The city of

Prince Rupert

Climate Change Adaptation Plan

January 2025

THE CITY OF PRINCE RUPERT

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Territory Acknowledgement

We respectfully acknowledge that what is now known as Prince Rupert is the traditional, ancestral, unceded territory of the Ts'msyen people. This plan contains recommendations that the City can undertake as part of the process of Indigenous reconciliation. This plan is by no means the answer to meaningful reconciliation, but it is intended to promote and support the continued dialogue to learn from and engage with Indigenous partners.

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Disclaimer

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Executive Summary

Prince Rupert is changing. The Port Authority and the City both anticipate the population to significantly grow from 12,300 people (2021 census) as a result of the port expansion within the next decade.[1] The anticipated growth is accompanied by a proportionate increase in housing demand and more activity within the city.

To ensure that the City's current activity and growth are not spoiled by the impacts of climate change, the Climate Adaptation Action Plan assesses future climate risks and involves the community in building actions for climate resilience. This plan is aligned with efforts within the Canadian National Adaptation Strategy (NAS), which calls for coastal communities like Prince Rupert to produce an adaptation plan by 2027.[2] The Climate Change Adaptation Plan will complement the Prince Rupert Community Energy and Emissions Plan (CEEP), with the goal to build actions that are sustainable as well as resilient.

For this plan, climate change is assessed using the representative concentration pathways (RCPs) for two climate scenarios: RCP 4.5 and RCP 8.5.[3] The RCP 4.5 scenario is referred to as "the planning scenario" and is useful to gather insights of climate impacts for the moderate changes anticipated. RCP 8.5 is referred to as "the worst-case scenario" and is useful to gather insights for the most extreme climate events.

For Prince Rupert, 13 types of extreme weather events or natural hazards are reviewed:

- Tsunami
- Ecoregion changes
- Flooding
- Extreme heat
- Drought
- High winds
- Landslides
- Severe storm
- Extreme cold
- Freezing rain/ice accumulation
- Snow accumulation
- Wildfire
- Land loss (due to relative sea level rise).

[1] Prince Rupert. Official Community Plan. https://www.princerupert.ca/building-development/official-community-plan.

[2] Service Canada. National Adaptation Strategy for Canada. 24 Nov. 2022, https://www.canada.ca/en/services/environment/

[3] RCP 8.5: The high-emissions scenario, where emissions continue to rise throughout the 21st century. It is based on ongoing high levels of emissions, which could be driven by population growth, ongoing global use of coal, other fossil fuels, or economic growth. RCP 4.5: The intermediate emissions pathways, where emissions peak at 2040 and 2080, respectively. These pathways also include carbon capture and sequestration, but result in more serious climate consequences.

Risk is defined as the likelihood of an event to have a negative outcome. Risk is used in this plan as a tool to identify which hazards result in the highest impact, what type of impacts are anticipated, and which populations and properties are the most vulnerable to these impacts. Risk reduction actions are developed through a follow-up investigation and community engagement activities to determine how Prince Rupert can ensure the climate adaptation approach is equitable and sustainable.

The top three hazard threats in both RCP scenarios are ecoregion changes, tsunami, and wildfire. Other notable changes in hazards include extreme heat, flooding, and landslides, which all advance by one threat level, increasing from "minimal" threat to "low" threat over time[4]. Risk results were similar where across the 13 thirteen hazards explored, the following 6 risk themes emerged:

1. Travel delays
2. Water system disruptions
3. Shift in human–wildlife interactions
4. Decline in health and wellbeing
5. Disrupted access to essential services
6. Decline in local food supply

Prince Rupert's 6 risk themes

[4] The Climate Risk and Vulnerability Assessment analyzes the likelihood, consequences, frequency, and impacts of climate hazards on residents, assets, and Prince Rupert's key sectors

The adapted Prince Rupert outlines a future where the City adopts and implements **23 actions** to reduce climate risk. The adaptation actions are organized as solutions to the 6 emerging risks identified.

Travel delays

To address travel delays, Prince Rupert develops four actions with a focus on resilient transportation infrastructure and emergency public transit.

TD1: Discourage Personal Vehicle Use During Extreme Weather

TD2: Free Transit During Extreme Weather

TD3: Shelter and Shade at Transit Hubs

TD4: Shade for Cycling and Walking Paths

Water system disruptions

The risks "decline in water supply" and "water system disruptions" are combined to focus on three adaptation actions for long-term planning with a climate lens for water major assets.

WD1: Continue to Review and Update Emergency Water Plan

WD2: Stormwater Management Bylaw

WD3: ICulvert Replacement and Build Back Better

Shift in human–wildlife interactions

To reduce the likelihood of negative human and wildlife interactions, the plan presents three adaptation actions to support a resilient tree canopy, additional invasive species reporting and raising awareness of Prince Rupert's biodiversity.

HA1: Support the Development of an Urban Forest Strategy

HA2: Biodiversity Education Program

HA3: Voluntary Reporting of Animal Sightings

Decline in health and wellbeing

Human health and well-being are supported by five adaptation actions focusing on temporary shelter, household and community emergency preparedness and uptake of climate resilience retrofits.

HW1: Compile a List of Emergency Shelters

HW2: Education on Household Emergency Preparedness

HW3: Education on Building Preparedness for Extreme Weather

HW4: Community Climate Standards

HW5: Review the Building Bylaw to Integrate Climate Standards in Site Planning

Disrupted access to essential services

Six adaptation actions address the decline in access to essential services. These actions focus on improving household adaptive capacity, exploring partnerships to improve trust with vulnerable populations, bolstering emergency support services, and improving energy and telecommunications during emergency response.

AE1: Continued Coordination of Emergency Telecommunications

AE2: Continued Review and Update Emergency Communications Strategy

AE3: Partner With Trusted Organizations to Ensure Identified Vulnerable Populations are Supported Through Emergency Support Services (ESS)

AE4: Participation in the B.C. Evacuee Registration and Assistance (ERA) Tool

AE5: Advocate for Improved Access to Insurance Coverage for Extreme Weather Events

AE6: Continue Best Practice in Community Back-up Power Generation

Decline in local food supply

To address local food supply two adaptation actions call for the support of improving local food infrastructure (production, processing and commerce).

LF1: Continue the Development of a Food Strategy

LF2: Local Food and Seafood Processing Feasibility and Coordination

This plan is the first iteration of a continuous process to track Prince Rupert's climate resilience over time. The CAAP calls for a renewal every five years to review the progress of implementing adaptation actions and updating the hazard and risk assessment with the most current climate data.

Introduction

Prince Rupert is changing. The Port Authority and the City both anticipate notable population growth from 12,300 people (2021 census), due in large part to various port operation expansions currently underway. This anticipated growth will increase housing demand in the city centre neighbourhoods—the midtown, downtown, and marina districts—as well as increase infill or greenfield development.

Parallel to this growth is the anticipated improvement to the socio-economic reality of Prince Rupert. The current unemployment rate is 9.5% (higher than the national average of 5.5%)[5] and approximately 9% of the population falls within the low-income status, with people over the age of 65 represented more than other age groups (13%).[6] Table 1 summarizes the key characteristics of Prince Rupert today and in the future.

[5] Statistics Canada. Labour Force Survey, July 2023. 4 Aug. 2023, https://www150.statcan.gc.ca/n1/daily-quotidien/230804/dq2308

[6] Low-income measure, after tax (LIM-AT) (Source: Statistics Canada. "Census Profile, Prince Rupert, City (CY), Census Subdivision." Census 2021, https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?)

Table 1. Summary of key Prince Rupert statistics.

	Present Day	Future(2040)[7]
People	12,300	unspecified
Housing	• 1960s–1980s construction. • 86% require minor repairs. • 14% in need of major repairs.	+2000–5000 new housing units.
Socio-economic status	• 9.5% unemployment. • 9% low income. • 13% low income and over age 65.	~2000 jobs.

With the expansion of the Port underway and the City's desire to ensure a safe and livable community into the future, as the climate changes, Prince Rupert is diving deeper into understanding climate risks to ensure that the City's current activity and anticipated growth are not spoiled by future extreme weather events. As Table 1 demonstrates, there is room to improve Prince Rupert's resilience. Factoring in the anticipated changes to the frequency and severity of future extreme weather events, additional improvements will need to be made to ensure Prince Rupert is resilient and adapted for climate change.

[7] City of Prince Rupert. Prince Rupert 2030 The Vision: A Vibrant City Hosting a Vibrant Port, 2030 Plan Growth Capacity Estimate. https://www.redesignrupert.ca/prince-rupert-2030

Adaptation Planning Efforts Underway

The federal government has been exploring options to improve preparation for, response to, and recovery from extreme weather events, with consideration given to how climate change will exacerbate the impact of future events. In 2023, the Canadian government released the National Adaptation Strategy (NAS), which provides direction for public organizations to begin exploring how to manage unavoidable impacts due to climate change. The NAS calls for the following action for municipalities: "By 2030, 80% of public and municipal organizations have factored climate change adaptation into their decision-making processes."[8] Coastal communities like Prince Rupert are urged to explore adaptation planning with more urgency, with the goal that "By 2027, 80% of coastal communities and 60% of businesses are implementing adaptation actions."[9] A summary of all climate change adaptation and mitigation activities of across levels of Canadian government is available in Table 2.

[8] Service Canada. National Adaptation Strategy for Canada. 24 Nov. 2022, https://www.canada.ca/en/services/environment/
[9] ibid.

Table 2. Summary of climate change action across levels of government.

	Adaptation	Mitigation
Federal	By 2030, 80% of public organizations factor climate change adaptation into decisions. By 2030, public infrastructure adopts codes and standards covering the top climate change risks. By 2027, 80% of coastal communities and 60% of businesses are implementing adaptation actions.	By 2030, there is a 40–45% reduction of greenhouse gases (GHGs).
Provincial	Actions to respond to sudden events like wildfires, floods, and heatwaves and to prepare for changes that happen more slowly, such as sea level rise, habitat loss, glacier recession, and water shortages.	By 2030, reduce 2007 GHG levels by 40%. By 2040, reduce 2007 GHG levels by 60%. By 2050, reduce 2007 GHG levels by 80%. Accelerated goal: By 2050, net-zero emissions.
Regional	Raise erosion concerns and advocate for restoration works. Invest in enhanced emergency preparedness, including efforts directed at wildfire prevention.	
Municipal		By 2020, reduce 2007 GHG levels by 33%.

A Plan for Prince Rupert

The provincial and regional governments have outlined specific hazards that require risk reduction interventions. This document is the first iteration of a climate change adaptation plan for Prince Rupert. A timeline of key phases of adaptation planning is illustrated in Figure 1. The plan summarizes key findings from the following phases:

1. **A background review** to define the plan's scope (physical boundary, time horizons, historical hazard impact).
2. **A hazard assessment** to determine the severity and frequency of future events, with climate change considerations.
3. **A risk assessment** to determine the impact of future hazards on Prince Rupert and to identify the top risks.
4. **Actions development** to determine risk reduction interventions to address top risks.
5. **Actions evaluation** to prioritize implementation of the proposed actions for risk reduction.
6. **The final plan** to define how to monitor and evaluate the success of each action.

The Climate Adaptation Action Plan (CAAP) leverages the expertise of international best practices and perspectives shared during community engagements. The combined knowledge generates a comprehensive and equitable adaptation plan that prepares Prince Rupert for future events in tandem with anticipated economic growth.

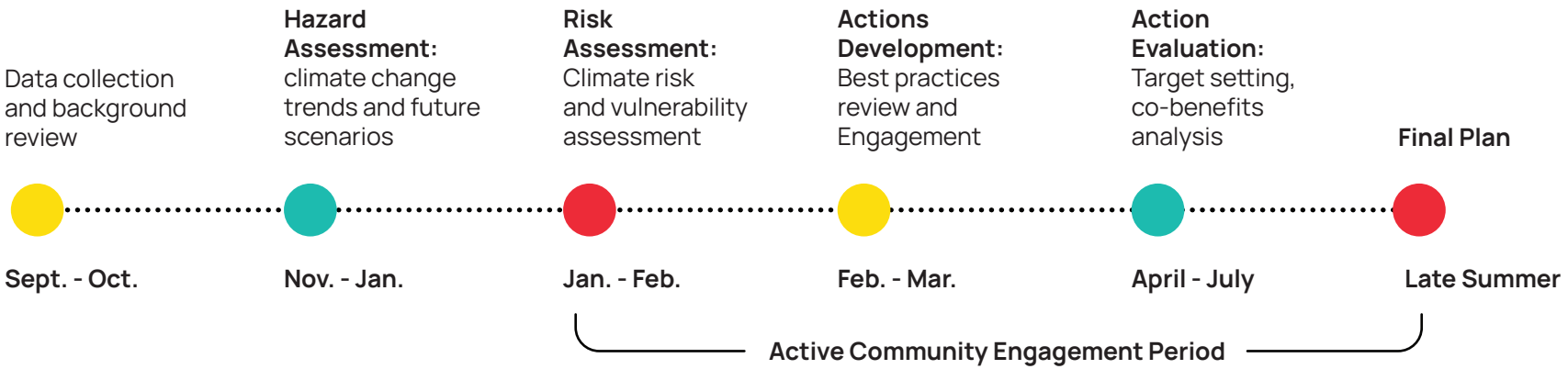


Figure 1. Illustration of the Climate Change Adaptation Plan development process.

Adaptation: Managing the Unavoidable

Climate change adaptation and mitigation can be described as two sides of the same coin. This analogy is used in municipal planning to distinguish climate adaptation needs from mitigation needs and to highlight where both components of climate action complement each other (Figure 2). Mitigation planning aims to limit global warming by reducing energy use and greenhouse gas emissions. Adaptation planning aims to manage the unavoidable present-day impacts of climate change through risk reduction.

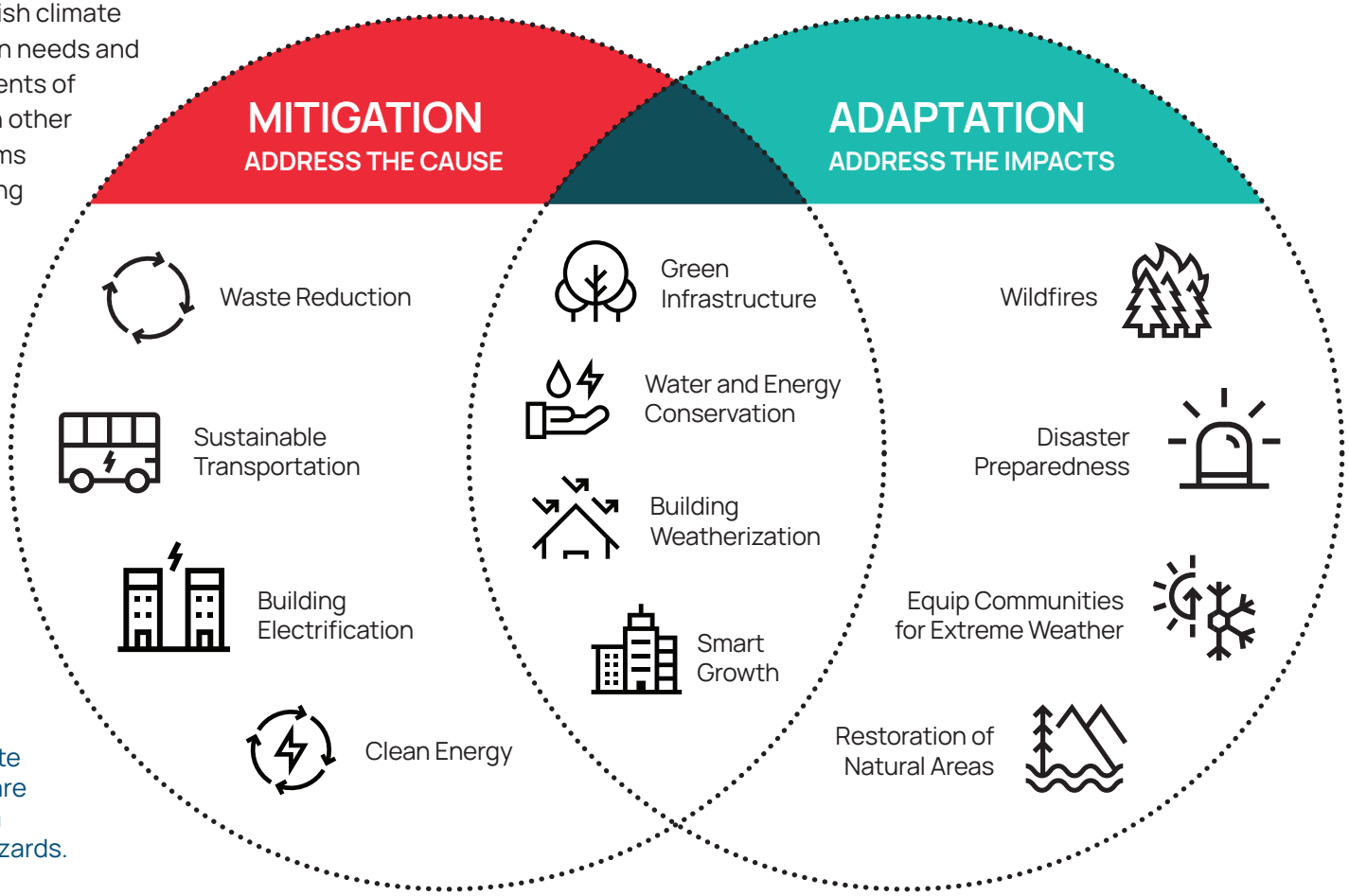


Figure 2. The intersection between climate mitigation and climate adaptation in municipalities. Mitigating the long-term impacts of climate change includes implementing actions to reduce greenhouse gas emissions and energy use. Adapting to the impacts of climate change entails planning to prepare for, respond to, and recover from extreme weather and climate hazards.

Mitigation planning in Prince Rupert is underway with the Community Energy and Emissions Plan (2017)[10] (CEEP). CEEP actions include ensuring new buildings are energy efficient; improving development density; performing residential energy efficiency retrofits; installing renewable heating and cooling for institutional, commercial, or industrial buildings; improving vehicle efficiencies and transportation infrastructure; upgrading organic waste management; boosting local food production; and increasing regional collaboration.

Many of these actions inherently support Prince Rupert's ability to adapt in a changing climate. For example, residential energy retrofits that reduce energy use and generate renewable energy also support the community's response to extreme heat and extreme cold events during which energy demand for heating or cooling will spike. Table 3 summarizes other CEEP actions that support Prince Rupert in climate adaptation.

[10] Community Energy Association, et al. Community Energy & Emissions Plan. 2017, https://www.princerupert.ca/sites/7/files/2023

Table 3. Prince Rupert's mitigation planning initiatives with potential for adaptation outcomes.

Mitigation Objectives	Mitigation Action	How These Mitigation Actions Support Adaptation
Building Efficiency	1.1 Promote electricity, natural gas, and other energy efficiency programs	Reducing energy use through efficiencies, local energy production, and local energy storage supports the City's response to increased energy demand for heating or cooling during extreme heat and cold events. Adding renewable energy and local generation promotes a robust and redundant energy system for Prince Rupert. This effort strengthens the city's climate resilience during extreme weather events that may result in power outages.
	1.2 District energy/renewable energy systems	
	1.3 Building code energy efficiency — educate and support compliance	
Addressing Growth and Development	2.2 Create re-zoning policy to achieve desired energy performance	Changes to the zoning code address energy efficiencies for mitigation but also support Prince Rupert's ability to handle spikes in energy demand during extreme heat and cold. The adaptation plan will go one step further. These actions will be reviewed alongside other zoning bylaws to ensure that with growth, new development is kept out of high-risk areas (i.e., floodplains, wildfire-prone areas, terrain instability, etc.)
	2.4 Density bonus for energy performance	
	2.9 Development permit area to enhance energy performance (e.g., orientation, landscaping)	
	2.11 Energy Step Code	
Residential Buildings	3.3 Education for realtors—energy efficiency and renewable energy	Retrofitting residential buildings empowers the community to get involved in climate action. Efficiencies explored here improve energy demand during extreme weather events and are catalysts to exploring additional adaptation planning actions such as "resilience retrofitting." Resilience retrofits will explore how residents can protect shelter from high winds, ice, snow, floods, wildfires.
	3.4 Comprehensive energy efficiency retrofit campaign (e.g., Energy Diet)	
	3.5 Voluntary or mandatory energy labelling of existing or new homes	

Mitigation Objectives	Mitigation Action	How These Mitigation Actions Support Adaptation
Commercial / Institutional Buildings and Transportation	4.2 Encourage biomass heating through education or leading by example	Exploring alternative and locally available fuels reduces the risk to the power supply during extreme weather events that may result in power disruption (i.e., high winds, severe storms, winter storms, wildfires, etc.)
Light-Duty Vehicle Transportation Urban Form	5.2 Land-use suite "enhanced"	Actions developed in adaptation will be coordinated with this effort of balancing the urban form for both sustainability and resilience (i.e., where infill and density are being explored, ensuring that new and existing buildings are equipped to handle exposure to site-specific hazards such as flooding or landslide).
	5.3 Street design	
	5.4 Implement 30 km/hr speed limit in parts of the community	
	5.5 Variable development cost charges to encourage infill development	
	5.6 Flow regional growth strategy official community plan, and local area plans through to zoning	
Light Duty Vehicle Transportation — Infrastructure and Collaboration	6.1 Active transportation planning	Adaptation will expand this work to ensure support infrastructure (e.g., bicycle racks) provide shading during extreme heat, severe storms, etc. to prevent damage to active transportation vehicles.
	6.2 Improve active transportation infrastructure	
	6.3 Anti-idling campaign/bylaw	Adaptation will expand this work to consider weather management plans for extreme heat and cold weather events to reduce exposure for general public and outdoor workers (where a vehicle may be the primary shelter on a work site).
	6.4 Special event planning	
	6.9 Raising awareness of ride sharing and guaranteed ride home programs	Adaptation will use this action as a model to investigate similar initiatives for extreme weather events and identify vulnerable populations that require this assistance.

Mitigation Objectives	Mitigation Action	How These Mitigation Actions Support Adaptation
Waste and Other	7.1 Organics diversion	Adaptation will expand this work to determine the capability of organic waste diversion to additionally collect organic debris (e.g., broken tree limbs) after extreme weather events.
	7.3 Support local food production (e.g., farmers' markets, community gardens)	Supporting the development of a Local Food Action Plan to ensure food security during extreme weather events (e.g., wildfires, severe storms, landslides) that interrupt delivery of supplies to Kaien Island.
Enabling Actions	8.1 Review land-use and transportation plans/policies for CEEP incorporation	Collaborating with regional, provincial, and federal agencies to ensure energy security, water security, and food security.
	8.3 Establish a regional energy co-operative	
	NEW ACTION—Green Marine Program—write letter of support for Port Authority	

The Climate Change Adaptation Plan will expand upon the work of the CEEP, with the goal to complement Prince Rupert's current efforts with additional actions for resilience in a changing climate.

Hazard Identification and Scoping

Several dimensions need to be defined to determine a clear extent for the risk assessment. This includes defining the physical boundaries, the time periods, the future climate change scenarios, the types of climate hazards, and the city sectors to assess for risk.

Physical Scope

Risk is assessed within the municipal boundaries of Prince Rupert. The city boundaries span beyond Kaien Island to include mainland areas adjacent to Shawatlan Lake in the northeast and coastal boundaries on all other sides. The Prince Rupert Airport is located on Digby Island west of Kaien Island. This region is out of the scope of this assessment.

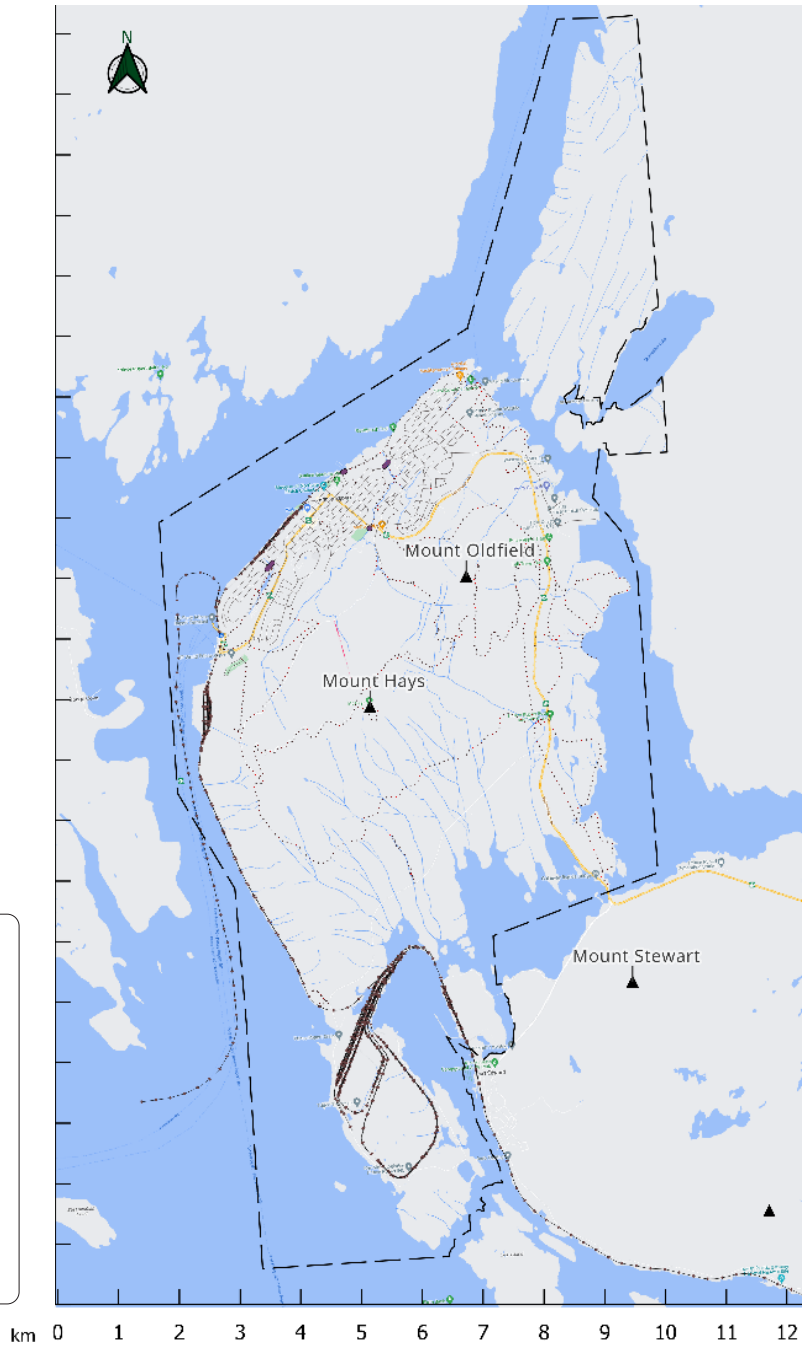


Figure 3. Map of Prince Rupert. Source: City of Prince Rupert, base map sourced from Google Roads.

Temporal Scope

As best practices dictate, climate change is assessed for one historical time horizon (1980–2010) and three future time horizons: near-term (2011–2040), mid-term (2041–2070), and long-term (2071–2100).

Climate Scenarios

Climate change is assessed using two climate scenarios: RCP 4.5 and RCP 8.5.[11] The RCP 4.5 scenario ("the moderate scenario") is useful for planning for the near-term future and frequent events (e.g., seasonal events such as spring freshet, extreme heat, extreme cold, etc.). The RCP 8.5 scenario ("the worst-case scenario") is useful for long-term planning (e.g.., infrastructure planning) for events that are anticipated to occur infrequently or that are anticipated to worsen in the long-term future.

[11] RCP 8.5: The high-emissions scenario, where emissions continue to rise throughout the 21st century. It is based on ongoing high levels of emissions, which could be driven by population growth, ongoing global use of coal, other fossil fuels, or economic growth. RCP 4.5: The intermediate emissions pathways, where emissions peak at 2040 and 2080, respectively. These pathways also include carbon capture and sequestration, but result in more serious climate consequences.

Climate Hazards

Generally, it is widely accepted that climate change influences trends such as warmer seasons, wetter events, wilder/unpredictable events, and trigger events caused by a combination of temperature and precipitation changes. Available climate data can be used to preview how climate change will influence the frequency and severity of future events. For Prince Rupert, 13 types of extreme weather events or natural hazards are reviewed.[12] The 13 event types can be organized into the four main categories of climate change influence (Figure 4).

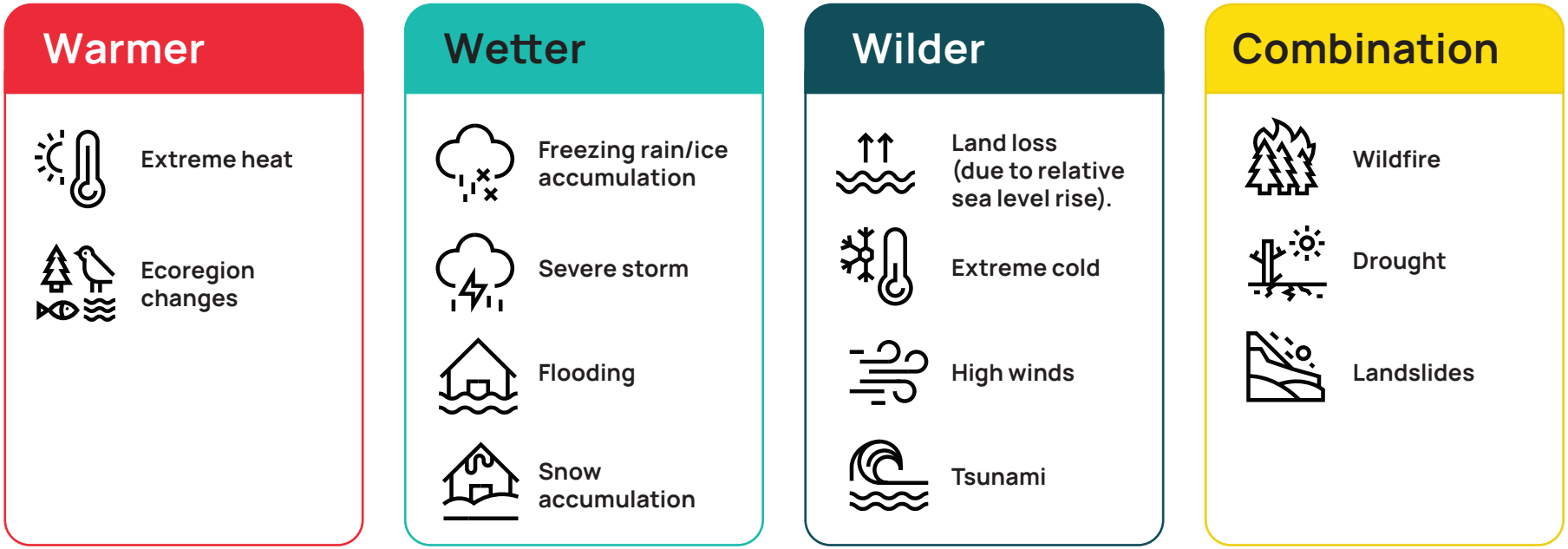


Figure 4. Thirteen natural hazards organized under four anticipated climate change trends: warming temperatures, increased precipitation, increasing unpredictability and/or severity of events, and events that may be triggered by a combination of these trends.

[12] For more details on how the 13 hazards are chosen for the scope of this project, refer to the Prince Rupert Climate Risk and Vulnerability Assessment

Each extreme weather event or natural hazard is defined using qualitative description or regional climate thresholds, including the following:

Extreme heat	Days with temperatures over 28°C.[13]
Ecoregion changes	Changes to temperature and precipitation that impact the survival of native flora and fauna.
Freezing rain/ice accumulation	Rainfall during days where surface temperature is below 0°C. When the rainfall reaches surfaces, it may result in ice accumulation.
Severe storm	Thunderstorms with heavy rain and intense lightning or damaging winds.
Flooding	The covering of normally dry land with a large amount of water.
Snow accumulation	Winter precipitation on days 0°C or lower.
Land loss (relative sea level rise)	Permanent flooding (inundation) due to the rise of the sea level relative to the shoreline. Prince Rupert will experience land loss as a result of this phenomenon.
Extreme cold/ cold snaps	Annual average minimum temperature recorded below -20°C.[14]
High winds	Sustained wind at a speed of 70 km/ hour or higher.[15]
Tsunami	**(seismic and non-seismic):** A series of waves in a water body caused by the displacement of a large volume of water, generally in an ocean or a large lake.
Wildfire	An unplanned, unwanted fire burning in a natural area, such as a forest, grassland, or prairie.
Drought	A period of time when an area or region experiences below-normal precipitation.
Landslides	Any type of slope failure or downward movement of rock and/or sediment.

[13] Environment and Climate Change Canada. Criteria for Public Weather Alerts. 26 July 2010, https://www.canada.ca/en/environment

[14] Extreme cold is defined locally for Prince Rupert and differs from weather alerts, which use a threshold of -35°C for coastal B.C.

[15] Ibid.

Key Sectors

Risk is evaluated for the community as a whole, but there are five sectors applied as lenses for assessing risk within Prince Rupert. The five sectors are:

- **Environment:** All areas of the city designated or planned as open space and natural environment.
- **People:** Residents, residential structures, and visitors.
- **Municipal services and assets:** Functions the municipality is responsible for, as well as structures owned by the municipality. This sector includes natural assets.
- **Economy:** Local businesses and commercial and industrial organizations.
- **Critical infrastructure:** A critical service or structure of the community, the loss of which causes cascading system-wide failures. This sector includes emergency services.

Risk Assessment

Risk is defined as the likelihood of an event to have a negative outcome. Conceptually, risk is a function of three key components: the likelihood of a hazard threat, the vulnerability to the hazard, and the consequence of the hazard (Figure 5).

- To what **extent** is an event a threat?
- How **frequently** doest it occur
- How will climate change impact the threat?

- What are the **direct** impacts? (injury, environmental costs)
- What are the **indirect** impacts? (disruptions, stress)

Risk = Threat Likelihood x Vulnerability x Consequence

- Is there a **history** of significant exposure?
- What is our current **capability** to address the threat?
- How **sensitive** are we to future impacts being the same or beyond historical events?

Figure 5. Conceptual formula of risk. The formula includes questions often prompted when evaluating each component.

Hazard **Threat Likelihood** is the probability that an extreme weather event or climate hazard will occur. Typically, many events can be described by the likelihood of an event (of a specific size) occurring in any given year (also known as the annual exceedance probability).

Vulnerability is a qualitative measure of coping with the stress and strain of natural hazards. For a thorough assessment, vulnerability is further broken down into the components of adaptive capacity, susceptibility, and sensitivity. Adaptive capacity reviews Prince Rupert's ability to respond to and absorb impacts. Sensitivity reviews the city's ability to recover from impacts. Susceptibility reviews the portion of the community directly within hazardous zones. Depending on the hazard, some impacts are site-specific, whereas others are experienced community-wide.

Consequence is divided into two types of impacts: direct and indirect. Direct consequences refer to tangible impacts (physical damage to structures, injury, environmental degradation, etc.). Indirect consequences refer to intangible impacts such as disruption and delays to typical activity. The direct impacts are scored based on the data related to financial impact, environmental impact, and human health impact. The indirect impacts are scored qualitatively with subject matter expert input about the duration of a disruption.

The risk component, "hazard threat likelihood," is reviewed in detail in the hazard assessment, see Appendix 2. The remaining risk components, "vulnerability" and "consequence," are evaluated in the risk assessment. The method used for the risk assessment is explained in detail in the Prince Rupert Climate Risk and Vulnerability Assessment (CRVA).

Measuring Risk

The final risk scores for each hazard are a product of vulnerability and consequence scores. The results are organized by highest to lowest risk. Accounting for the work in the hazard assessment, the final risk summary is organized by highest to lowest risk per time horizon the hazard is known to become an increasing threat. An example of the risk characterization table and key risk thresholds are provided in Table 4.

Table 4. Risk classification based on vulnerability and consequence scores.

Risk Characterization

Consequence	Very Low	Low	Medium	High	Very High
5 Severe	1	2	3	4	5
4 Major	0,8	1,6	2,4	3,2	4
3 Moderate	0,6	1,2	1,8	2,4	3
2 Minor	0,4	0,8	1,2	1,6	2
1 Insignificant	0,2	0,4	0,6	0,8	1
	0,2	0,4	0,6	0,8	1,00

Vulnerability

Risk					
	Insignificant 0,20 - 0,59	Minor 0,60 - 0,99	Moderate 1,00 - 1,99	High 2,00 -3,99	Very High 4,00 - 5,00

The risk evaluation assigns a value between zero and five, where each level of risk is a characteristic threshold of impact. A value of one is considered an "ideal risk," where the impact to normal activities is considered insignificant. These risks are often described as a nuisance or as having limited overall impact. A value of two is considered a "tolerable risk." This is the maximum threshold of risk Prince Rupert can handle within its capacity to prepare, respond, and recover. Risk levels for categories three, four, and five are best described by incremental changes in the level of impact (personal injury, property damages, financial loss, and disruption). Historical events are referenced to further describe each risk level (Figure 6).

The goal is to achieve a **tolerable risk** (a value less than 2.0) with an ultimate goal to achieve an **ideal risk** (a value less than 1.0). Any risks that are above a value of 2.0 will be explored further to determine risk reduction interventions for the final plan.

