

Climate Projections for the Cowichan Valley Regional District 2026



Executive summary

Climate change is already affecting the Cowichan Valley Regional District (CVRD) and will continue to do so over the coming decades. To better understand these changes and support informed decision-making, the CVRD partnered with the Pacific Climate Impacts Consortium (PCIC) to develop updated climate projections for the region. These projections provide a shared foundation for understanding future climate risks, informing planning processes, and supporting actions that enhance community resilience.

This report details future climate projections through the end of this century under a high greenhouse gas emissions scenario, using the latest generation of global climate modelling (CMIP6). It also provides a high-level overview of emerging and potential climate impacts across the region. Building on a similar assessment completed in 2017, this update includes new information on heatwaves, drought, snowfall and extreme events.

Key projected changes by the 2050s under a high emissions scenario include:

- Hotter, drier summers, including more frequent, and longer-lasting heatwaves
- The annual likelihood of temperatures exceeding 34°C rising from about 5% to 40%
- Fewer days of frost and ice and a longer, warmer growing season
- More precipitation during the cooler months, with more frequent and intense heavy rainfall
- Around 60% less annual snowfall, with more precipitation falling as rain
- Less summer rainfall, with uncertainty over how changing seasonal precipitation will influence future drought conditions

The projections reinforce the key findings from the 2017 assessment. Across the CVRD, summers are projected to become hotter and drier, while winter, spring and fall are projected to become warmer and wetter. These changes are expected to influence communities, ecosystems, watersheds, infrastructure, public health, and economic activities throughout the region.

By the 2050s, the number of summer days above 25°C is projected to more than double, increasing from an average of 18 days per year in the recent past to over 40 days per year. Warm overnight temperatures are also expected to become more common, with nights remaining above 16°C increasing from approximately one night per year to seven. These changes are likely to increase heat-related risks and demand for cooling across the region. At the same time, summer rainfall is projected to decrease by about 15%, which could exacerbate seasonal water shortages in a region that already experiences dry summer conditions.

Warmer winter temperatures will bring fewer days with frost and ice, less heating demand and a longer growing season. As temperatures rise, more winter precipitation is expected to fall as rain rather than snow. As a result, by the 2050s, snowfall is projected to decline to less than half of

historical levels across the region, whereas rainfall is expected to increase by about 30% in winter and 15% in spring and fall. Heavy rainfall events are also projected to become more frequent and intense. By the 2050s, the largest single-day rainfall event each year is projected to increase by approximately 15%, with even larger increases projected for rarer (e.g., 1-in-20-year) events.

While these changes are regional averages, climate conditions vary considerably within the CVRD due to differences in elevation and proximity to the ocean. For example, coastal and low-lying areas, where much of the population and agricultural activity is concentrated, are expected to experience the highest temperatures and greatest likelihood of exceeding heat warming thresholds. The maps and tables presented throughout this report highlight these regional variations, which can be important for local planning and decision-making.

The information presented in this report provides decision makers and community partners with an updated understanding of projected climate change and its implications for the Cowichan region. It supports wider efforts to reduce future risks and build more resilient communities. The regional climate impacts discussed in Chapter 7 are intended to support conversations among local governments, First Nations, community organizations and residents about how climate change may affect the region and what actions can be taken to prepare for these changes. Notably, adaptation can take many forms and will depend on the unique context of each community.

For those looking to explore the data in more detail, the complete data package contains projections for all three subregions under a moderate and high emissions scenario for the 2030s, 2050s and 2080s. See the report appendices for more details on accessing the complete dataset and for guidance on using future climate projections in your work.

CONTRIBUTING AUTHORS

Charles Curry and Stephen Sobie from the Pacific Climate Impacts Consortium (PCIC) conducted climate model downscaling, data analysis & interpretation and generated all data products, including maps, figures, and tables, for this assessment. Charles Curry, Ed Beard and Izzy Farmer (PCIC) served as lead writers for this report. Caitlyn O'Connor from the CVRD was the project manager for this assessment.

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1. Introduction

At the time of writing, the average global surface air temperature has increased by nearly 1.4 °C since the preindustrial era. Since 1948, British Columbia (BC) has warmed by over 2 °C.¹ While the temperature increase has been somewhat lower on Vancouver Island (around 1.2 °C), regional warming is projected to continue over the coming decades and affect other aspects of the climate, such as precipitation. Understanding and preparing for the regional and local manifestations of climate change will therefore be important for supporting safe and resilient communities in the years ahead.

Recognising this, the Cowichan Valley Regional District (CVRD) launched *New Normal Cowichan* in 2017, a multi-phased initiative focused on climate action and adaptation. As part of Phase 1, the CVRD partnered with the Pacific Climate Impacts Consortium (PCIC) to develop regional climate projections and conduct a high-level analysis of potential impacts. This work resulted in the *Climate Projections for the Cowichan Valley Regional District* (2017) report, which has since informed climate change adaptation strategies developed by both the CVRD and the Municipality of North Cowichan. The projections have also been used to update flood mapping for the region.

Since the 2017 report was published, the CVRD has gained more experience planning for and responding to climate change impacts. Flooding and drought have become key concerns in the region, with important implications for water availability and long-term planning. At the same time, extreme events in the CVRD and broader region – including the unprecedented June 2021 Pacific Northwest heatwave and the November 2021 atmospheric river event in BC – have garnered national and global attention and underscored the growing severity of climate risks.

¹ Global mean surface air temperature data are from the UK Met Office Climate Dashboard. Historical temperature changes for BC and Vancouver Island are based on an internal analysis conducted by PCIC using publicly available data from Environment and Climate Change Canada between 1948 and 2023.

Advancements in global climate modelling, improvements to PCIC's downscaling methods, and the development of new climate indicators, such as for snowfall, drought and heatwaves, have spawned interest in updating the regional climate information for Cowichan. In response, the CVRD has again partnered with PCIC to update the regional climate projections using the latest generation of global climate models from the Coupled Modeled Intercomparison Project Phase 6 (CMIP6), downscaled to a high spatial resolution suitable for local and regional planning.

The updated projections are intended to support ongoing climate adaptation and risk management initiatives across the Cowichan region. This includes informing existing strategies and programs, such as the CVRD Climate Change Adaptation and Risk Management Strategy, and more resilient approaches to water management, infrastructure design, land use planning, emergency management and regional hazard, risk and vulnerability assessments. The report is meant to provide a stronger evidence base for future decision-making by both CVRD and its community partners.

A selection of climate indicators is presented in this report to illustrate how the region's climate is expected to change over time. Chapter 2 provides an overview of the study methodology and guidance for interpreting figures and tables presented throughout the report. Chapters 3 through 6 present projected changes to a range of climate indicators, including seasonal temperatures and precipitation, and climate extremes. Each section includes a description of the indicator and a summary of how it is projected to change across the region for one or more future time periods.

The final chapter of this report identifies potential climate change impacts expected across the region, based on the projections listed here. These impacts are organized by sector and include watershed health, ecosystems and biodiversity, water supply and demand, health and wellbeing, the built environment, agriculture and food systems, and recreation and tourism. Where possible, impacts are considered through an equity lens that recognizes how certain populations may be disproportionately exposed to climate hazards while also facing greater barriers to preparing for, responding to and recovering from the projected changes. This chapter is not a comprehensive assessment of climate impacts; it is meant to encourage further discussion and analysis.

It should be noted that the information presented in this report is based on projected changes to temperature and precipitation only. Other climate-related phenomena, such as surface hydrology, wind, wildfire, humidity, sea level rise and storm surge, require more specialized modelling approaches and are beyond the scope of this project. As a result, this report should be used alongside other relevant resources to help prepare the region for the impacts of climate change.

The information in this report should also be interpreted with careful consideration of the local context. The CVRD spans approximately 3500 km², includes elevations reaching up to 1,400m and contains two distinct coastlines (Figure 1). Because of this, climate conditions vary considerably across the region, as do land use patterns, infrastructure, ecosystems, and population distribution. Readers should therefore be aware of the limitations and uncertainties associated with climate projections information. Guidance on the appropriate use of climate information for local adaptation planning is provided in the appendices at the end of this report.

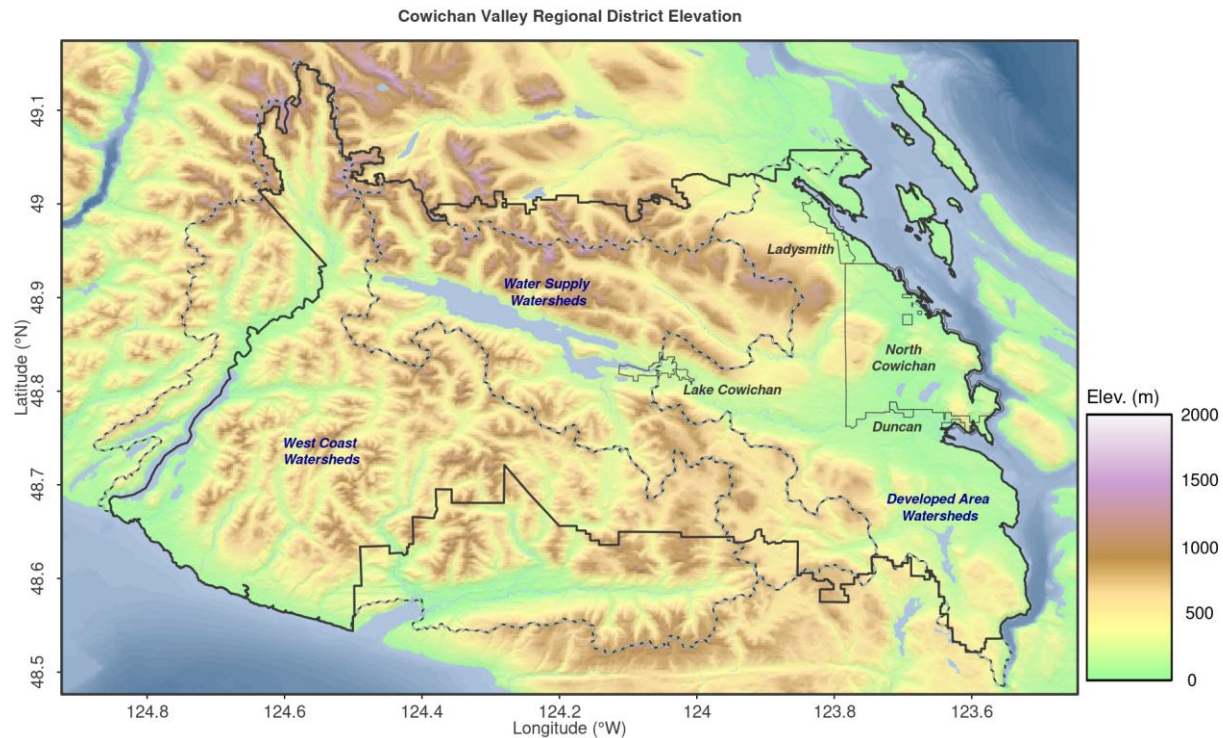


Figure 1. Area of interest showing the Cowichan Valley Regional District, with background relief (elevation) map. The bold black line indicates the Regional District boundary used to calculate regional averages reported in this assessment. Dotted black and grey lines show the boundaries of the three sub-regional watershed areas.

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2. Methods and presentation

Climate models

The climate projections in this report are based on an ensemble of nine state-of-the-art global climate models (GCMs). These models are drawn from a larger set developed as part of CMIP6, coordinated by the World Climate Research Programme. Each GCM represents the climate system using a global, three-dimensional grid with a horizontal resolution ranging from 100 km to 250 km, depending on the model.

To develop climate information that is more relevant at the regional scale, projections from coarse-resolution GCMs are statistically downscaled. This process first reduces biases in each model's simulated temperature and precipitation using observational data for Canada on a 10 km grid.² In a second step, the data are further downscaled to a resolution of 800 m using fine-scale climatological maps for BC. While this second downscaling step incorporates the influence of local topography, important features and local-scale influences on day-to-day weather are not represented in the dataset.³

Emissions scenarios

The climate projections presented in this report are based on a high greenhouse gas emissions scenario, known as Shared Socioeconomic Pathway 5-8.5 (SSP585). The pathway describes a future in which emissions continue to rise due to sustained and expanded use of fossil fuels worldwide. By the end of the century under SSP585, global mean surface air temperature is projected to be 4.3 °C higher than the 1850-1900 baseline, based on the average of 9 GCMs used in this analysis. In BC, the magnitude of warming is expected to be even larger. Projections for SSP245, a medium-intensity pathway, are also available in the data package accompanying this report. This emissions scenario reflects a future in which global energy systems transition toward lower-carbon technologies and emissions are substantially reduced compared to SSP585.⁴

The projected trajectories of air temperature and precipitation for BC under high, medium and low global emissions scenarios are provided in Figure 2. *For most climate indicators in this report, the magnitude of changes by mid-century (2050s) under SSP585 are roughly comparable to those projected by late-century (2080s) under SSP245. In addition, projected changes under all three scenarios are comparable until about mid-century. See Appendix B for more information about emissions scenarios and how they should be interpreted.*

² More on PCIC's downscaling methods can be found on the [Statistically Downscaled Climate Scenarios](#) page on our website.

³ Examples include realistic co-variability between nearby locations and the influence of fine-scale land cover type, such as those that can contribute to the urban heat island effect. It should also be noted that because the models are calibrated to observations from 1950-2012, more recent climate observations are not reflected in results displayed for the past, nor do they influence future-modelled behaviour.

⁴ More on SSPs can be found at <https://climatedata.ca/resource/understanding-shared-socio-economic-pathways-ssps/>

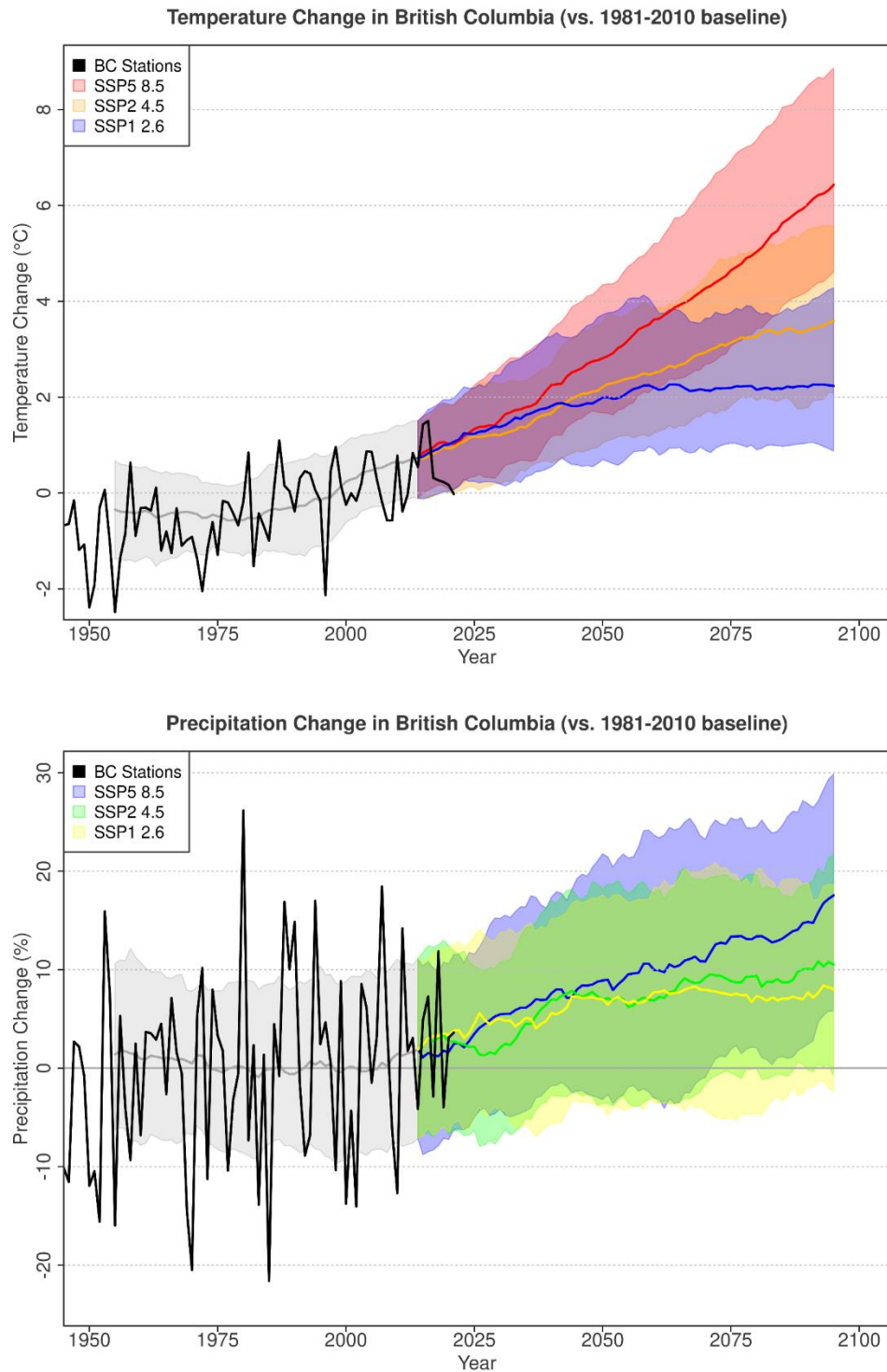


Figure 2. Projected changes in annual mean air temperature (*upper*) and total precipitation (*lower*) across BC, relative to their historical (1981-2010) values. Black curves show historical values obtained from station data in BC from 1948-2021. Coloured curves show median GCM projections under three emissions scenarios (SSP126, SSP245, SSP585) from 2015-2100. Shaded areas represent the 10th-90th percentile range of model projections for both the historical and future periods under each SSP.

Presentation of projections

TIME PERIODS, SEASONS AND INDICATORS

This report presents downscaled climate model results for three 30-year time periods:

- **Historical reference period:** 1981-2010 (referred to as the “past” or “1990s”)
- **Mid-century:** 2041-2070 (“2050s”), and
- **End-of-century:** 2071-2100 (“2080s”)

These 30-year periods were selected to smooth out year-to-year climate variability and better reflect long-term climate conditions, while also providing a sufficient number of years for analyzing climate extremes.

The seasonal definitions used in this report follow standard meteorological seasons:

- **Winter:** December 1 to February 28
- **Spring:** March 1 to May 31
- **Summer:** June 1 to August 31
- **Fall:** September 1 to November 30

This report presents results for a number of key climate indicators derived from model-simulated daily temperature and precipitation data. These indicators represent a “highlight reel” of the much more extensive set of climate indices delivered for this assessment. Indicators were selected for the report in consultation with CVRD staff based on their relevance to climate-related impacts across the region, the magnitude of projected change relative to recent historical conditions, or both.

In the following chapters, a plain language definition is provided for each indicator, followed by a summary of its projected change for the 2050s and 2080s under high emissions scenario SSP585. Detailed definitions of all indicators are provided in Appendix D.

MAPS, TABLES AND OTHER FIGURES

This report shares data in three main ways:

- i. Maps showing sub-regional differences across the CVRD
- ii. Tables of area-averaged results
- iii. Box-and-whisker plots illustrating seasonal change and variability

Most figures in this report are maps of the CVRD and surrounding area. Colour contours indicate the value of the indicated variable at a nominal spatial resolution of 800 m based on the legend in the upper right corner. *Due to the limitations of the downscaling methodology, along with the inherent uncertainty in future outcomes, the exact position of contours on the maps should not be interpreted literally and results should be used with caution.* All maps include a single number below the legend representing the area average across the entire CVRD, defined by the black boundary shown in Figure 1.

Presentation of projections (continued)

Two types of maps are presented in this report:

- **Single period maps** show the ensemble mean of a variable for a specific time period and are typically presented as a pair. For example, one map may show conditions for the historical time period (e.g., the “1990s”) and a second map may show conditions for a future period (e.g., “2050s”).
- **Future change maps** show the difference between historical and future-projected ensemble means in a single map (e.g., “projected change: 2050s -1990s”). These maps combine information from the corresponding single period maps and present change in relative terms, such as percentage change. In some cases, future change maps are provided alongside the historical period map to better illustrate the projected changes.

In the interest of concision, all future maps included in this summary report show projected changes for the 2050s.

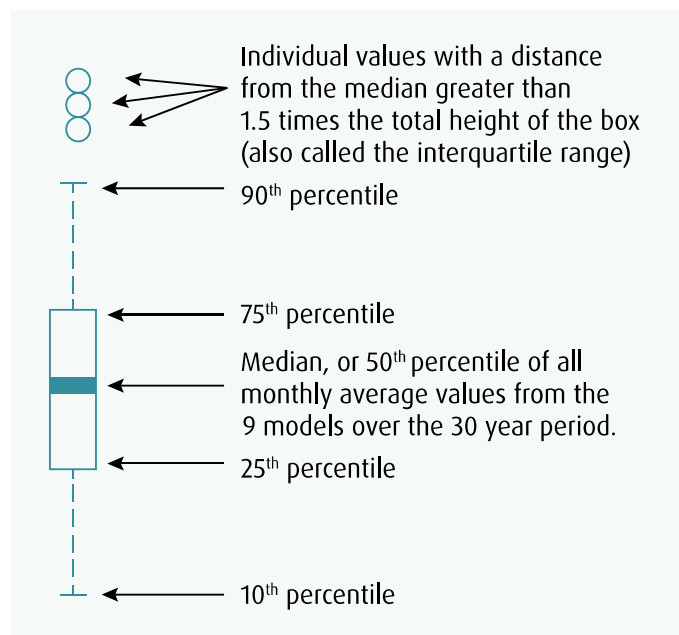
Tables throughout the report present the ensemble mean (50th percentile) along with the 10th and 90th percentile ranges in parentheses. The mean value may be interpreted as the most likely outcome. The 10th and 90th percentile range reflects the spread across models and provides an indication of uncertainty in future projections. While the text summaries generally focus on median values, the full range of projected changes should also be considered, particularly for critical decision-making.

Note that values cited in the text are often rounded to reflect the appropriate level of precision given the uncertainty in the climate projections (as expressed by the 10th and 90th percentile range). For example, a projected temperature of 6.1°C may be described as “around 6°C”, while a projected change of 13% may be referred to as “about 15%”.

	Average or mean of model ensemble	10 th percentile of model ensemble	90 th percentile of model ensemble	2050s change (°C)	
				Average	range
Past (°C)					
Winter	4			2.1	(1.8 to 3.4)
Spring	11			2.2	(1.4 to 4.2)

Presentation of projections (continued)

This report also includes several box-and-whisker plots that illustrate both the spread across projections from different climate models and the year-to-year variability within individual models. These plots represent regional averages for a given climate variable. The diagram here provides guidance on how to interpret the different components of a box-and-whisker plot.



A Note on Uncertainty

Not all projected changes from a climate model ensemble are necessarily substantial. For any given variable, location, and emissions scenario, each climate model produces a different projection of future climate conditions, resulting in a range of possible outcomes. Since no single model can be considered the “correct” one, the model ensemble mean is often used as a practical best estimate.

The 10th to 90th percentile range provides an indication uncertainty across the model ensemble. *When this range includes zero change, meaning that some models project an increase and others project a decrease, then relatively low confidence should be placed on the mean value.* In the relatively rare cases where fewer than half of the models agree on the direction of change, a note is included on the maps to indicate that confidence in the projected change is low.

Sub-regional analysis

For all indicators, the values presented in the tables have been averaged across the entire CVRD. However, climatic conditions vary considerably across the region due to differences in elevation (Figure 1) and proximity to the ocean. To capture this, sub-regional results are presented in the tables for selected indicators throughout the report.

Three sub-regions were defined for analysis based on watershed and sub-watershed boundaries (Figure 3). Providing results at the sub-regional scale supports watershed-based planning and protection efforts across the region. These sub-regions are:

- **West Coast Watersheds:** This region includes the wet, westward-flowing watersheds to the outer coast and is composed of a mix of protected park areas and resource lands.
- **Water Supply Watersheds:** This region includes the upper portions of the Cowichan, Koksilah, and Chemainus River watersheds and consists mainly of resource lands within the privately managed forest land base. Because this area is less influenced by the moderating effects of the ocean, temperatures tend to be more extreme than in the coastal sub-regions.
- **Developed Area Watersheds:** This region includes the smaller, eastward-flowing watersheds and coastal benchland areas where most of the region's population is located. For the larger Cowichan, Chemainus, and Koksilah River watersheds, only the lower sub-basins are included in this sub-region.

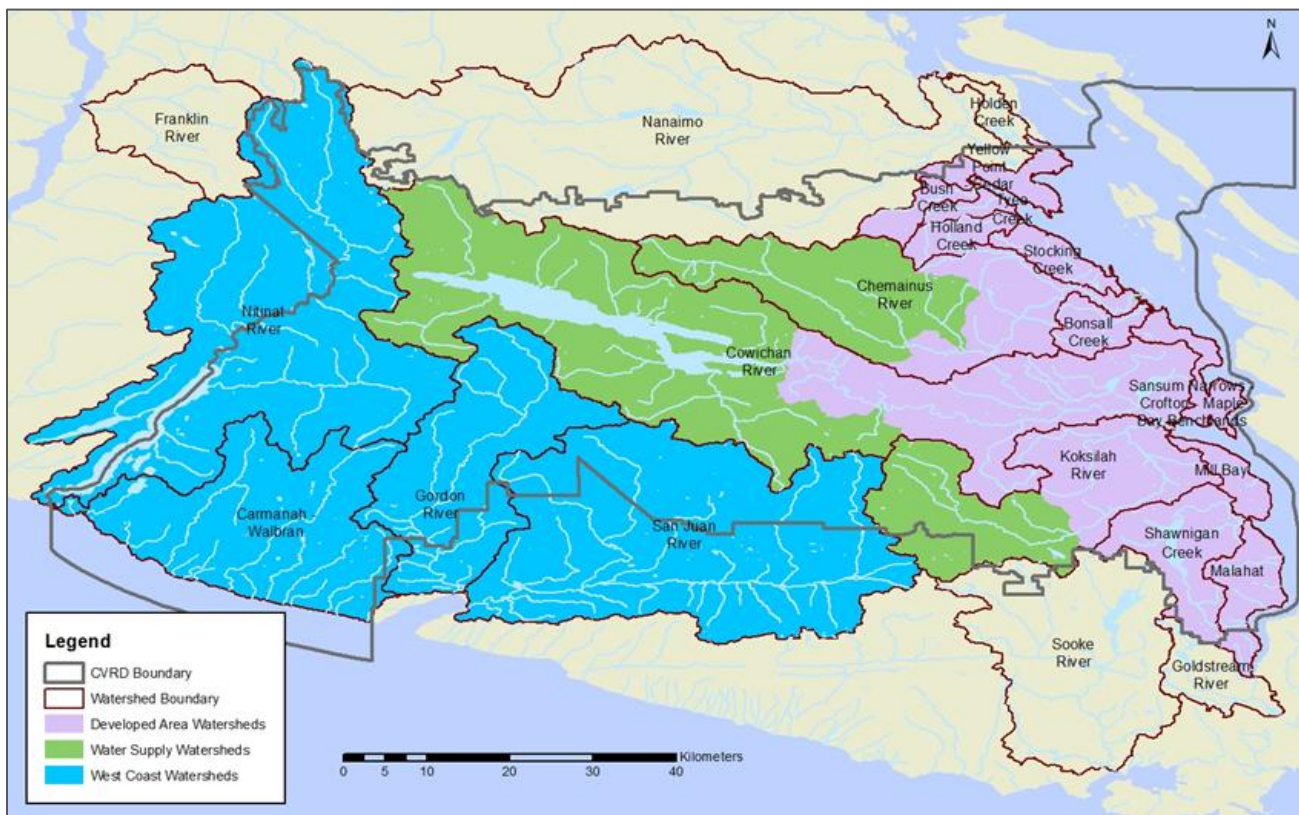


Figure 3. Three sub-regions within the CVRD and their component watersheds.



