TECHNICAL MEMORANDUM

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To:	Jenn Wilson	**Previous Issue Date:**	N/A
From:	Jeff Zukiwsky, RPP, MRM		
Client:	City of Salmon Arm		
Project Name:	City of Salmon Arm Climate Resiliency Plan		
Subject:	Climate Projections for the City of Salmon Arm		

1 INTRODUCTION

Our planet's climate is changing. In 2024, global surface temperatures averaged 1.5°C above pre-industrial levels—the warmest calendar year on record dating back to 1850[1] . Various observations, experiments, and studies have confirmed that greenhouse gas (GHGs) emissions resulting from human activities and natural causes have unequivocally been the dominant cause of the observed warming in Canada since the mid-20th century[2] . It follows that further emissions globally will determine the extent of future warming in Canada, where projected increases are expected to be about twice the global mean temperature[3].

Notwithstanding current commitments and efforts to reduce GHG emissions globally, further climate change is expected, as current and historical emissions are already "locked-in" due to the delayed response of the Earth's climate to changes in GHG concentrations. These emissions are amplifying existing climate-related impacts which are giving rise to new risks for people, infrastructure, the economy, and the natural environment. With every fraction of a degree of warming beyond 1.5°C, impacts will become more severe and costly [4]. Consequently, there is a growing need to implement strategies to adapt to changing climate conditions and the physical risks these changes pose, in addition to keeping temperatures as low or as close as possible to 1.5°C.

Understanding how the local climate has changed and is projected to change in the future is a precursor to identifying and prioritizing risks for adaptation actions. This memo presents historic climate trends and future projections for the City of Salmon Arm. Climate data and projections are provided for changes in average climate conditions and weather and associated environmental changes, with indicators for extreme weather events.

1.1 Key Findings

The provided climate projections, based on modeling and scientific research, paint a picture of significant environmental shifts that will affect daily life, infrastructure, natural resources, and community planning. Understanding these changes now will empower Salmon Arm to implement effective adaptation strategies and build resilience within the community.

[1] Copernicus, The 2024 Annual Climate Summary: Global Climate Highlights 2024, European Commission.
[2] Bush and Lemmen, ibid.
[3]Lulham, N., Warren, F.J., Walsh, K.A. and Szwarc, J., 2023: Canada in a Changing Climate: Synthesis Report, Government of Canada, Ottawa, Ontario.
[4]PCC, 2023: Sections. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee, and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115

Salmon Arm can expect to see the following climate-related changes by the 2060s:

- Hotter summers, with more extreme heat, heat waves, drier conditions, and more demand for space cooling.
- Milder, shorter winters, with fewer cold days, frost days, and less demand for space heating.
- More precipitation, including higher total annual precipitation levels, more wet days, and more heavy rainfall events.
- Changing seasons, with longer growing and frost-free seasons, an earlier onset of spring, and a later onset of the fall season.
- More extreme weather, such as freezing rain, windstorms, wildfires, and flooding.
- Changing environmental conditions, including forest and ecosystem shifts, invasive species, migration patterns for plants, animals, insects, and new vector-borne diseases.

2 CHANGES IN TEMPERATURE AND PRECIPITATION

This section provides projected changes in temperature and precipitation for the City of Salmon Arm. It is important to note that the future is inherently uncertain—we do not know exactly what it will look like. In terms of simulating the future climate for the city, the main sources of uncertainty relate to:

1. Differences between how climate models[5] represent the Earth-atmosphere system and how they simulate natural climate variability.
2. Knowing how greenhouse gas (GHG) emissions will evolve over time.

To help manage the first main source of uncertainty and build a more accurate picture of what the future climate may look like for the city, climate projections are derived from an ensemble of Global Climate Models (GCMs). ClimateData.ca—the primary source of the projections provided below—uses an ensemble of 35 GCMs. Percentiles can then be used to determine where the majority of outcomes fall across the different models. Below, we provide the climate modelling results for the average (mean) outcome and the 10th (low range) and 90th (high range) percentiles. With the exception of a few outliers, most of the results fall between these two percentiles.

Not all projections have the same amount of uncertainty. Temperature projections are generally high certainty. Precipitation projections are moderate certainty. Extreme weather events are often low to very low certainty.

The projections generated for the city are based on the central grid cell where the City of Salmon Arm is situated as shown in Figure 2-1 below.

[5] "A numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes, and accounting for most of its known properties." (ClimateData.ca, Glossary, accessed 2023).

Figure 2-1 Climate Projections Grid Map

To help manage the second main source of uncertainty in climate projections, ensemble results are based on a high emissions climate scenario, labelled "SSP5-8.5". The first part of the label (i.e., SSP5) refers to different Shared Socioeconomic Pathways. These Pathways characterize future GHG emissions and, in turn, the level of future warming. The second part of the label (i.e., 8.5) indicates the assumed level of radiative forcing by the end of the century[6] . The larger the number, the higher the level of radiative forcing and corresponding anticipated changes in the climate. For the purpose of the climate risk assessment, best practice necessitates working with the greatest plausible change scenario, which in practice means working with projected changes for the city under the SSP5-8.5 (high emissions) scenario. The primary justification for using SSP5 -8.5 is that it minimizes the chance of missing key risks during the risk assessment, ensuring the city is best equipped to manage the most material impacts of climate change. Uncertainties relating to whether the future unfolds along SSP5-8.5 or along a different, lower emissions scenario, can be managed during the adaptation planning phase when prioritizing actions. Some projections may not be available for the most recent climate models which include the SSP scenarios. In these cases, the older, but still informative, Representative Concentration Pathways (RCP) scenarios are used instead. Representative Concentration Pathways are similar to Shared Socioeconomic Pathways in that RCPs are greenhouse gas concentration trajectories adopted by the Intergovernmental Panel on Climate Change that represent different climate futures, based on varying levels of radiative forcing by the year 2100. Unlike SSPs, which combine socioeconomic trends with emissions pathways, RCPs focus solely on the concentration of greenhouse gases and their impact on the climate system. Despite these differences, both frameworks are used to explore a range of possible climate outcomes, and the scenarios are broadly comparable.

Table 2-1, Table 2-2, and Table 2-3 in the following sections provide a summary of projections for temperature, precipitation, and a range of other climate indicators, respectively. When determining how much the climate is anticipated to change at a specific location like the city, it is recommended to consider at least 30 years of data. In practice, this means calculating and comparing 30-year averages at different points in time—e.g., projected model outcomes for, say, the 2060s represent the annual average value for the period 2051-2080. This is necessary to ensure

[6]Radiative Forcing describes the amount of excess energy trapped within the Earth's climate system due to variations in a determinant of climate change factor, such as concentrations of GHGs in the atmosphere—e.g., 2.6 Watts per m^2, 4.5 Watts per m^2 or 8.5 Watts per m^2.

that long-term historical trends and projected changes in the climate are not biased by short-term natural variability in the climate—such as the influence that both El Niño and La Niña events exert on Canada's climate.

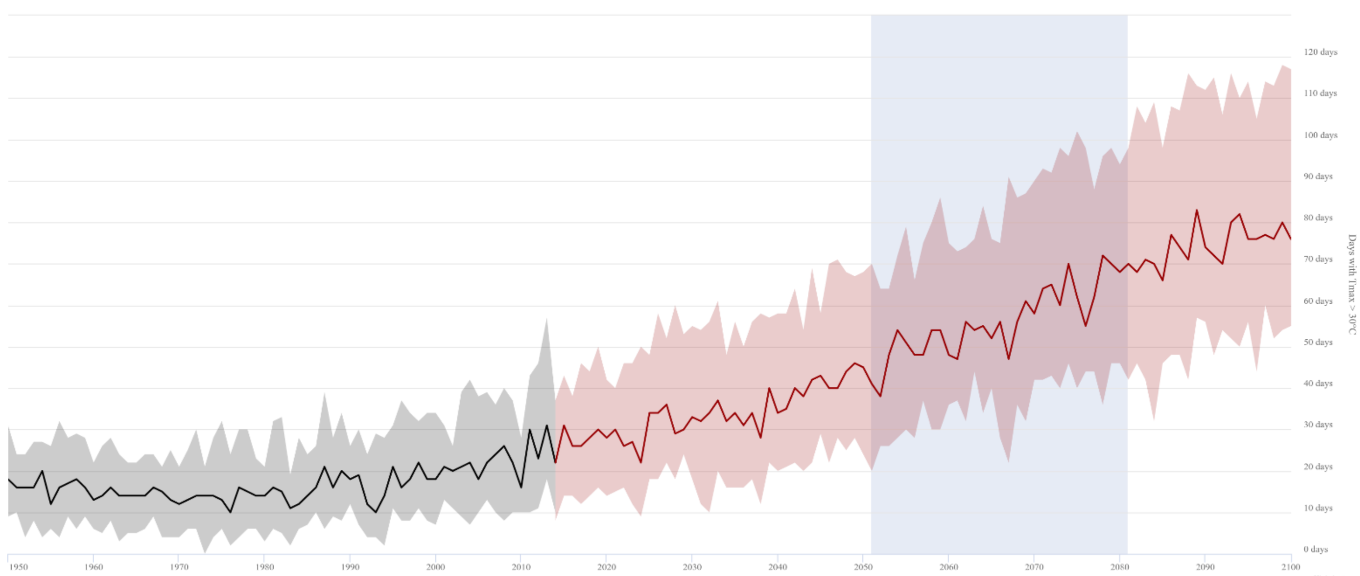
Below, results are provided for the future time-period of the 2060s (the annual average over 2051-2080). To enable a comparison with past conditions, modelled historical results are also presented for the 1981-2010 baseline period. To reduce bias when contrasting future climate projections with past conditions, it is recommended that modelled historical outcomes are compared with future projections from the same ensemble of models rather than with historical observations from local weather stations.

