100 Median	1065	279	259	246	283
2071-2100 High	1108	303	279	263	302

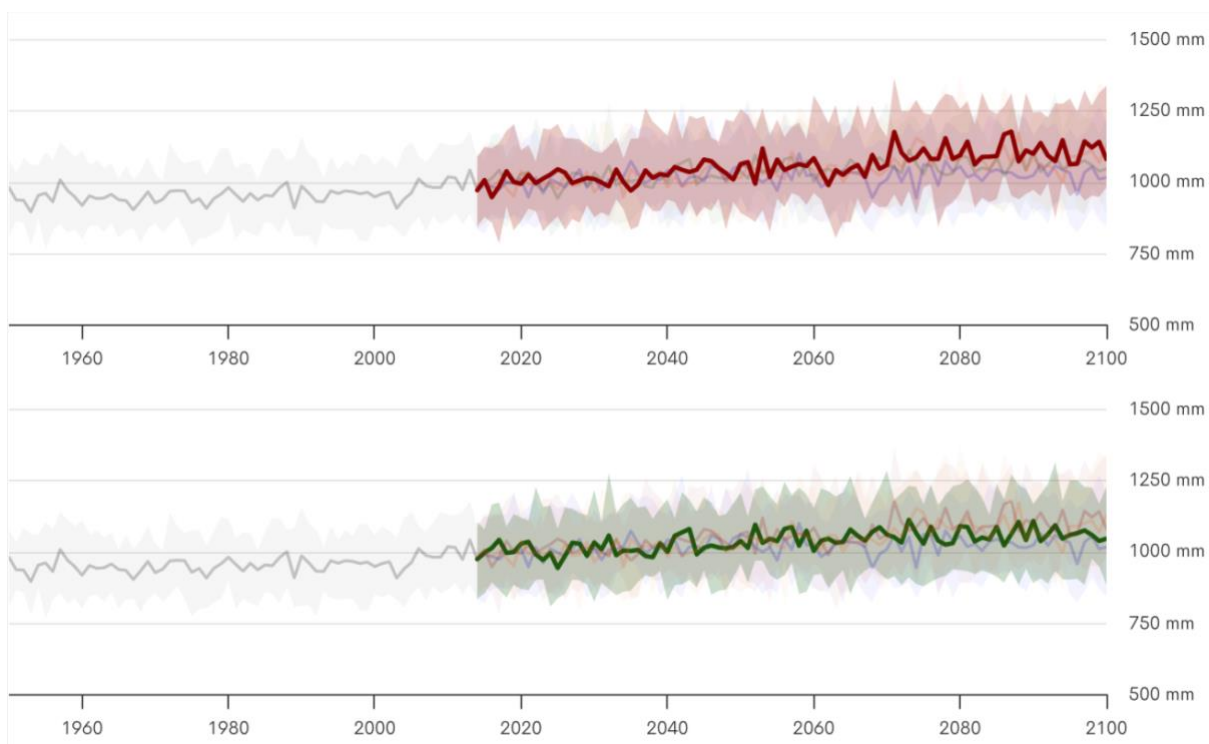


Figure 16: Projected Annual Precipitation for Kawartha Lakes – SSP5-8.5 (above); SSP2-4.5 (below)

Maximum Consecutive Dry Days

Maximum consecutive dry days indicate the maximum number of consecutive days with precipitation below 1mm/day, within the selected time period. Periods of dry weather can directly impact water availability, drive up demand for agricultural and landscape irrigation and water pumping, and increase energy demand. Drought conditions may result when dry periods are long-lasting. As shown in the table below, maximum consecutive dry days are projected to be relatively stable, albeit with a slight tendency to increase, over the coming century.

Table 27: Maximum Consecutive Dry Days for Kawartha Lakes - SSP5-8.5 and SSP2.4-5

Baseline (1971-2000): 13			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	13	13	14
SSP5-8.5 (2041-2070)	13	14	14
SSP5-8.5 (2071-2100)	13	15	16
SSP2-4.5 (2011-2040)	12	13	14
SSP2-4.5 (2041-2070)	12	13	15
SSP2-4.5 (2071-2100)	12	14	15

