Climate Projections for the City of Terrace

December 2022 (Draft)

Land Acknowledgement

We acknowledge the Tsimshian people, on whose unceded Traditional Territory the City of Terrace is located, and the the Haisla, Gitxsan, and Wet'suwet'en peoples, whose unceded Traditional Territories share the lands and waters in the regional context of this report. We recognize the shared roles and responsibilities to protect these lands and communities from the impacts of climate change.

Executive Summary

Terrace has already begun to feel the effects of climate change. The unprecedented heat dome event of 2021 is just one example that illustrates climate change is happening, and having an impact all around the city and across the region.

The City of Terrace (the City) requires locally specific information on how the climate will continue to change as it works to prepare infrastructure and enable citizens to prepare for continued climate change over time. Locally and regionally specific information enables planning for and building resilience over time, by informing planning and decision-making, and influencing resource allocation decisions across sectors.

The City has commissioned the Pacific Climate Impacts Consortium (PCIC) to prepare a comprehensive assessment of regional climate change for Terrace and has engaged Pinna Sustainability professionals to assist with conveying this assessment into a summary that can be used to plan and adapt to the changes ahead. This assessment provides information derived from global climate models on projected temperature and precipitation (rain and snow) in the coming decades. It gives us important insight into how these changes will differ by season, and by future time period (the 2050s and 2080s), and also offers information on expected changes in future weather extremes.

Climate models project an average annual temperature increase of about 3°C in the city by the 2050s. The projections show that the region will undergo a significant seasonal shift over time – by the 2080s, most September temperatures will be comparable to past July and August temperatures, and January daytime highs will be similar to past March temperatures. Alternatively, freezing temperatures outside the November to March period will be rare.

With the warming climate, the number of summer days where average temperatures reach above 25°C will more than double in the city, from 21 to 45 days per year, on average, by the 2050s. Very hot days, which recorded temperatures at 36°C, are projected to increase to 40°C by the 2050s. While these temperatures will lead to higher risks of wildfire, they will also cause a 50% increase in growing degree days by the 2050s and a 30% increase in the growing season length, a potential positive impact for the region.

The warming trend will have substantial implications for ecosystems and species, as well as water supply and demand, and will also impact food and agricultural sectors, along with the health of residents and visitors. Warmer winters mean the city will experience a 55% decrease in the number of frost days by the 2050s, with significant impacts on the natural environment, and reducing heating demand for buildings. Warmer summers will see a 4°C increase in the hottest summer days by the 2050s, creating a new demand for cooling in residential and commercial buildings.

Annual precipitation across the region is projected to rise by 8% by the 2050s and 15% by the 2080s, with significant increases expected in autumn. Projections show approximately 30% more precipitation on very wet days (95th percentile) and 50% more on extremely wet days (99th percentile) by the 2050s, which means that extreme precipitation events (rain and snow) will become much stronger over time. Despite the projected increased intensity of wet events, summer rainfall is expected to remain near historical levels by mid-century, with slight reductions by end of the century and a consequent slight increase in the length of summer dry spells.

The climate will change consistently throughout the city, as it is mostly located at low elevations. However, as temperature is elevation-dependent, there will be stronger changes in certain variables at high elevations. For example, while the number of "summer days" is projected to double within the municipal boundary of Terrace by the 2050s (where the past experienced 20 days a year, on average), it will nearly triple in the surrounding high-elevation areas (where the past experienced 5 days a year, on average). As a result, snowpack in these adjacent foothills and mountains will decrease in response to higher temperatures.

This document is intended to support decision-making throughout the region and to help community partners better understand how their work may be affected by the changing climate.

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CONTRIBUTING AUTHORS

Charles Curry and Stephen Sobie from Pacific Climate Impacts Consortium conducted climate model downscaling, analysis, and data interpretation, and provided valuable suggestions for the report.

Gillian Aubie Vines and Rodrigo Baston from Pinna Sustainability served as data interpreters, facilitators, and writers of this summary report. Jennifer MacIntyre was the City of Terrace's project manager for this work, supported by Sam Hadfield.

ACKNOWLEGEMENTS

We would like to acknowledge the time, effort, and input received from numerous City of Terrace staff and Technical Working Group members. We would also like to thank the Pacific Institute for Climate Solutions for providing resources through their Sustainability Intern Program, which allowed the City of Terrace to increase staff capacity, and Sam Hadfield for his contributions in this role.

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CHAPTER 1

Introduction

Terrace residents are becoming more familiar with climate-related events. In 2021, summer brought the region a sustained heat dome, with a 3-day period of daily maximum temperatures above 30°C that caused heat-related deaths in the city[1], and put unprecedented stress on the water supply and distribution system. That following winter, the region experienced an extreme cold spell followed by an extreme rainfall event that contributed to the overwhelming of the sanitary sewer system for the first time in 30 years. These events illustrate the city's vulnerability to extreme weather and climate events, and the importance of a better understanding of future climate.

The City of Terrace has commissioned this work to improve the ability to make climate-informed decisions that build the City's resilience to climate change. The high-resolution regional projections presented in this report are based on the RCP 8.5 emissions scenario, and are to be used as tools to help better understand how Terrace's climate can be expected to change by the 2050s and 2080s. The results delivered in this report may differ from results found in previous reports due to the smaller scale of the study area in this report, which presents a variety of common climatic indicators that, taken together, provide a picture of how the climate can be expected to evolve over time.[2] They provide a starting point for the City to use when making asset management decisions, and when planning and investing in new or replacing ageing City infrastructure.

The last section of this report offers insight into the expected effects that climate change will have across the city, and through the community. Insights are shared on how climate change will have an impact on ecosystems; water resources; stormwater management; parks, recreation and culture; transportation; land use; buildings and energy systems; the economy; tourism; food and agriculture; human health; and emergency services. These summaries are designed to support future planning efforts.

TERRACE CLIMATE ADAPTATION PLAN

The City of Terrace is currently working on a multi-phased project to develop a city-specific **Climate Adaptation Plan**. This work involves:

○ **Phase 1:** Climate Projections Report
○ **Phase 2:** Climate Risk Assessment
○ **Phase 3:** Climate Adaptation and Mitigation Strategy

This report completes the Phase 1 climate projections and impacts analysis to support the next two phases of the planning process, by providing climate projections for the region that illustrate the dramatic changes we can expect in years to come.

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[1] https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf

[2] The Skeena Channel Management Report (McElhanney, 2021) analysis was based on best available data at the time, specifically the Plan2Adapt tool. The Plan2Adapt data corresponding to the Terrace region encompasses an area much larger that the region analyzed in this report. Due to the larger geographical scale, and the averaging that occurs in that analysis, it is less able to indicate Terrace-specific projections than this report.

A Note on Data Interpretation

Data in the report is broken into the municipality of Terrace, the Terrace region, and high and low elevation areas within the region (420-metre threshold). This elevation was chosen because it is the highest elevation found in the City of Terrace (Terrace Mountain).

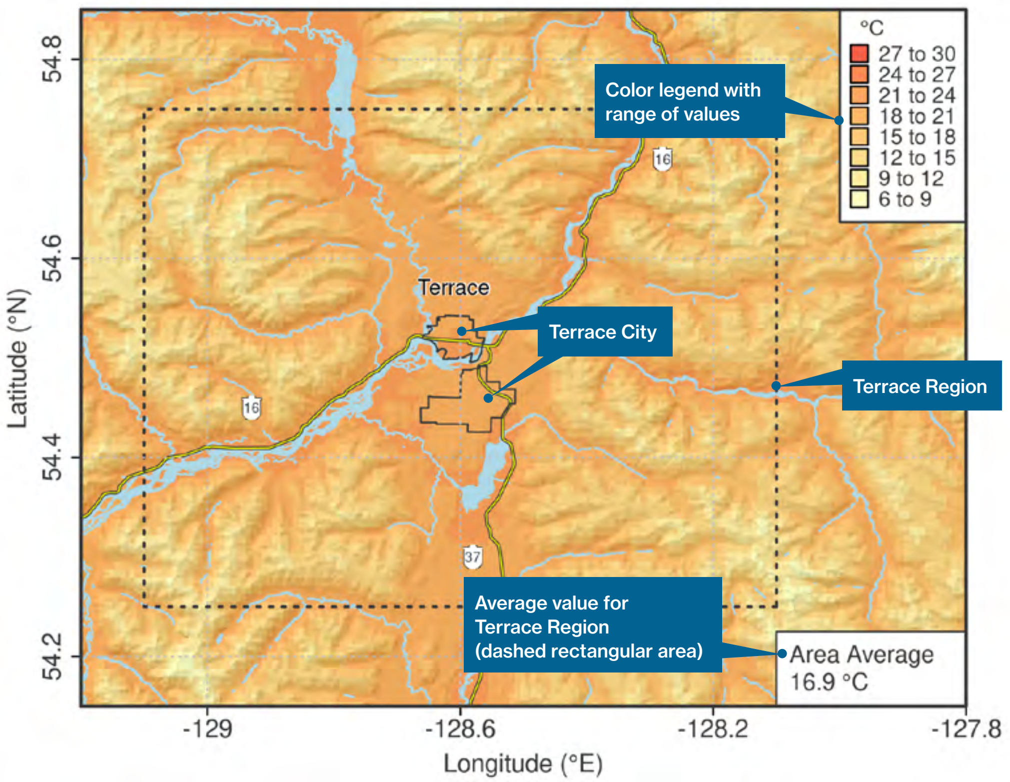
Past: In the tables, "past" refers to the historical baseline period of 1971–2000 (referred to as "1980s", the middle decade of this period), which is a World Meteorological Organization standard time period. Values are based on 12 different global climate models that have been adjusted to maximize agreement with historical observations and downscaled to high resolution (approximately 1 km x 1 km).

Selection of future time periods: Future projections are for the 2050s (spanning the 2041–2070 period) and 2080s (2071–2100 period). Values for each time period are averaged over each 30-year period. The range provided for each reflects the projections simulated by 12 different global climate models driven by a single future greenhouse gas emissions scenario (see Appendix 1: Methodology). Since any one of the model simulations could be the closest representation of the actual future climate, this range in results is an integral part of exploring climate change in an uncertain future.

Definition of seasons: Seasons are presented as winter (December-January-February), spring (March-April-May), summer (June-July-August), and autumn (September-October-November).

Understanding "average change": A 3°C average annual change may not seem like a big shift. However, it is a significant change that will be noticeable to everyone. For example, imagine a

How to interpret the maps:



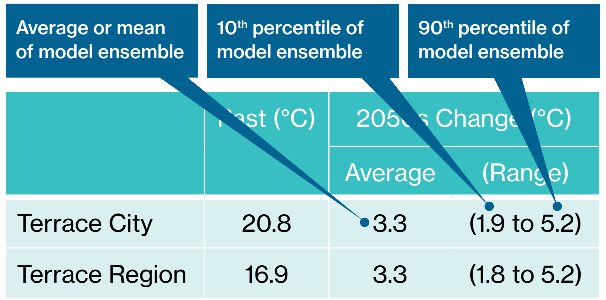
year where every day was normal except for a 36-day period where temperatures were 10 degrees warmer than the historical average over that period. That year will end up being only 1 degree warmer than the historical annual average. Now imagine a climate three times warmer than that. In this future climate, even the coldest years may be warmer than the warmest years in the past, and the warmest years will be unprecedented.[3]

How to read the tables and maps: Except where noted otherwise, all values and projected changes cited in the text and figures are average (mean) estimates from the climate models. The range in climate model results, which represents the uncertainty in these average estimates, can be viewed in the tables for each variable. The following methods were used when developing the values shown in the tables, maps, and plots in this report:

- In tables throughout the document, projected change is given for the mean of the model ensemble along with the range (10th to 90th percentile) of the model ensemble. The 10th to 90th percentile range describes the uncertainty among the models and natural climate variability.
- Past, future, and projected change values are also summarized in tables for the Terrace region. Table values are shown for four different regions: the municipal boundary of Terrace (Terrace City), Terrace region (rectangular area on the maps), low elevation areas (<420 m), and high elevation areas (>420 m) within the Terrace region.
- In each map, the average value for the Terrace region (shown as the dashed grey rectangular area) is displayed in the bottom right-hand corner.
- This report provides several box-and-whisker plots to illustrate year-to-year and model-to-model variability over time. The diagram below illustrates how these plots are to be interpreted. The boxes in the report represent the likely ranges for each time period.

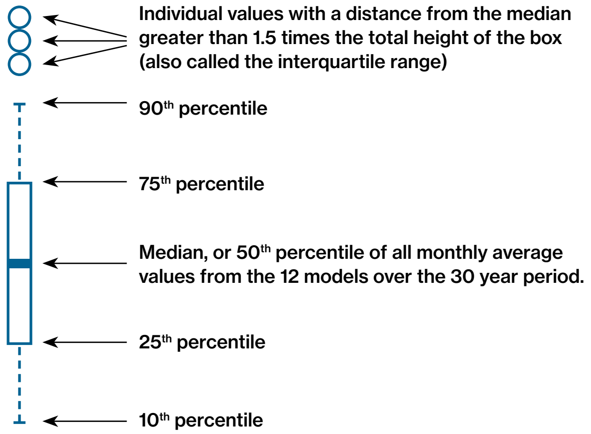
More information on climate scenario and model selection, as well as indicator derivation, is provided in Appendix 1.

How to read the tables:



	Past (°C)	2050s Change (°C)	
		Average	(Range)
Terrace City	20.8	3.3	(1.9 to 5.2)
Terrace Region	16.9	3.3	(1.8 to 5.2)

How to read the box-and-whisker plots:



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[3] Trevor Murdock, (Episode 1 – B.C. in 2050 “2050: Degrees of Change”, CBC, 2020.)

CHAPTER 2

General Climate Projections

The City of Terrace can expect noticeable climate changes in the coming decades:

- Warmer temperatures across all seasons.
- More pronounced changes in the shoulder seasons, due to lengthening summer-like temperatures and shorter periods of winter-like temperatures.
- A growing season that will last nearly all year.
- More “summer days”
- More extreme hot days in summer.
- Fewer days below freezing.
- More precipitation (rain and snow) in autumn, winter, and spring.
- Less precipitation falling as snow.
- More intense extreme temperature and precipitation events.

The experienced intensity of these changes each year, and each season, will vary, meaning these changes will not be steady over time. But by the 2050s, Terrace’s climate will be measurably different from the past. By the 2080s, residents of the city will experience a substantially different climate than in the Terrace of today.

This chapter contains historical (past) information and future projections for annual and seasonal temperature and precipitation, while the following chapters provide similar information for more targeted indicators, including many that describe climate extremes. For each indicator, a short description is provided, followed by data tables and maps showing projected behavior.

2.1 Warmer Temperatures

ABOUT THIS INDICATOR

Summer maximum temperature refers to the daily maximum temperature, averaged over the 90 days of summer (from June through August), and averaged over 30 years. **Winter minimum temperature** refers to the daily minimum temperature averaged over the 90 days of winter (from December through February), averaged over 30 years. These 30-year averaged values can hide both larger and smaller temperature increases that will be experienced during individual years, months, and days in the future. As a result, these indicators show typical summer highs and winter lows, and not values that would be experienced in warmer or cooler years. The latter are represented by extreme indicators, provided in the following sections.

PROJECTIONS

Projections show that by the 2050s, summers and winters will be over 3°C warmer on average. Compared to a projected average global warming of 2°C by the same period, it indicates a significant temperature change for the City of Terrace. By the 2080s, temperatures may increase by over 5°C. As noted above, these 30-year averaged values can hide both larger and smaller temperature increases that will be experienced as specific periods.

The maps below show the projected temperature changes across the region, indicating that although changes in temperature will be similar across the region, the lowest elevations will remain the warmest.