2.1 Longer, Warmer Summers

High temperatures place limits on plant and animal life, influence our ability to perform work and participate in outdoor recreation, and affect building designs and energy consumption[7] . As temperatures rise, people are much more likely to experience a range of adverse health outcomes, including hospitalization and in some cases, premature death. Vulnerable populations including the elderly, children, people with chronic illness, and homeless populations are particularly at-risk of heat exhaustion and heat stroke.

Figure 2-2 shows the projected number of Very Hot Days each year in the city between 1950-2100. Very Hot Days occur when the daily maximum temperature reaches 30°C or higher, and typically occurs during the summer months (June, July, August). During the 1981-2010 baseline time period, there were fewer than 19 Very Hot Days occurring per year on average. However, this is projected to increase to 50 Very Hot Days by the 2060s under SSP5-8.5.

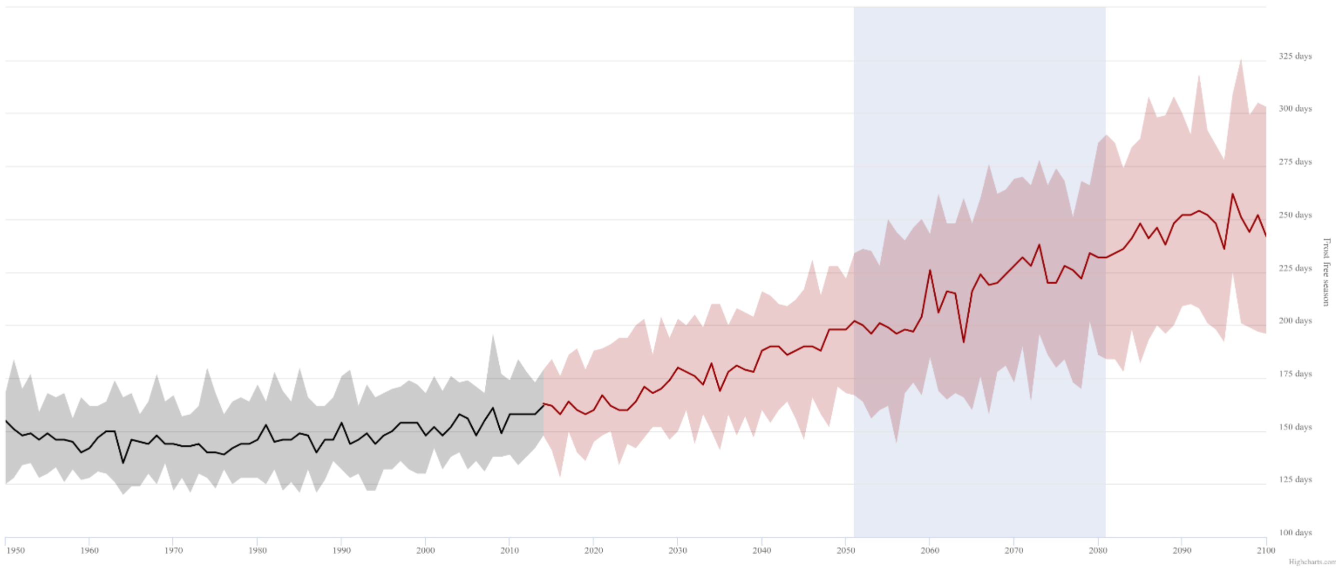
Figure 2-2 Number of Very Hot Days in the City of Salmon Arm (1950-2100)



[7] Prairie Climate Centre, 2023.

Figure 2-3 shows the projected length of the growing season (frost-free days) each year in the city between 1950-2100. The growing season lengthens as the last spring frost occurs earlier and the first fall frost occurs later, resulting in more frost-free days for planting and harvesting. During the 1981-2010 baseline time period, the growing season started on average on May 4th and ended on October 2nd. This season is projected to increase by 74 days by the 2060s under SSP5-8.5, with the new season starting March 25th and ending November 5th.

Figure 2-3 Length of Growing Season (# of Days) in the City of Salmon Arm (1950-2100)



Longer, Wamer Summers

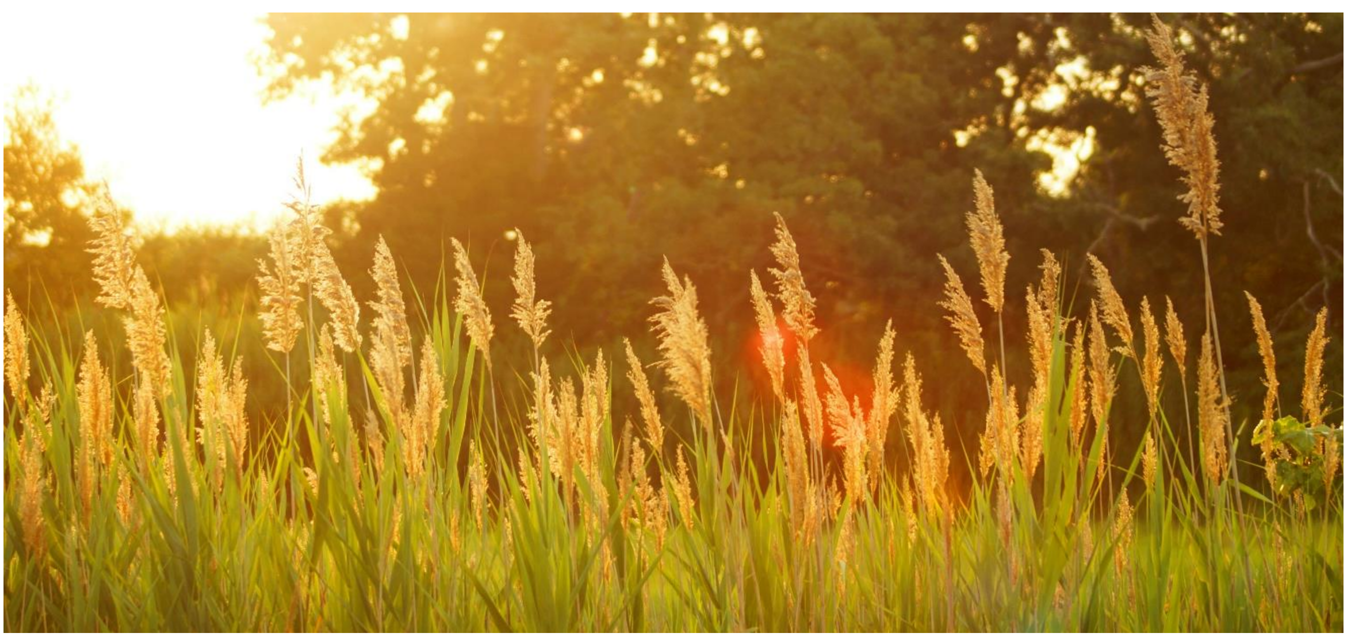


Table 2-1 Summary of projected climate changes for the City of Salmon Arm under SSP5-8.5: Longer, Warmer Summers

Climate Indicator	Baseline Mean	Projected Values for the 2060s			Change
		10th Percentile	Mean	90th Percentile	
Annual mean temperature (°C)	**7.6**	10.0	**11.6**	13.0	**+4.0**
Spring mean temperature (°C)	**7.8**	9.4	**11.7**	14.1	**+3.9**
Summer mean temperature (°C)	**18.1**	20.4	**22.6**	24.8	**+4.5**
Very hot days (30°C) (days)	**19**	42	**50**	80	**+31**
Tropical nights (days)[8]	**0**	0	**1**	10	**+1**
Hottest day[9] (°C)	**34.6**	38.2	**40.1**	43	**+5.5**
Summer days (days)[10]	**55**	86	**99**	125	**+44**
Number of heat wave days[11]	**13**	30	**50**	79	**+37**
Cooling degree days (CDD)[12]	**113**	333	**447**	759	**+334**
Growing season (frost free season) (days)[13]	**150**	174	**224**	251	**+74**
Date of last spring frost (number corresponding to the day of the year)	**May 4**	Mar 14	**Mar 25**	Apr 22	**40 Days Earlier**
Date of first fall frost (number corresponding to the day of the year)	**Oct 2**	Oct 12	**Nov 5**	Nov 22	**33 Days Later**
Growing degree days (base 5 degrees)[14]	**1,795**	2,472	**2,664**	3,198	**+869**

[8] A Tropical Night occurs when the lowest temperature of the day does not go below 20 °C

[9] The hottest day is the warmest daytime temperature during the time period.