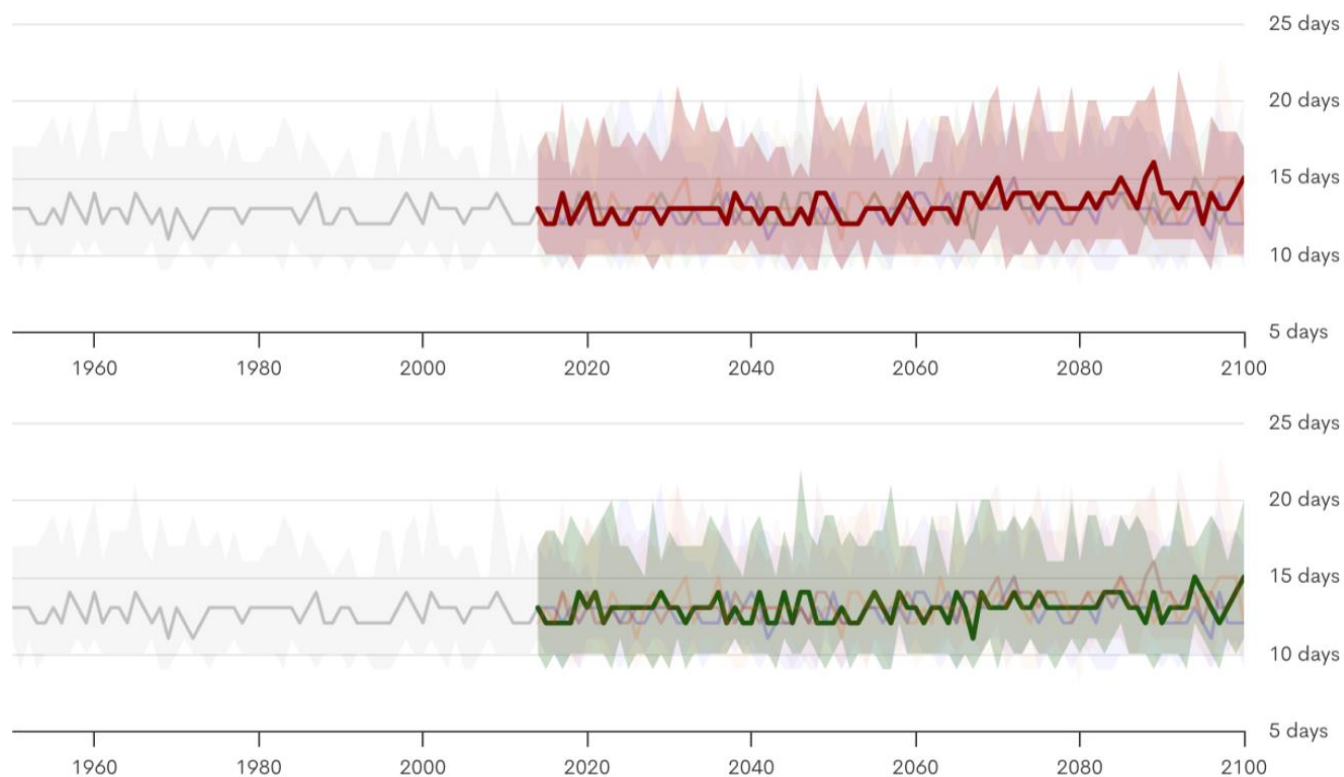


Figure 17: Maximum Consecutive Dry Days for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Extreme Weather Events

In the past decade, Canada has been experiencing more frequent and intense extreme weather events that significantly affect our population and industries. These events come in the form of heat waves, drought, wildfires, more frequent and intense extreme precipitation and flooding events, and wind and ice storms. Over the last forty years, extreme weather events have resulted in damages of \$31 billion in Canada alone, with global costs estimated at nearly \$5 trillion. The likelihood and the severity of these events are increasing with climate change and are projected to cause hundreds of trillions of dollars in economic damage globally. Extreme weather events will affect communities across Canada, from damage to infrastructure and critical services, to economic and industry productivity, and in particular the health of vulnerable populations ^[13]. Future extreme weather models predict shorter return periods of extreme events – that is, an increase in the likelihood of 25, 50, and 100 year events – in the future.

It helps to clarify what terms like "25-year" or "100-year event" actually describe because they are widely misunderstood. Rather than indicating how often an event occurs, these terms express an annual probability: a "100-year event" simply means there is a 1% chance of that event occurring in any given year, while a "25-year event" carries a 4% annual chance. These probabilities reset every year regardless of what happened the year before, meaning severe events can and do occur in consecutive years or multiple times within a decade. As climate change intensifies, an extreme weather event that historically carried a 1% annual chance may occur with 2%, 5%, or greater likelihood in any given year, meaning what previous generations experienced as a rare, once-in-a-lifetime event may occur several times within the lifespan of a community or single piece of municipal infrastructure.

Heavy or Extreme Precipitation

Warmer air holds more moisture and drives greater evaporation, increasing both the intensity and variability of precipitation across the region. Increased intensity and frequency of heavy rainfall and storm events are among the major climate hazards facing Ontario's infrastructure and communities under climate change ^[14]. Extreme rain and flood events have frequently been experienced in Southern Ontario in the last 10 years, and with projected increases in annual precipitation there is the potential of increased flood risk and high intensity storms.