3. General climate projections

The CVRD is already experiencing a warming climate and can expect to see further change in the coming decades. This section presents general projections for temperature and precipitation in the region. More detailed information on temperature and precipitation indices is provided in Chapters 4 through 6.

Overall, the CVRD can expect:



These changes will not always happen consistently across the region or over time, as natural year-to-year variability in the local climate will continue. For most variables, projected changes become apparent by the 2050s. By the 2080s, under a high emissions scenario, projections indicate substantial changes, resulting in a climate that is markedly different from today – particularly for temperature-based variables.

Warmer temperatures

ABOUT THE INDICATORS

Daytime High Temperature (TX) and *Nighttime Low Temperature (TN)* are averaged over each season and annually in the tables and maps below to provide an overview of overall warming in the CVRD.

PROJECTIONS

Both daytime and nighttime temperatures are projected to increase across the CVRD in the future, consistent with broader global and regional warming trends. By season, the greatest temperature increases are expected in summer, when both daytime highs and nighttime lows are projected to be about 3°C warmer by the 2050s and nearly 5°C warmer by the 2080s. In winter, daytime high temperatures are projected to increase from around 4°C in the recent past to around 6°C by the 2050s and to about 8°C by the 2080s. Nighttime low temperatures in winter are projected to increase from around –0.5°C in the recent past to around 1.5°C by the 2050s and 3°C by the 2080s.

TABLE 1: REGIONAL AVERAGE DAYTIME HIGH TEMPERATURE (TX)

	Past (°C)	2050s Change (°C)		2080s Change (°C)	
		Average	(Range)	Average	(Range)
Winter	4	2.1	(1.7 to 3.5)	3.5	(2.9 to 6.5)
Spring	11	2.1	(1.4 to 4.0)	3.5	(2.7 to 6.3)
Summer	20	2.9	(2.3 to 5.1)	4.7	(4.1 to 8.7)
Fall	12	2.7	(2.1 to 4.6)	4.0	(3.6 to 7.2)
Annual	12	2.4	(2.0 to 4.5)	3.8	(3.4 to 7.0)

TABLE 2: REGIONAL AVERAGE NIGHTTIME LOW TEMPERATURE (TN)

	Past (°C)	2050s Change (°C)		2080s Change (°C)	
		Average	(Range)	Average	(Range)
Winter	–0.5	2.0	(1.8 to 3.8)	3.7	(3.3 to 6.9)
Spring	3	2.2	(1.4 to 3.6)	3.2	(2.8 to 5.7)
Summer	10	2.7	(2.3 to 4.3)	4.6	(3.9 to 7.4)
Fall	5	2.8	(2.1 to 4.7)	4.1	(3.6 to 7.3)
Annual	4	2.3	(2.0 to 4.3)	3.9	(3.5 to 6.6)

The maps below show how regional average summer and winter temperatures vary across the region and indicate widespread warming in both seasons in the future. In winter, temperatures are projected to remain warmest along the coastlines as well as in low elevation valley bottoms. Nighttime low temperatures are expected to be near or above 0°C, even at higher elevations. In summer, temperatures on the east coast and in low elevation areas such as the Cowichan Valley and Lake Cowichan will continue to exceed temperatures on the west coast. These patterns illustrate how proximity to the ocean and elevation shape local climate conditions across the region.

Warmer temperatures (continued)

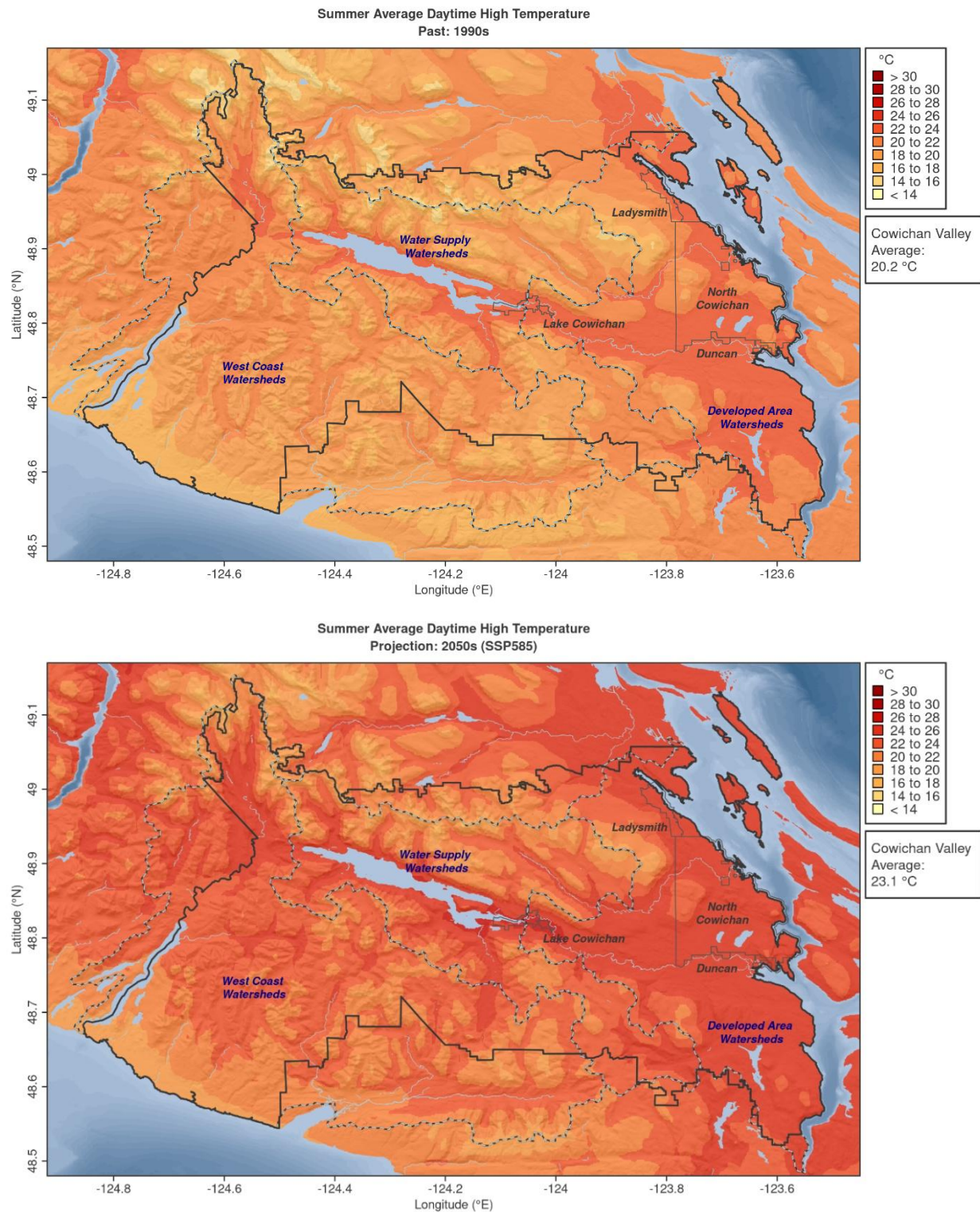


Figure 4. *Upper:* Summer average daytime high temperature (TX) in the past. *Lower:* Projected summer average daytime high temperature (TX) in the 2050s.

Warmer temperatures (continued)

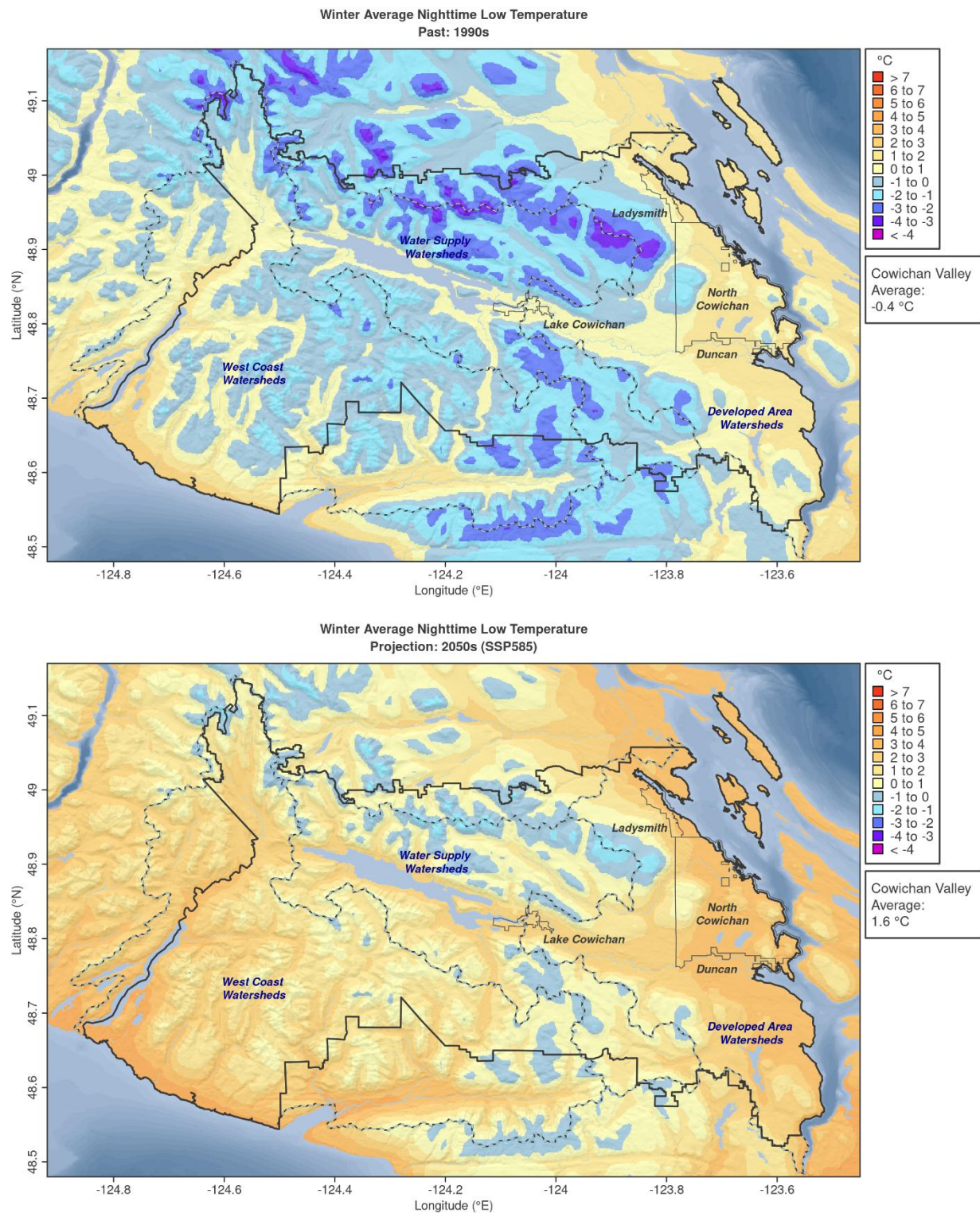


Figure 5. *Upper:* Winter average nighttime low temperature (TN) in the past. *Lower:* Projected winter average nighttime low temperature in the 2050s.

Seasonal temperature change and variability

ABOUT THE INDICATOR

In the figure below, average daily temperatures in the past are compared with future projections for each month of the year. The box-and-whisker plots below show the range of temperatures across all nine climate models and all 30 Januarys, Februarys, etc., for each time period. Hence, the boxplots reflect both year-to-year differences and differences between climate models in the past and future periods. Refer to *Chapter 2: Methods and Presentation* for guidance on interpreting box-and-whisker plots.

PROJECTIONS

In the future, daily average temperatures are projected to increase in every month of the year. Key changes include:

- Freezing temperatures in winter becoming increasingly rare.
- A longer growing season (see Chapter 5)—loosely defined as the period when daily mean temperatures consistently exceed 5°C—resulting in a shorter winter season.
- Notably hotter summer temperatures, with average daily temperatures in August exceeding 25°C during the warmest years by the 2050s.

See Chapters 4 and 5 for additional projections of temperature-related indicators, including changes in temperature extremes and differences among sub-regions.

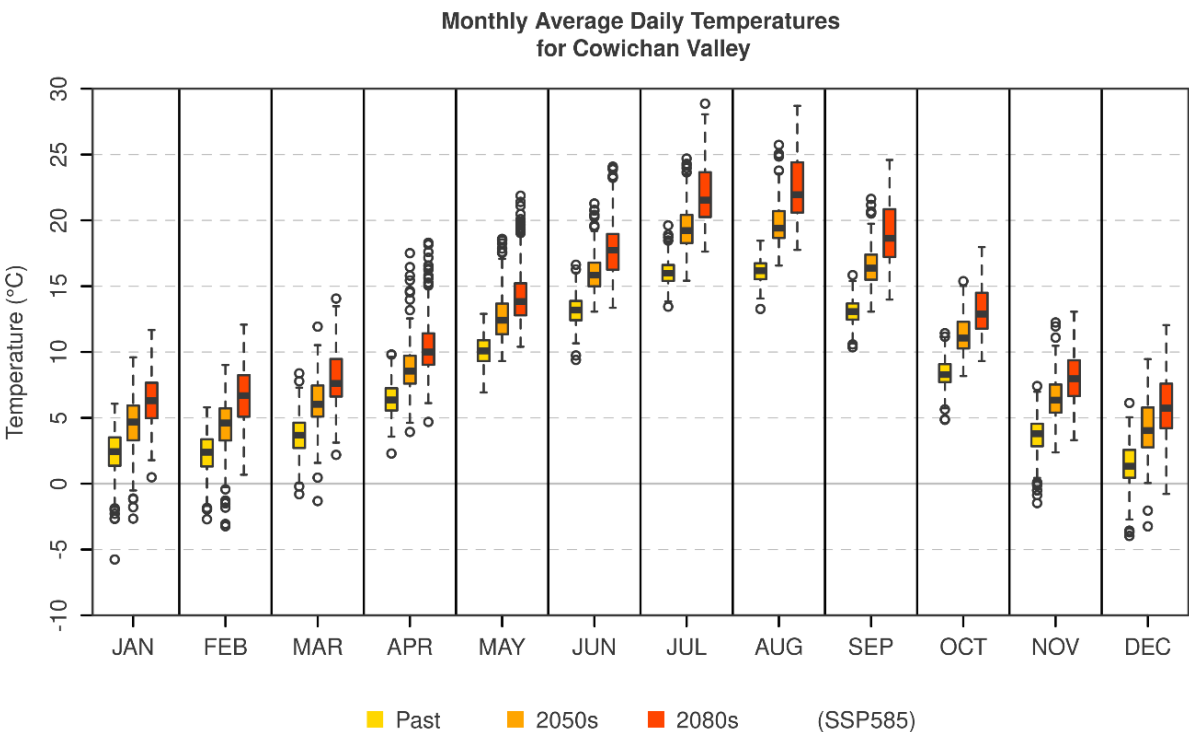


Figure 6. Annual cycle of monthly mean daily temperatures in the past, 2050s and 2080s.



Wetter winters, drier summers

ABOUT THE INDICATOR

Total Precipitation (PR) is the sum of rainfall and snowfall received over a given period.

PROJECTIONS

The figure below displays total precipitation for each season across the CVRD. Precipitation in the Cowichan has a strong seasonality, characterized by wet winters and dry summers. In the future, this behaviour is expected to strengthen, with winter, spring and fall projected to become wetter, and summer becoming drier.

Across the CVRD, annual total precipitation is projected to increase by about 4% by the 2050s and 11% by the 2080s. Seasonal changes are expected to be more pronounced. By the 2050s, spring precipitation is projected to increase by about 6% and fall precipitation by about 10%. Changes in winter precipitation are relatively small by the 2050s, but by the end of the century winter precipitation is projected to increase by about 10% compared to historical conditions. As described further in Chapter 6, these totals mask a much larger increase in winter rainfall at the expense of decreasing snowfall over the region. In summer, precipitation is expected to decline by nearly 15% by the 2050s. Combined with rising summer temperatures, which increase potential evaporation, these reductions are expected to enhance the likelihood of drought across the CVRD.

The map of historical fall precipitation (Figure 8, upper) shows a familiar pattern of high precipitation in the west and considerably lower precipitation in the east. This pattern is reinforced in the change map shown for the 2050s (Figure 8, lower), with the western areas receiving the largest increases in precipitation in absolute terms. The map of projected summer rainfall change (Figure 9) follows a similar pattern, with the largest decreases (in absolute and relative terms) occurring in the western part of the CVRD.

See *Chapter 6: Precipitation* for projections of rain and snow separately, including changes in precipitation extremes and differences among subregions.

Wetter winters, drier summers (continued)

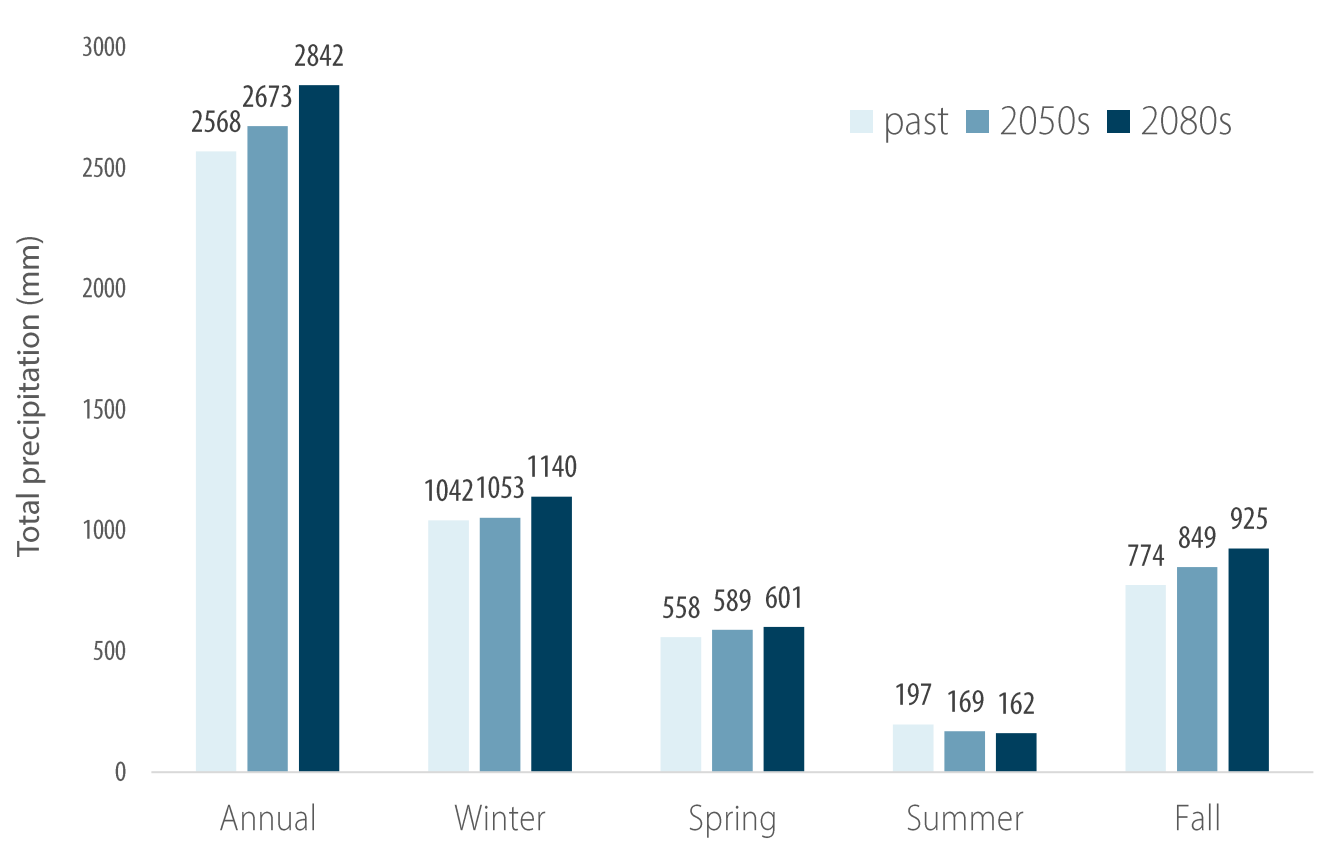


Figure 7. Total precipitation (mm) by season for the past, 2050s, and 2080s.

Precipitation in the Cowichan has a strong seasonality, characterized by wet winters and dry summers. In the future, this behaviour is expected to strengthen, with winter, spring and fall projected to become wetter, and summer becoming drier.

Wetter winters, drier summers (continued)

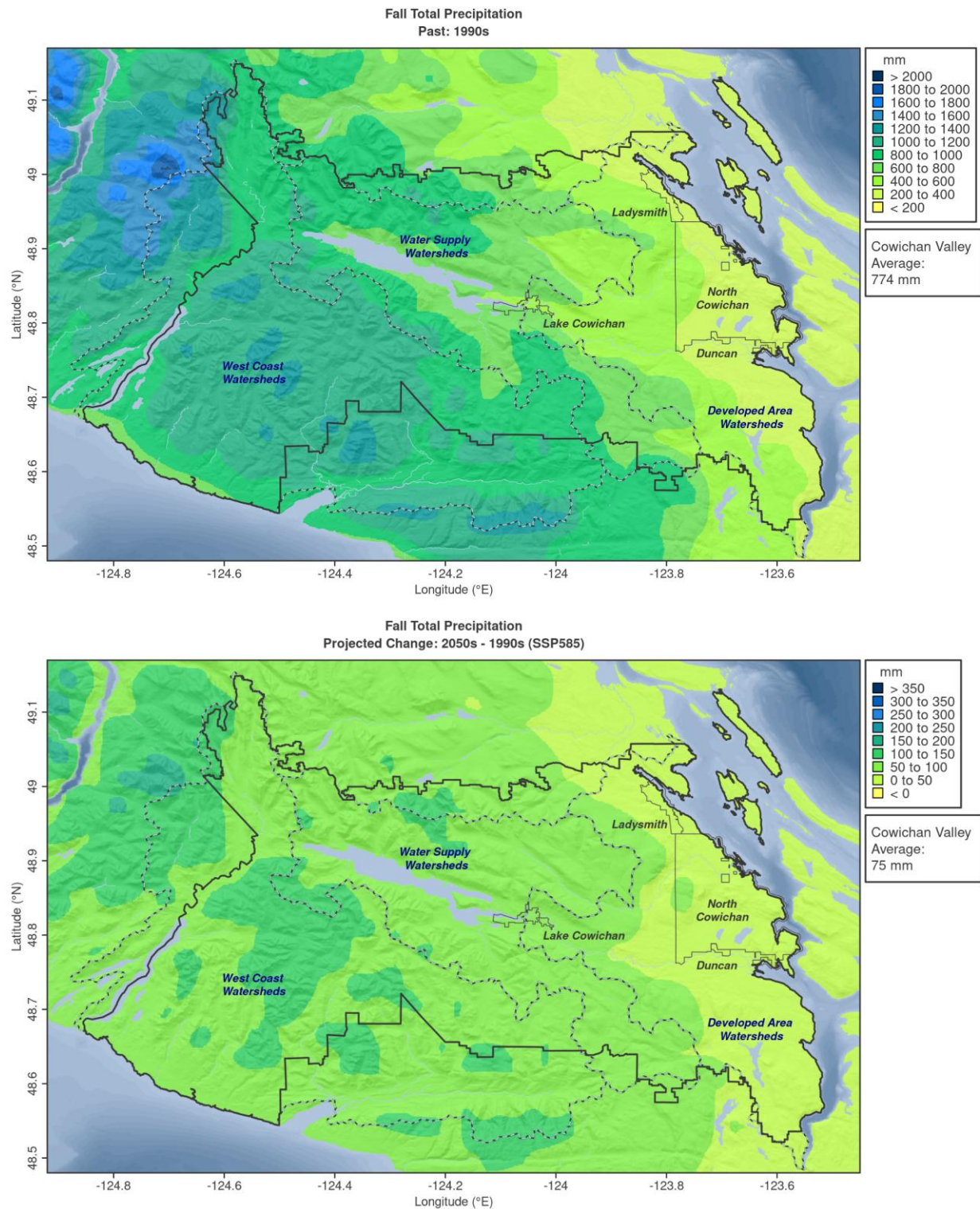


Figure 8. *Upper:* Total fall precipitation (mm) in the past. *Lower:* Projected change in fall precipitation (mm) in the 2050s. Note that while the upper map shows total precipitation in the past, the lower map shows the *change* in fall precipitation between the 1990s and 2050s.