[10] A Summer Day is a day when the temperature rises to at least 25 °C

[11] A heat wave occurs when at least three days in a row reach or exceed 30 °C. This indicator counts the total number of days which meet this criteria.

[12] Cooling Degree Days (CDD) give an indication of the amount of air conditioning that may be required to maintain comfortable conditions in a building during warmer months. A threshold temperature of 18°C is used, and for any day when the mean temperature exceeds this value, cooling degree days are accrued. So, if the daily mean temperature on a given day is 24°C, then 6 cooling degree days are accrued for this day. Cooling degree days values are totalled over the year; the larger the cooling degree days value the greater the requirement for air conditioning.

[13] The Frost-Free Season is the approximate length of the growing season, during which there are no freezing temperatures to kill or damage plants

[14] Growing Degree Days (GDD) give an indication of the accumulated heat available for plant growth and development during the growing season. A base temperature of 5°C is used, representing the minimum temperature at which significant growth occurs for many plants. For any day when the mean temperature exceeds this value, Growing Degree Days are accrued. So, if the daily mean temperature on a given day is 15°C, then 10 Growing Degree Days (15°C - 5°C) are accrued for this day. Growing Degree Days values are totalled over the year. The larger the GDD value, the longer the potential growing season

2.2 Shorter, Milder Winters

Cold weather affects various aspects of our daily lives, including our health and safety, the survivability of certain plants and animals, and our participation in outdoor winter activities. Cold temperatures can also influence the design of buildings and infrastructure and our transportation and energy use requirements.

Figure 2-4 shows the projected number of Cold Days each year in the city between 1950-2100. Cold Days occur when the daily minimum temperature falls to -15°C or lower, and typically occurs during the winter months (December, January, February). During the 1981-2010 baseline time period, there were almost 11 Cold Days occurring per year on average. By the 2060s this is projected to decrease to less than 5 Cold Days annually under SSP5-8.5.

Figure 2-4 Number of Cold Days (<-15°C) in the City of Salmon Arm (1950-2100)

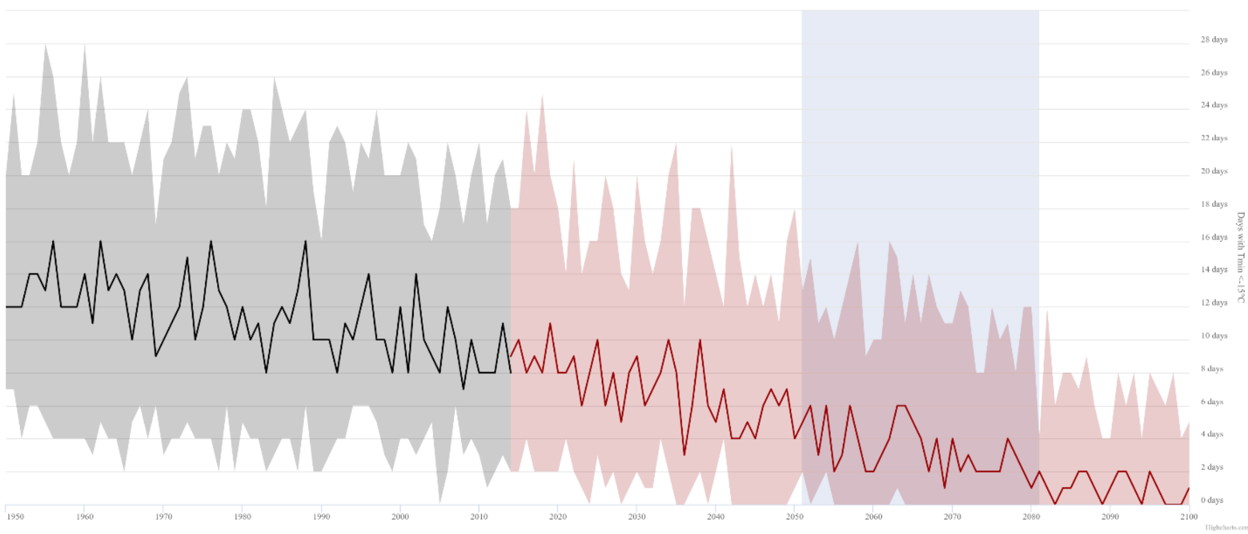


Figure 2-5 shows the modeled number of freeze-thaw cycles each year in the city between 1950-2100. The annual number of freeze-thaw cycles is the number of times the temperature goes from freezing to melting within a given year. As temperatures in winter months increase, there will be fewer freeze-thaw cycles. During the 1981-2010 baseline time period, there were almost 87 freeze-thaw cycles occurring per year on average. By the 2060s this is projected to decrease to less than 45 freeze-thaw cycles annually under SSP5-8.5.

Figure 2-5 Number of Annual Freeze-Thaw Cycles in the City of Salmon Arm (1950-2100)

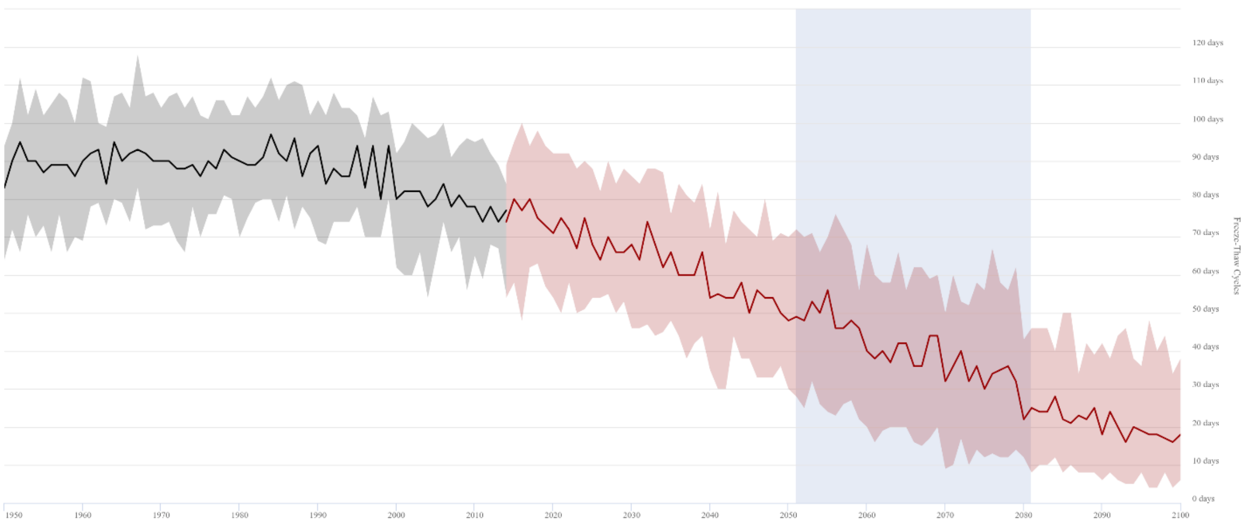


Table 2-2 Summary of projected climate changes for Salmon Arm under SSP5-8.5: Shorter, Milder Winters

Climate Indicator	Baseline Mean	Projected Values for the 2060s			Change
		10th Percentile	Mean	90th Percentile	
Fall mean temperature (°C)	**7.3**	9.1	**11**	12.8	**+3.6**
Winter mean temperature (°C)	**-2.9**	-1.9	**0.8**	3.4	**-3.7**
Cold days (-15°C) (days)	**11**	3	**5**	7	**-6**
Very cold days (-30°C) (days)	**0**	0	**0**	0	**0**
Icing days (days)[15]	**43**	16	**21**	27	**-22**
Freeze-thaw cycles (days)[16]	**87**	22	**45**	57	**-42**
Coldest minimum temperature (°C)	**-26.6**	-21.7	**-19.6**	-16.5	**-7**
Heating degree days (HDD)[17]	**4,082**	2,637	**3,094**	3,278	**-988**
Frost days (days)[18]	**150**	47	**82**	101	**-68**

[15] An Icing Day is a day on which the air temperature does not go above freezing (0 °C).
[16] A simple count of days when the air temperature fluctuates between freezing and non-freezing temperatures. Under these conditions, it is likely that some water at the surface was both liquid and ice at some point during the 24-hour period
[17] Heating Degree Days (HDD) give an indication of the amount of heating that may be required to maintain a comfortable temperature inside buildings. A base temperature of 18°C is used, and for any day when the mean temperature falls below this value, Heating Degree Days are accrued. So, if the daily mean temperature on a given day is 14°C, then 4 Heating Degree Days (18°C - 14°C) are accrued for this day.
[18] A frost day is one on which the coldest temperature of the day is lower than 0 °C

2.3 Total Precipitation and Extreme Precipitation Events

Adequate precipitation is crucial to water supply and demand, health of ecosystems, electricity generation, and wildfire suppression[19] . However, when a large amount of precipitation falls in a relatively short period of time or smaller amounts build up over a long period of consecutive days, it can result in flooding and negatively impact our infrastructure, buildings, agriculture, and human and terrestrial health.