The projections of several extreme precipitation indices are presented in this section. Wet days are days on which at least a total of 10 mm or 20 mm of rain or frozen precipitation falls. Frozen precipitation is measured according to its liquid equivalent: 10 cm of snow is usually about 10 mm of precipitation ^[15].

Max 1-day precipitation indicates the amount of precipitation that falls on the wettest day of the year. The max 1-day precipitation amount could be the result of a short but intense precipitation event such as a storm or because a moderate amount of snow and/or rain falls continuously all day, rather than all at once.

The tables below show the projected wet days (both 10 mm and 20 mm), as well as the max 1-day precipitation for Kawartha Lakes. Wet days that experience more than 10mm of precipitation are projected to increase by 8 days per year by 2100 and wet days that experience more than 20mm

per year are projected to increase by 4 days per year by 2100. Maximum 1-day precipitation is also projected to increase from the baseline of 36mm to 46mm per year by 2100.

Baseline (1971-2000): 27

Table 28: Wet Days $\geq 10\text{mm}$ for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	27	30	31
SSP5-8.5 (2041-2070)	30	32	34
SSP5-8.5 (2071-2100)	32	35	37
SSP2-4.5 (2011-2040)	28	30	32
SSP2-4.5 (2041-2070)	29	32	33
SSP2-4.5 (2071-2100)	30	32	35

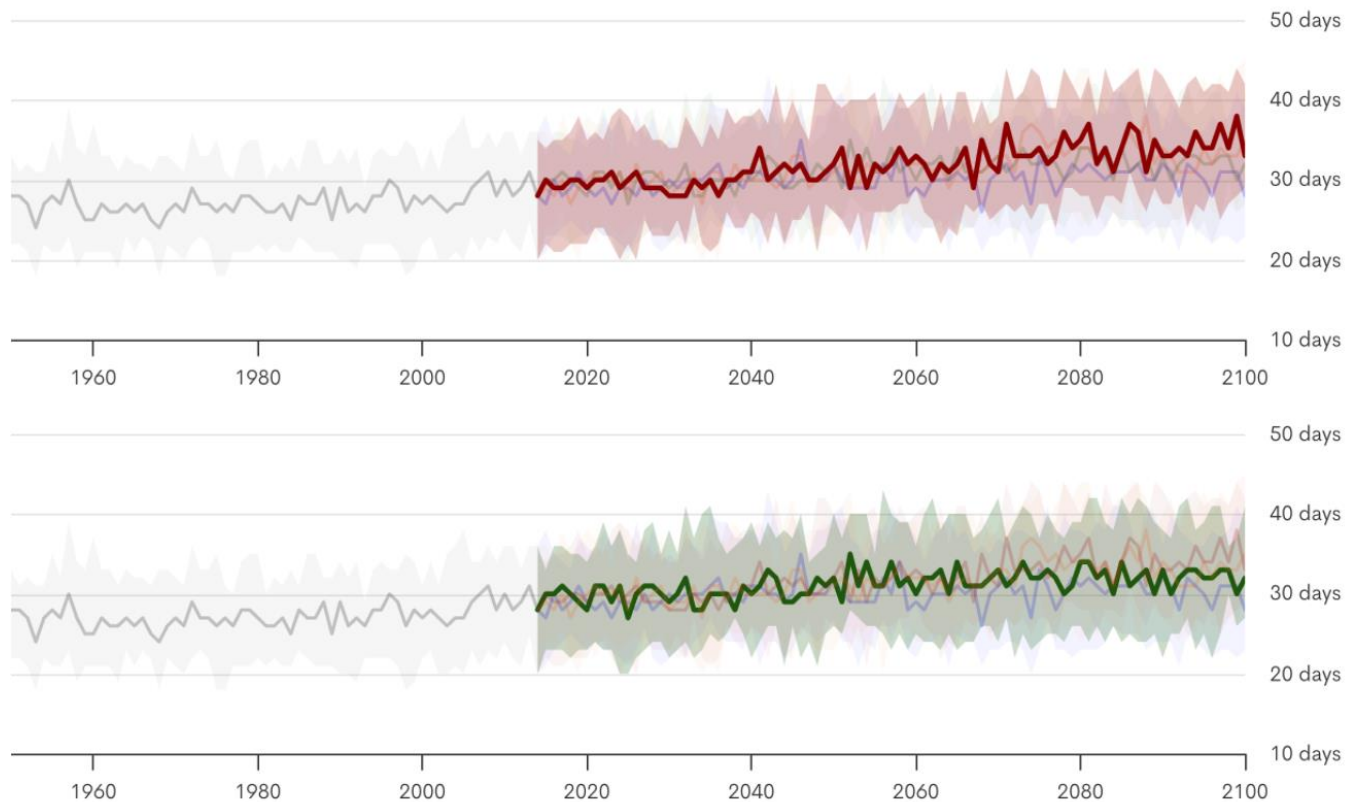


Figure 18: Wet Days $\geq 10\text{mm}$ for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Table 29: Wet Days $\geq 20\text{mm}$ for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 5			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	6	7	8
SSP5-8.5 (2041-2070)	7	8	9
SSP5-8.5 (2071-2100)	8	9	11
SSP2-4.5 (2011-2040)	6	6	7
SSP2-4.5 (2041-2070)	7	7	8
SSP2-4.5 (2071-2100)	7	8	9