Wetter winters, drier summers (continued)

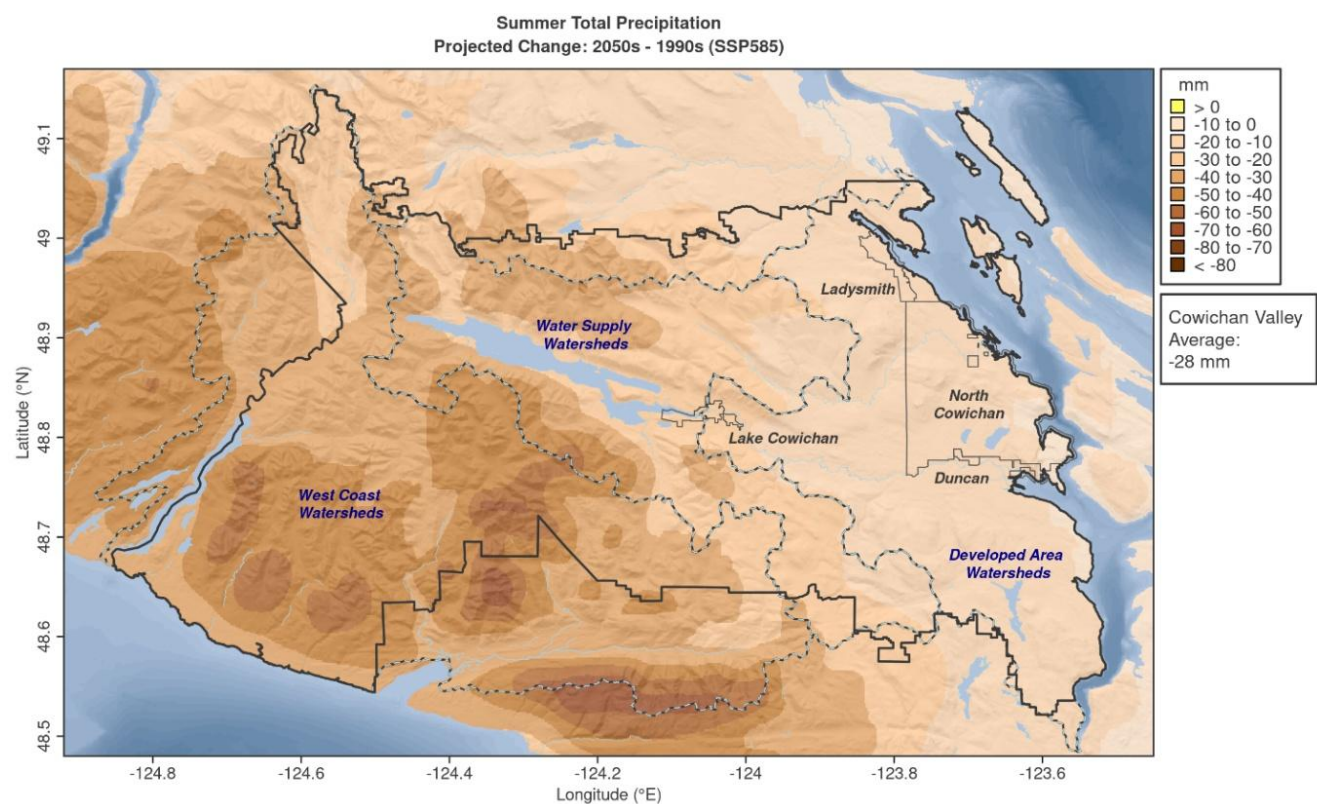


Figure 9. Projected change in summer precipitation (mm) from the past to the 2050s.

In summer, precipitation is expected to decline by nearly 15% by the 2050s. Combined with rising summer temperatures, which increase potential evaporation, these reductions are expected to enhance the likelihood of drought across the CVRD.

Seasonal precipitation change and variability

ABOUT THE INDICATOR

The figure below compares total precipitation in the past with future projections for each month of the year. Each box-and-whisker plot shows the range of precipitation across all nine climate models and all 30 Januarys, Februarys, etc., within each time period. These plots reflect both year-to-year variability and differences among climate models for the past and future periods. Refer to *Chapter 2: Methods and Presentation* for guidance on interpreting box-and-whisker plots.

PROJECTIONS

Precipitation in the CVRD is highly seasonal, with the largest amounts occurring in the fall, winter and spring. The figure below shows that both average precipitation and precipitation extremes are expected to increase in the wetter months of the year and decrease in July and August.

Precipitation patterns naturally vary considerably from year to year, making the long-term climate change signal more difficult to distinguish than for temperature. In the future, variability across models and years increases for most months of the year, indicating greater uncertainty and more variable precipitation conditions, especially in fall and winter.

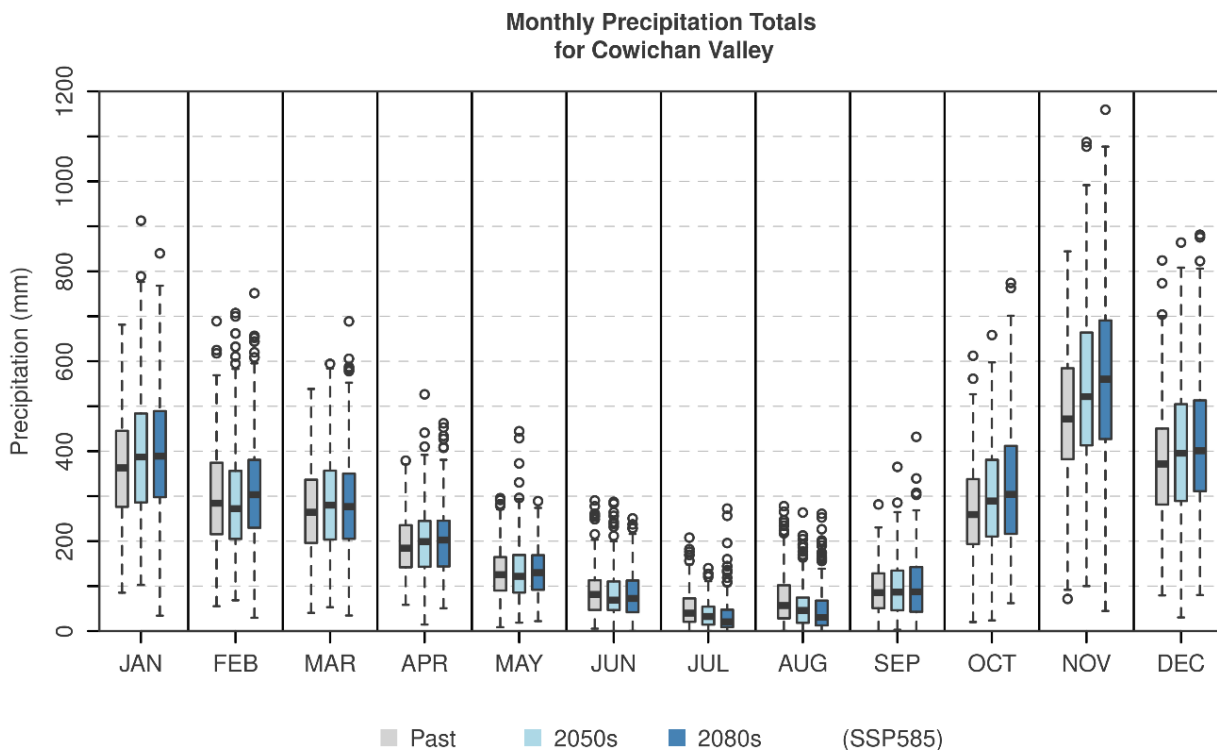


Figure 10. Annual cycle of total monthly precipitation (mm) in the past, 2050s and 2080s periods.



4. Winter temperatures

This section examines projected changes in winter temperatures across the region. Overall, both average and extreme temperatures are expected to increase. As a result, the CVRD can expect fewer days with frost and ice, and a lower demand for heating, as demonstrated below.

Warmest Winter Day, Coldest Winter Night

ABOUT THE INDICATORS

The *Warmest Winter Day* is the highest daily maximum temperature recorded during the winter months, in an average year. Together with the *Coldest Winter Night* – the lowest daily minimum temperature in a year – these indicators describe the projected “new normal” winter conditions for the region under a high emissions scenario.

PROJECTIONS

Both the warmest winter daytime temperature and the coldest winter nighttime temperature are projected to increase in the future. The maps below illustrate this warming by the 2050s and show that winter temperatures remain coldest at higher elevations and in areas farther from the ocean.

TABLE 3: WARMEST WINTER DAY AND COLDEST WINTER NIGHT

	Past (°C)	2050s (°C)	2080s (°C)	2050s Change (°C)		2080s Change (°C)	
				Average	(Range)	Average	(Range)
Warmest winter day	11	13	15	2.3	(1.7 to 4.2)	4.1	(3.2 to 6.9)
Coldest winter night	−11	−7.5	−4.5	3.4	(2.9 to 5.3)	6.4	(5.4 to 10.4)

Warmest Winter Day, Coldest Winter Night (continued)

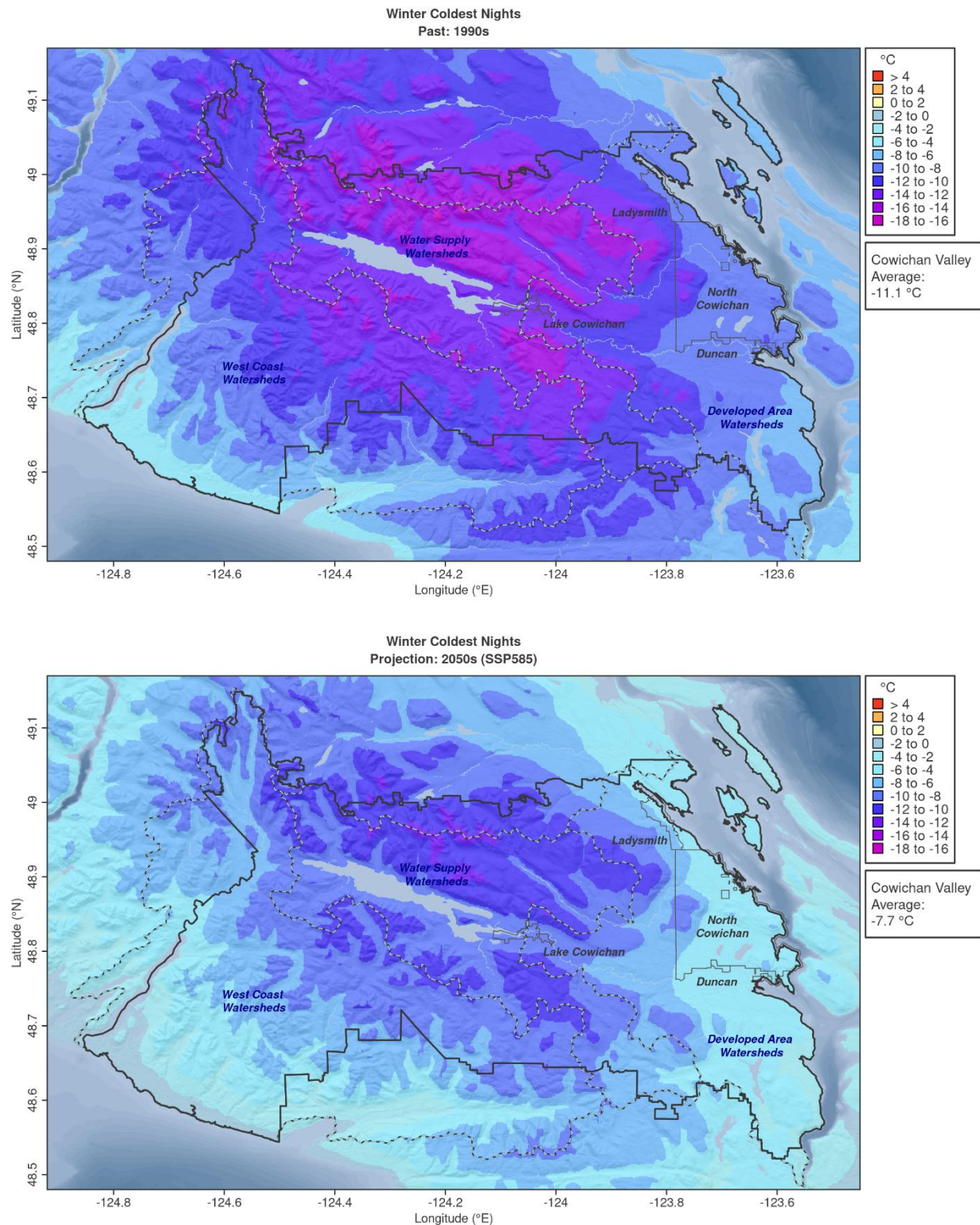


Figure 11. *Upper:* Coldest winter night in the past. *Lower:* Projected coldest winter night in the 2050s.

1-in-20-year Coldest Night

ABOUT THE INDICATOR

The *1-in-20-Year Coldest Nighttime Low* describes extreme cold temperatures so low that they are only expected to occur once every 20 years, on average. In other words, there is a 5% chance of experiencing this temperature in any given year.⁵

PROJECTIONS

In the past, the 1-in-20-year coldest night had a temperature of around -18.5°C . In the future, this temperature is projected to rise to about -13.5°C by the 2050s and -10°C by the 2080s.

While average and extreme winter temperatures are projected to warm, the CVRD will continue to experience occasional cold air flowing in from Interior BC through the Cascade Range. This means that multi-day cold snaps will still occur, although they are expected to become less frequent in the future. *For this reason, emergency response systems and healthcare services will still need to be prepared for periods of extreme cold.*

TABLE 4: 1-IN-20-YEAR COLDEST NIGHT

	Past (°C)	2050s (°C)	2080s (°C)	2050s Change (°C)		2080s Change (°C)	
				Average	(Range)	Average	(Range)
1-in-20-year Coldest Nighttime Low	-18.5	-13.5	-10	5	(3 to 6)	8.5	(6.5 to 12)

⁵Note that the occurrence of such an event in one year does not prevent it from occurring again in subsequent years. For this reason, the annual exceedance probability (e.g., 5%) provides a useful equivalent measure for understanding the likelihood of an event occurring in any given year.

Frost Days and Ice Days

ABOUT THE INDICATORS

Frost Days is the annual number of days when the daily minimum temperature (TN) falls below 0°C, which may result in frost at ground level. This indicator is useful for understanding how often below-freezing temperatures occur in the future, which can affect native and agricultural species.

Ice Days occur when daytime high temperatures (TX) do not exceed 0°C, meaning temperatures do not rise above freezing at any point in the day. These conditions can affect ecosystems, species and transportation systems in the region.

PROJECTIONS

In the past, the CVRD experienced an average of 75 frost days and 11 ice days per year, with higher numbers in the Water Supply Watersheds – where winter temperatures are typically colder – than in the Developed Areas and West Coast Watersheds (Figure 12).

In the future, the region can expect far fewer frost and ice days in all three sub-regions. By the 2050s, the number of frost days across the CVRD is projected to be roughly half of historical levels, and by the 2080s, it is expected to decline to about one-quarter of historical levels. Across the region, ice days may become quite rare by the mid- to late-century under a high emissions scenario.

TABLE 5: FROST DAYS AND ICE DAYS

	Past (days)	2050s (days)	2080s (days)	2050s Change (days)		2080s Change (days)	
				Average	(Range)	Average	(Range)
Frost Days (TN < 0°C)	75	34	15	–41	(–64 to –33)	–59	(–74 to –56)
Ice Days (TX < 0°C)	11	4	2	–7	(–8 to –5)	–9	(–10 to –8)

Frost Days and Ice Days (continued)

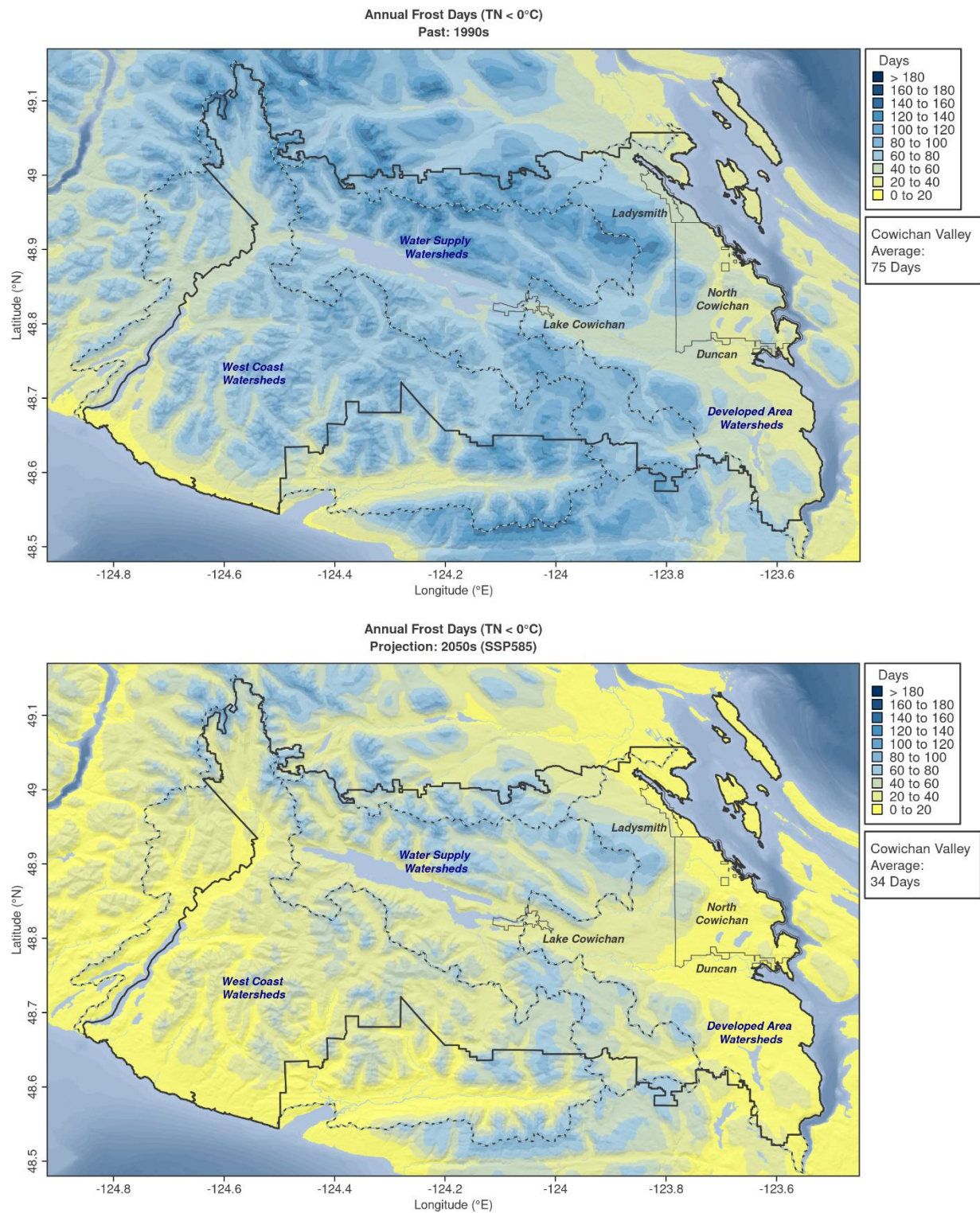


Figure 12. *Upper:* Number of annual frost days in the past. *Lower:* Projected number of annual frost days in the 2050s.

Heating Degree Days

ABOUT THE INDICATOR

Heating Degree Days (HDD) are calculated by summing the number of degrees that the daily mean temperature falls below 18°C for every day in a year.⁶ This measure can be helpful for estimating heating demand for buildings during the cooler months.

PROJECTIONS

HDD are projected to decline in the future. Because HDD is a cumulative measure of temperature over time, it is one of the clearest indicators of a warming climate, both in recent historical observations and in model projections. Across the CVRD, heating demand is projected to decrease by around 20% by the 2050s and 30% by the 2080s. These trends are generally consistent across sub-regions, with a slightly greater decline in HDD in the Developed Area by the end of the century under a high emissions scenario.

Despite this overall reduction in HDD, the region will continue to experience periodic cold winter conditions. Easterly “polar outflows” from Northwestern Canada through the Cascade Range can still bring sub-zero temperatures to the region. As a result, building heating systems will need to remain responsive to occasional extreme cold temperatures in the future.

TABLE 6: HEATING DEGREE DAYS⁷

	Past (deg- days)	2050s (deg- days)	2080s (deg- days)	2050s Change (%)		2080s Change (%)	
				Average	(Range)	Average	(Range)
Region	3644	2884	2462	-21	(-37 to -18)	-32	(-53 to -30)
West Coast	3680	2904	2461	-21	(-37 to -18)	-33	(-53 to -30)
Water Supply	3884	3115	2682	-20	(-35 to -17)	-31	(-51 to -28)
Developed Area	3288	2561	2181	-22	(-39 to -19)	-37	(-55 to -31)

⁶ For example, if the daily average temperature on January 1 is 10°C, followed by one day at 4°C, two days at -1°C and three days at 0°C, then HDD for that week are calculated as: $(18-10) + (18-4) + 2 \times (18-(-1)) + 3 \times (18-0) = 114$. This results in a total of 1144 degree-days. Days with an average temperature equal to or greater than 18°C are not included in the calculation.

⁷ Note that the past HDD values presented here differ from those in the National Building Code of Canada (NBCC). This is because the values in this assessment are averaged over a larger geographic area. For building design at specific locations within the CVRD, consult the relevant Table C-2 values in the NBCC.



5. Summer temperatures

This section presents summer temperature indicators for the CVRD, including information about growing season length, heatwaves, cooling demand, and the frequency and magnitude of a 1-in-20-year extreme heat event. Overall, summers are projected to become hotter with more frequent and intense heat waves. As temperatures rise, the CVRD can expect a longer growing season and a higher demand for cooling across the region.

Growing Season Length and Growing Degree Days

ABOUT THE INDICATORS

Growing Season Length (GSL) measures the number of days in a year when temperatures are warm enough for most vegetation to grow. GSL is defined as the number of days between the first span of at least six consecutive days with daily average temperatures above 5°C, and the first span, after July 1, of at least six consecutive days with temperatures below 5°C. This measure helps illustrate how climate change may affect forests, agricultural and landscaped areas, grasses, weeds and pollen production.

Growing Degree Days (GDD) are calculated by summing the number of degrees that the daily mean temperature is above 5°C for every day in a year. Here, 5°C is considered a threshold temperature at which most vegetation will grow. Higher GDD values indicate warmer conditions that can accelerate plant growth and maturity.

Whereas GSL measures how long the growing season lasts, GDD measure how much heat accumulates during the growing season. For example, two regions could have the same growing season length of 250 days, but one region may accumulate more growing degree days if temperatures there are consistently warmer during the growing season.

PROJECTIONS

As the climate warms, the growing season in the CVRD is projected to lengthen and the number of GDD is expected to rise. Historically, eastern parts of the region within the Developed Area Watershed have experienced the longest growing seasons and the highest number of GDD. While this pattern is expected

Growing Season Length and Growing Degree Days (continued)

to continue in the future, this area also exhibits a smaller relative increase in both indices compared to the Water Supply Watershed, which historically has the shortest growing season. The maps in Figure 13 show where the greatest changes in GSL and GDD are expected to occur, including along Cowichan and Chemainus Rivers and around the shorelines of Cowichan Lake.

Together, these changes suggest that warmer conditions will support longer and warmer periods of active plant growth and productivity across the region. However, because GSL and GDD are based solely on a lower temperature threshold, they do not account for other important constraints on growth and productivity, such as water availability, extreme heat, pests, wildfire, or changes in precipitation. As a result, both indicators should be considered upper limits for estimates of future productivity.

A related measure to GSL is the length of the frost-free season, which is expected to increase substantially by the middle and end of the century. See Chapter 4 for more information about frost projections.

TABLE 7: GROWING SEASON LENGTH

	Past (days)	2050s (days)	2080s (days)	2050s change (days)		2080s change (days)	
				Average	(Range)	Average	(Range)
Region	245	297	325	53	(43 to 83)	81	(71 to 110)
West Coast	246	300	328	55	(44 to 85)	82	(74 to 109)
Water Supply	223	277	312	54	(45 to 91)	90	(76 to 131)
Developed Area	270	316	338	46	(37 to 72)	68	(60 to 85)

TABLE 8: GROWING DEGREE DAYS

	Past (deg-days)	2050s (deg-days)	2080s (deg-days)	2050s change (deg-days)		2080s change (deg-days)	
				Average	(Range)	Average	(Range)
Region	1586	2244	2679	658	(531 to 1237)	1092	(962 to 2076)
West Coast	1500	2152	2596	652	(528 to 1222)	1096	(959 to 2053)
Water Supply	1471	2092	2503	621	(499 to 1164)	1032	(900 to 1983)
Developed Area	1846	2561	3014	716	(579 to 1345)	1168	(1040 to 2218)

Growing Season Length and Growing Degree Days (continued)

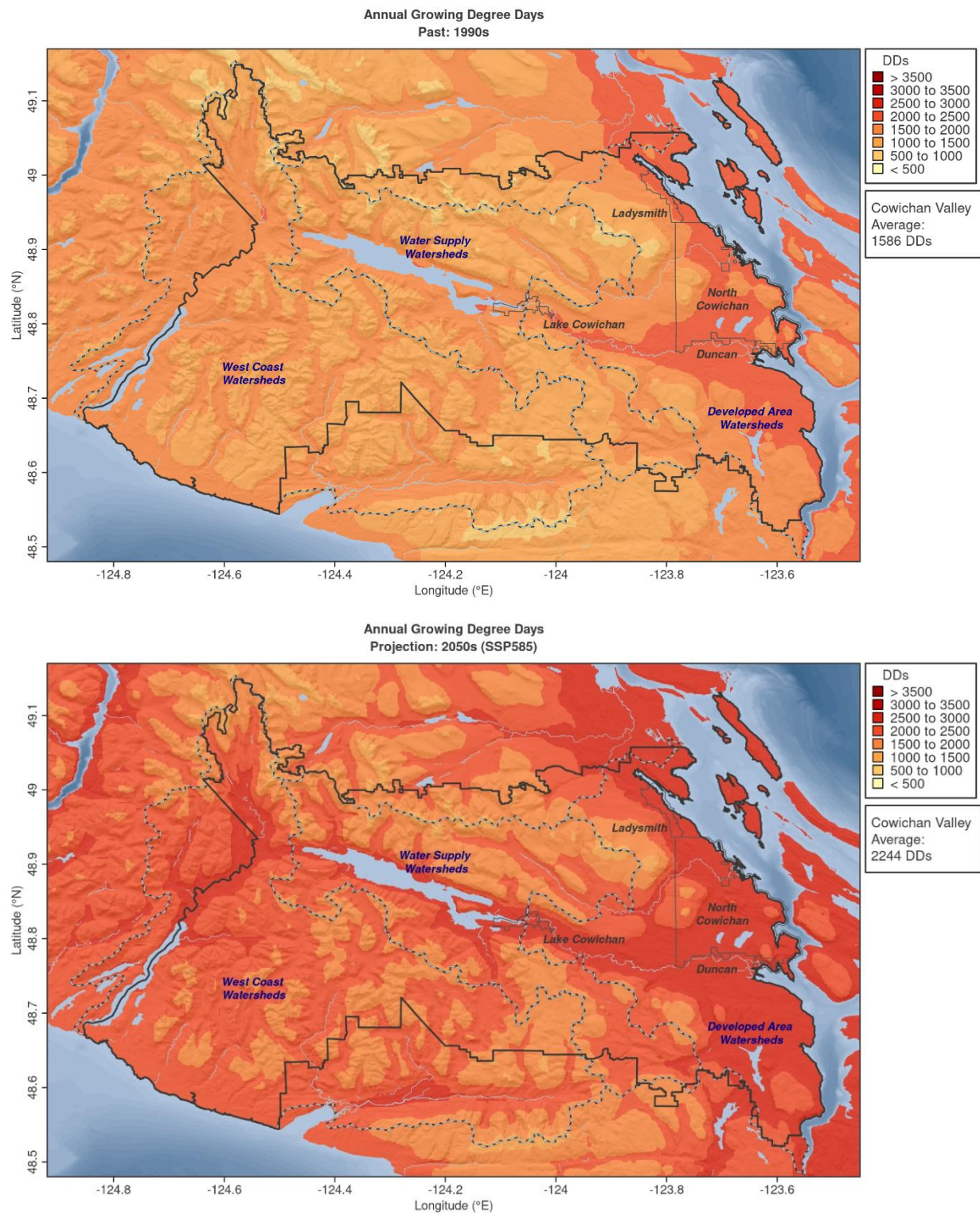


Figure 13. *Upper:* Annual number of growing degree days in the past. *Lower:* Projected number of growing degree days in the 2050s.