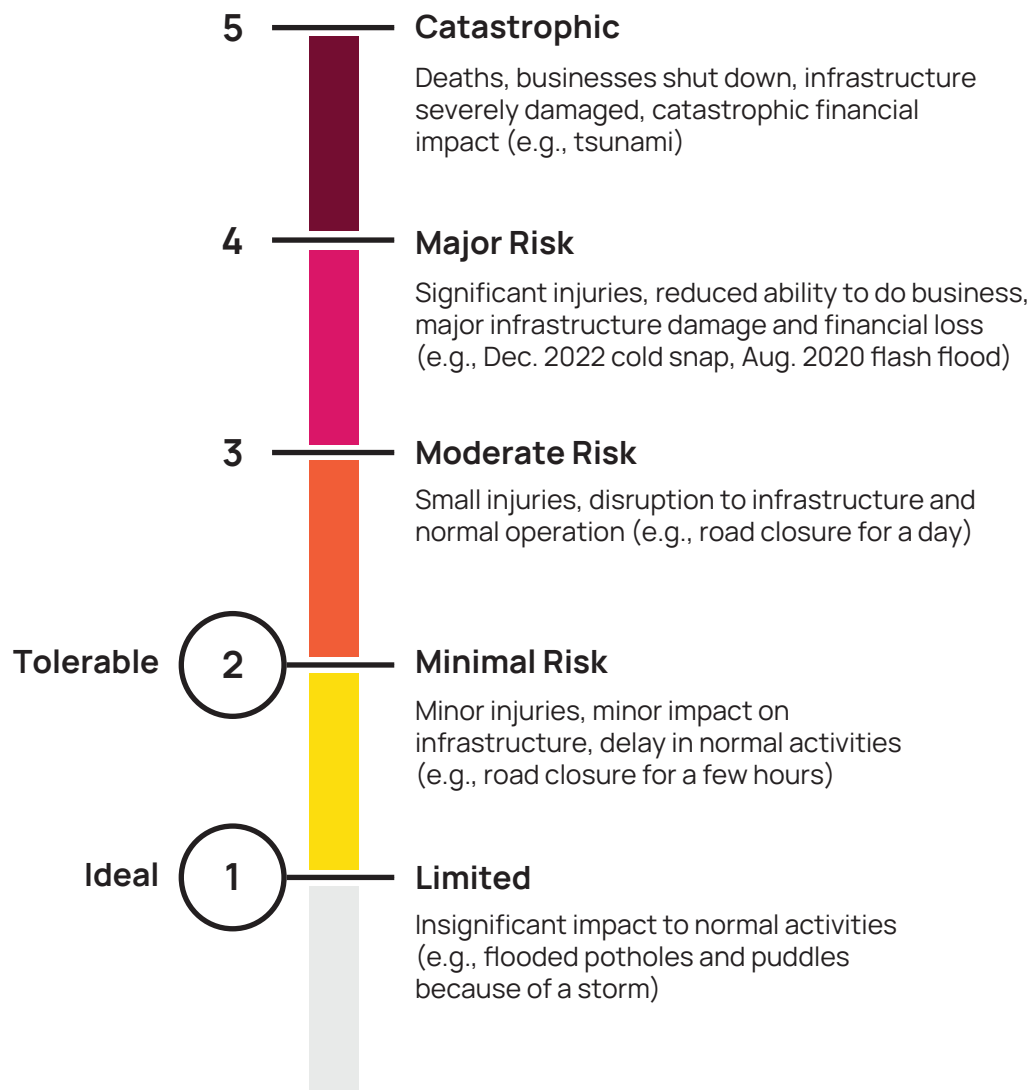


Figure 6. Illustration of risk level.

Risk Summary

Hazards Assessment

A moderate future climate (RCP 4.5) presents hazard threat scores ranging from zero (no threat) to 2.3 (moderate threat). For the worst-case scenario (RCP 8.5), hazard threat scores range from 0.3 (a minimal threat) to 2.7 (moderate threat). A detailed list of final hazard threat scores is available in Table 5. The top three hazard threats in both scenarios are "ecoregion changes," "tsunami," and "wildfire." Most hazards stay within a given threat level in both future pathways; however, there are exceptions for "extreme heat," "flooding," and "landslides, which all advance by one threat level, increasing from "minimal" threat to "low" threat.

Table 5. Risk scores by hazard for the moderate (RCP 4.5) and worst-case (RCP 8.5) scenarios.

Natural Hazards	Hazard Assessment		
	RCP 4.5	RCP 8.5	Trend
Ecoregion changes	2.3 (moderate)	2.7 (moderate)	Similar
Tsunami (seismic and non-seismic)	2.0 (low)	2.0 (low)	Similar
Wildfire	1.3* (low)	1.8* (low)	Similar
Severe storm/storm surge	1.2 (low)	1.3 (low)	Similar
Extreme heat	0.8 (minimal)	1.3 (low)	Increasing
Flooding	0.8 (minimal)	1.3 (low)	Increasing
Landslides	0.9 (minimal)	1.1 (low)	Increasing
Freezing rain/Ice accumulation	0.9 (minimal)	0.8 (minimal)	Similar
High winds	0.7 (minimal)	0.7 (minimal)	Similar
Land loss (sea level rise)**	0.7 (minimal)	0.7 (minimal)	Similar
Snow accumulation	0.6 (minimal)	0.7 (minimal)	Similar
Dry weather/drought	0.0 (no threat)	0.3 (minimal)	Similar
Extreme cold/cold snaps	0.4 (minimal)	0.2 (minimal)	Similar

Risk Assessment

Expanding from the hazard assessment, the risk assessment indicates that "tsunami," "ecoregion changes," and "high winds" are the top risks in the planning scenario. For the RCP 8.5 worst-case scenario, "land loss" (due to sea level rise), "tsunami," and "ecoregion changes" are the top risks. Although "land loss" and "tsunami" present the highest risks, other events occur more frequently and are emerging in earlier time horizons. "Ecoregion changes" and "high winds" emerge as top risks in the near-term future and "flooding" emerges as the top risk in the mid-term horizon (Table 6).

Both "extreme cold" and "snow accumulation" present an ideal risk level in the moderate and worst-case scenarios. All other hazards present a value over ideal in at least one of the two scenarios and are investigated further to identify the key drivers of risk in Prince Rupert.

Table 6. Ranking of near-, mid-, and long-term climate risks for Prince Rupert. Climate risks are grouped by the time period in which the hazard threat emerges as a significant threat, and then they are ranked from highest to lowest risk for each time horizon.

Summary		Hazard Assessment		Risk Assessment	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Near-Term Risks	High Winds	0.7	0.7	**1.8**	**1.8**
	Ecoregion Changes	2.3	2.7	**1.7**	**2.0**
	Severe Storm/Storm Surge	1.2	1.3	**1.3**	**1.7**
	Wildfire	1.3	1.8	**0.8**	**1.2**
Mid-Term Risks	Flooding	0.8	1.1	**1.8**	**1.8**
	Landslides	0.9	1.3	**1.2**	**1.6**
	Extreme Heat	0.8	1.3	**0.8**	**1.2**
	Freezing Rain/Ice Accumulation	0.9	0.8	**0.8**	**0.9**
Long-Term Risks	Tsunami (Seismic and Non-Seismic)	0.7	0.7	**2.1**	**2.3**
	Land Loss	0.7	0.7	**1.6**	**2.4**
	Dry Weather Conditions/ Drought	0.0	0.3	**0.8**	**1.2**
Diminishing Risks	Extreme Cold/Cold Snaps	0.4	0.2	**0.8**	**0.8**
	Snow Accumulation	0.6	0.7	**0.5**	**0.4**

Risk Summary

Comparison of Scenarios and Setting Risk Reduction Goals

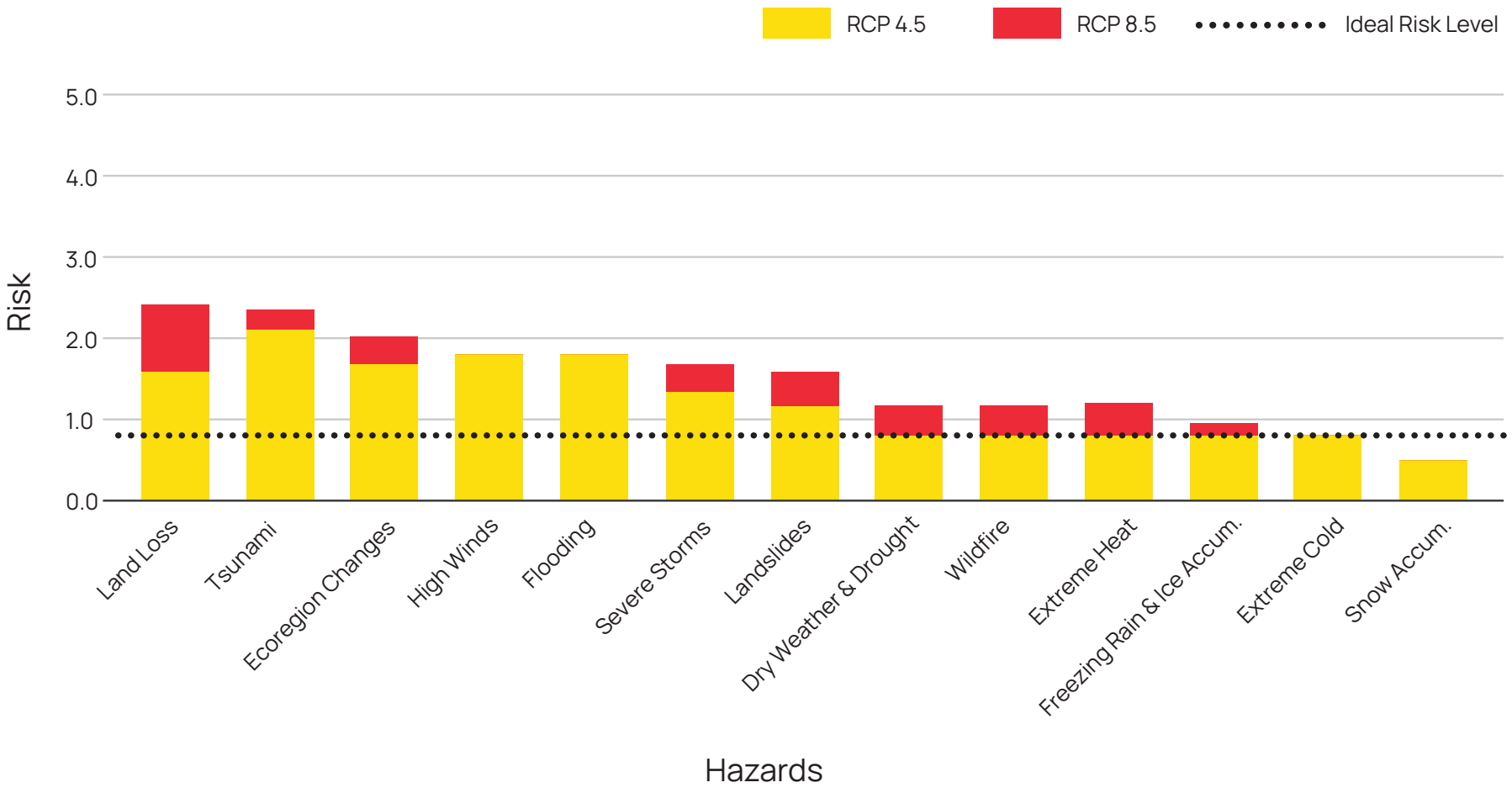


Figure 7. Graph of the risk scores per hazard per climate change scenario. The dashed black line indicates the ideal level of risk for Prince Rupert.

Drivers for Climate Risk

Prince Rupert has some underlying vulnerabilities that affect the City's ability to prepare for, respond to, and recover from future climate events. Across the 13 hazards explored, the following 6 risk themes emerged:

1. **Travel delays:** Structural damages and travel disruptions along transportation routes to and from Kaien Island.
2. **Water system disruptions:** Impacts to water infrastructure that could limit the normal flow of the water supply or stormwater.
3. **Shift in human–wildlife interactions:** Interactions between humans, animals, and the environment that pose a threat to public health or recreation. Public health threats refer to vector-borne diseases or injury due to animal attacks. Recreation threats refer to lost observance of migratory species, which may negatively impact tourism.
4. **Decline in health and wellbeing:** Prolonged exposure to adverse conditions that negatively impact health (e.g., heat stress, dehydration, frostbite, smoke inhalation).
5. **Disrupted access to essential services:** Disruptions to the delivery of goods and services to Kaien Island that create a shortage (food, medical supplies, fuel, cashflow) or outage (telecommunications).
6. **Decline in local food supply:** Disruptions to agriculture and aquaculture, causing a decrease in annual yield.

Prince Rupert's 6 risk themes

To connect all of the elements investigated, Tables 7-13 summarizes the risk themes by the hazards that trigger an impact to an element of the system. This preliminary organization of risk information serves two functions:

- **It identifies risk reduction interventions to address impacts created by specific hazards.** Although several hazards may result in the same risk, risk reduction interventions may vary. For example, road travel delays may be caused by several types of hazards, including wet weather events (i.e., storms and floods) that may result in pooling water on roads or high winds that may result in debris (e.g., broken tree limbs) on roads. In both cases, the same groups of people or system elements are considered vulnerable but the risk reduction intervention to address the risk differs.
- **It identifies risk reduction interventions that address impacts created by several hazards.** In other instances, several hazards may produce similar impacts in Prince Rupert, and organizing the information will identify where a single risk reduction intervention may be suitable to address needs for multiple types of extreme weather events.

Travel delays

Table 7. Summary of extreme weather events leading to the risk of travel delays for Prince Rupert.

Travel delays		
Applicable Hazards	**Impact**	**Vulnerable Sectors**
• Extreme heat	• Roads buckling • Traffic • Adverse travel conditions • Road closures	**Critical infrastructure** • Transportation routes (air, rail, road, ship) • Highway 16 • Paramedic services **Economy** • Industry • Local businesses **Municipal assets and services** • Public transit • Trails **Community** • Pedestrians • Drivers • Residents unable to clear ice and snow
• Severe storms • Flooding	• Pooling water • Traffic • Adverse travel conditions • Road closures	
• High winds/tornados • Extreme cold/cold snaps • Freezing rain/ice accumulation • Wildfire	• Broken tree limbs • Potholes • Traffic • Adverse travel conditions • Road closures	

Water system disruptions

Table 8. Summary of extreme weather events leading to the risk of decline in water supply for Prince Rupert.

Decline in water supply		
Applicable Hazards	**Impact**	**Vulnerable Sectors**
• Extreme heat • Ecoregion changes • Severe storms • Flooding	• Water quality (temperature, pH, turbidity, odour, biochemical oxygen demand [BOD], dissolved oxygen [DO])	**Environment** • Water bodies • Aquatic species **Critical infrastructure** • Water supply
• Drought/dry spell	• Water quantity (groundwater table, lake levels)	

Table 9. Summary of extreme weather events leading to the risk of water system disruptions for Prince Rupert.

Water and sewer system disruptions		
Applicable Hazards	**Impact**	**Vulnerable Sectors**
• Extreme cold/cold snaps • Freezing rain/ice accumulation	• Water main break	**Critical Infrastructure** • Water supply
• Severe storms • Storm surge • High winds • Land loss (relative sea level rise)	• Urban flood (stormwater) • High sea level	**Municipal assets and services** • Stormwater management • Facilities by the shoreline
• Wildfire	• Emergency water supply	**Critical Infrastructure** • Fire services

Shift in human–wildlife interactions

Table 10. Summary of extreme weather events leading to the risk of negative human and wildlife interactions for Prince Rupert.

Shift in human and wildlife interactions		
Applicable Hazards	**Impact**	**Vulnerable Sectors**
• Extreme heat • Ecoregion changes	• Vector-borne disease • Animal migration	**Environment** • Common pests (cucumber beetle) • Invasive species (Knotweed, starfish, green crab) • Key food species **Community** • Rare incidents of residents and domestic animals interacting with wolves and black bears **Economy** • Tourism (grizzly bears, black bears, wolves, orcas, humpback whales)

Decline in health and wellbeing

Table 11. Summary of extreme weather events leading to the risk of decline in human health and wellbeing for Prince Rupert.

Decline in health and wellbeing		
Applicable Hazards	**Impact**	**Vulnerable Sectors**
• Wildfire	• Water stress • Outdoor air quality • Indoor air quality	**Community** • Residents, especially children, seniors, and immunocompromised residents **Municipal assets and services** • Personnel working outdoors
• Extreme heat	• Heat stress • Indoor air quality	**Environment (overall)** **Community (overall)** **Municipal assets and services** • Personnel working outdoors
• Extreme heat • Ecoregion changes	• Mold	**Community** • Residential buildings
• Extreme cold	• Frostbite	**Community** • Residential buildings **Municipal assets and services** • Personnel working outdoors

Disrupted access to essential services

Table 12. Summary of extreme weather events leading to the risk of disrupted access to essential services for Prince Rupert.

Disrupted access to essential services		
Applicable Hazards	**Impact**	**Vulnerable Sectors**
• Extreme heat • Severe storms • Flooding • High winds/tornados • Extreme cold/cold snaps • Freezing rain/ice accumulation • Snow accumulation	• Access to medical services • Access to financial services • Telecom outage • Traffic • Road closures • Access to shelter • Delivery of emergency response	**Critical infrastructure** • Telecommunications • Transportation routes • Powerlines • Emergency services **Economy** • Industry • Local businesses • Banking **Municipal assets and services** • Medical services • Emergency response **Community** • Unhoused population • Displaced residents

Decline in local food supply

Table 13. Summary of extreme weather events leading to the risk of decline in local food supply for Prince Rupert.

Decline in local food supply		
Applicable Hazards	**Impact**	**Vulnerable Sectors**
• Dry weather conditions/drought • Ecoregion changes	• Food shortages	**Environment** • Crop plants **Economy** • Commercial fishing **Community (overall)**

Developing Solutions to Risk Drivers

The hazard and risk assessment consider future climate change impacts with the current operations of Prince Rupert. This reference case is known as the "business as planned" (BAP) case. The future of Prince Rupert built during action development and evaluation is known as the "adapted Prince Rupert" which envisions a Prince Rupert resilience to future impacts of climate change as actions for adaptation are integrated in operation.

As explored in the previous section, risk drivers are the challenges Prince Rupert aims to address through risk reduction interventions. Throughout the development of the recommendations and implementation strategy for this plan, best practices, engagement, and literature, for each solution is explored thoroughly.

Learning From Other Communities

A best practice review explores adaptation actions from similar communities, such as the City of Campbell River, the District Municipality of Ucluelet, the City of Prince George, and the District Municipality of Sooke, and identifies additional solutions to develop for Prince Rupert.

The six emerging risk themes for Prince Rupert also appeared across these communities. Two additional themes, governance and economic viability, were also identified. For the governance theme, communities outlined the need for a regional approach to address climate change. This is particularly important for honouring Indigenous sovereignty and autonomy and for planning for weather events, such as flooding (watershed dependent), tsunamis, and sea level rise, that occur beyond the municipal boundaries. For the economic viability theme, communities outlined actions specific to tourism and fishing industries to encourage local businesses to participate in developing climate action plans for business.

Extensive engagement with the community was critical to acquire as much local context and expertise to inform this plan as possible. The methods used for this project are outlined below.

Engagement Activities

SSG facilitated the following engagement to collect feedback about the adaptation options Prince Rupert should consider in the final plan. The engagement process allows the community to comment on:

- Any concerns related to climate vulnerability;
- Potential adjustments to actions to ensure they are tailored to Prince Rupert;
- Additional actions to explore;
- The priority of proposed actions; and
- The level of community participation for each action.

There are **six engagement activities**: meetings with the established advisory committee, an online interactive map, community workshops, a community survey, focus groups, and interviews. The following sections describe how each activity contributed to the design of the plan.

1 Advisory Committee

The advisory committee was composed of city representatives, business owners, environmental groups, community organizations, post-secondary institutions, and highly engaged individuals. This group was consulted and involved regularly as a key interested party.

2 Online Interactive Map

Developed early in the planning process, the interactive map was hosted on the City's website to gather information about community members' observations of natural hazards and their concerns about future climate risks.

3 Public Workshop and Outreach

In winter 2024, SSG facilitated an in-person workshop and a public outreach event. A second public outreach event occurred in April. These events were the first opportunities for the public to comment on the hazard and risk assessment phases of the CCAP. The community was also consulted about early scoping for potential actions.

4 Community Survey

The goal of the community survey was to provide a space for the community of Prince Rupert—including its diverse populations—to feel "seen/heard" in prioritizing adaptation actions (CAP process) and to participate in enhancing resiliency (CAP implementation). The resulting participation would allow Prince Rupert to understand the community's priorities related to adaptation actions and its level of preparedness to participate in draft actions. The community survey took place over a one-month period and was hosted online via the city website. A total of 51 survey participants provided feedback on:

- Concerns about climate vulnerabilities;
- Considerations for prioritizing actions;
- Emergency register;
- Emergency communications;
- Emergency shelters;
- Household emergency preparedness;
- Community initiatives; and
- Demographics.

Respondents' top priorities for actions in the CAAP include:

- Preventing infrastructure damage;
- Improving the climate resilience of the community as a whole;
- improving the climate resilience of vulnerable groups (e.g., people with low incomes, children, seniors, unhoused people); and
- Decreasing health risks related to climate hazards.

5 Focus Groups

SSG facilitated three focus groups to gather information about key assets and climate vulnerabilities. Each focus group had its own theme and included diverse community members with relevant experience. The themes included public and emergency services, ecosystem changes, and economic impacts. The feedback from these sessions focused on:

- Concerns about the impacts of climate hazards;
- Challenges for emergency response;
- Existing efforts that support climate adaptation;
- Local assets for responding to climate hazards; and
- Potential climate adaptation actions.

6 Interviews

SSG facilitated sessions to interview representatives of small- and medium-sized businesses to gather feedback on the draft actions.

Action Evaluation and Prioritization

The proposed actions were also evaluated and prioritized by municipal staff and the advisory committee members using a multi-criteria analysis (MCA) approach. A MCA is a framework that helps weigh the pros and cons of a particular project or a set of options to enable a decision.

On its own, the MCA does not provide a clear answer to questions about which option is best or whether a project is acceptable. At their root, such questions involve value judgements, and no method can provide a clear answer without being based on these subjective values. Instead, these methods are best thought of as a framework for ordering preferences and judgements in a consistent and clear way. The MCA was completed using feedback from nine participants across the following criteria:

Policy Alignment: The action is compatible with the existing programs, plans, and policies within the business-as-planned (BAP) operations across all levels of government.

Responsibility: The identified department within Prince Rupert that will lead the action implementation.

Key Partners: The identified departments and/or external partners that will support the action implementation.

Personnel Capacity Required: The annual staff time required to implement the action. This action is measured by the amount of full-time employment (FTE) needing to be resourced.

Cost: The financial cost range to implement an action. Cost ranges used in other plans are organized as follows:

- $ = Less than $50,000
- $$ = $50,000–250,000
- $$$ = $250,000–$1million
- $$$ = $1 million–$10 million
- $$$$$ = Over $10 million

Timeline: The timeframe in which an action can be successfully implemented. The timeline uses 30-year time horizons: the near-term, mid-term, and long-term. Factors to consider to ensure the successful implementation of an action include the anticipated timeframe during which climate change influences are anticipated to occur and the lifecycle of infrastructure.

Priority: A final score determined by the outcome of the multi-criteria analysis. This step includes equity considerations and is described in more detail in the Multi-Criteria Analysis section.

Upon completion of the multi-criteria analysis, the adaptation actions are ranked in order of priority for implementation.

Quick Win: actions that will be ready to implement within the first few years of implementation. The action must meet one or more of the criteria to be considered a quick win:

- Considered ongoing (an action that requires updates on a regular cycle)
- Considered a high priority for Prince Rupert
- Build upon recommendations or actions from higher levels of government
- Relative ease to resource (low cost, available funding, available staffing, etc.)

MCA Results

The **top three priorities** for Prince Rupert are as follows:

1. **Emergency Communications Strategy**
2. **Free Transit During Extreme Weather**
3. **Shelter and Shade at Transit Hubs**

These priorities offer a starting point to address emergency preparedness that focuses on segments of the community that rely on active/public transit and may need to be sheltered in an emergency.

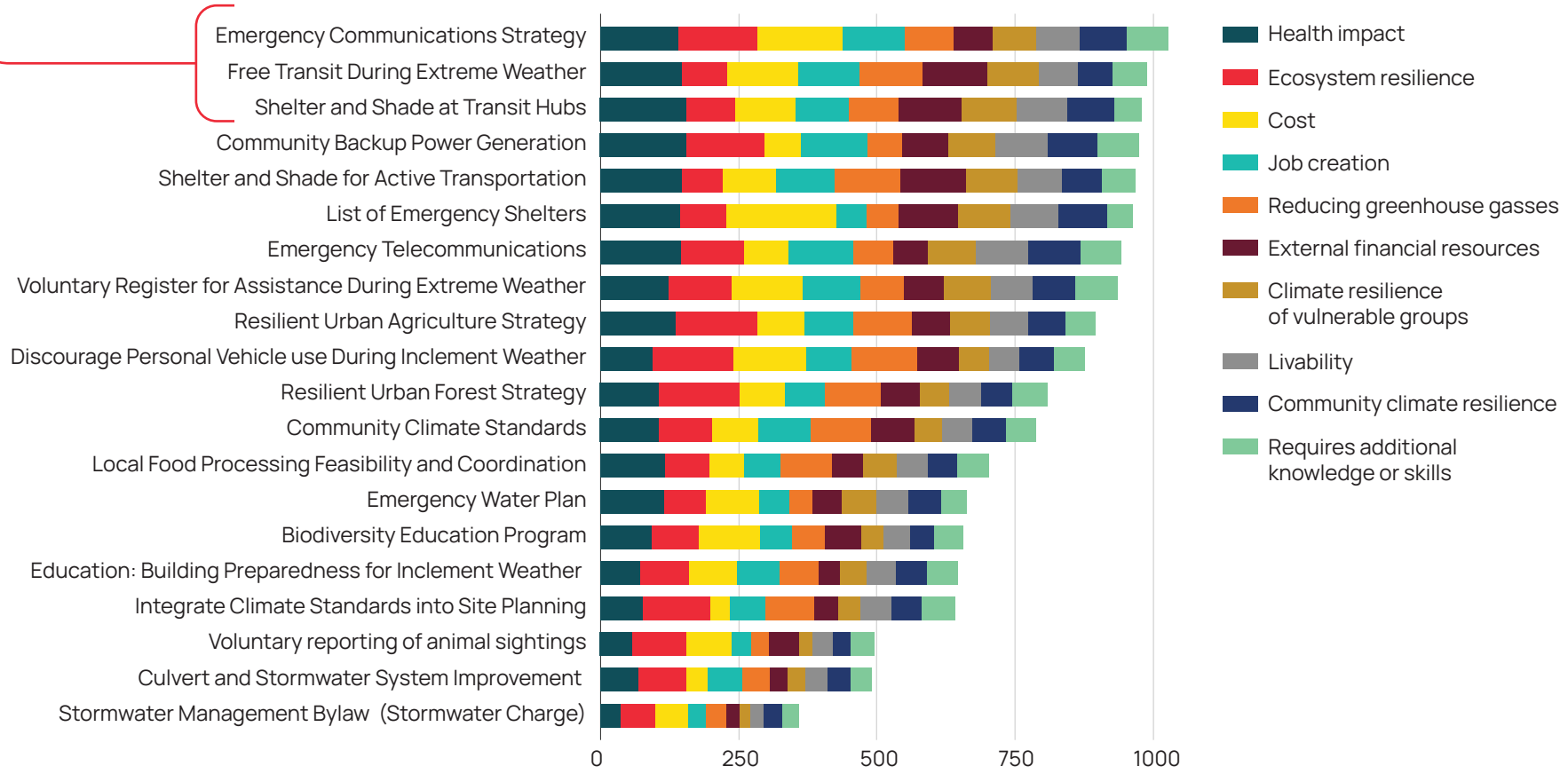


Figure 8. Graph of the final scores for each action broken down by the score of each criteria.

Of the 20 actions reviewed, actions related to addressing “travel delays” and “access to essential services” always topped the priority list (rank within 1 to 10). Actions to address “local food supply” fell in the middle of the ranking, followed by “human health and wellbeing”, “human and wildlife interactions", and “utility system disruptions". This is the final suggested order of priority for action implementation. Within each theme, actions are ordered by timeline.

These top priorities differ from the survey results described above, but the following sections reveal areas of high interest from the survey which align with results from the MCA.

Emergency Notifications

Many people are interested in having a reliable emergency notification system. A high percentage of respondents (70%) already receive information through the City’s emergency notification system, but more (91%) would prefer to receive notifications this way.

Household Preparedness

Interest in making homes more resilient and improving emergency preparedness is high. Sixty-two percent of respondents indicated they would be “very likely” or “likely” to use resources on these topics, with an additional 18% indicating they would be “somewhat likely” to use them.

Emergency Shelter

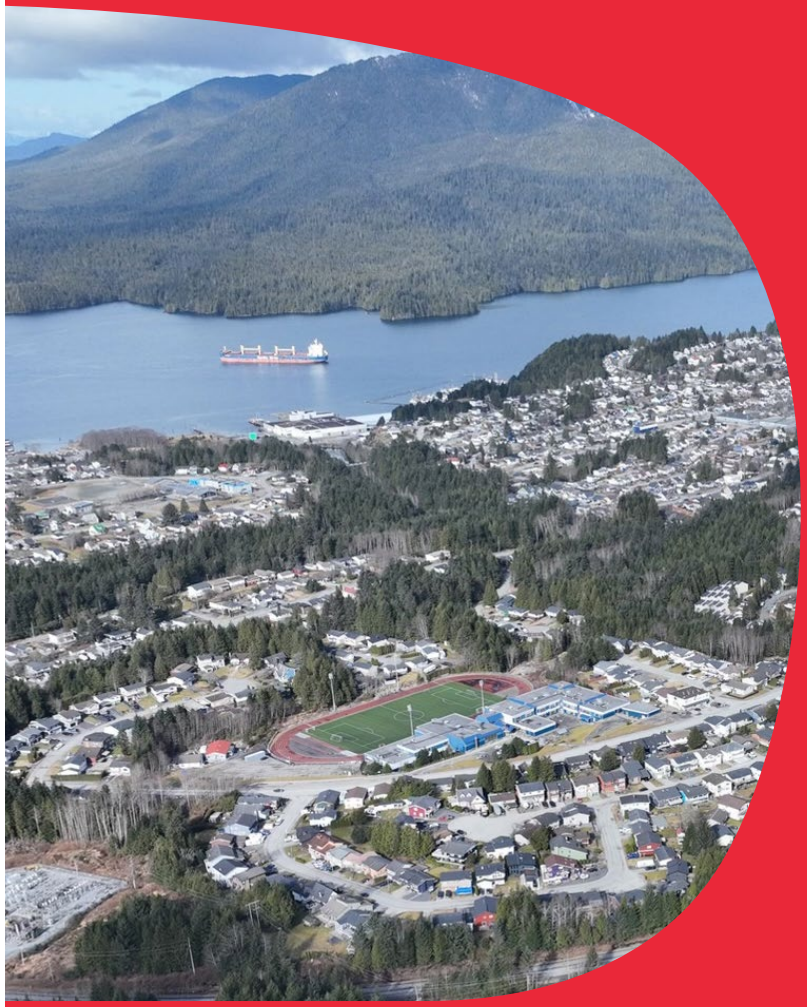
About a quarter (28%) of respondents indicated they or someone they know are “very likely” or “likely” to use an emergency shelter during an extreme event. An additional 34% indicated they or someone they know are “somewhat likely” to use an emergency shelter.

Respondents indicated that feeling safe is the most important consideration that would make them more likely to use a shelter (selected by over half of respondents).

Recommendations and Implementation Strategy

After feedback from all engagement activities was reviewed to determine if any adjustments to the priority of final adaptation actions were required. The adapted Prince Rupert outlines a future where the City adopts and implements the following 23 actions to reduce climate risk. The full details of the actions and implementation requirements are detailed in Appendix 1.

The following sections summarize key considerations for implementing each action. Actions that meet the “Quick Win” criteria are also identified with a brief description for how it can be quickly implemented. Where applicable, available external funding streams are identified to further support Prince Rupert with implementation. These funding opportunities are subject to availability at the time of this plan’s development.



Travel delays

A major result of engagement was the call for immediate action to tackle travel delays during extreme weather. In the near term, Prince Rupert can implement a study to identify routing during extreme weather, explore options for shade and shelters for public and active transportation users, and use mass communications to explain the risks of personal vehicle use during extreme weather events. Transportation is a joint responsibility between the municipality and the province and the ongoing discussions with B.C. Transit will push measures such as the "provision of free transit during extreme weather" into the mid-term future for implementation. Additional infrastructure for shading along transit and active transportation will require feasibility studies before implementation.

TD1	Discourage Personal Vehicle Use During Extreme Weather	**Quick Win:** Can be integrated into current emergency notification program and key community communication services
TD2	Free Transit During Extreme Weather	
TD3	Shelter and Shade at Transit Hubs	
TD4	Shade for Cycling and Walking Paths	

Access to Essential Services

Access to Information

Information is considered a valuable asset in emergency preparation and response for the community. The City's current Emergency Notification System is well received, with the community expressing interest in using social platforms to share emergency information. The community is also interested in the City's contingency communications when power outages occur. Printable information packages and radio services could be explored further to ensure the Prince Rupert Emergency Communications Strategy is robust with built-in redundancies.

From the community survey 46 of the 51 respondents shared how people currently receive information in Prince Rupert. The top three methods by which are:

- 70% (32 people) receive notifications via text phone call or email via the Prince Rupert Emergency Notifications System[16]
- (50%, 23 people) Prince Rupert's Facebook page
- (48%, 22 people) Social media posts by friends and family on Facebook

The same group was asked how they prefer to receive information about emergencies where

44 of the 51 respondents answered:

- 90% (40 people) preferred Prince Rupert's Emergency Notifications System (text, phone call, or email)
- 30% (13 people) chose the Prince Rupert Facebook page, but this was a far second choice
- 22% (11 people) chose a phone call from a family member, friend, or neighbour
- Less than 10 respondents selected other methods (social media, sirens, etc.)

[16] City of Prince Rupert. Prince Rupert Notification System. https://princerupert.connectrocket.com/

Businesses in the tourism sector experience a delay in getting information, and the onus is on these businesses to distribute information. As a quick win, Prince Rupert can implement a QR code that is a map to existing resources for emergencies. Hotels/businesses could keep it on their desks and visitors could scan it for up-to-date information on emergencies and how to respond.

During the focus group with local businesses we learned how extreme weather events cause losses to businesses. Storms and high winds that cause hydro (electricity) and telephone lines to go down create losses for businesses. In one example, a business owner reported losing $10,000-15,000 annually due to closures related to communication system shutdowns.

AE1	Continued Coordination of Emergency Telecommunications	✓	**Quick Win:** Continuation of current participation on this work
AE2	Continued Review and Update Emergency Communications Strategy	✓	**Quick Win:** Continuation of current participation on this work

Access to Emergency Support Services

Prince Rupert's strong social capacity means that a majority of the community actively helps neighbours, friends, or family members. This effort is informal and varies across the city.

Prince Rupert offers formal training through the Emergency Support Service (ESS) Volunteer Program.[17] The program requires interested community volunteers to commit at least two hours per month (with some variation) and provides free training by the Justice Institute of B.C. (JIBC). As part of training and development, volunteers learn about the B.C. Evacuee Registration and Assistance (ERA)[18] tool. Acknowledging that not all individuals are comfortable to self-identify on a provincial register, the City may partner with trusted organizations to ensure that the needs of vulnerable people are met during an emergency while maintaining their anonymity and autonomy.

During the focus groups, we learned that is not always readily identifiable. A large "hidden" population with precarious housing was identified which includes: people who live in overcrowded housing because of high rents, people who live in cars, and people who "couch surf" with family or friends because they cannot afford housing. Working with trusted organizations with expertise on addressing housing security in Prince Rupert would be vital to ensuring this vulnerable group has access to resources during extreme weather events.

The benefits of this partnership will be two-fold:

A. Partners to provide ESS staff and volunteers training materials to recognize the specific needs of vulnerable populations in Prince Rupert.

B. ESS to provide partners with the ability to place requests on behalf of vulnerable people and disseminate general basic resources to those not self-identified on any official registry.

This partnership would also fill the gap of events that have emergency needs that do not require evacuation but call for a stay-in-shelter protocol. This action may also apply to vulnerable populations prone to isolation due to limited means of transportation, limited mobility, and/or uncleared paths and roads from snow, ice, or debris.

[17] City of Prince Rupert. "Get Involved as an ESS Volunteer." Emergency Preparedness, https://www.princerupert.ca/services/public-safety/emergency-social-services-information/get-involved.

[18] Government of British Columbia. Emergency Support Services (ESS). https://ess.gov.bc.ca/.

During the development of this plan, it was identified that there are limits to expanding the ESS volunteer effort. ESS resources for recruiting and managing materials are at capacity. Additional staffing would be needed to ensure successful implementation and uptake. This may not be available in this cycle of the plan but could be explored again in a future budget, as it is considered a community priority. Areas of support services to improve with additional resources include:

- Digitizing emergency response information and local knowledge data;
- Allocating funding for emergency resource storage;
- Working with public organizations to coordinate emergency shelter;
- Expanding the Emergency Service Volunteer Program; and
- Hiring personnel to specifically coordinate emergency support services across public organizations.

AE3	Partner With Trusted Organizations to Ensure Identified Vulnerable Populations are Supported Through Emergency Support Services (ESS)	✓	**Quick Win:** The city ESS Volunteers is an available program.
AE4	Participation in the B.C. Evacuee Registration and Assistance (ERA) Tool	✓	**Quick Win:** Already in development
AE5	Advocate for Improved Access to Insurance Coverage for Extreme Weather Events		

Access to Post-Event Relief and Recovery

There is an ongoing concern that climate change has made available insurance policies for extreme weather events unaffordable for Canadians.[19] The Government of Canada first announced their plan for a subsidized flood insurance program for households at high risk of flooding in the 2023 federal budget[20]. This was updated to the National Flood Insurance Program in 2024[21] and the program is poised to launch in 2025.

Flooding is the costliest hazard in Canada.[22] However, to address additional hazards affecting Prince Rupert, the following action calls on the City to advocate for improved access to insurance coverage for a broader scope of extreme weather events, prioritizing the interests of households that fall within lower income brackets. Prince Rupert should share available resources from the Insurance Bureau of Canada within this plan's education programs.