TABLE 1: SUMMER MAXIMUM TEMPERATURES

	Past (°C)	2050s (°C)	2050s Change (°C)		2080s (°C)	2080s Change (°C)	
			Average	(Range)		Average	(Range)
Terrace City	20.8	24.1	3.3	(1.9 to 5.2)	26.2	5.5	(3 to 8.3)
Terrace Region	16.9	20.2	3.3	(1.8 to 5.2)	22.3	5.5	(3 to 8.3)
Low Elev. (< 420m)	20.8	24.1	3.3	(1.8 to 5.1)	26.2	5.5	(3 to 8.3)
High Elev. (> 420m)	15.1	18.4	3.3	(1.8 to 5.2)	20.6	5.5	(3 to 8.4)

TABLE 2: WINTER MINIMUM TEMPERATURES

	Past (°C)	2050s (°C)	2050s Change (°C)		2080s (°C)	2080s Change (°C)	
			Average	(Range)		Average	(Range)
Terrace City	-4.2	-0.7	3.4	(2.4 to 4.8)	1.5	5.7	(4.2 to 7.7)
Terrace Region	-7	-3.6	3.4	(2.4 to 4.8)	-1.3	5.7	(4.2 to 7.7)
Low Elev. (< 420m)	-4.6	-1.1	3.4	(2.4 to 4.8)	1.1	5.7	(4.2 to 7.7)
High Elev. (> 420m)	-8.1	-4.6	3.4	(2.4 to 4.8)	-2.4	5.7	(4.2 to 7.7)

FIGURE 1: SUMMER AVERAGE DAYTIME HIGH TEMPERATURE—PAST

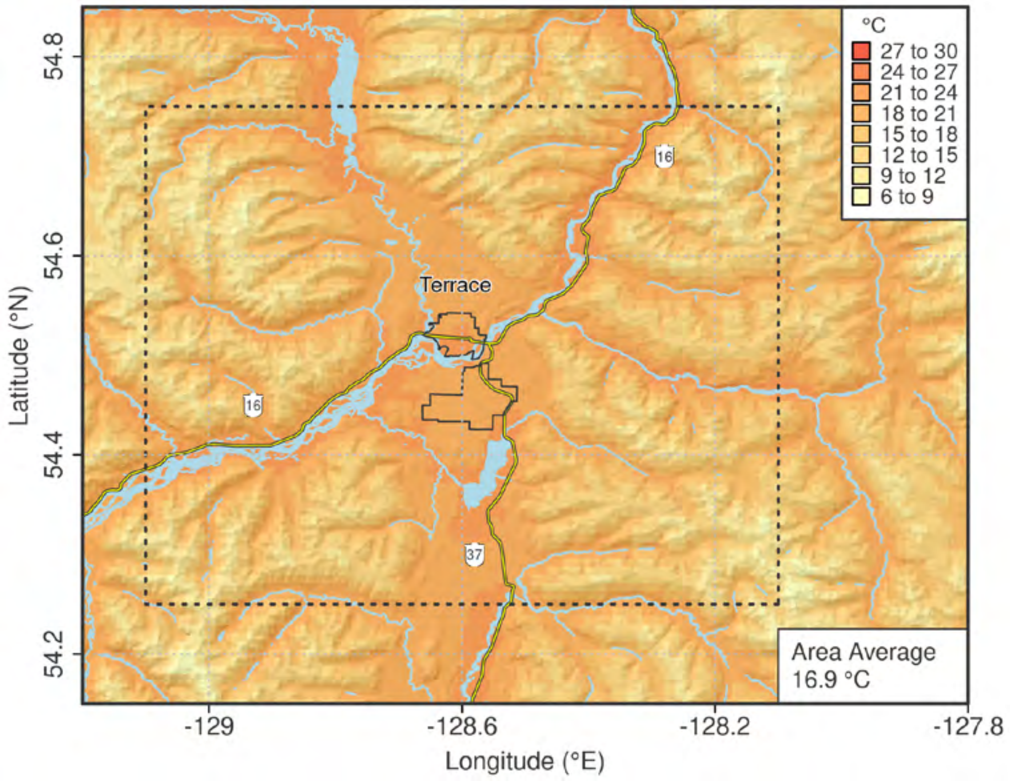


FIGURE 2: SUMMER AVERAGE DAYTIME HIGH TEMPERATURE—FUTURE (2050s)

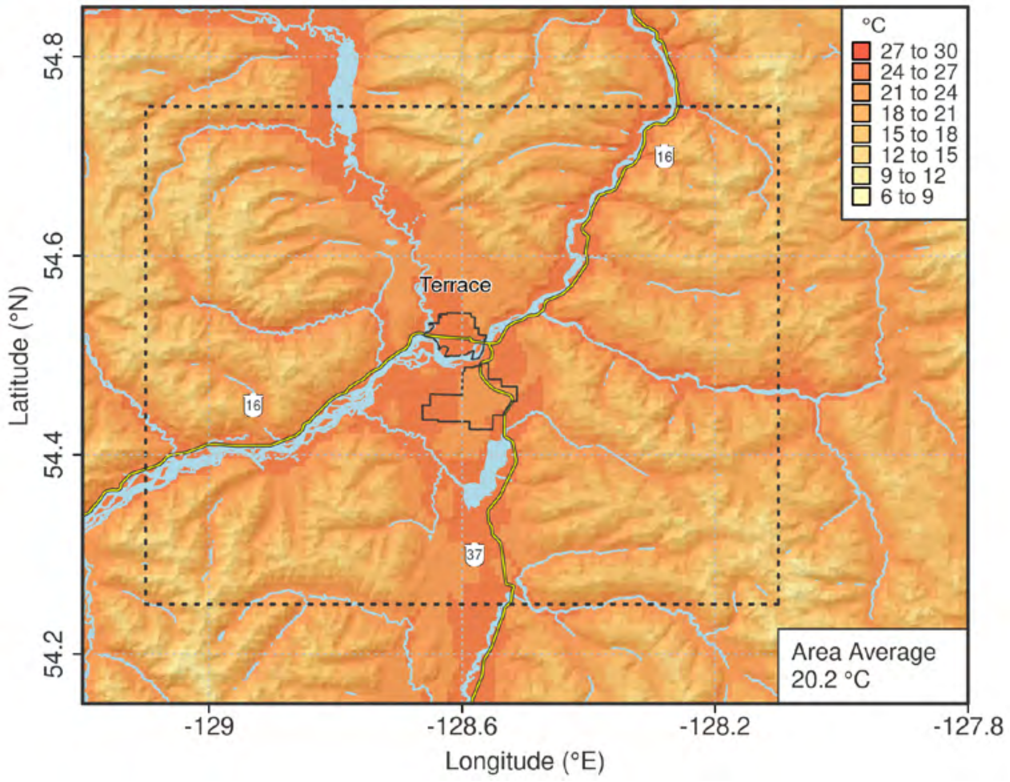


FIGURE 3: WINTER AVERAGE NIGHTTIME LOW TEMPERATURE—PAST

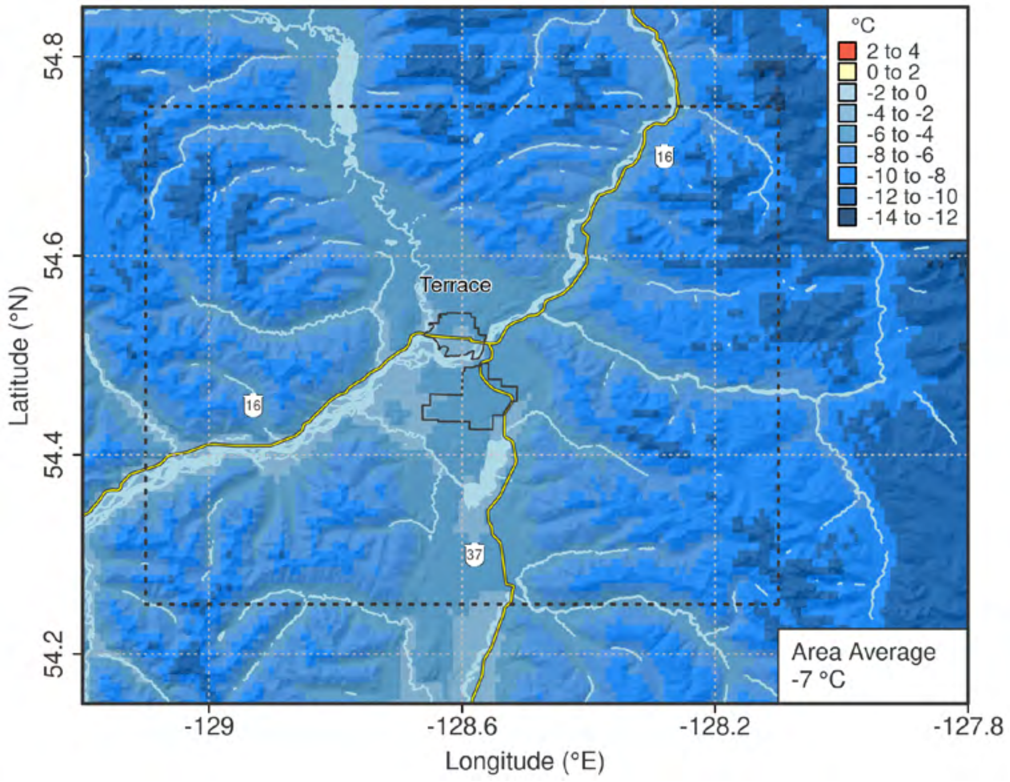
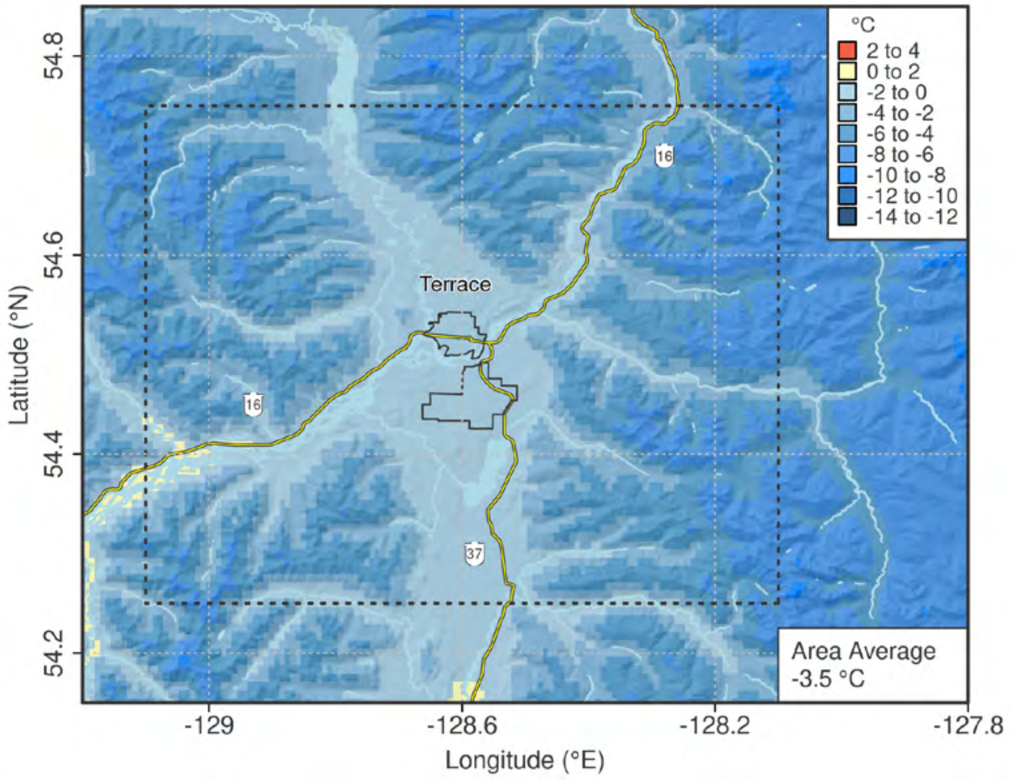


FIGURE 4: WINTER AVERAGE NIGHTTIME LOW TEMPERATURE—FUTURE (2050s)



2.2 Seasonal Variability in Temperature

The box-and-whisker plots of monthly daytime high and nighttime low temperatures provide a comparison of year-to-year variability over time. The daytime high temperature plot (Figure 5) shows that by the 2050s, these temperatures will be warmer in all months than in the past. In the 2080s, most September temperatures will be comparable to past July and August temperatures, and January daytime highs will be similar to past March temperatures. **This marks a significant change for Terrace and the surrounding regions.**

Winter nighttime temperatures in the past usually fell below the freezing point. By the 2050s, this is projected to occur about half the time; by the 2080s, winter temperatures will not dip below freezing very often (less than 25%). By the 2080s, average nighttime lows will be more than 5°C warmer than in the past, with spring, winter and autumn projected to warm faster than summer, with winter nights warming the most. **Freezing temperatures outside the November to March period will be very rare.**

FIGURE 5: MONTHLY DAYTIME HIGH TEMPERATURE—PAST, 2050s AND 2080s

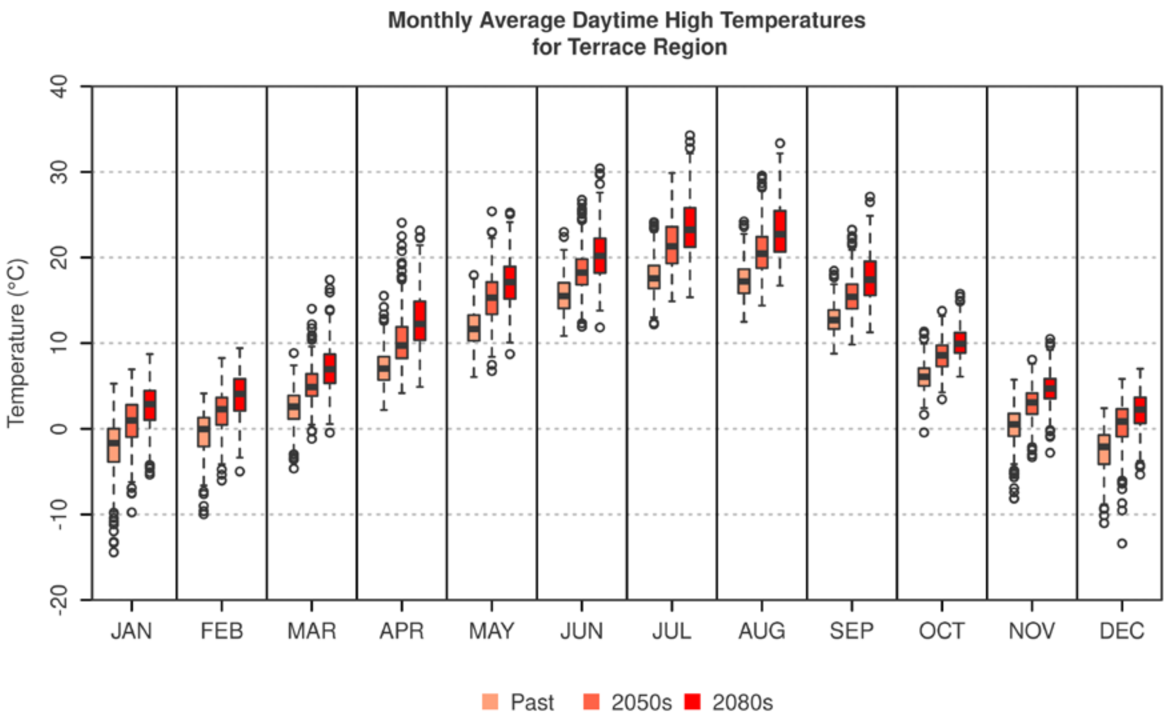
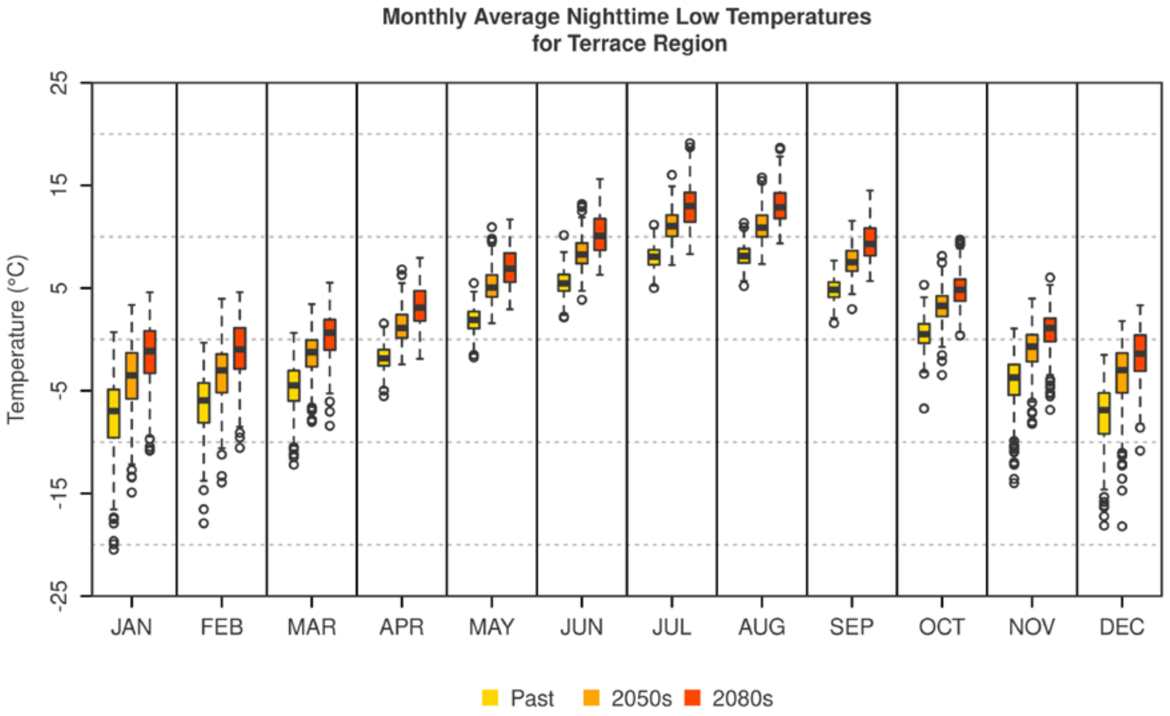


FIGURE 6: MONTHLY NIGHTTIME LOW TEMPERATURE—PAST, 2050s AND 2080s



2.3 Wetter in the Colder Months

ABOUT THIS INDICATOR

Total precipitation is all precipitation summed over a month, season, or year, including rain and snow water equivalent. This is a high-level indicator of how precipitation patterns are expected to change.

PROJECTIONS

Projections show that Terrace will experience an 8% increase in total annual precipitation by the 2050s and a 15% increase by the 2080s, on average. Autumn, winter, and spring will all experience an increase in precipitation, with autumn projected to have the largest increases of 15% by the 2050s and 25% by the 2080s. The average projected change in summer precipitation is slightly negative (-6% by end of the century but with a wide range over model projections), so summers may be slightly drier over time.

Table 3 and the maps in Figures 7 and 8 below show the projected change in precipitation, annually. The maps show that higher elevations that are historically wet (or snowy) will experience larger increases in precipitation.