Cooling Degree Days

ABOUT THE INDICATOR

Cooling Degree Days (CDD) are calculated by summing the number of degrees that the daily mean temperature exceeds 18°C for every day in a year.⁸ This measure can be helpful for estimating the demand for mechanical cooling (i.e., air conditioning) in buildings in the warmer months.

PROJECTIONS

In the past, the CVRD typically experienced around 39 CDDs per year, with most occurring during the summer months. As the climate warms, CDDs are expected to increase substantially. By the 2050s, CDDs are projected to increase nearly four-fold and by the 2080s they are projected to increase almost seven-fold compared to the recent past. While the greatest demand for cooling will continue to occur in summer, it will increasingly occur during late spring and early fall.

Along with a projected decline in heating degree days, an increase in CDDs is one of the clearest indicators of a warming climate, both in recent historical observations and modelled projections. Because CDDs are closely linked to cooling demand, communities across the region may need to adopt new approaches to maintain comfortable and safe indoor temperatures, such as designing and retrofitting buildings to improve thermal performance and expanding urban tree canopy cover to reduce heat exposure.

TABLE 9: COOLING DEGREE DAYS

	Past (deg- days)	2050s (deg- days)	2080s (deg- days)	2050s Change (deg-days)		2080s Change (deg-days)	
				Average	(Range)	Average	(Range)
Region	39	144	260	105	(64 to 236)	235	(180 to 584)
West Coast	24	96	198	73	(40 to 183)	175	(137 to 512)
Water Supply	39	131	240	92	(55 to 216)	200	(162 to 548)
Developed Area	60	223	368	163	(105 to 332)	308	(257 to 724)

⁸ For example, if the daily mean temperature on July 1 is 20°C, followed by three days of 21°C, one day of 25°C and two days of 16°C, then the cooling degree days for that week are calculated as: $(20-18) + 3 \times (21-18) + (25-18) = 18$ degree-days. Note that days with temperature equal to or less than 18°C are not counted.

Cooling Degree Days (continued)

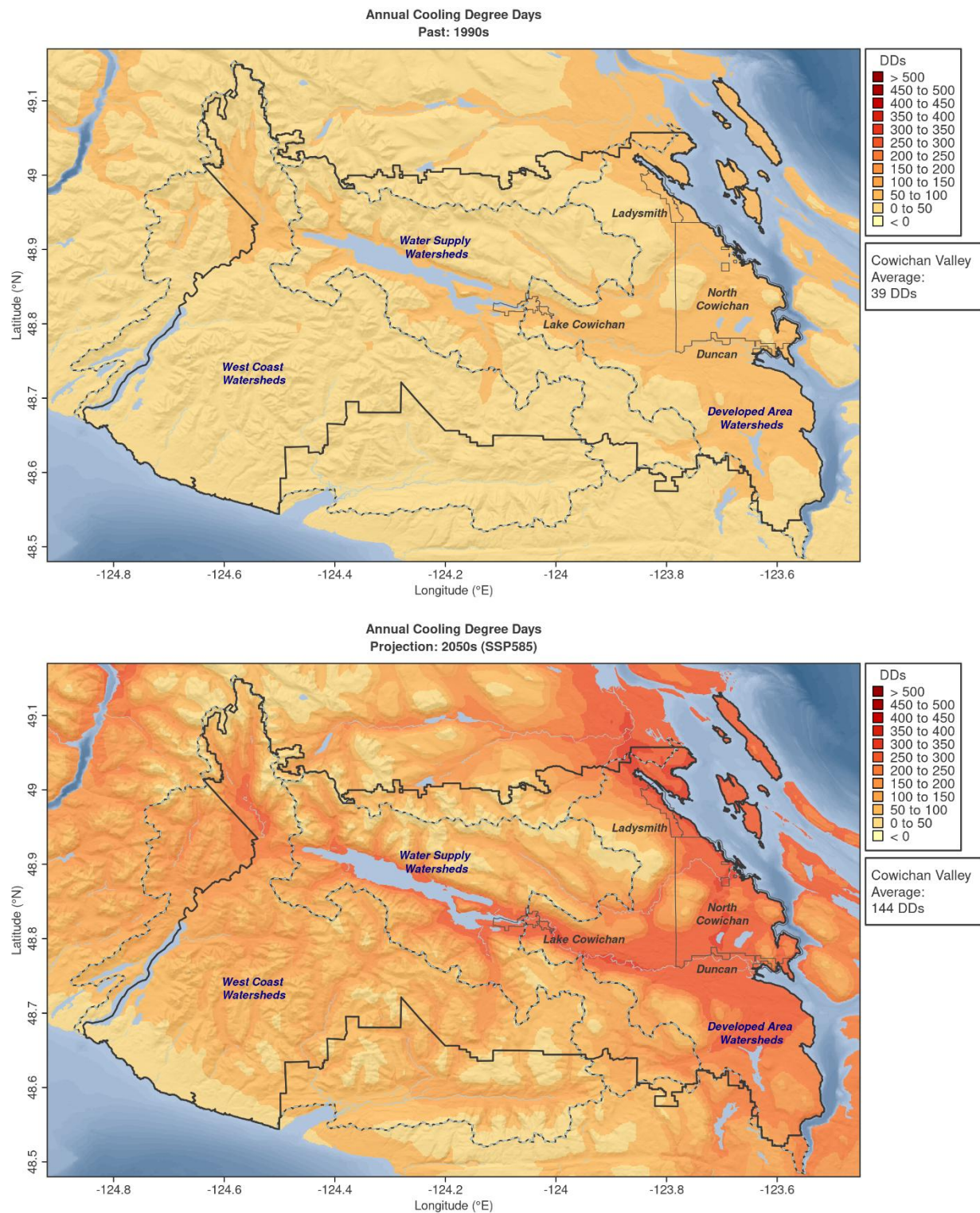


Figure 14. *Upper:* Annual number of cooling degree days in the past. *Lower:* Projected number of cooling degree days in the 2050s.

Summer Days and Temperate Nights

ABOUT THE INDICATORS

Summer Days are days with a daytime high temperature (TX) greater than 25°C. *Temperate Nights* are nights when the nighttime low temperature (TN) stays above 16°C. Tables 10 and 11 present projections for the entire region as well as the Developed Area sub-region, which experiences higher temperatures overall and is where most of the population is situated.

PROJECTIONS

Across the CVRD, the number of summer days is projected to more than double by the 2050s and more than triple by the 2080s. At the same time, the number of nights each year with temperatures above 16°C is projected to increase from only one night historically to seven nights by the 2050s, and to around 30 nights by the 2080s under a high emissions scenario. As shown in Tables 10 and 11 and in the maps in Figures 15 and 16, summer days and temperate nights will continue to occur more frequently in the Developed Area than in other parts of the CVRD in the future.

TABLE 10: SUMMER DAYS (DAYS WITH TX > 25°C)

	Past (days)	2050s (days)	2080s (days)	2050s Change (days)		2080s Change (days)	
				Average	(Range)	Average	(Range)
Region	18	43	60	25	(17 to 48)	42	(38 to 85)
Developed Area	25	59	79	34	(24 to 61)	308	(48 to 94)

TABLE 11: TEMPERATE NIGHTS (NIGHTS WITH TN > 16°C)

	Past (days)	2050s (days)	2080s (days)	2050s Change (days)		2080s Change (days)	
				Average	(Range)	Average	(Range)
Region	1	7	32	6	(4 to 25)	31	(19 to 80)
Developed Area	2	16	48	14	(8 to 42)	46	(33 to 95)

Summer Days and Temperate Nights (continued)

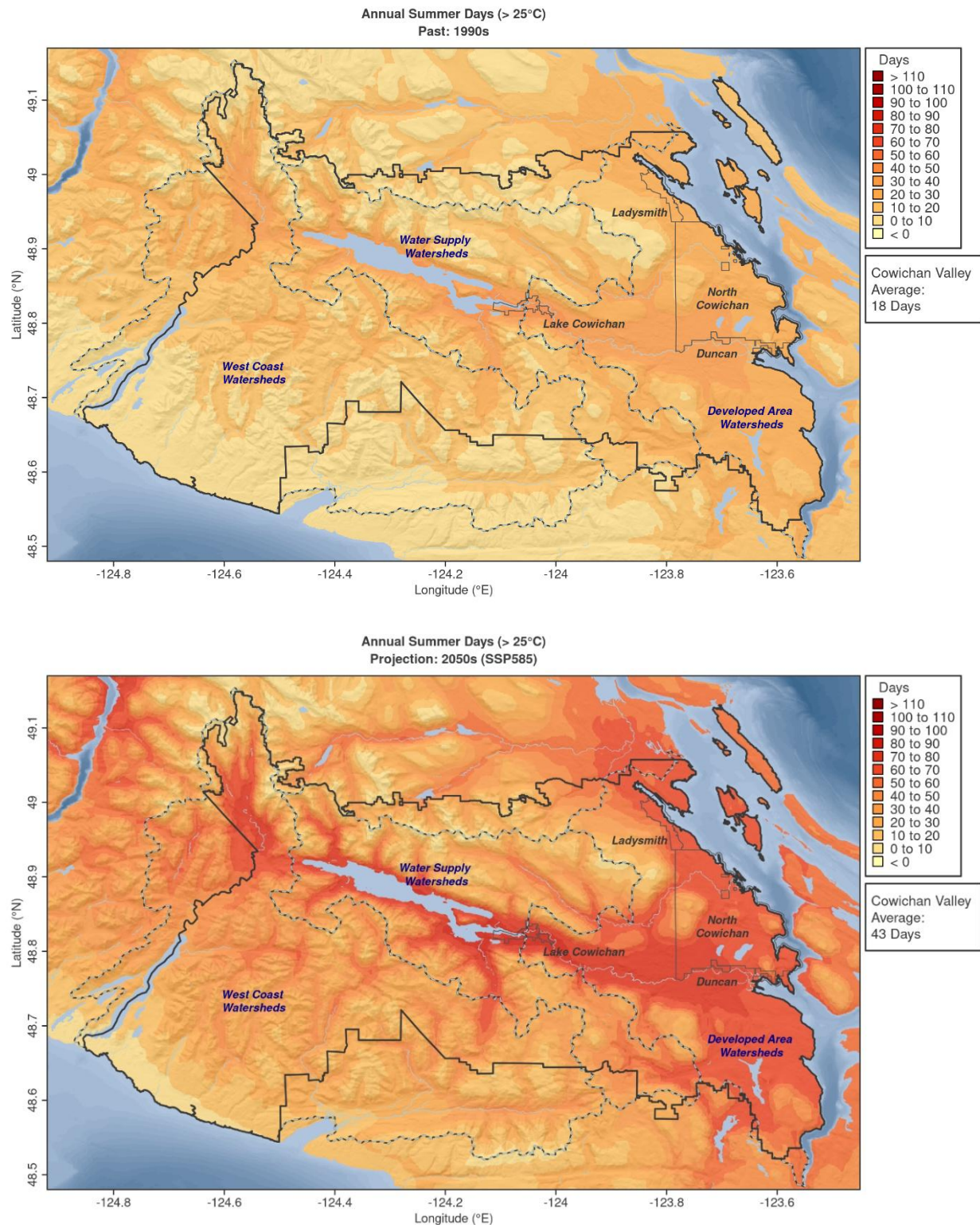


Figure 15. *Upper:* Annual count of summer days in the past. *Lower:* Projected number of annual summer days by the 2050s.

Summer Days and Temperate Nights (continued)

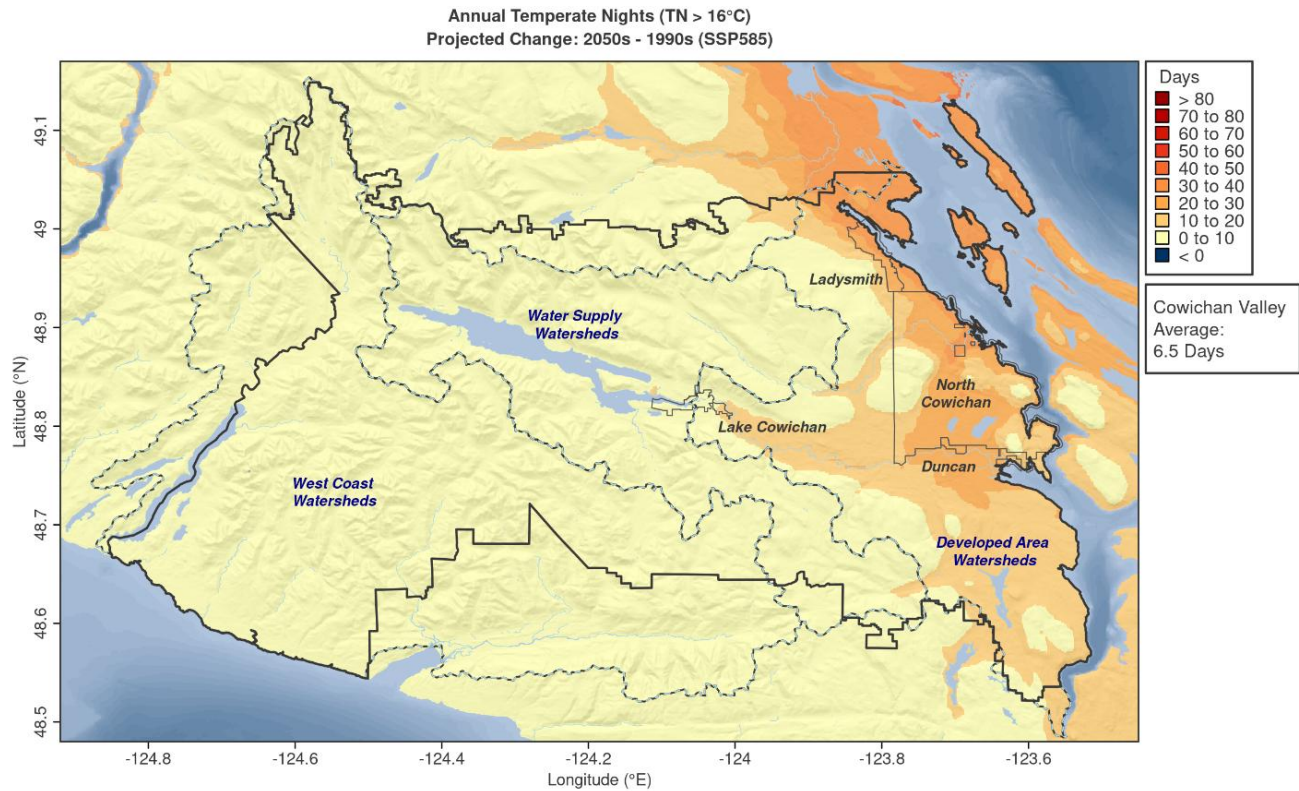


Figure 16. Projected change in the number of temperate nights from the past to the 2050s.

The number of nights each year with temperatures above 16°C is projected to increase from only one night historically to seven nights by the 2050s, and to around 30 nights by the 2080s.

Extreme heat

ABOUT THE INDICATORS

Several heatwave indicators are presented below:

- *Heatwave Days* are the number of days in a year classified as a heatwave
- *Longest Heatwave Length* is the duration (in days) of the longest heatwave in a year
- *Heatwave Number* is the number of distinct heatwaves in a year
- *Extreme Heatwave Maximum Temperature* is the daily maximum temperature (TX) during the most extreme heatwave in a year
- *Extreme Heatwave Minimum Temperature* is the nighttime minimum temperature (TN) during the most extreme heatwave in a year
- *Hottest Day* is the daily maximum temperature (TX) on the hottest day of the year, which may or may not occur during a heatwave

For this assessment, heatwaves are defined using a relative temperature threshold broadly aligned with the emergency health alert criteria for BC.⁹ Results are provided for both the entire CVRD and the Developed Area sub-region, which has the highest population and therefore the greatest exposure to heat-related health impacts.

PROJECTIONS

In the past, there was usually around one heatwave per year, typically lasting up to two days and reaching peak daily temperatures of around 32°C. In the future, heat waves are projected to become hotter, longer, and more frequent. On average, the CVRD can expect around 2 additional heatwaves per year by the 2050s, and 3 more per year by the 2080s (Figure 17). Across the region, heatwaves are expected to increase in length from about 2 days on average historically, to about 3 days by the 2050s and 7 days by the 2080s.

These changes are expected to be most pronounced in the Developed Area, where temperatures are already higher than in the rest of the region. By the 2050s, the Developed Area can expect around four heatwaves per year, increasing to about six per year by the 2080s. Heatwaves are also expected to lengthen, approaching eight consecutive days or more by the 2080s, and will feature warmer daytime and nighttime temperatures. The peak temperature on the hottest day of the year in the Developed Area is projected to increase by about 3°C by the 2050s and 6°C by the 2080s.

⁹ See [BC Provincial Heat Alert and Response System \(BC HARS\): 2023 \(May 2023\)](#). The lower threshold temperatures used in our heatwave definition, intended for use throughout BC, are a daily maximum temperature (TX) of 28°C and a daily minimum temperature (TN) of 13°C. In addition, a heatwave must: (1) last at least two full days; and (2) have TX and TN values exceeding their 95th percentile in the past.

Extreme heat (continued)

TABLE 12: HOTTEST DAY AND HEATWAVES

		Region			Developed Area		
		Past	2050s	2080s	Past	2050s	2080s
Heatwave days (days)	HWD	1	8 (5 to 23)	20 (15 to 64)	2	12 (8 to 33)	28 (21 to 80)
Longest heatwave length (days)	HWXL	2	3 (3 to 9)	7 (5 to 36)	2	4 (3 to 11)	8 (6 to 45)
Number of heatwaves in a year	HWN	1	3 (2 to 5)	4 (4 to 7)	1	4 (2 to 6)	6 (5 to 7)
TX during most extreme annual heatwave (°C)	TXHX	32	32 (32 to 33)	33 (32 to 34)	32	33 (32 to 34)	34 (33 to 35)
TN during most extreme annual heatwave (°C)	TNHX	16	17 (16 to 18)	18 (17 to 21)	16	17 (17 to 19)	19 (18 to 21)
TX on hottest day of the year (°C)	TXx	31	34 (34 to 37)	37 (36 to 40)	32	35 (35 to 38)	38 (37 to 41)

“These projected heatwave temperatures seem low”

Heatwave temperatures in this assessment may not appear as extreme as temperatures experienced on individual hot days in the past. This is because:

- The values are averaged across the whole region, which includes cooler high-elevation areas
- The results represent average annual extremes over 30-year periods, not single extreme events
- The projections reflect a range of possible futures from multiple climate models

As a result, individual years can still experience hotter temperatures than the averages shown here. The mean values represent the best estimate of future conditions, while the upper limit of the range shows the highest projected temperatures amongst all models.

For more, see *Chapter 2: Methods and Presentation*

Extreme heat (continued)

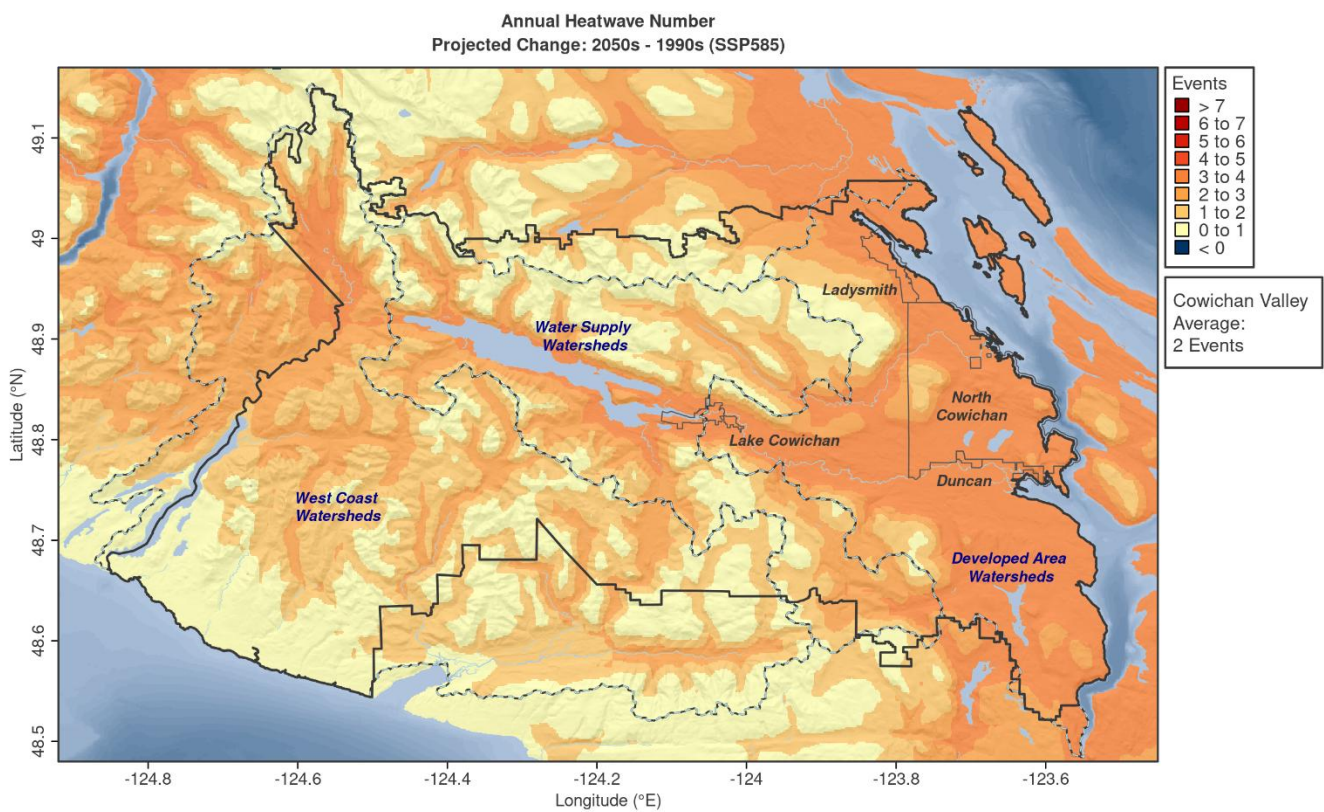


Figure 17. Projected change in the number of distinct heatwaves from the past to the 2050s.

In the future, heatwaves are projected to become longer, stronger and more frequent.



1-in-20-year Hottest Day

ABOUT THE INDICATOR

The *1-in-20-Year Hottest Day* describe an extreme daytime high temperature (TX) so warm that it is only expected to occur, on average, once every 20 years. In other words, the 1-in-20-year hottest day has a 5% chance of occurring in any given year.

PROJECTIONS

In the future, 1-in-20-year hottest day is projected to become hotter and more frequent. Figure 18 below illustrates projected changes in both the frequency and magnitude of this extreme heat event. Note that the projected changes in the frequency and magnitude of the 1-in-20-year hottest day are distinct and should be interpreted separately.

The upper panel shows projected changes in the frequency of the historical 1-in-20-year hottest day (34°C). In the past, a daily maximum temperature of 34°C occurred approximately once every 20 years across the CVRD. By the 2050s, a daily maximum temperature of 34°C is projected to occur roughly once every 2.5 years, or with a 40% annual probability. By the 2080s, the annual probability of exceeding 34°C increases to roughly 80% or occurring nearly every year.

The lower panel in Figure 18 shows projected changes in the intensity of the 1-in-20-year hottest day. In the past, the magnitude of this event was approximately 34°C. By the 2050s, the daily maximum temperature during the 1-in-20-year hottest day is projected to increase to around 37.5°C. By the 2080s, the 1-in-20-year hottest day is projected to exceed 40°C.