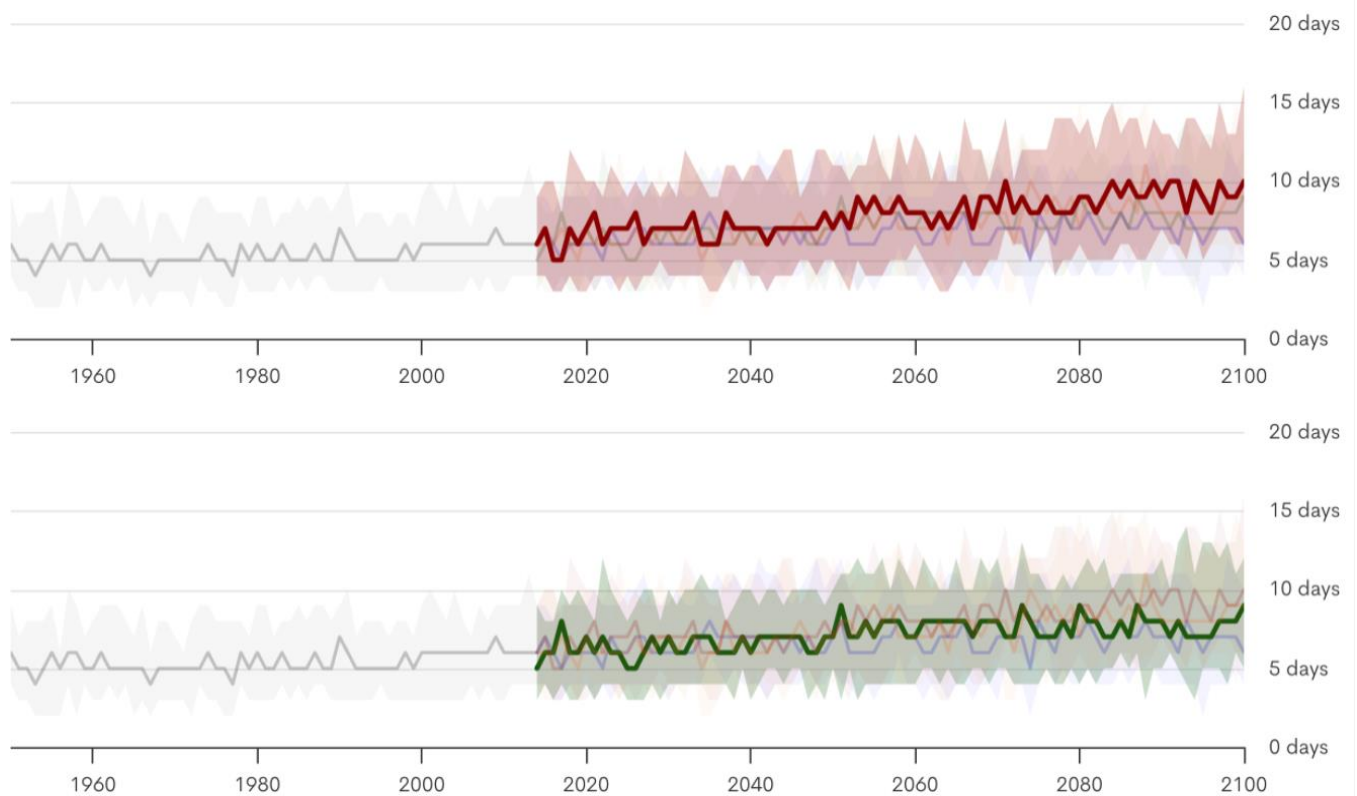


Figure 19: Projected Wet Days $\geq 20\text{mm}$ for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Table 30: Maximum 1-Day Precipitation for Kawartha Lakes - SSP5-8.5 and SSP2-4.5

Baseline (1971-2000): 36			
Emissions Scenario	Low	Median	High
SSP5-8.5 (2011-2040)	37	40	43
SSP5-8.5 (2041-2070)	38	42	45
SSP5-8.5 (2071-2100)	41	46	49
SSP2-4.5 (2011-2040)	37	39	42
SSP2-4.5 (2041-2070)	38	41	44
SSP2-4.5 (2071-2100)	38	42	46