TABLE 3: SEASONAL AND ANNUAL PRECIPITATION

		Past (mm)	2050s (mm)	2050s Change (%)		2080s (mm)	2080s Change (%)	
				Average	(Range)		Average	(Range)
SPRING	Terrace City	224	241	8	(-1 to 16)	259	16	(6 to 30)
	Terrace Region	294	315	8	(0 to 15)	336	15	(4 to 29)
SUMMER	Terrace CIty	162	160	0	(-19 to 17)	156	-3	(-25 to 33)
	Terrace Region	219	213	-2	(-22 to 16)	205	-6	(-29 to 22)
AUTUMN	Terrace City	494	564	14	(4 to 28)	606	23	(10 to 37)
	Terrace Region	694	796	15	(4 to 26)	855	23	(11 to 37)
WINTER	Terrace City	479	507	6	(1 to 17)	538	13	(-4 to 25)
	Terrace Region	655	691	6	(1 to 15)	734	12	(-4 to 24)
ANNUAL	Terrace City	1358	1473	9	(1 to 14)	1558	15	(9 to 22)
	Terrace Region	1865	2021	8	(1 to 14)	2135	15	(7 to 27)

FIGURE 7: AUTUMN TOTAL PRECIPITATION—PAST

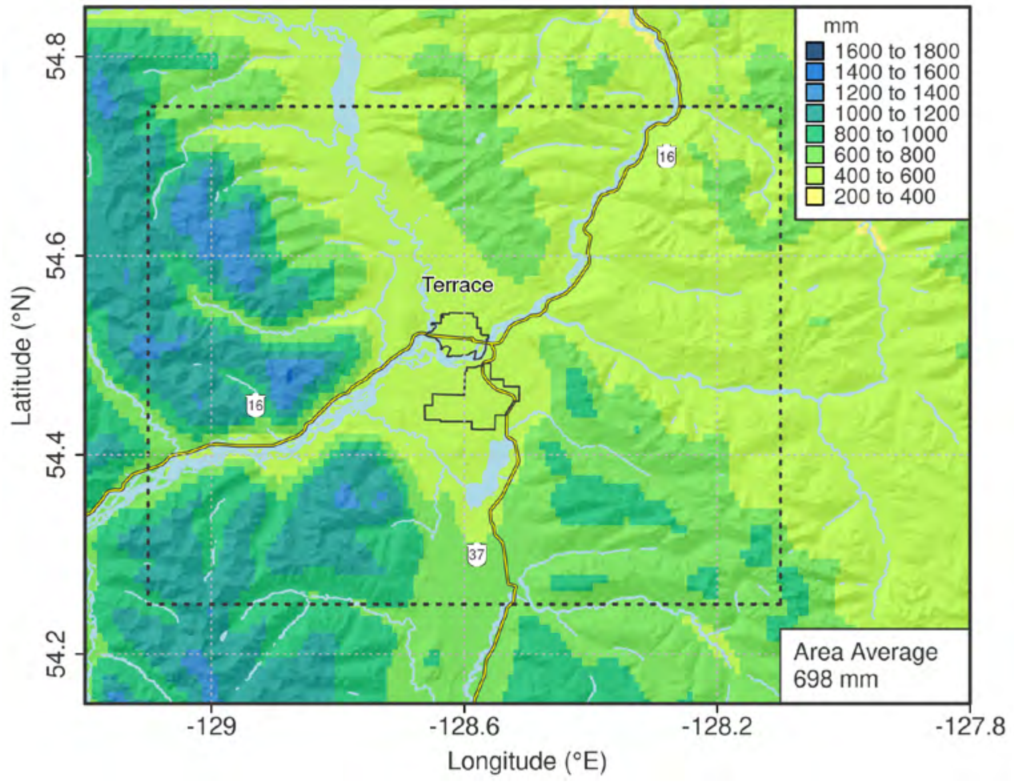
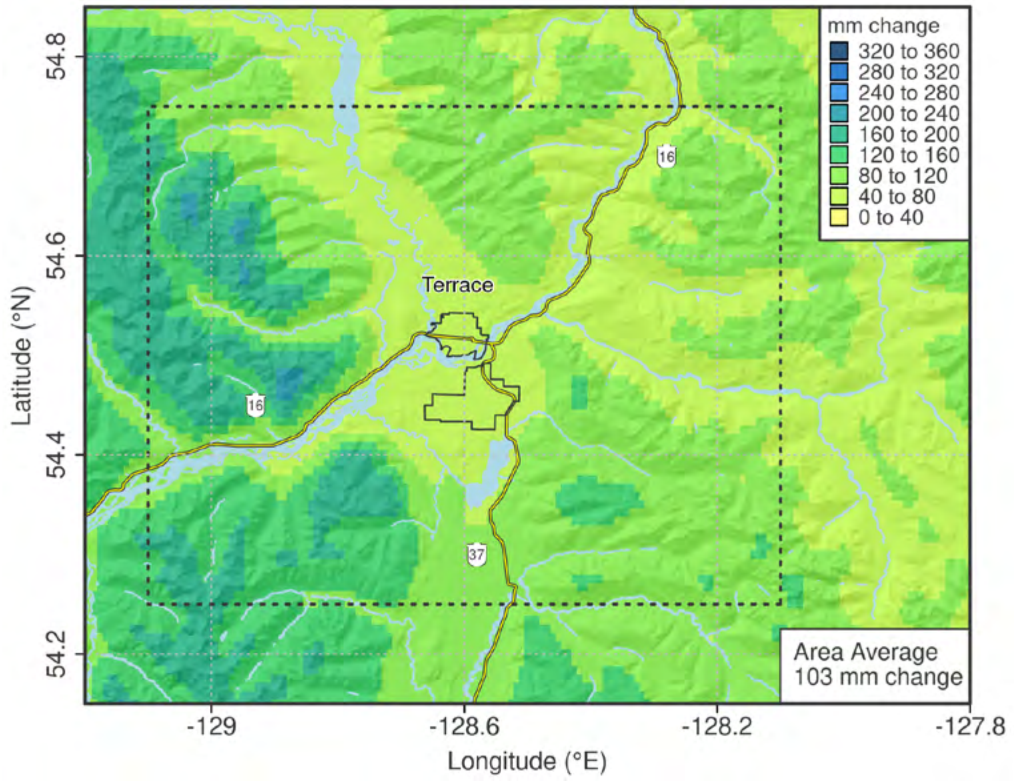


FIGURE 8: AUTUMN TOTAL PRECIPITATION—PERCENT CHANGE (2050s)



2.4 Precipitation as Snow

ABOUT THIS INDICATOR

Precipitation as snow is determined by the annual sum of all precipitation that occurs when the daily average temperature is below 0°C.

PROJECTIONS

Terrace and the surrounding region can expect warmer autumn, winter, and spring seasons (Figures 5 and 6). In the lower elevations, this change will cause more precipitation to falling as rain than snow. By the 2050s, we can expect snowfall in the region to decrease by approximately 50%, annually, on average (Table 4). Terrace will begin to experience more rainfall in autumn, winter, and spring (Figure 9).

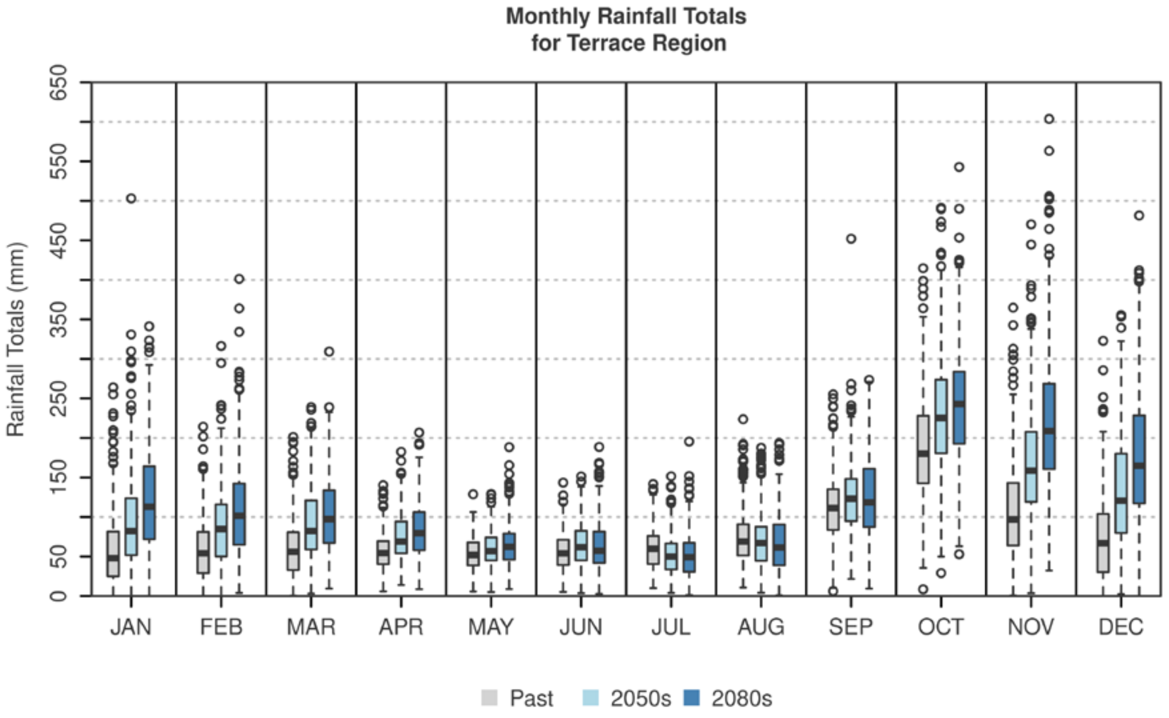
TABLE 4: PRECIPITATION AS SNOW

	Past (mm)	2050s (mm)	2050s Change (mm)		2080s (mm)	2080s Change (mm)	
			Average	(Range)		Average	(Range)
Terrace Region	429mm	227mm	-202mm	(-222 to -169mm)	147mm	-282mm	(-329 to -234mm)
			-47%	(-59 to -41%)		-66%	(-81 to -54%)

2.5 Seasonal Variability in Rainfall

As mentioned above, autumn, winter and spring precipitation is expected to increase, and summer precipitation is expected to decrease slightly in the Terrace region. Projections also show that much more of the cold season precipitation will fall in the form of rain. The boxplot below illustrates the expected changes to the amount of rainfall, by month, in the Terrace region. Future increases in rainfall are noticeable in all cold-season months, especially in November through January, when the range of monthly rainfall in the 2080s has little overlap with the 1980s ranges. The boxplots also show the variability in rainfall will increase dramatically over time.

FIGURE 9: MONTHLY TOTAL RAINFALL—PAST, 2050s, AND 2080s



CHAPTER 3

Warm Temperature Indicators

The average summer (June-July-August) daytime high temperatures are projected to rise, which implies that summer temperatures will be significantly warmer than they were in the past. With these changes, the occurance of heat stress and wildfire events will increase, which pose significant risks to people and ecosystems. Warmer weather may also have advantages, and careful planning and strategic investments will be required to take advantage of these benefits. The descriptions of selected temperature indicators and their projected changes are provided below.

3.1 Summer Days

ABOUT THIS INDICATOR

Summer days tell us how many days exceed a maximum daily temperature of 25°C in any one year. This measure indicates how often we can expect "summer weather" to occur in the future.

PROJECTIONS

Historically, Terrace has had an average of 21 summer days every year and the projections show that we will experience many more in the future. The number of summer days is expected to double by the 2050s and triple by the 2080s. At the higher elevations, this change will reach a striking 6-fold increase by the 2080s, from **4 summer days to 25 annually, on average**. Tropical nights, defined as nights remaining above 20°C, are historically rare in the City of Terrace but will begin to occur over time, and are projected to occur 5 days a year, on average, by the 2080s.

The maps below show that the number of summer days will be highest in the low-elevation areas of the region, which includes the City of Terrace, meaning that the area with the highest population will experience the warmest temperatures. The maps also show that while the warmest temperatures will occur in the valleys and lowlands, the largest changes are expected at higher elevations.

TABLE 5: SUMMER DAYS (> 25°C)

	Past (days)	2050s (days)	2050s Change (days)		2080s (days)	2080s Change (days)	
			Average	(Range)		Average	(Range)
Terrace City	21	45	24	(10 to 42)	65	44	(18 to 74)
Terrace Region	9	24	15	(5 to 26)	38	29	(10 to 50)
Low Elev. (< 420m)	20	45	25	(10 to 42)	65	45	(18 to 75)
High Elev. (> 420m)	4	14	10	(3 to 19)	25	21	(7 to 38)

FIGURE 10: ANNUAL SUMMER DAYS (> 25°C) — PAST

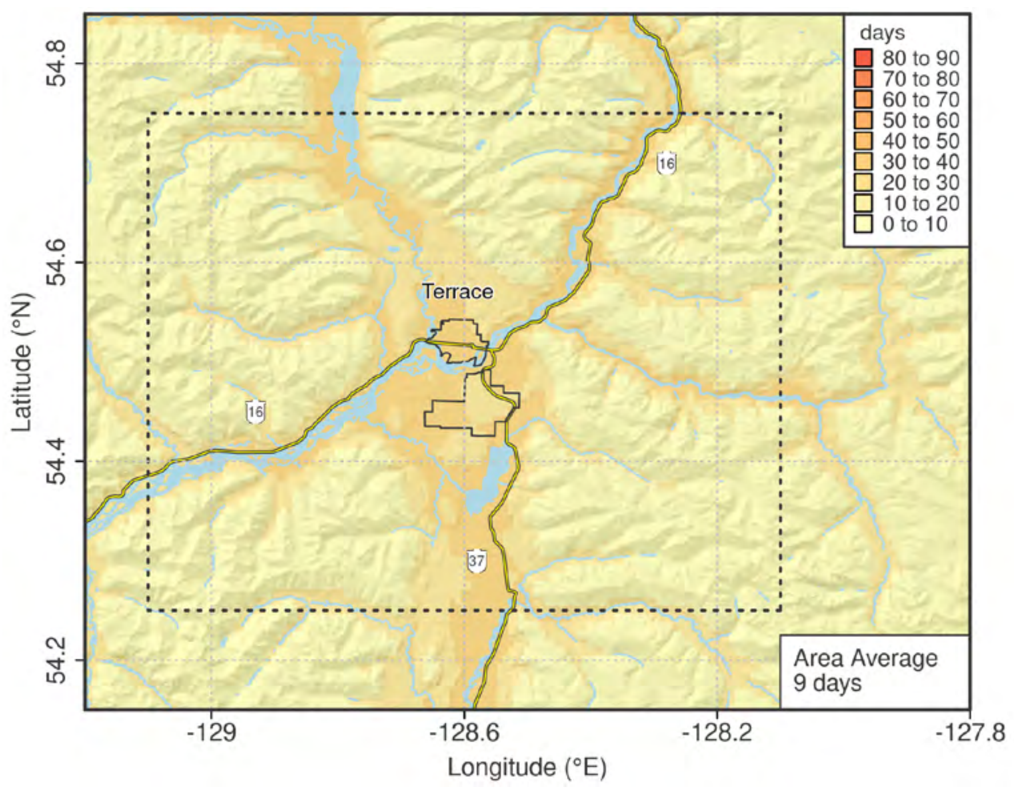
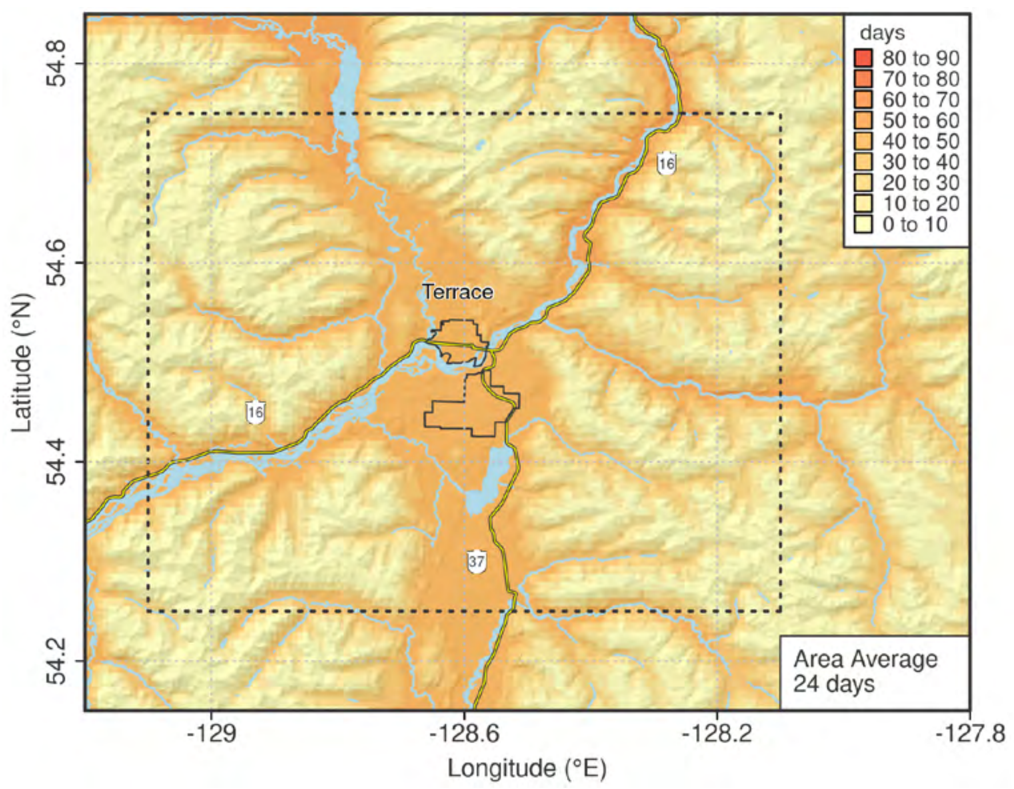


FIGURE 11: ANNUAL SUMMER DAYS (> 25°C) — FUTURE (2050s)



3.2 Hottest Day and Warmest Night

ABOUT THESE INDICATORS

Hottest day refers to the hottest daytime high temperature of the year while **warmest night** refers to the warmest nighttime low temperature of the year. The hottest days and warmest nights are usually experienced during the summer months. Taken together, these indicators illustrate how daily extreme temperature changes are projected to unfold over time.