1-in-20-year Hottest Day (continued)

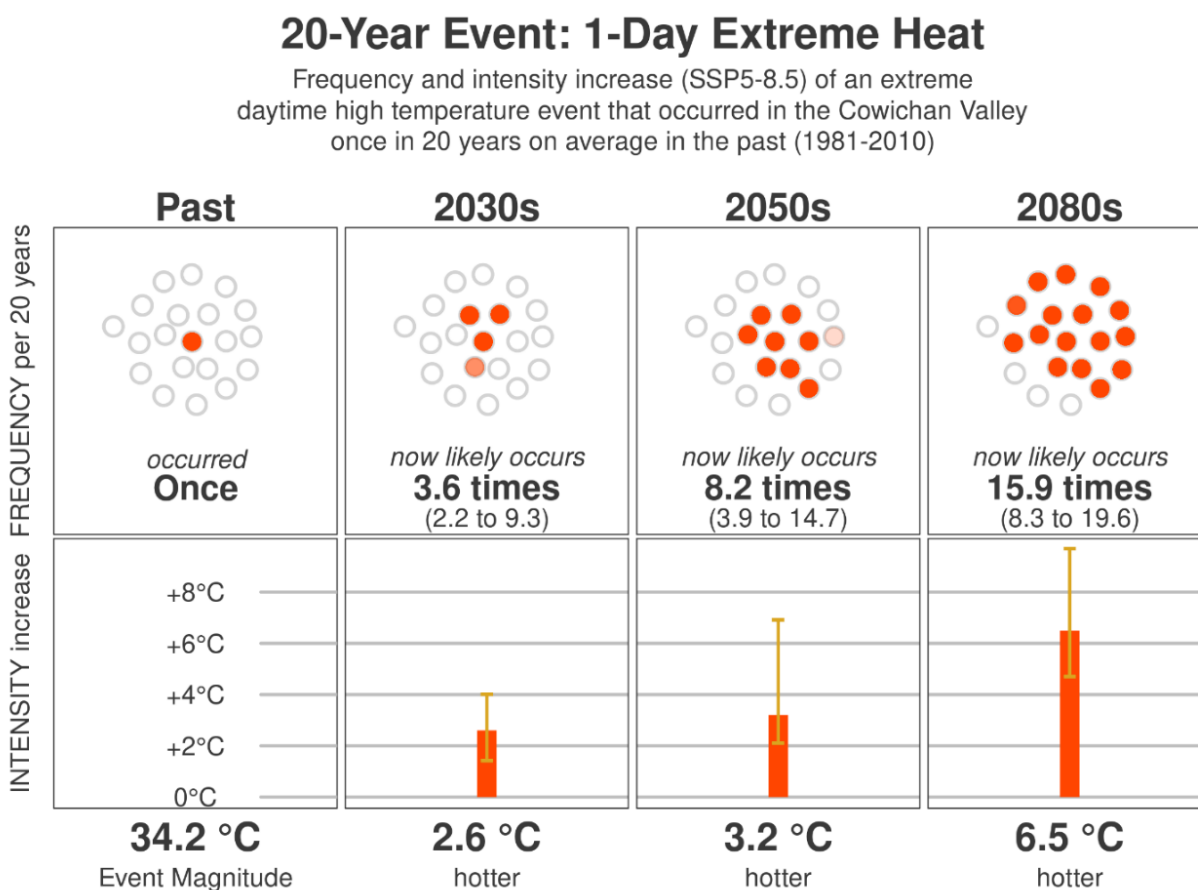


Figure 18. *Upper panel:* Frequency of the 1-in-20-year hottest day temperature in the past projected for three future periods. *Lower panel:* Magnitude (°C) of the 1-in-20-year hottest day in the past and future periods. Figure is adapted from IPCC, 2021: Summary for Policymakers.¹⁰

¹⁰ 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. 3-32, doi:10.1017/9781009157896.001.



6. Precipitation

This section examines projected changes in precipitation across the CVRD, including rainfall, snowfall, consecutive dry days, drought, and the frequency and intensity of extreme precipitation events. As temperatures warm, more precipitation is expected to fall as rain instead of snow, and wet days and extreme rainfall events are projected to become wetter in winter, spring and fall. In contrast, summers are projected to become drier, increasing the likelihood of drought conditions, particularly in the Developed Area.

Total rainfall

ABOUT THE INDICATOR

Total Rainfall is the total amount of rain (mm) that falls in a season or year. Table 12 presents annual and seasonal rainfall totals for the entire CVRD and the three sub-regions. The maps in Figures 19 and 20 show projected changes in winter and summer rainfall across the region.

PROJECTIONS

Total rainfall is projected to increase across the CVRD, following a strong seasonal pattern. Like total precipitation (Chapter 3), rainfall is expected to increase in fall, winter and spring, and decrease in summer. The largest increases are expected to occur in winter, followed by fall and spring. Annually, CVRD can expect 18% more rainfall by the 2050s and about 29% more by the 2080s. Winter rainfall is projected to increase by about 31% by the 2050s and 40% by the 2080s. As illustrated in the following section, these increases are largely driven by a shift from snowfall to rainfall as temperatures rise in winter. Summer rainfall across the CVRD is projected to decrease by about 15% by the 2050s and 18% by the 2080s.

The Water Supply Area is expected to see the largest relative increases in rainfall, with annual totals increasing by approximately 40% by the 2050s and 60% by the 2080s. As shown in Figure 17, the greatest increases in rainfall occur at higher elevations. In contrast, projected decreases in summer rainfall are relatively uniform across the region, with the largest absolute declines occurring at higher elevations.

Total rainfall (continued)

TABLE 13: TOTAL RAINFALL

	Region			West Coast		
	Past (mm)	2050s Change (%)	2080s Change (%)	Past (mm)	2050s Change (%)	2080s Change (%)
Winter	806	31 (18 to 47)	40 (29 to 66)	1073	26 (14 to 42)	35 (23 to 58)
Spring	492	15 (8 to 23)	18 (5 to 30)	679	14 (6 to 22)	16 (2 to 27)
Summer	197	-14 (-31 to -1)	-18 (-44 to -6)	264	-15 (-33 to -2)	-19 (-46 to -6)
Fall	727	16 (11 to 25)	28 (13 to 36)	1007	14 (9 to 24)	26 (10 to 35)
Annual	2220	18 (12 to 29)	29 (16 to 33)	3017	16 (10 to 27)	26 (12 to 29)
	Water Supply			Developed Area		
	Past (mm)	2050s Change (%)	2080s Change (%)	Past (mm)	2050s Change (%)	2080s Change (%)
Winter	772	39 (25 to 59)	58 (42 to 83)	539	24 (11 to 38)	31 (19 to 54)
Spring	473	17 (11 to 27)	24 (10 to 34)	297	10 (6 to 19)	16 (3 to 24)
Summer	196	-14 (-30 to -1)	-18 (-43 to -6)	107	-13 (-27 to -1)	-16 (-41 to -3)
Fall	705	19 (13 to 28)	30 (17 to 40)	423	15 (9 to 21)	24 (15 to 33)
Annual	2146	22 (15 to 35)	35 (22 to 41)	1366	15 (9 to 25)	24 (13 to 28)

Total rainfall (continued)

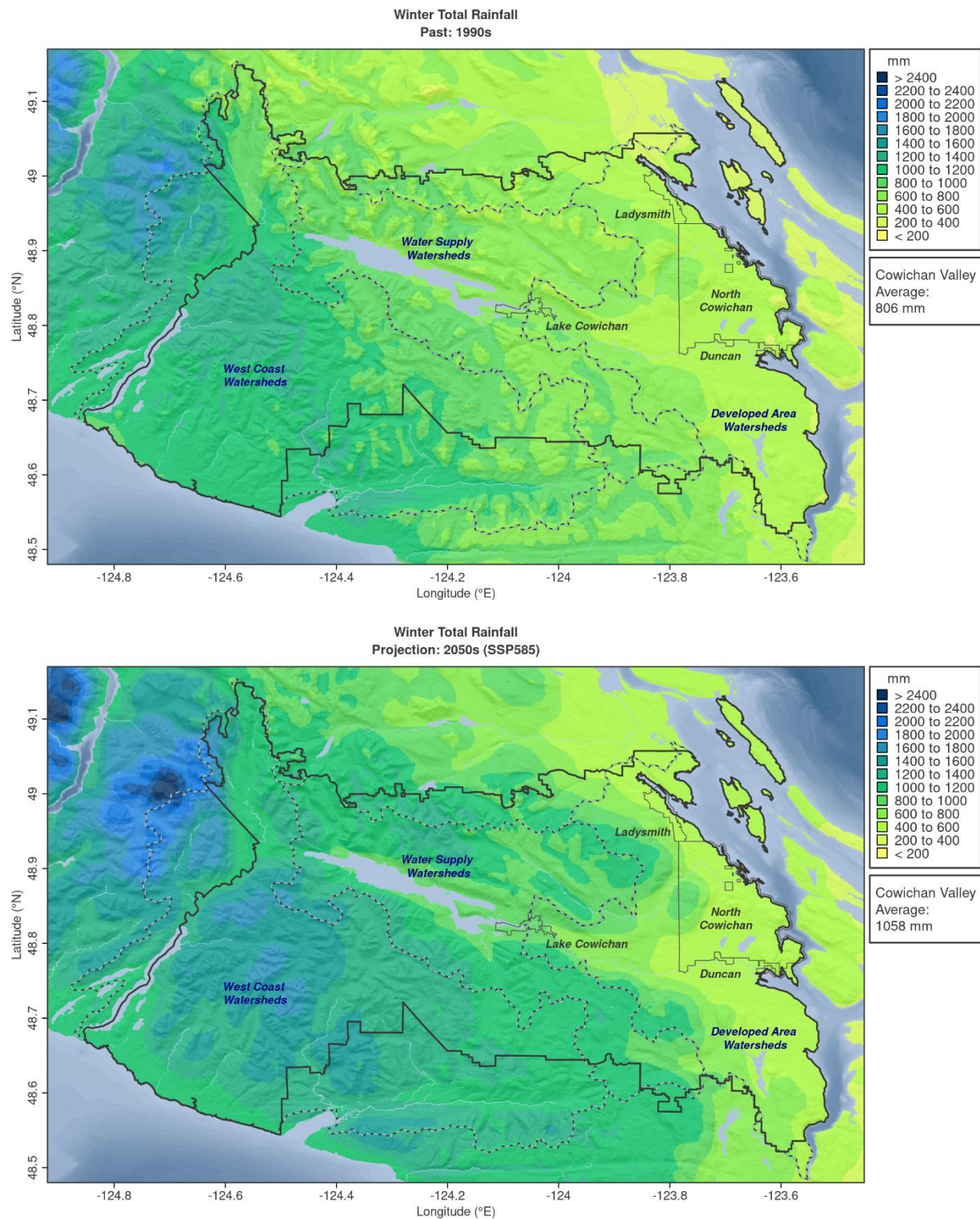


Figure 19. Upper: Winter rainfall (in mm) in the past. Lower: Projected winter rainfall (in mm) in the 2050s.

Total rainfall (continued)

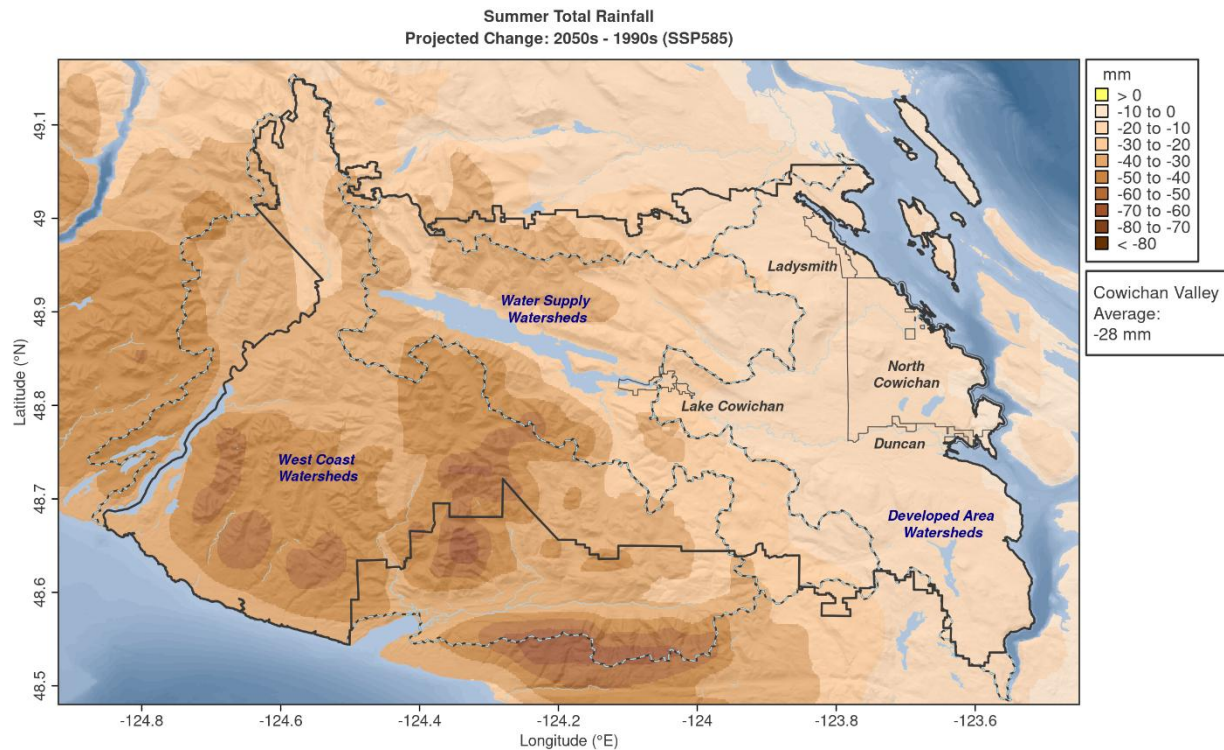


Figure 20. Projected change in summer rainfall (mm) from the past to the 2050s. Note that this map shows the decrease in summer rainfall between the 1990s and 2050s, rather than the values in either period, as in the previous figure.

Summer rainfall across the CVRD is projected to decrease by about 15% by the 2050s and 18% by the 2080s, with the largest declines occurring at higher elevations.



Total snowfall

ABOUT THE INDICATOR

Total Snowfall is the total amount of snowfall (mm) in a season or year. It is calculated using information on both precipitation and temperature.¹¹ Table 13 displays past and future total annual snowfall (snow water equivalent, or SWE) in the CVRD and the three sub-regions. The maps in Figure 21 illustrate how warming temperatures will influence snowfall in different areas across the CVRD.

PROJECTIONS

In the past, average snowfall across the CVRD was about 350 mm per year, with the west coast receiving significantly more snowfall than eastern parts of the region. In the future, average annual snowfall is projected to decrease across the entire region by about 60% by the 2050s and 80% by the 2080s.

The most substantial relative decreases in snowfall are expected in the West Coast Area, where snowfall was historically highest. By the 2050s, the West Coast is projected to see roughly 65% less snowfall per year, and roughly 85% less by the 2080s. Across the region, snowfall is expected to occur primarily at higher elevations in the last half of this century.

¹¹ The snowfall projections included in this report are based on a widely validated empirical relationship between total daily precipitation and temperature. Snowfall projections should be interpreted with caution because the amount of precipitation that falls as snow is highly sensitive to local temperature, making the results subject to uncertainty in both temperature and precipitation. Over time, however, this uncertainty is expected to decrease as winter temperatures rise above 0°C more frequently across the CVRD.

Total snowfall (continued)

TABLE 14: TOTAL SNOWFALL (SWE)

	Past (mm)	2050s (mm)	2080s (mm)	2050s Change (%)		2080s Change (%)	
				Average	(Range)	Average	(Range)
Region	349	136	65	-61	(-85 to -48)	-81	(-97 to -75)
Developed Area	172	72	30	-58	(-85 to -48)	-82	(-97 to -75)
Water Supply	478	198	101	-59	(-83 to -45)	-79	(-97 to -71)
West Coast	364	133	56	-64	(-88 to -50)	-85	(-98 to -79)

Extreme snowfall events

While there is high confidence that overall snowfall will decline significantly across the region, CMIP6 models have limited ability to simulate the local atmospheric conditions that produce rare but sometimes heavy snowfall events in southwest BC.

While average and extreme winter temperatures are projected to increase, the CVRD will continue to experience occasional multi-day cold spells driven by cold air outbreaks from the BC Interior through the Cascade Range. As a result, the potential for extreme snowfall events will remain in the future.

Emergency management systems and community services will therefore need to maintain readiness for occasional significant snowfall events, despite the overall decrease in snowfall across the region.



Total snowfall (continued)

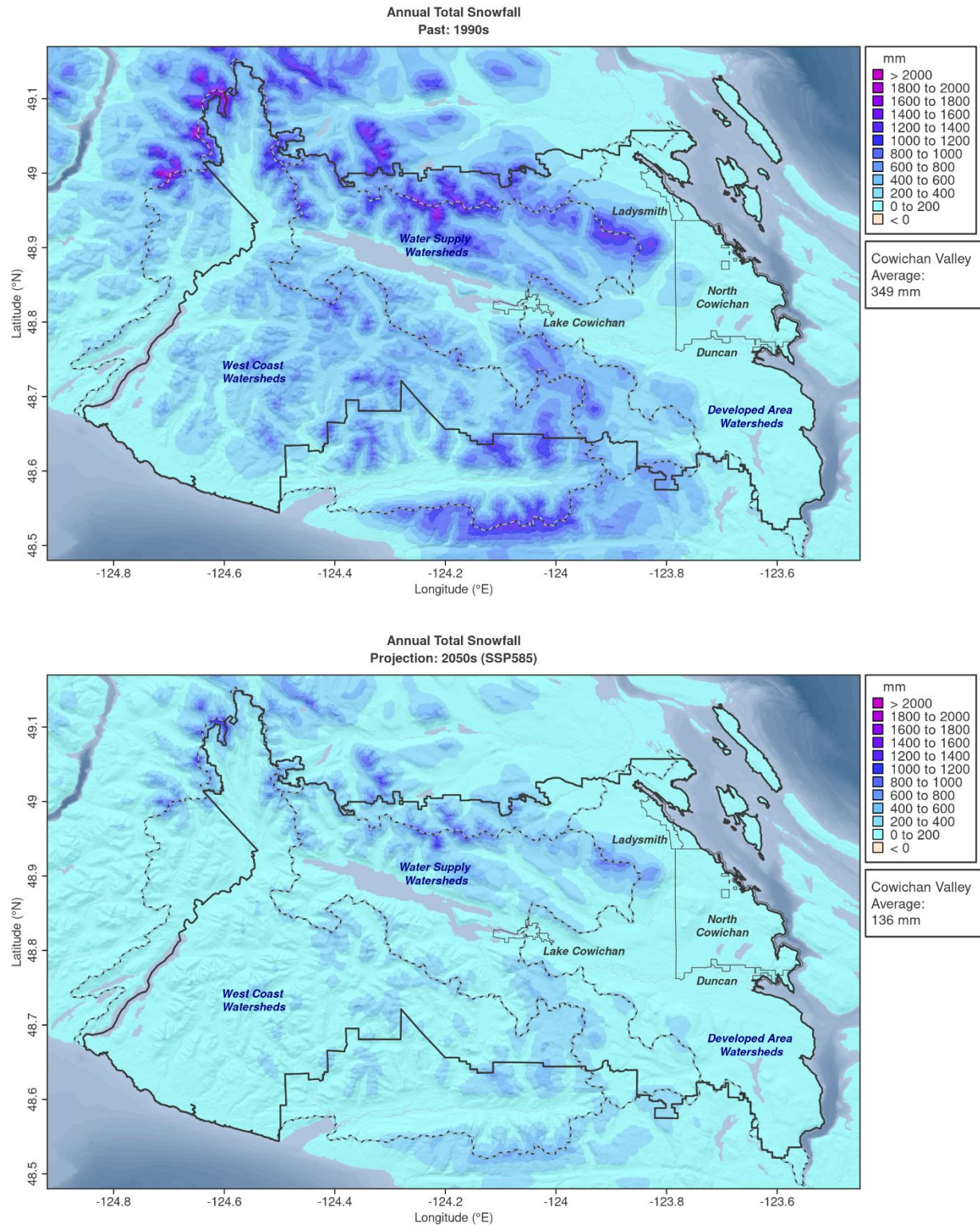


Figure 21. Upper: Annual total snowfall (in mm) in the past. Lower: Projected snowfall (in mm) in the 2050s.



Dry spells and drought

ABOUT THE INDICATORS

Consecutive Dry Days measures the longest consecutive string of days in a year with less than 1 mm of precipitation. While useful, it does not account for the amplifying effect of warm temperatures on dryness, where higher temperatures increase evaporation, or how cooler conditions enhance humidity and precipitation.

The *1-in-10-year Warm Season Drought* describes a drought occurring between April and September that is so dry it is only expected to occur once every 10 years, on average. In other words, this event has a 10% chance of occurring in any given year. This indicator considers changes in both temperature and precipitation.

PROJECTIONS

In the past, the average consecutive dry spell lasted about 23 days. This is projected to increase by 1 day in the 2050s and by 4 days in the 2080s (Table 14). However, because the projected range for both time periods includes the historical value, this suggests little to no change in this indicator.

PCIC developed additional drought indicators to better capture the combined effects of temperature and precipitation on water availability. These indicators estimate the frequency of wet and dry conditions during the warm season (April - September), cold season (October - March), and annually (September - August), as well as changes in the frequency of historical 1-in-10-year extreme wet and dry events. All drought indicators are included in the complete data package accompanying this report. See Appendices A and D for more information on these indicators and the complete data package.

TABLE 15: CONSECUTIVE DRY DAYS

	Past (days)	2050s (days)		2080s (days)	
		Average	(Range)	Average	(Range)
Consecutive Dry Days	23	24	(22 to 29)	27	(23 to 40)

Dry spells and drought (continued)

Figure 22 shows the projected change in the frequency of a 1-in-10-year warm season drought in the CVRD. Across most of the region, changes are small, with return periods remaining close to the historical value of 10 years (approximately 8-12 years). In the Developed Area, such drought events may become more likely in the future, with return periods increasing to once every 4-8 years. However, as with *Consecutive Dry Days*, there is considerable range across models for this indicator, and therefore the results should be interpreted with caution.

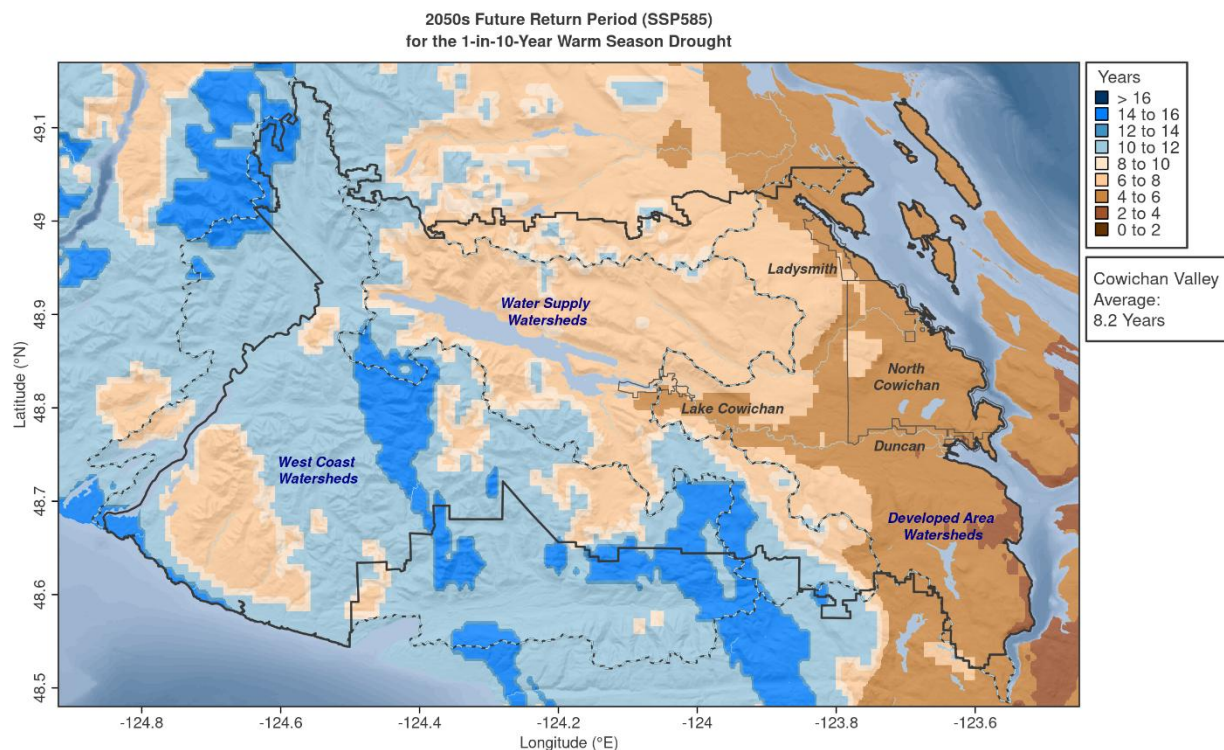


Figure 22. Projected future (2050s) return period for a historical 1-in-10-year warm season (April to September) drought event. Note that there is low confidence in the projected changes for this indicator.

Similarly, changes in the remaining SPEI-based drought indicators are generally small across the region. While the map shows the number of drier-than-normal months is projected to increase in the east by the 2050s and decrease in the west, the range of projected changes is large and limits confidence in the direction or magnitude of change.

Despite some uncertainty in these compound drought metrics, they should be considered alongside more robust indicators presented in this report, which indicate (with higher confidence) increasing summer temperatures and decreasing summer rainfall across the CVRD. Taken together, these results suggest that dry spells and drought conditions may become more frequent in the future, especially in the eastern part of the region where summers are already warm and dry.



Extreme precipitation

ABOUT THE INDICATORS

The extreme precipitation indicators describe the largest precipitation events of the year:

- *Annual Maximum One-Day Precipitation (RX1DAY)* is the amount of precipitation expected on the wettest day of the year.
- *Annual Maximum 5-Day Precipitation (RX5DAY)* is the total precipitation accumulated over the wettest consecutive 5-day period in a year.
- *95th-percentile Wettest Days (R95P)* describes the total amount of precipitation that falls during very wet days. It is calculated by first determining the historical 95th percentile of daily precipitation across all days receiving at least 1 mm of precipitation, then summing all the amounts that exceed this threshold. Unlike RX1DAY and RX5DAY, R95P typically reflects the multiple heavy precipitation events over the course of a year, rather than during a single storm.

PROJECTIONS

To highlight the considerable differences in precipitation across the CVRD, the table below shows precipitation amounts for the three sub-regions as well as the regional average. The maps in Figure 23 echo the patterns found for seasonal averages shown earlier in this section: namely, that the much wetter conditions in the West Coast compared to the rest of the domain will continue in the future.

By the 2050s, both the annual maximum one-day precipitation (RX1DAY) and five-day precipitation (RX5DAY) totals are projected to increase by approximately 15% in all three sub-regions and across the region overall. Meanwhile, precipitation falling on very wet days (R95P) is projected to increase by about 30%, indicating a growing contribution of intense rainfall events to precipitation totals. By the 2080s, these increases are projected to be even larger.