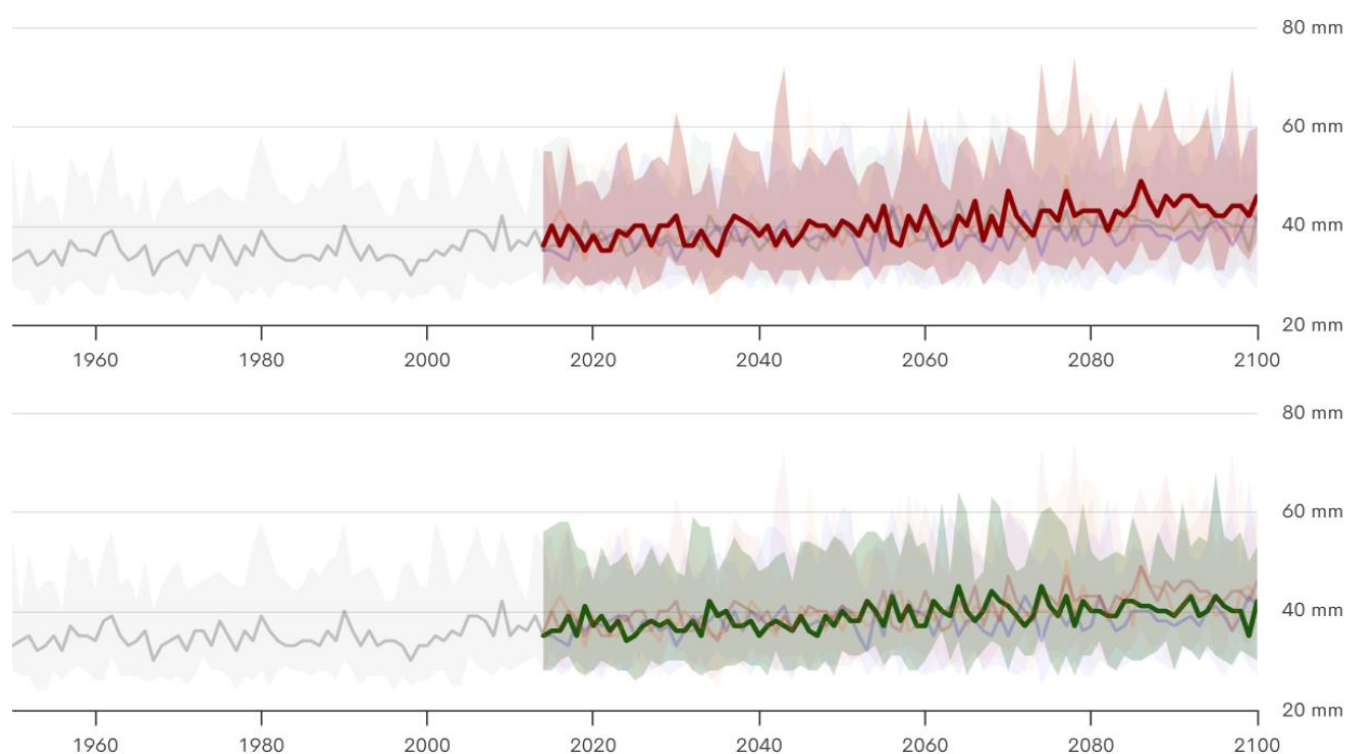


Figure 20: Maximum 1-Day Precipitation for Kawartha Lakes - SSP5-8.5 (above); SSP2-4.5 (below)

Intensity-Duration-Frequency

Intensity-duration-frequency (IDF) curves represent one way to analyze and predict heavy precipitation under a changing climate. They provide a graphical representation of the probability that a given average rainfall intensity will occur. IDF Curves are used to design stormwater infrastructure and inform flood mapping. To date, much of storm water infrastructure has been built to the historical rainfall intensities of 100 year regional storms such as Hurricane Hazel and the Timmins Storm. Rainfall intensity (mm/hr), rainfall duration (how many hours it rained at that intensity) and rainfall frequency/return period (how often that rain storm repeats itself) are the parameters that make up the axes of the graph of an IDF curve ^[16].

Due to the changing climate, using IDF curves based on historical observations alone are inappropriate for long-term decision-making. To account for climate change impacts to extreme rainfall and IDF curves, Environment and Climate Change Canada (ECCC) recommends the use of a scaling methodology as there is strong evidence that the intensity of precipitation is closely linked to temperature increases, by a general factor of around 7% for every 1°C increase in temperature. This methodology is described in more detail in CSA W231:25 'Developing and interpreting intensity-duration-frequency (IDF) information under a changing climate' ^[17]. ClimateData.ca provides historical and climate change-scaled IDF data for all ECCC IDF stations in Canada.