PROJECTIONS

Across all seasons, the hottest day and warmest night are projected to increase. Hottest days are projected to warm more in spring from 25°C to 30°C, while warmest nights in spring and summer will increase from 10°C to 15°C and 15°C to 20°C, respectively, by the 2050s.

TABLE 6: ANNUAL HOTTEST DAY AND WARMEST NIGHT

		Past (°C)	2050s (°C)	2050s Change (°C)		2080s (°C)	2080s Change (°C)	
				Average	(Range)		Average	(Range)
HOTTEST DAY	Terrace City	31.5	35.2	3.7	(1.6 to 5.1)	37.6	6.1	(3.1 to 8.2)
	Terrace Region	27.1	30.8	3.7	(1.5 to 5.2)	33.2	6.1	(3 to 8.2)
	Low Elev. (< 420m)	31.2	34.9	3.7	(1.5 to 5.2)	37.3	6.1	(3 to 8.1)
	High Elev. (> 420m)	25.2	29	3.7	(1.5 to 5.2)	31.4	6.1	(3 to 8.3)
WARMEST NIGHGT	Terrace CIty	15.4	18.6	3.2	(1.8 to 4.7)	20.7	5.3	(3.5 to 7.5)
	Terrace Region	12.8	16	3.2	(2 to 4.7)	18.1	5.3	(3.6 to 7.5)
	Low Elev. (< 420m)	15.2	18.4	3.2	(1.9 to 4.7)	20.5	5.3	(3.6 to 7.5)
	High Elev. (> 420m)	11.8	14.9	3.2	(2 to 4.7)	17.1	5.3	(3.6 to 7.5)

3.3 1-in-20 Hottest Day

ABOUT THIS INDICATOR

1-in-20 hottest day refers to the day so hot that it is expected to occur only once every 20 years. In other words, there is a 5% chance in any year that temperatures could reach this magnitude.[4]

PROJECTIONS

Extreme heat events will increase in intensity as the climate warms. In the past, the 1-in-20 hottest day in the City of Terrace was around 35°C. By the 2050s, this will increase to 40°C, and to nearly 42°C by the 2080s. While the entire region will experience hotter extreme temperatures, the lower elevations in the region will experience the highest temperatures. In addition, although the projected changes are similar across the region, they show an increasing gradient of change from the coast (west) to the interior (east).

TABLE 7: 1-IN-20-YEAR HOTTEST DAY

	Past (°C)	2050s (°C)	2050s Change (°C)		2080s (°C)	2080s Change (°C)	
			Average	(Range)		Average	(Range)
Terrace City	35.7	40.1	4.3	(2.2 to 6.2)	42.6	6.8	(3.5 to 8.9)
Terrace Region	31.3	35.7	4.3	(2.5 to 6)	38.1	6.8	(3 to 9.2)
Low Elev. (< 420m)	35.4	39.7	4.3	(2.3 to 6)	42.2	6.8	(3.3 to 8.9)
High Elev. (> 420m)	29.4	33.8	4.3	(2.6 to 6)	36.2	6.8	(2.9 to 9.3)

FIGURE 12: 1-IN-20-YEAR HOTTEST DAY – PAST

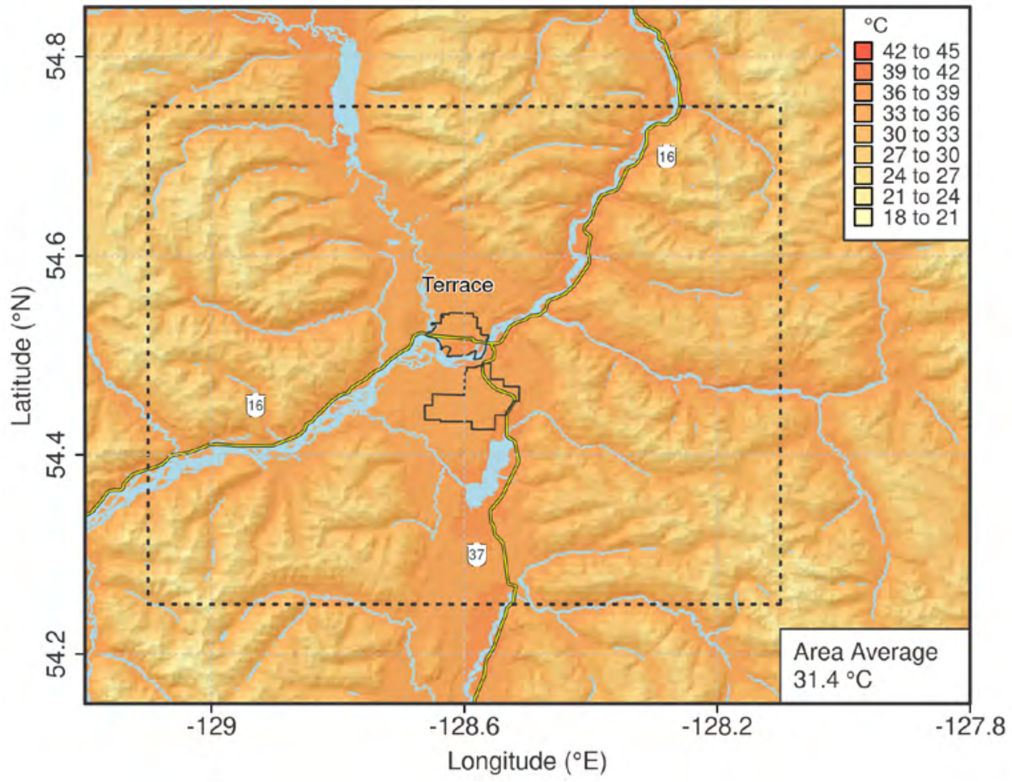
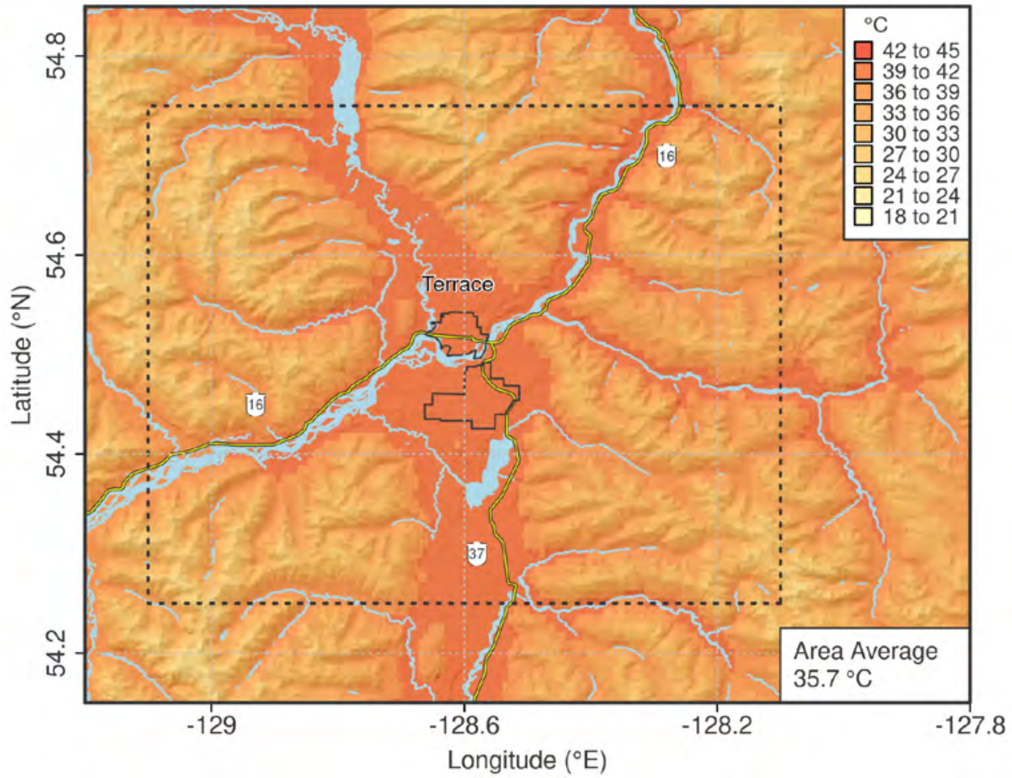


FIGURE 13: 1-IN-20-YEAR HOTTEST DAY – FUTURE (2050s)



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[4] For the 1-in-20 events described in this report, the "5% chance of occurrence" is based on an average over each 30-year period. To be precise, since climate change will occur throughout that time, there is slightly less than a 5% chance of such an event occurring at the beginning of the period and more than a 5% chance at the end of the period, with an average 5% chance over the period.

3.4 Growing Season Length and Growing Degree Days

ABOUT THESE INDICATORS

Growing season length is an annual measure that indicates the period when crops and other plants grow successfully. This measure counts the number of days between the first span of 6 days (or more) with daily average temperatures above 5°C, and the first span, after July 1, of 6 days with temperatures below 5°C. This measure helps us to understand how opportunities for agriculture may be affected by projected changes.

Growing degree days are another measure of heat accumulation that is useful for agriculture and horticulture. Growing degree days are calculated here by how warm daily temperatures are compared to a base temperature of 5°C (although different base temperatures may be used for different crops). For example, if a day had an average temperature of 11°C, that day would have a value of 6 growing degree days. Growing degree days are calculated in this way for each day of the ear, and then summed to obtain a tally for the full year. This measure is a useful indicator of opportunities for agriculture, as well as the potential for invasive species to thrive due to a longer period of suitable conditions for their growth and reproduction.

PROJECTIONS

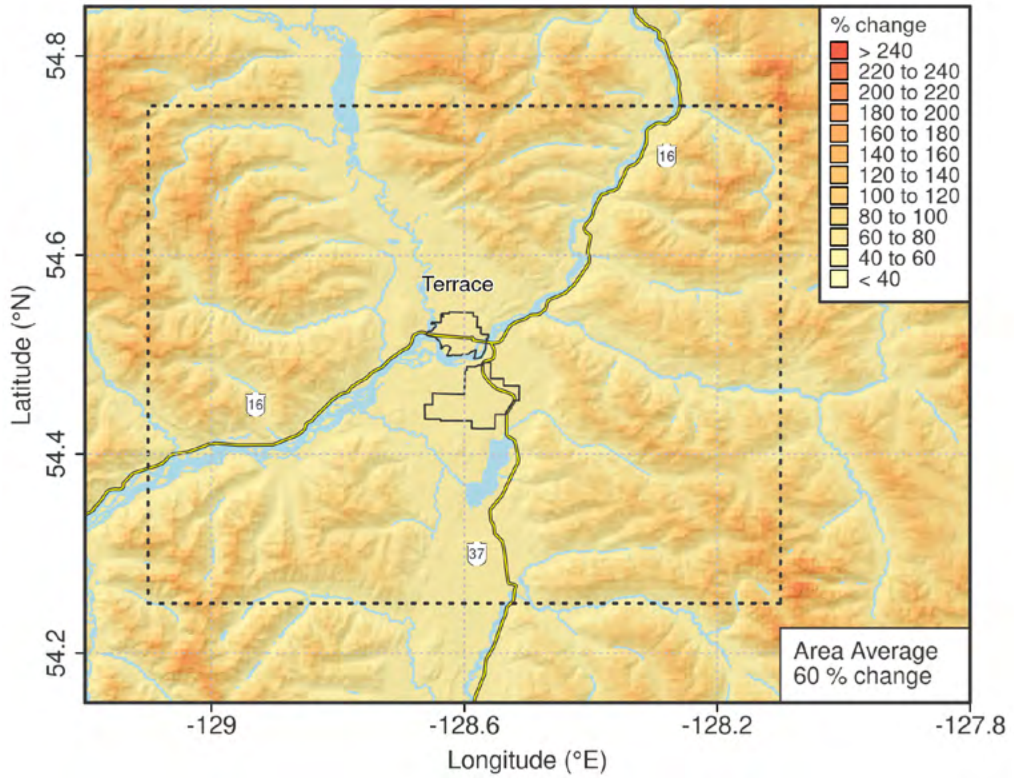
In the past, the growing season in low elevations lasted an average of 200 days. By the 2050s, the growing season is projected to increase to 260 days (+30%), and by the 2080s to increase to 300 days (+50%), **almost a year-round growing season**. All things being equal, this suggests a positive gain for agriculture in the region. However, since growing season length uses only a lower temperature threshold and ignores changes in precipitation, it should be interpreted as an upper limit for estimates of future agricultural productivity.

In the past, the lower elevations of the region where agricultural activity occurs had 1440 growing degree days. By the 2050s, projections indicate an increase of almost 50% more growing degree days and 85% more by the 2080s. As Figure 12 illustrates, the largest changes will be seen at higher elevations.

TABLE 8: GROWING SEASON LENGTH AND GROWING DEGREE DAYS (THRESHOLD: 5°C)

	Past (days)	2050s (days)	2050s Change (%)		2080s (days)	2080s Change (%)	
			Average	(Range)		Average	(Range)
Growing Season Length							
Terrace City	204	266	31	(20 to 38)	306	50	(40 to 59)
Terrace Region	155	204	31	(21 to 42)	239	54	(38 to 64)
Low Elev. (< 420m)	201	260	29	(20 to 37)	299	49	(38 to 59)
High Elev. (> 420m)	135	179	33	(21 to 43)	212	58	(37 to 68)
Growing Degree Days							
Terrace City	1477	2172	47	(30 to 68)	2701	83	(52 to 117)
Terrace Region	919	1472	60	(36 to 91)	1894	106	(64 to 160)
Low Elev. (<420m)	1439	2122	48	(30 to 68)	2639	83	(52 to 119)
High Elev. (>420m)	682	1178	73	(42 to 112)	1557	128	(76 to 119)

FIGURE 14: ANNUAL GROWING DEGREE DAYS – PERCENT CHANGE (2050s)



3.5 Cooling Degree Days

ABOUT THIS INDICATOR

Cooling degree days refers to the number of degrees that a day's average temperature is above 18°C. To determine the number of cooling degree days in a month, the number of degrees that the daily mean temperature exceeds 18°C for each day is summed over the entire month. This measure may be used to estimate the demand for air conditioning in buildings.

PROJECTIONS

Historically, cooling demand for Terrace has been low, with an average of 50 cooling degree days per year. However, projections indicate an average increase of a factor of almost 4 by the 2050s and a factor of 7 by the 2080s. For reference, this represents a cooling load similar to Kelowna, BC, by the 2050s, and Lytton, BC, by the 2080s, resulting in an increase in cooling demand over time.[5] While the total changes indicate a notable increase in cooling demand compared to the past, these large relative increases are partly due to the small historical baseline values.

This projected increase in cooling degree days is mirrored by the sizable projected decrease in heating degree days in the region, presented in Chapter 4.