Extreme precipitation (continued)

TABLE 16: EXTREME PRECIPITATION

	Past (mm)	2050s (mm)	2080s (mm)	2050s Change (%)		2080s Change (%)	
				Average	(Range)	Average	(Range)
One-day maximum precipitation (RX1DAY)							
Region	97	112	117	16	(6 to 24)	21	(17 to 29)
Developed Area	61	71	75	16	(5 to 25)	23	(16 to 28)
Water Supply	100	115	121	15	(6 to 23)	21	(16 to 30)
West Coast	125	144	151	15	(7 to 23)	20	(16 to 29)
5-day maximum precipitation (RX5DAY)							
Region	234	263	272	13	(6 to 23)	17	(14 to 23)
Developed Area	142	159	166	12	(4 to 23)	17	(11 to 21)
Water Supply	241	271	279	13	(5 to 23)	16	(13 to 23)
West Coast	305	341	358	12	(7 to 23)	17	(14 to 24)
95 th Percentile Wettest Days (R95P)							
Region	579	765	828	32	(17 to 49)	43	(34 to 78)
Developed Area	330	422	474	28	(14 to 43)	43	(25 to 65)
Water Supply	598	782	852	31	(16 to 49)	43	(33 to 75)
West Coast	772	1043	1123	35	(19 to 51)	45	(37 to 84)

Extreme precipitation (continued)

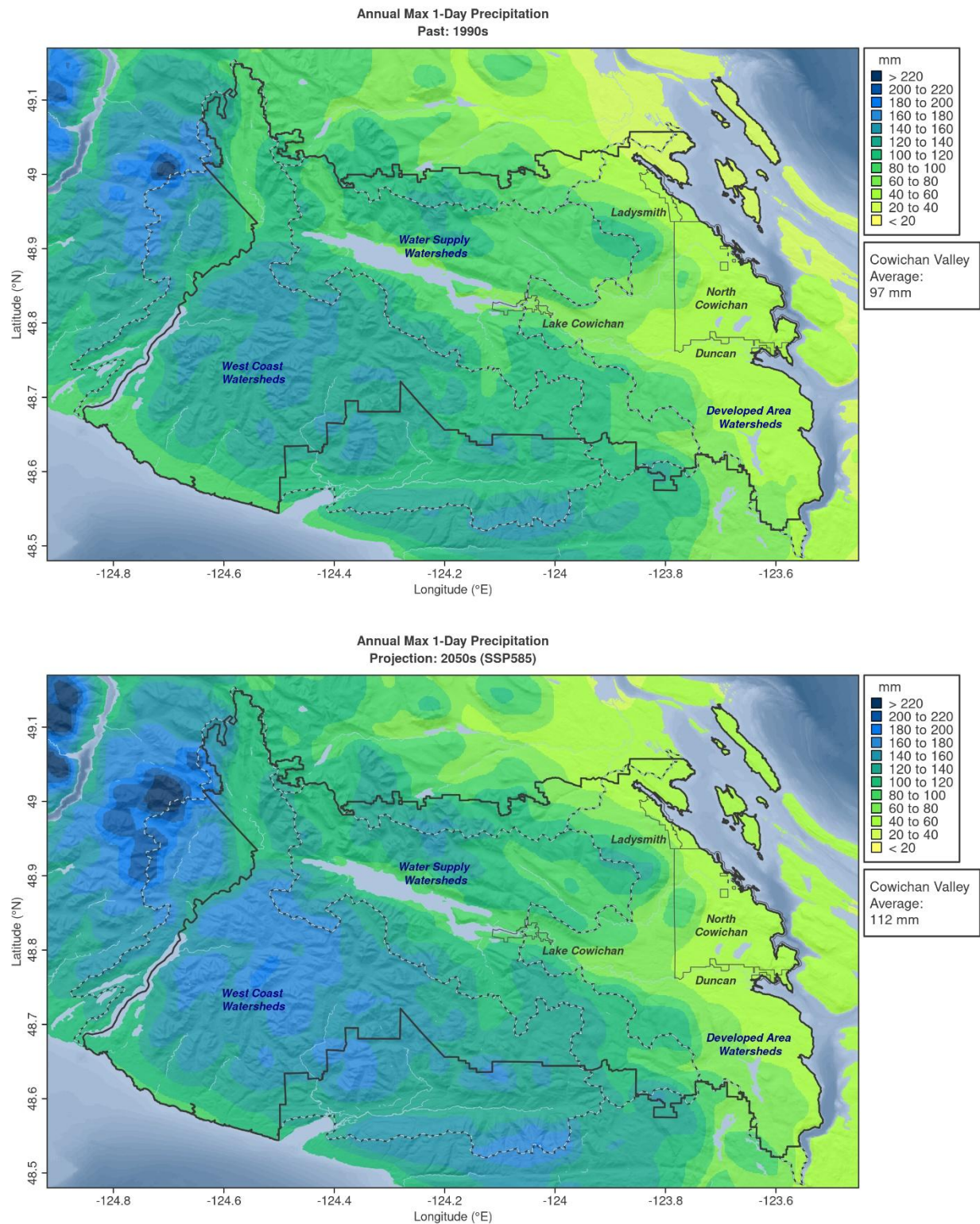


Figure 23. *Upper:* Annual maximum 1-day precipitation in the past. *Lower:* Projected maximum 1-day precipitation in the 2050s.

1-in-20-year Wettest Day and Wettest 5 Days

ABOUT THE INDICATORS

The *1-in-20-Year Wettest Day* and *1-in-20-year Wettest 5 Days* describe rainfall events so extreme they are expected to occur, on average, only once every 20 years. In other words, these events have a 5% chance of occurring in any given year.

PROJECTIONS

The frequency and magnitude of extremely wet days are expected to increase over time in the CVRD. In the past, the average 1-in-20-year wettest day produced around 146 mm of precipitation, while the average 1-in-20-year wettest 5-day period was about 325 mm. Historical rainfall totals for both indicators are considerably larger in the West Coast and Water Supply Watershed Areas than in the Developed Area. Future projections indicate that extreme precipitation events will become more severe across all three sub-regions. The 1-in-20-year wettest day is projected to increase by around 20% by the 2050s and 27% by the 2080s. Projected increases in the 1-in-20-year wettest 5-days are somewhat smaller but still significant, reaching 13% by the 2050s and 24% by the 2080s.

TABLE 17: 1-IN-20-YEAR WETTEST DAY AND WETTEST 5 DAYS

	Past (mm)	2050s (mm)	2080s (mm)	2050s Change (%)		2080s Change (%)	
				Average	(Range)	Average	(Range)
1-in 20-year maximum one-day rainfall							
Region	146	175	189	20	(8 to 33)	29	(19 to 36)
Developed Area	90	106	118	18	(12 to 34)	31	(22 to 37)
Water Supply	151	181	195	20	(10 to 33)	29	(21 to 38)
West Coast	189	228	240	21	(6 to 32)	27	(15 to 35)
1-in 20-year maximum 5-day rainfall							
Region	325	364	397	12	(8 to 35)	22	(16 to 28)
Developed Area	200	226	241	13	(7 to 34)	21	(13 to 25)
Water Supply	329	371	410	13	(9 to 36)	25	(17 to 30)
West Coast	433	488	535	13	(9 to 35)	24	(17 to 28)

1-in-20-year Wettest Day and Wettest 5 Days (continued)

20-Year Event: 1-Day Extreme Precipitation

Frequency and intensity increase (SSP5-8.5) of an extreme precipitation event that occurred in the Cowichan Valley once in 20 years on average in the past (1981-2010)

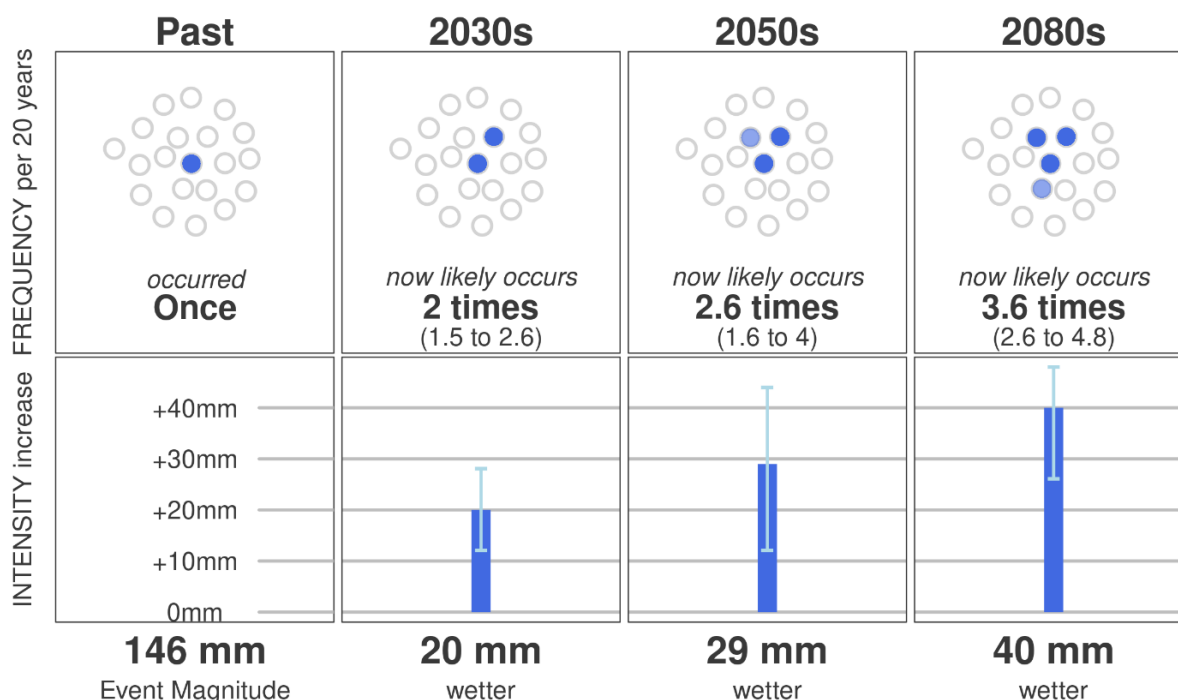


Figure 24. *Upper panel:* Frequency of a 1-in-20 year single-day maximum precipitation event in the past and three future periods. *Lower panel:* Magnitude (mm) of a 1-in-20-year single-day maximum precipitation event in the past and future periods. Figure is adapted from IPCC, 2021: Summary for Policymakers¹².

The upper panel of Figure 24 shows how the frequency of a 1-in-20-year single-day precipitation event is projected to change in the future, illustrated by the number of blue dots. In the past, a single-day precipitation event of 146 mm would occur approximately once every 20 years in the CVRD, or with a 5% annual probability. By the 2050s, the annual probability of this event occurring is projected to increase to 13%, or once every eight years. By the 2080s, this probability reaches 18%, or nearly once every 5 years.

The lower panel shows how the magnitude of a single-day precipitation event associated with the same 1-in-20-year frequency (or 5% annual probability) changes over time. In the past, a 1-in-20-year single-day precipitation event had a magnitude of 146 mm. By the 2050s, this increases to approximately 175 mm and by the 2080s, to around 185 mm.

¹² 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. 3-32, doi:10.1017/9781009157896.001.

7. Regional impacts

Impacts from climate change are already being felt across the Cowichan region. They can be widespread and overlapping, influencing areas such as the built environment, ecosystems and biodiversity, and community health and wellbeing. The projected changes outlined in this report indicate that, without sustained reductions in global greenhouse gas emissions, these impacts will persist and, in many cases, intensify over the coming decades.

By the 2050s, Cowichan can expect warmer year-round temperatures, hotter extremes, and changes to seasonal precipitation. Summer is expected to become hotter and drier, exacerbating already dry conditions for the region. In contrast, fall, winter and spring are projected to become wetter and milder. As temperatures warm, Cowichan can expect significantly less snowfall as more precipitation falls as rain instead. Heavy rainfall events are expected to occur more frequently and with greater magnitude. Because of climate variability, these changes may not occur evenly from one year to the next. Planners and decision makers will need to consider this complexity as they prepare for future conditions.

The case for investing in climate adaptation is clear. For every \$1 spent on adaptation measures today, \$13 to \$15 is estimated to be returned in future years through direct and indirect benefits.¹³

This chapter illustrates some of the emerging and future climate impacts facing the Cowichan region based on the projections in this report. The discussion was informed by engagement with CVRD and local government staff, and community organizations from across the region. It is not a complete assessment of expected impacts. Rather, this information is intended to spark deeper discussion among decision makers and community leaders on how to prepare for the interrelated climate impacts facing Cowichan.

As a region, preparing for these changes will require considering future climate conditions in planning and decision making. Because climate change impacts affect many different stakeholders and rightsholders, Cowichan's strong partnerships and shared commitment to stewardship will provide a strong foundation for collaborative climate action. By building on these strengths, communities, organizations, local governments and the CVRD can work together to align policies, actions, and initiatives that strengthen resilience to climate change.

¹³ "Damage control: Reducing climate impacts", Canadian Climate Institute, 2022

Climate equity

The impacts described in this chapter will not be experienced equally across the region, nor across society. Around the world, climate change often acts as a “risk multiplier”, worsening other issues such as housing affordability and food security. As a result, climate change can deepen existing inequities.

People who already face social and economic barriers are often the most affected by climate change. Individuals and households with limited resources may have fewer options to prepare for, respond to, and recover from climate impacts. For example, unhoused people can be severely impacted during flooding events as they have fewer options to relocate or protect themselves and their belongings.

Some people may be more exposed to climate impacts because of where they live and work, or the environments they rely on. For example, in the Cowichan region, some First Nations communities face higher flood risk because reserve lands are located within flood plains without protective dike systems, due in part to feasibility constraints and a legacy of colonial displacement. Alternatively, people living in neighbourhoods with fewer trees and more pavement may experience greater exposure to extreme heat because of the urban heat island effect.

Certain populations are more sensitive to climate impacts. Even when people experience the same climate hazard, the impacts can be different based on existing vulnerabilities that often overlap. For example, people living with chronic health conditions, older adults, pregnant people, infants and young children are at higher risk of experiencing health effects from climate change.



Advancing climate equity in the Cowichan Valley requires acknowledging existing disparities and ensuring that climate action is inclusive, collaborative, and responsive to community needs. This includes supporting Indigenous leadership and knowledge systems, which offer long-standing stewardship practices and place-based knowledge that are essential to climate resilience. Embedding equity into climate planning helps reduce disproportionate impacts, strengthen community resilience, and supports broader goals of reconciliation and community well-being.



Watershed health

CONTEXT

Healthy watersheds are essential to the wellbeing of communities and ecosystems across the Cowichan region. There are 18 major watersheds in the CVRD that shape the region's water supply, support social and cultural values, provide critical habitats, and help manage the effects of climate change. For this report, three broader watershed areas have been defined (Section 2.3). The *Water Supply Watersheds* encompasses Cowichan Lake – the region's largest water body – and upper portions of the Cowichan, Koksilah and Chemainus River sub-basins. These headwaters, the source of much of the region's water supply, are largely comprised of private managed forest lands where forestry activities play a key role in shaping watershed health. The *West Coast Watersheds* include the Carmanah and Walbran Valleys, which are characterized by cascading coastal creeks and old growth forests, and include a mix of park and resource lands. The *Developed Area Watersheds* includes the lower portions of the Cowichan, Koksilah and Chemainus River watersheds, as well as smaller watersheds and surrounding benchlands where most of the region's population is situated. In recent years, extended drought conditions in summer have threatened the health of Cowichan watersheds. Efforts are underway across the region to strengthen watershed health, including water conservation strategies such as irrigation scheduling, rainwater capture, and raising the height of the Cowichan Lake Weir.

IMPACTS

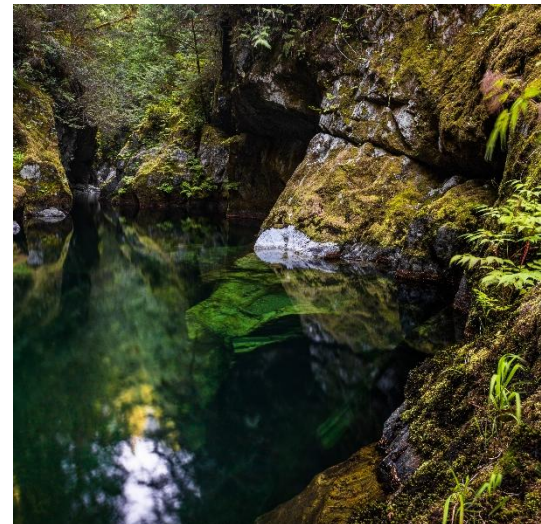
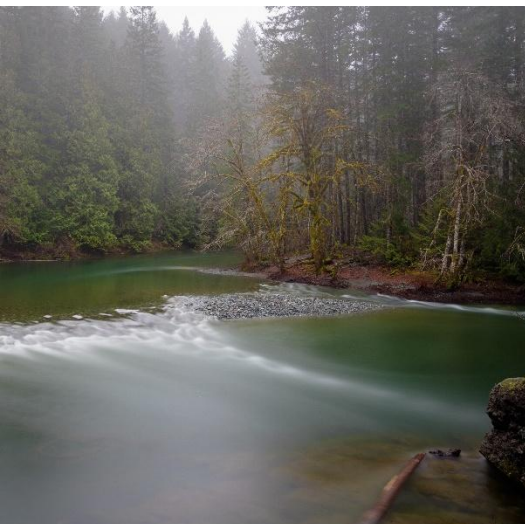
In the future, hotter temperatures and less summer rainfall are expected to worsen normally dry conditions during the warmer months. This may reduce water quality, availability and flows, and raise the temperature of streams across the region. Extended dry periods in summer can lower water levels and cause pollutants to become concentrated in waterways, with severe consequences for watershed health and the species they support. In 2023, an unprecedented fish die-off occurred in the Cowichan River due to extremely low water levels, elevated temperatures, and poor water quality. Tens of thousands of fish were killed, illustrating how climate change can push already stressed watersheds beyond ecological thresholds.

Watershed health (continued)

Extended periods of hot, dry weather can also increase wildfire risk. When fire damages vegetation and soils within a watershed, ash, debris and other materials can wash into nearby streams, rivers and lakes and increase water turbidity. Wildfire can also reduce the land's natural ability to absorb and retain water by exposing soils directly to the elements. As a result, heavy rainfall events following a wildfire can generate greater surface runoff, erosion and sediment transport into waterways.

During the colder months, warming temperatures will lead to a greater portion of precipitation falling as rain instead of snow. At higher elevations, snowpack acts as natural storage, releasing water gradually as temperatures increase in the spring. Rising temperatures combined with less snowfall may therefore affect the timing and availability of water during the warmer months. Although more rain is expected in the fall, winter and spring, current water capture and storage capacity in the CVRD is limited and may need to be expanded to help manage summer drought conditions.

In the future, heavy rainfall events are expected to occur more often and with greater severity. Heavy rainfall can overwhelm waterways and riparian areas, causing runoff, erosion, and flooding of low-lying areas. When heavy rain falls over hard, dry ground, less water infiltrates into soils, limiting groundwater recharge and increasing the movement of sediment and contaminants into waterways. Heavy rainfall can also increase the likelihood of landslides on steep terrain. These effects may be amplified in areas where development, forestry practices or wildfire have altered the natural drainage capacity of the land.





Ecosystems and biodiversity

CONTEXT

Cowichan is home to a diversity of rare and sensitive ecosystems, including Coastal Douglas-fir forests, Garry oak woodlands, wetlands and riparian habitats, rocky outcrops, coastal bluffs and a variety of shoreline ecosystems. Summers are typically long and dry, which is a major factor in the region's ecology. More than half of the region is forested, with some notable areas of old growth in the west that are not currently protected. Watersheds across the CVRD support a wide range of aquatic and terrestrial ecosystems. The Cowichan River, which spans most of the region, is a Canadian Heritage River and is recognized as one of the world's most biologically important areas for fish, waterfowl and wildlife. In the north, the Chemainus River is home to Coho salmon and serves as an important migration corridor for Roosevelt elk. Stewardship initiatives such as the X'pey Restoration and Protection Project led by the Quw'utsun' Cultural Connections Society (QCCS) are being implemented across the region to help safeguard ecosystems and species into the future.

IMPACTS

Climate change is expected to place additional stress on ecosystems and species in the region, leading to shifts in biodiversity. Warmer seasonal temperatures and greater climate variability may alter the timing and balance of biological cycles, including processes that rely on temperature cues such as predator-prey, parasite-host, and pollinator dynamics. These changes will threaten some species and benefit others. Specialist species may be particularly vulnerable, potentially reducing regional biodiversity. For many species, the speed and scale of the projected changes may exceed their capacity to adapt.

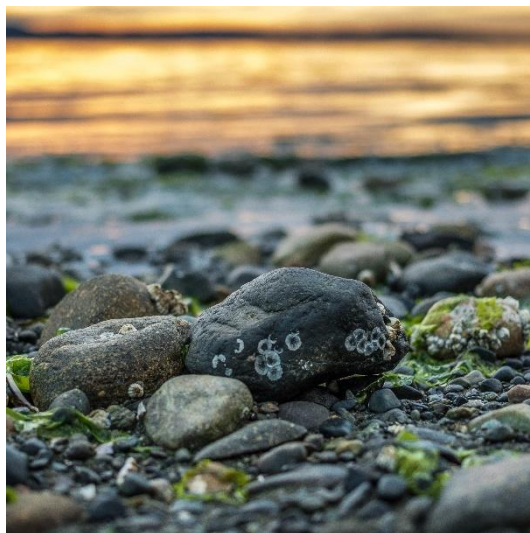
In summer, hotter temperatures combined with reduced rainfall will continue to strain drought-sensitive species, including X'pey (Western redcedar), a cultural keystone species (sunt'le') that is already under stress. In addition to reducing water availability, drought conditions can slow the decomposition of bacteria, fungi and other soil organisms, thereby limiting nutrient availability for plants and other terrestrial species. Stressed vegetation may become more vulnerable to competition, pests and disease outbreaks. In addition, wildfire can reduce air quality, pollute water bodies, and destroy habitats through large-scale vegetation loss.

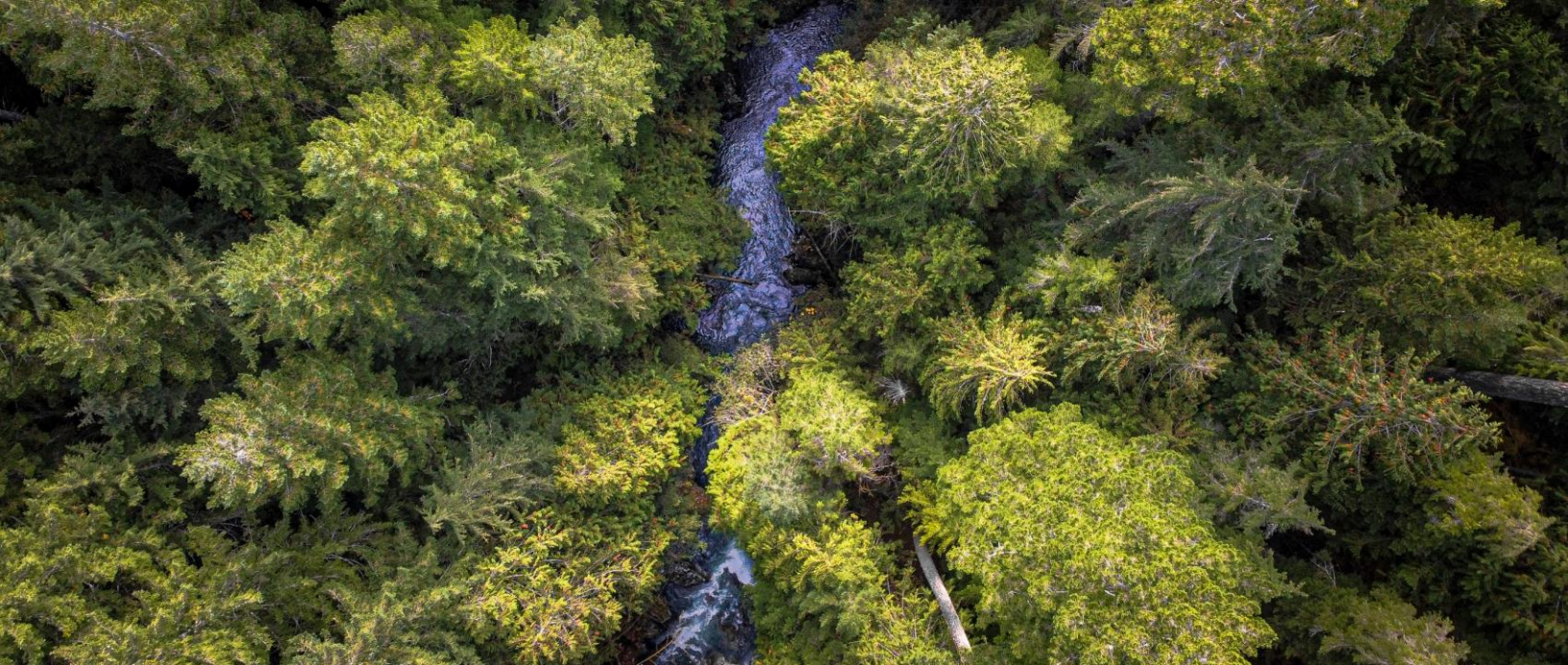
Ecosystems and biodiversity (continued)

In freshwater, estuary and shoreline ecosystems, hot, dry conditions can lower water levels and raise water temperatures. For example, juvenile salmon, which spend time in the Cowichan River over the summer, can undergo behavioural and physiological changes when water temperatures exceed 20°C. If temperatures become too high, mortality can occur. In coastal areas, intertidal zones are also vulnerable to extreme heat. The 2021 heat dome, which brought several consecutive days of extreme temperatures, resulted in widespread mortality of clams, mussels and other species inhabiting intertidal areas.

In fall, winter and spring, extreme rainfall events can disrupt critical ecological processes – such as salmon spawning – by increasing channel erosion and introducing sediment into waterways and estuaries. For salmon, heavy flooding can wash away eggs or bury them under excess sediment or silt, reducing survival rates. The effects of heavy rainfall may be compounded if heavy rains occur following extended periods of dry weather or in areas affected by wildfire.

Overall, the impacts of climate change on ecosystems and biodiversity are compounded by environmental changes from human development. Land use changes and habitat fragmentation can reduce ecosystem connectivity and resilience, limiting the ability of species and ecosystems to adapt to changing conditions.





Water supply and demand

CONTEXT

Across the region, drinking water is supplied primarily by groundwater wells and, in some areas, by surface water from regional lakes and rivers. There are 58 aquifers within the CVRD made up of either sand and gravel or bedrock. Key surface water reservoirs include Cowichan Lake, Holland Lake, Shawnigan Lake and Stocking Lake. Water management in the Cowichan region is complex, with its complicated hydrology, varied land uses, and multiple service providers, including municipalities, improvement districts and private water utilities. Rapid population growth, urbanization and development are placing increasing pressure on water resources, and in some areas, available supplies are already fully allocated. As a result, water availability is increasingly recognized as a limiting factor for future growth and development in the region.