The station selected to produce localized IDF curves for Kawartha Lakes was the Lindsay Filtration Plant. Projections are based on increases from the precipitation baseline, which is the average amount of precipitation in the years the station was active. For the Lindsay Filtration Plant station, this baseline was calculated between 1965 and 1989. The table below depicts baseline precipitation intensity.

Table 31: Historical Return Period Rainfall Amounts (mm) and Return Period Rainfall Rates (mm/hr) (1965-1989)

Duration	Return Period Measure	2 years	5 years	10 years	25 years	50 years	100 years
5 min	Rainfall Amounts (mm)	8.4	11.0	12.7	14.9	16.5	18.1
5 min	Rainfall Rates (mm/hr)	101	132.2	152.8	178.9	198.3	217.5
10 min	Rainfall Amounts (mm)	12.2	15.7	18.0	20.9	23.1	25.2
10 min	Rainfall Rates (mm/hr)	73.3	94.2	108.0	125.6	138.5	151.4
15 min	Rainfall Amounts (mm)	14.8	18.7	21.3	24.6	27.1	29.5
15 min	Rainfall Rates (mm/hr)	59.1	74.8	85.2	98.4	108.2	117.9
30 min	Rainfall Amounts (mm)	19.3	25.6	29.8	35.1	39.0	42.8
30 min	Rainfall Rates (mm/hr)	38.7	51.3	59.6	70.1	77.9	85.7
1 h	Rainfall Amounts (mm)	24.1	33.4	39.6	47.3	53.1	58.8
1 h	Rainfall Rates (mm/hr)	24.1	33.4	39.6	47.3	53.1	58.8
2 h	Rainfall Amounts (mm)	28.4	39.3	46.6	55.8	62.6	69.4
2 h	Rainfall Rates (mm/hr)	14.2	19.7	23.3	27.9	31.3	34.7
6 h	Rainfall Amounts (mm)	36.6	50.8	60.2	72.1	80.9	89.7
6 h	Rainfall Rates (mm/hr)	6.1	8.5	10.0	12.0	13.5	14.9
12 h	Rainfall Amounts (mm)	39.8	53.3	62.2	73.4	81.8	90.1
12 h	Rainfall Rates (mm/hr)	3.3	4.4	5.2	6.1	6.8	7.5
24 h	Rainfall Amounts (mm)	43.6	56.4	64.8	75.4	83.3	91.2
24 h	Rainfall Rates (mm/hr)	1.8	2.3	2.7	3.1	3.5	3.8

Based on the City of Kawartha Lakes 2026 Storm and Stormwater Guidelines the Regional Timmins Storm shall be applied throughout the City for the sizing of municipal infrastructure^[18]. The IDF curve parameters can be found in the Flood Plain Mapping Study, Fenelon South Tributary Technical Report (November 2023)^[19]. In general, the Regional Timmins storm data (Table 32) exceeds the rainfall amounts and intensity shown in Table 31 but is less than the climate projections provided below.

Table 32: Rainfall Intensity calculated with the IDF Parameters in the City of Kawartha Lakes' Storm and Stormwater Infrastructure Guidelines (Regional Storm - Timmins)

Duration	Return Period Measure	2 years	5 years	10 years	25 years	50 years	100 years
5 min	Rainfall Amounts (mm)	9.4	10.8	12	13.6	14.9	16.2
5 min	Rainfall Rates (mm/hr)	112.8	129.9	144	163.4	179.4	194.8
10 min	Rainfall Amounts (mm)	14.1	16.7	18.8	21.7	23.9	26.2
10 min	Rainfall Rates (mm/hr)	84.4	100.3	112.8	130.1	143.3	157.3
15 min	Rainfall Amounts (mm)	17	20.6	23.3	27.1	30.0	33.1
15 min	Rainfall Rates (mm/hr)	68.1	82.3	93.3	108.6	119.9	132.4
30 min	Rainfall Amounts (mm)	22.1	27.3	31.3	36.8	40.8	45.4
30 min	Rainfall Rates (mm/hr)	44.3	54.5	62.5	73.6	81.7	90.9
1 h	Rainfall Amounts (mm)	27.1	33.6	38.7	45.9	51.1	57.1
1 h	Rainfall Rates (mm/hr)	27.1	33.6	38.7	45.9	51.1	57.1
2 h	Rainfall Amounts (mm)	32	39.6	45.6	54.1	60.3	67.3
2 h	Rainfall Rates (mm/hr)	16	19.8	22.8	27	30.2	33.7
6 h	Rainfall Amounts (mm)	40.1	48.8	55.8	65.7	73.5	81.4
6 h	Rainfall Rates (mm/hr)	6.7	8.1	9.3	11	12.2	13.6
12 h	Rainfall Amounts (mm)	45.8	54.8	62.3	72.9	81.5	89.8
12 h	Rainfall Rates (mm/hr)	3.8	4.6	5.2	6.1	6.8	7.5
24 h	Rainfall Amounts (mm)	52	61.2	69.2	80.3	89.9	98.2
24 h	Rainfall Rates (mm/hr)	2.2	2.6	2.9	3.3	3.7	4.1