TABLE 9: COOLING DEGREE DAYS (THRESHOLD: 18°C)

	Past (degree days)	2050s (degree days)	2050s Change (degree days)		2080s (degree days)	2080s Change (degree days)	
			Average	(Range)		Average	(Range)
Terrace City	49	189	141	(57 to 240)	350	301	(116 to 501)
Terrace Region	17	82	65	(23 to 116)	169	152	(52 to 262)
Low Elev. (< 420m)	44	178	134	(53 to 229)	332	288	(110 to 481)
High Elev. (> 420m)	5	38	33	(10 to 65)	95	90	(25 to 163)

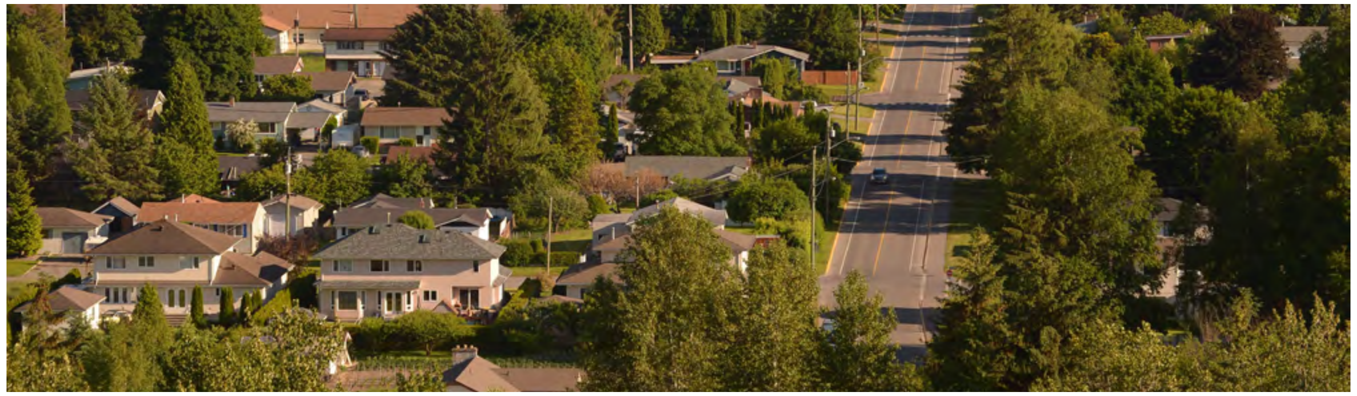


FIGURE 15: ANNUAL COOLING DEGREE DAYS – PAST

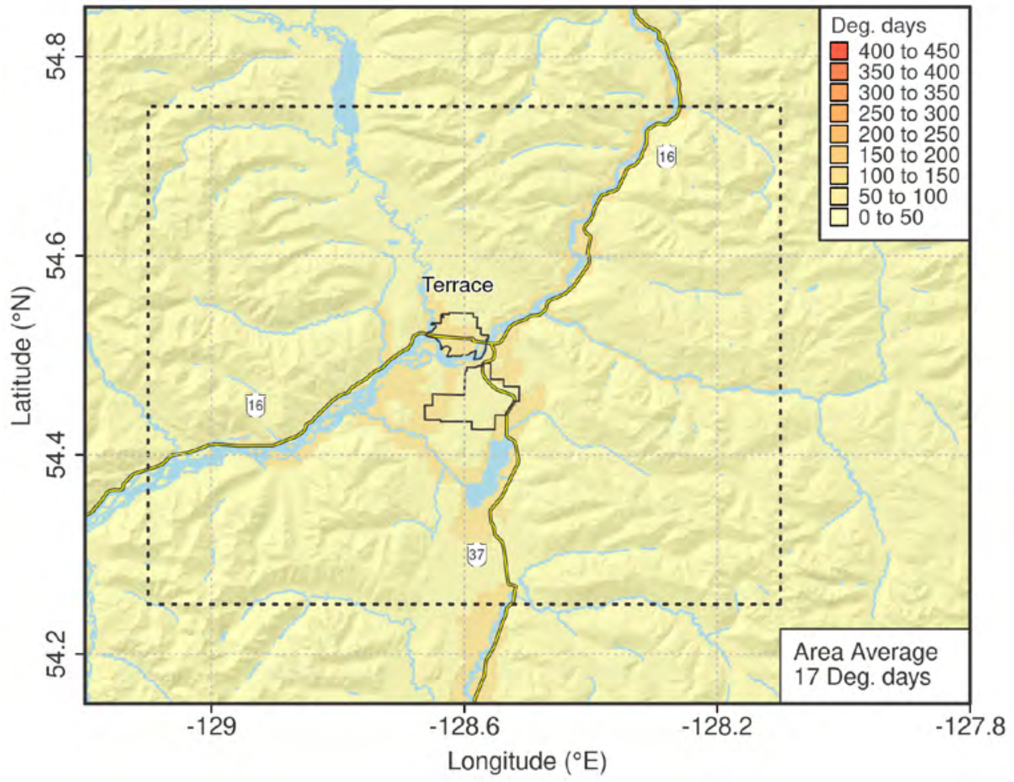
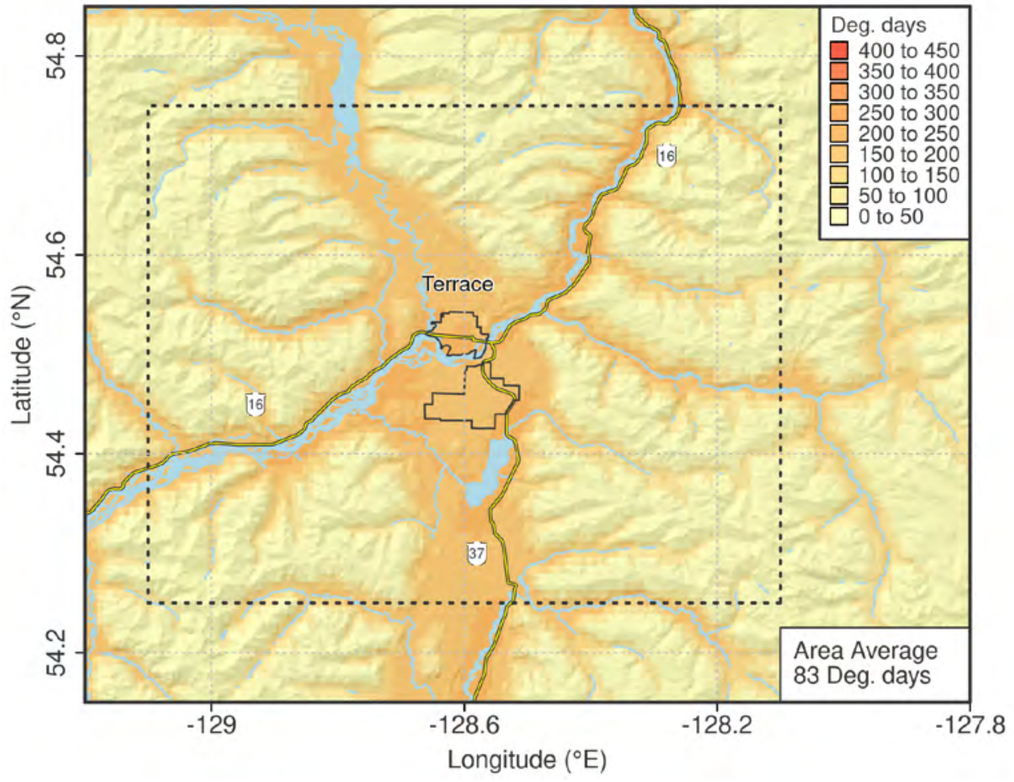


FIGURE 16: ANNUAL COOLING DEGREE DAYS – FUTURE (2050s)



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[5] This comparison is only in reference to the heating and cooling degree day variables, and does not reflect an overall similarity of climate.

CHAPTER 4

Cold Temperature Indicators

Future climate projections suggest Terrace will see warmer winter months (December-January-February), and shorter autumn-like and spring-like conditions. These indicators provide insight into the projected changes to cold season temperatures in the region.

4.1 Cold Day and Night Extremes

ABOUT THESE INDICATORS

Coldest winter night is the lowest temperature in winter. **Warmest winter day** is the highest temperature in winter.

PROJECTIONS

Compared to the past, the warmest winter day temperature in the City of Terrace will rise from 8°C to 10°C by the 2050s. By the end of the century, the warmest winter day is projected to reach 10°C throughout the region and reach 12°C in Terrace City.

Coldest nights are projected to warm in all seasons, with winter nights warming the most. The coldest winter nights in Terrace and the surrounding lowlands will be warmer than -10°C by the end of the century. While not shown below, coldest days in spring and autumn have been below freezing in the past (with values from the 1980s of -1°C and -5°C, respectively). Spring is projected to warm above freezing to 3°C by the 2050s (a change of 4°C) and in the autumn to 1°C by the 2080s (a change of 6°C). These projections illustrate that winter, autumn, and spring temperatures are on the rise, and future cold seasons will feel very different from those of the past.

TABLE 10: WINTER WARMEST DAY AND COLDEST NIGHT

	Past (°C)	2050s (°C)	2050s Change (°C)		2080s (°C)	2080s Change (°C)	
			Average	(Range)		Average	(Range)
Winter Warmest Day							
Terrace City	8.3	10.4	2.1	(0.9 to 3.7)	12.2	3.9	(2.6 to 5.8)
Terrace Region	6.5	8.6	2	(0.9 to 3.6)	10.4	3.8	(2.7 to 5.6)
Low Elev. (< 420m)	8.1	10.2	2.1	(0.9 to 3.7)	12	3.9	(2.6 to 5.7)
High Elev. (> 420m)	5.8	7.8	2	(0.8 to 3.5)	9.6	3.8	(2.7 to 5.6)
Winter Coldest Night							
Terrace City	-18.6	-12.5	6.1	(4.4 to 8.4)	-8.5	10.1	(8.1 to 11.6)
Terrace Region	-22.5	-16.2	6.2	(4.2 to 8.3)	-12.3	10.2	(8.3 to 11.6
Low Elev. (<420m)	-19.4	-13.2	6.2	(4.3 to 8.4)	-9.2	10.1	(8.2 to 11.6)
High Elev. (>420m)	-23.8	-17.6	6.3	(4.2 to 8.3)	-13.6	10.3	(8.3 to 11.7)

4.2 **1-in-20 Coldest Night**

ABOUT THIS INDICATOR

1-in-20 coldest night refers to a nighttime low temperature so cold that it is expected to occur only once every 20 years. That is, there is a 5% chance in any year that a minimum temperature of this value will occur. This indicator is a marker of somewhat rare, extremely cold winter temperatures.

PROJECTIONS

In the past, the temperature of the 1-in-20 coldest night in Terrace City was -25°C. Projections show an increase to -20°C by the 2050s and to -15°C by the 2080s. High elevations will show a similar rate of change, with the historical 1-in-20 coldest night of -30°C warming by 5°C and 10°C by the 2050s and 2080s, respectively. This shows that towards the end of the century, the 1-in-20 coldest night at higher elevations will be comparable to historical values in Terrace City. This marks a significant change in the region.

TABLE 11: 1-IN-20 COLDEST NIGHT

	Past (°C)	2050s (°C)	2050s Change (°C)		2080s (°C)	2080s Change (°C)	
			Average	(Range)		Average	(Range)
Terrace City	-24.3	-18.2	6.1	(3 to 10)	-14	10.3	(7.9 to 13.7)
Terrace Region	-29.8	-23.3	6.5	(3.1 to 10.2)	-19	10.8	(8.6 to 14)
Low Elev. (< 420m)	-25.8	-19.4	6.3	(3.3 to 10.3)	-15.2	10.6	(8.2 to 14.1)
High Elev. (> 420m)	-31.6	-25	6.5	(3 to 10.2)	-20.7	10.9	(8.8 to 14)

FIGURE 17: 1-IN-20-YEAR COLDEST NIGHT – PAST

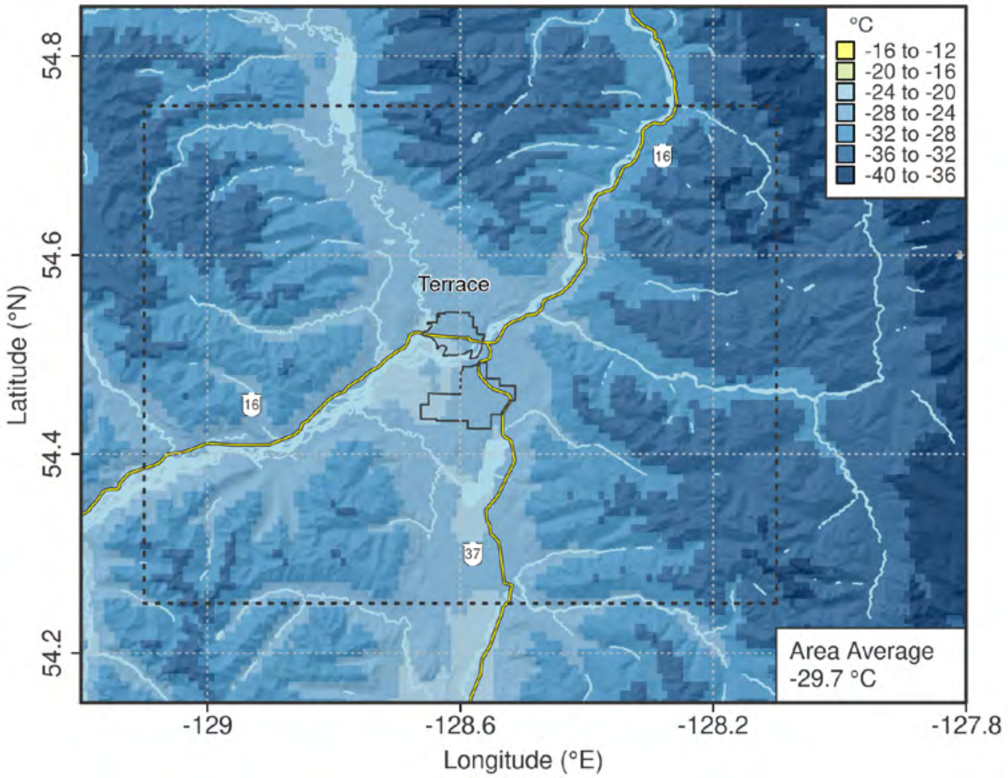
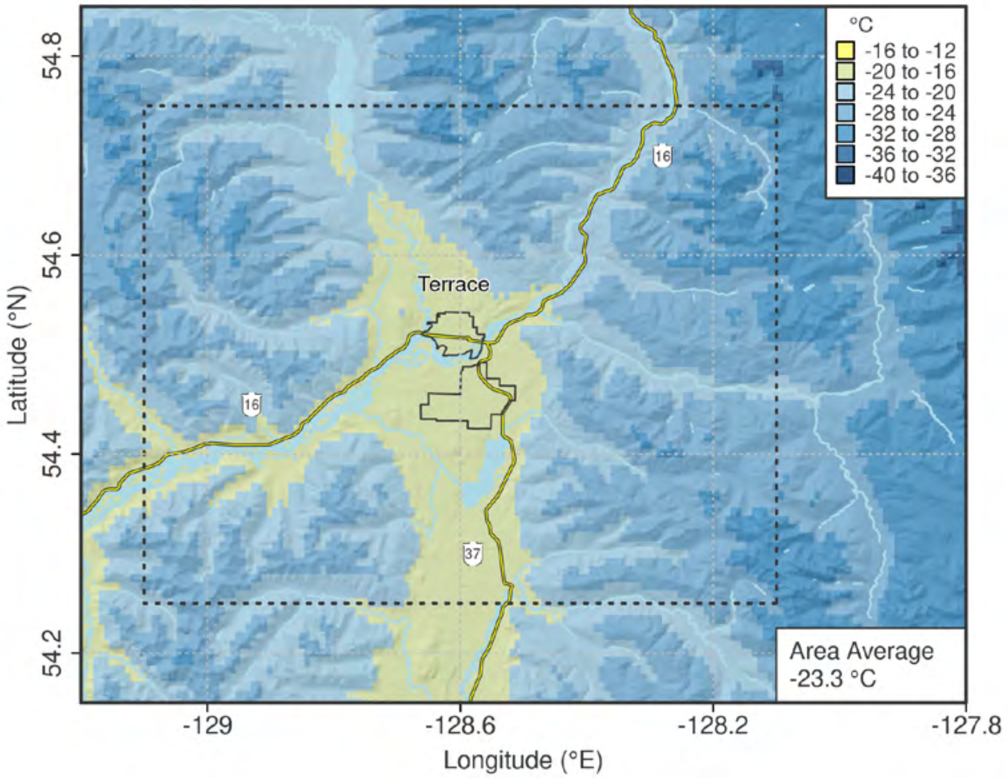


FIGURE 18: 1-IN-20-YEAR COLDEST NIGHT – FUTURE (2050s)



4.3 **Ice Days and Frost Days**

ABOUT THESE INDICATORS

Ice days are days when daytime high temperature is less than 0°C. This measure offers insight into how changes in the number of days where the temperature does not rise above freezing could affect ecosystems, species, agriculture, and transportation in the region.

Frost days is an annual count of days when the daily low temperature is less than 0°C, which may result in frost on the ground. Unlike an ice day, the daytime high temperature may rise above freezing on a frost day.

PROJECTIONS

In the past, the city had roughly 40 ice days a year on average. Projections indicate a drop to 20 ice days by the 2050s and to 15 by the 2080s, representing significant reductions by 40% and 65%, respectively, for these periods.

With respect to frost days, the region had a past average of approximately 175 frost days a year. In the future, 60 fewer frost days are projected in the 2050s and 95 fewer in the 2080s. This means that by the 2080s the region may have only about half of the frost days that occurred historically. This decrease is in line with the shortening of the winter season as noted in the general climate projections (Chapter 2).