Figure 2-6 shows the number of Heavy Precipitation Days – where 10mm or more precipitation falls within a day – that are modeled for the city between 1950-2100. During the 1981-2010 baseline time period, there were an average of 6 Heavy Precipitation Days occurring per year. This is projected to increase to 8 Heavy Precipitation Days annually by the 2060s under SSP5-8.5.

Figure 2-6 Number of Heavy Precipitation Days (10mm) in the City of Salmon Arm (1950-2010)

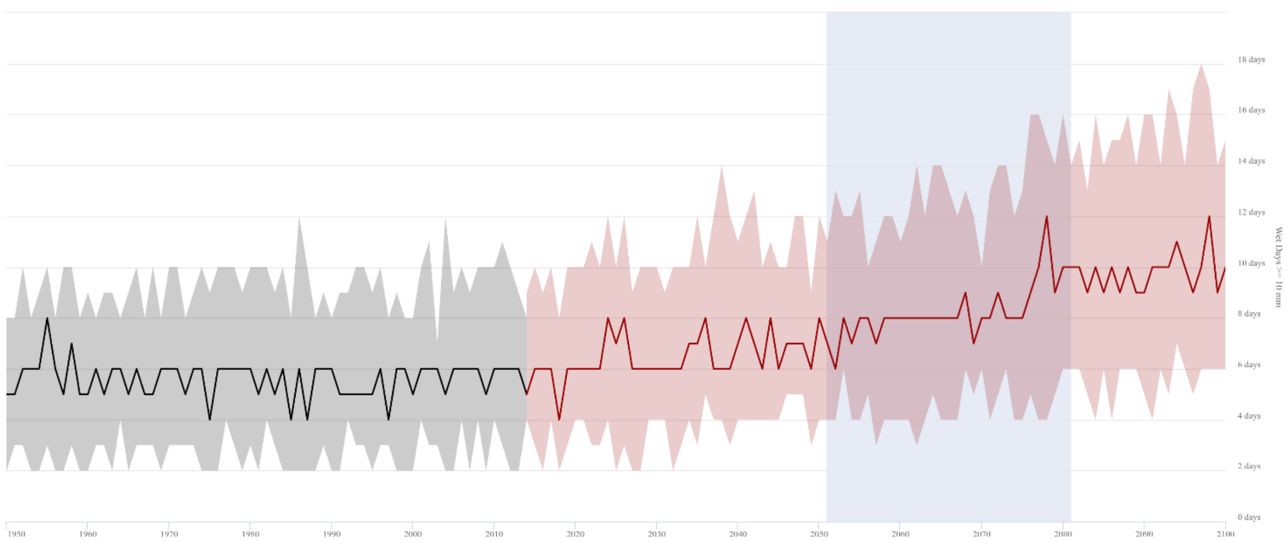
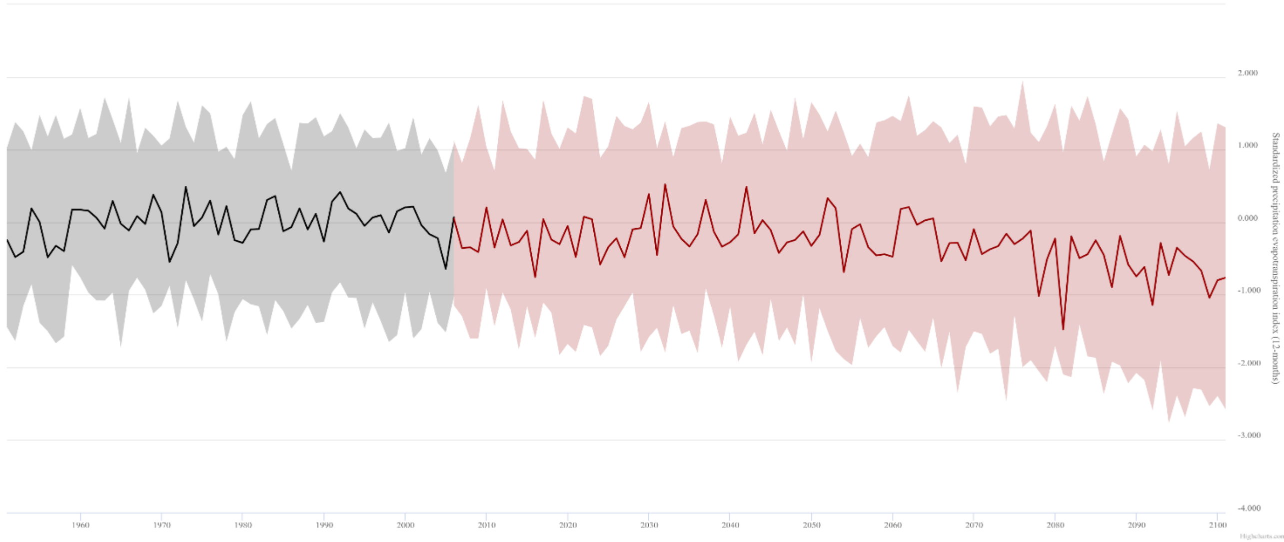


Figure 2-7 shows the change in the Standardized Precipitation Evapotranspiration Index (SPEI) in the city between 1950-2100. The SPEI is a way to measure how dry or wet the weather has been over time. It looks at both how much rain or snow has fallen and how much water is lost due to heat (like from evaporation). A positive SPEI means conditions are wetter than usual, and a negative SPEI means it is drier than usual. It is a commonly used indicator to track drought conditions. The SPEI is projected to decrease in the future as conditions become hotter and drier on average. While the total amount of precipitation is projected to increase, temperatures are also projected to increase as well. The SPEI takes into account not just the total amount of precipitation, but also water loss due to evaporation and transpiration from higher temperatures. For the City of Salmon Arm, the SPEI is projected to decrease and drought conditions are projected to worsen on average, even though total mean annual precipitation and extreme precipitation events are projected to increase.

[19] Prairie Climate Centre, 2023

Figure 2-7 Standardized Precipitation-Evapotranspiration Index (SPEI) in the City of Salmon Arm (1950-2010)



Extreme Precipitation

Table 2-3 Summary of projected climate changes for the City of Salmon Arm under SSP5-8.5: Precipitation

Climate Indicator	Baseline Mean	Projected Values for the 2060s			Change
		10th Percentile	Mean	90th Percentile	
Mean annual precipitation (mm)	**556**	479	**620**	765	**+57**
Winter precipitation (mm)	**171**	125	**197**	275	**+26**
Spring precipitation (mm)	**108**	78	**124**	178	**+16**
Summer precipitation (mm)	**132**	60	**131**	215	**-1**
Fall precipitation (mm)	**145**	99	**168**	245	**+23**
Heavy precipitation days (10 mm) (days)[20]	**6**	7	**8**	10	**+2**
Heavy precipitation days (20 mm) (days)[21]	**0**	1	**1**	1	**+1**
Wet days (days)[22]	**139**	133	**140**	144	**+1**
Dry days (days)[23]	**226**	232	**225**	221	**-1**
Maximum 1-day precipitation (mm)[24]	**19**	20	**23**	25	**+4**
Maximum 5-day precipitation (mm)[25]	**41**	43	**47**	51	**+6**
1:100-year short duration rainfall intensity (24h) (mm/hr)[26]	**2.4**	2.9	**3.1**	3.6	**+0.7**
Standardized Precipitation Evapotranspiration Index (SPEI) 12-month[27]	**-0.01**	-1.76	**-0.28**	1.31	**-0.27**

[20] A Heavy Precipitation Day (HPD) 10mm is a day on which at least a total of 10 mm of rain or frozen precipitation falls
[21] A Heavy Precipitation Day (HPD) 20mm is a day on which at least a total of 20 mm of rain or frozen precipitation falls
[22] The number of days in a year with rain/snow
[23] The number of days in a year without rain/snow
[24] The amount the precipitation that falls on the wettest day of the year
[25] The wettest five-day period
[26] The 1:100-year precipitation intensity that falls within a 24-hour period
[27] The Standardized Precipitation Evapotranspiration Index (SPEI) is a drought index based on the difference between precipitation and potential evapotranspiration. Negative (positive) values indicate a water deficit (surplus). The current 12-month SPEI covers the period between the calendar months of January to December. The data for this variable is based on CMIP 5 modeling as CMIP 6 results are unavailable at this time.