[19] Extreme weather puts insurer profits at risk, impacting consumer affordability https://www150.statcan.gc.ca/n1/pub/11-621-m/11-621-m2024003-eng.htm

[20] $31.7 million over three years, starting in 2023–24, to Public Safety Canada and the Canada Mortgage and Housing Corporation to work with the Department of Finance Canada to stand-up a low-cost flood insurance program, aimed at protecting households at high risk of flooding and without access to adequate insurance. This would include offering reinsurance through a federal Crown corporation and a separate insurance subsidy program https://www.budget.canada.ca/2023/report-rapport/chap4-en.html

[21] https://insurance-portal.ca/article/national-flood-insurance-program-promised-again-in-budget/

[22] Public Safety Canada. Get Prepared. 21 Dec. 2018, https://www.getprepared.gc.ca/cnt/hzd/flds-en.aspx

Increased Energy Demand

Actions are designed to address energy concerns related to:

- Property improvements for resilience to energy demand during extreme heat (cooling) and extreme cold (heating) and
- Ensuring energy security for the community during a power outage.

Prince Rupert has identified primary and alternate power sources. This is an advantage for the city, and further planning will involve a review and update to ensure new development is incorporated into back-up power planning.

AE6	Continue Best Practice in Community Back-up Power Generation		**Quick Win:** This action is a continuation of current work

This action and action "AE6: Community Climate Standards" share a suite of options for resilience retrofits. However, unlike the Community Climate Standards, this action is geared towards encouraging businesses and developers to consider resilience retrofitting for existing properties and resilience measures for new builds.

Local Food Supply

Identifying the decline in food supply opened up a much larger discussion about food security in Prince Rupert. This plan identifies the link between local agriculture/aquaculture and changes in biodiversity, creating an understanding that food system planning will go beyond this plan for deeper discussions related to specific food stocks.[23]

Prince Rupert and Ecotrust Canada[24] are working to improve the local food system. This work is happening in parallel to the adaptation plan. Recently the community was asked to participate in a survey[25] to offer feedback on possible policies to support this initiative. Through the adaptation engagement activities and the risk assessment, food security was identified as a vulnerability for the community that can be exacerbated by climate change. This plan offers insight on how climate change may affect urban agriculture and aquaculture but recognizes that food production and food security will be built out in a separate plan for the community.

What we learned in focus groups was the vulnerability to Area Indigenous Nations as they face the potential loss of traditional food sources due to extreme weather. Over time, increasingly severe and frequent hazards affect the viability of local seafood production. Comments included that "more work could be done with identifying Indigenous populations" and capturing nuances related to how they are affected. Participants also noted that the livelihoods of fish harvesters, hunters and foragers are vulnerable to climate hazards. Some of the Food Strategy planning underway is actively addressing these concerns.

LF1	Continue the Development of a Food Strategy
LF2	Local Food and Seafood Processing Feasibility and Coordination

[23] Prince Rupert. "Food Systems Planning." Rupert Talks, https://engage.princerupert.ca/official-community-plan-update/

[24] The Northwest Food Systems Initiative aims to build local food access, literacy, and security for social and economic resiliency on Coast Ts'msyen Territory in Prince Rupert and Northwestern BC. Lough, Shannon. "Fukasaku of Prince Rupert: Putting Local Food Producers and Consumers at the Heart of a Food Market." Ecotrust Canada, 21 Oct. 2021, https://ecotrust.ca/latest/blog/fukasaku-of-prince-rupert

[25] Prince Rupert. "Food Systems Planning." Rupert Talks, https://engage.princerupert.ca/official-community-plan-update/surveys/food-systems-food-security-survey.

Human Health and Wellbeing

Emergency Shelter

Shelter was identified as the top basic need during emergencies, followed by access to medical treatment and ensuring security for vacated properties. To ensure the community will use shelters, community feedback suggests that shelter information includes descriptions of what makes them safe, as well as the type of amenities people can access (beds, hot meals, clean clothes, medication, first aid, pet services, etc.).

About a quarter (28%) of community survey respondents indicated they or someone they know are “very likely” or “likely” to use an emergency shelter during an extreme event. An additional 34% indicated they or someone they know are “somewhat likely” to use an emergency shelter.

There are a few identified shelters that fall within the ownership of Prince Rupert. To ensure there is an adequate amount of shelter in a disaster, the City can work with emergency services to set up a checklist for key partners to ensure any available shelter outside the City’s ownership meets standards to be used in the event of an emergency. Shelters that meet standards will be added as additional available safe spaces. Once published, this information would be communicated on the city website, in print materials, and through future community education programs to ensure people know they have a place to go in the event of an emergency.

HW1	Compile a List of Emergency Shelters
	**Quick Win:** Resources for this action exist but are not currently compiled on the city website

Community Education for Extreme Weather

The importance of safe shelter is echoed in the interest in education programs to improve preparedness and the climate resilience of homes and businesses. This action is presented as a two-part series to ensure that the entry points to home improvements are financially accessible as well as scalable when investments in resilience retrofits can be made.

From a focus group with local businesses, we learned a local bakery and physiotherapist office that had to close down for several days during a recent heat wave; while temperatures were "twenty-something" degrees Celsius outside, it was about 40°C inside and the buildings had poor airflow, making it impossible for the businesses to operate

Action HW2 leverages the B.C. Home Preparedness Guide[26] for the City and key partners to educate and empower homeowners and renters to take action during extreme weather events to protect their homes from impacts.

The B.C. Home Preparedness Guide[27] provides checklists and planning tips to ensure households have a procedure to follow when extreme weather events take place. This guide provides information about how to shelter in place, how to turn off utilities, stock-piling and safe storage of emergency supplies, securing the home, and preparing for evacuation.

During the community survey, it was identified many seniors have low incomes and are more vulnerable to poor indoor conditions (i.e. such as mold, indoor air quality, cooling) during extreme heat and snow removal during winter. Community education for seniors with targeted available resources can reduce vulnerability for this group.

Action HW3 will have a broader appeal for property owners, business owners, and homeowners. In this education program, the community will learn more about a suite of possible resilience retrofits applicable to their property. These retrofits may require some upfront investment, and additional information on financial incentives and grants would be provided to empower property owners to take action.

[26] Prepared B.C. Home Preparedness Guide. 2023, https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/

[27] ibid.

A feasibility study was completed by EcoTrust Canada and Prince Rupert to consider how to encourage retrofitting to homes in Prince Rupert.[28] A list of available rebates have now been published on the city website which include B.C. Better Homes programs, Canada Greener Homes Initiative and others.

Two challenges related to working with landlords were identified in the conversations about households:

1. Getting landlords to participate in resilience retrofits.
2. Finding affordable housing if landlords do consider renovations (i.e., "renoviction").[29]

To encourage general buy-in for resilience retrofits, Prince Rupert may consider sourcing trusted partners in insurance to provide information about the cost of extreme weather events. General resources are provided by the Insurance Bureau of Canada[30] to get the City started. Landlords will require additional guidance on resilience retrofits to ensure they are compliant with Bylaw 3476, 2021:Business Regulation and Licensing (Rental Units).[31]

HW2	Education on Household Emergency Preparedness
HW3	Education on Building Preparedness for Extreme Weather

Uptake of Climate Resilience Retrofits

Actions "HW4" and "HW5" address the need to integrate resilience retrofitting standards into policies for existing buildings as well as planned new developments. The action "HW4 Community Climate Standards" is intended for homeowners and renters, businesses, and property owners. The standards will be coordinated with the community engagement part of "HW2: Education: Building Preparedness for Extreme Weather" and "HW3: Education on Household Emergency Preparedness." Action "HW5: Review the Building Bylaw to Integrate Climate Standards in Site Planning" addresses integrating resilience standards into new development planning.

HW4	Community Climate Standards
HW5	Review the Building Bylaw to Integrate Climate Standards in Site Planning

[28] Lough, Shannon. "Home Energy Upgrade Program Feasibility Study: City of Prince Rupert." Ecotrust Canada, 12 Sept. 2023, https://ecotrust.ca/latest/research/home-energy-upgrade-program-feasibility-study-city-of-prince-rupert/

[29] Prince Rupert City Bylaw. "Rental Maintenance and Licensing Standards." City of Prince Rupert, https://www.princerupert.ca/community/housing-information/rental-maintenance-and-licensing-standards.

[30] Insurance Bureau of Canada. Stay Protected. https://www.ibc.ca/stay-protected

[31] City of Prince Rupert. Bylaw 3476, 2021: Business Regulation and Licensing (Rental Units). https://www.princerupert.ca/media/580.

Human and Wildlife Interaction

Ecoregion changes are anticipated to begin in the near-term future and continue over all time horizons. To address these changes, the adaptation plan supports developing an Urban Forest Strategy for Prince Rupert. The strategy would be a concerted effort to consolidate all key ideas for ecoregion conservation to adapt the ecoregion for the anticipated changes due to climate change. Other hazards (e.g., extreme heat, drought, wildfire) that negatively impact our interactions with wildlife would also be addressed, with considerations regarding how to select plant species resilient to heat stress, water stress, high winds, and wildfire spread (high moisture content).

Work still needs to be done to identify suitable partners for this strategy and to map the strategy's interaction with the Outdoor Parks and Recreation Plan[32] and other relevant policies and plans. Scoping for this strategy may go beyond the city's borders to consider natural systems boundaries (watersheds, migration patterns, soil types, etc.). Given the extent of the criteria and this action's lower priority, it is earmarked for mid-term implementation.

There is an opportunity to establish the benefits of Prince Rupert's natural system by organizing natural assets of the Urban Forest Strategy within green infrastructure asset classes. Benefits include natural shading, reducing flooding from storms, and rehabilitating local food sources. Asset classes to consider include the urban tree canopy, nature-based solutions for stormwater management, and biodiversity restoration projects (such as the Skeena River Salmon Enhancement Program[33] and the Seal Cove Salt Marsh Restoration[34]).

HA1	Support the Development of an Urban Forest Strategy

[32] City of Prince Rupert. Outdoor Parks and Recreation Plan. 2023, https://www.princerupert.ca/building-development/community-planning/outdoor-parks-and-recreation-plan.

[33] "Prince Rupert Port Authority Contributes $94,000 to Salmon Enhancement Projects." The Northern View, 13 Dec. 2022, https://www.thenorthernview.com/news/prince-rupert-port-authority-contributes-94000-to-salmon-enhancement-projects

[34] Prince Rupert Port Authority Celebrates Completion of Seal Cove Salt Marsh Restoration Project. 27 Apr. 2022, https://www.rupertport.com/prince-rupert-port-authority-celebrates-completion-of-seal-cove-salt-marsh-restoration-project/.

To prepare for anticipated wildlife changes across different types of interactions (gardening, hiking, fishing, pest control, etc.), this action provides education to the community in collaboration with key partners to ensure that residents and tourists are informed about how to safely interact with and care for local ecosystems.

HA2	Biodiversity Education Program
HA3	Voluntary Reporting of Animal Sightings

Water Disruptions

The vulnerability of the water distribution system was under evaluation during the time of the adaptation planning process. The Infrastructure Replacement Strategy[35] details the risk of the linear assets of Prince Rupert's water system. Climate change design specifications should be considered when planning the revitalization of water supply and stormwater systems.

To account for the work underway, the solutions cover concern for managing stormwater during wet weather events, continued protection of source water protection and continued planning for emergency water supplies for wildfire mitigation.

Action "WD2" will also explore options to incentivize property owners to participate in stormwater storage options to store water for non-potable use. Potential stormwater storage options include, but are not limited to, rain barrels, native species planting, and grass swales. Properties participating in stormwater storage apply a deduction to local improvement charges.

WD1	Continue to Review and Update Emergency Water Plan	**Quick Win:** This action is a continuation of current work
WD2	Stormwater Management Bylaw	
WD3	Culvert Replacement and Build Back Better	

With ample activity already underway to improve the water supply and water systems within Prince Rupert, this group of actions was prioritized lower than other risk themes. The placement for implementation is suitable given that these actions will occur on a longer, ongoing timeline.

[35] Urban Systems, and City of Prince Rupert. Infrastructure Replacement Strategy. 31 Jan. 2023, https://engage.princerupert.ca/community-infrastructure-replacement.

Next Steps

Implementation of the Climate Adaptation Action Plan will require a renewal of the plan every five years to update actions as needed to ensure an adapted and resilient Prince Rupert. During the renewal process, the City may consider renewing hazard and risk assessments to update the impacts anticipated by climate change with the most current climate data.

The city of

Prince Rupert

Climate Change Adaptation Plan

THE CITY OF PRINCE RUPERT

January 2025

Appendix 1:

Adapted Prince Rupert Actions

Travel delays

Theme	Travel Delays				
Action	**TD1**	**Discourage Personal Vehicle Use During Extreme Weather**	**Cost**	**Timeline**	**Priority**
Use mass communications to discourage people from using personal vehicles during extreme weather events that affect transportation routes (e.g., low visibility, slippery surfaces, closures) and provide information about alternatives (e.g., public transit) with the aim of reducing exposure to extreme weather. **Hazards Addressed:** Severe Storms, High Winds, Flooding, Ice Accumulation, Snow Accumulation **Risk Addressed:** Travel Delays			$	Near-Term	10
			Quick Win		
			Yes: This action can be integrated into the current emergency notification program and key community communication services.		
			Lead Department		
			City (Fire and Emergency Services)		
			Key Partners		
			Province (B.C. Transit) North Coast Transition Society Salvation Army Church of the Annunciation Soup Kitchen Seniors Centres		

Theme	Travel Delays				
Action	**TD2**	**Free Transit During Extreme Weather**	**Cost**	**Timeline**	**Priority**
In the near-term future, conduct a study that includes public engagement to identify potential routes and determine demand for free transit during extreme heat and cold and other extreme weather events. In the mid-term, investigate external funding streams to provide free transit on routes identified by study. **Hazards Addressed:** Severe Storms, High Winds, Flooding, Ice Accumulation, Snow Accumulation **Risk Addressed:** Travel Delays			$$$	Near-Term Mid-Term	2
			Quick Win		
			No: This action is to be developed for the first time with funding and support required from B.C. Transit.		
			Lead Department		
			City (Planning and Development Services) City (Transportation) City (Communications)		
			Key Partners		
			B.C. Transit		

Theme	Travel Delays			
Action	**TD3**	**Shelter and Shade at Transit Hubs**	**Cost**	**Timeline**	**Priority**
Provide shading and shelter at bus stops and other transit hubs to reduce direct exposure to rain, wind, and temperature extremes. **Hazards Addressed:** Extreme Heat, Extreme Cold, Severe Storms, High Winds, Flooding, Ice Accumulation, Snow Accumulation **Risk Addressed:** Travel Delays			$$$	Near-Term	3
			Quick Win		
			No: This action is to be developed for the first time with funding and support required from B.C. Transit.		
			Lead Department		
			City (Planning and Development Services) City (Public Works) City (Transportation)		
			Key Partners		
			Kaien Trails Society		

Theme	Travel Delays				
Action	**TD4**	**TD4: Shade for Cycling and Walking Paths**	**Cost**	**Timeline**	**Priority**
Provide shading along cycling and walking paths and explore other measures for making them more comfortable during rain, wind, and temperature extremes. **Hazards Addressed:** Extreme Heat, Extreme Cold, Severe Storms, High Winds, Flooding, Ice Accumulation, Snow Accumulation **Risk Addressed:** Travel Delays			$$$	Near-Term	3
			Quick Win		
			No: This action is to be developed for the first time with funding and support required from B.C. Transit.		
			Lead Department		
			City (Planning and Development Services) City (Public Works)		
			Key Partners		
			B.C. Transit Kaien Trails Society		

Access to Essential Services

Theme	Access to Essential Services				
Action	**AE1**	**Continued Coordination of Emergency Telecommunications**	**Cost**	**Timeline**	**Priority**
Continue to coordinate with regional public and emergency services organizations to invest in back-up systems for telecommunication outages (internet, phone lines, cellular). **Hazards Addressed:** ALL **Risk Addressed:** Access to Essential Services			$	Mid-Term	7
			Quick Win		
			Yes: This action is a continuation of the City's current participation in this work.		
			Lead Department		
			City (Fire and Emergency Services) City (Administration) City (Communications)		
			Key Partners		
			Regional Agency City (Fire and Emergency Services)		

Theme	Access to Essential Services				
Action	AE2	Continued Review and Update Emergency Communications Strategy	Cost	Timeline	Priority
			$	Near-Term Ongoing	1

- Update the City's Emergency Communications Strategy to include efforts to promote increased uptake of Prince Rupert's Emergency Notification System by residents and businesses and ensure information about emergencies is distributed effectively through Social Media.
- Provide tourism sector businesses, including hotels and tour operators, with an approach for providing up-to-date information on emergencies..
- Include guidelines for disseminating information via the Emergency Notification System , Facebook, and local radio and TV stations (Action TD 1).
- Review and update the strategy every five years with a process involving public engagement to determine preferred communication methods and channels for receiving emergency information.

Hazards Addressed: ALL

Risk Addressed: Access to Essential Services

Quick Win

Yes: This action is a review and update of ongoing work.

Lead Department

City (Fire and Emergency Services)

City (Communications)

City (Administration)

Key Partners

Key partners collaborate with the City as trusted partners to reach vulnerable groups. A list of potential partners include:

- Salvation Army
- Church of the Annunciation Soup Kitchen
- Seniors Centres

For communication with businesses:

- Chamber of Commerce
- Tourism Prince Rupert

Theme	Access to Essential Services				
Action	AE3	Partner With Trusted Organizations to Ensure Identified Vulnerable Populations are Supported Through Emergency Support Services (ESS)	Cost	Timeline	Priority
			$	Near-Term	8

Provide training materials for ESS staff and volunteers to address emergency needs under different hazard conditions. This list may include, but is not limited to, some of the following primary needs:

- Groceries
- Medications
- Transportation to a safer place
- Warmth
- Snow or debris removal
- Assistance contacting family or neighbours

Ensure partnering organizations can request and are supplied with basic survival supplies to disseminate to vulnerable populations within its services.

Hazards Addressed: ALL

Risk Addressed: Access to Essential Services

Quick Win

Yes: The city ESS Volunteers is an available program.

Lead Department

City (Fire and Emergency Services)

City (Public Health)

Key Partners

Province

North Coast Transition Society

Salvation Army

Church of the Annunciation Soup Kitchen

Seniors Centres

Theme	Access to Essential Services				
Action	**AE4**	**AE4: Participation in the B.C. Evacuee Registration and Assistance (ERA) Tool**	**Cost**	**Timeline**	**Priority**
Promote the B.C. ERA voluntary register. This tool is for citizens that require assistance evacuating from their primary residence during extreme weather events. The service will be run online, with in-person accommodation available at a B.C. Services Centre office. This action aims to prioritize encouraging seniors and individuals living with a disability to get a B.C. ID and opt-in to a register. **Hazards Addressed:** ALL **Risk Addressed:** Access to Essential Services			$	Near-Term	8
			Quick Win		
			✓ Yes: This action is already in development.		
			Lead Department		
			City (Fire and Emergency Services) City (Public Health) City (Communications)		
			Key Partners		
			Province North Coast Transition Society Salvation Army Church of the Annunciation Soup Kitchen Seniors Centres		

Theme	Access to Essential Services				
Action	**AE5**	**Advocate for Improved Access to Insurance Coverage for Extreme Weather Events**	**Cost**	**Timeline**	**Priority**
Promote awareness around obtaining insurance and what coverage options should be considered to ensure homeowners and business owners are protected against extreme weather events. Bring forward a resolution through the Union of B.C. Municipalities (UBCM) to higher levels of government to develop a tax rebate program for families under a certain income bracket to compensate for increased insurance costs due to the frequency of extreme weather events. **Hazards Addressed:** ALL **Risk Addressed:** Access to Essential Services			$	Near-Term	NA
			Quick Win		
			No		
			Lead Department		
			City Administration		
			Key Partners		
			Union of B.C. Municipalities (UBCM) Federation of Canadian Municipalities Public Service Canada Canada Mortgage and Housing Corporation Insurance Bureau of Canada Institute for Catastrophic Loss Reduction Canadian Climate Institute		

Theme	Access to Essential Services				
Action	**AE6**	**Continue Best Practice in Community Back-Up Power Generation**	**Cost**	**Timeline**	**Priority**
Continue to incorporate back-up power systems (with the most current engineering practices) to ensure coverage for critical infrastructure and essential services. Where applicable, collaborate with B.C. Hydro and explore opportunities for back-up power in the designs for new assets. **Hazards Addressed:** ALL **Risk Addressed:** Access to Essential Services			$	Mid-Term	4
			Quick Win		
			✓ Yes: This action is a continuation of current participation in this work.		
			Lead Department		
			City (Planning and Development Services) City (Public Works)		
			Key Partners		
			Energy Utility Providers		

Local Food Supply

Theme	Local Food Supply				
Action	**LF1**	**Continue the Development of a Food Strategy**	**Cost**	**Timeline**	**Priority**
Develop a Food Strategy to address concerns related to food security and ensure a local food supply during emergencies. The proposed strategy will include considerations for climate change impacts and will follow up on tools suggested in the Official Community Plan. **Provide Resources** • Food Policy Council • Rent subsidies for land or facilities • Land for community gardens and other urban agriculture • Development of farmers' markets **Projects and Programs** • Community gardens, roof-top gardens, and greenhouses • Food waste recovery and composting • Demonstration gardens • An urban hen pilot program/bylaw • An urban beehive policy/bylaw (continued on next page)			$$$	Near-Term	9
			Quick Win		
			No: This action is to be developed for the first time outside of this plan in a separate body of work.		
			Lead Department		
			City (Planning and Development Services) City (Recreation)		
			Key Partners		
			Salvation Army Church of the Annunciation Soup Kitchen School District 53 Ecotrust Canada Ts'mysen Culture Society		

Theme	Local Food Supply	
Action	LF1	Continue the Development of a Food Strategy

Advocacy

- Education about and promotion of local food production
- Municipal food production website
- Good Food Box programs
- Edible school gardens

Encourage and facilitate farmers' markets Monitoring, Evaluation, Policy

- Zoning/land-use bylaws to enable food production, processing, and marketing
- Development permit areas and guidelines (to integrate edible landscaping in multi-family residential, commercial, and industrial land developments)
- Food security assessments/strategies
- Food procurement policies
- Business licence bylaws (for selling produce)
- Food system mapping/community food assessments
- Tax break/incentive bylaws (to be used for food system infrastructure such as processing plants or other food system elements)

Hazards Addressed: Biodiversity Change, Drought

Risk Addressed: Local Food Supply

Theme	Local Food Supply				
Action	**LF2**	**Local Food and Seafood Processing Feasibility and Coordination**	**Cost**	**Timeline**	**Priority**
Work with local First Nations and the food industry to identify and assess the feasibility of local food processing opportunities in Prince Rupert, with the aim of increasing food security and supporting local production (agriculture and aquaculture). The study should consider existing efforts that can be scaled, identify how to locally train personnel, and involve close collaboration with First Nations communities involved in both food and seafood production. **Hazards Addressed:** Biodiversity Change **Risk Addressed:** Local Food Supply			$$	Mid-Term	13
			Quick Win		
			No: This action is to be developed for the first time outside of this plan in a separate body of work.		
			Lead Department		
			City (Recreation) City (Planning and Development Services)		
			Key Partners		
			Ecotrust Canada Metlakatla Ts'mysen Culture Society		

Human Health and Wellbeing

Theme	Human Health and Wellbeing				
Action	**HW1**	**Compile a List of Emergency Shelters**	**Cost**	**Timeline**	**Priority**
In collaboration with regional government agencies and provincial emergency services organizations, compile a list of publicly accessible buildings, including the Prince Rupert Recreation Complex, that can function as emergency shelters and heating and cooling shelters. **Hazards Addressed:** Extreme Heat, Extreme Cold **Risk Addressed:** Human Health and Wellbeing			$	Near-Term	6
			Quick Win		
			✓ Yes: The action can leverage existing resources and compile information to publish on the City's website.		
			Lead Department		
			City (Fire and Emergency Services) City (Public Works)		
			Key (Starting) Partners		
			HEMSBC for emergency shelter list Salvation Army Church of the Annunciation Soup Kitchen BC First Nations Health Authority (FNHA) School District 53		

Theme	Human Health and Wellbeing			
Action	**HW2**	**Education on Household Emergency Preparedness**	**Cost**	**Timeline**	**Priority**
This action is a two-part series. HW2 covers basic property improvements for homeowners and renters. HW3 covers property improvements that require investment from homeowners or property owners. Develop and implement a communication strategy that builds upon the City's existing efforts to distribute information about how households can prepare for current climate hazards (severe storms, high winds, wildfire smoke). Include existing resources like the B.C. Household Preparedness Guide. Partner with trusted organizations to ensure information reaches diverse Prince Rupert residents. Update information and the communication strategy every five years to cover current and emerging climate risks. **Hazards Addressed:** High Winds, Severe Storms, Wildfire **Risk Addressed:** Human Health and Wellbeing			$$	Near-Term	16
			Quick Wins		
			No: This action is to be developed for the first time.		
			Lead Department		
			City (Fire and Emergency Services) City (Planning and Development Services)		
			Key Partners		
			Northern Health BC First Nations Health Authority (FNHA) Insurance		

Theme	Human Health and Wellbeing			
Action	**HW3**	**Education on Building Preparedness for Extreme Weather**	**Cost**	**Timeline**	**Priority**
This action is a two-part series. HW2 covers basic property improvements for homeowners and renters. HW3 covers property improvements that require investment from homeowners or property owners. Develop an education program on how to make properties more resilient to extreme weather, with tailored information for local businesses, building owners, homeowners, and renters. Provide resources to support building upgrades, including a guide for selecting general contractors for home and roof upgrades and repairs to improve resilience, as well as information about financial incentives and grants available from utility providers and other levels of government. Update information and the communication strategy every five years to cover current and emerging climate risks. **Hazards Addressed:** High Winds, Severe Storms, Flooding, Wildfire **Risk Addressed:** Human Health and Wellbeing			$$	Near-Term	16
			Quick Wins		
			No: This action is to be developed for the first time.		
			Lead Department		
			City (Fire and Emergency Services) City (Planning and Development Services)		
			Key Partners		
			Northern Health BC First Nations Health Authority (FNHA) Insurance		

Theme	Human Health and Wellbeing			
Action	**HW4**	**Community Climate Standards**	**Cost**	**Timeline**	**Priority**
Create and implement guidelines to improve the resilience of existing buildings to extreme weather. The standards will include, but are not limited to, the following guidelines: • Cool roof guidelines for reducing indoor heat; • Landscaping guidelines, including guidelines for maintaining trees, adding trees, and incorporating native plant species to reduce heat stress, water stress, and wildfire spread (coordinated with action HA3: Urban Forest Strategy); • Guidelines for energy efficiency upgrades, including insulation, windows, and high-efficiency heat pumps to reduce energy demand, improve indoor temperatures, and ensure shelters are more resilient to extreme weather events; • Guidelines for waterproofing home foundations, including sealing foundations, ensuring adequate foundation drainage, installing a sump pump, and installing downspout drainage; and • Guidelines for improving stormwater drainage (coordinated with action WD2: Stormwater Management Bylaw). **Hazards Addressed:** Extreme Heat, Extreme Cold, Wildfire, Drought **Risk Addressed:** Human Health and Wellbeing			$$	Mid-Term	12
			Quick Win		
			No		
			Lead Department		
			City (Planning and Development Services)		
			Key Partners		
			BC First Nations Health Authority (FNHA)		

Theme	Human Health and Wellbeing			
Action	**HW5**	**Review the Building Bylaw to Integrate Climate Standards in Site Planning**	**Cost**	**Timeline**	**Priority**
Integrate Community Climate Standards into the building bylaw to improve the climate resiliency of new developments and existing non-residential buildings. Suggested solutions include, but are not limited to, the following: • Design guidelines for passive cooling, including site selection, shading, glazing, and window operability; • Cool roof guidelines for reducing indoor heat; • Landscaping guidelines, including guidelines for maintaining trees, adding trees, and incorporating native plant species to reduce heat stress, water stress, and wildfire spread (coordinated with action HA3: Urban Forest Strategy); • Guidelines for energy efficiency upgrades, including insulation, windows, and high-efficiency heat pumps to reduce energy demand, improve indoor temperatures, and ensure shelters are more resilient to extreme weather events; • Guidelines for waterproofing home foundations, including sealing foundations, ensuring adequate foundation drainage, installing a sump pump, and installing downspout drainage; and • Guidelines for improving stormwater drainage (coordinated with action WD2: Stormwater Management Bylaw). **Hazards Addressed:** Extreme Heat, Extreme Cold, Wildfire, Drought **Risk Addressed:** Human Health and Wellbeing		$$	Mid-Term	17
			Quick Win		
			No		
			Lead Department		
			City (Planning and Development Services)		
			Key Partners		
			Developers		

Human and Wildlife Interaction

Theme	Human and Wildlife Interactions				
Action	**HA1**	**Support the Development of an Urban Forest Strategy**	**Cost**	**Timeline**	**Priority**
			$$$	Mid-Term	11

Integrate climate change impacts in a new plan specifically for managing the urban forest. The proposed HA3: Urban Forest Strategy would include:

- **Native Species Monitoring:** Identifying roles for the City, local organizations, and citizen scientists, including considering a collaborative native species monitoring program throughout the community.
- **Habitat Protection for Native Species:** Managing habitat loss for birds, pollinators, and other animals reliant on the current flora in Prince Rupert.
- **Resilient Flora:** Identifying flora resilient to expected changes in climate and building resilience through diversified plantings throughout the City.
  - Resilience Group A: Natural shading and cooling (fauna heat stress prevention)
  - Resilience Group B: Robustness (wind resilient)
  - Resilience Group C: Drought-resistance
  - Resilience Group D: Peat protection (moisture control for wildfire prevention)
  - Resilience Group E: Muskeg protection (cultural observance and water filtration)

(continued on next page)

Quick Win

No: This action is to be developed for the first time outside of this plan in a separate body of work.

Lead Department

City (Planning and Development Services)

City (Recreation)

City (Communications)

Theme	Human and Wildlife Interactions	
Action	HA1	Support the Development of an Urban Forest Strategy

- **Tree Canopy Cover for Urban Areas:** Completing a feasibility assessment and developing policies with targets set to increase the urban canopy for natural cooling during extreme heat.
- **New Tree Planting:** When new trees are added to public property (developments, recreational spaces, watercourses), they should be added to Public Works Tree Management plan to be regularly maintained to remove limbs from hazardous scenarios (e.g., close proximity to power lines may result in power outages). This action would also introduce improved soil standards for new trees and other plants.
- **Restoration of Existing Habitats for Biodiversity and Food Impact:** seek opportunities or partnerships to restore wildlife habitat with a food system (e.g., restoration of salmon pathways through Hays Creek and other tributaries).

Hazards Addressed: Biodiversity Change, Extreme Heat, Wildfire, Drought

Risk Addressed: Human and Animal Interactions, Travel Delays

Theme	Human and Wildlife Interactions	
Action	HA2	Biodiversity Education Program

Inform and educate residents, local businesses, and visitors about Prince Rupert's biodiversity and provide information on how to identify and address common pests and invasive species and how to safely interact with wildlife and care for local ecosystems. Provide information in digital and hard-copy format, as well as via signage in relevant areas (e.g., trailheads, near harbour) in collaboration with organizations that maintain relevant spaces and trails. Collaborate with the tourism sector to ensure visitors access relevant information, such as through QR codes leading to a webpage with information for tourists. The program will cover:

- Common pests and invasive species, including cucumber beetle and tank caterpillars, and how to address them;
- Information about shifts in animal behaviour due to climate change;
- Adverse wildlife interactions, including how to respond to deer, bear, and wolf encounters;
- Positive wildlife interactions, including supporting pollinators, practicing sustainable fishing practices, and responsibly observing eulachon and salmon runs; and
- Opportunities to report animal sightings and invasive species and contribute to wildlife monitoring initiatives. The program may also include campaigns on specific issues such as bear awareness and managing garbage to minimize nuisance from ravens.

Hazards Addressed: Biodiversity Change

Risk Addressed: Human and Wildlife Interactions

Cost	Timeline	Priority
$$$	Mid-Term	15

Quick Win

No: This action is to be developed for the first time. Partners need to be identified.

Lead Department

City (Administration)

City (Communication)

Key Partners

BC First Nations Health Authority (FNHA)

North Coast Skeena Stewardship Society (Eelgrass)

Adjacent Communities

Ecotrust Canada

Theme	Human and Wildlife Interactions			
Action	**HA3**	**Voluntary Reporting of Animal Sightings**	**Cost**	**Timeline**	**Priority**
Collaborate with grassroots organizations and nonprofits to develop a dedicated platform for residents to report non-native animals and unusual animal sightings in the community. The platform can be shared alongside information about changes in animal habits as a part of HA2: Biodiversity Education Program. **Hazards Addressed:** Biodiversity Change **Risk Addressed:** Human/Animal Interface			$$	Mid-Term	18
			Quick Win		
			No: This action is to be developed for the first time. Partners need to be identified.		
			Lead Department		
			City (Administration) City (Communication)		
			Key Partners		
			BC First Nations Health Authority (FNHA) North Coast Skeena Stewardship Society (Eelgrass) Department of Fisheries and Oceans (Green Crab) Adjacent Communities		

Water Disruptions

Theme	Water Disruptions				
Action	WD1	Continue to Review and Update Emergency Water Plan	Cost	Timeline	Priority
Continue work to ensure a safe back-up potable water supply and grey emergency water supply for Prince Rupert. **Hazards Addressed:** Severe Storms, Flooding, Drought, Wildfire **Risk Addressed:** Water System Disruptions			$$	Long-Term	14
			Quick Wins		
			Yes: This action is a continuation of current participation in this work.		
			Lead Department		
			City (Public Works)		

Theme	Water Disruptions				
Action	**WD2**	**WD2: Stormwater Management Bylaw**	**Cost**	**Timeline**	**Priority**
Develop a local improvement charge for stormwater improvements. A fee will be charged for the amount of hard surface on a property. Fees will vary by property type. This action will also explore options to incentivize property owners to participate in stormwater storage options to store water for non-potable use. Potential stormwater storage options include, but are not limited to, rain barrels, native species planting, and grass swales. **Hazards Addressed:** Severe Storms, Flooding **Risk Addressed:** Water System Disruptions			$	Mid-Term	20
			Quick Wins		
			No: This action is to be developed for the first time. Funding, support, and partners need to be identified.		
			Lead Department		
			City (Public Works)		

Theme	Water Disruptions				
Action	**WD3**	**WD3: Culvert Replacement and Build Back Better**	**Cost**	**Timeline**	**Priority**
Integrate climate resilience considerations into the design and planning of new infrastructure. As a follow-up to Prince Rupert's Infrastructure Replacement Strategy, this action suggests that culverts/stormwater sewers that are due for replacement should also be assessed for potential re-sizing. The hazard assessment completed as part of this plan suggests that replacements typically aim to handle 20% more water by volume. **Hazards Addressed:** Severe Storms, Flooding **Risk Addressed:** Water System Disruptions			$$$	Long-Term, Ongoing	19
			Quick Wins		
			No		
			Lead Department		
			City (Public Works)		
			Key Partners		
			BC First Nations Health Authority (FNHA) North Coast Skeena Stewardship Society (Eelgrass) Department of Fisheries and Oceans (Green Crab) Adjacent Communities		

The city of

Prince Rupert

Climate Change Adaptation Plan

January 2025

Appendix 2:

Climate Change Trends and Future Scenarios

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About this Document

Request

The City of Prince Rupert requests that existing climate data and projects are examined to establish climate change trends and future scenarios, and research into the likelihood, consequence, frequency and impacts of each hazard type on people and sectors.

Proposal

In the Project Backgrounder, SSG identified a comprehensive list of historic natural hazards as well as current interventions to reduce disaster risk. The list of hazards will be further informed by the feedback from public workshops. The work in the Climate Change Trends and Future Scenarios will reorganize the list of natural hazards by probability of future threat.

To complete this task, future climate data is collected for both the representative concentration pathway (RCP) 4.5 and RCP 8.5. The future climate presented in RCP 4.5 will establish likely trends expected for Prince Rupert and RCP 8.5 will allow SSG to examine the worst-case scenario for the future climate. The RCP 4.5 scenario will be key to the next phases to establish community exposure and vulnerability, whereas the RCP 8.5 scenario will establish thresholds for disaster risk reduction with a focus on critical infrastructure.

Result

Climate change trends & future scenarios identified.

Key Terms

Adaptive capacity: A key component of vulnerability, it is the ability of built, natural, human, and social systems to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. Conceptually, vulnerability is a function of adaptive capacity, sensitivity, and exposure.

Climate: The long-term weather patterns of a given location averaged over a period of time, typically 30 years.

Climate change: Changes in long-term weather patterns caused by natural phenomena and exacerbated by human activities that alter the chemical composition of the atmosphere through the build-up of greenhouse gases which trap heat and reflect it back to the earth's surface.

Climate adaptation: The process by which human and natural systems adjust to actual or expected climate change and its effects on built, natural, social, and human systems. Adaptation seeks to moderate or avoid harm, or even take advantage of beneficial opportunities that result from the changing climate.

Climate hazards: The potential occurrence of climate-related physical events, such as extreme weather events (e.g. heat waves or floods), or climate change trends, such as increasing temperatures, that may result in loss of life, injury, or other health impacts, as well as damage to natural, built, or human systems.

Climate mitigation: Any activities (e.g. policy, program, regulation, infrastructure, activity, or other project-based measures) that contribute to the reduction of greenhouse gas concentrations in the atmosphere.

Critical infrastructure: The physical structures, facilities, networks and other assets which provide services that are vital to the social and economic functioning of a community or society.

Eco Region: Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. [1]

Essential Services: The physical structures, facilities, networks and other assets which provide services that are vital to the emergency preparedness, response and recovery of a community or society.

Exposure: A key component of vulnerability. It is the presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected by climate-related events. For example, assets located in a

[1] U.S. EPA Office of Research and Development (ORD) - National Health and Environmental Effects Research Laboratory (NHEERL) . "Level III Ecoregions of the Conterminous United States." FGDC Metadata, https://gaftp.epa.gov/EPADataCommons

floodplain or people living in poor-quality housing are more exposed to the impacts of climate change. Conceptually, vulnerability is a function of adaptive capacity, sensitivity, and exposure.