TABLE 12: ANNUAL ICE DAYS AND FROST DAYS

	Past (days)	2050s (days)	2050s Change (days)		2080s (days)	2080s Change (days)	
			Average	(Range)		Average	(Range)
Ice Days							
Terrace City	37	21	-16	(-21 to -12)	13	-24	(-31 to -16)
Terrace Region	75	43	-32	(-40 to -24)	28	-47	(-55 to -37)
Low Elev. (< 420m)	40	22	-17	(-23 to -13)	14	-25	(-32 to -18)
High Elev. (> 420m)	91	52	-39	(-48 to -30)	34	-57	(-66 to -46)
Frost Days							
Terrace City	108	50	-58	(-77 to -47)	32	-76	(-93 to -62)
Terrace Region	175	115	-60	(-84 to -45)	80	-95	(-129 to -71)
Low Elev. (<420m)	116	57	-58	(-80 to -45)	37	-79	(-99 to -63)
High Elev. (>420m)	202	141	-61	(-85 to -44)	100	-102	(-144 to -74)

FIGURE 19: ANNUAL FROST DAYS (TN < 0°C) – PAST

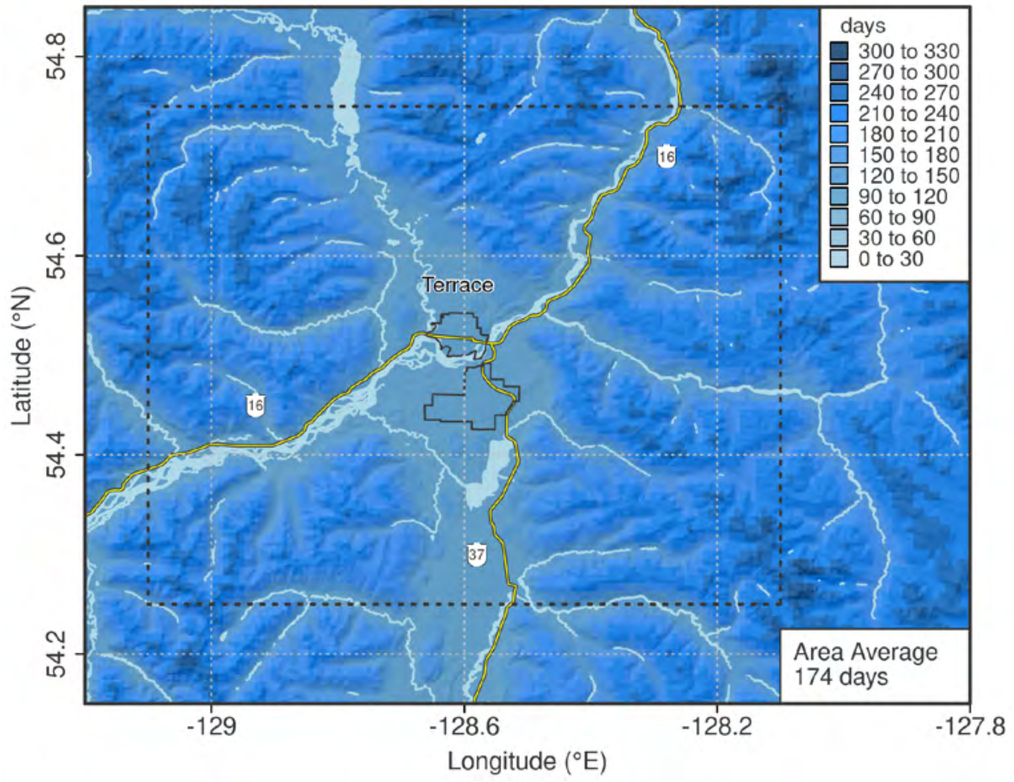
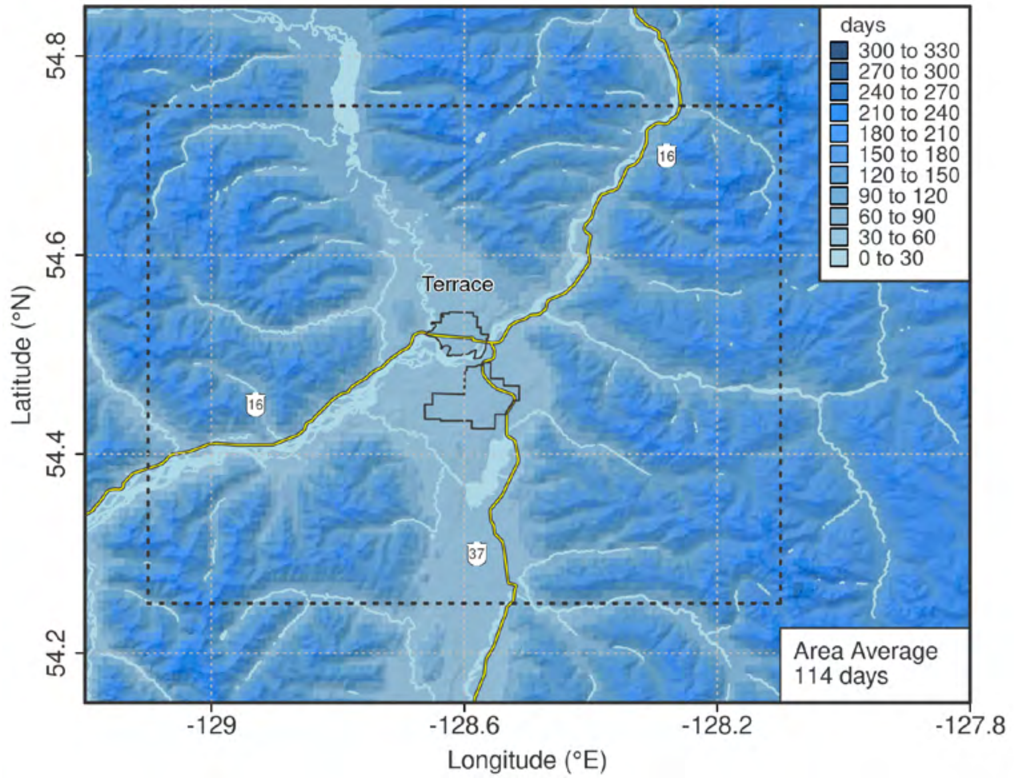


FIGURE 20: ANNUAL FROST DAYS (TN < 0°C) – FUTURE (2050S)



4.4 Heating Degree Days

ABOUT THIS INDICATOR

Heating degree days is a derived variable that can be useful for indicating energy demand (i.e., the need to heat homes, etc.). To determine the number of heating degree days in a month, the number of degrees that the daily mean temperature is below 18°C for each day is summed over the entire month. For example, if a given day saw an average temperature of 14°C (4°C below the 18°C threshold), that day contributed 4 heating degree days to the total. If a month had 15 such days, and the rest of the days had average temperatures above the 18°C threshold, that month would contain 60 heating degree days.

PROJECTIONS

In the past, Terrace required heating on more days during the year than cooling. The past annual average heating degree day total is 4165. In response to the warming climate, heating degree days are projected to decrease by roughly 20% (to 3186 days) by the 2050s and by 40% (to 2641 days) by the 2080s. This change is similar across the region and will be felt the most in the City of Terrace, where most buildings are located.

TABLE 13: ANNUAL HEATING DEGREE DAYS

	Past (degree days)	2050s (degree days)	2050s Change (degree days)		2080s (degree days)	2080s Change (degree days)	
			Average	(Range)		Average	(Range)
Terrace City	4165	3186	-978	(-1228 to -669)	2641	-1523	(-1778 to -1094)
Terrace Region	5300	4245	-1055	(-1341 to -700)	3625	-1675	(-2021 to -1156)
Low Elev. (< 420m)	4255	3270	-984	(-1237 to -669)	2721	-1534	(-1794 to -1094)
High Elev. (> 420m)	5773	4685	-1087	(-1388 to -714)	4034	-1738	(-2124 to -1183)

CHAPTER 5

Precipitation Indicators

The majority of Terrace's drinking water comes from a primary water source from a confined aquifer known as the Frank St. Wells, with Deep Creek and the Skeena River serving as emergency backup sources. Changes in precipitation will have an impact on water quality and may affect water supply.

As noted in Chapter 2, climate models project an 8% increase in total annual precipitation across the region by the 2050s. An increase of precipitation can be expected over autumn, winter, and spring, with the greatest increases in the autumn (15%). A warmer climate means that more moisture is held in the atmosphere, resulting in more intense precipitation from storms in the future. These changes will challenge drainage and stormwater infrastructure in the city, which will need to be designed using new thresholds for extreme weather events. The following indicators may provide some guidance for anticipating the precipitation amounts from such events.

5.1 Single-Day Maximum

ABOUT THIS INDICATOR

Single-day maximum precipitation describes the amount of precipitation that falls on the wettest day of the year, on average. This is a helpful indicator when planning for stormwater management and land-use planning for flooding.

PROJECTIONS

As noted above, precipitation is increasing across three seasons (autumn, winter, and spring). Over time, this precipitation will often be concentrated into the wettest days of the year. The wettest single day of the year will see an average of 10% more precipitation by the 2050s, and 25% more by the 2080s. The wettest day of the year could occur at any time, but most likely these days will occur in the autumn and winter seasons. This is true of all of the extreme precipitation indicators described in this section. Although percent changes are similar across elevations, actual precipitation amounts are different depending on elevation, as shown in the maps and table below.

TABLE 14: ANNUAL MAXIMUM 1-DAY PRECIPITATION

	Past (mm)	2050s (mm)	2050s Change (%)		2080s (mm)	2080s Change (%)	
			Average	(Range)		Average	(Range)
Terrace City	56	61	9	(0 to 17)	67	22	(9 to 34)
Terrace Region	68	74	10	(2 to 16)	83	23	(11 to 35)
Low Elev. (< 420m)	55	61	10	(1 to 17)	68	22	(9 to 35)
High Elev. (> 420m)	73	80	10	(2 to 16)	90	23	(11 to 35)

FIGURE 21: ANNUAL MAXIMUM 1-DAY PRECIPITATION – PAST

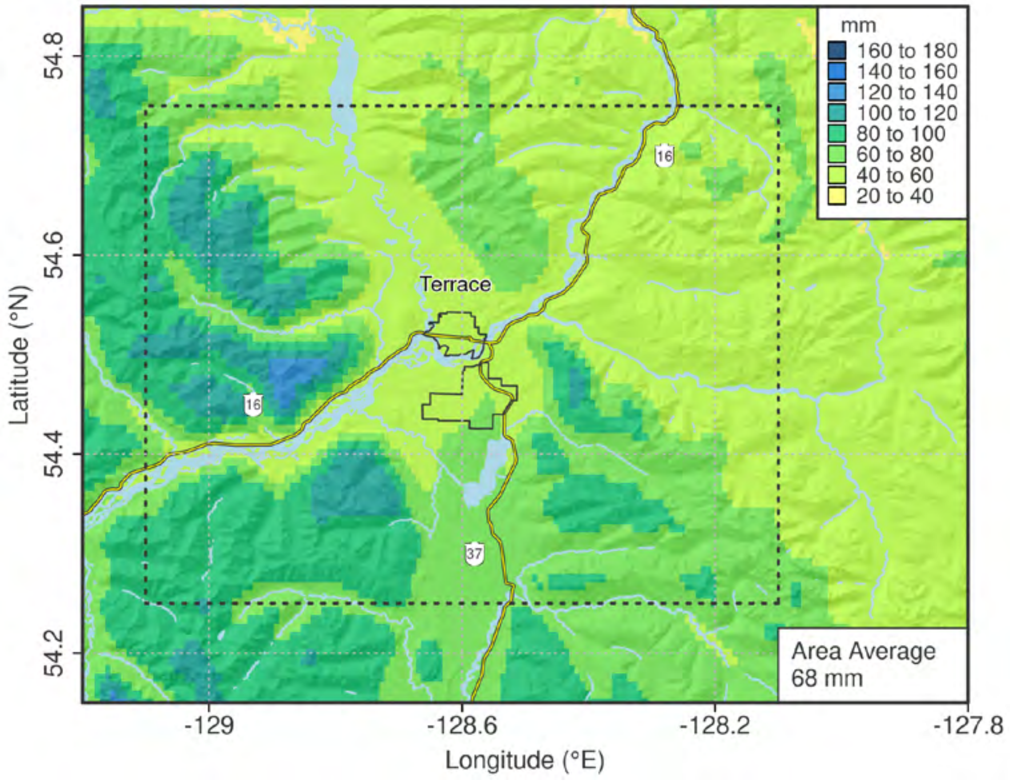
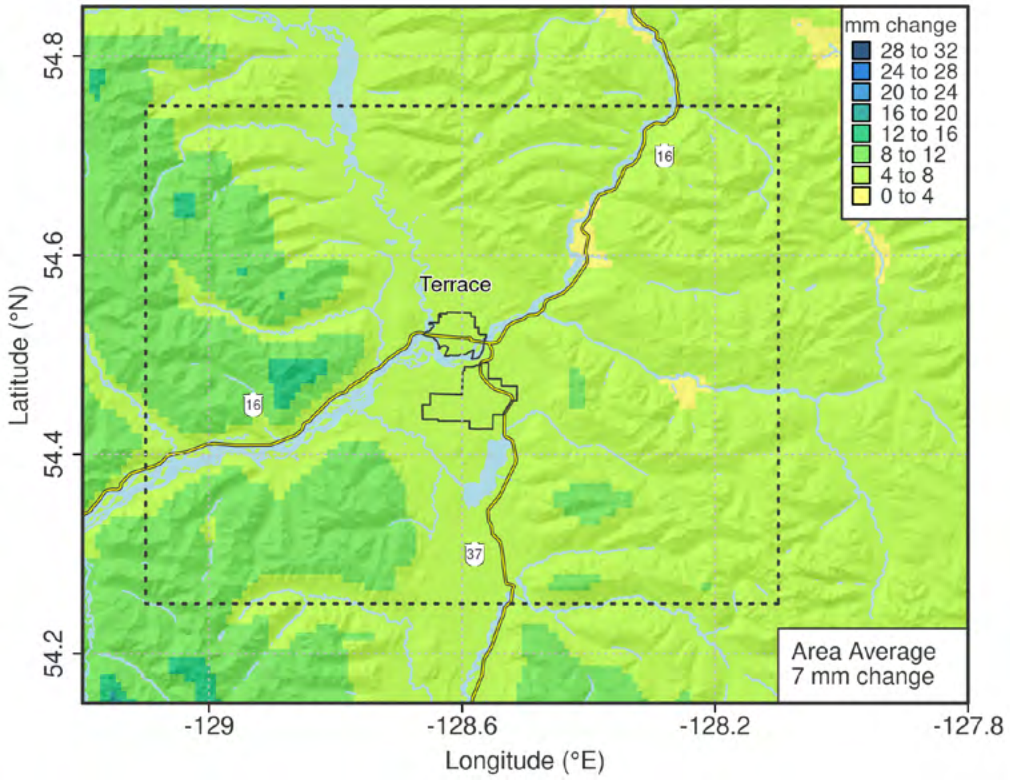


FIGURE 22: ANNUAL MAXIMUM 1-DAY PRECIPITATION – FUTURE (2050s)



5.2 1-in-20 Wettest Single Day

ABOUT THIS INDICATOR

The 1-in-20 wettest single day is the day so wet that it occurs only once every 20 years. That is, there is a 5% chance in any year that a 1-day precipitation event of this magnitude will occur. This represents a more rare event than the single-day annual maximum. This is a helpful indicator when planning for stormwater management.

PROJECTIONS

Terrace can expect precipitation to increase during the 1-in-20 (or 5% chance) wettest day extreme storm events in the future. By the 2050s, 1-in-20 wettest day events will deliver up to 10% more precipitation, and up to 25% more by the 2080s. Similar as with the other precipitation indicators, valley bottoms receive less precipitation than higher elevations, as seen in the maps below.

TABLE 15: 1-IN-20-YEAR WETTEST SINGLE DAY

	Past (mm)	2050s (mm)	2050s Change (%)		2080s (mm)	2080s Change (%)	
			Average	(Range)		Average	(Range)
Terrace City	86	94	9	(-2 to 19)	105	22	(8 to 34)
Terrace Region	107	117	9	(1 to 20)	132	23	(10 to 37)
Low Elev. (< 420m)	87	95	9	(0 to 24)	107	23	(8 to 36)
High Elev. (> 420m)	117	128	9	(1 to 19)	144	23	(11 to 37)

FIGURE 23: 1-IN-20-YEAR WETTEST SINGLE DAY – PAST

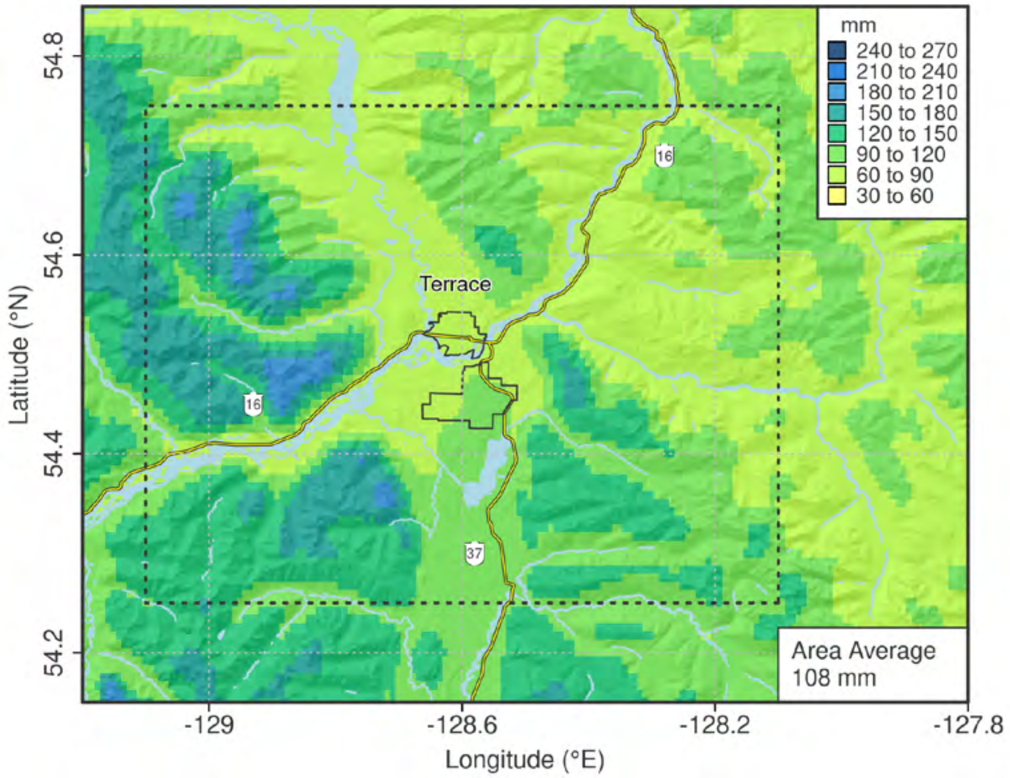


FIGURE 24: 1-IN-20-YEAR WETTEST SINGLE DAY – FUTURE (2050s)