IMPACTS

In the future, less rainfall, longer dry spells, and hotter temperatures in the summer may increase the likelihood of drought and water scarcity in the CVRD. Drought – which is typically associated with hot weather – can reduce surface and groundwater recharge, straining water supply during periods of peak demand. This demand may increase in the future as summers become hotter and heat waves become longer, stronger and more frequent. In some areas, reduced groundwater recharge could also lead to insufficient water pressure for fighting fires.

Low water levels can create additional challenges for residents who rely on groundwater wells. As water levels drop, pollutants can become concentrated, affecting water quality. When water levels are very low, insufficient groundwater recharge combined with overdrawing from wells can lead to saltwater intrusion, where saltwater from oceans and estuaries encroaches into freshwater systems. Saltwater intrusion can have wide-ranging impacts to drinking water quality, agriculture, ecosystem health and more. In the future, the likelihood and extent of saltwater intrusion may be further impacted by rising sea levels.

Water supply and demand (continued)

In fall, winter and spring, more frequent and intense precipitation events may compromise the ability of watersheds to hold and store water for summer use. Heavy rainfall can lead to runoff, particularly in areas where precipitation falls over bedrock or other hard surfaces. Studies conducted in the Cowichan Valley indicate that groundwater recharge rates vary across the region and, as a result, changes to precipitation patterns will affect the region's groundwater resources unevenly.

Heavy rainfall can erode upland soils, introducing nutrients, silt, organic materials and contaminants into water systems. Increased turbidity from fine sediments can interfere with water treatment and disinfection, while excess organic materials can promote algal blooms. Algal blooms produce cyanotoxins that can lead to taste and odour issues and make it more difficult to treat drinking water. In areas where water supply catchments are not protected, more intense rainfall and runoff can increase the number of pollutants entering wells and surface reservoirs.

Over time, these combined climate pressures may limit the region's bioregional carrying capacity, constraining future population growth and development. In response, the CVRD and community partners have been actively working to address water supply challenges. The CVRD Drinking Water and Watershed Program adopts a water centric approach to policy, planning and operational decision making to ensure future generations have access safe and sustainable drinking water. Organizations such as the Cowichan Watershed Board and the Shawnigan Basin Society lead efforts in stream restoration, monitoring, public outreach and other stewardship initiatives across the CVRD.



Health and well-being

CONTEXT

Human health is closely connected to the environment in which we live. Clean air, safe drinking water, and healthy soils are foundational to our physical health, while time spent in nature supports mental, emotional and spiritual health. Climate change is already affecting health and well-being across the region, and these impacts are not felt equally. Cowichan has an aging population, a growing number of unhoused individuals, and some of the highest numbers of people living with asthma and chronic obstructive pulmonary disease (COPD) in BC. One in five adults live alone, especially among older age groups, and roughly half of residents live with a long-term condition or disability.¹⁴ These social, demographic, and health factors, among others, can increase vulnerability to climate impacts, highlighting the need for targeted strategies to protect the health and well-being of all community members.

IMPACTS

As temperatures warm, heat waves in Cowichan are expected to be longer, stronger and more frequent. Sustained hot temperatures can increase the risk of heat-related stress and illnesses, particularly among older adults, young children, people with pre-existing conditions, outdoor workers, and people living in poor quality housing. In the future, nighttime temperatures are also projected to increase, offering little relief from daytime heat for people without access to a cool indoor space. In June 2021, a record-breaking “heat dome” resulted in over 600 deaths and hundreds of hospital admissions across the province, illustrating just how damaging extreme heat can be to human health and well-being.

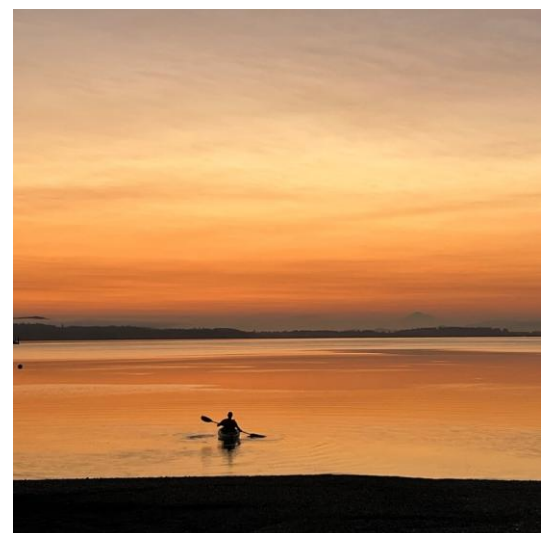
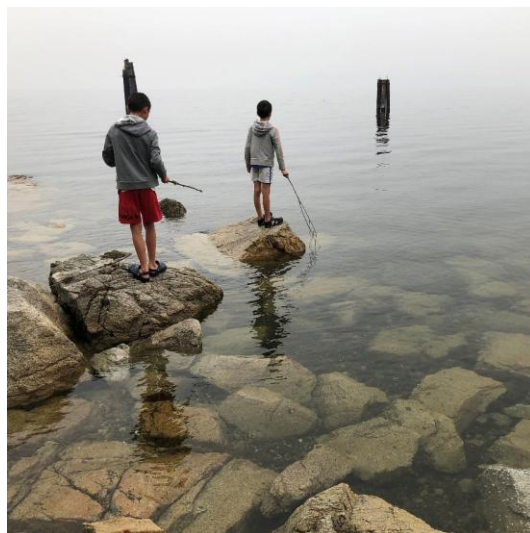
While extreme cold events are projected to become less severe in the future, Cowichan must still be prepared for extreme cold events of the past, as they can still occur. Extreme cold can have serious health impacts, particularly for people who do not have access to safe and reliable shelter.

¹⁴ See <https://ourhealthourcommunity.com/>

Health and well-being (continued)

Hotter and drier conditions in the summer can increase wildfire risk in Cowichan and surrounding areas. Wildfires occurring within the region may lead to displacement and property damage. Exposure to wildfire smoke can impact respiratory health, particularly for people with chronic conditions, like asthma, diabetes or COPD, pregnant people, young children, and older adults. During periods of extreme heat, certain pollutants (e.g., ground level ozone) can become more concentrated, further reducing air quality.

Climate change can have direct impacts on mental, emotional and spiritual health. Living through an extreme event or grappling with uncertainty about the future can increase levels of stress and compromised mental health. Furthermore, witnessing changes to the places we love or how we are used to living in the region can lead to psychological distress. In the future, it will be prudent to strengthen social support networks, as the effects of climate change may be experienced more by people who have limited resources to prepare for and recover from these changes.





Built environment

CONTEXT

Cowichan's growing population is driving new development across the region. Many older buildings, including apartments and houses, were not designed to handle temperature extremes, and much of the region's infrastructure is aging with limited capacity for upgrades. As a predominately rural area, Cowichan is largely made up of forested lands that are subject to wildfire, with much of the housing and infrastructure located in the wildland-urban interface (where fires can spread between forests and buildings). In addition, many homes, farms, community spaces and businesses are situated near rivers, floodplains or estuaries that are vulnerable to overland flooding. Across the region, liquid waste is managed through a combination of sewer systems and individual septic systems, overseen by private operators, improvement districts, municipalities, and the CVRD.

IMPACTS

In the future, more heavy rainfall and multi-day extreme heat events are expected to strain infrastructure and buildings across the region. Across their service life, roads, drainage systems and other infrastructure may face conditions that they were not previously designed to withstand. Design choices made today should consider projected future conditions, especially for critical infrastructure expected to last for many decades.

Stormwater systems

More intense rainfall may put significant pressure on aging or undersized stormwater and drainage systems, limiting their ability to effectively capture and treat non-point source pollution from runoff associated with agricultural activities, failed septic systems, urban surfaces, vehicles and gardening products. Extreme, multi-day precipitation events can also cause flooding in low-lying areas where drainage infrastructure and waterways become overwhelmed and soils become saturated. Flooding can disrupt critical services through power outages, road closures, and sewer backups, and may cause serious damage to homes and properties. Flooding may disproportionately impact households and communities that are situated along flood plains in the region.

Sewage and water treatment

Sewage and water treatment facilities depend on adequate flows to ensure that treatment is effective and effluent is properly diluted. In the future, lower water levels in summer, driven by hotter temperatures and reduced precipitation, may limit the amount of water entering treatment systems and increase risks to the environment and public health. During the fall, winter and spring, more frequent and intense rainfall events can increase turbidity in surface water, reducing the efficiency of treatment processes, increasing maintenance requirements, and raising water treatment costs. In some cases, these conditions may increase the likelihood of boil-water advisories for affected communities.

Housing, buildings and energy use

As the climate changes, the case for investing in well-designed, resilient housing and buildings becomes increasingly important. More frequent multi-day extreme heat can place stress on building materials and foundations, and reduce the performance of heating, ventilation and air conditioning (HVAC) systems. Heavy wildfire smoke can compromise indoor air quality, which is of particular concern for critical facilities such as hospitals, long-term care homes and other essential service buildings. In addition, extreme storm events can damage power lines and other energy infrastructure, increasing the risk of electricity outages across the region.

Warmer year-round temperatures are expected to influence long-term energy demand in the CVRD. As winters become milder, heating demand is expected to decline over time. At the same time, hotter summer temperatures and more frequent multi-day extreme heat will increase demand for cooling. As a coastal region, Cowichan has traditionally benefited from cooler nighttime temperatures that help homes and other buildings cool down naturally overnight. As both daytime and nighttime temperatures rise, this passive cooling effect will become less reliable. As a result, more homes and buildings may require mechanical cooling systems, alongside other adaptive strategies such as improved building design, passive cooling strategies and outdoor shading to maintain safe and comfortable indoor environments.

Roads and transportation

Preparing transportation networks for climate change will require updates to how they are designed, built and maintained. More frequent and intense rainfall events can wash out roads and highways, damage infrastructure, and create unsafe travel conditions. Limited alternate routes mean flooding can cut off all access routes between parts of the region, as seen during the Chemainus River flooding in 2020 and 2021. Landslides and washouts are a particular concern in areas such as Youbou, where steep slopes adjacent to infrastructure can block road access. For example, a section of Allenby Road along the Cowichan River has been closed or partially closed for nearly five years due to slope instability following the 2021 atmospheric river event. Hotter, drier summers could also lead to closures along major transportation corridors due to increasing wildfire risk. As a result, extreme events such as heavy rain and wildfire have the potential to isolate some communities.

As winter temperatures warm, fewer days below 0°C should result in fewer freeze-thaw cycles, which are known to damage roads, bridges and other transportation infrastructure. Warmer winters may also make walking and cycling more appealing throughout the year, supporting greater use of active transportation methods.



Agriculture and food security

CONTEXT

With its Mediterranean-like climate, long growing season, and fertile soils, the Cowichan Valley is well known as a place of agriculture. Across the region, the Quw'utsun people have been growing and cultivating food and medicines since time immemorial, and these practices remain vital for food sovereignty and community resilience. Today, the Cowichan region is home to more than 700 farms and one of the largest wine-producing regions in BC. Farming communities across the CVRD are already learning to navigate the impacts of climate change and working collaboratively to strengthen local food systems and build resilience for the future.

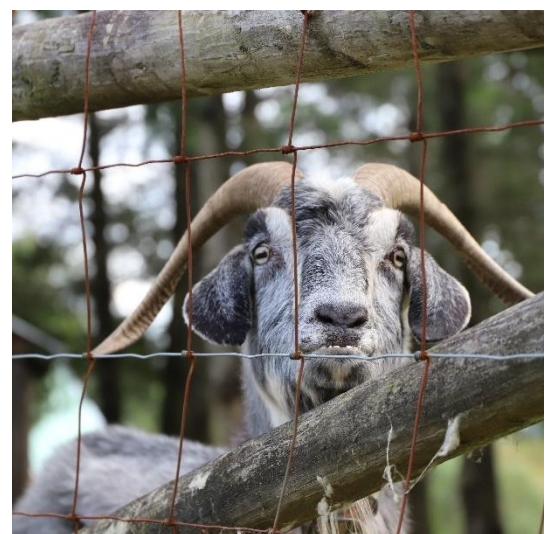
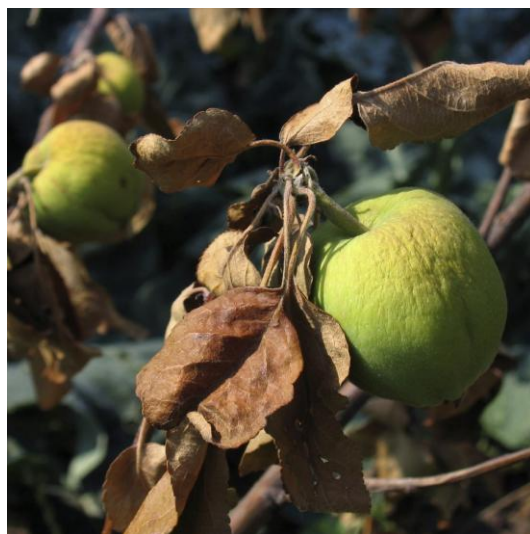
IMPACTS

As temperatures continue to rise, Cowichan can expect a longer and warmer growing season, fewer days below 0°C, and an earlier onset of spring. These changes may enhance the growth and productivity of food and medicinal plants across the region by extending the period suitable for growth and creating more favourable conditions for pollinators. However, hotter and drier summer conditions could also intensify existing challenges and introduce new ones. Heat stress, sun scald, invasive species and emerging plant diseases could threaten the health and productivity of food systems in the CVRD. In recent years, dry summer conditions have increased competition for water in several Cowichan watersheds as irrigation demand overlaps with periods of critically low flows for aquatic habitats. In the Koksilah watershed, irrigation for forage crops has been restricted multiple times when stream flows have dropped below thresholds required for fish survival.

Warming temperatures and changing seasonal precipitation could affect the distribution and abundance of plants and animals that are central to Indigenous food sovereignty. In shoreline and estuary areas, multi-day extreme heat events can raise water temperatures and affect the growing and harvesting of foods. For example, heat stress among shellfish can reduce growth rates, reproduction and survival. Warmer waters can also promote the proliferation of harmful bacteria that contribute to shellfish poisoning.

In fall, winter and spring, heavier rainfall and more rapid snowmelt can increase runoff onto and off farms, leading to soil erosion, nutrient loss, and crop damage. Low lying areas may face greater risk of flooding, and excessively wet conditions could create opportunities for certain plant diseases and pests to flourish.

Adaptation strategies and technologies that reduce agricultural water demand – such as drought-resistant crops, rainwater capture, desalinization and soil conditioning techniques – will be essential for supporting climate-resilient communities, ecosystems, and food systems in the future. Initiatives like the Cowichan Estuary Restoration Project, which aims to restore 70 hectares of marsh habitat and revitalize the estuary as place for Quw’utsun agriculture, will also play an important role in strengthening regional food security as the climate changes.





Recreation and tourism

CONTEXT

The CVRD has a mild climate that supports year-round recreation and tourism. Visitors and residents alike value the Cowichan region for its natural beauty and breadth of outdoor activities. Across the region, the CVRD manages eight regional parks covering over 400 hectares, 160 km of trail systems and 202 community parks. Cowichan Lake, at over 30 kilometres long, is the largest waterbody and draws visitors from around the world for swimming, boating and fishing. The lake is also the source of the Cowichan River, which flows east to Cowichan Bay and is widely recognized as one of BC's premier trout fishing destinations. Other popular activities in the region include hiking, paddling, off-roading, and mountain biking. Visitors are also attracted to the Cowichan area for its variety of vineyards, breweries, festivals, markets, and rich cultural heritage.

IMPACTS

Climate change will create both opportunities and challenges for recreation and tourism in the CVRD. Warmer temperatures could extend the season for summer recreation and outdoor activities, potentially boosting tourism and economic productivity. At the same time, traditional winter sports may become more difficult to sustain as snowpack declines and winters become warmer.

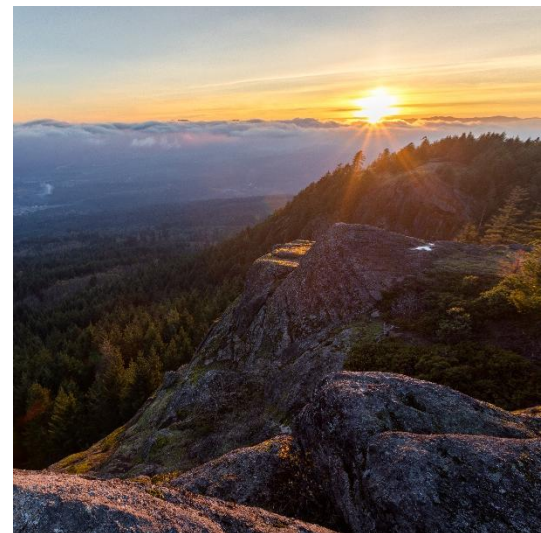
In summer, hotter temperatures may encourage more people to seek relief near lakes and coastlines, bolstering the need to protect freshwater, marine and shoreline ecosystems. During the hottest periods of the year, multi-day extreme heat events and wildfire smoke from surrounding areas could deter visitors and make outdoor activities unsafe, reducing visits to parks, farms, wineries, and other outdoor attractions. In some cases, elevated wildfire risk could lead to the closure of campgrounds and parks.

Drought and low stream flows are already affecting fishing and other water-based recreation in the CVRD. Low flows in regional waterways can increase water temperatures and concentrate pollutants, which can lead to recreational closures to help protect aquatic ecosystems. In 2025, recreational fishing on the

Recreation and tourism (continued)

Cowichan River was closed for more than six weeks during July and August because of low water levels. In the future, hotter and drier summers are expected to become more common, which may increase the duration of these types of closures, particularly in eastern parts of the region where the largest declines in summer rainfall and highest summer temperatures are projected.

Heavier rainfall during the fall, winter and spring may increase damage to trails, parks and recreation infrastructure, resulting in more frequent closures and higher maintenance costs. During the 2021 atmospheric river event, several bridges and trails were washed out in the Cowichan region that resulted in lengthy closures and expensive repairs.



8. Conclusion

This report uses the latest climate modelling (CMIP6) to explore how global climate change is projected to affect the Cowichan Valley Regional District over the coming decades under a high GHG emissions scenario (SSP585). It builds on a similar assessment completed in 2017 with updated modelling, improved downscaling methods, additional climate indicators, and an updated evaluation of potential climate impacts across the Cowichan region.

For those looking to explore the data further, the complete data package contains projections for all three subregions under medium (SSP245) and high (SSP585) emissions scenarios for the 2030s, 2050s and 2080s.

See the appendices for details on accessing the complete dataset and guidance for using climate projections.

Visit www.CowichanAdapts.ca for additional climate information, adaptation resources and examples of local climate action.

As temperatures rise, Cowichan can expect warmer conditions year-round, a longer and warmer growing season, more extreme heat, and changes to seasonal precipitation. Summers are expected to be drier, with hotter temperatures and longer, more intense and more frequent heat waves. In fall, winter and spring, rain is projected to increase with heavy rainfall events becoming wetter and occurring more frequently. Winters are expected to be milder with significantly less snowfall. Together, these changes suggest that climate-related hazards such as extreme heat, flooding, drought and wildfire may become more severe over time.

Examples of how the climate projections in this report can be used include:

- Raising awareness of how climate change will impact the region
- Supporting strategic and long-term planning
- Informing emergency preparedness and response planning for extreme events
- Conducting risk assessments to inform adaptation actions
- Designing infrastructure that considers future climate conditions

The region has already experienced a range of climate-related challenges, including extreme heat, low summer flows, and intense rainfall events. The projections in this report provide a consistent evidence base for climate-related planning and decision-making across the CVRD. This shared foundation ensures that CVRD departments, municipalities, First Nations, and regional partners can work together from the same understanding of future climate conditions, supporting coordinated, efficient and strategic action. Because climate impacts transcend jurisdictional boundaries, a shared understanding of future conditions is essential for effective cross-boundary planning and investment. Integrating up-to-date, locally relevant climate information into planning processes will help the CVRD and its partners protect community well-being, safeguard natural systems, support economic resilience and ensure that long-term decisions remain responsive to a changing climate.

Appendix A: How to use this report

Complete data package

This report provides a summary of projected changes for a host of climate change indicators derived from temperature and precipitation under a high emissions scenario (SSP585). It should be considered a “highlights reel” of the most important changes for the Cowichan region.

The complete data package from this assessment is also available. It contains summary tables (Excel XLSX) and maps (PNG) for the following:

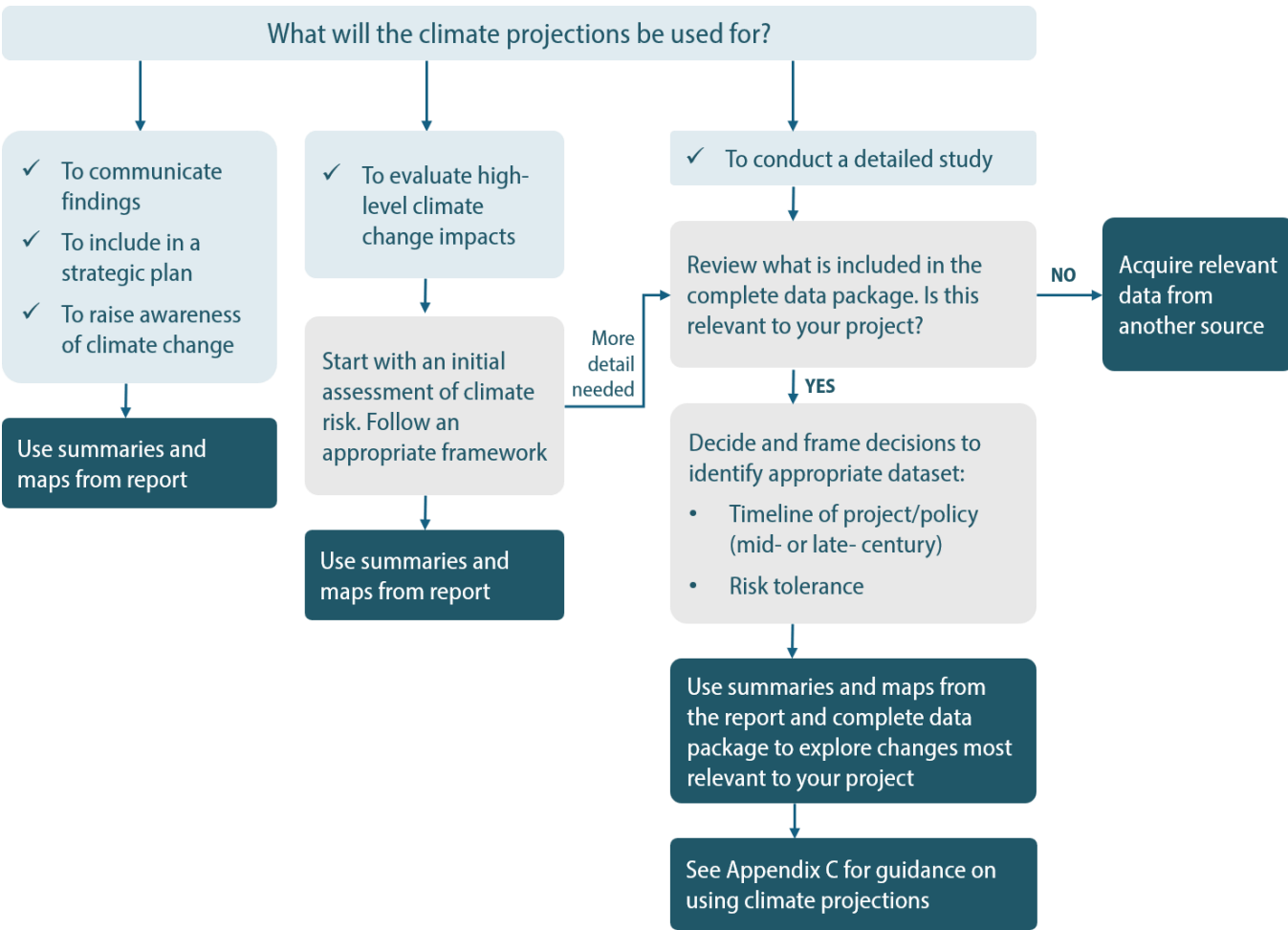
- ✓ **The Cowichan Valley Regional District and 3 watershed area sub-regions**
 - Developed Area Watersheds
 - Water Supply Watersheds
 - West Coast Watersheds
 - See p. 13 for a description of each watershed area
- ✓ **77 climate indicators derived from temperature and precipitation**
 - See Appendix D for a complete list of climate indicators
 - Please note that variables related to other climate-related hazards, such as sea level rise or wind, require different modelling and are not provided
- ✓ **Four time periods**
 - 1981-2010 or “1990s” (baseline period)
 - 2021-2050 or “2030s”
 - 2041-2070 or “2050s”
 - 2071-2100 or “2080s”
- ✓ **Two emissions scenarios**
 - Moderate: SSP2-4.5
 - High: SSP5-8.5

Visit **CowichanAdapts.ca** (or contact environment@cprd.bc.ca) to access the complete data package from this assessment.

Climate data decision tree

The decision tree below can help determine which data from this assessment might be most useful for a given application, from communicating high-level findings to conducting a more detailed study of climate impacts.

Before using climate projections, it is important to do appropriate background reading, identify relevant partners and determine the appropriate level of engagement to ensure that the projected changes are both meaningful and well-suited to your context.



Appendix B: Backgrounder on climate data

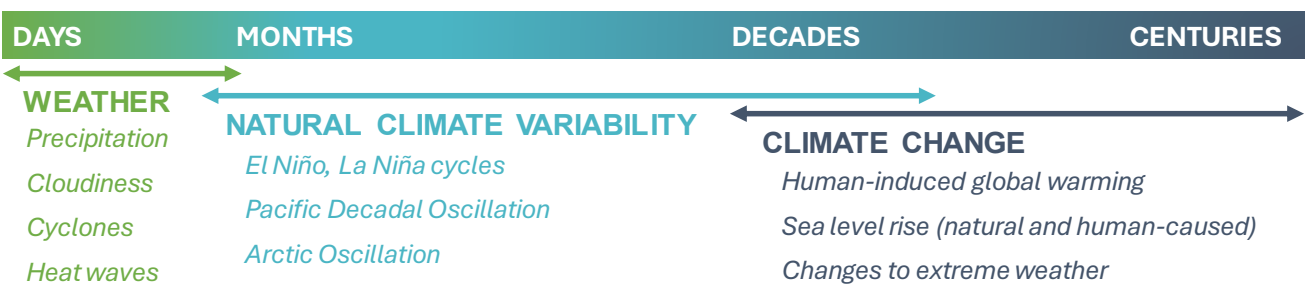
The Earth's climate is changing due to the burning of fossil fuels, which releases greenhouse gases (GHGs) and aerosols into the atmosphere. Over the past century, these emissions have increased atmospheric GHG concentrations well above preindustrial levels, driving widespread warming across the planet.