3 CHANGES IN EXTREME WEATHER EVENTS

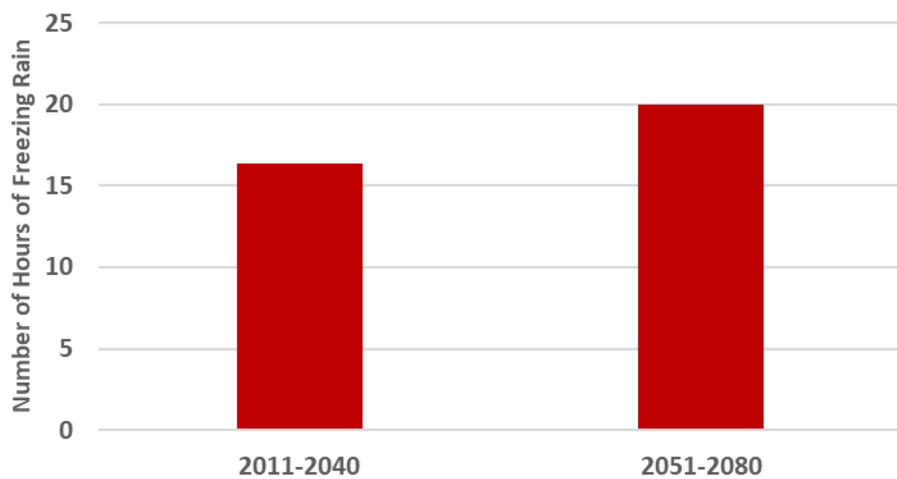
The extreme weather projections presented below are based on data from Environment and Climate Change Canada (ECCC) and published literature. Historic trend data was obtained from the Salmon Arm CS weather station. Extreme weather events considered include freezing rain, windstorms, fire weather, and flooding.

It is important to note that the weather station data is unlikely to have captured all of the extreme events that have impacted the city historically due to the spatial variability of weather patterns.

3.1 Freezing Rain

An analysis of published studies suggests the number of hours of freezing rain is projected to increase in the city as result of climate change, as shown in Figure 3-1[28]. There is very low confidence associated with the specific projections for Salmon Arm, but medium confidence that the number of hours of freezing rain in most areas of Canada is anticipated to increase.

Figure 3-1 Change in Number of Hours of Freezing Rain in Salmon Arm between 2020s and 2060s



3.2 Windstorms

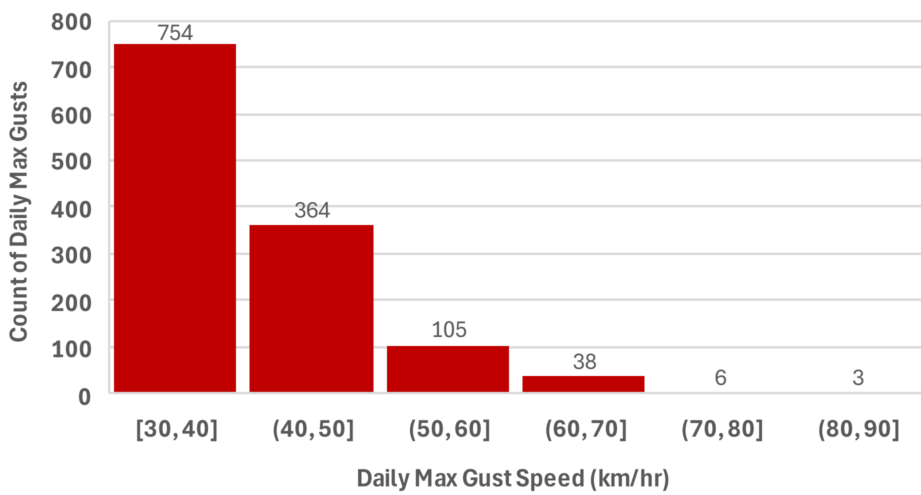
According to ECCC criteria for public weather alerts, a high wind event across the majority of British Columbia (including Salmon Arm area) occurs when wind gusts reach 90km/h or higher[29]. Data from the Salmon Arm station between 1991-2025 in Figure 3-2, shows maximum daily wind gusts below this limit[30]. There were no wind speed events on record during this period which exceeded 90 km/h.

[28]McCray, C. D., Paquin, D., Thériault, J. M., & Bresson, É. (2022). Annual frequencies of freezing rain diagnosed from the fifth-generation Canadian Regional Climate Model (CRCM5) for the past and future climates. Data is made available at: https://www.frdr-dfdr.ca/repo/dataset/a224a0ef-0e0b-47c4-b609-c6447a7f8f74

[29]Environment and Climate Change Canada. (2021). Criteria for public weather alerts. Government of Canada. Retrieved from https://www.canada.ca/en/environment-climate-change/services/types-weather-forecasts-use/public/criteria-alerts.html#wind.

[30] Data retrieved from Climate West staff (2024).

Figure 3-2 Historic High Wind Events in Salmon Arm between 1991-2025



How wind will be affected by climate change is not as well understood as variables such as temperature. Published studies that have assessed projected changes in mean and extreme wind speeds in Canada and North America suggest small changes (a few percent) of mixed sign (increases and decreases), that are often not statistically robust[31]. Annual maximum wind pressure (either with a 1:10 or a 1:50-year return interval) are projected to slightly increase in Salmon Arm (+0.7% and +1.1% respectively)[32]. In general, however, climate models have insufficient resolution to represent small-scale phenomena such as tornados and convective windstorms. There is thus very low confidence in these projections.

3.3 Wildfires and Wildfire Smoke

Salmon Arm has historically seen fires to the north, northwest, and southwest of town[33]. Two fires in particular, the 1973 Eden Fire and the 1998 Salmon Arm/Silver Creek fire have resulted in evacuations and property damage. The 2023 Bush Creek fire was another notable fire which prompted the evacuation of more than 8,000 people from eight Shuswap communities. Importantly, the area burned by wildfire across Canada is expected to increase with climate change. There are three reasons for this:

1. Warmer seasonal temperatures mean a longer fire season;
2. Warmer conditions increase the chance of lightning strikes, driven by anticipated increases in convective storms; and
3. Warmer temperatures—coupled with earlier spring snow melt and higher summer extreme temperatures—dry out wildland fuels, unless there is a significant increase in precipitation (projected increases, on average, are not sufficient to offset the drying effect hotter weather in summer).

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[31]See, for example: Kumar, D., Mishra, V. and Ganguly, A. R., 2015: Evaluating wind extremes in CMIP5 climate models, Climate Dynamics, 45 (1-2), 441-453; and Jeong., D. I. and Sushama, L., 2018: Projected changes to extreme wind and snow environmental loads for buildings and infrastructure across Canada, Sustainable Cities and Society, 36, 225-236.
[32]Pacific Climate Consortium, Design Value Explorer, accessed March 2024 [https://pacificclimate.org/analysis-tools/design-value-explorer].
[33]Map of historical wildfire perimeters. https://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc

Fire weather—that leads to wildland fires and associated smoke—is expected to become more likely in the future especially as temperatures are projected to increase[34]. Fire weather refers to the compound effect of temperature, soil moisture, humidity and wind conditions that are conducive to triggering and sustaining wildfires[35].

Figure 3-3 Fire Weather Index

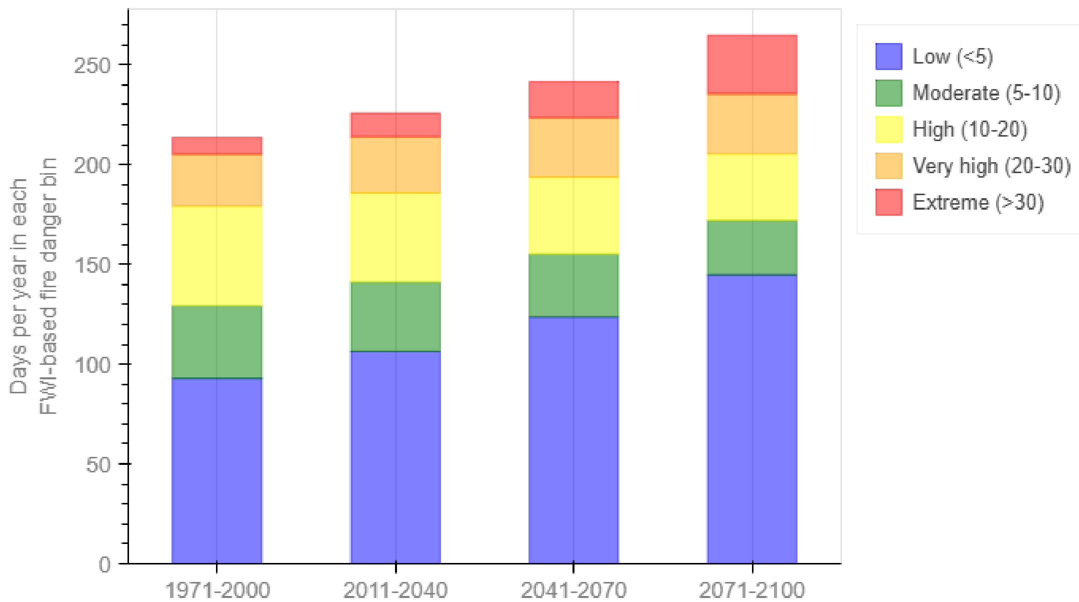


Figure 3-3 shows a 33.3% increase in “Low” fire danger days, rising from 92.8 historically to 123.7 in the 2060s. "Moderate" fire danger days decrease by 14.0%, from 36.5 to 31.4, while "High" fire danger days drop by 22.5%, from 49.8 to 38.6. "Very High" fire danger days increase by 14.2%, going from 26.1 to 29.8. The most significant change is in the "Extreme" category, which jumps by 116.9%, from 8.3 days historically to 18.0 in the 2060s. Overall, fire weather danger is increasing in both number of days where fire weather criteria are met and in the average fire weather severity.