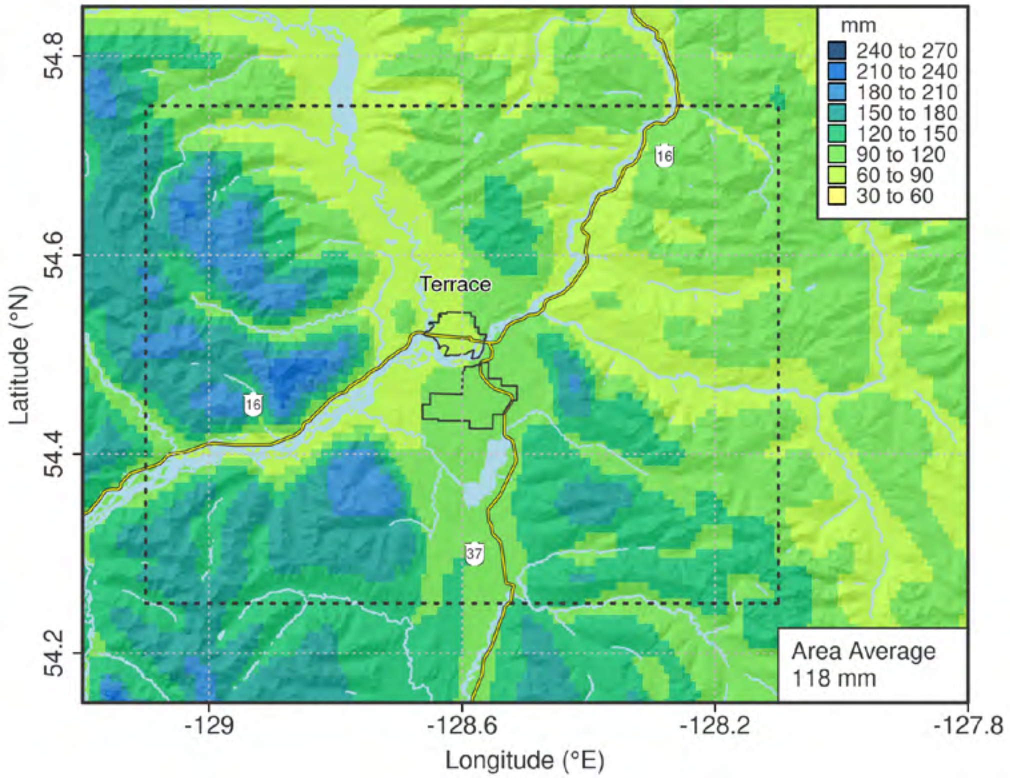
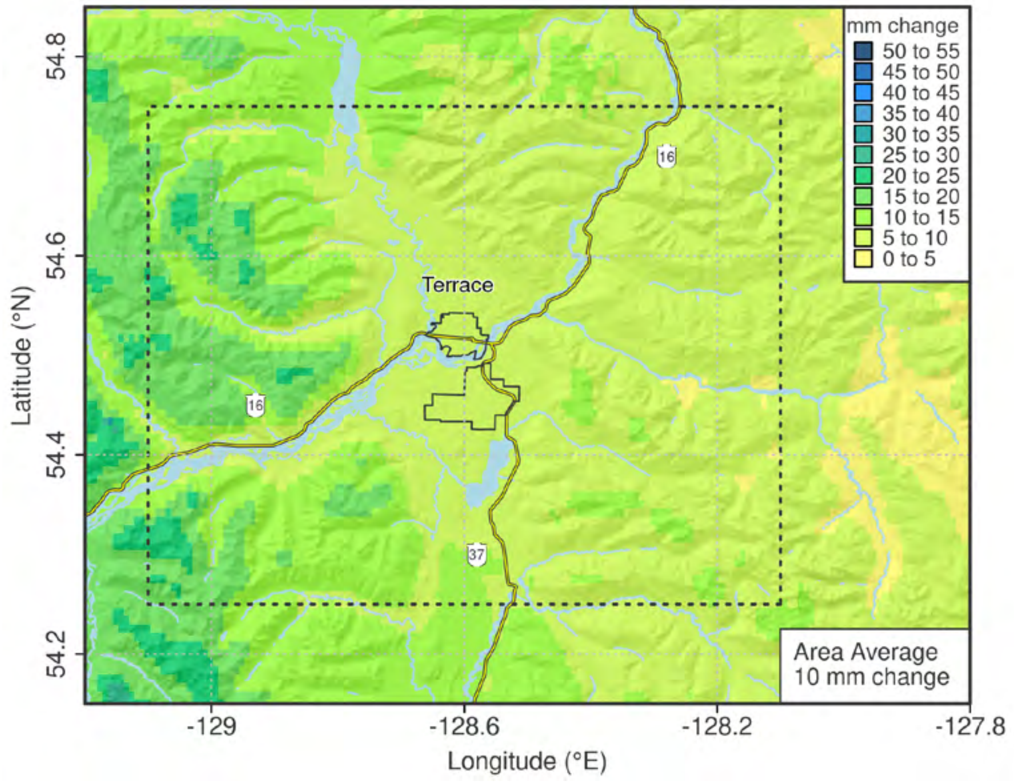


FIGURE 25: 1-IN-20-YEAR WETTEST SINGLE DAY – PERCENT CHANGE (2050S)



5.3 5-Day Maximum Precipitation

ABOUT THIS INDICATOR

5-day maximum precipitation describes the largest amount of precipitation that falls over a period of 5 consecutive days in a typical year over the period of interest. This is a helpful indicator when planning for stormwater management.

PROJECTIONS

As noted earlier, an 8% increase in total annual precipitation is expected by the 2050s across the region, with models projecting the increase will be concentrated into the wettest days. In the future, the region can expect the amount of rain in the wettest 5-day period to increase by an average of approximately 10% by the 2050s, and 20% by the 2080s. The most significant increase in the 5-day maximum is projected to take place in the autumn season (regionally, approximately 10% more than past autumn events by 2050, on average). For the City of Terrace, average precipitation during those events will be 115 mm, on average, representing roughly 15% increase from the past.

As with the previous indicator, percent changes are similar across elevations, but total precipitation values increase with elevation, as shown in the maps and tables below.

TABLE 16: ANNUAL MAXIMUM 5-DAY PRECIPITATION

	Past (mm)	2050s (mm)	2050s Change (%)		2080s (mm)	2080s Change (%)	
			Average	(Range)		Average	(Range)
Terrace City	119	132	11	(-1 to 24)	140	18	(5 to 31)
Terrace Region	153	168	10	(0 to 20)	180	18	(8 to 32)
Low Elev. (< 420m)	122	134	11	(0 to 22)	144	18	(6 to 31)
High Elev. (> 420m)	167	184	10	(1 to 20)	198	19	(9 to 32)

5.4 Precipitation on the Wettest Days

ABOUT THIS INDICATOR

Precipitation on wettest days describes the total amount of precipitation that falls on the wettest days of the year, specifically on days when precipitation exceeds a threshold set by the annual 95th percentile and 99th percentile of wet days during the baseline period (1971–2000). These measures indicate how much total annual precipitation falls during these heavy events, which is a combination of both how often these events occur, and the amount of precipitation that falls during each event.

PROJECTIONS

The wettest spells in the region are becoming wetter. The wettest days that exceed the baseline 95th-percentile threshold could produce roughly 30% more precipitation by the 2050s, and 55% more precipitation by the 2080s. Moreover, the corresponding increases for the wettest days exceeding the 99th-percentile threshold are approximately 45% by mid-century, and 85% by the end of the century. The model projections indicate that most of this precipitation increase is due to more days exceeding these thresholds in the 2050s, with an increase in the amount of precipitation becoming evident by the 2080s.

TABLE 17: WETTEST DAYS INDICATORS

	Past (mm)	2050s (mm)	2050s Change (%)		2080s (mm)	2080s Change (%)	
			Average	(Range)		Average	(Range)
95th Percentile Precipitation							
Terrace City	314	406	30	(2 to 48)	481	54	(23 to 85)
Terrace Region	417	545	31	(2 to 50)	648	56	(23 to 86)
Low Elev. (< 420m)	329	429	30	(1 to 49)	508	55	(22 to 85)
High Elev. (> 420m)	459	602	31	(2 to 50)	716	56	(23 to 87)
99th Percentile Precipitation							
Terrace City	99	148	50	(1 to 81)	185	88	(34 to 165)
Terrace Region	134	196	46	(1 to 74)	245	84	(32 to 157)
Low Elev. (<420m)	104	155	49	(0 to 77)	193	86	(33 to 158)
High Elev. (>420m)	148	215	45	(1 to 73)	270	83	(31 to 155)

FIGURE 26: ANNUAL 95TH PERCENTILE WETTEST DAYS – PAST

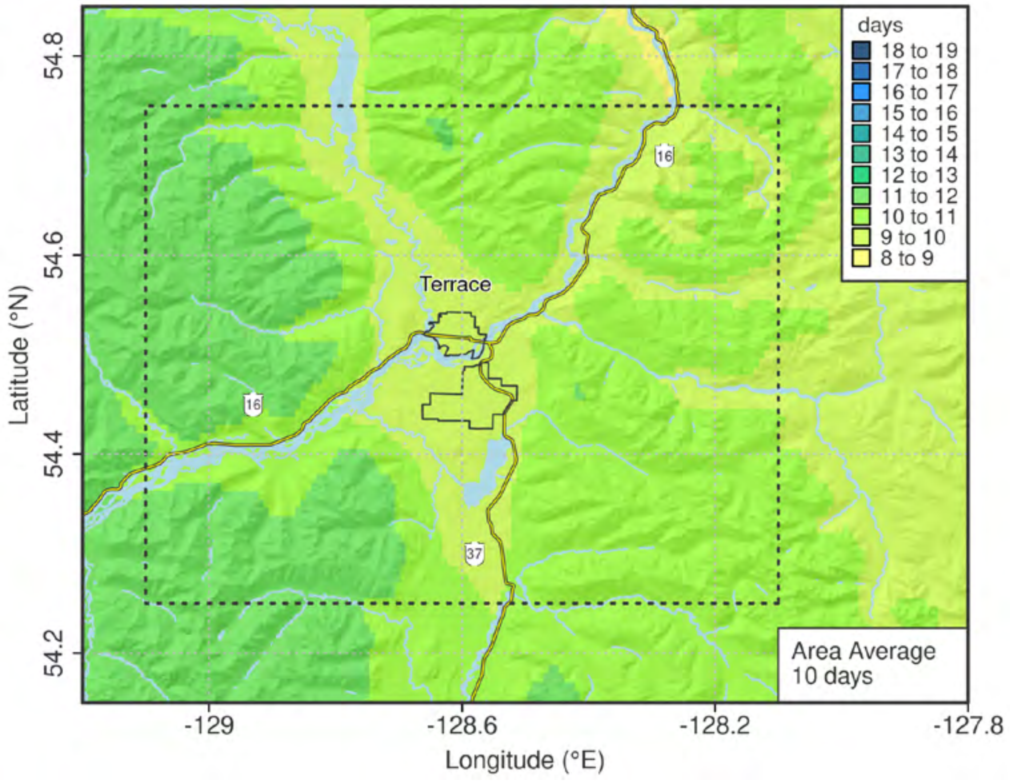
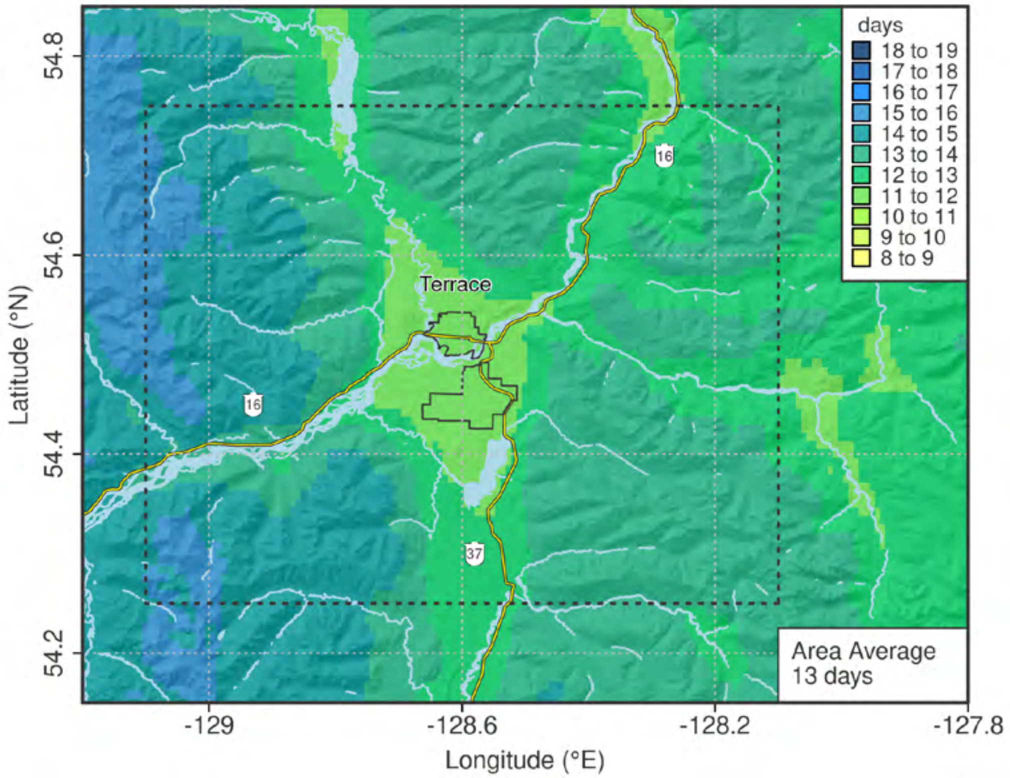


FIGURE 27: ANNUAL 95TH PERCENTILE WETTEST DAYS – FUTURE (2050s)



CHAPTER 6

Local Impacts

Terrace and the surrounding region can expect a future climate that is unlike that of the past. Recent climate events illustrate that climate change is already happening, including the 2021 extreme heat dome, and the 2022 winter flood; the projections detailed in this report indicate that more events like these will happen over time, with more frequency and increased intensity. Extreme weather has already caused social, environmental, and economic stress to many across the city and region, stresses that will increase over time. While warming may bring opportunities for the region, rising temperatures and increase in variability of weather will continue to challenge the City of Terrace and the surrounding region.

This chapter provides initial considerations about how climate change will have an impact on 12 interconnected sectors of the city. This work provides a direction for decision makers to consider when planning for the future and will help community partners understand how climate change will affect ongoing and planned initiatives.

6.1 **Ecosystems**

CONTEXT

Close to the Pacific Coast, Terrace, and the surrounding Skeena Valley are located in a hybrid coastal-interior rainforest on the Skeena River. The City of Terrace benefits from coastal marine and interior continental climates and is situated at the point where several valley systems come together. Coastal weather systems cause moist, warmer air to move across the city, causing temperatures that support a wide variety of flora and fauna not often found this far north. Culturally important species in the region include Sitka spruce, western redcedar, western hemlock, bears, and salmon. Ecologically important species in the region include the cutthroat trout, brown creeper, barred owl, and ruby-crowned kinglet.

IMPACTS

The changing climate will modify the distribution of many fauna and flora, increasing the risk of a decline in local species. Warmer summers will increase the risk of wildfires and extend the wildfire season into autumn. Warmer summers and winters can increase the reproductive cycles of forest pests, and lead to an increase in invasive species like Japanese knotweed. Plants susceptible to heat stress will be at risk with more extreme heat events.

Warmer air temperatures will lead to warmer water temperatures, causing stress to aquatic species and leading to the decline of species that are not only important for the natural environment, but also for the economy, such as salmon. Fish will also be impacted by turbidity and erosion, which may put spawning locations at risk during and after extreme weather events. Spawning may also be challenged by possible reductions in warm season streamflow. Further modelling is required to understand the impact of warmer temperatures on local aquatic species.

The projected changes will result in a changing character of the ecosystems in the region.

6.2 Water Resources

CONTEXT

Most of Terrace's drinking water comes from the Frank St. Wells' confined aquifer, with Deep Creek and Skeena River serving as emergency backup sources. These backup sources have operational challenges that hinder their timely, on-demand use. The airport lands operate with their own well system and aquifer, separate from the City wells on Frank Street, and the industrial development planned for those lands will increase water demand from those systems.

IMPACTS

Hotter and drier summers, combined with increasing water demand, will stress the existing water supply, triggering water restrictions and water-use conflicts. During hot, dry spells, water from the aquifer may not meet demand, prompting the activation of backup water supplies, which are currently vulnerable to system failures given heat-related river turbidity, and triggering boil-water advisories. Over time, additional storage outside of the aquifer may be necessary to handle the demand, leading to higher costs to the City and residents. During the wet seasons, Terrace can expect to shift from a nival (snow) to pluvialnival (rain-and-snow) dominated watershed, resulting in earlier spring freshet timing and larger autumn flows[6]. Also, increasing flood frequency can impact groundwater quality, also affecting the water supply. More work is needed to understand the specific implications of drought and extreme weather on the aquifer, and the local water management and treatment implications of relying on the emergency water system.

6.3 Stormwater Management

CONTEXT

The City's current stormwater and drainage system is largely original, with portions that are currently undersized, and future residential growth stemming from industrial development in the northwest will continue to stress the system. The current system relies on outputting into natural water courses, and the City requires residents to manage stormwater on-site. Heavy rain events overload the stormwater system, causing localized flooding and overflow of natural water courses, leading to infrastructure and environmental damage. These events can also increase infiltration to the sanitary system, creating backups within specific areas. A recent Stormwater Master Plan developed by the City takes future climate model projections and population growth considerations into account and provides recommendations for stormwater and drainage upgrades. This report will provide further climate projections to be incorporated into system design.