Equity: The principle of being fair and impartial, requiring freedom from bias. In particular, climate equity is a principle promoting solutions that give equal opportunity for everyone to benefit from investments in climate change while ensuring vulnerable populations do not bear an unequal burden from impacts.

Extreme Weather Events: includes unexpected, unusual, severe, or unseasonal weather; weather at the extremes of the historical distribution—the range that has been seen in the past. Technically, these events are defined as lying in the most unusual ten percent (10th or 90th percentile of a probability density function). For Canada, thresholds for extreme weather events can be accessed from the Public Weather Alert. Note: When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season).

Impacts (also commonly referred to as consequences): The outcome of climate hazards on natural, built, and human systems. This includes the effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure. Impacts generally manifest in some form of damage, disruption, or complete loss and can be generally categorized as physical, social, or economic. Impacts can be considered direct (damage to a building) or indirect (loss of a job or income as a result of damage to a building). Impacts result due to the interaction of climate events or trends (occurring within a specific time period) and the vulnerability of an exposed society or system.

Resilience: The capacity of a system, either social, economic, or environmental, to cope with hazardous events or disturbances. This can involve responding to hazards or reorganizing systems in ways that allow them to maintain their essential function, identity, and structure. Conceptually, resilience is a function of the likelihood of a hazard, the vulnerability and the level of disruption.

Risk: The potential for negative consequences where something of value is at stake and where the outcome is uncertain. It is often represented as the probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Conceptually, risk is defined as a function of the probability of a hazard, the vulnerability (the level of adaptive capacity, exposure and sensitivity of the system) and consequence (direct and indirect impacts).

Risk characterisation: Applying a qualitative (relying on expert judgment) or quantitative (using metrics to define risk components) to assign values for risk. The result is a classification of risk values into a range of minimal, moderate and high risk. This step allows for prioritization of at-risk assets, services and communities.

Sensitivity: The extent to which rising levels of greenhouse gas emissions will affect the earth's temperature. A high sensitivity to climate change means more adaptation actions will need to be implemented to avoid large climate impacts, while a lower sensitivity would mean we have more time to adapt. Conceptually, vulnerability is a function of adaptive capacity, sensitivity and exposure.

Vulnerability: The likelihood of being adversely affected due to characteristics of human or social-ecological systems that are exposed to hazardous climatic events or trends. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (low adaptive capacity). Ecosystems, geographic areas, assets, humans, etc. can be classified as vulnerable, and this is of particular concern if a vulnerability in one area (e.g. humans) increases as a result of potential impairment or increased vulnerability in other areas (e.g. assets). Conceptually, vulnerability is a function of adaptive capacity, sensitivity and exposure.

Abbreviations

asl	above sea level
CMIP	Coupled Model Intercomparison Project
ENSO	El Nino / Southern Oscillation
GCM	Global Circulation Model
GHG	Greenhouse Gas Emissions
IPCC	Intergovernmental Panel for Climate Change
msl	mean sea level
RCP	Representative Concentration Pathways
SPEI	Standard Precipitation Evapotranspiration Index
SSP	Shared Socio-economic Pathways

Introduction

The analysis of climate trends and future scenarios for Prince Rupert will review changes across climate indicators. The climate indicators generally belong to one of the four main themes: temperature, precipitation, terrain, and biodiversity. Combinations of the climate indicators present scenarios for natural hazards to occur.

This step of analysis is known as the "determination of the hazard threat likelihood" and it is part of the series as per Infrastructure Canada's Climate Lens general guidance.[2] The Climate Lens provides a basic approach to climate risk reduction. The approach is a risk characterisation exercise where risk is defined as a function of three key components: the probability of a hazard threat, the vulnerability to the hazard, the consequence of the hazard.

Figure 1. Concept of risk

Previously explored in the Project Backgrounder, the historical natural hazards were reviewed to determine which climate indicators are known to contribute to the resulting natural hazard event. This preliminary list (Table 1) is used to assume that future natural hazards will be triggered by the same climate indicators by which historic events occurred. It is possible that the changes in the climate indicators may introduce natural hazards previously not considered a threat. The future climate scenarios are further explored using representative concentration pathways (RCP).

[2] Infrastructure Canada. Infrastructure Canada - Climate Lens - General Guidance. 28 May 2018, https://www.infrastructure.gc.ca/.

Table 1. Establishing a list of hazards by triggering climate conditions from historic events

Hazard	Key Climate Indicators	Historic Event Characteristics		
		Event	Event Threshold	Event Climate Conditions
Extreme Heat	• Maximum Temperature • Tropical Nights over 20°C • Number of Days with Temperature over 30°C • Humidity over 30	Jun 28, 2021	30.0 °C (17°C warmer than the summer average)	• Maximum temperature • High Summer Mean Temperature
Extreme Cold / Cold Snaps	• Minimum Temperature • Annual Days with Temperature under -20°C • Freeze/Thaw Cycles • Wind Chill	Jan 23, 1916	-21.1C (22°C colder than the winter average)	• Minimum Temperature • Low Winter Mean Temperature
		Dec 18, 2022	Cold Snap	• Abrupt Freeze/Thaw Cycle
Dry Weather / Drought	• Number of consecutive dry days	Dec 16, 2018	Dry Weather + Storm Surge (Dry summer followed by storm surge)	• Consecutive Dry Days • Summer Total Precipitation
Extreme Rainfall / Severe Thunderstorm / Storm Surge	• High Tide • Sea Level Rise • Maximum 1-Day Precipitation	Sep 24, 2021	Extreme Rainfall (In the 7 days, 221 mm of rainfall)	• Maximum 5-day Precipitation
Flooding	• Maximum 1-Day Precipitation • Maximum 5-Day Precipitation • Seasonal Precipitation • Snowmelt (freshet)	Aug 15, 2020	Flash Flooding (Rainfall over 150 mm over 3 days)	• Maximum 1-day Precipitation • Maximum 5-day Precipitation

Hazard	Key Climate Indicators	Historic Event Characteristics		
		Event	Event Threshold	Event Climate Conditions
High Winds	• Wind Speed	Nov 24, 2021	Wind Gusts, 110 km/hr	Wind Speed
Landslides	• Number of consecutive dry days • Maximum 1-Day precipitation • Seasonal Temperature • Seasonal Precipitation	Sept. 1, 2022	Land instability	no climate indicators documented
Land Loss	• Sea Level Rise • Land Subsidence			
Tsunami (non-seismic)	• Terrain instability		No historical event recorded	Local assessment needed
Tsunami (seismic)	• Earthquake	Oct 28, 2012	7.7 magnitude earthquake	3.5m water level
Biodiversity	• Mean Annual Temperature • Mean Annual Precipitation • Frost Days		Himalayan knotweed, Giant Knotweed Bohemian knotweed, Japanese knotweed	

Future Climate Pathways

Climate science occasionally refines the pathways that determine where the global climate is headed. Developed for use by the United Nations Intergovernmental Panel on Climate Change (IPCC), the recognized global authority on advancing the understanding of global climate change, the Representative Concentration Pathways (RCPs) describe different climate change scenarios, depending on the amount of greenhouse gases (GHG) emitted over time.

With the IPCC Sixth Assessment Report now in circulation, another set of pathways refine the RCPs and are known as the Shared Socio-economic Pathways (SSPs). The SSPs are an exploration of the impacts of climate mitigation policies, technologies, and growth patterns on GHG emissions. RCPs describe the pathways for GHG concentrations in the atmosphere, whereas SSPs look at the impacts of global action on people, economies, and development, and how those affect GHG emissions.

Using the RCPs

Each RCP scenario accounts for changes to land use and land cover, as well as the lifecycle of various gases and aerosols in the atmosphere. The pathways differ in the actions taken to reduce GHG emissions.[3] RCPs have been used by municipalities across the globe to project climate trends for their given area to better understand the types of climate actions that need to be taken.

RCP 8.5: The high-emissions (worst-case) scenario, where emissions continue to rise throughout the 21st century. It is based on ongoing high levels of emissions, which could be driven by population growth, ongoing global use of coal, economic growth, or other fossil fuel use.

RCP 6.0 and 4.5: Intermediate emissions pathways, where emissions peak at 2040 and 2080, respectively. These pathways also include carbon capture and sequestration, but result in more serious climate consequences.

RCP 2.6: The most ambitious pathway, requiring emissions to decline starting in 2020, reach zero emissions by 2100, and then decline further through carbon capture and sequestration.

[3] van Vuuren et al. (2011). The Representative Concentration Pathways: An Overview. Climatic Change, 109 (1–2), 5–31.

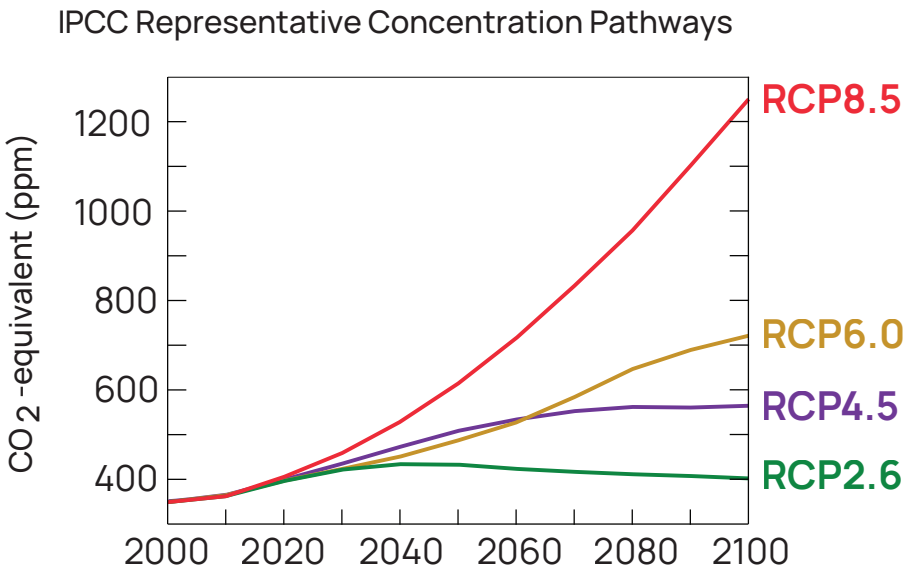

Figure 2. Representative concentration pathway projections by equivalent amount of carbon dioxide emissions in parts per million.

Scenario RCP 4.5 and RCP 8.5

RCP 8.5 scenario represents a future where GHG emissions continue to rise in the atmosphere, primarily due to continued use of fossil fuels. The RCP 8.5 scenario has been criticized for overestimating global coal reserves, leading to continued coal use and greater contributions of GHGs to the atmosphere.[4] The world has a 35% chance of exceeding RCP 8.5 by the end of the century.[5]

While the RCP 8.5 scenario may be an overestimation of atmospheric carbon by the end of the century, climate scientists have noted that RCP 4.5 is most likely an underestimation.[6] Consequently, most climate scientists have applied a conservative approach, modelling climate trends based on the RCP 8.5 scenario. In the event that emissions trend closer to the RCP 4.5 scenario, the conditions modelled for this project will be delayed by a period of time but not eliminated entirely.

Global GHG emissions in 2022 are tracking towards the RCP 8.5 scenario, and this is expected to continue into the mid-century based on the current global emissions pathway.[7] Due to these trends, RCP 8.5 was selected as the most suitable scenario for analyzing the worst-case scenario for Prince Rupert's climate risk. However, assuming the policies to reduce the emissions of GHGs across the globe are successfully implemented, the expected actual climate scenario at the end of the century will fall between RCP 4.5 and RCP 8.5.

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[4] Hausfather, Z. and G. P. Peters,, Jan 2020. Emissions- The "business as usual" story is misleading. Nature, Jan 29 2020. Accessed April 2022: https://www.nature.com/articles/d41586-020-00177-3.

[5] Christensen, P., Gillingham, K., & Nordhaus, W. (2018). Uncertainty in forecasts of long-run economic growth. Proceedings of the National Academy of Sciences, 115(21), 5409-5414.

[6] Ibid.

[7] Schwalm, C.R., S. Glendon, and P. B. Duffy., 2020. RCP8.5 tracks cumulative CO2 emissions. Proceedings of the National Academy of Sciences,117 (33,) 19656-19657.

Climate change risk reduction planning includes preparation, response and recovery strategies for a number of anticipated climate events. Catastrophic events (the worst-case scenario explored through RCP 8.5) are of a magnitude to be anticipated to occur infrequently. This case is useful for long-term planning for infrastructure. To plan for the near-term future and frequent events (i.e. seasonal events such as spring freshet, extreme heat, extreme cold, etc.) RCP 4.5 is applied.

Using the SSPs

The most recent set of climate model experiments, known as the Sixth Phase of the Coupled Model Intercomparison Project (CMIP6)[8] use the Shared Socioeconomic Pathways (SSP) scenarios as presented in the IPCC Sixth Assessment Report (AR6)[9]. The scenarios are:

SSP1: Sustainability (Taking the Green Road)
SSP2: Middle of the Road
SSP3: Regional Rivalry (A Rocky Road)
SSP4: Inequality (A Road divided)
SSP5: Fossil-fueled Development (Taking the Highway)

Newer climate indicator data such as "humidity" are now available in the SSP futures. Although the Climate Change Trends and Future Scenarios for Prince Rupert uses data with the RCP future scenarios, newer data from the SSP futures can be mapped to RCP futures:

[8] Canadian Centre for Climate Modelling and Analysis, and Environment and Climate Change Canada. "CMIP6 Climate Scenarios." Climate Modelling, Projections and Analysis, https://climate-scenarios.canada.ca/?page=cmip6-scenarios.

[9] Masson-Delmotte, Valérie, et al., editors. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2021. https://www.ipcc.ch/

Table 2. Mapping the RCP future projections to the SSP future projections

RCP	Corresponding SSP[10]
RCP 8.5 The high-emissions (worst-case)	**SSP 5 - 8.5** • Fossil-fueled Development • highest emissions no-policy baseline
RCP 4.5 Intermediate emission reduction	**SSP 2 - 4.5** • no significant shift in social, economic and technological trends from historical patterns • intermediate emission reduction
RCP 2.6 Ambitious emission reduction	**SSP 1 - 2.6** • low challenges to mitigation and adaptation due to rapid shift • near-term emissions reductions

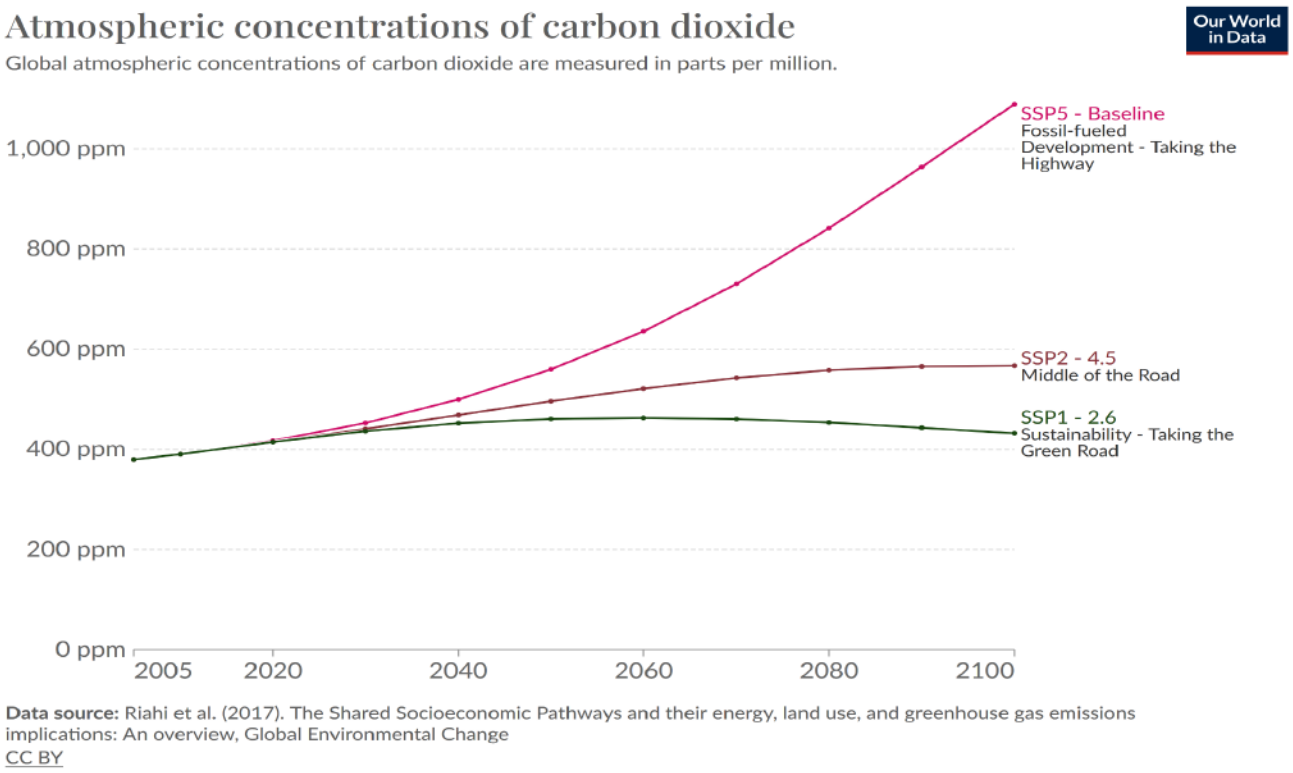

Figure 3. Shared socioeconomic pathways (Source: Our World in Data[11])

[10] Harrisson, Thomas. "Explainer: How 'Shared Socioeconomic Pathways' Explore Future Climate Change." Carbon Brief, 19 Apr. 2018, https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/.

[11] "Data Explorer: IPCC Scenarios." Our World in Data, https://ourworldindata.org/explorers/ipcc-scenarios.

Confidence Levels

Climate projections are designed to demonstrate how the climate will respond to a selected RCP scenario over a longer period of time (e.g. 30-year climate normal period). While projections cannot guarantee a particular outcome, it is expected that the projections will show a trend if a particular RCP scenario is followed (e.g. RCP 8.5).

Since climate projections are not expected to provide exact predictions around future climate, confidence levels are used to determine the likelihood of changes in climate expected under a given RCP scenario. Confidence levels can be based on several factors, including a comparison between historical observations and future climate, the level of agreement between the different climate simulations, and considerations for the physical processes driving the change in climate.

As new IPCC reports are released, higher-quality observations and improvements in models are made, allowing for better projections. Figure 4 demonstrates the relationship between the strength of evidence for a given climate parameter (e.g., temperature) and the level of agreement within the scientific community. When including the uncertainties of factors such as melting permafrost, increased forest fires, and changes to existing carbon sinks on land and in the ocean, the pathway lies much closer to RCP 8.5.

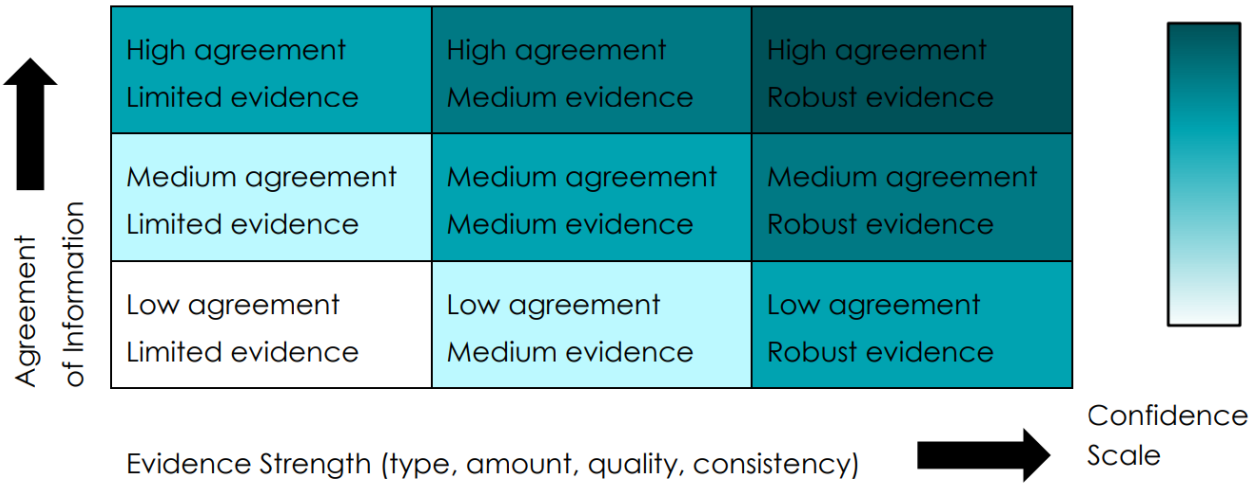

Figure 4. Conceptual depiction of the relationship between evidence and confidence.[12]

[12] Adapted from: IPCC, 2012 – Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (Eds.). Available from Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 8RU ENGLAND, 582 pp.

Based on information available to date, Table 3 demonstrates a sample of climate parameters (e.g. temperature) and their confidence levels. Parameters that are direct inputs into climate models, such as temperature and precipitation, are often associated with having a high level of evidence and general agreement that these changes are happening.

Table 3. Sample climate parameters and their confidence levels.

High Evidence, High Agreement	High Evidence, Medium Agreement	Low Evidence, High Agreement
Mean, Maximum, Minimum Temperature Extreme Heat Extreme Cold Growing Season	Total Precipitation Extreme Precipitation	Ice Potential

Data Collection

Most Climate indicators are collected from climatadata.ca for RCP 4.5 (SSP2-4.5) and RCP 8.5 (SSP5-8.5). Biodiversity data is collected from Adapt West[13]. Wind speed[14] and relative sea level rise[15] are collected from Natural Resources Canada databases. Prince Rupert provided additional precipitation data for better local context to precipitation changes. See Appendix A for the detailed list of collected climate indicators.

Timescale of Assessment

The historical time horizon is collected to benchmark the future climate scenarios. This period is defined by the years 1950 - 2010. The future scenarios analysis covers the time span from the present day to 2100 with results for three time horizons: Near-term(years 2011 to 2040), Mid-term (years 2041 to 2070) and Long-term (years 2071 to 2100).

The 2100 end year is used as it aligns with climate data projections which typically span projection periods extending to an end year between 2070 and 2100, with the largest weather changes typically projected to happen toward the end of this time span. Although a time span ending in 2100 is longer than typical community planning guidelines, many of the decisions made in the near-term will continue to determine the scale of risk the community will face further into the future. For example, the location of future development and many infrastructure investment decisions have resilience implications that will endure to the end of the century.

Scope of Boundaries for Assessment

The climate assessment values relate to the ~10 km x 6 km grid cell that Prince Rupert lies within as available on climatedata.ca. The values for this grid cell do not necessarily reflect varying microclimates. The grid cell covers the municipal boundaries of Prince Rupert which is the key boundary for planning and decision making for this project.

Data Gaps

Prince Rupert is out of bounds for SPEI data available on climatedata.ca. From the AdaptWest database, there are no significant changes to SPEI in the ecoregion boundary, but some range for the Hargreave's Ref. Evaporation.

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[13] Wang, Tongli, et al. "Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America." PLOS ONE, edited by Inés Álvarez, vol. 11, no. 6, June 2016, p. e0156720, https://adaptwest.databasin.org/app/ecoregion

[14] Environment and Climate Change Canada. "Projected Surface Wind Speed Change Based on CMIP5 Multi-Model Ensembles." Open Government Licence - Canada, https://dd.weather.gc.ca/climate/cmip5/netcdf/historical/annual/anomaly/.

[15] Jahnke-Bornemann, Annika. "Sea Level Rise from AR5." Universität Hamburg, https://www.cen.uni-hamburg.de/en/icdc/data/.

Hazard Threat Assessment

The hazard threat for each climate change indicator is calculated as the difference in the future value from the historical value. For indicators related to temperature measurements, change is measured in degree Celsuis. Many indicators are measured in terms of time (specifically days), these values are converted to weeks to be measured by "Timing" thresholds. Precipitation and other non-frequency indicators are calculated as the percentage of change between the future value and historical value.

The change in a climate indicator is given a score that can be described as "no change" (score: 0), "minimal change" (score: 1), "low change" (score: 2), "moderate change" (score: 3), "high change"(score: 4) or "very high change" (score: 5) based on the degree of change (negative or positive). Table 4 summarizes the scale to use by the type of climate indicator for the assessment.

Table 4. A qualitative analysis of threat probability based on the change of the climate indicator. [16]

Score	Description	Temperature Change (°C)	Precipitation & Other Non-Frequency Indicators (%)	Flooding (elevation, m)	Timing (weeks)	SPEI[17]
5	Very High Decrease	-20.0	-200	-2.0	-20.0	-2.0
4	High Decrease	-10.0	-100	-1.0	-10.0	-1.0
3	Moderate Decrease	-5.0	-50	-0.5	-5.0	-0.5
2	Low Decrease	-2.0	-20	-0.2	-2.0	-0.2
1	Minimal Decrease	-1.0	-10	-0.1	-1.0	-0.1
0	No Change	0.0	0	0.0	0.0	0.0
1	Minimal Increase	1.0	10	0.1	1.0	0.1
2	Low Increase	2.0	20	0.2	2.0	0.2
3	Moderate Increase	5.0	50	0.5	5.0	0.5
4	High Increase	10.0	100	1.0	10.0	1.0
5	Very High Increase	20.0	200	2.0	20.0	2.0

[16] American National Standards. AWWA J100-21 Risk and Resilience Management of Water and Wastewater Systems. 2021, https://engage.awwa.org/PersonifyEbusiness/Bookstore/Product-Details/productId/88116441.
[17] Standardized Precipitation Evapotranspiration Index (SPEI) - values range from (-5) to +5. The smaller values indicate stronger degrees of drought, and larger values indicate higher degrees of moisture.

To assess the hazard threat level, the combination of climate change indicators that promote the hazard threat are grouped. The hazard threat is given a final threat score based on the average of the climate change indicators combined for the hazard. The scores are reviewed and adjusted with additional context from subject-matter experts. This final list is ranked from highest threat level to lowest threat level with the intent to help prioritize risk reduction measures.

Climate Trends

Full details of climate data collected can be found in Appendix B and C. Generally, the trends indicate warmer seasons (hotter summers, milder winters), and higher volumes of precipitation annually.

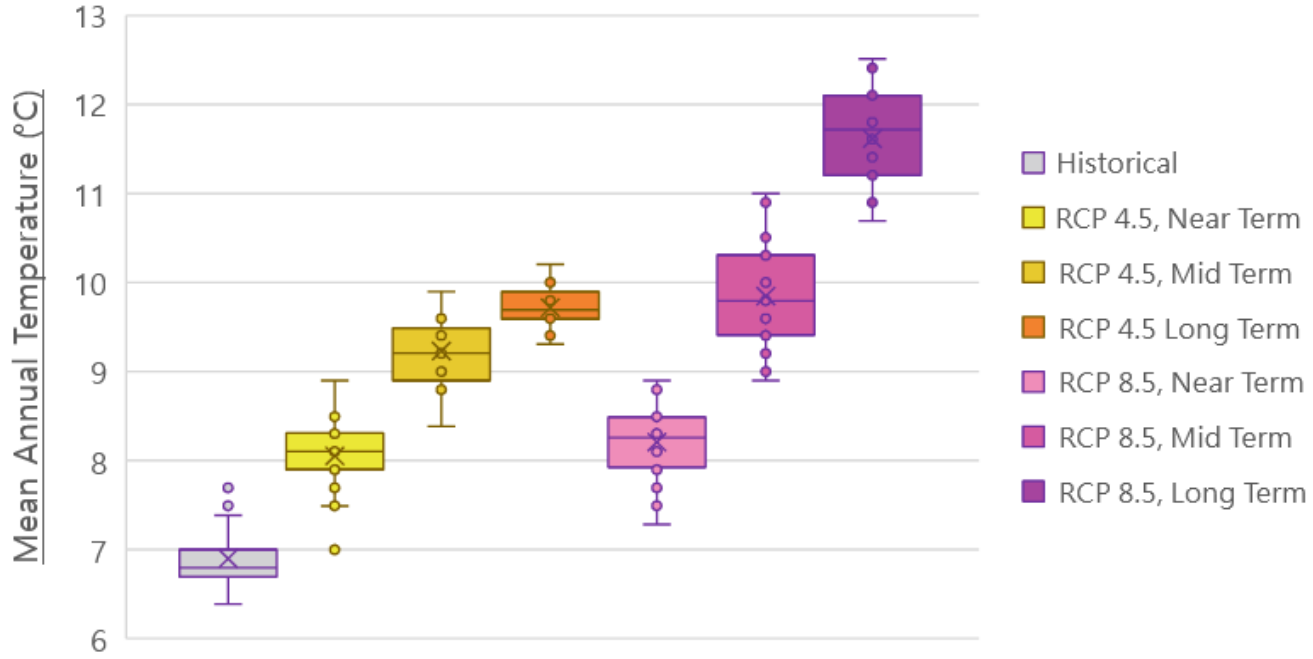

Figure 5. Boxplot of mean annual temperature for each time horizon for RCP 4.5 and RCP 8.5

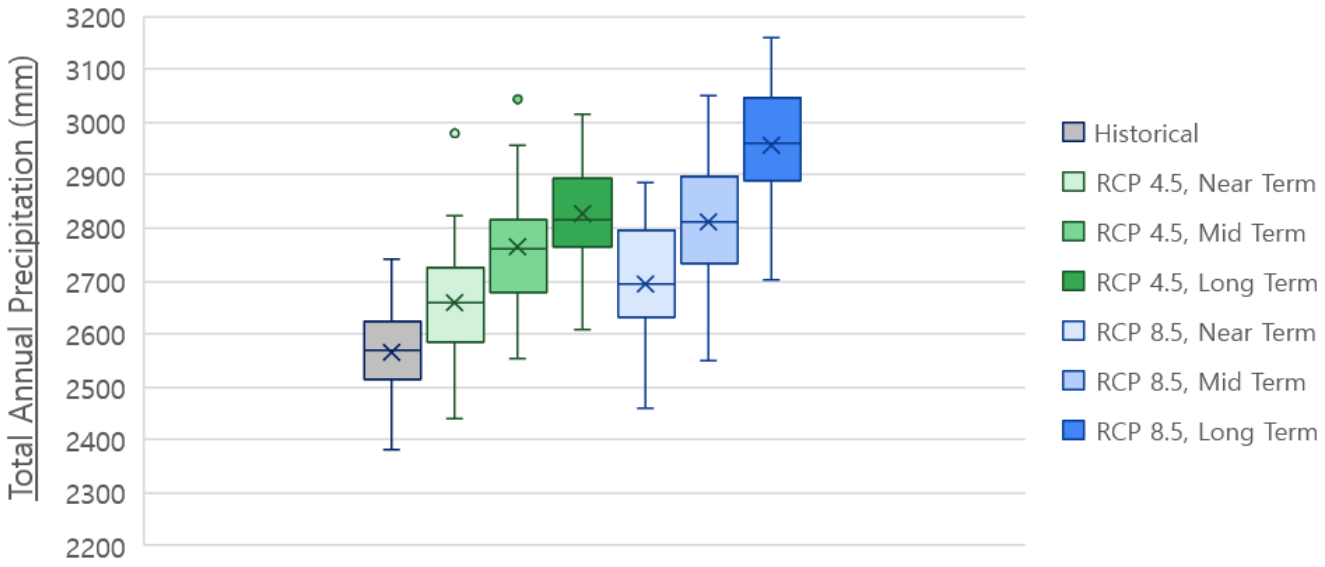

Figure 6. Boxplot of total annual precipitation for each time horizon for RCP 4.5 and RCP 8.5

Summary tables below highlight key climate indicators that change over time. Over the near term (2011 - 2040), the future projections are similar for both pathways:

Table 5. Summary of key climate indicators for the near-term future

	Climate Indicator	RCP 4.5	RCP 8.5
Near Term	Annual Temperature	↑ +1°C	Similar to RCP 4.5
	Humidity > 30 occurrence	↑ +1 day	
	Annual Precipitation	↑ +100mm	
	Maximum 1-day Precipitation	↑ +10mm	
	Maximum 5-day Precipitation	↑ +10mm	
	Freeze/Thaw Cycle	↓ -10 cycles	
	Frost Free Days	↑ +40 days	
	Annual Growing Degree Days	↑ +400 degree days	

These trends continue through the mid-term with similar outcomes for both RCP 4.5 and RCP 8.5. Seasonally, temperatures increase significantly by approximately 3 - 4°C for both pathways. In RCP 4.5, Prince Rupert will handle 200mm more precipitation annually and in RCP 8.5 annual precipitation increases 300mm.

Table 6. Summary of key climate indicators for the mid-term future

	Climate Indicator	RCP 4.5	RCP 8.5
Mid Term	Annual Temperature	↑ +3°C	↑ +4°C
	Humidity > 30 occurrence	↑ +4 days	↑ +5 days
	Annual Precipitation	↑ +200mm	↑ +300mm
	Maximum 1-day Precipitation	↑ +10mm	↑ +10mm
	Maximum 5-day Precipitation	↑ +20mm	↑ +30mm
	Freeze/Thaw Cycle	↓ -20 cycles	↓ -20 cycles
	Frost Free Days	↑ +70 days	↑ +70 days
	Annual Growing Degree Days	↑ +700 degree days	↑ +1000 degree days

The projections branch away in the long-term future with general trends similar to the mid term. In the RCP 4.5 projection, Prince Rupert seasonal temperatures rise between 3 - 4°C. For the RCP 8.5 projection, the seasonal temperatures rise between 6 - 7 °C. The occurrence of tropical nights and maximum temperatures above 30°C are uncommon for the RCP 4.5 pathway but in RCP 8.5, it occurs at least once annually. Both futures virtually see no temperatures below (-15)°C.

Table 7. Summary of key climate indicators for the long-term future

	Climate Indicator	RCP 4.5	RCP 8.5
Long Term	Annual Temperature	↑ +4°C	↑ +6°C
	Humidity > 30 occurrence	↑ +7 days	↑ +27 days
	Annual Precipitation	↑ +300mm	↑ +500mm
	Maximum 1-day Precipitation	↑ +10mm	↑ +20mm
	Maximum 5-day Precipitation	↑ +30mm	↑ +40mm
	Freeze/Thaw Cycle	↓ -20 cycles	↓ -30 cycles
	Frost Free Days	↑ +70 days	↑ +90 days
	Annual Growing Degree Days	↑ +900 degree days	↑ +1600 degree days

Hazard Threat for RCP 4.5

Hazard threats for the RCP 4.5 future scenario are presented in Table 8. Most threats score lower than 2.0 (low threat) to 0.7 (minimal threat). The top three hazard threats are land loss, Tsunamis and ecoregion changes. Land loss due to sea level rise is a permanent change to the environment and is ranked high due to this context as well as the amount of increase in the rise of water on shoreline areas. The Tsunami risk assessment shows minimal changes to the hazard using a climate change sea level rise value. Non-seismic tsunamis will need additional review given landslides threat change with the future climate. The Tsunami risk assessment recommends "a regional slope assessment to determine any slopes that might pose a risk." The temperature and precipitation variation shift the ecoregion into a type characteristically different from other areas in North America.

The environment is naturally temperate and wet, positioning Prince Rupert to maintain cooler summers and milder winters. Extreme cold and extreme heat threats are minimal, but may occur due to factors that contribute to environmental temperature (i.e. changes in the polar jet stream causing cold snaps or humidity causing extreme heat). Snow and ice accumulation are expected to become more unlikely in the future climate, where virtually all precipitation is expected to be rainfall. Given the increases in annual and seasonal precipitation, the likelihood for severe storm events and flooding are expected to increase. Dry weather conditions seem unlikely, but the trend for the number of consecutive dry days is increasing over time. More research is needed to understand the changes in the water balance over time.

Although the climate indicators show increasing threat of a wildfire, the natural environment is on a natural fire break and less likely to change in a future climate.