Figure 3-4 shows the length of the fire season, or number of days per year with measurable fire danger. The ranges of blue, green, and red boxes represent the ensemble 10th percentile to 90th percentile for RCP2.6, RCP4.5, and RCP8.5, respectively (the low, medium, and high emissions scenarios respectively – see Section 2 for more details). The fire season length for Salmon Arm increases from a mean value of 213.6 days historically to 241.5 days in the 2060s following RCP8.5, representing a 13% increase.

[34]Gosselin, P., Campagna, C., Demers-Bouffard, D., et al., 2022: Natural Hazards, in P. Berry & R. Schnitter (Eds.), Health of Canadians in a Changing Climate: Advancing our Knowledge for Action. Ottawa, ON: Government of Canada.
[35] IPCC, 2021: Annex VII: Glossary [Matthews, J., et al. (eds.)]. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 2215–2256.

Figure 3-4 Fire Season Length

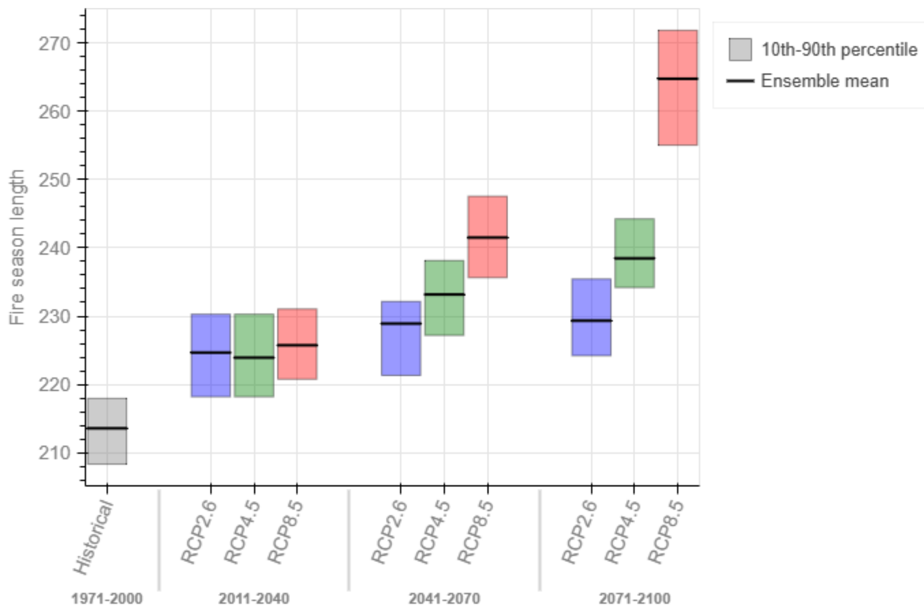
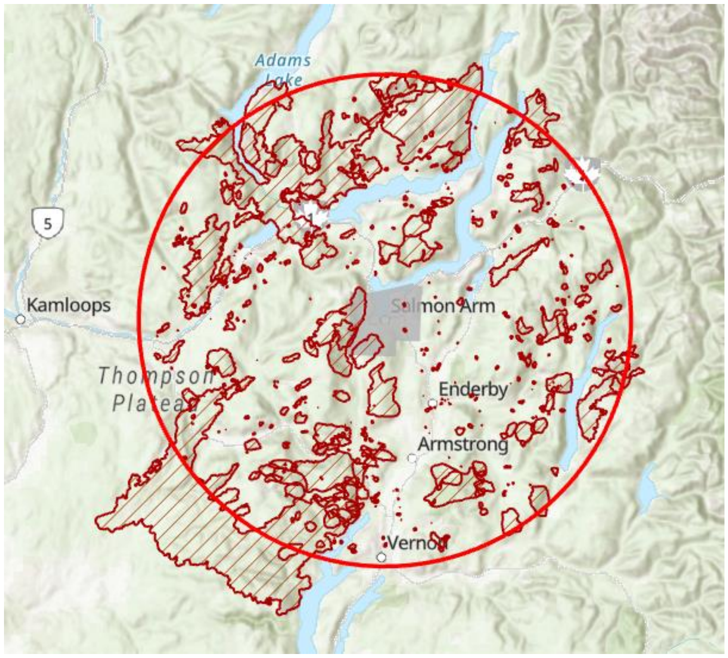


Figure 3-5 shows a map of historical wildfire events that were caused by weather events (e.g., lightning) within 40km the city. A total of 473 wildfires occurred within 40km of the city between 1919-2024[36], with significant fires to the north, northwest, and southwest. While direct flame front spread from 40km to the city center is highly unlikely, extreme fire behavior, often associated with the dry, windy conditions accompanying lightning storms, can generate long-distance ember spotting. Embers carried by strong winds can travel several kilometers ahead of the main fire. FireSmart BC notes documented instances of embers spreading up to 17km[37]. The 40km radius provides a buffer that is roughly twice this distance that accounts for the potential for significant spot fires to occur much closer to the Wildland-Urban Interface (WUI) than the original ignition point, potentially initiating new fires well within the range where they pose a more immediate threat

[36] Data retrieved from iMapBC Historical Fire layers https://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc
[37] https://firesmartbc.ca/why-we-focus-on-embers/

Figure 3-5 Map of Historic Wildfire Events within 40km of Salmon Arm between 1919-2023



There are currently no published studies of the impact of climate change on future smoke-PM2.5[38] levels (the primary component of smoke giving rise to health concerns) in Canada. Studies have linked historic increases in the area burned with higher concentrations of PM2.5, as well as associated increases in adverse public health outcomes. Thus, with current trends in the area burned in Canada expected to increase with climate change (see wildfires above), it is reasonable to expect that PM2.5 levels attributable to wildfire smoke will likewise increase.

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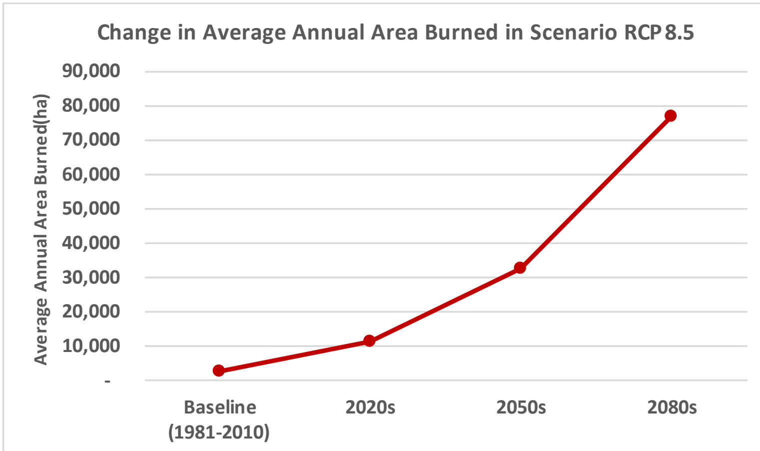
[38] Particulate matter with a size of 2.5 microns or less.

Average annual area burned can be used as a proxy to measure the prevalence of smoke. Figure 3-6 below illustrates the change in the annual average area burned for the Pacific Montane region.

Figure 3-6 Annual Area Burned Projections for the Pacific Montane Region



3.4 Flooding

Salmon Arm has experienced several notable floods over the past century, often tied to rapid snowmelt, heavy rainfall, and rising levels of Shuswap Lake. Significant regional events include the Great Flood of 1894 and the Fraser Valley flood of 1948, both of which raised water levels across southern BC. In 1972 and 1997, widespread flooding in the interior also affected Salmon Arm, with high lake levels and localized impacts. More recently, major flood years like 2012, 2017, and 2018 saw roads inundated, waterfront properties threatened, and emergency measures enacted as Shuswap Lake rose dramatically.

Projected increases in temperature and seasonal precipitation are expected to alter the timing and duration of spring thaw, and atmospheric river events are anticipated to increase in frequency and intensity, both increasing flood risk potential across the Province[39]. In addition, projected increases in extreme precipitation, combined with the challenges of aging infrastructure suggests that rainfall flooding risks, alongside river and lake flooding risks, will likely increase across British Columbia[40]. Table 3-1 captures the projected median changes in different 1:100-year short duration, high intensity rainfall events at the Stewart weather station (the nearest weather station with available data). This data indicates that on average, there will be a ~30% increase in the intensity of 1:100 year rainfall events in the City.