IMPACTS

Increasing intensity of extreme precipitation events will continue to overwhelm the City's already undersized stormwater and sewerage infrastructure, to an ever-increasing scale. Surcharge and backups into houses may be amplified and erosion can be expected at discharge locations. Localized flooding may also occur in places with historical storm drain capacity issues, and buildings that have previously been able to manage stormwater on-site may be unable to deal with new, higher precipitation levels. Properties needing to handle stormwater on-site will need developers that understand future projections and are able to make design and construction interventions to manage higher volumes during future events. As more intense precipitation events increase debris in drains, more maintenance might be required to keep them clear, resulting in higher costs for the City.

6.4 Parks, Recreation, and Culture

CONTEXT

Terrace is home to vast wilderness areas that surround the city and provide a range of recreational and outdoor pursuits, including world-class fishing, hunting, and skiing. The city has 38 parks covering over 270 hectares of land in the main portion of the city, and two indoor recreational facilities, the Sportsplex and Aquatic Centre. In addition, the City maintains multiple sports fields, baseball diamonds, and operates Ferry Island, a municipal campground with 103 campsites. This infrastructure, and the natural setting, contribute to the cultural, social, and economic vitality of the community.

IMPACTS

An increasing number of warm summer days will lengthen the season for summer recreation, which may increase economic opportunities for both outdoor and indoor activities. This will increase the pressure on recreational spaces including lakes, trails, campgrounds, and indoor facilities, and require additional outdoor staff year-round. Demand for indoor programming to support residents escaping heat extremes and smoke will increase, and outdoor facilities may require additional shading and cooling infrastructure. Hotter temperatures will increase cooling costs for indoor facilities and trigger longer campfire bans in parks and forests. The warmer temperatures could also increase the presence of invasive flora and fauna in parks and natural areas and may cause regional and provincial park closures during the wildfire season.

More frequent and more intense extreme precipitation events during autumn and winter may increase the maintenance of recreational infrastructure (trails, campsites, etc.) and the risks to the public outdoors during storm events. This may be an increased concern during the annual freshet over the short term.

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[6] Skeena Channel Management Study, McElhanney, 2021, Page 23.

6.5 Transportation

CONTEXT

Terrace is northwestern British Columbia's primary services and transportation hub, intersected by the Canadian National Railway, as well as Highway 16 and Highway 37. As regional economic growth causes population increase over time, a climate-robust transportation network will become increasingly important. While the flat topography of the downtown and nearby residential areas ("the Horseshoe") is suitable for walking and cycling, the cold winter temperatures may continue to pose a challenge to the enhancement and useability of year-round active transportation.

IMPACTS

Warming temperatures during the autumn, winter, and spring will likely delay and shorten the window for winter snowfall, making winter travel safer earlier in autumn and later in spring – increasing related economic activity while reducing snow removal costs for the City. Active transportation will potentially be more desirable for more months of the year; however, increased precipitation might offset this trend.

With precipitation falling in more extreme events, an increase in runoff could overwhelm existing drainage infrastructure. This will be coupled with an increased risk of landslides and slope instability, could threaten roads and bridges leading to temporary closures of transportation corridors, interrupting transportation systems and impacting vital road links in the city to bench residential areas (e.g., Skeenaview Drive, Lanfear Drive, and Kalum Lake Road). Hotter, drier summers might cause more rutting and other deficiencies in asphalt, which can shorten road lifespan, leading to higher maintenance costs. Increased dust on gravel roads will also require dust suppression along key corridors.

6.6 Land Use

CONTEXT

Terrace's land base is divided into two separate areas – the urban residential areas to the north, and the airport and industrial lands to the south – bisected by the Skeena river. As the name suggests, the city was developed on terraces, where hills and steep slopes separate areas and neighbourhoods. Terrace will continue to grow – the population is expected to increase due to growth in industrial developments that are planned across the region.

IMPACTS

An increase in the frequency and intensity of extreme weather events is likely to continue to alter the location of stream and river beds, including the Kitsumkalum and Skeena Rivers, and the floodplain limits, affecting the safety of existing infrastructure and altering potential locations for future infrastructure.[7] Intense precipitation is also likely to trigger landslides, potentially affecting properties on the upper terrace lands.

6.7 Building and Energy Systems

CONTEXT

Housing in Terrace is primarily single- and multi-family, and like City-owned buildings, has been designed for the cool coastal climate. While the City is interested in pursuing resilient building practices through the BC Energy Step Code, building costs are high as materials need to be shipped in from southern jurisdictions.

Energy is provided by BC Hydro (electricity) and Pacific Northern Gas (natural gas). In the City of Terrace, the majority of homes are heated with gas, with the remaining heating coming from electric baseboard heaters or wood stoves. In rural areas where gas is not available, energy for heating is provided by electric, diesel, or wood heating systems.

IMPACTS

Buildings in Terrace, which have been designed for a cool coastal climate, may overheat during hot spells, and lead to health impacts on the population, especially for vulnerable people who do not have access to cooling during heat waves. Warmer temperatures regionally, and across the province may also lead to more frequent and longer wildfire seasons, compromising indoor air quality and increasing homeowner costs with air purification systems. Warmer temperatures year-round will likely reduce heating demand in the winter months, while increasing cooling demand in the summer, and energy demand to power air filtration during smoky days. Consequently, energy peak requirements and costs may increase during the warmer months.

Increased precipitation in the wet season can increase building moisture and associated mould. With future extreme precipitation events becoming more intense, damage to buildings will likely increase.

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[7] River flows in the Skeena and Kitsumkalum Rivers were increased by 10% from historical levels to account for the potential effects of climate change on extreme events in the Skeena Channel Management Study (McElhanney, 2021) and were increased by 30% from historical levels to account for the potential effects of climate change in the Kitsumkalum River Flood Mitigation Plan (McElhanney, 2022). The maximum predicted water velocity, and associated water surface elevation, was considered when recommending mitigation measures.

When coupled with damage from wind, hail, and other storm-related impacts to buildings, this may have an impact on the City's operational and maintenance budgets, residents, property owners, and local businesses. Buildings near cliffs and floodplains are especially at risk of extreme precipitation events as erosion and flooding become more prevalent. On the other hand, periods of drought may affect the water supply, leading to an increasing need for water conservation and retention during drier years. New buildings need to be designed to be resilient to future climate conditions, in order to protect the population from extreme weather events.

6.8 Economy

CONTEXT

Resource industries have traditionally been the backbone of Terrace's regional and local economy, including forestry and mining. The region is experiencing rapid growth in the local economy and population due to industrial projects in the region, such as Prince Rupert's port expansion project, and LNG Canada's projects are increasing business development in the city. Tourism is also an important part of the local economy, providing year-round attractions to visitors and residents.

IMPACTS

Warmer temperatures will change the distribution and composition of ecosystems and are likely to affect the reproductive cycles of forest pests like the mountain pine beetle and spruce beetle, which could impact timber supply and result in job losses in the forestry sector. Hotter and drier summers will increase the likelihood of severe wildfires, which will impair forestry operations, compromise air quality, and reduce tourism. Flooding in the wet seasons may cause damage to natural and economic infrastructure, further limiting industrial activities and reducing tourism.

6.9 Tourism

CONTEXT

Terrace offers activities year-round for residents and visitors. Fishing in the Skeena and Kitimat Rivers attracts significant numbers of international tourists annually, and mountain bikers have been attracted to the region in increasing numbers every year. Home to a rich First Nations culture that has existed for time immemorial, First Nations tourism is central to the tourism economy, with a suite of cultural activities and destinations surrounding Terrace. In the winter, the surrounding mountains are a main tourist destination, offering world-class skiing and snowboarding, and are well frequented by local and international visitors.

IMPACTS

As the climate changes, so will the types of tourism activities that attract visitors to the region. Longer summers may benefit the tourism industry, with spring, summer, and autumn tourism activities starting sooner and lasting longer into the year. This benefit will be moderated by the increased occurrence of wildfires, and the associated road closures and poor air quality. Warmer winter temperatures could have negative impacts on snow-based tourism, and mountain-based operators may be able to take advantage of a long summer season to extend warmer weather activities. Sport fishing may suffer due to increases in water temperatures and related loss of fishing resources, and tourism at large may be negatively affected by the extreme weather events that may disturb access to destinations.

6.10 Food and Agriculture

CONTEXT

The coastal influence on Terrace's climate makes it able to support fruit trees and other edible crops including grapes, leafy greens, herbs, root vegetables, and a wide range of berries. There are also many farms raising livestock, game, and poultry, producing meats and other animal-based products. The region has the potential for more agricultural production, not only in rural areas but also in small-scale lots within the city boundary. Water availability varies heavily by geographic area, which will influence which areas of Terrace and the surrounding region will be able to take full advantage of a longer growing season.

IMPACTS

As the climate warms, growing seasons become longer, which can have a positive impact on local food security and medium-scale production. However, longer, warmer summers can cause water stress, and conflicts between producers and the general public during shortages, which, if not adequately planned for, could challenge the agricultural sector. Warmer temperatures may also lead to diminished soil quality, heat stress in plants, and a rise in agricultural pests. Increasing variability in climate will also challenge farmers, making it harder to plan and execute successful harvests.

6.11 Human Health

CONTEXT

A growing population that includes many outdoor-oriented residents is seeing the natural beauty that they have come to enjoy being challenged and disturbed by climate change. While the city has historically had excellent air quality and cool temperatures, wildfires have caused residents to seek refuge indoors, and recent heat waves have prompted the City to offer cooling centres. These events are changing the public's climate perception, and causing climate stress in addition to heat and air quality-related illnesses.

IMPACTS

The city has already experienced unseasonably high temperatures, which cause disproportionate impacts on vulnerable people, including children, seniors, and those experiencing homelessness. As smoke from wildfires becomes more frequent, air quality and related respiratory illnesses will become a greater health concern. Warming temperatures may also increase vector-borne disease transmission and spread. Compromised air quality, extreme heat, and extreme precipitation may decrease the ability to recreate outside and cause physical and mental health issues to outdoor workers and residents alike. City operations staff may also experience mental and physical stress by working long hours during repeated extreme climate events.

6.12 Emergency Services

CONTEXT

Terrace has experienced extensive flood events from the Skeena River in the past, and the community has faced significant infrastructure damage over time. In recent years, evacuation alerts were ordered to protect low-lying communities at risk of flooding. In 2022 alone, various States of Local Emergency were declared for landslides, flooding, and the Emergency Operation Centre (EOC) was activated in 2021 and 2022 to deal with spring freshet-related flooding. While the City is providing local support to reduce flooding impact, this role for the City will increase given the reliance of surrounding communities on Terrace as an evacuation hub.

IMPACTS

Increasing extreme weather events will likely enhance flood, landslide, and erosion risks in rivers and creeks, causing the EOC to be activated more often, and for longer. These events have the potential to abandon people in remote locations and compromise evacuation routes. More staff may be necessary at the Emergency Operation Centre, as well as more police, fire, ambulance, and other frontline responders to answer to more frequent emergencies, which in addition to causing mental stress, will reduce staff capacity to complete their day-to-day tasks.

Warming temperatures will increase the risk of wildfires and damage to homes in the wildland-urban interface. Protective measures, such as FireSmart, will need to be taken to ensure homes in the interface are resilient to wildfires. Extreme heat will need to be included as a component of the Emergency Response Plan and work will need to be done in completing a heat risk assessment and how this impacts vulnerable communities.

APPENDIX

Methodology

A.1 Climate Scenario Selection

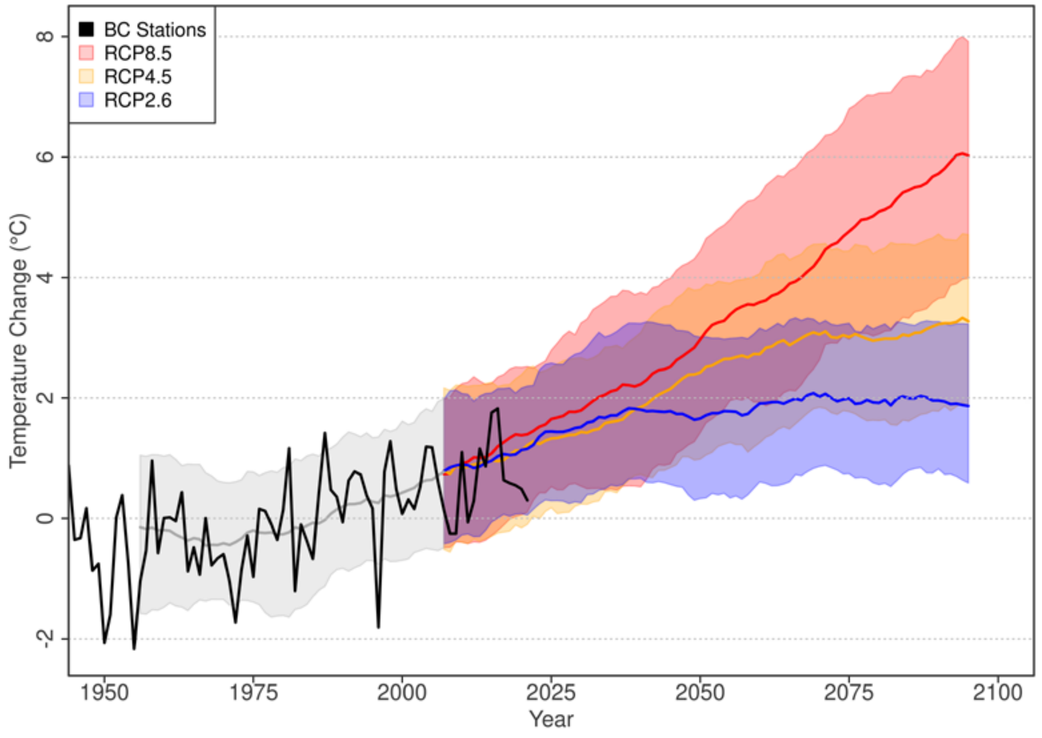
REPRESENTATIVE CONCENTRATION PATHWAYS (RCP)

RCP describes potential 21st century scenarios of GHG emissions, atmospheric GHG concentrations, aerosols, and land use. These RCPs are used for making projections and are based on the factors that drive human-caused GHG emissions: population size, economic activity, lifestyle, energy use, land use patterns, technology adoption, and climate policy. Each of the RCPs directly relates to the choices made by global society.

Various future trajectories of greenhouse gas (GHG) emissions are possible, and they depend directly on global political initiatives and socioeconomic changes over the coming years. This report presents a recognized roughly "business as usual" GHG emissions scenario for the remainder of the century, known as Representative Concentration Pathway 8.5 (RCP8.5).

The RCP4.5 "medium stabilization" scenario represents mitigation efforts that result in about half of the emissions compared to the RCP8.5 scenario. Substantial and sustained reductions in GHG emissions – for example, extensive adoption of biofuels and vegetarianism, along with carbon capture and storage – would be required to achieve RCP2.6, which is the only pathway predicted to keep global warming below 2°C above pre-industrial temperatures. The projected temperature change in British Columbia for each pathway is illustrated below.

FIGURE 29 – FUTURE TEMPERATURE BY EMISSIONS SCENARIO FOR BC



A.2 Climate Model Selection

Many different, highly sophisticated models are used to simulate how Earth's climate will respond to changes in greenhouse gas concentrations, each with different strengths and weaknesses. To manage the uncertainty associated with modelling, it is best practice to apply an ensemble approach that uses several models to describe the bounds of projected climate change.

The results in this report are based on a subset of climate models selected by PCIC from the Coupled Model Intercomparison Project 5 (CMIP5). The CMIP5 climate models were first screened to remove those that least accurately represented historical data. From the remainder, an ensemble of 12 models was chosen to provide the widest range of projected changes for a set of climate parameters.

Information from the large-scale global climate models was translated into projections at local scales using a procedure called downscaling. The model projections were downscaled to a 10-km grid using a historical daily time series of temperature and precipitation (ANUSPLIN) in conjunction with the climate model projections. BCCAQ statistical downscaling was used, which is a hybrid climate analogue/quantile mapping method. These daily observations and future projections at 10-km resolution were then draped over an 800-m grid (PRISM) of 1971–2000 average temperature or precipitation to generate high-resolution maps of projected changes in the region.

ABOUT CLIMATE MODELS

More information about climate models, and other related educational materials can be found at:

- https://www.pacificclimate.org/resources/climate-insights-101
- https://www.climate.gov/maps-data/climate-data-primer/predicting-climate/climate-models
- https://climatedata.ca/resource/multi-model-ensembles/

For those interested in knowing how the global climate model results were customized to regional scales, please see:

- https://pacificclimate.org/data/statistically-downscaled-climate-scenarios

A.3 Indicator Derivation

The historical baseline period used for all indicators in the report is 1971–2000. Values are averaged over this 30-year period to smooth out annual variability. The future projections are for the 2050s (which is an average of modelled values over the 2041–2070 period) and 2080s (2071–2100). The three RCP scenarios described above have somewhat similar GHG concentrations in the 2050s but diverge considerably by the 2080s. Indicators of climate change take a similar divergent pattern by the 2080s.

Many of the indicators of extreme events used in this report are derived using the definitions recommended by the Expert Team on Climate Change Detection and Indices (ETCCDI), known as the CLIMDEX indices.[8] The indicator names in this report have been translated into plain language, with the original CLIMDEX names provided in the tables for reference. Some indicators are defined by ETCCDI on a monthly basis only, such as TXx (monthly maximum daytime high temperature). In some cases, seasonal and annual versions of CLIMDEX indices were considered by taking the corresponding maximum (or minimum) from the highest (or lowest) monthly values in that season or year.

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[8] http://www.climdex.org/indices.html