Table 8. RCP 4.5 Summary of hazard threat levels and the contributing climate indicators

RCP 4.5 Hazard Threat		Contributing Climate Indicators		
Hazard Rank	**Threat Score**	**Key Climate Indicators**	**Trend**	**Rationale**
Land Loss	2.0 (low)	Relative sea level Land subsidence	Increasing	Current planning uses a 1m rise to prepare low elevation areas from threat; this is ~30% increase in the rise of water around shoreline areas.
Tsunami (seismic and non-seismic)	2.0 (low)	Current safety height 3.95 msl Future safety height 4.95 msl Relative sea level Rise (m)	Increasing	Minimal changes to the hazard threat due to climate changes. Current climate change planning uses a +1m SLR to prepare low elevation areas from future threat
Ecoregion Changes	2.0 (low)	Mean annual temperature	Warming	Trends show a general shift in ecoregion. By the characteristics of temperature and precipitation, it is distinct from any other known ecoregion. Mean annual temperature increases 4°C by 2100. Mean annual precipitation increases to ~300mm. Seasons become milder with less likelihood of snow or ice accumulation.
		Mean annual precipitation	Increasing	
		Frost-free days	Increasing	
		Freeze/thaw cycles	Decreasing	
		Ice days	Decreasing	
Landslides	1.2 (low)	# of consecutive dry days	Increasing	It anticipated that landslides are of concern given general increasing trends of dry days and wet days. These events happening in succession may trigger a landslide. The number of consecutive dry days increases by 2 days in the long term horizon. Precipitation increases for heavy events (+5 mm for a 1-Day Maximum Precipitation, and 7 additional days with over 20 mm precipitation).
		Maximum 1-Day precipitation	Increasing	
		Spring Temperature	Increasing	
		Spring Precipitation	Increasing	
		Autumn Precipitation	Increasing	

RCP 4.5 Hazard Threat		Contributing Climate Indicators		
Hazard Rank	**Threat Score**	**Key Climate Indicators**	**Trend**	**Rationale**
Extreme Rainfall / Severe Storm / Surge	1.2 (low)	High Tide	NA	Trends show an increase in volume of water. Short duration rainfall increases 10mm (1-Day Maximum Precipitation) and long duration rainfall increases 30 mm (5-day Maximum Precipitation). The frequency of rainfall generally increases with an additional 9 days with over 20 mm precipitation. Warmer winters indicate rainfall with lower likelihood of snow storms.
		Sea Level	Increasing	
		Maximum 1-Day Precipitation	Increasing	
		Maximum 5-Day Precipitation	Increasing	
Flooding	1.1 (low)	High Tide	NA	The increased volume of water received by precipitation are anticipated to be key contributors to future flooding. Localized flooding volumes may increase to match the 1-Day Maximum Precipitation (+5 mm by 2100). River flooding may increase to match the 5-Day Maximum Precipitation (+10 mm by 2100). Other plausible contributions: winter temperatures which promote rainfall over snow accumulation. Relative sea level rise promotes the occurrence of storm surge/ coastal flooding.
		Relative Sea Level	Increasing	
		Maximum 1-Day Precipitation	Increasing	
		Maximum 5-Day Precipitation	Increasing	
		Snow Accumulation	NA	

RCP 4.5 Hazard Threat		Contributing Climate Indicators		
Hazard Rank	**Threat Score**	**Key Climate Indicators**	**Trend**	**Rationale**
Extreme Heat	0.8 (Minimal)	Maximum Temperature	Increasing	Maximum Temperature rises 4°C by 2100. Maximum temperature is still under 30°C. Days over 30°C and Tropical nights are uncommon, but the trends are showing an increased likelihood. Extreme heat becomes more likely with the humidex, the trend increases over time with the addition of 6 days (historically only 1) with the humidex contributing to days' feelings like 30°C.
		Tropical Nights over 20°C	Increasing	
		Annual Number Days w Max Temp >30°C	Increasing	
		Days with Max Humidex > 30	Increasing	
Freezing Rain / Ice Accumulation	0.8 (Minimal)	# of ice days	Decreasing	Decreasing trends for cooler temperatures result in a lower likelihood for freezing rain or ice accumulation. Winter average temperature is historically over 0°C and by 2100 is anticipated to reach 5°C. Precipitation is increasing but will likely result in rainfall.
		# of frost days	Decreasing	
		Maximum 1-Day Precipitation	Increasing	
		Winter Precipitation	Increasing	
		Winter Temperature	Increasing	
		Freeze/Thaw Cycles	Decreasing	
High Winds	0.7 (Minimal)	Maximum wind speed	Increasing	Minimal changes to the hazard threat due to climate changes
Snow Accumulation	0.4 (Minimal)	Winter temperature	Increasing	Similar to Freezing Rain / Ice Accumulation. Decreasing trends for cooler temperatures result in a lower likelihood for snow accumulation. Winter average temperature is historically over 0°C and by 2100 is anticipated to reach 5°C. Precipitation is increasing but will likely result in rainfall.
		Winter precipitation	Increasing	

RCP 4.5 Hazard Threat		Contributing Climate Indicators		
Hazard Rank	**Threat Score**	**Key Climate Indicators**	**Trend**	**Rationale**
Extreme Cold / Cold Snaps	0.3 (minimal)	Minimum Temperature	Increasing	Warming climate reduces the likelihood of this hazard.
		Annual Days with Tmin under -15°C	Decreasing	
		Freeze/Thaw Cycles	Decreasing	
Dry Weather Conditions / Drought	0.1 (Minimal)	Number of consecutive dry days	Increasing	Increase in Annual total precipitation (higher volume of water annually), Increase in growing degree days over 5°C. Still remains a threat due to Medium change in annual average temperature and seasonal temperatures.
		Precipitation days > 10mm	Increasing	
		Precipitation days > 20mm	Increasing	
		Annual number of growing degree days over 5°C	Increasing	
Wildfire	1.5* (Minimal)	# of consecutive dry days	Increasing	*Wildfires are uncommon given the natural fire break. The trends show increasing trends for consecutive dry days (2 day increase by 2100), annual temperature (4°C increase by long term horizon) and maximum temperature (the 4°C increase moves the maximum temperature from 23°C to 27°C)
		Mean annual temperature	Increasing	
		Summer temperature	Increasing	
		Summer precipitation	Increasing	
		Maximum temperature	Increasing	

Hazard Threat for RCP 8.5

Hazard threats for the RCP 8.5 future scenario are presented in Table 9. Hazard threats range from 2.6 (moderate threat) to 0.3 (minimal threat). The top three hazard threats are similar to the RCP 4.5 scenario but the rank of "Ecoregion changes" moves to the top place shifting from a low to a moderate hazard threat from RCP 4.5 to RCP 8.5. The shifts in the ecoregion characteristics are even more pronounced in this future where the mean annual temperature rises 6°C and mean annual precipitation rises 550mm by 2100.

The traits of hazard threats are similar and may worsen in the RCP 8.5 scenario due to higher annual temperature and precipitation. One significant change is the decrease in winter precipitation in this future pathway, although this indicator does not typically contribute to a known hazard threat.

Table 9. Summary of RCP 8.5hazard threat levels and the contributing climate indicators

RCP 8.5 Hazard Threat Level		Contributing Climate Indicator		
Hazard	**Threat Score**	**Key Climate Indicators**	**Trend**	**Rationale**
Ecoregion Changes	2.5 (moderate)	Mean Annual Temperature	Warming	Trends show a general shift in ecoregion. By the characteristics of temperature and precipitation, it is distinct from any other known ecoregion. Mean annual temperature increases 6°C by the long-term horizon. Mean annual precipitation increases to ~550 mm. Seasons become milder with less likelihood of snow or ice accumulation. A loss of 7 weeks of frost days.
		Mean Annual Precipitation	Increasing	
		Frost-Free Days	Increasing	
		Freeze/Thaw Cycles	Decreasing	
		Ice Days	Decreasing	
Land Loss	2.0 (low)	Relative Sea Level Land Subsidence	Increasing	Relative Sea Level Rise: Current planning uses a 1m rise to prepare low elevation areas from threat this is ~30% increase in the rise of water around shoreline areas.
Tsunami (seismic and non-seismic)	2.0 (low)	Current Safety Height 3.95 (msl) Future Safety Height 4.95, (msl) Relative Sea Level Rise (m)	Increasing	Minimal changes to the hazard threat due to climate changes. Current climate change planning uses a +1m SLR to prepare low elevation areas from future threat

RCP 8.5 Hazard Threat Level		Contributing Climate Indicator		
Hazard	**Threat Score**	**Key Climate Indicators**	**Trend**	**Rationale**
Extreme Rainfall / Severe Thunderstorm / Storm Surge	1.3 (low)	High Tide	NA	Trends show an increase in volume of water. Short duration rainfall increases 20 mm (1-Day Maximum Precipitation) and long duration rainfall increases 40 mm (5-day Maximum Precipitation). The frequency of rainfall generally increases with an additional 2 weeks with over 20 mm precipitation. Warmer winters indicate rainfall with lower likelihood of snow storms.
		Sea Level	Increasing	
		Maximum 1-Day Precipitation	Increasing	
		Maximum 5-Day Precipitation	Increasing	
Flooding	1.3 (low)	High Tide	NA	The increased precipitation is anticipated to be key contributors to future flooding. Localized flooding volumes may increase to match the 1-Day Maximum Precipitation (+20 mm by the long-term horizon). River flooding may increase to match the 5-Day Maximum Precipitation (+40 mm by the long-term horizon). Relative sea level rise promotes the occurrence of storm surge/ coastal flooding.
		Relative Sea Level	Increasing	
		Maximum 1-Day Precipitation	Increasing	
		Maximum 5-Day Precipitation	Increasing	
		Snow Accumulation	NA	
Extreme Heat	1.3 (low)	Maximum Temperature	Increasing	Maximum Temperature rises 6°C by long-term horizon. Maximum temperature is marginally under 30°C. Tropical nights have become more common. Number of days with a maximum temperature over 30°C is uncommon, but the trend is increasing. The humidex trend increases with the addition of 27 days (historically only 1) feeling like 30°C.
		Tropical Nights over 20°C	Increasing	
		Annual number of days with a Tmax over 30°C	Increasing	
		Days with Max Humidex > 30	Increasing	

RCP 8.5 Hazard Threat Level		Contributing Climate Indicator		
Hazard	**Threat Score**	**Key Climate Indicators**	**Trend**	**Rationale**
Landslides	1.1 (low)	Number of consecutive dry days	Increasing	It is anticipated that landslides are of concern given general trends increase the degree of dry days and wet days. These events in succession could trigger a landslide.The number of consecutive dry days increases by 2 days in the long term horizon. Precipitation increases across heavy events (+20 mm for a 1-Day Maximum Precipitation, and 13 additional days with over 20 mm precipitation).
		Maximum 1-Day precipitation	Increasing	
		Spring Temperature	Increasing	
		Spring Precipitation	Increasing	
		Autumn Precipitation	Increasing	
Freezing Rain / Ice Accumulation	0.9 (minimal)	Number of ice days	Decreasing	Decreasing trends for cooler temperatures result in a lower likelihood for freezing rain or ice accumulation. Winter average temperature is historically over 0°C and long-term horizon is anticipated to reach 8°C. Winter precipitation is a decreasing trend.
		Number of frost days	Decreasing	
		Maximum 1-Day Precipitation	Increasing	
		Winter Precipitation	decreasing	
		Winter Temperature	Increasing	
		Freeze/Thaw Cycles	Decreasing	
High Winds	0.7 (minimal)	Maximum wind speed	Increasing	Minimal changes to the hazard threat due to climate changes
Snow Accumulation	0.7 (minimal)	Winter Temperature	Increasing	Winter average temperature is historically over 0°C, and anticipated to increase to 8°C by 2100. Winter precipitation is decreasing.
		Winter Precipitation	Decreasing	

RCP 8.5 Hazard Threat Level		Contributing Climate Indicator		
Hazard	**Threat Score**	**Key Climate Indicators**	**Trend**	**Rationale**
Dry Weather Conditions / Drought	0.5 (minimal	Number of consecutive dry days	Increasing	Increase in Annual total precipitation and likelihood of 10 mm rainfall and 20 mm rainfall contribute to a low threat level to dry conditions or drought. Consecutive dry days are an increasing trend, adding 2 days to dry periods. Winter precipitation is the only season where precipitation decreases where dry periods may occur.
		Precipitation days over 10mm	Increasing	
		Annual number of growing degree days over 5°C	Increasing	
Extreme Cold / Cold Snaps	0.3 (minimal)	Minimum Temperature	Increasing	Warming climate reduces the likelihood of this hazard.
		Annual Days with Tmin under -15°C	Decreasing	
		Freeze/Thaw Cycles	Decreasing	
Wildfire	1.8 (Minimal)	# of consecutive dry days	Increasing	Wildfires are uncommon given the natural fire break. The trends show increasing trends for consecutive dry days (2 day increase by 2100), annual temperature (6°C increase by 2100) and maximum temperature (29°C)
		Summer Temperature	Increasing	
		Summer Precipitation	Increasing	
		Maximum Temperature	Increasing	

Next Steps

Through this analysis of the future climate scenarios, there are 12 hazards with threat levels ranging from moderate to minimal. The top five hazards in both future scenarios are significantly influenced by increasing volumes of precipitation. The current assessment alone does not allude to any high risk scenarios as the threat levels did not reach high or very high thresholds. This will be addressed in the next exercise: the Climate Change Vulnerability and Risk Assessment.

Table 10. Summary of hazard threat level for RCP 4.5 and RCP 8.5

#	RCP 4.5 Hazard Threat	Threat Score	RCP 8.5 Hazard Threat	Threat Score
1	Land Loss	2.0 (low)	Ecoregion Changes	2.5 (moderate)
2	Tsunami (seismic and non-seismic)	2.0 (low)	Land Loss	2.0 (low)
3	Ecoregion Changes	2.0 (low	Tsunami (seismic and non-seismic)	2.0 (low)
4	Landslides	1.2 (low)	Severe Storm / Storm Surge	1.3 (low)
5	Severe Storm / Storm Surge	1.2 (low)	Flooding	1.3 (low)
6	Flooding	1.1 (low)	Extreme Heat	1.3 (low)
7	Freezing Rain / Ice Accumulation	0.8 (minimal)	Landslides	1.1 (low)
8	Extreme Heat	0.8 (minimal)	Freezing Rain / Ice Accumulation	0.9 (minimal)
9	High Winds	0.7 (minimal)	High Winds	0.7 (minimal)
10	Snow Accumulation	0.4 (minimal)	Snow Accumulation	0.7 (minimal)
11	Extreme Cold / Cold Snaps	0.3 (minimal)	Dry Weather / Drought	0.5 (minimal)
12	Dry Weather / Drought	0.1 (minimal)	Extreme Cold / Cold Snaps	0.3 (minimal)
13	Wildfire	1.5* (minimal)	Wildfire	2.0* (minimal)

Appendix A – Climate Indicators[18]

Climate Change Indicator	Short Name	Description
Mean Annual Temperature	tg_mean	The average of the daily maximum temperature and the daily minimum temperature
Winter Mean Temperature	tg_djf	The average of the daily maximum temperature and the daily minimum temperature for the winter season
Spring Mean Temperature	tg_mam	The average of the daily maximum temperature and the daily minimum temperature for the spring season
Summer Mean Temperature	tg_jja	The average of the daily maximum temperature and the daily minimum temperature for the summer season
Autumn Mean Temperature	tg_son	The average of the daily maximum temperature and the daily minimum temperature for the autumn season
Maximum Temperature	txmax	The highest maximum temperature (Tmax) in the selected time period. Also known as the The Hottest Day. The Hottest Day describes the warmest daytime temperature in the selected time period. In general, the hottest day of the year occurs during the summer months.
Minimum Temperature	tx_min	The daily minimum temperature (Tmin).
Annual #/Days w Min Temp ←15°C	tnlt_-15	The number of days where the lowest temperature of the day is colder than -15°C.
Annual #/Days w Min Temp ←25°C	tnlt_-25	The number of days where the lowest temperature of the day is colder than -25°C.

[18] Source of definition is climatedata.ca unless otherwise specified

Climate Change Indicator	Short Name	Description
Annual #/Days w Max Temp >30°C	txgt_30	The number of days with a maximum temperature (Tmax) greater than 30°C.
Annual #/Days w Max Temp >32°C	txgt_32	The number of days with a maximum temperature (Tmax) greater than 32°C.
Annual # of growing degree days >5°C	gddgrow_5	The number of degree days accumulated above a threshold temperature of 5°C in the selected time period. The larger the degree day total, the more heat energy available in the time period considered for agricultural growth. For forage crops and canola, a threshold temperature of 5°C is generally used.
Cooling Degree Days	cddcold	The number of degree days accumulated ABOVE 18°C in the selected time period. The most common use of degree days is for tracking energy use.
Heating Degree Days	hddheat	The number of degree days accumulated BELOW 18°C in the selected time period. The most common use of degree days is for tracking energy use.
Freeze-thaw cycles (#)	dlyfrzthw	A freeze-thaw cycle occurs when the daily maximum temperature (Tmax) is higher than 0°C and the daily minimum temperature (Tmin) is less than or equal to -1°C. Freeze-thaw cycles can have major impacts on infrastructure. Water expands when it freezes, so the freezing, melting and refreezing of water can, over time, cause significant damage to roads, sidewalks, and other outdoor structures.
Frost Free Days (# days)	frost_free_season	The number of degree days accumulated above 0°C in the selected time period. Cumulative degree days above 0°C can be used to determine when climate conditions are warm enough to support the growth of certain plants and pests. For example, the black-legged tick, which carries Lyme disease, requires the accumulation of at least 2800 degree days above 0°C for its survival. Warmer conditions can speed the development rate of these species and lead to an extension of their geographical range.
Frost Days (# days)	frost_days	A day when the daily MINIMUM temperature (Tmin) is below 0°C. The number of frost days is an indicator of the length and severity of the winter season. A location with a large number of frost days is also likely to have a short growing season, since frost is harmful to many plants.

Climate Change Indicator	Short Name	Description
Ice days (#)	ice_days	A day when the daily MAXIMUM temperature (Tmax) is less than 0°C. This index is an indicator of the length and severity of the winter season.
Tropical Nights Tmin >22°C	tr_22	A Tropical Night occurs when the daily minimum temperature (Tmin) is greater than 22°C. Hot summer days and heat waves become particularly stressful if overnight temperatures do not provide cooling relief. Tropical nights make it more difficult for the body to cool down and recover from hot days.
Annual Total Precipitation	prcptot	The total amount of precipitation (mm) accumulated annually. Additional monthly precipitation data provided by Prince Rupert
Winter Total Precipitation	prcp_djf	The total amount of precipitation (mm) accumulated in the winter
Spring Total Precipitation	prcp_mam	The total amount of precipitation (mm) accumulated in the spring
Summer Total Precipitation	prcp_jja	The total amount of precipitation (mm) accumulated in the summer
Autumn Total Precipitation	prcp_son	The total amount of precipitation (mm) accumulated in the autumn
Precipitation days >10mm	r10mm	The number of days with precipitation >= 10 mm.
Precipitation days >20mm	r20mm	The number of days with precipitation >= 20 mm.
Maximum 1-day total precipitation	rx1day	The largest precipitation total that falls in a single day in the selected time period. Short duration, high intensity precipitation events may lead to flash flooding, particularly in urban areas where storm drains may be overwhelmed. Heavy snowfall events can cause damage to buildings and disrupt transportation services.
Maximum 5-day total precipitation	rx5day	The maximum total precipitation that falls over a consecutive 5-day period. High precipitation totals can cause flooding in urban areas, damage to crops and roads, and erode top soil.

Climate Change Indicator	Short Name	Description
# of consecutive dry days	cdd	The maximum number of consecutive days with precipitation below 1mm/day, within the selected time period.
Days with Max Humidex > 30	hxmax_30	(CMIP6 dataset ONLY, uses SSP projections) the number of days where the Humidex is greater than 30. In Canada, it is recommended that outdoor activities be moderated when the humidex exceeds 30, and that all unnecessary activities cease when it passes 40 (Mekis et al., 2015).
Standardized Precipitation Evapotranspiration Index	SPEI	(CMIP 6 dataset ONLY, uses SSP projections) a drought index based on the difference between precipitation (P) and potential evapotranspiration (PET). Negative values indicate water deficit. Positive values indicate water surplus. Drought can occur on a variety or timescales and impacts will depend on how widespread and how long-lived a drought is.
Ecoregion	eco_region	The expected type of ecosystem for a region based of climate parameters (temperature and precipitation). Level 1 Ecoregion is a generic name which may apply to several regions across North America as having similar climate parameters. Data available from Adapt West Ecoregion Data Explorer
Windspeed	SCFWND_min	Minimum value recorded from the Annual Anomaly for the historical period of 1986-2005 (km/hr), negative value represents wind moving in the West direction. Data available from Open Data Canada
Windspeed	SCFWND_max	Maximum value recorded from the Annual Anomaly for the historical period of 1986-2005 (km/hr), negative value represents wind moving in the West direction. Data available from Open Data Canada
Windspeed	SCFWND	Twenty-year average changes in wind speed (%) for four time periods (2021-2040; 2041-2060; 2061-2080; 2081-2100), with respect to the reference period of 1986-2005. Data available from Open Data Canada
Relative Sea Level Rise	rel_slr	Report available from Natural Resources Canada, Hamburg Sea level rise from AR5 dataset clipped to North America Pacific Region.

Appendix B: Climate Indicator Summary

Climate Summary			Historical	RCP 4.5			RCP 8.5		
#	Climate Change Indicator	Short Name	1950 - 2010	2011 - 2040	2041 - 2070	2071 - 2100	2011 - 2040	2041 - 2070	2071 - 2100
1	Mean Annual Temperature	**tg_mean**	7.06	8.73	9.96	10.53	8.81	10.72	12.79
2	Autumn Mean Temperature	**tg_son**	7.83	9.25	10.23	10.89	9.39	11.24	13.02
3	Winter Mean Temperature	**tg_djf**	1.72	3.45	4.79	5.44	3.76	5.71	7.94
4	Spring Mean Temperature	**tg_mam**	6.01	7.81	9.17	9.67	8.12	9.81	11.64
5	Summer Mean Temperature	**tg_jja**	12.91	14.64	16.11	16.65	14.66	16.64	18.78
6	Maximum Temperature	**txmax**	23.76	25.35	26.86	27.34	25.54	27.80	29.68
7	Minimum Temperature	**tn_mean**	4.15	5.85	7.16	7.73	6.04	7.91	10.08
8	Tropical Nights Tmin >18°C	**tr_18**	0	0.05	0.19	0.6	0.06	0.99	16.09
9	Tropical Nights Tmin >20°C	**tr_20**	0	0	0	0.06	0	0.03	1.69
10	Tropical Nights Tmin >22°C	**tr_22**	0	0	0	0	0	0	0.03
11	Annual #/Days w Max Temp >30°C	**txgt_30**	0.07	0.20	0.49	0.47	0.22	0.59	1.63
12	Annual #/Days w Max Temp >32°C	**txgt_32**	0.00	0.10	0.17	0.20	0.07	0.20	0.68

Climate Summary			Historical	RCP 4.5			RCP 8.5		
#	Climate Change Indicator	Short Name	1950 - 2010	2011 - 2040	2041 - 2070	2071 - 2100	2011 - 2040	2041 - 2070	2071 - 2100
13	Humidity >30	hxmax30	1	2	5	7	2	6	27
14	Annual #/Days w Max Temp ←15°C	tnlt_-15	2.12	1.61	0.73	0.47	1.37	0.46	0.12
15	Annual #/Days w Max Temp ←25°C	tnlt_-25	0.00	0.06	0.00	0.00	0.02	0.00	0.00
16	Annual Total Precipitation	prcptot	2643.60	2771.29	2872.96	2926.66	2768.80	2920.83	3173.16
17	Autumn Total Precipitation	prcp_son	946.82	1012.32	1073.00	1096.91	1042.22	1138.45	1219.09
18	Winter Total Precipitation	prcp_djf	797.70	846.84	878.00	946.36	867.28	927.44	996.98
19	Spring Total Precipitation	prcp_mam	547.15	569.66	601.47	618.95	576.94	619.17	660.63
20	Summer Total Precipitation	prcp_jja	387.29	385.13	402.98	414.20	411.54	398.74	423.76
21	Maximum 1-day total precipitation	rx1day	81.93	88.77	92.00	91.95	88.59	94.15	105.70
22	Maximum 5-day total precipitation	rx5day	184.33	199.55	205.82	215.48	197.98	216.23	226.23
23	Precipitation days >10mm	r10mm	92.81	94.77	100.45	101.32	97.55	100.59	106.32
24	Precipitation days >20mm	r20mm	36.76	39.71	42.61	44.17	40.70	43.87	49.89
25	# of consecutive dry days	cdd	13.80	14.28	14.29	14.46	13.87	14.32	15.69

Climate Summary			Historical	RCP 4.5			RCP 8.5		
#	Climate Change Indicator	Short Name	1950 - 2010	2011 - 2040	2041 - 2070	2071 - 2100	2011 - 2040	2041 - 2070	2071 - 2100
26	Windspeed (Min), km/hr	SFCWND	6.45	7.29	7.16	6.91	6.92	6.93	6.92
27	Windspeed (Min), km/hr	SFCWND_min	-4.45	-5.03	-4.94	-4.76	-4.77	-4.78	-4.77
28	Windspeed (Max), km/hr	SFCWND_max	151.64	171.43	168.34	162.39	162.80	162.96	162.70
29	Standardized Precipitation Evapotranspiration Index	SPEI	No data for Prince Rupert on climatedata.ca, AdaptWest shows no significant change in regards to ecoregion, but some range for the Hargreave's Ref. Evaporation						
30	Ecoregion	Eco_Region	Changes do not share a similarity to an existing ecoregion, the temperature and precipitation changes are unique						
31	Freeze-thaw cycles (#)	dlyfrzthw	41.95	33.12	23.26	18.79	30.39	21.01	14.12
32	Ice days (#)	ice_days	16.7725	15.64	9.19	8.27	13.76	8.97	4.61
33	Frost Days (# days)	frost_days	78.5675	62.6	44.31	33.04	58.41	39.22	24.95
34	Frost Free Days (# days)	frost_free_season	212.97	250.05	284.20	284.45	253.83	282.47	300.47
35	Annual # of growing degree days >5°C	gddgrow_5	1228.88	1637.58	1990.05	2137.37	1623.96	2207.74	2887.86
36	Heating Degree Days	hddheat	4099.26	3826.25	3471.64	3344.47	3757.32	3302.71	2923.64
37	Cooling Degree Days	cddcold	2.1025	8.64	25.51	38.79	8.65	33.34	158.36

Climate Summary			Historical	RCP 4.5			RCP 8.5		
#	Climate Change Indicator	Short Name	1950 - 2010	2011 - 2040	2041 - 2070	2071 - 2100	2011 - 2040	2041 - 2070	2071 - 2100
38	Relative Sea Level Rise	**rel_slr**	From the Tsunami Risk Assessment: The rate of sea level rise is expected to increase in the future although projections of sea level rise are highly uncertain. The sea level rise policy for BC (BC Ministry of Environment, 2011b) recommends using a 1.0 m rise in global mean sea level between the year 2000 and 2100 for planning purposes.						

Appendix C: RCP 4.5 Hazard Threat Assessment

Climate Indicator	Near Term			Mid Term			Long Term			Overall		
	Change	Threat Level	Score	Change	Threat Level	Score	Change	Threat Level	Score	Sum	Rank	Overall Trend
Mean Annual Temperature	1.67°C	Low	2	2.90°C	Moderate	3	3.47°C	Moderate	3	8	2.7	Increasing
Winter Mean Temperature	1.73°C	Low	2	3.07°C	Moderate	3	3.72°C	Moderate	3	8	2.7	Increasing
Spring Mean Temperature	1.81°C	Low	2	3.17°C	Moderate	3	3.67°C	Moderate	3	8	2.7	Increasing
Summer Mean Temperature	1.73°C	Low	2	3.20°C	Moderate	3	3.74°C	Moderate	3	8	2.7	Increasing
Autumn Mean Temperature	1.43°C	Low	2	2.41°C	Moderate	3	3.07°C	Moderate	3	8	2.7	Increasing
Maximum Temperature	1.60°C	Low	2	3.11°C	Moderate	3	3.59°C	Moderate	3	8	2.7	Increasing
Minimum Temperature	1.70°C	Low	2	3.01°C	Moderate	3	3.58°C	Moderate	3	8	2.7	Increasing
Annual #/Days w Min Temp ←15°C	1.61	No Change	0	-1.39	No Change	0	-1.65	No Change	0	0	0.0	Decreasing
Annual #/Days w Min Temp ←25°C	0.06	No Change	0	-0.02	No Change	0	-0.02	No Change	0	0	0.0	Decreasing
Annual #/Days w Max Temp >30°C	0.20	No Change	0	0.42	No Change	0	0.40	No Change	0	0	0.0	Increasing
Annual #/Days w Max Temp >32°C	0.10	No Change	0	0.10	No Change	0	0.13	No Change	0	0	0.0	Increasing
Tropical Nights Tmin >18°C	0.05	No Change	0	0.13	No Change	0	0.54	No Change	0	0	0.0	Increasing
Tropical Nights Tmin >20°C	0	No Change	0	-0.03	No Change	0	0.03	No Change	0	0	0.0	Increasing

Climate Indicator	Near Term			Mid Term			Long Term			Overall		
	Change	Threat Level	Score	Change	Threat Level	Score	Change	Threat Level	Score	Sum	Rank	Overall Trend
Tropical Nights Tmin >22°C	0	No Change	0	-0.03	No Change	0	-0.03	No Change	0	0	0.0	Increasing
Days with Max Humidex > 30	2	No Change	0	4.00	No Change	0	6.00	Low	2	2	0.7	Increasing
Annual Total Precipitation	5%	No Change	0	9%	No Change	0	11%	Minimal	1	1	0.3	Increasing
Winter Total Precipitation	9%	No Change	0	10%	Minimal	1	19%	Minimal	1	1	0.3	Increasing
Spring Total Precipitation	4%	No Change	0	10%	No Change	0	13%	Minimal	1	0	0.0	Increasing
Summer Total Precipitation	-1%	No Change	0	4%	Minimal	1	7%	No Change	0	2	0.7	Increasing
Autumn Total Precipitation	7%	No Change	0	13%	Minimal	1	16%	Minimal	1	3	1.0	Increasing
Maximum 1-day total precipitation	8%	No Change	0	12%	Minimal	1	12%	Minimal	1	2	0.7	Increasing
Maximum 5-day total precipitation	8%	No Change	0	12%	Minimal	1	17%	Minimal	1	2	0.7	Increasing
Precipitation days >10mm	2%	No Change	0	7.64	No Change	0	8.51	No Change	0	0	0.0	Increasing
Precipitation days >20mm	8%	No Change	0	5.86	Minimal	1	7.42	Low	2	3	1.0	Increasing
Number of consecutive dry days	3%	No Change	0	0.49	No Change	0	0.66	No Change	0	0	0.0	Increasing
Cooling Degree Days	311%	Very High	5	1113%	Very High	5	1745%	Very High	5	15	5.0	Increasing
Heating Degree Days	-7%	No Change	0	-15%	Minimal	1	-18%	low	2	3	1.0	Decreasing

Climate Indicator	Near Term			Mid Term			Long Term			Overall		
	Change	Threat Level	Score	Change	Threat Level	Score	Change	Threat Level	Score	Sum	Rank	Overall Trend
Annual number of growing degree days >5°C	33%	Low	2	62%	Moderate	3	74%	Moderate	3	8	2.7	Increasing
Freeze-thaw cycles (#)	-21%	Low	2	-45%	Low	2	-55%	Moderate	3	7	2.3	Decreasing
Frost Free Days (# days)	5.30	Moderate	3	71.23	High	4	71.48	High	4	11	3.7	Increasing
Frost Days (# days)	-2.28	Moderate	3	-34.26	Moderate	3	-45.53	High	4	10	3.3	Decreasing
Ice days (#)	-0.16	No Change	0	-7.58	Minimal	1	-8.50	Low	2	3	1.0	Decreasing
Windspeed	13%	Minimal	1	11%	Minimal	1	7%	No Change	0	2	0.7	Decreasing
Windspeed	13%	Minimal	1	11%	Minimal	1	7%	No Change	0	2	0.7	Decreasing
Windspeed	13%	Minimal	1	11%	Minimal	1	7%	No Change	0	2	0.7	Decreasing
Relative Sea Level Rise	33%	Low	2	33%	Low	2	33%	Low	2	6	2.0	NA

Appendix D: RCP 8.5 Hazard Threat Assessment

Climate Indicator	Near Term			Mid Term			Long Term			Overall		
	Change	Threat Level	Score	Change	Threat Level	Score	Change	Threat Level	Score	Sum	Rank	Overall Trend
Mean Annual Temperature	1.75°C	Low	2	3.66°C	Moderate	3	5.73°C	High	4	9	3.0	Increasing
Winter Mean Temperature	2.04°C	Moderate	3	3.99°C	Moderate	3	6.22°C	High	4	10	3.3	Increasing
Spring Mean Temperature	2.12°C	Moderate	3	3.81°C	Moderate	3	5.64°C	High	4	10	3.3	Increasing
Summer Mean Temperature	1.75°C	Low	2	3.73°C	Moderate	3	5.87°C	High	4	9	3.0	Increasing
Autumn Mean Temperature	1.57°C	low	2	3.42°C	Moderate	3	5.20°C	High	4	9	3.0	Increasing
Maximum Temperature	1.79°C	low	2	4.05°C	Moderate	3	5.93°C	High	4	9	3.0	Increasing
Minimum Temperature	1.89°C	low	2	3.76°C	Moderate	3	5.93°C	High	4	9	3.0	Increasing
Annual number of days with Tmax < (-15°C)	-0.75	No Change	0	-1.66	No Change	0	-2.00	No Change	0	0	0.0	Decreasing
Annual number of days with Tmax < (-25°C)	0.00	No Change	0	-0.02	No Change	0	-0.02	No Change	0	0	0.0	
Annual number of days with Tmax > 30°C	0.15	No Change	0	0.52	No Change	0	1.56	Minimal	1	1	0.3	Increasing
Annual number of days with Tmax > 32°C	0.00	No Change	0	0.13	Minimal	1	0.61	Minimal	1	2	0.7	Increasing

Climate Indicator	Near Term			Mid Term			Long Term			Overall		
	Change	Threat Level	Score	Change	Threat Level	Score	Change	Threat Level	Score	Sum	Rank	Overall Trend
Tropical Nights Tmin > 18°C	0.00	No Change	0	0.93	No Change	0	16.03	Moderate	3	3	1.0	Increasing
Tropical Nights Tmin > 20°C	-0.03	No Change	0	0.00	No Change	0	1.66	Minimal	1	1	0.3	Increasing
Tropical Nights Tmin > 22°C	-0.03	No Change	0	-0.03	No Change	0	0.00	No Change	0	0	0.0	
Days with maximum humidex > 30	1.00	No Change	0	5.00	Minimal	1	26.00	Moderate	3	4	1.3	Increasing
Mean Annual Total Precipitation	5%	No Change	0	10%	Low	2	20%	Moderate	3	5	1.7	Increasing
Winter Total Precipitation	-25%	Low	4	-27%	Low	4	-23%	Low	4	12	4.0	Decreasing
Spring Total Precipitation	6%	Minimal	1	3%	Minimal	0	9%	Low	0	1	0.3	Increasing
Summer Total Precipitation	10%	Minimal	1	20%	Low	2	29%	Low	2	5	1.7	Increasing
Autumn Total Precipitation	-28%	Low	3	-22%	Low	2	-17%	Minimal	1	6	2.0	
Maximum 1-day total Precipitation	8%	Minimal	1	15%	Low	2	29%	Low	2	5	1.7	Increasing
Maximum 5-day total Precipitation	7%	Minimal	1	17%	Moderate	3	23%	Low	2	6	2.0	Increasing
Precipitation days >10mm	1.11	Minimal	1	1.93	Low	2	15%	Low	2	5	1.7	Increasing
Precipitation days >20mm	1.02	Low	2	1.88	Low	2	36%	Low	2	6	2.0	Increasing

Climate Indicator	Near Term			Mid Term			Long Term			Overall		
	Change	Threat Level	Score	Change	Threat Level	Score	Change	Threat Level	Score	Sum	Rank	Overall Trend
Number of consecutive dry days	0.07	No Change	1	0.27	No Change	1.89	14%	Minimal	1	2	0.7	Increasing
Cooling Degree Days	311%	Very High	5	1486%	Very High	5	7432%	Very High	5	15	5	Increasing
Heating Degree Days	-8%	No Change	0	-19%	Minimal	1	-29%	Low	2	3	1.0	Decreasing
Annual number of growing degree days >5°C	32%	Low	2	80%	Moderate	3	135%	High	4	9	3.0	Increasing
Freeze-thaw cycles (#)	-28%	Low	2	-50%	Low	2	-66%	Moderate	3	7	2.3	Decreasing
Frost Free Days	5.84	High	4	9.93	High	4	12.50	Very High	5	13	4.3	Increasing
Frost Days	-2.88	Moderate	3	-5.62	High	4	-7.66	High	4	11	3.7	Decreasing
Ice days	-3.01	Low	2	-7.80	High	4	-12.16	Very High	5	11	3.7	Decreasing
Windspeed (Minimum)	7%	No Change	0	8%	No Change	0	7%	No Change	0	0	0.0	
Windspeed (Median)	7%	No Change	0	7%	No Change	0	7%	No Change	0	0	0.0	
Windspeed (Maximum)	7%	No Change	0	7%	No Change	0	7%	No Change	0	0	0.0	

Appendix E: Summary of Historical Climate

Table i. Summary of key environmental indicators for Prince Rupert

Environmental Indicator	Value	Definition
Lowest Elevation	0.0 m	The lowest point of land.
Highest Elevation	696 m (Mount Hays)	Highest point of land.
Average Water Level	3.85 m	The average of all hourly water levels over the available period of record.
Low Water Level	1.80 m	The lowest of all hourly water levels over the available period of record.
High Water Level	5.90 m	The highest of all hourly water levels over the available period of record.
Highest Water Level	7.98 m	The highest water level recorded over the period of record.
Tsunami Water Level	3.5 m[19]	The vertical displacement of the mean sea level due to a tsunami.

Climate

Prince Rupert is a coastal community located in the province of British Columbia. It bears climate and ecoregion similarities to other west coast cities in North America. However, it holds the title as the wettest city in Canada. The climate themes explored in this section further reveal the unique attributes of this region.

Temperature

The region has a temperate climate with the average annual temperature within 7 to 8°C. Winters here are mild, with average winter temperatures within 2 to 3°C. Summers are cool with average summer temperatures within 12 - 13°C. Minimum temperatures in the region rarely decline beyond 0°C with only 2 days annually dropping below -15°C. The record minimum temperatures in the region were set in May 1905 with a record -16.1°C and surpassed in January 1916 with the absolute record of -21.1°C. In more recent years, the coldest temperature recorded was January 2020 at -13.7°C. Relatively mild, cold temperatures can be of concern with high wind speeds, known as the wind chill factor.

[19] Modeled from the 1964 Tsunami in the Tsunami Flood Risk Assessment

Table ii. Estimating Wind Chill Factor[20]

Wind speed (km/h)	Estimating wind speed	Temperature (°C)				
		0	- 5	-10	-15	-20
10	Wind felt on face - wind vane begins to move	-3	- 9	-15	-21	-27
20	Small flags extended	-5	-12	-18	-24	-30
30	Wind raises loose paper, large flags flap and small tree branches move	-6	-13	-20	-26	-33
40	Small trees begin to sway and large flags extend and flap strongly	-7	-14	-21	-27	-34
50	Large branches of trees move, telephone wires whistle	-8	-15	-22	-29	-35
60	Trees bend and walking against the wind is hard	-9	-16	-23	-30	-36

Maximum temperatures in the region is around 24°C. The probability of a day over 30°C to occur is less than one day annually. Combined with humidity[21], the likelihood for temperatures to feel like 30°C increases to only one day annually. Maximum temperature records have only been seen in the last decade with the record first set in 2013 an extreme heat event was declared for temperatures hitting 20.4°C. Only eight years later, in June 2021 the reported extreme heat event topped the record to 30°C.