[39]Atmospheric rivers are narrow bands of concentrated moisture in the atmosphere that enter western Canada from the Pacific Ocean and can lead to extreme precipitation events such as those witnessed in November 2021. Reference: Bonsal, B.R., Peters, D.L., Seglenieks, F., Rivera, A. and Berg, A. (2019). Changes in freshwater availability across Canada, Chapter 6 in Canada's Changing Climate Report, (Eds.) E. Bush and D.S. Lemmen, Government of Canada, Ottawa, Ontario, 261–342. https://changingclimate.ca/CCCR2019/chapter/6-0/
[40]Auditor General of British Columbia (2018). Managing Climate Change Risks: An Independent Audit. Office of the Auditor General of B.C., Victoria, British Columbia. https://www.bcauditor.com/sites/default/files/publications/reports/Climate_Change_FINAL_0.pdf

Table 3-1 Projected changes in 1:100-year short duration, high intensity rainfall events in Salmon Arm

Event duration	Baseline (mm/hr)	2060s (mm/hr)	% change
5-minute	116.1	149.0	28%
10-minute	72.2	93.0	29%
15-minute	60.6	78.0	29%
30-minute	37.4	48.0	28%
1-hour	21.5	28.0	30%
2-hour	11.4	15.0	32%
6-hour	5.1	6.6	29%
12-hour	3.7	4.8	30%
24-hour	2.4	3.1	29%

4 ENVIRONMENTAL CHANGES & OTHER IMPACTS

This section presents an overview of projected changes to environmental conditions and natural systems, and other impacts that may affect the city as a result of changes in the climate.

4.1 Changes in Streamflow

Climate change is projected to significantly alter streamflow patterns across British Columbia. Studies by the Pacific Climate Impacts Consortium[41] and BC Hydro[42] indicate that while annual water availability may modestly increase due to higher precipitation, the seasonal distribution of streamflow is expected to shift. Specifically, spring snowmelt is anticipated to occur earlier, leading to reduced summer flows and increased winter runoff.

In addition to timing shifts, the magnitude of streamflows is also expected to change. Annual water availability may increase modestly due to higher winter and spring precipitation; however, summer flows are projected to decline, particularly in snowmelt-dependent and glacier-fed basins like in the Shuswap region. These changes could have significant implications for hydroelectric power generation, water supply, and ecosystem health.

Modeled stream flow data was collected from the Pacific Climate Impacts Consortium[43]. This data is simulated daily streamflows over the period 1945-2100. Data was collected for tributary sites leading into Shuswap Lake. Three stations were chosen: the Eagle River near Malakwa, the Seymour River near Seymour Arm, and the Adams River near Squilax. All three stations show the same trend, with increasing annual average flows, decreasing summer flows, and increasing winter, spring, and fall flows.

The annual averages of daily average flow rates for one representative tributary with the highest average flow rates, the Adams River near Squilax, are given in **Figure 4-1**. The annual averages of the seasonal daily average flow rates for the same location are given in **Figure 4-2**.

[41] Hydrologic Impacts of Climate Change on BC's water Resources, Pacific Climate Impacts Consortium. https://www.pacificclimate.org/sites/default/files/publications/Zwiers.HydroImpactsSummary-CampbellPeaceColumbia.Jul2011-SCREEN.pdf

[42] Potential Impacts of Climate Change on BC Hydro's Water Resources Report. BC Hydro. https://www.ijc.org/sites/default/files/2018-08/BCHydro%20climate_change_report_2012_1.pdf

[43] Data is provided for each station for 12 CMIP5 scenarios. The average across each scenario for each timestep is used, and resampled to calculate the annual and seasonal average daily flows. Streamflow is provided in cubic metres per second ($m^3\ s^{-1}$). https://www.pacificclimate.org/data/station-hydrologic-model-output

Figure 4-1 Annual Average of Daily Average Flow Rates for Shuswap Lake Tributaries

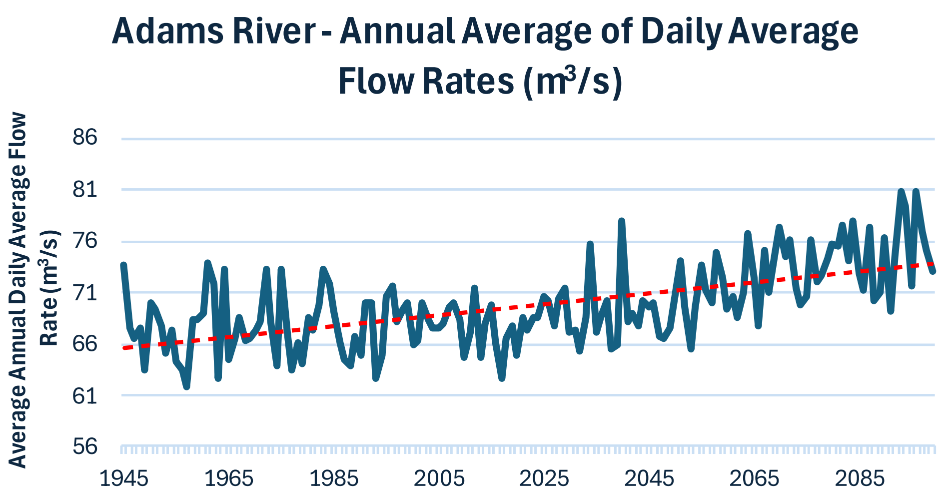
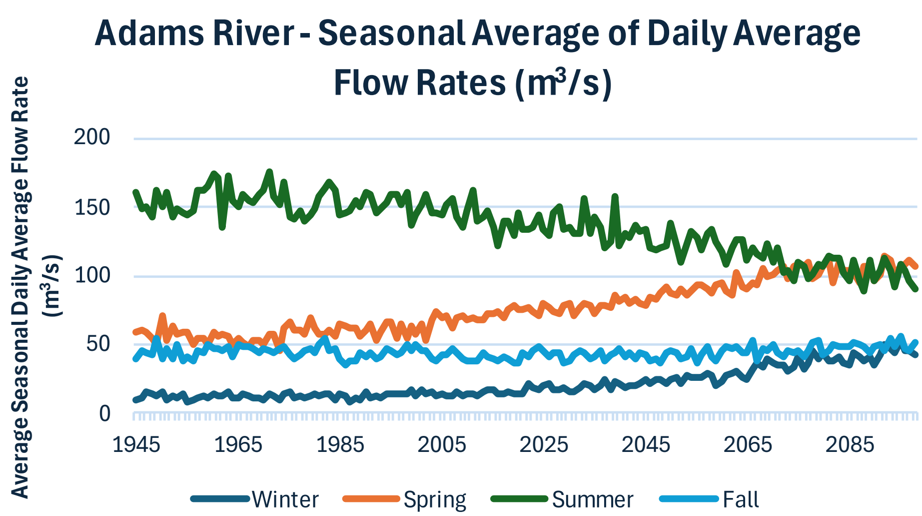


Figure 4-2 Annual Average of Daily Average Flow Rates for Shuswap Lake Tributaries



4.2 Forests and Ecosystems

Biogeoclimactic zones are areas with similar climates, vegetation, and soils. The city is currently located in the Interior Douglas-Fir Biogeoclimatic zone, as shown in Figure 4-3. As temperature and precipitation are projected to increase, the biogeoclimatic zone is likely to shift. By the 2060s, the biogeoclimactic zone for the city itself is projected to be “Novel”, which means it is likely to be a biogeoclimactic zone not currently found in British Columbia. The biogeoclimactic zones in the regions outside the city are projected to be similar to those found in the Okanagan Valley. The Interior Cedar-Hemlock biogeoclimactic zone will move northwards into what is currently the Interior Douglas-Fir Biogeoclimatic zone as shown in Figure 4-3 and Figure 4-4.

These changes in regional ecosystems will have consequences for the diversity of species that reside in natural areas in and around the city. Some species will shift their ranges northward as the ecoregions shift; other species (mainly plants) may not be able to make the shift. The provision of some ecosystem services (e.g., pollination, water filtration, recreation, stormwater attenuation, carbon sequestration, aesthetics, etc.) may also be adversely impacted (reduced or lost).