Tables 33, 34, and 35 represent the change in IDF curves under the SSP5-8.5 emission scenario. The projections cover a 30-year frame from 2011-2040, 2041-2070 and 2071-2100. As shown in these tables, the intensity of rainfall is projected to increase. While longer, more frequent rainfall events (e.g. a typical rainy day) will bring slightly higher amounts of rain, the intensity of rainfall during more infrequent, extreme storms (i.e. 1 in 25, 50, 100-year storms) is projected to significantly increase. The projected IDFs demonstrate that the intensity (mm/hr) of rainfall will increase, with more rain falling in shorter time periods. Storms that occur less frequently (e.g. 100-year storms) are projected to see the greatest increase in intensity. Furthermore, such heavy precipitation events are projected to become more common than they once were.

Table 33: Projected Return Period Rainfall Amounts (mm) and Return Period Rainfall Rates (mm/hr) Baseline Precipitation Intensity Rates (mm/hr) (2011-2040) - SSP5-8.5

Duration	Return Period Measure	2 years	5 years	10 years	25 years	50 years	100 years
5 min	Rainfall Amounts (mm)	9.6	12.5	14.5	16.9	18.8	20.6
5 min	Rainfall Rates (mm/hr)	115	150	174	203	225	247
10 min	Rainfall Amounts (mm)	13.8	17.8	20.5	23.8	26.2	28.7
10 min	Rainfall Rates (mm/hr)	83	107	123	143	157	172
15 min	Rainfall Amounts (mm)	16.8	21.3	24.3	28.0	30.8	33.5
15 min	Rainfall Rates (mm/hr)	67	85	97	112	123	134
30 min	Rainfall Amounts (mm)	22.0	29.0	34.0	40.0	44.0	48.5
30 min	Rainfall Rates (mm/hr)	44	58	68	80	88	97
1 h	Rainfall Amounts (mm)	27.0	38.0	45.0	54.0	60.0	67.0
1 h	Rainfall Rates (mm/hr)	27	38	45	54	60	67
2 h	Rainfall Amounts (mm)	32.0	44.0	52.0	64.0	72.0	78.0
2 h	Rainfall Rates (mm/hr)	16	22	26	32	36	39
6 h	Rainfall Amounts (mm)	41.4	58.2	66.0	84.0	90.0	102.0
6 h	Rainfall Rates (mm/hr)	6.9	9.7	11	14	15	17
12 h	Rainfall Amounts (mm)	44.4	60.0	70.8	82.8	92.4	102.0
12 h	Rainfall Rates (mm/hr)	3.7	5	5.9	6.9	7.7	8.5
24 h	Rainfall Amounts (mm)	48.0	62.4	74.4	84.0	96.0	103.2
24 h	Rainfall Rates (mm/hr)	2	2.6	3.1	3.5	4	4.3

Table 34: Projected Return Period Rainfall Amounts (mm) and Return Period Rainfall Rates (mm/hr) Baseline Precipitation Intensity Rates (mm/hr) (2041-2070) - SSP5-8.5

Duration	Return Period Measure	2 years	5 years	10 years	25 years	50 years	100 years
5 min	Rainfall Amounts (mm)	10.9	14.3	16.5	19.3	21.3	23.4
5 min	Rainfall Rates (mm/hr)	131.0	171.0	198.0	231.0	256.0	281.0
10 min	Rainfall Amounts (mm)	15.8	20.3	23.3	27.0	29.8	32.7
10 min	Rainfall Rates (mm/hr)	95.0	122.0	140.0	162.0	179.0	196.0
15 min	Rainfall Amounts (mm)	19.0	24.3	27.5	31.8	35.0	38.0
15 min	Rainfall Rates (mm/hr)	76.0	97.0	110.0	127.0	140.0	152.0
30 min	Rainfall Amounts (mm)	25.0	33.0	38.5	45.5	50.5	55.5
30 min	Rainfall Rates (mm/hr)	50.0	66.0	77.0	91.0	101.0	111.0
1 h	Rainfall Amounts (mm)	31.0	43.0	51.0	61.0	69.0	76.0
1 h	Rainfall Rates (mm/hr)	31.0	43.0	51.0	61.0	69.0	76.0
2 h	Rainfall Amounts (mm)	36.0	50.0	60.0	72.0	80.0	90.0
2 h	Rainfall Rates (mm/hr)	18.0	25.0	30.0	36.0	40.0	45.0
6 h	Rainfall Amounts (mm)	47.4	66.0	78.0	96.0	102.0	114.0
6 h	Rainfall Rates (mm/hr)	7.9	11.0	13.0	16.0	17.0	19.0
12 h	Rainfall Amounts (mm)	51.6	68.4	80.4	94.8	105.6	116.4
12 h	Rainfall Rates (mm/hr)	4.3	5.7	6.7	7.9	8.8	9.7
24 h	Rainfall Amounts (mm)	55.2	72.0	84.0	96.0	108.0	117.6
24 h	Rainfall Rates (mm/hr)	2.3	3.0	3.5	4.0	4.5	4.9