Table iii. Summary of key climate indicators for Prince Rupert[22]

Climate Indicator	Value	Definition
Mean Annual Temperature (°C)	7.06	The average of the daily maximum temperature and the daily minimum temperature for the selected time period. Autumn represents months September, October and November. Winter represents months December, January, and February. Spring represents months March, April, and May. Summer represents months June, July and August.
Autumn Mean Temperature (°C)	7.83	
Winter Mean Temperature (°C)	1.72	
Spring Mean Temperature (°C)	6.01	
Summer Mean Temperature (°C)	12.91	

[20] Environment and Climate Change Canada (ECCC). Wind Chill Index. https://www.canada.ca/en/environment-climate-change/services/weather-health/wind-chill-cold-weather/wind-chill-index.html.

[21] In Canada, the humidex is used to describe how hot the weather feels to the average person, by combining the effect of heat and humidity. It is recommended that outdoor activities be moderated when the humidex exceeds 30, and that all unnecessary activities cease when it passes 40 (Mekis et al., 2015).

[22] Environment and Climate Change Canada. "Prince Rupert." Climate Data Canada, https://climatedata.ca/explore/location/

Climate Indicator	Value	Definition
Maximum Average Temperature (°C)	23.76	The highest maximum temperature in the selected time period. Also known as The Hottest Day.
Minimum Average Temperature (°C)	4.15	The daily minimum temperature in the selected time period
Tropical Nights Tmin >18°C	0	A Tropical Night occurs when the daily minimum temperature is greater than the threshold temperature 18, 20 or 22°C respectively.
Tropical Nights Tmin >20°C	0	
Tropical Nights Tmin >22°C	0	
Annual #/Days w Max Temp >30°C	0.07	The number of days with a maximum temperature is greater than 30 or 32°C respectively.
Annual #/Days w Max Temp >32°C	0.00	
Humidity >30	1	The number of days where the Humidex is greater than 30.
Annual #/Days w Max Temp ←15°C	2.12	The number of days where the lowest temperature of the day is colder than -15 or -25°C respectively.
Annual #/Days w Max Temp ←25°C	0.00	

Table iv. Summary of Extreme Weather Events related to temperature

Event Date	Event Type	Key Indicator	Description
May 3, 1905[23]	Extreme Cold	Minimum Temperature Spring Mean Temperature	-16.1 °C recorded, this is 22 degrees colder than the spring average
Jan 23, 1916[24]	Extreme Cold	Minimum Temperature Winter Mean Temperature	-21.1 °C recorded, this is 22 degrees colder than the winter average
Jan 12, 2020[25]	Extreme Cold	Minimum Temperature Winter Mean Temperature	-13.7 °C recorded, this is 14 degrees lower than the winter average
Dec 18, 2022[26]	Cold Snap	Freeze/Thaw Cycle	Declared a state of local emergency due to an escalation of water main and water service breaks. Residents asked to run taps at a slow drip to prevent their own pipes from freezing.
2013[27]	Extreme Heat	Maximum temperature Annual Mean Temperature	20.4 °C recorded, this is 13 degrees warmer than the annual average
Jun 28, 2021[28]	Extreme Heat	Maximum temperature Summer Mean Temperature	30.0 °C recorded, this is 17 degrees warmer than the summer average

[23] "Cold Snaps All Weather Records in Prince Rupert." Prince Rupert Northern View, 17 Jan. 2020, https://www.thenorthernview.com/news/cold-snaps-all-weather-records-in-prince-rupert/.

[24] ibid.

[25] ibid.

[26] Femia, Victoria. "Increased Water Main Breaks Prompt Local Emergency in Prince Rupert, B.C." Global News, 18 Dec. 2022, https://globalnews.ca/news/9357557/increased-water-main-breaks-prompt-local-emergency-in-prince-rupert-b-c/.

[27] Mangione, Kendra. "59 Temperature Records Broken in a Single Day as B.C. Swelters under 'Heat Dome.'" CTV News, 28 June 2021, https://bc.ctvnews.ca/59-temperature-records-broken-in-a-single-day-as-b-c-swelters-under-heat-dome-1.5488672.

[28] ibid.

Precipitation

Annual average precipitation in the region boasts an accumulation of 2634mm. This is well above average across North America where most of the land mass experiences between 100 - 1500 mm annual accumulation. The rainfall in this region better resembles precipitation found in coastal South Asia (Bangladesh 2666mm and Singapore 2497mm), island nations (Fiji 2592mm in Oceania), or coastal South America (Guyana with 2387mm or Suriname with 2331mm).

Although its northern latitude signifies that there is snow accumulation, only 4% of the total precipitation is snow (~91mm), the remaining 96% is rainfall (~2543mm).[29] Figure i below visualizes the monthly temperatures (maximum, minimum, and average values) and average monthly precipitation. Opportunities for snowfall occur when precipitation is above 0 millimeters and the temperature is below 0 degrees Celsius. Although possible in the winter, average winter temperatures are typically too mild for snowfall.

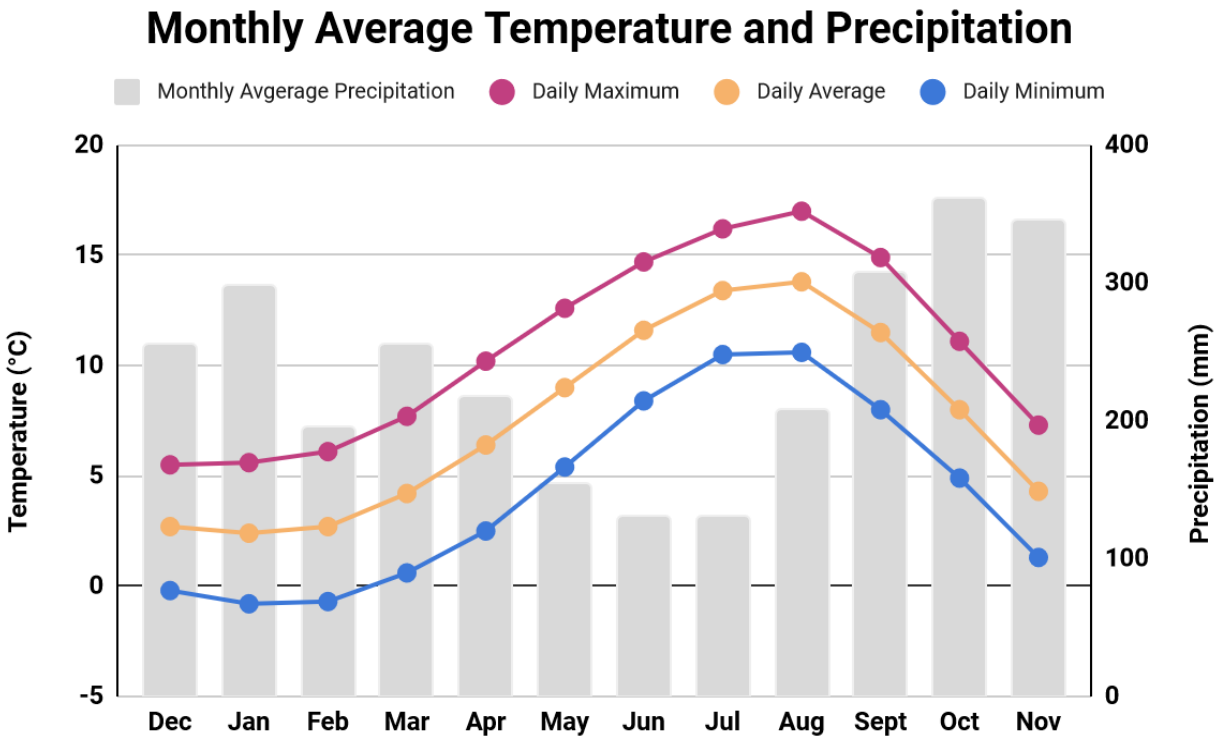

Figure i. Monthly minimum, maximum and average temperature (left axis) and monthly average precipitation (right axis). Sources: Temperature values available for weather station "PRINCE RUPERT A" for 1981 - 2010 and precipitation values available from City of Prince Rupert.

Seasonally, the wettest time of year is autumn which may experience 940mm precipitation accumulation annually followed by a wet winter with almost 800mm.

[29] Environment and Climate Change Canada. Canadian Climate Normals 1981-2010 Station Data - Prince Rupert A. 25 Sept. 2013, https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnProx&txtRadius=25&opt

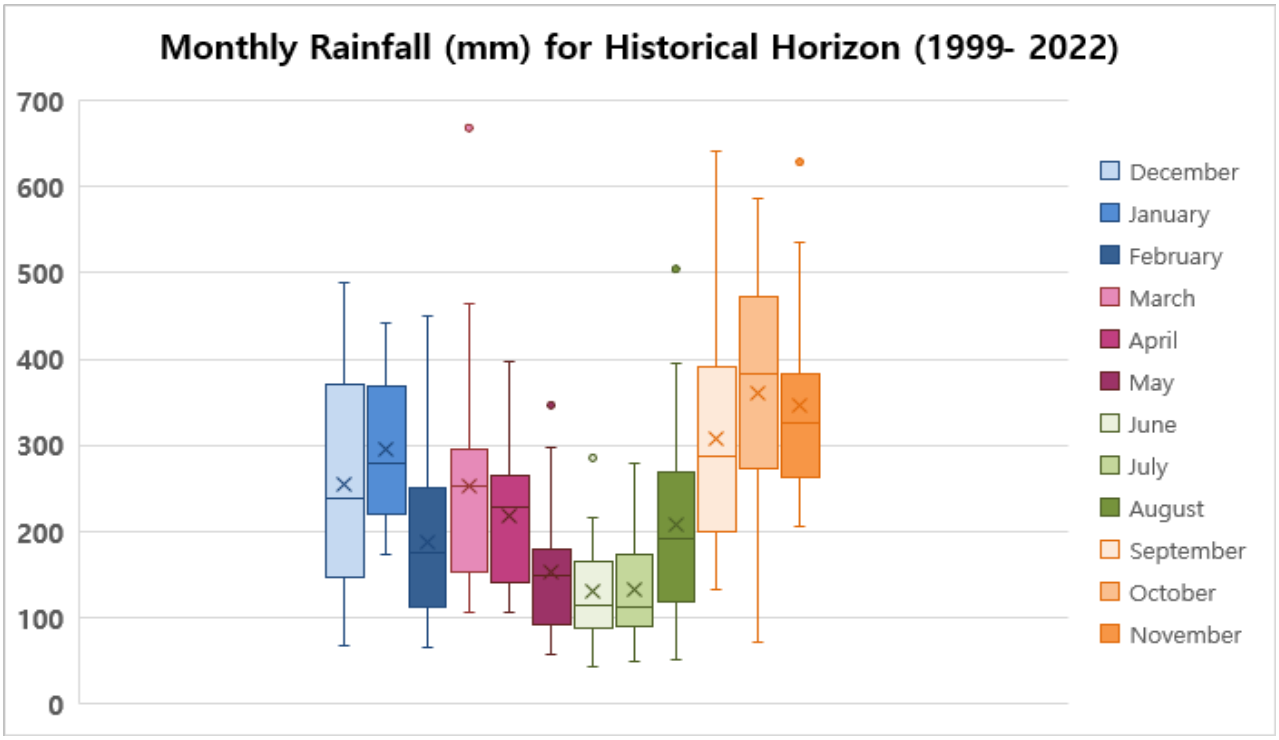

Figure ii. Boxplot of the monthly rainfall for the time horizon 1999 - 2022.[30]

The maximum 1-day total precipitation can average 80 mm in accumulation. Flash flooding is a possibility with large amounts of single-day rainfall. In August 2020 Prince Rupert experienced 150 mm of rainfall accumulation over 2 days resulting in flash flooding. The event was triggered by the significant rainfall as well as a relatively dry season. Similarly, the maximum 5-day total precipitation averages 184 mm in accumulation. In September 2021 a rainfall event brought 221mm of rainfall in a single week (typically the entire rainfall for the month). Although no flooding was reported, long duration and high volume rainfall could lead to the possibility of overland flooding as well as river flooding.

Although the region normally handles large amounts of rainfall, key indicator pairings to look for include maximum 1-day and 5-day rainfall with the number of consecutive dry days. Where large rainfall events follow a particularly dry period, there is the opportunity of land instability (i.e. the flash flooding and landslide August 2020) or water quality issues (December 2018 storm surge after dry summer).[31]

[30] City of Prince Rupert, Annual Rainfall

[31] After the Incident Report. Operations Department, 15 Mar. 2019, https://ehq-production-canada.s3.ca-central-1.amazonaws.com/

Table v. Summary of climate indicators related to precipitation

Climate Indicator	Value	Definition
Annual Total Precipitation (mm)	2643.60	The total amount of precipitation (mm) accumulated or the selected time period. Autumn represents months September, October and November. Winter represents months December, January, and February. Spring represents months March, April, and May. Summer represents months June, July and August.
Autumn Total Precipitation (mm)	946.82	
Winter Total Precipitation (mm)	797.7	
Spring Total Precipitation (mm)	547.15	
Summer Total Precipitation (mm)	387.28	
Maximum 1-day Precipitation (mm)	81.92	The maximum accumulation of precipitation that falls in on a single day in the selected time period.
Maximum 5-day Precipitation (mm)	184.32	The maximum accumulation of precipitation that falls over a consecutive 5-day period.
Precipitation days >10mm	92	The number of days with precipitation greater or equal to 10mm and 20mm respectively.
Precipitation days >20mm	36	
# of consecutive dry days	13	The maximum number of consecutive days with precipitation below 1mm/day, within the selected time period.

Another climate phenomena unique to the west coast is the El Nino / Southern Oscillation (ENSO). El Nino events are periodic warming of the ocean waters in the eastern and central tropical Pacific Ocean. Over a period of months to years, the pattern reverses and this cooling phase is known as La Niña. Impacts of ENSO are strongest in winter and spring.[32] For Prince Rupert, snowfall is statistically significant decline during El Nino as well as temperature increase a degree. During La Nina, snowfall may increase and temperature may fall a few degrees from average.[33]

Table vi. Summary of impacts of ENSO for the month of March in British Columbia[34]

Climate Indicator	El Nino	La Nina
Temperature	1.0 to 1.5 degrees Celsius above normal throughout the region. Statistically significant for southern B.C.	1.0 degree Celsius below normal in the south and as much as 3.0 below normal in the north. Statistically significant everywhere except southeast B.C.
Total Precipitation	Slightly below normal except along the Pacific coast where it is near normal. No coherent pattern of statistical significance	Near normal along the Pacific coast. No coherent pattern of statistical significance
Snowfall	30 to 50% below normal along the Pacific Coast. Statistically significant for southern B.C.	Up to 40% above normal in the interior increasing up to 90% above normal along the outer coast. Statistically significant for southern B.C.

Biodiversity

Ecoregions describe the expected type of ecosystem for a region based on climate parameters. Prince Rupert is known as the Coastal Western Hemlock-Sitka Spruce Forests and is generally categorized as a Marine West Coast Forest[35]. This region is unique due to the temperate and wet climate with very few areas across North America comparable to the ecoregion.

The biodiversity of this region includes a variety of aquatic and terrestrial flora and fauna. A keystone species for many parts of British Columbia is the grizzly bear whose health can signal overall health of the environment. The area is also a common sightseeing point of the whale (orcas, humpback and gray whales) during feeding and migration.

[32] Natural Resources Canada. Indicators of Climate Variability and Change. 2 Nov. 2009, https://natural-resources.canada.ca/

[33] Taylor, Bill. "Effect of El Niño/Southern Oscillation (ENSO) on British Columbia and Yukon Winter Weather." Aquatic and Atmospheric Science Division, Pacific and Yukon Region, Environment Canada, Mar. 1998, https://publications.gc.ca/site/archivee-archived.html?url=https://publications.gc.ca/collections/collection_2020/eccc/en84/

[34] ibid.

[35] Ecoregion Level 1 category. Level 1 Ecoregion categories may apply to several regions across North America as having similar climate parameters

In the subsections to follow, the concentration is on known invasive species. For a list of species residing in Prince Rupert, please refer to the full report of Biodiversity of the Prince Rupert Forest Region.[36]

Flora

An invasive plant known as Knotweed is known to cause damage as it can grow through concrete and asphalt. There are four variations of knotweed - Himalayan, Giant Knotweed, Bohemian and Japanese. Residents are urged to report sightings of these plants for disposal.[37] Giant Hogweed and Cow Parsnip are noxious plants known to burn and lesions if handled without protection. Cow Parsnip is not subject to removal if spotted as it is a native species, but Giant Hogweed should be reported for removal.[38]

Fauna

So far, no invasive species have been detected in the Prince Rupert Harbour, while a few have been found in the general area of BC's north coast and the Alaskan southeast coast.[39]

Historical Extreme Weather Events and Natural Hazards

Hazards are the potential occurrence of physical events, such as extreme weather events on the scale of a few hours to a few weeks or extreme climate events on the scale of a few months to years. Each hazard is mapped to climate indicators and historical weather events investigated in earlier sections. These indicators may influence the likelihood for a hazard to present a threat to the community.

Extreme heat and extreme cold events are defined as daily temperature events that are significantly above average. For the case of extreme heat, the indicator "number of tropical nights over 20°C" is also factored in due to the limited cooling. Humidity may exacerbate warm days to "feel like" an extreme event. Similarly, wind chill may exacerbate the sensitivity of cold days to feel like an extreme cold event.

Flooding and drought are opposing sides of the spectrum of water capacity of a system. In a flood event, the system is overflowing with water and in a drought event, the system does not receive enough water. Drought can be measured through significant consecutive dry days, however flooding may occur through a few climate scenarios. Localized flooding (also known as overland flooding) may occur during a significant short duration rainfall event (climate indicator: 1-day rainfall event) and may also be triggered by a high groundwater table. Riverine flooding (also known as fluvial flooding) occurs in floodplains and is categorized by long-duration heavy rainfall (climate indicator: 5-day rainfall event). Seasonally, autumn rainfall may trigger a freshet event as it is the wettest season annually.

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[36] Radcliffe, C., et al. Biodiversity of the Prince Rupert Forest Region. British Columbia Ministry of Forests, https://www.for.gov.bc.ca/hfd/pubs/docs/mr/lmr/lmr082-2.pdf.

[37] City of Prince Rupert. "Invasive Species and Noxious Weeds." Services, https://www.princerupert.ca/services/invasive-species

[38] ibid.

[39] "Aquatic Invasive Species." Prince Rupert Port Authority, https://www.rupertport.com/aquatic-invasive-species/

Similar to flooding, coastal storm surges may result in temporary high water due to a high tide, sea level rise and heavy rainfall events. Tsunamis also present high water which may result in shoreline flooding. Long term shoreline flooding (also known as inundation) results in shoreline land loss, this phenomenon will be explored in next steps in this assessment.

Table vii. Summary of current known hazards and interventions

Hazard	Climate Conditions	Current Interventions
Extreme Heat	Maximum Temperature Tropical Nights >20°C Number of Days with Temperature >30°C Humidity >30	**Established:** known causes
Extreme Cold / Cold Snaps	Minimum Temperature Annual Days with Temperature under -20°C Freeze/Thaw Cycles Wind Chill	**Established:** known causes
Dry Spell / Drought	Number of consecutive dry days	**Established:** known causes
Severe Storm / Storm Surge	High Tide Sea Level Rise Maximum 1-Day Precipitation	**Established:** known causes
Flooding - Localized	Maximum 1-Day Rainfall Groundwater Table	**Established:** known causes
Flooding - Riverine	Maximum 5-Day Rainfall Seasonal Precipitation Snowmelt (freshet) Groundwater Table	**Established:** known causes
High Winds	Wind Speed	**Established:** known causes

Hazard	Climate Conditions	Current Interventions
Landslides	Number of consecutive dry days Maximum 1-Day precipitation Seasonal Temperature Seasonal Precipitation	**Established:** 30% or greater slope areas within the townsite area that are potentially hazardous
Land Loss	Sea Level Rise Land Subsidence	**To Consider:** Prince Rupert may consider a local sea level rise analysis.
Tsunami (non-seismic)	Terrain instability	**To Consider:** will require a regional slope assessment to determine any slopes that might pose a risk.
Tsunami (seismic)	Earthquake	**Established:** Houseboats are not permitted in high wave velocity areas like Fern Passage.
Biodiversity	Mean Annual Temperature Mean Annual Precipitation Frost Days	**Established:** Prince Rupert must work to retain significant naturally vegetated areas between development nodes.

The next step will establish the climate future for Prince Rupert across three time horizons: the near future (2030), the mid-term future (2050) and the long-term future. In the next step of analysis, climate data will be collected and reviewed across the horizons for key trends (illustrated through representative concentration pathway 4.5) and potential worst case scenarios (illustrated through representative concentration pathway 8.5).

Through the analysis of the future climate, the list of natural hazards will be reorganized to prioritize potential future threats. This will be the first component to establishing climate risk.

Climate Risk = Hazard Threat Probability X Vulnerability X Exposure[40]

[40] UNESCO: United Nations Educational, Scientific and Cultural Organization. "Glossary of Basic Terminology on Disaster Risk Reduction." UNESDOC Digital Library, https://unesdoc.unesco.org/ark:/48223/pf0000225784.

The city of

Prince Rupert

Climate Change Adaptation Plan

January 2025

THE CITY OF PRINCE RUPERT

Appendix 3:

Climate Risk and Vulnerability Assessment

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Purpose of Document

The Climate Risk and Vulnerability Assessment analyzes the likelihood, consequences, frequency, and impacts of climate hazards on residents, assets, and Prince Rupert's key sectors. The analysis involves:

- Mapping corporate and community functions, services, sectors, and assets (including natural assets, infrastructure, and socioeconomic resources);
- Overlaying localized climate change hazards, vulnerabilities, and impacts to identify future climate risks;
- Determining the exposure and sensitivity of functions, services, sectors, and assets to hazards, as well as the interdependencies between these elements;
- Overlaying social, environmental, and economic information with a focus on disadvantaged communities that may experience the most negative effects of climate change; and
- Evaluating current and future adaptive capacity using social, environmental (i.e., natural infrastructure), economic, and risk indicators for each zone.

Disclaimer

Reasonable skill, care, and diligence have been exercised to assess the information acquired during the preparation of this analysis, but no guarantees or warranties are made regarding the accuracy or completeness of this information. This document, the information it contains, the information and basis on which it relies, and the associated factors are subject to changes that are beyond the control of the authors. The information provided by others is believed to be accurate but has not necessarily been verified.

This analysis includes strategic-level estimates of climate risk and vulnerability that should not be relied upon for design or other purposes without verification. The authors do not accept responsibility for the use of this analysis for any purpose other than that stated below and do not accept responsibility for any third-party use, in whole or in part, of the contents of this document. This analysis applies to the City of Prince Rupert and cannot be applied to other jurisdictions without analysis. Any use by the City of Prince Rupert, its sub-consultants, or any third party, or any reliance on or decisions based on this document, are the responsibility of the user or third party.

Abbreviations

ALARP	As low as reasonably practicable
AQHI	Air Quality Health Index
CI	Climate indicator
CRVA	Climate Risk and Vulnerability Assessment
FCL	Flood construction level
GHG	Greenhouse gas emissions
IPCC	Intergovernmental Panel on Climate Change
NAS	National Adaptation Strategy
NCRD	North Coast Regional District
PIEVC	Public Infrastructure Engineering Vulnerability Committee
RCP	Representative Concentration Pathways

Key Terms

Adaptive capacity: The ability of built, natural, human, and social systems to adjust to climate change by moderating potential damages, taking advantage of opportunities, or coping with the consequences. Conceptually, vulnerability is a function of adaptive capacity, sensitivity, and susceptibility.

Climate: The long-term weather patterns of a given location averaged over a period of time, typically 30 years.

Climate change: Changes in long-term weather patterns caused by natural phenomena and exacerbated by human activities that alter the chemical composition of the atmosphere through the build-up of greenhouse gases that trap heat and reflect it back to the Earth's surface.

Climate adaptation: The process by which human and natural systems adjust to actual or expected climate change and its effects on built, natural, social, and human systems. Adaptation involves moderating risk or avoiding harm, and taking advantage of beneficial opportunities that result from the changing climate.

Climate hazards: The occurrence of climate-related physical events, such as extreme weather events (e.g., heat waves or floods), or climate change trends, such as increasing temperatures, that may result in loss of life, injury, or other health impacts, as well as damage to natural, built, or human systems.

Climate mitigation: The reduction of greenhouse gas emissions through policies, programs, regulations, infrastructure, and other activities.

Consequence (also commonly referred to as impacts): The outcome of climate hazards on natural, built, and human systems. This includes the effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure. Impacts generally manifest in some form of damage or disruption and can generally be categorized as physical, social, or economic. Impacts can be considered **direct** (physical injury or loss) or **indirect** (delays and disruptions to normal activity).

Critical infrastructure: The physical structures, facilities, networks, and other assets that provide services vital to the social and economic functioning of a community or society.

Direct consequence: Related to physical contact with a hazard, these damages are typically tangible (damage to structures, crops/livestock, physical injury, environmental degradation, damage to possessions, etc.).

Ecoregion: Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components.[1]

[1] U.S. EPA Office of Research and Development (ORD) - National Health and Environmental Effects Research Laboratory (NHEERL) . "Level III Ecoregions of the Conterminous United States." FGDC Metadata, https://gaftp.epa.gov/EPADataCommons

Essential services: The physical structures, facilities, networks, and other assets that provide services vital to the emergency preparedness, response, and recovery of a community or society.

Equity: The principle of being fair and impartial, requiring freedom from bias. In particular, climate equity is a principle promoting solutions that give equal opportunity for everyone to benefit from investments in climate change while ensuring vulnerable populations do not bear an unequal burden from climate impacts.

Exposure: People, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be impacted directly or indirectly by the consequences of climate-related events. For example, assets located in a floodplain or people living in poor-quality housing are more exposed to the direct impacts of climate change.

Extreme weather events: Unexpected, unusual, severe, or unseasonal weather and weather at the extremes of the historical distribution—the range that has been seen in the past. Technically, these events are defined as lying in the most unusual 10% (10th or 90th percentile of a probability density function). For Canada, thresholds for extreme weather events can be accessed from the Public Weather Alert.[2] Note: When a pattern of extreme weather persists for some time, such as a season, it may be classed as an **extreme climate event**, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season).

Indirect consequence: Related to non-physical contact with a hazard, these damages are typically intangible (production losses, market disturbances, loss of time, migration, etc.).

Representative Concentration Pathways (RCPs): Scenarios developed by the United Nations Intergovernmental Panel on Climate Change (IPCC) that describe the rate at which future greenhouse gas emissions (GHG) increase. For adaptation planning, RCP 4.5 and RCP 8.5 are typically used to plan for a moderate increase in GHGs and a worst-case scenario, respectively.

Resilience: The social, economic, or environmental capacity of a system to cope with hazardous events or disturbances. Resilience may involve responding to hazards or reorganizing systems in ways that allow them to maintain their essential function, identity, and structure. Conceptually, resilience is a function of the likelihood of a **hazard**, the **vulnerability**, and the **level of disruption**.

Risk: The potential for negative consequences where something of value is at stake and where the outcome is uncertain. Risk is often represented as the probability of hazardous events or trends occurring multiplied by the impacts of these events or trends. Conceptually, risk is defined as a function of the probability of a hazard, vulnerability to a hazard (the level of adaptive capacity, exposure, and sensitivity of the system), and the consequences of a hazard (direct and indirect impacts).

[2] Environment and Climate Change Canada. Criteria for Public Weather Alerts. 26 July 2010, https://www.canada.ca/en/environment-climate-change/services/types-weather-forecasts-use/public/criteria-alerts..

Risk characterization: Applying a qualitative (relying on expert judgment) or quantitative (using metrics to define risk components) analysis to assign values for risk. The result is a classification of risk values into a range of minimal, moderate, and high risk categories. This step enables prioritization of at-risk assets, services, and communities for climate adaptation policies.

Sensitivity: Describes the **physical vulnerability** to climate hazards (i.e., structural conditions, available resources). A high sensitivity score means more and quicker adaptation actions need to be implemented to avoid large climate impacts, while a lower sensitivity means we have more time to adapt. Conceptually, vulnerability is a function of **adaptive capacity**, **sensitivity**, and **susceptibility**.

Susceptibility: Describes the **spatial vulnerability** to a climate risk, which is shaped by proximity to known hazardous zones or areas that have been historically impacted by hazards. Conceptually, vulnerability is a function of **adaptive capacity**, **sensitivity**, and **susceptibility**.

Vulnerability: The heightened likelihood an individual, geographic area, asset, or human or socio-ecological system will be adversely affected by hazardous climatic events due to external stress or strain. Vulnerability is shaped by **sensitivity (relative state of repair or public health)** or **susceptibility (proximity to hazardous areas)** and **adaptive capacity (available/designated resources)**.

Adaptation: Managing the Unavoidable

Climate change adaptation and mitigation can be described as two sides of the same coin. This analogy is used in municipal planning to distinguish climate adaptation from mitigation and to highlight where both components of climate action complement each other (Figure 1). Mitigation planning aims to limit global warming through reducing energy use and greenhouse gas emissions. Adaptation planning aims to manage the unavoidable consequences of climate change through risk reduction.

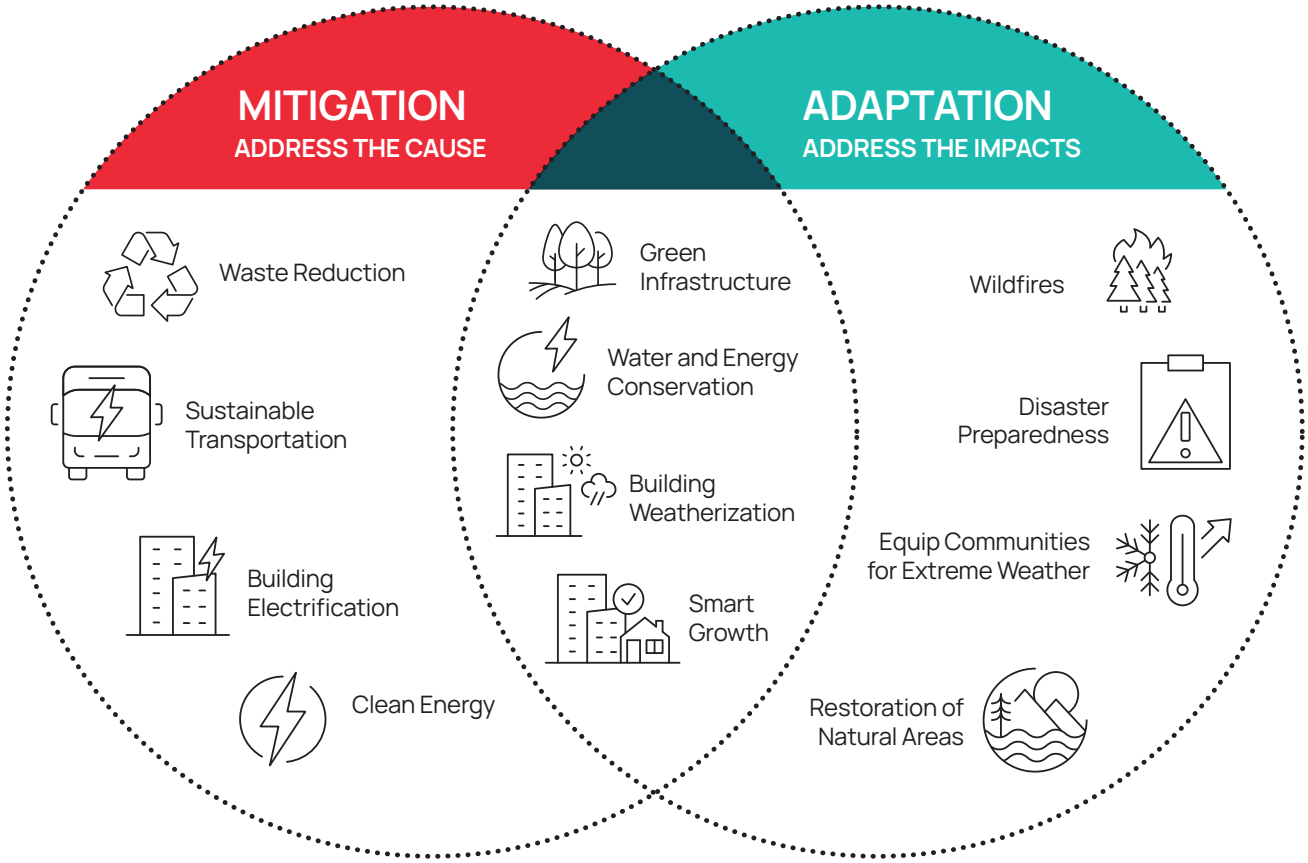

Figure 1. The intersection between climate mitigation and climate adaptation in municipalities. Mitigating the long-term impacts of climate change includes actions to reduce greenhouse gas emissions and energy use. Adapting to the impacts of climate change entails planning to prepare for, respond to, and recover from extreme weather and climate hazards. (Source: City of Windsor Adaptation Plan Draft, 2023).

The Climate Risk and Vulnerability Assessment (CRVA) is part of a series of documents for Prince Rupert's Climate Adaptation Action Plan. Previously, SSG conducted a Background Review by compiling a list of policies, plans, programs, and historical climate hazards to determine the context for adaptation planning. Additionally, SSG developed the Climate Change Future Scenarios Report to investigate how historical hazards may change in severity and frequency into the future. The CRVA reviews the extent of vulnerabilities, as well as the capacity of Prince Rupert to absorb and avert shocks and stresses related to future climate risk. The CRVA will be used as a tool to develop risk-reduction actions in the next steps of adaptation planning,

Prince Rupert's Progress

As of 2024, a number of climate hazards have been investigated for future risk in Prince Rupert. In the Background Review, SSG completed a review of policies, plans, and programs to outline the City of Prince Rupert's understanding of climate risks and existing interventions. Table 1 provides a summary of these findings, as well as feedback from engagement. Please note that existing interventions may involve the support of or leadership from the Regional District and/or Province. Follow-up interventions define potential areas for further action based on what has been established thus far.

Table 1. Summary of current known hazards, the climate drivers that may influence the severity or frequency of hazards, and current interventions to reduce risk to hazards.

Hazard	Climate Drivers	Interventions
Extreme heat	• Maximum temperature • Tropical nights greater than 20°C • Number of days with temperature greater than 30°C • Humidity greater than 30°C	**Existing:** Through provincial resources, Northern Health issues Heat Warning Alert and Extreme Heat Emergency Alert. The vulnerable population is locally identified. Some cooling centres are defined.
Extreme cold/ cold snaps	• Minimum temperature • Number of days with temperature under -20°C • Freeze/thaw cycles • Wind chill	**Existing:** The City of Prince Rupert's Active Emergency Operations Centre addresses water main breaks during cold snaps. **Follow-up:** The Infrastructure Replacement Strategy (2023)[3] identifies very high and high risk linear assets to improve.

[3] Urban Systems and City of Prince Rupert. Infrastructure Replacement Strategy. 31 Jan. 2023

Hazard	Climate Drivers	Interventions
Dry weather conditions/ drought	• Number of consecutive dry days	**Existing:** Known causes available from B.C. Drought Information Portal[4] with preparation procedures available from B.C. Water Scarcity and Response Plan (2022).[5]
Severe storms/ storm surges	• High tide • Sea level rise • Maximum one-day precipitation • Wind speed	**Existing:** BC Hydro operates a combustion turbine generator to provide back-up power during supply outages. Ecotrust's Energy Advisor Program supports household retrofits to reduce potential loss of power, improve insulation, etc.
High winds	• Wind speed (for this climate, severe storms are closely related to high wind events, and the two hazards are typically coupled)	
Flooding	• Maximum one-day precipitation • Maximum five-day rainfall • Seasonal precipitation • Snowmelt (freshet) • Groundwater table	**Existing:** B.C. Flood Hazard Area Land Use Management Guidelines (2018) suggest incorporating sea level rise into building standards in all coastal areas to include storm surge, wave effect, and freeboard when determining the flood construction level (FCL) of new buildings. **Follow-up:** Building bylaw update to establish the FCL for Prince Rupert.
Landslides	• Number of consecutive dry days • Maximum one-day precipitation • Seasonal temperature • Seasonal precipitation	**Existing:** Within the Official Community Plan (OCP; Bylaw 3460), areas within the townsite with slopes of 30% or greater are potentially hazardous.

[4] Province of British Columbia. "British Columbia Drought Information Portal." Water Management Branch, Ministry of Forests, https://governmentofbc.maps.arcgis.com/apps/MapSeries/

[5] Province of British Columbia. British Columbia Drought and Water Scarcity Response Plan. Ministry of Water, Land and Resource Stewardship on behalf of the Inter-Agency Drought Working Group, https://www2.gov.bc.ca/gov/content/environment/climate

Hazard	Climate Drivers	Interventions
Land loss	• Sea level rise • Land subsidence	**Existing:** Large businesses and industry along the shoreline have evacuation plans. The Port Authority is considering terminal retrofits in anticipation of sea level rise. **Follow-up:** A key recommendation from the Tsunami Flood Risk Assessment (2019) suggests Prince Rupert consider a local sea level rise analysis.
Tsunami (non-seismic)	• Terrain instability	**Follow-up:** A key recommendation from the Tsunami Flood Risk Assessment (2019) suggests Prince Rupert consider a regional slope assessment to determine any slopes that might pose a risk.
Tsunami (seismic)	• Earthquake	**Existing:** Houseboats are not permitted in high wave velocity areas like Fern Passage.
Ecoregion changes	• Mean annual temperature • Mean annual precipitation • Frost days	**Existing:** Prince Rupert's OCP recognizes the need to retain significant naturally vegetated areas between development nodes. Knotweed is monitored by the municipality, while aquatic invasive species are monitored by the Prince Rupert Port Authority. The region is too far north to be affected by the spread of Lyme disease more common in southern B.C. Local food generation is supported by Ecotrust programming (community garden, regenerative ocean farming, ocean clean-up, kelp/shellfish hatchery). Ts'msyen Culture Society is working on policies for more sustainable and culturally minded aquaculture. Tourism Prince Rupert's Travel Pledge seeks to lay a foundation for more sustainable tourism. **Follow-up:** Update land-use bylaw to recognize significant naturally vegetated areas. Ongoing partnership with Ecotrust to complete a food systems assessment.