Figure 4-3 British Columbia Biogeoclimatic Zone Projections[44] - Current

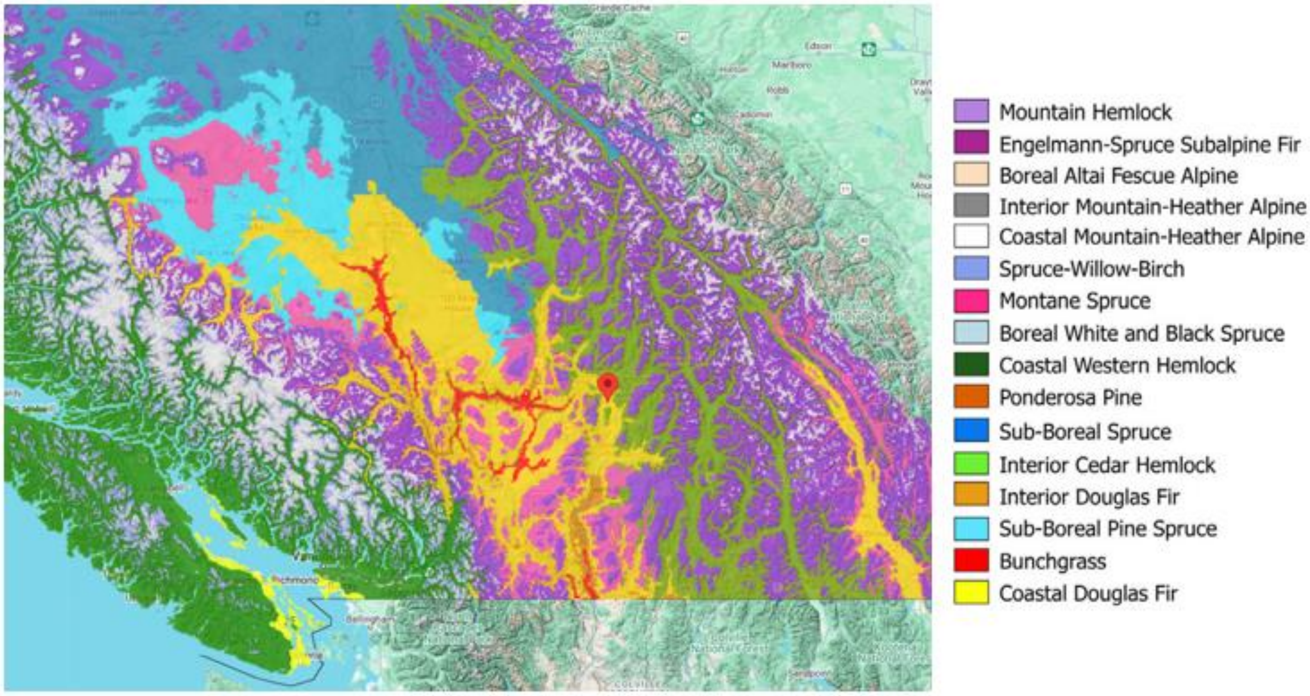
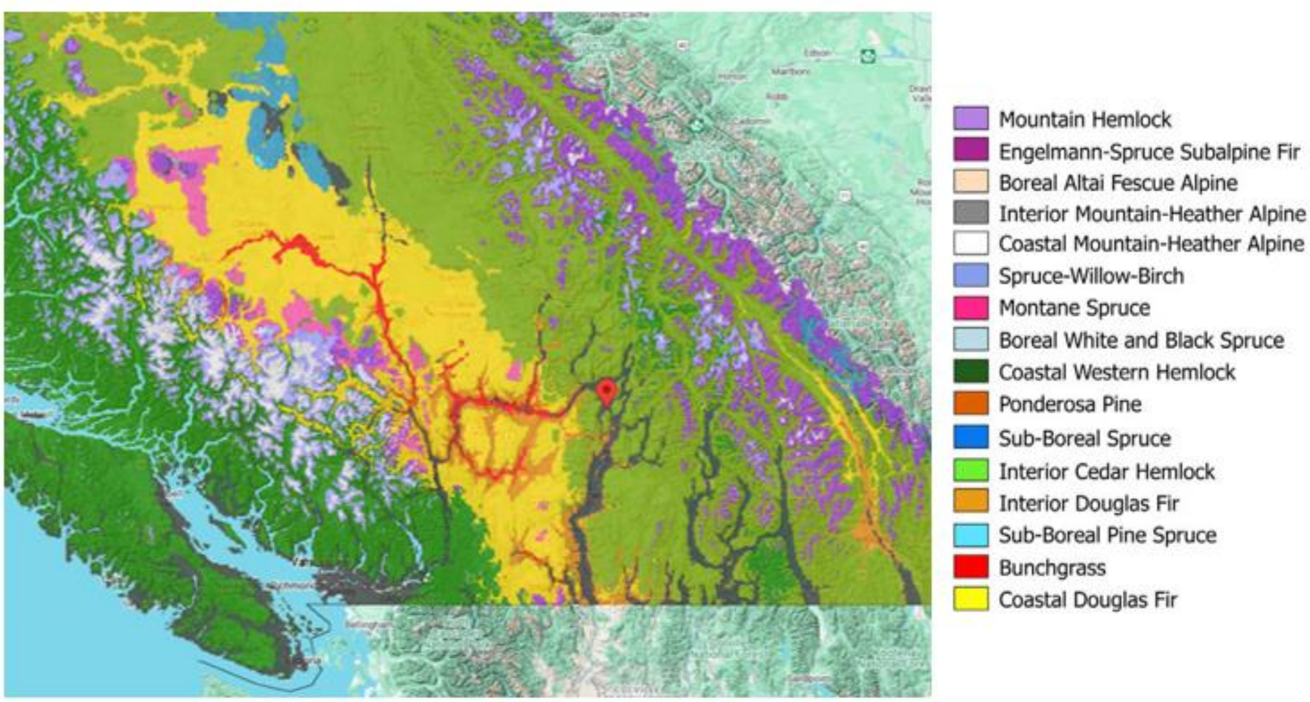


Figure 4-4 British Columbia Biogeoclimatic Zone Projections – 2060s



4.3 Invasive Species and Pests

Climate change is anticipated to increase the potential for invasive species and insect pests, such as the mountain pine beetle. These populations benefit from warming conditions that increase overwinter survival and promote faster generation times[45]. Changes in invasive species and pests as a result of climate change may include the following[46]:

- New species arrivals—reduced climatic barriers allow new species to thrive
- Population expansion and rapid reproduction—better winter survival rates, increased competitiveness, and genetic traits that enable faster development and more reproductive cycles during longer growing seasons
- More dispersal—more opportunity for dispersal during extreme weather events
- More habitat—ability to take advantage of stressed native ecosystems and urban forests, or newly disturbed sites after extreme weather events
- More vulnerable hosts—native species stressed or damaged due to climate change impacts will be more vulnerable to attack
- Crop impacts – changes in pest dynamics may affect crop suitability and reduce yields, particularly in arable farming areas, leading to increased management costs and food security concerns

Figure 4-5 Black Henbane – A Poisonous Invasive Plant recently found in BC

[44]Projections for each of the 16 BCG zones compares results between a baseline period of 2001–2009 and the 2050s. Results are based on consensus predictions with the best-model agreement among 20 climate change scenarios. Sources: The University of British Columbia (2022). ClimateBC and Bioclimatic Envelope Modelling. https://cfcg.forestry.ubc.ca/projects/climate-data/climatebc-and-bioclimatic-envelope-modelling/; Wang, T., Campbell, E.M., O'Neill, G.A. and Aitken, S.N. (2012). Projecting future distributions of ecosystem climate niches: Uncertainties and management applications. Forest Ecology and Management, 279, 128–140. https://doi.org/10.1016/j.foreco.2012.05.034
[45] Sambaraju, K., et al., 2012: Climate change could later the distribution of mountain pine beetle outbreaks in western Canada. Ecography 35:211-223.
[46]Gifford, R., Brown, C., Baron, C., Clement, D., Melnychuk, N., Nelson, H., Sales, L. and Spittlehouse, D. (2022). British Columbia Chapter in Canada in a Changing Climate: Regional Perspectives Report, (ed.) F.J. Warren, N. Lulham and D.S. Lemmen; Government of Canada, Ottawa, Ontario.

4.4 Vector-borne Diseases

As the climate continues to warm across Canada, new exotic mosquito-borne diseases (MBDs) – such as malaria, dengue, chikungunya virus and Zika virus – that were originally unable to survive may emerge[47]. With warmer temperatures, higher humidity, and more precipitation expected, mosquito species that are principal carriers of these MBDs will undergo physiological changes that increase their survival and ability to transmit diseases to humans. Small numbers of these species have already been introduced in parts of Canada, with some having established themselves in limited regions.

Additionally, rising temperatures are expected to create more suitable environments for tick species and tick-borne diseases (TBDs) to survive in Canada[48]. Aside from Lyme disease that is transmitted by black-legged ticks, four other TBDs – Anaplasmosis; Babesiosis; Powassan virus; and Borrelia miyamotoi disease – have already started to emerge in southern parts of central and eastern Canada. Climate change can also indirectly influence the spread of diseases in animals, like Chronic Wasting Disease which has begun to affect deer and elk in the region.

5 CLOSURE

The services provided by Associated Engineering (B.C.) Ltd. in the preparation of this memo were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

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[JZ/IG/ml]

[47] Ng, V., et al., 2019: Could exotic mosquito-borne diseases emerge in Canada with climate change? Canada Communicable Disease Report, 45(4), 98–107.

[48] Bouchard, C., 2019: Increased risk of tick-borne diseases with climate and environmental changes. Canada Communicable Disease Report, 45(4), 83–9.