Global average temperatures have already increased by over 1°C, and Canada is warming at approximately twice the global rate. This warming has contributed to widespread impacts in Canada and around the world and is directly linked to the total amount of GHGs emitted since the beginning of the industrial era. Although a 1°C temperature increase at a specific location may seem modest, even small increases in global average temperatures represent substantial changes because they reflect long-term warming averaged across the entire Earth system.

Understanding Weather, Climate, Natural Variability and Climate Change

To understand climate change, it is important to distinguish between weather and climate, and the natural and human influences that affect the climate on different time scales:

- **Weather** is what we experience when we step outside. It consists of short-term (minutes to days) variations in the atmosphere.
- **Climate** is the general state of weather, including its extremes, over periods ranging from months to many years. Climate can be thought of as the statistics of weather. Descriptions of normal climate conditions at a particular location are often derived from nearby weather observations and collected over long time periods – typically 30 years or more.
- **Natural climate variability** causes fluctuations in climate conditions that can span a few months to a few decades or longer. Natural climate variability is not influenced by human activity, but its influence can either mask or enhance human-induced climate change for the periods over which it occurs. Natural climate variability can also affect seasonal weather (e.g., El Niño/La Niña cycles).
- **Climate change** refers to changes in the state of the climate that persist over an extended period. Both natural processes and human influence can result in changes in climate. Climate science indicates that human influence is the unequivocal cause of the global warming that has been observed since the beginning of the 20th century.

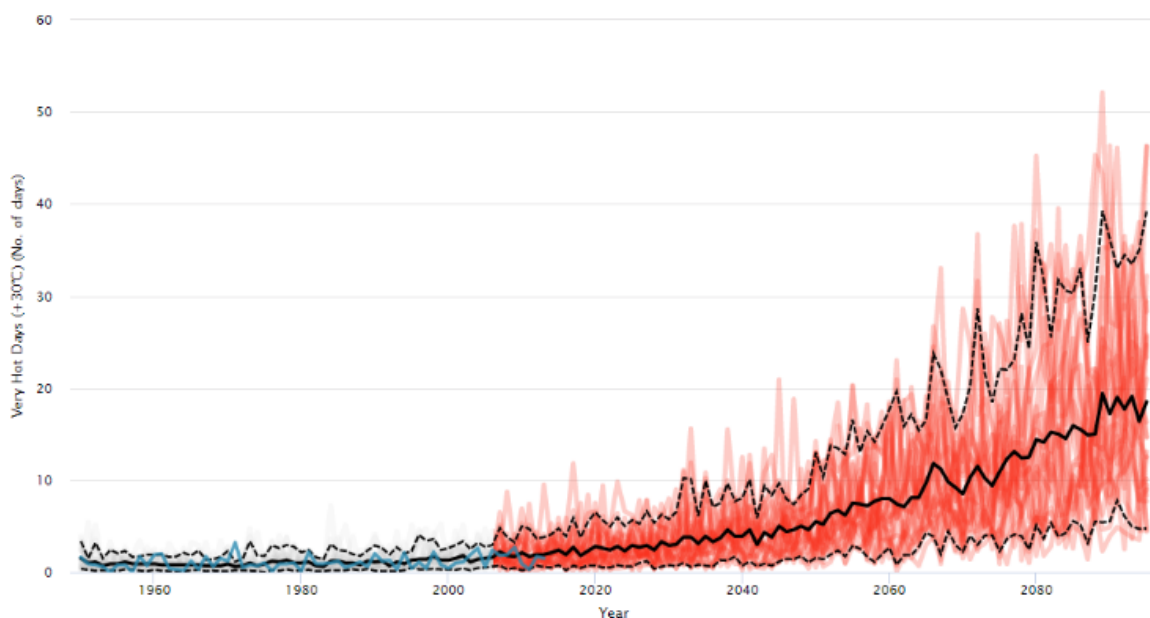


What is climate data?

Historically, practitioners and decision-makers have relied on past weather and climate observations to understand climate-related risks. However, because the climate is changing, past conditions are no longer sufficient for understanding future risk. Combining historical climate observations with projections of the future climate provides a stronger and more reliable basis for planning and decision-making.

The amount of future warming and related climate changes will depend how much GHGs are emitted globally. Because we cannot know exactly how society will develop in the future, scientists use a range of possible emissions scenarios to explore different climate futures. These scenarios are based on different assumptions about factors affecting global GHG emissions, including population growth, climate policy, land use changes, energy intensity, economic activity, and more. The scenarios used in this assessment are called Shared Socio-economic Pathways (SSPs).

Scientists around the world develop global climate models (GCMs) to simulate how the Earth's climate may change under different emissions scenarios. These models are tested against historical climate observations and compared with one another to improve confidence in their results. Through the Coupled Model Intercomparison Project (CMIP), scientists can combine results from many climate models to create an ensemble that represents a range of plausible future climate conditions. While climate models cannot capture every possible future, they help us understand the range of changes that could occur.



The figure above shows results from an ensemble of 24 GCMs. The number of very hot days (days with maximum temperatures exceeding 30°C) is shown between 1950 and 2100. Each red line represents the projections from single model. The solid black line shows the median, or middle, projection across all 24 models. The dotted lines showing the range that contains most model results, from the 10th percentile (lower range) to the 90th percentile (upper range).

Understanding Shared Socio-economic Pathways

To project future climate conditions, climate models need information about how GHG emissions may change over time. Shared socio-economic pathways (SSPs) provide a set of possible futures based on different assumptions about how society may develop over the coming century.

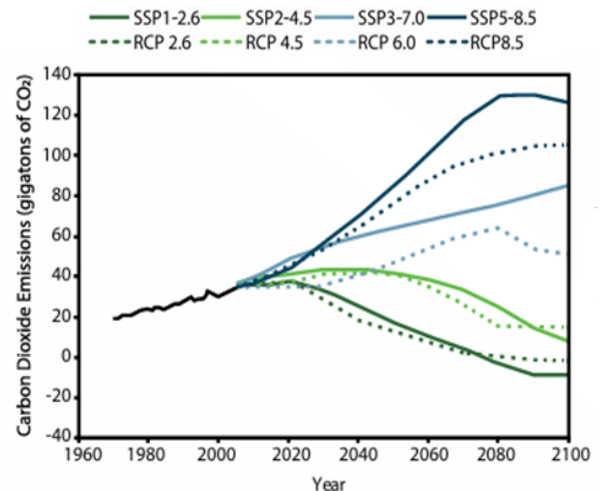
SSPs consider factors such as:

- (1) how population, education, energy use, technology – and more – may change over the next century, and
- (2) the level of ambition for mitigating climate change globally

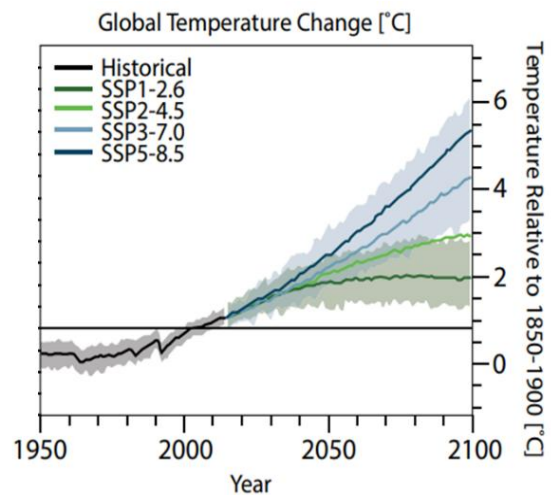
Together, these assumptions create different emissions pathways that can be used to explore how the climate may change under a range of future conditions.

The latest generation of climate modelling (CMIP6) uses five main SSPs (SSP1 to SSP5). Each pathway represents a different future, ranging from low emissions (SSP1) to high emissions (SSP5). SSPs replace an earlier set of emissions scenarios called Representative Concentration Pathways (RCPs), which were used in the previous generation of climate modelling (CMIP5).

The figures below show projected GHG emissions and global temperatures under different emissions scenarios. In the near term, while future emissions vary considerably, projected temperatures remain similar. This is because the climate system responds slowly to changes in emissions. Around the middle of the century, however, temperature projections begin to diverge more noticeably as the effects of different emissions pathways become increasingly important.



SSP scenarios used by CMIP6 models for global CO₂ emissions by the end of this century. The scenarios used for CMIP5 (RCPs) are also shown.



Historical and future temperature change from 1950-2100, relative to 1850-1900. After 2014, models are driven by the SSP scenarios indicated, with ranges shown for SSP1-2.6 and SSP3-7.0. The horizontal line shows temperature change that has occurred up to 1995-2014 (about +0.85°C).

Climate change uncertainty

While we know the climate is changing, we cannot predict exactly what future conditions will be – even with highly sophisticated climate models. This is because all climate projections contain some uncertainty.

There are three main sources of uncertainty in climate projections:

- ✓ **Natural climate variability** refers to the natural climatic fluctuations that occur without human influence. These fluctuations can temporarily mask or enhance the effects of human-induced climate change and can be difficult to predict.
- ✓ **Model uncertainty** exists because climate models are simplified representations of the Earth's climate system. While they are very powerful tools, no model can perfectly capture every process that influences the climate. Different models may also represent climate processes in slightly different ways. To account for model uncertainty, climate scientists use an ensemble, or collection, of climate models to represent a range of plausible future conditions. For BC, PCIC uses an ensemble of nine climate models that are best suited to the region.
- ✓ **Scenario uncertainty** reflects the fact that we do not know how GHG emissions will change in the future. Future emissions will depend on many factors that are impossible to predict. In the near term, scenario uncertainty is less significant because projected changes remain similar up until the middle of the century. In the long term, it is best practice to evaluate future projections under more than one emissions pathway to help address this uncertainty.

Climate uncertainty should not stand in the way of action. Climate projections provide valuable information about the direction and magnitude of future change and can help decision-makers assess risks and plan for the future. At the same time, it is important to recognize that actual future conditions could fall outside the projected range, particularly when managing long-term or critical risks.

Appendix C: Guidance for using climate projections

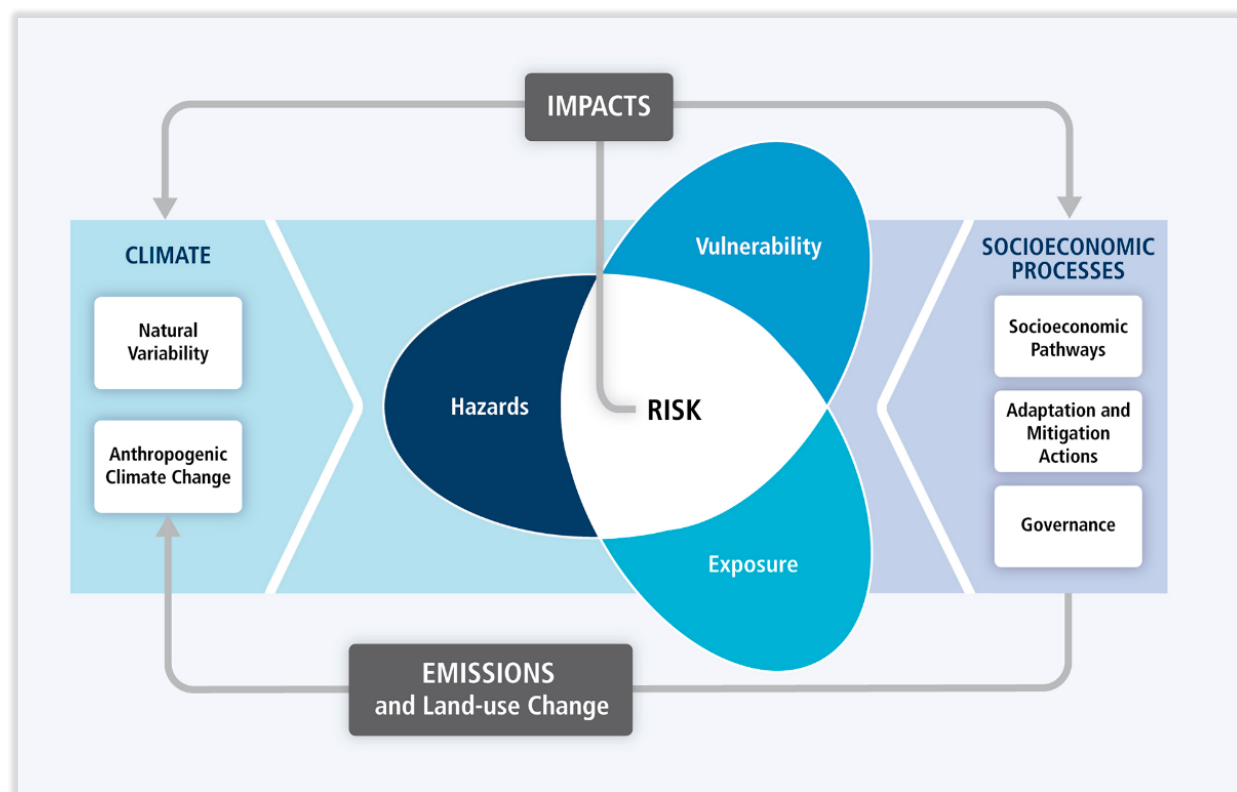
Key Messages

- ✓ **Climate projections are complex**, and you will likely need advice and guidance from experts in the field. Allow adequate time for consultation.
- ✓ **The climate has always varied naturally** from year to year and decade to decade. These natural fluctuations now occur alongside long-term warming caused by GHG emissions and can sometimes mask or amplify climate change.
- ✓ **Since we do not know what future global emissions will be**, climate projections are produced for multiple emissions scenarios. In the CMIP6 ensemble, projections are generally similar in the near term (up to 2050s) but begin to differ more significantly beyond the middle of this century.
- ✓ **There is no single “most likely” emissions scenario.** The most appropriate scenario to use will depend on factors such as your planning horizon and risk tolerance. Considering a high emissions scenario can help ensure that adaptation measures remain effective for a longer period of time if, in fact, a lower emissions scenario plays out.
- ✓ **Review multiple climate indicators** to develop a more comprehensive understanding of future climate risks. Consider both annual and seasonal projections, as changes may vary throughout the year.
- ✓ **In many cases, it is not enough to rely on the median (middle) climate projection.** It is important to consider the full range of possible outcomes, including both lower and higher estimates (10th and 90th percentiles), especially when planning for high-risk impacts or long-lived infrastructure. When managing risk, do not ignore outcomes that fall outside the typical projected range, particularly for rare but high-impact events.

Assessing climate risk

Climate risk is the risk posed by the impacts of climate change. It depends on the complex interaction between the climate-related hazard(s), exposure and vulnerability¹⁵.

- ✓ **Hazards** are climate-related events or conditions, such as extreme heat or heavy rainfall, that may become more frequent or severe with climate change.
- ✓ **Exposure** refers to what is located in an area that could be affected by a hazard, such as people, ecosystems, or infrastructure.
- ✓ **Vulnerability** describes how sensitive or able to cope those exposed elements are. For example, some communities may be more vulnerable to extreme heat due to factors such as age, health or access to cooling.



Climate risk is greatest when a severe hazard happens in a place where people or assets are highly exposed and where there is high vulnerability. Climate data can help us understand how hazards may change in the future, but it is only one part of assessing overall climate risk.

¹⁵ IPCC, 2014: Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.

Which emissions scenario(s) should I use?

Climate projections are generated using climate models and emissions scenarios. Differences between models reflect limits in our understanding of how the climate systems works. Differences between emissions scenarios reflect uncertainty about how society will change in the future, including decisions on energy use, land practices, technology and climate policy. Because of these uncertainties, it is best to consider a range of possible futures as represented by different climate models and emissions scenarios.

For this assessment, PCIC has selected a range of climate models that are well suited to regions across BC to reduce model uncertainty. For the report, all projected changes are under a high emissions scenario (SSP585), but a moderate emissions scenario (SSP245) is also available in the complete data package. The choice of emissions scenario depends on the context of the decision, including the planning horizon and the level of risk being considered, as described below.

TIME HORIZON

When choosing an emissions scenario, it is important to consider how long your decision or project will last. Planners and decision-makers may be able to minimize scenario uncertainty by first determining the decision-making timeframe.

In the near term (the next couple decades), projections are similar across emissions scenarios. This means the choice of scenario is less important for short-lived or frequently updated decisions. For example, a material choice for road surfacing that is revisited every 20-30 years may not be highly sensitive to the emissions scenario used. In many cases, planning for the 2050s under a high emissions (SSP585) scenario is roughly equivalent to planning for the 2080s under a moderate emissions scenario (SSP245).

Over longer time periods (50 to 75 years or more), projections begin to diverge more significantly, and the choice of emissions scenario becomes more important. For example, designing the capacity of a storm sewer system that will last 75 years requires consideration of longer-term changes in climate conditions. In this case, the choice of emissions scenario has more weight.

LEVEL OF ACCEPTABLE RISK

Climate scientists can help explain how climate hazards may change, but it is up to decision-makers to determine what level of risk is acceptable for their assets or responsibilities. This requires discussion between relevant partners to understand potential impacts under different scenarios.

When selecting scenarios, decision makers should consider:

1. "What parts of the project are most sensitive to climate change?"
2. "How likely is the hazard should a higher emissions pathway occur?"
3. "What level of risk is acceptable?"
4. "How should risk and cost be balanced?"

Determining acceptable risk often requires input from multiple partners and should be guided by relevant organizational policies or frameworks. For guidance on assumption of risk, see the [CVRD Risk Tolerance Policy](#).

Appendix D: Complete List of Climate Indices

Code	Variable	Definition	Units
TEMPERATURE INDICES			
TM	Mean (average) temperature	Average daily temperature (in a year or season)	°C
TX	Maximum temperature	Average daytime high temperature (in a year or season)	°C
TN	Minimum temperature	Average nighttime low temperature (in a year or season)	°C
TXX	Hottest Day	Highest daytime high temperature (in a year or season)	°C
TNX	Warmest Night	Highest nighttime low temperature (in a year or season)	°C
TXN	Coldest Day	Lowest daytime high temperature (in a year or season)	°C
TNN	Coldest Night	Lowest nighttime low temperature (in a year or season)	°C
SU, SU30	Summer Days	Number of days in a year with a maximum temperature above 25°C (SU) or 30°C (SU30)	days
TR16, TR20	Temperate and Tropical Nights	Number of days in a year with a minimum nighttime temperature above 16°C (TR16) or 20°C (TR20)	days
TX90P	Hot Days Frequency	Percentage of days in a year with a maximum temperature exceeding the 90 th percentile of the past	%
TN90P	Hot Nights Frequency	Percentage of days in a year with a minimum temperature exceeding the 90 th percentile of the past	%
TX10P	Cold Days Frequency	Percentage of days in a year with a maximum temperature below the 10 th percentile of the past	%
TN10P	Cold Nights Frequency	Percentage of days in a year with a minimum temperature below the 10 th percentile of the past	%

Code	Variable	Definition	Units
WSDI	Warm Spell Duration	Number of at least 6 consecutive days when the max temperature exceeds the 90 th percentile of the past	days
CSDI	Cold Spell Duration	Number of at least 6 consecutive days when the max temperature is below the 10 th percentile of the past	days
DTR	Diurnal Temperature Range	The difference between the highest and lowest daily temperatures (in a year or season)	°C
FTD	Freeze-Thaw Days	Number of days (in a year or season) with a maximum temperature above 0°C and a minimum temperature below 0°C	days
ID	Ice Days	Number of days (in a year or season) with a maximum temperature below 0°C	days
FD	Frost Days	Number of days (in a year or season) with a minimum temperature below 0°C	days
GSL	Growing Season Length	Number of days between the first span of at least 6 days with an average temperature above 5°C and the first span of 6 days after July 1st with an average temperature below 5°C	days
CDDcold18C	Cooling Degree Days	Cumulative difference of the daily average temperature above 18°C. Rough estimate of annual cooling required for a generic building.	degree days
HDDheat18C	Heating Degree Days	Cumulative difference of the daily average temperature below 18°C. Rough estimate of annual heating required for a generic building.	degree days
FDDfreeze0C	Freezing Degree Days	Cumulative difference of the daily average temperature below 0°C.	degree days
GDDgrow5C	Growing Degree Days	Cumulative difference of the daily average temperature above 5°C. A measure of whether climate conditions are warm enough to support plant and insect growth.	degree days

Code	Variable	Definition	Units
HEATWAVE INDICES¹⁶			
HWD	Heatwave Days	Number of days classified as a heatwave in a year	days
HWXL	Longest Heatwave Length	Length of the longest heatwave in a year	days
HWN	Heatwave Number	Number of distinct heatwaves in a year	n/a
TXH	Average Heatwave Maximum Temperature	Maximum temperature averaged over all heatwaves in a year	°C
TXHX	Extreme Heatwave Maximum Temperature	Maximum temperature during the most extreme heatwave in a year	°C
TNH	Average Heatwave Minimum Temperature	Minimum temperature averaged over all heatwaves in a year	°C
TNHX	Extreme Heatwave Minimum Temperature	Minimum temperature during the most extreme heatwave in a year	°C
HWDD	Heatwave Degree Days	Cumulative difference of the daily average temperature above the heatwave threshold	degree days
PRECIPITATION INDICES			
PR	Total Precipitation	Total precipitation (in a season or year)	mm
RN	Total Rainfall	Total rainfall (in a season or year)	mm
SN	Total Snowfall	Total snowfall (in a season or year)	mm ¹⁷
SDII	Wet Day Precipitation	Average daily precipitation on days with at least 1mm of precipitation	mm
R1MM	Wet Days > 1mm	Number of days (in a year or season) with at least 1mm of precipitation	days
R10MM	Wet Days > 10mm	Number of days (in a year or season) with at least 10mm of precipitation	days

¹⁶ For this assessment, heat waves are defined to occur when both **maximum and minimum temperatures (a) exceed the BCHARS threshold of TX=28°C and TN=13 °C and (b) exceed the 95th percentile of the past, for at least 2 consecutive days.**

¹⁷ mm rain equivalent.

Code	Variable	Definition	Units
R20MM	Wet Days > 20mm	Number of days (in a year or season) with at least 20mm of precipitation	days
RX1DAY	Maximum 1-day Precipitation	The largest amount of precipitation that falls in a single day (in a season or year)	mm
RX2DAY	Maximum 2-day Precipitation	The largest amount of precipitation that falls in a 2-day period (in a season or year)	mm
RX5DAY	Maximum 5-day Precipitation	The largest amount of precipitation that falls in a 5-day (in a season or year)	mm
R95DAYS	Very Wet Days	Number of days in a year when total precipitation exceeds the 95 th percentile of the past	days
R99DAYS	Extreme Wet Days	Number of days in a year when total precipitation exceeds the 99 th percentile of the past	days
R95P	Very Wet Day Amount	Total precipitation in a year that falls on "Very Wet Days"	mm
R99P	Extreme Wet Day Amount	Total precipitation in a year that falls on "Extreme Wet Days"	mm
CDD	Consecutive Dry Days	Number of days during the longest consecutive stretch of dry days (days with less than 1mm precipitation) in a year	days
CWD	Consecutive Wet Days	Number of days during the longest consecutive stretch of wet days (days with at least 1mm of precipitation) in a year	days
WATER BALANCE (DROUGHT) INDICES¹⁸			
AgYrDry	Agricultural Year Dry Months	Number of months between September and August with moderate to severe drought (SPEI ≤ -1)	months
AgYrWet	Agricultural Year Wet Months	Number of months between September and August with moderate to severe wetness (SPEI ≥ 1)	months

¹⁸ The SPEI is a normalized measure of the balance between wet and dry conditions over 6–12-month periods. It uses monthly average temperature and precipitation data only (land surface conditions are not included).

Code	Variable	Definition	Units
WSDry	Warm Season Dry Months	Number of months between April and September with moderate to severe drought ($SPEI \leq -1$)	months
CSDry	Cold Season Dry Months	Number of months between October and April with moderate to severe drought ($SPEI \leq -1$)	months
WSWet	Warm Season Wet Months	Number of months between April and September with moderate to severe wetness ($SPEI \geq 1$)	months
CSWet	Cold Season Wet Months	Number of months between October and April with moderate to severe wetness ($SPEI \geq 1$)	months
AgYrDry_RP10	Agricultural Year Dry Return Period	Return period of historical 1-in-10 year dry event (lowest 10% of SPEI)	years
AgYrWet_RP10	Agricultural Year Wet Return Period	Return period of historical 1-in-10 year wet event (highest 10% of SPEI)	years
WSDry_RP10	Warm Season Dry Return Period	Return period of historical warm season 1-in-10 year dry event (lowest 10% of SPEI)	years
CSDry_RP10	Cold Season Dry Return Period	Return period of historical cold season 1-in-10 year dry event (lowest 10% of SPEI)	years
WSWet_RP10	Warm Season Wet Return Period	Return period of historical warm season 1-in-10 year wet event (highest 10% of SPEI)	years
CSWet_RP10	Cold Season Wet Return Period	Return period of historical cold season 1-in-10 year wet event (highest 10% of SPEI)	years
RETURN LEVELS			
RN1DAY_RL RN2DAY_RL RN5DAY_RL	Maximum 1-, 2-, and 5-day Rainfall Return Level	5, 10, 20, 30 and 50-year return levels for maximum 1-day, 2-day or 5-day rainfall	mm
TX_RL	Maximum Temperature Return Level	5, 10, 20, 30 and 50-year return levels for maximum temperature	°C
TN_RL	Minimum Temperature Return Level	5, 10, 20, 30 and 50-year return levels for minimum temperature	°C
RETURN PERIODS			
RN1DAY_Future-RP, RN2DAY-Future-RP, RN5DAY_Future-RP	Maximum 1, 2 and 5-day Rainfall Return Period	Future return period of the historical 5, 10, 20, 30 and 50-year maximum 1-day, 2-day and 5-day rainfall amount	years

Code	Variable	Definition	Units
TXx_RPx Hottest Day	Maximum Temperature Return Period (e.g., 1-in-20 Hottest Day)	Future return period of the historical 5, 10, 20, 30 and 50-year maximum temperature	years
TNx_RPx	Minimum Temperature Return Period (e.g., 1-in-20 Coldest Night)	Future return period of the historical 5, 10, 20, 30 and 50-year minimum temperature	years