Table 35: Projected Return Period Rainfall Amounts (mm) and Return Period Rainfall Rates (mm/hr) Baseline Precipitation Intensity Rates (mm/h) (2071-2100) - SSP5-8.5

Duration	Return Period Measure	2 years	5 years	10 years	25 years	50 years	100 years
5 min	Rainfall Amounts (mm)	12.8	16.8	19.4	22.8	25.3	27.7
5 min	Rainfall Rates (mm/hr)	154.0	202.0	233.0	273.0	303.0	332.0
10 min	Rainfall Amounts (mm)	18.7	24.0	27.5	32.0	35.2	38.5
10 min	Rainfall Rates (mm/hr)	112.0	144.0	165.0	192.0	211.0	231.0
15 min	Rainfall Amounts (mm)	22.5	28.5	32.5	37.5	41.3	45.0
15 min	Rainfall Rates (mm/hr)	90.0	114.0	130.0	150.0	165.0	180.0
30 min	Rainfall Amounts (mm)	29.5	39.0	45.5	53.5	59.5	65.5
30 min	Rainfall Rates (mm/hr)	59.0	78.0	91.0	107.0	119.0	131.0
1 h	Rainfall Amounts (mm)	37.0	51.0	60.0	72.0	81.0	90.0
1 h	Rainfall Rates (mm/hr)	37.0	51.0	60.0	72.0	81.0	90.0
2 h	Rainfall Amounts (mm)	44.0	60.0	72.0	86.0	96.0	106.0
2 h	Rainfall Rates (mm/hr)	22.0	30.0	36.0	43.0	48.0	53.0
6 h	Rainfall Amounts (mm)	55.8	78.0	90.0	108.0	126.0	138.0
6 h	Rainfall Rates (mm/hr)	9.3	13.0	15.0	18.0	21.0	23.0
12 h	Rainfall Amounts (mm)	60.0	80.4	94.8	111.6	120.0	132.0
12 h	Rainfall Rates (mm/hr)	5.0	6.7	7.9	9.3	10.0	11.0
24 h	Rainfall Amounts (mm)	64.8	84.0	98.4	112.8	127.2	139.2
24 h	Rainfall Rates (mm/hr)	2.7	3.5	4.1	4.7	5.3	5.8

The figure below illustrates how the 24-hour rainfall volume (mm) will change in the future. Historically, a 1 in 100 year event was represented by a total rainfall volume of 91.2 mm over a 24-hour period. Under the SSP5-8.5 climate scenario, the future 1 in 100 year event in the time frame of 2071-2100 will see a total rainfall volume of 139.2 mm or a 52.6% increase. Another way to note this change, is that a 24-hour rainfall event that historically resulted in 91.2 mm is projected to have a return period of less than 50 years between 2011-2040; a return period of less than 25 years between 2041-2070; and a return period of less than 10 years between 2071-2100. The increasing intensity of rainfall events may have implications with stormwater systems designed to historical rainfall patterns affecting the municipality's ability to maintain service levels into the future.



Figure 21: 24-Hour Rainfall Volumes by Return Period for Lindsay Filtration Plant

Conclusion

This Climate Science Report is the baseline that will inform the Kawartha Lakes Climate Strategy by offering updated climate data to support informed decision making as the municipality advances the consolidation of a refreshed plan.

The climate data in this report offers a clear indication that climate change is affecting Canada, Ontario, and Kawartha Lakes. Rising temperatures, changes in precipitation, and an increase in extreme weather events result in significant climate impacts that will have potential ecological, infrastructural, socioeconomic and cultural implications for the community.

Future climate projections for Kawartha Lakes show significant and multifaceted changes. With rising annual temperatures and increased frequency and intensity of heat waves, the community faces heightened risks of heat-related illnesses and impacts, especially for populations that are more highly exposed and have a lower capacity to adapt (e.g., limited access to financial or social resources, knowledge or tools). Additionally, the projected decrease in extreme cold days and frost days, coupled with changes in precipitation, could disrupt ecosystems and exacerbate challenges like water availability and the spread of vector-borne diseases. These changes signify the urgent need for comprehensive adaptation strategies to safeguard public health, infrastructure, and natural resources in Kawartha Lakes.

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