Hazard	Climate Drivers	Interventions
Wildfire	• Number of consecutive dry days • Seasonal temperature • Seasonal precipitation • High winds	**Existing:** Exploring resources needed to manage wildland risks. Wildfire prevention under exploration by North Coast Regional District Strategic Plan (2023–2026). In 2025, consider applying for a Fire Smart coordinator position, with partial funding from the Province. In 2024, participate in the Wildland Fire Summit to initiate dialogue about how the fire department can build the resources needed to manage wildland risks.

CRVA Scope

Temporal Scope

The CRVA assesses future climate vulnerability and risk for three time horizons:

- The near term (2011 to 2040),
- The mid term (2041 to 2070), and
- The long term (2071 to 2100).

Physical Scope

The CRVA assesses vulnerability and risk within the municipal boundaries of Prince Rupert.

Key Sectors

The CRVA's development involved a review of adaptation considerations across five major sectors to capture a wide amount of activity that occurs in Prince Rupert. The five sectors are described below.

- **Environment:** All areas of the city designated or planned as open space and natural environment.
- **Community:** Residents and residential structures.
- **Municipal services and assets:** Functions the municipality is responsible for, as well as structures owned by the municipality. This sector includes natural assets.
- **Economy:** Local businesses and commercial and industrial organizations.
- **Critical infrastructure:** A critical service or structure to the community, where the loss of the service delivery function causes cascading system-wide failures. This sector includes emergency services.

Climate Scenarios

The analysis in this document draws on two climate scenarios: the RCP 4.5 and the RCP 8.5. The RCP 4.5 scenario, the moderate scenario, is useful for planning for the near-term future and frequent events (i.e., seasonal events, such as spring freshet, extreme heat, extreme cold, etc.).

The RCP 8.5 scenario, the worst-case scenario, is useful for infrastructure and other long-term planning. The catastrophic events in the RCP 8.5 scenario have impacts that are anticipated to occur infrequently or on a very long timescale (i.e., 1-in-100-year flood, tsunamis, sea level rise).

Climate Hazards

This assessment explores the 13 hazards detailed below.

1. **Tsunami (seismic and non-seismic):** A series of waves in a water body caused by the displacement of a large volume of water, generally in an ocean or a large lake.
2. **Ecoregion changes:** Changes to temperature and precipitation that impact the survival of native flora and fauna.
3. **Flooding:** The covering of normally dry land with a large amount of water.
4. **Extreme heat:** Days with temperatures over 28°C.[6]
5. **Drought:** A period of time when an area or region experiences below-normal precipitation.
6. **High winds:** Sustained wind at a speed of 70 km/hour or higher.[7]
7. **Landslides:** Any type of slope failure or downward movement of rock and/or sediment.
8. **Severe storm:** Severe thunderstorms with heavy rain, and intense lightning or damaging winds.
9. **Extreme cold/cold snaps:** Annual average minimum temperature recorded below -20°C.[8]
10. **Freezing rain/ice accumulation:** Rainfalls during days where surface temperature is below 0°C. When the rainfall reaches surfaces such as tree branches or sidewalks, it may result in ice accumulation on surfaces.
11. **Snow accumulation:** Winter precipitation on days 0°C or lower.
12. **Wildfire:** An unplanned, unwanted fire burning in a natural area, such as a forest, grassland, or prairie.
13. **Land loss (relative sea level rise):** Permanent flooding (inundation) due to the rise of the sea level relative to the shoreline. Prince Rupert will experience land loss as a result of this phenomenon.

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[6] Environment and Climate Change Canada. Criteria for Public Weather Alerts. 26 July 2010, https://www.canada.ca/en/environment

[7] Ibid.

[8] Defined a threshold for Prince Rupert as the public weather alerts would use a threshold of -35°C for coastal B.C., which is significantly cooler than historical trends, as provided by climatedata.ca.

Framing Adaptation Through Climate Risk Reduction

Canada's National Adaptation Strategy (NAS) provides direction for public organizations to begin exploring how they can manage unavoidable climate changes. For municipalities, the strategy calls for the following action: "By 2030, 80% of public and municipal organizations have factored climate change adaptation into their decision-making processes."[9]

The CRVA is an undertaking to meet this direction. It follows the guidance of leading federal agencies, including Infrastructure Canada's Climate Lens, to assess climate risk for Prince Rupert.[10] The Climate Lens uses a risk management framework to identify, evaluate, and manage climate risks. It provides a foundation for public organizations to understand local climate risk in preparation for developing an adaptation plan.

Understanding Climate Risk

Risk is defined as a function of three key components: the probability of a hazard threat, the vulnerability to the hazard, and the consequence of the hazard (see Figure 2).

Figure 2. Conceptual formula of risk.

[9] Service Canada. National Adaptation Strategy for Canada. 24 Nov. 2022, https://www.canada.ca/en/services/environment/

[10] Infrastructure Canada. Infrastructure Canada - Climate Lens - General Guidance. 28 May 2018, https://www.infrastructure.gc.ca/. Note: Completing a Climate Lens report is not required for this project, although it may be required for projects funded by Infrastructure Canada's funding streams.

The CRVA assesses all three components of risk to develop a risk score for each hazard. The following subsection describes each component in detail with thresholds to determine the level of risk.

Risk Assessment Method

The CRVA uses a risk assessment method aligned with ISO 31000 Risk Management Standard,[11] the standard recommended by the Climate Lens. This CRVA analytical approach expands on the High Level Screening Guide from Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol to include detail from the J-100 Risk and Resilience Management of Water and Wastewater Systems (ANSI/AWWA, 2010).[12] This hybrid method retains as much detail as possible for each component of risk and can be evolved in future iterations to include modelled data.

Hazard Threat Likelihood

The hazard threat likelihood (often simplified to "hazard likelihood") is the probability that an extreme weather event or climate hazard will occur. Hazard likelihoods were measured as part of the Prince Rupert Climate Change Trends and Future Scenarios. To produce that report, historically significant events were reviewed to collect evidence of the severity and frequency of and the key climate drivers for each hazard. The report determined hazard likelihood values for each time horizon for the first time—no previous analysis had established the hazard likelihood for Prince Rupert.

Assessing the hazard likelihood begins with determining the influence of climate change on climate indicators (CI). It is the difference between the future value and the historical value of the CI. For indicators related to temperature measurements, change is measured in degrees Celsius. Many indicators are measured in terms of time (specifically days). These values are converted to weeks to be measured by "timing" thresholds. Precipitation and other non-frequency indicators are calculated as the percentage of change between the future value and historical value.

CI Threat Likelihood = future value - historic value

CI Threat Likelihood (%) = (future value - historic value)/historic value

The change in a climate indicator is given a score on a scale of -0.5 to 0.5 with -0.5 being a very high decrease and 0.5 being a very high increase. Table 2 summarizes the scales used for this assessment.

[11] International Organization for Standardization. ISO 31000 Risk Management. https://www.iso.org/iso-31000

[12] This standard is an American National Standard, as designated by the American National Standards Institute, and falls under the jurisdiction of the American Water Works Association (AWWA).

Table 2. A qualitative analysis of threat probability based on the change of the climate indicator.[13]

Hazard Threat Likelihood Scoring Methodology						
Score	**Definition**	**Temperature Change (°C)**	**Precipitation & Other Non-Frequency Indicators**	**Flooding (elevation, m)**	**Timing (weeks)**	**SPEI[14]**
-5	**Very High Decrease**	-20	-200%	-2.0	-20.0	-2.0
-4	**High Decrease**	-10	-100%	-1.0	-10.0	-1.0
-3	**Moderate Decrease**	-5	-50%	-0.5	-5.0	-0.5
-2	**Low Decrease**	-2	-20%	-0.2	-2.0	-0.2
-1	**Minimal Decrease**	-1	-10%	-0.1	-1.0	-0.1
0	**No Change**	0	0%	0.0	0.0	0.0
1	**Minimal Increase**	1	10%	0.1	1.0	0.1
2	**Low Increase**	2	20%	0.2	2.0	0.2
3	**Moderate Increase**	5	50%	0.5	5.0	0.5
4	**High Increase**	10	100%	1.0	10.0	1.0
5	**Very High Increase**	20	200%	2.0	20.0	2.0

[13] American National Standards. AWWA J100-21 Risk and Resilience Management of Water and Wastewater Systems. 2021, https://engage.awwa.org/PersonifyEbusiness/Bookstore/Product-Details/productId/88116441.

[14] Standardized Precipitation Evapotranspiration Index (SPEI)—Values range from (-5) to +5. The smaller values indicate stronger degrees of drought and larger values indicate higher degrees of moisture.

To assess the hazard threat level, the combination of climate change indicators that drive the hazard threat are grouped. The hazard threat is given a final threat score based on the average of the threat likelihood score for the combined climate change indicators.

$$\textbf{Hazard Threat Likelihood} = (CIScore_1 + CIScore_2 + \ldots CIScore_n)/n$$

The scores are reviewed and adjusted with additional context from subject-matter experts.[15] This final list is ranked from highest threat level to lowest threat level to help prioritize risk reduction measures.

Please refer to the Prince Rupert Climate Change Trends and Future Scenarios Report for the hazard likelihood result for Prince Rupert (Appendix 2).

Measuring Vulnerability

Vulnerability is a qualitative measure of the adaptive capacity, susceptibility, and sensitivity of an asset or group of people to the hazard impact. Table 3 assigns thresholds for each score related to the three components of vulnerability. Vulnerability is scored on a scale of 0.2 to 1.0, with 0.2 being "very low" and 1.0 being "very high."

Adaptive capacity describes **institutional vulnerability** to climate risk. It is defined as the ability of built, natural, human, and social systems to adjust to impacts of climate change. To measure adaptive capacity, the City's capability to address hazards is assessed. Through engagement, the score is validated or adjusted. If a community has a very low adaptive capacity, its institutions lack capabilities to address the hazard and have no planned responses to it. If a community has a very high adaptive capacity, its institutions have a high level of capacity to address the hazard and have planned and tested responses to it.

Susceptibility describes **spatial vulnerability** to a climate risk (the proximity of known hazardous zones or where historical impacts have occurred). These values may be derived from spatial data or subject-matter expertise. If a community has very high susceptibility, the hazard is likely to have severe negative consequences (e.g., it could lead to significant injuries and deaths, significantly damage local roads and homes, cause a blackout, bring businesses to a halt, etc.). If a community has a very low susceptibility, the hazard is likely to have insignificant consequences for the community.

Sensitivity describes **physical vulnerability** to climate hazards (i.e., structural conditions, available resources). These values are derived from asset management and infrastructure plans. If a community has a very high sensitivity, potentially affected infrastructure and systems are in a very high state of disrepair and public resources are overwhelmed. If a community has a very low sensitivity, potentially affected infrastructure and systems are well-maintained and public resources are readily available to respond to the hazard.

[15] In the case where the climate indicator trends decrease the threat likelihood of a hazard, the inverse score of the climate indicator threat likelihood is used. For example, a warming winter average temperature may have a high likelihood score for rapid increasing changes in the temperature, but this indicator will negatively impact the hazard threat likelihood of snow accumulation once values significantly rise above 0°C. The inverse value will be applied to reflect a lower likelihood over time for snow accumulation.

Table 3. Vulnerability scoring criteria.

Score		Susceptibility Is this area likely to be directly impacted without steps to reduce exposure to the hazard?	Sensitivity Is there adequate **preparation** to withstand hazard impacts?	Adaptive Capacity Is there adequate capacity to **respond** to this hazard?
1.0	Very High	• Very high likelihood the threat will translate to identified consequences • Within impact extent • History of impact	• Extensive rebuilding required • Public resources overwhelmed for an extended period of time	• Lack of capabilities to address hazard • Responses not implemented
0.8	High	• High likelihood the threat will translate to identified consequences • Within/adjacent to impact extent • History of impact	• High state of disrepair • Public resources at capacity • Injuries and illnesses overwhelm medical support for a brief period of time	• Low-level capabilities to address hazard • Responses partially implemented or not achieving risk management objectives
0.6	Medium	• Medium likelihood the threat will translate to identified consequences • Adjacent to impact extent • History of impact	• Repairs needed immediately • Public resources at moderate capacity • Injuries and illnesses require sophisticated medical support that does not strain the response capability of the jurisdiction	• Medium-level capabilities to address hazard • Responses implemented and mostly achieving risk management objectives
0.4	Low	• Low likelihood the threat will translate to identified consequences • Adjacent to impact extent	• Minimal repairs needed • Public resources available	• Medium- to high-level capabilities to address hazard • Responses implemented and achieving risk management objectives except in extreme conditions
0.2	Very Low	• Very low likelihood that the threat event (if occurs) will translate to identified consequences (adjacent to impact extent)	• System recently received adequate repairs/ upgrades • Public resources readily available	• High-level capabilities to address hazard • Responses implemented and regularly test for critical risks

Measuring Consequence

Consequence is measured both quantitatively and qualitatively. Consequence is divided into two types of impacts: direct and indirect. Direct consequences refer to tangible impacts (physical damage to structures, injury, environmental degradation, etc.). Indirect consequences refer to intangible impacts such as disruption and delays to typical activity. The direct impacts are scored based on the data related to financial impact, environmental impact, and human health impact. The indirect impacts are scored qualitatively with subject matter expert input about the duration of a disruption. See the table below for consequence scoring criteria.

Table 4. Consequence scoring criteria.

Consequence Scoring Criteria			
Score	**Definition**	**Impacts**	
		Direct	**Indirect**
5.0	**Severe**	• Fatality • Catastrophic environmental impact • Catastrophic financial impacts (> $10M)	Loss of ability to meet business objectives based on severely impacted infrastructure or operations
4.0	**Major**	• Long-term injuries and/or shock • Major environmental impacts • Major financial impacts ($1M–$10M)	Reduced ability to meet business objectives based on major impacts to infrastructure or operations
3.0	**Moderate**	• Short-term injuries and/or shock • Moderate environmental impacts • Moderate financial impacts ($100K–$1M)	Disruption to infrastructure or normal operations
2.0	**Minor**	• Minor injuries • Minor environmental impacts • Minor financial impacts ($10K–$100K)	Minimal impacts to infrastructure or normal operations
1.0	**Limited**	Costs of < $10K	Insignificant impact to infrastructure or operations

Measuring Risk

The final risk scores for each hazard, found in the table below, are a product of vulnerability and consequence scores.

Table 5. Risk classification based on the vulnerability and consequence scores.

Risk Characterization

Consequence	0,2 Very Low	0,4 Low	0,6 Medium	0,8 High	1,00 Very High
5 Severe	1	2	3	4	5
4 Major	0,8	1,6	2,4	3,2	4
3 Moderate	0,6	1,2	1,8	2,4	3
2 Minor	0,4	0,8	1,2	1,6	2
1 Insignificant	0,2	0,4	0,6	0,8	1

Vulnerability

Risk	Insignificant	Minor	Moderate	High	Very High
	0,20 - 0,59	0,60 - 0,99	1,00 - 1,99	2,00 -3,99	4,00 - 5,00

Target Setting

The risk assessment is completed when final risk scores are determined reasonable within the local context (through public engagement feedback and any additional analysis recommended). The next phase of the adaptation plan is target setting for climate risk reduction.

Climate Risks in Prince Rupert

This assessment includes feedback from engagement activities conducted throughout the project. Engagement includes public workshops, an online interactive mapping exercise, focus groups, and revisions of the risk assessment with key stakeholders.

The process began with a preliminary risk assessment involving thorough research on historical hazards and current interventions. The information was collected from news media reporting of events, extreme weather advisories, and policy review (design standards, emergency management planning, etc.). This information was used to develop a preliminary risk score. This score was later refined with information collected during the engagement feedback.

In addition to the risk scores, the list of current interventions (Table 1) was updated to add information and additional interventions identified by interested and affected parties. A list of vulnerable assets, places, and people is compiled as a result of the CRVA. The following sections detail key findings with summary tables presenting the strengths and challenges anticipated when addressing future climate risk.

In cases where gaps are identified, actions will be developed to reduce future climate risk. Planning and prioritization of risk reduction actions will be addressed in the following phase for **Adaptation Actions Development**.

Risk Summary

Top Risks

Climate risks scores are ranked according to the value for both climate pathways: moderate scenario (RCP 4.5) and worst-case scenario (RCP 8.5). The top three risks for the moderate scenario are tsunami, flooding, and high winds. For the worst-case scenario (RCP 8.5), the flooding and high winds values are similar, and the top risks are shuffled to once again include tsunami (risk increases in comparison with the moderate scenario), as well as emerging risks of land loss (relative sea level rise) and ecoregion changes.

Overall, tsunami, land loss, ecoregion changes, severe storm, landslides, wildfire, drought, and freezing rain are anticipated to present an increasing risk over time (see Table 6). The elements of risk for each hazard are inspected in more detail in the following section.

Table 6. Risk scores by hazard for the planning (RCP 4.5) and worst-case (RCP 8.5) scenarios.

Risk Summary	RCP 4.5	RCP 8.5	Trend
Tsunami (seismic and non-seismic)	2.1	2.3	Increasing
Land loss	1.6	2.4	Increasing
Ecoregion changes	1.7	2.0	Increasing
Flooding	1.8	1.8	Similar
High winds	1.8	1.8	Similar
Severe storm/storm surge	1.2	1.8	Increasing
Landslides	1.2	1.6	Increasing
Extreme heat	1.2	1.2	Similar
Wildfire[16]	0.8	1.2	Increasing
Dry weather conditions/drought	0.8	1.2	Increasing
Freezing rain/ice accumulation	0.8	0.9	Increasing
Extreme cold/cold snaps	0.8	0.8	Similar
Snow accumulation	0.8	0.4	Lower

Risk Overview

To help set priorities for adaptation planning, the risk scores were cross-referenced with the Hazard Threat Level Assessment completed in the Climate Change and Future Scenarios Report (see Appendix 1 for the Hazard Summary and Appendix 5 for the report). In the Hazard Threat Level Assessment, hazards are grouped by the time period in which the threat emerges and are listed in order from highest to lowest threat score. Table 7 presents a summary of the hazard threat scores, along with scores for vulnerability and consequence and the final risk score for the moderate scenario.

This overview presents a summary of the key risks and the climate conditions that promote them. The following section provides a detailed assessment of the vulnerability and consequence levels for each hazard.

[16] Prince Rupert is located on Kaien Island. The water surrounding the island is a natural break from wildfire spread occurring in adjacent areas. The concern about wildfire for Prince Rupert is more related to air quality from fires occurring nearby and wildfire spread on the island.

Table 7. Ranking of near-, mid-, and long-term climate risks for Prince Rupert. Climate risks are grouped by the time period when the hazard threat emerges as a significant threat and then ranked from highest to lowest risk for each time horizon.

RCP 4.5 Summary		Hazard Threat	Vulnerability	Consequence	Risk	Ranking
Near-term risks	High winds	0.7	0.6	3.0	**1.8**	1
	Ecoregion changes	1.6	0.7	2.5	**1.7**	2
	Severe storm/storm surges	1.3	0.7	2.0	**1.3**	3
	Wildfire*	1.3	0.3	2.5	**0.8**	4
Mid-term risks	Flooding	0.8	0.6	3.0	**1.8**	5
	Landslides	0.9	0.5	2.5	**1.2**	6
	Freezing rain/ice accumulation	0.9	0.4	2.0	**0.8**	7
	Extreme heat	0.8	0.5	1.5	**0.8**	8
Long-term risks	Tsunami (seismic and non-seismic)	2.0	0.5	4.5	**2.1**	9
	Land loss	2.0	0.5	3.0	**1.6**	10
	Dry weather conditions/ droughts	0.0	0.3	2.5	**0.8**	11
Diminishing risks	Extreme cold/cold snaps	0.4	0.4	2.0	**0.8**	13
	Snow accumulation	0.6	0.3	1.5	**0.5**	12

Notably, tsunamis—the top risk—present a high threat to the community but occur infrequently with a high chance that such an event would not directly impact Prince Rupert, a sheltered island. Additionally, land loss due to sea level rise occurs on a long timeframe (decades), which reduces the urgency to address this hazard immediately (although this assessment offers useful insight for infrastructure and other long-term planning). At this time, commercial and residential areas are set back from low shoreline elevation.

High winds pose the most immediate risk given that these events have a history of occurrence and are expected annually. The influence of climate change on high winds is minimal, but the overall impact to the community is high. Ecoregion changes are an emerging hazard, which will result in changes to the survival of native flora and fauna. This hazard was further explored in engagement (Appendix 4) to understand the capacity of each sector to address ecoregion change and compile the information related to key native and non-native species to monitor. Severe storms and wildfires are risks emerging as soon as the near-term future. An increase in the severity and/or frequency of these events is anticipated. Severe storms have a history in Prince Rupert, and the amount of water a single storm may produce is anticipated to increase. More exploration is needed to determine the potential for wildfires on Kaien Island, an area with a large amount of fire fuel from coastal peat deposits. In addition to local wildfires, wildfires occurring elsewhere are a concern due to the potential for fire smoke to travel to Prince Rupert by wind.

By the mid-term future, the effects of winter warming are more pronounced, making rainfall more likely than snowfall during precipitation events. During colder months, this increases the risk of flooding (heavy rainfall and saturated soils), and the risk of landslides emerge in this period (winter rainfall and freeze/thaw cycles contribute to unstable terrain). Extreme heat events may start to emerge in this period, and the frequency and severity of extreme heat will increase into the long-term future.

In the long-term future, the full effects of climate change are noticeable along the shoreline due to sea level rise. Both sea level rise and tsunamis pose risks to marine infrastructure and port facilities. Warming patterns in the long term further exacerbate ecoregion changes and increase the risk of extreme heat, wildfires, and severe storms.

Although the region will see no shortage of precipitation in the long term, the freshwater balance in the local water supply (primarily Shawatlan Lake) may be disrupted as snow and ice melt. Snowpack and glacial water sources will diminish as snow and ice accumulation become less likely. In addition, seasonal temperatures become warmer, increasing the likelihood of dry periods.

The following section, Emerging Vulnerabilities and Impacts, dives deeper into the shocks and stresses on key sectors of the community for each climate hazard.

Emerging Vulnerabilities and Impacts

This investigation thoroughly examines components of vulnerability to identify gaps in Prince Rupert's current adaptive capacity.

Top Vulnerabilities

As shown in Table 7, the top vulnerabilities for Prince Rupert are ecoregion changes (High, 0.7) and severe storms/storm surges (High, 0.7). Ecoregion changes are driven by larger global climate patterns (seasonal warming and ocean acidification) that disrupt local biodiversity (hibernation, migration, growing period, invasive species).

Prince Rupert's vulnerability to extreme storms is driven by the low adaptive capacity of the built environment. A significant amount of stormwater infrastructure is in need of repair, while many homes need repairs and upgrades to drainage and roofing, making severe storms an urgent issue.

Six hazards are classified as a "medium" threshold vulnerability. These include:

1. Flooding (Medium, 0.6)
2. High winds (Medium, 0.6)
3. Extreme heat (Medium, 0.5)
4. Landslides (Medium, 0.5)
5. Land loss (Medium, 0.5)
6. Tsunami (Medium, 0.5)

The following section expands on the rationale for the vulnerability scores and identifies sectors and elements of sectors with the highest vulnerability. Tables 9–13 identify the strengths (adaptive capacity) and weaknesses (sensitivity and susceptibility to hazards) .

Through this assessment, vulnerabilities were found to be similar for hazards belonging to one of the following four themes:

1. **Wetter weather conditions:** Hazards with a strong link to precipitation events.
2. **Wilder climate conditions:** Hazards with strong links to global climate phenomena.
3. **Warmer weather conditions:** Hazards with a strong link to warmer temperatures.
4. **Combination of weather conditions:** Hazards with links to temperature and precipitation changes.

The table below illustrates the hazards that fall into each of the themes.

Table 8. Climate hazards in Prince Rupert by theme.

	Description	Hazards
Wetter weather conditions	Hazards with strong links to precipitation events	• Severe storms/storms surges • Ice accumulation/freezing rain • Snow accumulation • Flooding
Wilder climate condition	Hazards with strong links to global climate phenomena	• Extreme cold/cold snaps • High winds • Tsunami (seismic and non-seismic) • Land loss (relative sea level rise)
Warmer weather conditions	Hazards with a strong link to warmer temperatures	• Extreme heat/heat waves • Ecoregion changes
Combination of weather conditions	Hazards with links to temperature and precipitation changes	• Dry weather conditions/drought • Wildfire • Landslides

By grouping the hazards by common vulnerabilities, Prince Rupert can use vulnerability mapping (Table 14) as a tool to develop actions for the CAAP that address several needs at once.

Wet Weather Conditions

Severe storms/storm surges	Ice accumulation/freezing rain	Snow accumulation	Flooding

Severe Storms and Flooding

In Prince Rupert, hazards related to precipitation events include storms, ice/snow accumulation (i.e., as a result of snowstorms and blizzards), and flooding. As a whole, these hazards create poor travel conditions and impede the movements of goods and people. Storms and floods increase the risk of road blockages until water/ice/snow or debris is removed. This risk is particularly pronounced for Prince Rupert because Kaien Island has limited access points (rail, bridges, ports) to surrounding communities. In particular, the Yellowhead Highway (Highway 16) is the only major roadway in and out of Prince Rupert via the Galloway Rapids Bridge. This connection is mutual, whereby if Prince Rupert is disconnected, surrounding communities dependent on Prince Rupert are also cut off from basic necessities. Precipitation events also decrease travel safety by making

roads more slippery and reducing visibility. Tourism may be affected due to road diversions and delays and disruptions to scheduled flights, ferries, and cruise ships. Economic activity reliant on import and export of goods may be disrupted due to uncertainty of marine activity (risky travel conditions).

Prince Rupert's Infrastructure Replacement Strategy (2023) identifies an ongoing concern with stormwater management during wet weather conditions. A portion of sewer infrastructure still requires stormwater separation. Additionally, 33% of the current stormwater infrastructure has reached its service life and is in need of replacement or repair.[17] Precipitation has already increased in Prince Rupert, and moving forward, the stormwater infrastructure will be expected to handle a higher volume of water from wet weather events. For example, the five-day maximum total precipitation increases 15 mm (8% increase) in the near term and 31 mm (17% increase) in the long term.[18] To manage future risk, Prince Rupert must explore infrastructure options to increase the stormwater volume capacity.

Severe Storm and Storm Surge Summary		
Hazard Threat	Low (1.2)	Events are anticipated to be similar to historic trends, where small increases in frequency and severity will be seen as soon as the near-term future. Changes to precipitation indicators are all less than 20%. Relative sea level rise increases less than 20%.
Vulnerability	High (0.7)	Extent of impact affects the entire community. Residential structures may require repair to withstand future events. Reduced safety for all modes of travel and personnel working outdoors.
Consequence	Low (2.0)	Overall impact requires a few days of recovery for at-risk stormwater lines.
Risk	Medium (1.8)	Overall risk score reflects the state of repair for stormwater infrastructure, capacity to repair residential structures, and travel disruptions.

Flooding Summary		
Hazard Threat	Very Low (0.8)	Events are anticipated to be similar to historic trends, where very small increases in frequency and severity will be seen in the mid-term future. Changes to precipitation indicators are all less than 20%.

[17] Urban Systems and City of Prince Rupert. Infrastructure Replacement Strategy. 31 Jan. 2023, p. 6 of 51., Table 2 Summary of Infrastructure Backlog

[18] See the Future Climate and Scenarios Analysis for further information about how precipitation is changing.

Flooding Summary			
Vulnerability		Medium (0.6)	Extent of impact is site-specific. The community has identified the beaches, Water Street, and Hays Creek as areas prone to flooding. Low-lying areas and hard surfaces with low permeability near rivers are also identified as areas of concern.
Consequence		Medium (3.0)	River flooding of the Skeena River (upstream of the city boundary) may result in major railway and highway disruptions requiring days or weeks to resume normal operation. Overland (pluvial) flooding may result in diversion of traffic away from high- velocity floodwater.
Risk		Medium (1.3)	Overall risk score reflects the susceptibility to economic disruption from flooding occurring outside the city boundary (along Highway 16 and railway), sensitivity of low-lying hard surfaces near creeks, and the velocity of floodwater.

Snow and Ice Accumulation

Although snow and ice accumulation can occur any time between October and April, the total maximum accumulation period is between three and four weeks. Although this is a relatively short accumulation period compared to that of other Canadian cities, it can pose a risk for residents who are physically unable to clear residential paths. Members of the Project Advisory Committee noted that neighbours support one another to clear walkways and pedestrian paths. Such informal efforts can be scaled up to address the needs of vulnerable populations across the municipality.

Snow Accumulation Summary			
Hazard Threat		Very Low (0.6)	Little to no changes to severity and frequency compared to historic events.
Vulnerability		Low (0.3)	Extent of impact affects the entire community. A vulnerable population is identified for snow clearing as well as neighbourhoods that are not adequately cleared.
Consequence		Low (1.5)	Overall impact requires a few days of recovery as the density of snow may cause physical damage to at-risk water mains and/or greenhouses.
Risk		Very Low (0.5)	Overall risk score reflects structures' sensitivity to dense snow and the capacity to clear snow community-wide.

Freezing Rain and Ice Accumulation Summary			
Hazard Threat		Very Low (0.9)	Little changes to severity and frequency compared to historic events anticipated in the mid-term future and beyond.
Vulnerability		Low (0.4)	Extent of impact affects the entire community. No historical record of the event, but the response would be similar to snow accumulation.
Consequence		Low (2.0)	Overall impact requires a few days of recovery as ice may cause physical damage to at-risk water mains. De-icing and debris removal are required for transportation routes to prevent significant disruptions.
Risk		Low (0.8)	Overall risk score reflects structures' sensitivity to ice damage and the capacity to quickly remove ice from critical infrastructure (with a priority to roadways).

Summary of Wet Weather Vulnerability

The table below summarizes the strengths and weaknesses in addressing vulnerability during wetter weather conditions in Prince Rupert.

Table 9. Prince Rupert's strengths and weaknesses in addressing vulnerability during wetter weather conditions.

Sector	Strengths	Weaknesses
Community	• Social capacity among neighbours to clear residential snow accumulation	• Additional interventions needed to weather-proof homes with unfinished basements • Low visibility for pedestrians and drivers during storms • Residents unable to clear snow from property
Environment	• Small amount of snowfall annually • This region is adapted to dealing with precipitation	
Municipal assets and services	• Snow and Ice Control Policy (2003) ensures transportation routes are accessible during adverse winter weather	• Seasonal clogging of storm drainage due to debris and snow

Sector	Strengths	Weaknesses
Critical infrastructure	• The City's Infrastructure Replacement Strategy (2023) identifies vulnerable assets • Stormwater Management Bylaw oversees the stormwater separation still required in some areas	• Thirty-three percent of stormwater infrastructure is beyond service life, which increases vulnerability to local storms • Transportation blockages/closures • Decreased safety for marine transportation • Potential impacts from landslide events (?) • Downing powerlines • Telecommunications disruptions
Economy		• Travel delays • Logistics delays

Wilder Climate Conditions

Extreme cold/cold snaps	High winds	Tsunami (seismic/non-seismic)	Land loss (sea level rise)

Prince Rupert is projected to experience wilder climate conditions related to hazards shaped by global atmospheric patterns, including extreme cold/cold snaps, high winds, tsunamis, and land loss (relative sea level rise). While these events have relatively little in common with each other, there are a few smaller risk linkages within this grouping of hazards.

Extreme Cold and Cold Snaps

Although annual and seasonal temperatures show a warming trend over time, periods of extreme cold may occur due to the disrupted polar jetstream,[19] which will bring frigid arctic air to mid-latitudes. Cold snaps during periods where the ground is wet may result in ice accumulation, causing slippery conditions. Heavy ice accumulation could cause water main breaks by putting pressure on pipes below the surface. This is of great concern for Prince Rupert as 19% of water mains are considered at high to very high risk of condition-based failure based on a review of asset age and break data.[20] The Public Works Department has an emergency response team and local contractors that have provided standby support to respond to water main breaks during cold snaps.

[19] Lindsey, Rebecca. "Understanding the Arctic Polar Vortex." National Oceanic and Atmospheric Administration (NOAA), http://www.climate.gov/news-features/understanding-climate/understanding-arctic-polar-vortex.
[20] Urban Systems and City of Prince Rupert. Infrastructure Replacement Strategy. 31 Jan. 2023

During cold weather, high winds create a "wind chill factor"[21] that makes the day feel colder. To minimize the risk of frostbite, people must minimize their exposure to extreme cold exacerbated by wind chill.[22] Unhoused individuals face the highest risk, and shelter centres may lack the capacity to meet the increased demand for services during cold snaps. Additionally, broken tree limbs (due to high winds) near power lines could cause power outages during cold periods, when heating demand is high. This is mitigated by the community generator run by BC Hydro, which provides back-up power during outages.[23]

Extreme Cold and Cold Snaps Summary			
Hazard threat		Very Low (0.4)	Little changes to severity and frequency compared to historic events. By the long-term future, events become less likely to occur.
Vulnerability		Low (0.4)	Extent of impact affects the entire community. Unhoused populations face the risk of exposure without adequate shelter. Reduced safety for personnel working outdoors.
Consequence		Low (2.0)	Overall impact requires a few days recovery as ice may cause physical damage to at-risk water mains.
Risk		Very Low (0.5)	Overall risk score reflects the capacity to address the unhoused population and the sensitivity of at-risk water mains.

High Winds

Like severe storms, high winds produce adverse travel conditions and safety concerns. High winds may break tree limbs, which can impede pedestrian and vehicle paths and damage power lines, buildings, telecommunication towers, roads, and other paths (e.g., walking trails). High winds also present risks for air and ship travel and cause travel delays. There are emerging concerns regarding fire management related to the relationship between high winds and wildfire, as windy conditions may promote the spread of wildfire events. This relationship will be explored further in the risk assessment for wildfire.

High Winds Summary			
Hazard Threat		Very Low (0.7)	Little to no changes to severity and frequency compared to historic events across all time horizons.

[21] Wind chill factor is described as the resultant human sensation felt by the cooling effect of wind blowing on a surface. Environment and Climate Change Canada (ECCC). Wind Chill Index. https://www.canada.ca/en/environment.

[22] Ibid.

[23] The 46 MW Prince Rupert Generating Station is primarily intended to provide short-term energy during transmission interruptions in this area; it is also permitted to operate 300 days a year using natural gas as the primary fuel source. BC Hydro Power Smart. Thermal Generation - Alternative Energy Sources. https://www.bchydro.com/energy-in-bc/operations/thermal

High Winds Summary			
Vulnerability		Medium (0.6)	Extent of impact affects the entire community. Reduced safety for all modes of travel and for personnel working outdoors.
Consequence		Medium (3.0)	Overall impact could require days or weeks of recovery for debris removal (downed trees causing disruptions to roads or damaging power lines). Disruption to economic activity due to transportation delays.
Risk		Medium (1.2)	Opportunity to reduce risk by exploring building retrofits specifically for high winds (reinforcing entries, roof inspections, anchoring loose connections, storm shutters, etc.).

Tsunami

Prince Rupert's Tsunami Risk Assessment[24] uses a 1-m increase in sea level to project long-term future risks from tsunamis. Although a tsunami event poses catastrophic risks for Prince Rupert, the likelihood of a tsunami affecting a sheltered island is low. In preparation for these events, the City has an emergency alert service to contact home phones, cell phones, and emails. Emergency personnel are deployed to low-lying areas with megaphones to evacuate the few residential areas at risk. Emergency planning would also consider evacuation plans, warning signs, and sirens. Restrictions are already in place for houseboats where wave velocity is known to be high.

As the sea level rises, the height of tsunamis will also rise(producing a 1-m higher wave in future events); however, the increased height will have a minimal impact on the consequences of tsunamis.[25]

Tsunami Summary			
Hazard threat		Low (2.0)	Small changes to severity and frequency compared to historic events may be noticed in the long-term future (height of wave due to relative sea level rise).
Vulnerability		Medium (0.5)	Extent of impact is site-specific and dependent on the proximity to the wave. Houseboats restricted from high wave velocity areas (like Fern Passage).

[24] City of Prince Rupert. Tsunami Emergency Preparedness. https://engage.princerupert.ca/7939/

[25] From the City of Prince Rupert Tsunami Risk Assessment: "The results show that the addition of 1m on sea level does not significantly impact the overall tsunami wave characteristic in the Prince Rupert region." Where current risks indicate that "Marine infrastructure and port facilities are the most exposed areas under seismic-generated tsunami scenarios."

Tsunami Summary			
Consequence		Very High (4.5)	Kaien Island is sheltered, and severe consequences are unlikely. Overall impact requires months of recovery, as the majority of industry is near the shoreline. Residential areas are largely unexposed to the direct impacts.
Risk		High (2.1)	Overall risk score reflects the primary functions of the community taking place near the shoreline (ports, downtown, road network) and the severity of impact.

Land Loss Due to Relative Sea Level Rise

Although the Prince Rupert shoreline will be impacted by relative sea level rise,[26] the changes are not anticipated to be dramatic. The projections (Figure 3) are a useful tool for planning shoreline infrastructure and marine transportation to withstand the impacts of the anticipated sea level. In addition to its influence on tsunamis, sea level rise can compound the impact of storm surge events along the coastline, increasing risk for coastal structures. A recommendation from the Tsunami Risk Assessment would be for the City to conduct a Sea Level Rise Policy to map sea level rise and restrict growth or require adaptive interventions in these areas to reduce future risk.

From an aquatic biodiversity perspective, sea level rise may negatively impact shallow aquatic plants in salt marshes, key breeding grounds for fish.[27] The Seal Cove Salt Marsh was recently restored by a joint project between the City and the Prince Rupert Port Authority to reduce environmental impact by developing the Fairview-Ridley Connector Corridor.[28] The project included regrading the intertidal areas and transplanting underwater plants (i.e., eelgrass) for aquatic habitats. An existing creek was restored, with additional shoreline vegetation added to develop more places for birds and other wildlife to forage, breed, and nest.[29]

[26] Relative Sea Level Change is the change in ocean level relative to land. Whereas global sea level change can be attributed to thermal expansion of water and meltwater from glaciers, ice caps, and ice sheets, relative sea level change is the combination of the effects from global sea level change and the vertical motion of the land.

[27] Eyquem, J., and Intact Centre on Climate Adaptation,. Rising Seas and Shifting Sands: Combining Natural and Grey Infrastructure to Protect Canada's Communities. University of Waterloo, https://www.intactcentreclimateadaptation.ca/wp-content/uploads/

[28] Prince Rupert Port Authority. Prince Rupert Port Authority Celebrates Completion of Seal Cove Salt Marsh Restoration Project. 27 Apr. 2022, https://www.rupertport.com/prince-rupert-port-authority-celebrates-completion-of-seal-cove-salt-marsh

[29] Millar, Kimberley. "Seal Cove Salt Marsh Opens with $4 Million Prince Rupert Port Authority Investment." The Northern View, 28 Apr. 2022, https://www.thenorthernview.com/news/seal-cove-salt-marsh-opens-with-4-million-prince-rupert-port-authority

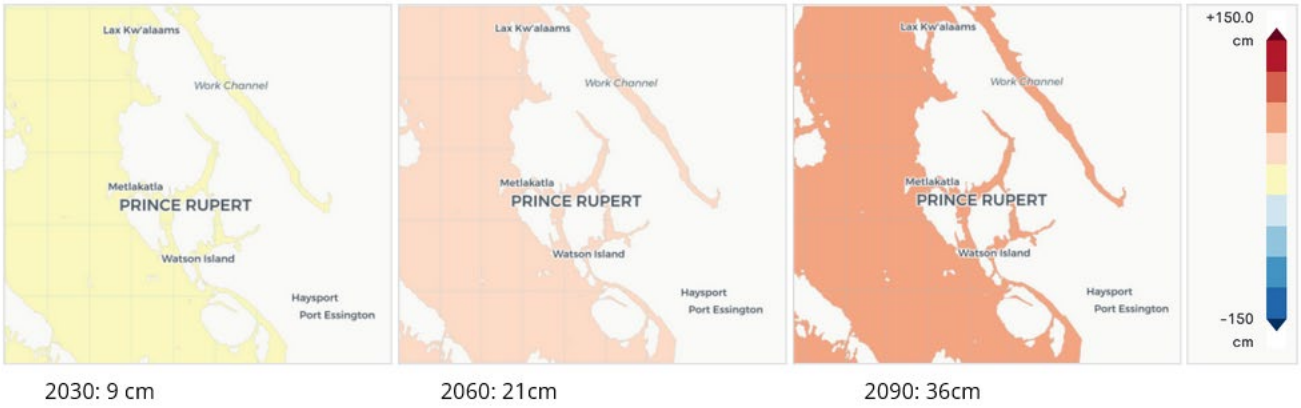

Figure 3. Relative sea level rise for RCP 4.5 for the three time horizons. (Source: climatedata.ca[30]).

The cascading impacts of sea level rise and other ocean impacts on aquatic life are explored in the Ecoregion Changes section.

Land Loss (Relative Sea Level Rise) Summary			
Hazard threat		Low (2.0)	Small changes to severity and frequency compared to historic events. Changes will be noticeable in the long-term future.
Vulnerability		Medium (0.5)	Extent of impact is site-specific and limited to shoreline areas.
Consequence		Medium (3.0)	Impact occurs gradually over time and requires planning for recovery.
Risk		Medium (1.7)	Overall risk score reflects the extent of impact to shoreline areas, with major economic functions for the community.

[30] James, T.S., Robin, C., Henton, J.A., and Craymer, M., 2021. Relative sea-level projections for Canada based on the IPCC Fifth Assessment Report and the NAD83v70VG national crustal velocity model; Geological Survey of Canada, https://doi.org/10.4095/327878

Summary of Wilder Climate Vulnerability

The table below summarizes the strengths and weaknesses in addressing vulnerability during wilder weather conditions in Prince Rupert.

Table 10. Prince Rupert's strengths and weaknesses in addressing vulnerability during wilder weather conditions.

Sector	Strengths	Weaknesses
Community	• Houseboats are restricted in high wave velocity areas	• Exposure to frostbite during extreme cold events for unhoused population and personnel working outdoors • Industry near the shoreline
Environment	• Kaien Island is sheltered from direct impacts of tsunamis • Restoration of Seal Cove Salt Marsh	• Broken tree limbs during high wind events
Municipal assets and services	• Tsunami Flood Risk Assessment • Tsunami evacuation signs and plans • Emergency Alerts • Coast Guard	• Need designated shelters for high wind events
Critical infrastructure	• Emergency Response Team for water main breaks during cold snaps	• Water main breaks during cold snaps • Increased heating demand during extreme cold events • Transportation blockages/ closures • Power outages • High winds moving cargo ships (anchor-dragging events, lost cargo)
Economy		• Travel delays • Logistics delays

Warming Weather Conditions

Extreme heat/heat waves	Ecoregion changes

In Prince Rupert, hazards related to warm weather and climate include heat waves and ecoregion changes. Data on the hottest days of the year was reviewed to determine the extent to which the temperature may exceed conditions comfortable for human health.[31] Ecoregion changes focus on the incremental warming that occurs seasonally and has implications for the local ecosystem.

Extreme Heat and Heat Waves

Prince Rupert is experiencing warmer temperatures relative to its historical patterns. Heat stress is a common risk for humans, plants, and animals during heat waves. Over all future periods, only one to two days of extreme heat (over 28°C) are expected annually. However, the humidex days over 30 (days that feel like 30°C) may add two additional days annually in the near-term and mid-term future and one to three weeks in the long-term future. Additionally, advisory committee members raised the concern that humidity could encourage mold growth in older buildings. Currently, few local buildings have air conditioning systems that could reduce the risk of heat stress and mold growth. Given the temperate climate, the warming weather risk is limited to the long-term future. Warm weather and/or increased humidity may encourage more people to improve cooling systems, increasing energy demand for cooling. To align with climate mitigation efforts, cooling systems should consider renewable energy sources to reduce energy consumption and greenhouse gas emissions.

Extreme Heat Summary			
Hazard threat		Very Low (0.8)	Future severe temperatures are 20% warmer and more frequent than historical severe temperature events, but remain under values considered threatening to human health and wellness. Changes noticeable in the long-term future.
Vulnerability		Medium (0.5)	Extent of impact affects the entire community. Populations vulnerable to heat stress may require assistance. Personnel working outdoors and the unhoused population are directly exposed.
Consequence		Low (0.5)	Impact requires a few hours recovery to provide support for exposed communities or residents prone to heat stress.

[31] According to Public Safety Canada, heat alerts for Prince Rupert are sent when the temperature exceeds 28°C for two or more days. Environment and Climate Change Canada. Criteria for Public Weather Alerts. 26 July 2010, https://www.canada.ca/en/environment-climate-change/services/types-weather.

Extreme Heat Summary			
Risk		Medium (1.8)	Overall risk score reflects the exposure to heat and long-term risk to energy demand due to increased cooling.

Ecoregion Changes

While ecoregion changes are subtle, they are expected to impact local food supply and tourism in Prince Rupert. As seasonal temperatures warm and the number of frost days decreases, native flora and fauna patterns will be out of sync with the environmental conditions (i.e., feeding, reproduction, and hibernation patterns will be impacted).[32] Consequently, non-native species may thrive and compete with native species. Table 11 identifies invasive species to watch for in Prince Rupert as the ecoregion climate shifts.

Table 11. Identified invasive species.

Identified Invasive Species	Identified by the Port Authority: Didemnum Vexillum, European Green Crab Identified by City of Prince Rupert: Knotweed Identified in engagement: Starfish

On land, animals are shifting their migratory patterns. Some animals may migrate further north, creating the potential for an increase in interactions between humans and wildlife on trails (wolf interactions). Common pests (e.g., cucumber beetle) that damage crops may become more common as the climate warms. Currently, no formal urban gardens are maintained in Prince Rupert. Local food practices are foraging, informal food production (crops grown and harvested among friends and neighbours), and fishing. Table 12 identifies potential local food sources within Prince Rupert.

Table 12. Potential local food sources for Prince Rupert.[33]

Terrestrial Food Stock	Beans, beets, broccoli, brussel sprouts, cabbage, carrots, cauliflower, corn, cucumber, kale, lettuce, onions, peas, peppers, spinach, squash, tomato, chanterelles mushrooms, salmonberries, huckleberries, soapberries, soapberries, fiddleheads, deer, moose, bear.
Aquatic Food Stock	Five salmon species (Chinook, Sockeye, Coho, Chum, Pink), sea asparagus, seaweed, shellfish, crab, prawns, halibut, snapper, tuna, eulachon, herring, octopus, seal, sea lion.[34]

[32] Bolen, Anne. "Witnessing Wildlife and Climate Out of Sync." The National Wildlife Federation (NWF), 17 Mar. 2017, https://blog.nwf.org/2017/03/witnessing-wildlife-and-climate-out-of-sync/.
[33] Prince Rupert. Official Community Plan. https://www.princerupert.ca/building-development/official-community-plan.
[34] Bear, seal, and sea lion are less consumed than other identified local food stocks.

Revitalizing commercial fishing and aquaculture is of interest for food security, as sea level rise[35] and changes to ocean surface temperature[36] may disrupt the aquatic food chain. The Prince Rupert shoreline features salt marshes. Sea level rise may kill shoreline vegetation (i.e., eelgrass and kelp) due to too much sediment from deposition and/or drowning with no air during low tide. Aquatic species that live and breed near the shoreline rely on this shallow vegetation for habitat and breeding grounds.[37]

In a focus group on ecoregion changes, one participant highlighted that growing kelp and shellfish has become more difficult due to increasing algal blooms and diatoms linked to warmer waters. In freshwater systems (rivers and creeks), algal blooms decrease the ability of salmon, an important local species, to survive. Figures 4–6, provided by Fisheries and Oceans Canada, illustrate the key species in the aquatic food chain and how they are disrupted by the influences of climate change.

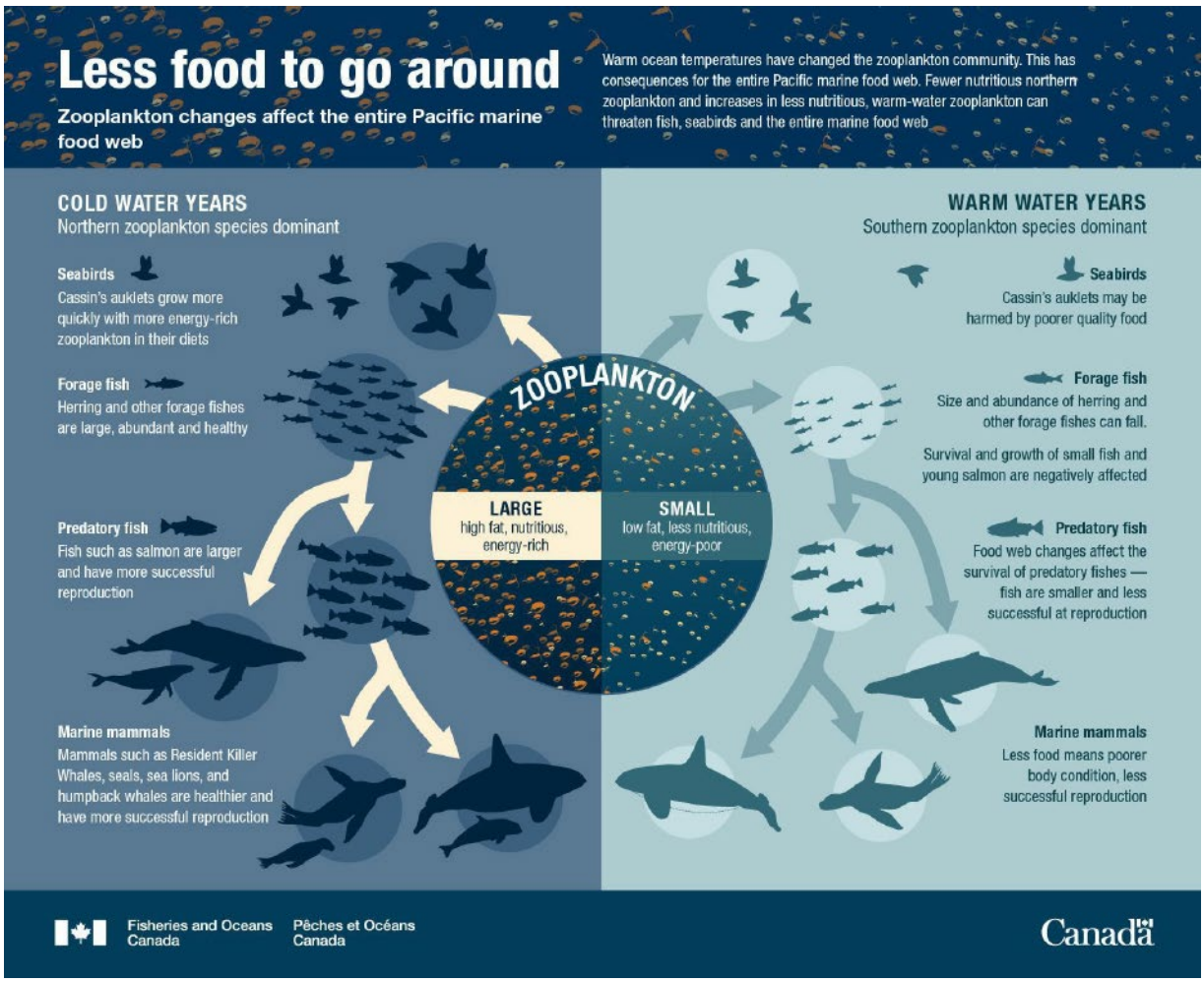

Figure 4. Pacific aquatic food chain (Source: Fisheries and Oceans Canada).

[35] Eyquem, J., and Intact Centre on Climate Adaptation,. Rising Seas and Shifting Sands: Combining Natural and Grey Infrastructure to Protect Canada's Communities. University of Waterloo, https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2021/

[36] Fisheries and Oceans Canada. Canada's Oceans Now: Pacific Ecosystems, 2021. 9 June 2022, https://www.dfo-mpo.gc.ca/oceans/

[37] Ibid.

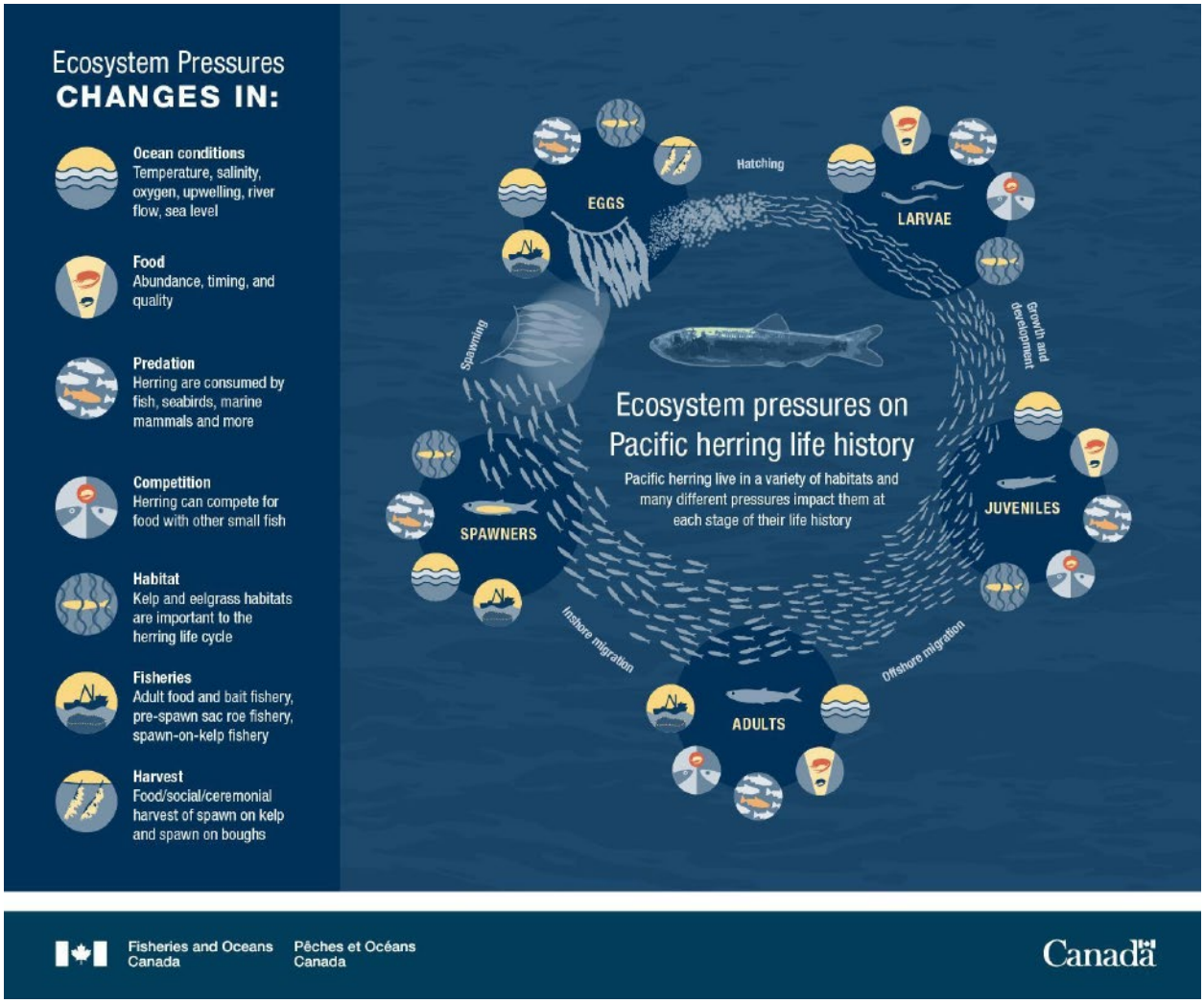

Figure 5. Climate change impacts on Pacific herring (Source: Fisheries and Oceans Canada).

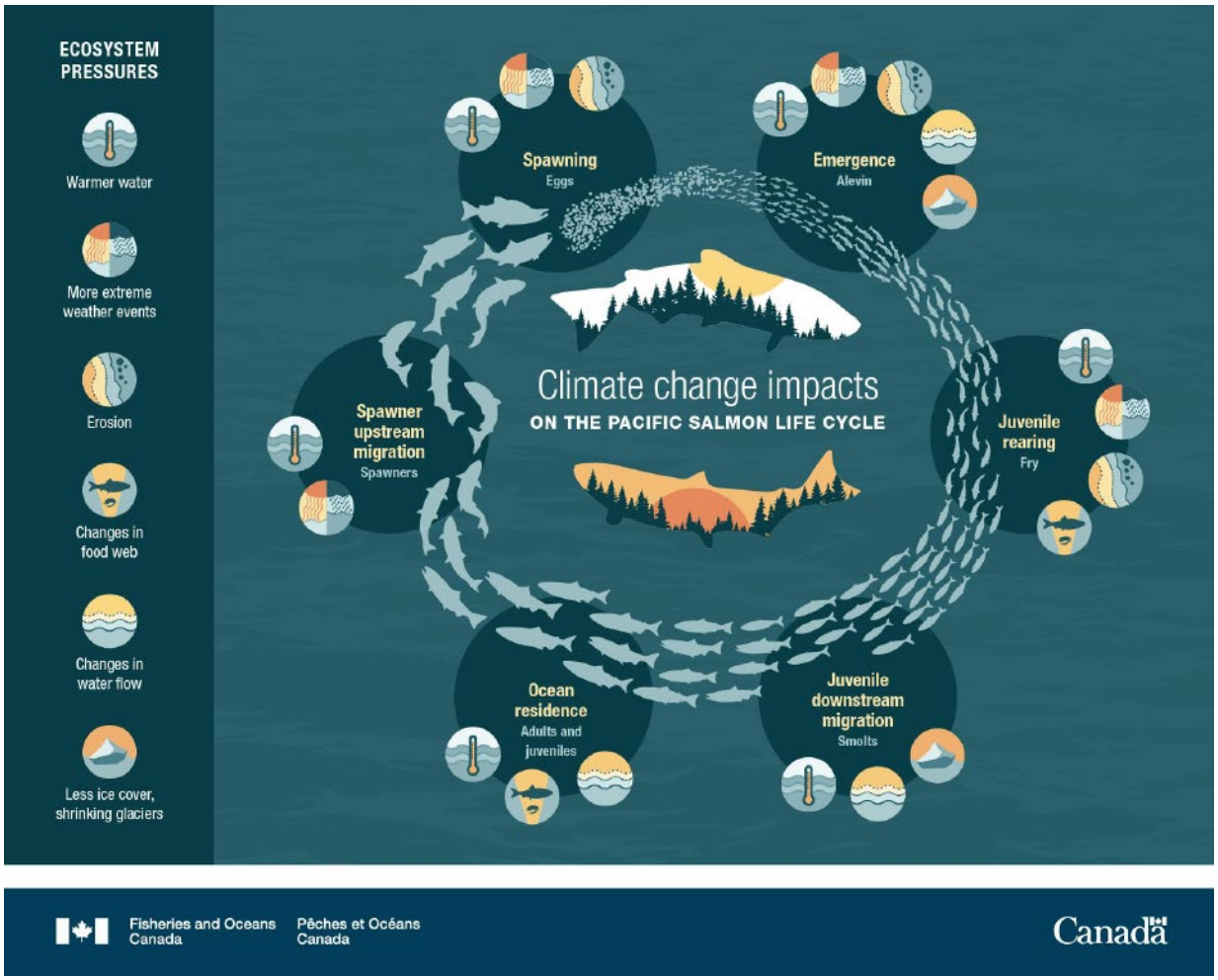

Figure 6. Climate change impacts on Pacific salmon (Source: Fisheries and Oceans Canada).

Ecoregion Changes Summary			
Hazard threat		Medium (2.3)	Changes to seasonal temperatures, precipitation, and global water composition. Significant changes to temperature indicators (rise over 20%) from historic trends emerge in the near-term future and beyond.
Vulnerability		High (0.7)	A wide variety of species (land, freshwater, saltwater) to consider vulnerabilities to seasonal changes.
Consequence		Medium (2.5)	Environmental changes are linked to potential economic impact to local food supply, commercial fishing, and tourism industry. Overall impact requires weeks to months of recovery.
Risk		High (2.1)	Overall risk score reflects the number of species monitored (native and non-native), quality of local food supply, and the industries impacted by the change in these species.

Summary of Warming Weather Vulnerabilities

The table below summarizes the strengths and weaknesses in addressing vulnerability during warming weather conditions in Prince Rupert.

Table 13. Prince Rupert's strengths and weaknesses in addressing vulnerability to warming weather conditions.

Sector	Strengths	Weaknesses
Community	• Existing tree canopy (mostly undeveloped areas) • Northern cities have a lower threat of vectors carrying disease[38]	• Mold growth in older buildings • Heat stress • Need for cooling in buildings • Demand for cooling and shading structures • Need for additional tree canopy in urban areas
Environment	• The Official Community Plan calls for protecting biodiversity through the Environmentally Sensitive Lands Policy,[39] whereby development is restricted by near intertidal marshes, streams, riparian areas, and other lands • Warming presents longer growing season	• Heat events were historically uncommon; hot weather is unfamiliar • Introduction of non-native species • Biodiversity loss (large aquatic fauna) • Algae blooms in freshwater decreases the survivability of aquatic species (salmon) • Out of sync biological patterns (aquatic species, hummingbirds)
Municipal assets and services	• The City upgraded the water supply dam and plans to upgrade the water treatment facility[40]	• Increased likelihood of Giardia, Cryptosporidium[41,42] in the water supply, leading to a need for more treatment to clean the water)

[38] Lyme disease—the primary concern for Prince Rupert's latitude—is unlikely to spread to Prince Rupert. Source: BC Centre for Disease Control. Lyme Risk Areas in BC. https://maps.bccdc.ca/Lyme/

[39] Prince Rupert. Official Community Plan. Page 47, https://www.princerupert.ca/building-development/. Environmentally Significant Lands policy calls for the preservation of Intertidal marshes, streams, riparian areas and other environmentally sensitive lands.

[40] Millar, Kimberley. "It's Dam Time in Prince Rupert with Woodworth Lake Water Conversion." Terrace Standard, https://www.terracestandard.com/news/its-dam-time-in-prince-rupert-with-woodworth-lake-water-conversion

[41] Lough, Shannon, and Nick Laws. "Microscopic Parasite Found in Prince Rupert Water Affecting Thousands." Castlegar News, 16 Dec. 2018, https://www.castlegarnews.com/news/microscopic-parasite-found-in-prince-rupert

[42] Prince Rupert. Watershed Report. https://engage.princerupert.ca/7910/widgets/29770/documents/

Sector	Strengths	Weaknesses
Critical infrastructure	• Invasive species management at ports (Didemnum Vexillum, European Green Crab)[43]	
Economy		• Lower terrestrial food stock due to pest infestation and/or heat stress • Lower aquatic food stock due to warm water and sea level rise disrupting the food chain • Uncertainty for eco-attractions due to animal behavioural changes in response to climate changes (deer, grizzly bears, wolves, orcas and humpback whales) • Cultural spaces are compromised where losses to flora are significant

Combination of Weather Conditions

Dry weather conditions/drought	Wildfire	Landslides

In Prince Rupert, hazards that are caused by a combination of temperature and precipitation events include droughts, wildfires, and landslides.

Dry Weather and Drought

Droughts are typically associated with long periods with no precipitation. These events are uncommon in Prince Rupert and have little likelihood of occurring in the future. When they do occur, droughts could contribute to flooding and wildfires. If a severe storm occurs after a significant dry period, soils may be too dry to actively absorb rainfall, increasing the likelihood of flooding. Droughts also contribute to the spread of wildfires by drying out forested areas that fuel fire with dry wood fibres.[44] Although droughts are highly unlikely, droughts would cause water stress to forested areas and crops and potentially affect future lake levels (rainfall recharge and snowmelt).

[43] Prince Rupert Port Authority. Aquatic Invasive Species. https://www.rupertport.com/aquatic-invasive-species/.

[44] Merzdorf, Jessica. "A Drier Future Sets the Stage for More Wildfires." Climate Change: Vital Signs of the Planet, https://climate.nasa.gov/news/2891/a-drier-future-sets-the-stage-for-more-wildfires

Dry Weather and Drought Summary			
Hazard threat		Very Low (0.0)	Little to no changes to severity and frequency compared to historic events.
Vulnerability		Low (0.3)	No historical record of the event. Adaptive capacity addressing general water security would support response to dry weather.
Consequence		Medium (2.5)	Impact requires weeks of recovery and is anticipated to impact future local food and water supply.
Risk		Low (0.8)	Overall risk reflects the low likelihood of the event occurring and the anticipated impact to local food and water supply.

Wildfires

Significant dry periods may make forested areas more vulnerable to wildfire spread. Additionally, Prince Rupert has large coastal peat deposits[45] that, when dry, could fuel wildfire and enable it to quickly spread. Conversely, when peat is wet, these areas can smother a fire and limit further spread.[46] Additionally, high winds, a common hazard in Prince Rupert, can contribute to wildfire spread. The Wildland Urban Interface (WUI)[47] classifies the risk of wildfire spread across B.C. This is a useful tool at the provincial level, and it provides insights for municipalities. For Prince Rupert, the risk of wildfire spread to urban areas is low. Some areas, primarily forested areas, are recognized as "moderate" threats. There are also some "moderate" threat areas along Highway 16 near Galloway Rapids Bridge. This location, as well as the municipality, is eligible for Fire Smart Communities funding and support to address existing threats (see Appendix 6: Wildland Urban Interface, grey dotted boundary).

Although the CRVA focuses on wildfires ignited on Kaien Island, wildfires on the mainland have affected and will continue to affect access to rail and road networks, reducing access to the mainland. Air quality is also a concern where wind patterns may bring smoke from wildfires occurring nearby.[48] Wildfire smoke has many components and is generally harmful to human health, as it contains a high concentration of particulate matter (PM 2.5). The air quality health index (AQHI)[49,50] is used to measure real-time changes to air quality caused by wildfire.

Fire services that operate within Prince Rupert also service Port Edward.

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[45] Maynard, D. E. Peatland Inventory of British Columbia. 1988–33, Mineral Resources Division Geological Survey Branch, p. 24, https://cmscontent.nrs.gov.bc.ca/geoscience/PublicationCatalogue/OpenFile/BCGS_OF1988-33.pdf.

[46] Wong, Julia. "Wildfires in Peat an Added Challenge for Alberta Firefighters." CBC, 22 May 2023, https://www.cbc.ca/news/canada/edmonton/wildfires-peat-challenge-alberta-firefighters-1.6850347.

[47] Government of British Columbia. Wildland Urban Interface Risk Class Maps. Provincial Strategic Threat Analysis 2021 Update, https://www2.gov.bc.ca/gov/content/safety/wildfire-status/prevention/fire-fuel-management/wui-risk-class-maps/wui-downloads.

[48] BlueSky Canada. Smoke Forecast. https://firesmoke.ca/forecasts/current/

[49] Environment and Climate Change Canada. Wildfire Smoke, Air Quality and Your Health. 29 June 2023, https://www.canada.ca/en/environment-climate-change/services/air-quality-health-index/wildfire-smoke.html.

[50] Province of British Columbia, Ministry of Environment and Climate Change Strategy. Air Quality Health Index. https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality/aqhi.

Wildfire Summary		
Hazard threat	Low (1.3)	Minimal changes to severity and frequency with low chances of occurrence due to high precipitation received on Kaien Island (limiting dry fuel for fire).
Vulnerability	Low (0.3)	Site-specific event where the vulnerability to spreading depends on the available fuel for the fire. Spread of wildfire smoke from adjacent areas poses a risk to human health. The Wildland Urban Interface
Consequence	Medium (2.5)	Impact requires weeks of recovery and is anticipated to impact transportation networks (road and rail) and economic activity.
Risk	Low (0.8)	Overall risk reflects the low likelihood of a wildfire igniting on Kaien Island, but there is still potential for impact to human health and economic activity from wildfires occurring nearby.

Landslides

Landslides are related to land instability. Soils may become unstable in steep areas that experience a fluctuation of wet and dry weather conditions (long dry periods followed by a large rainfall) and could trigger debris flow and landslides. The City has identified and mapped the townsite areas with slopes of 30% or greater that are potentially hazardous.[51] After the Oldfield Fish Hatchery closed due to a landslide cutting off the water supply in 2021, a follow-up assessment recommended relocating the facility to reduce future risk.[52] The landslide risk to Prince Rupert is site-specific, primarily occurring where steep slopes near major roads and water supplies disrupt activity.

Land Loss (Relative Sea Level Rise) Summary		
Hazard threat	Very Low (0.9)	Little to no changes to severity and frequency compared to historic events.
Vulnerability	Medium (0.5)	Site-specific event, where slopes over 30% are identified as at-risk of landslide.
Consequence	Medium (2.5)	Impact requires weeks of recovery and is anticipated to impact transportation networks (road and rail) and economic activity.

[51] Prince Rupert. Official Community Plan, Map 5. https://www.princerupert.ca/building-development/official-community-plan

[52] Oldfield Fish Hatchery Qualitative Landslide Partial Risk Assessment. 021–187.

Land Loss (Relative Sea Level Rise) Summary			
Risk		Low (0.8)	Overall risk reflects the low likelihood of occurrence, restriction for steep slope development to reduce exposure, as well as the level of impact to major transportation networks and economic activity.

Summary of Combination Weather Vulnerabilities

The table below summarizes the strengths and weaknesses in addressing vulnerability to combination weather conditions in Prince Rupert.

Table 14. Prince Rupert's strengths and weaknesses in addressing vulnerabilities to combination weather conditions.

Sector	Strengths	Weaknesses
Community		• Poor air quality (concern for PM 2.5) due to smoke from wildfires in adjacent communities
Environment	• Wet peat can smother wildfires • The presence of potential wildfire fuel is high (coastal peat deposit, large forested areas); however, this environment does not experience significant dry periods to encourage wildfire spread • Kaien Island is a natural fire break (not prone to wildfire spread from adjacent communities)	• Dry peat can cause rapid spread of fire • Water stress to flora and fauna during drought • From sea level to a height of 696 m (Mount Hays), the island features steep slopes
Municipal assets and services	• Hazardous terrain restrictions • Exploring opportunities to enhance resources and training for firefighters	• Evacuation plan needed in the case of a wildfire. Data on the residents unable to evacuate on their own is not available • Adjacent communities rely on essential services from Prince Rupert during wildfires
Critical infrastructure		• Transportation routes need to be reviewed to ensure clear evacuation paths.

Sector	Strengths	Weaknesses
Economy	• After the landslide that affected the Hatchery, the Landslide Risk Assessment proposed relocating the Hatchery	• Disruption to local business if events prevent movement of goods and planned tours • Water stress to natural attractions such as the Sunken Gardens, Rushbrook Trail, etc., which could affect tourism

Outlining Key Vulnerabilities

Prince Rupert has seven key vulnerabilities across all 13 hazards explored.

1. **Logistic delays:** Structural damages and disruptions in the movement of goods and services to and from Kaien Island.
2. **Decline in water supply:** Impacts to Woodworth Lake Reservoir and other water sources that could impact the quality or quantity of the water supply.
3. **Water system disruptions:** Impacts to water infrastructure that could limit the normal flow of the water supply or stormwater.
4. **Shift in human-wildlife interactions:** Interactions between humans, animals, and the environment that pose a threat to public health through injury (animal attacks) or the transfer of disease (vector-borne diseases).
5. **Decline in health and well-being:** Prolonged exposure to adverse conditions that negatively impact health (i.e., heat stress, dehydration, frostbite, smoke inhalation).
6. **Disrupted access to essential services:** Disruptions in the delivery of goods and services to Kaien Island that create a shortage (food, medical supplies, fuel, cashflow) or outage (telecommunications).
7. **Decline in local food supply:** Disruptions to crop yields and fishing activity.

Table 15 describes the hazards that cause the key vulnerabilities, the consequences of these hazards, and the vulnerable populations and infrastructure. Analyzing hazards in relation to vulnerabilities enables the development of solutions that address multiple climate risks. For example, severe storms and flooding can both cause pooling water on transportation routes, leading to traffic and logistical delays. A similar approach could be used for both these hazards to address vulnerable transportation routes, though the volume of water that would need to be redirected during a storm versus a flood event may differ.

Table 15. Key vulnerabilities created by multiple hazards and mapped across the five sectors for Prince Rupert.

Vulnerability	Applicable Hazards	Consequence	Vulnerable Populations & Elements
Travel delays	Extreme heat	Roads buckling Traffic Adverse travel conditions Road closures	Critical infrastructure • Transportation routes (air, rail, road, ship) • Highway 16 • Paramedic services Economy • Industry • Local businesses Municipal assets and services • Public transit • Trails Community • Pedestrians • Drivers • Residents unable to clear ice and snow
	Severe storms Flooding	Pooling water Traffic Adverse travel conditions Road closures	
	High winds/tornados Extreme cold/cold snaps Freezing rain/ice accumulation Wildfire	Broken tree limbs Potholes Traffic Adverse travel conditions Road closures	
Decline in water supply	Extreme heat Ecoregion changes Severe storms Flooding	Water quality (temperature, pH, turbidity, odour, biochemical oxygen demand [BOD], dissolved oxygen [DO])	Environment • Water bodies • Aquatic species Municipal assets and services • Stormwater management Critical infrastructure • Water supply
	Drought/dry spell	Water quantity (groundwater table, lake levels)	

Vulnerability	Applicable Hazards	Consequence	Vulnerable Populations & Elements
Water system disruptions	Extreme cold/cold snaps Freezing rain/ice accumulation	Water main break	Critical Infrastructure • Water supply
	Severe storms Storm surge High winds Land loss (relative sea level rise)	Urban flood (stormwater) High sea level	Municipal assets and services • Stormwater management • Facilities by the shoreline
	Wildfire	Emergency water supply	Critical Infrastructure • Fire services
Shift in human-animal interactions	Extreme heat Ecoregion changes	Vector-borne disease Animal migration	Environment • Common pests (e.g., cucumber beetle) • Invasive species (e.g., knotweed, starfish, green crab) • Key food species Community • Rare incidents of residents and domestic animals interacting with wolves and black bears Economy • Tourism (grizzly bears, black bears, wolves, orcas, humpback whales, hummingbirds)

Vulnerability	Applicable Hazards	Consequence	Vulnerable Populations & Elements
Decline in health and well-being	Wildfire	Air quality	Community • Residents, especially children, seniors, and immunocompromised residents Municipal assets and services • Personnel working outdoors
	Extreme heat	Heat stress	Environment (overall) Community (overall) Municipal assets and services • Personnel working outdoors
	Extreme heat Ecoregion changes	Mold	Community • Residential buildings
	Extreme cold	Frostbite	Community • Residential buildings Municipal assets and services • Personnel working outdoors

Vulnerability	Applicable Hazards	Consequence	Vulnerable Populations & Elements
Disrupted access to essential services	Extreme heat Severe storms Flooding High winds/tornados Extreme cold/cold snaps Freezing rain/ice accumulation Snow accumulation	Access to medical services Access to financial services Telecom outage Traffic Road closures Access to shelter Delivery of emergency response	Critical infrastructure • Telecommunications • Transportation routes • Powerlines • Emergency services Economy • Industry • Local businesses • Banking Municipal assets and services • Medical services • Emergency response Community • Unhoused population • Displaced residents
Decline in local food supply	Dry weather conditions/drought Ecoregion changes	Food shortages	Environment • Crop plants Economy • Commercial fishing Community (overall)

Target Setting and Next Steps

To develop the Climate Adaptation and Action Plan, SSG and the City of Prince Rupert will work together to determine suitable objectives and actions to reduce the risk of hazards, with the goal of reducing all risks to a score of 1.0.

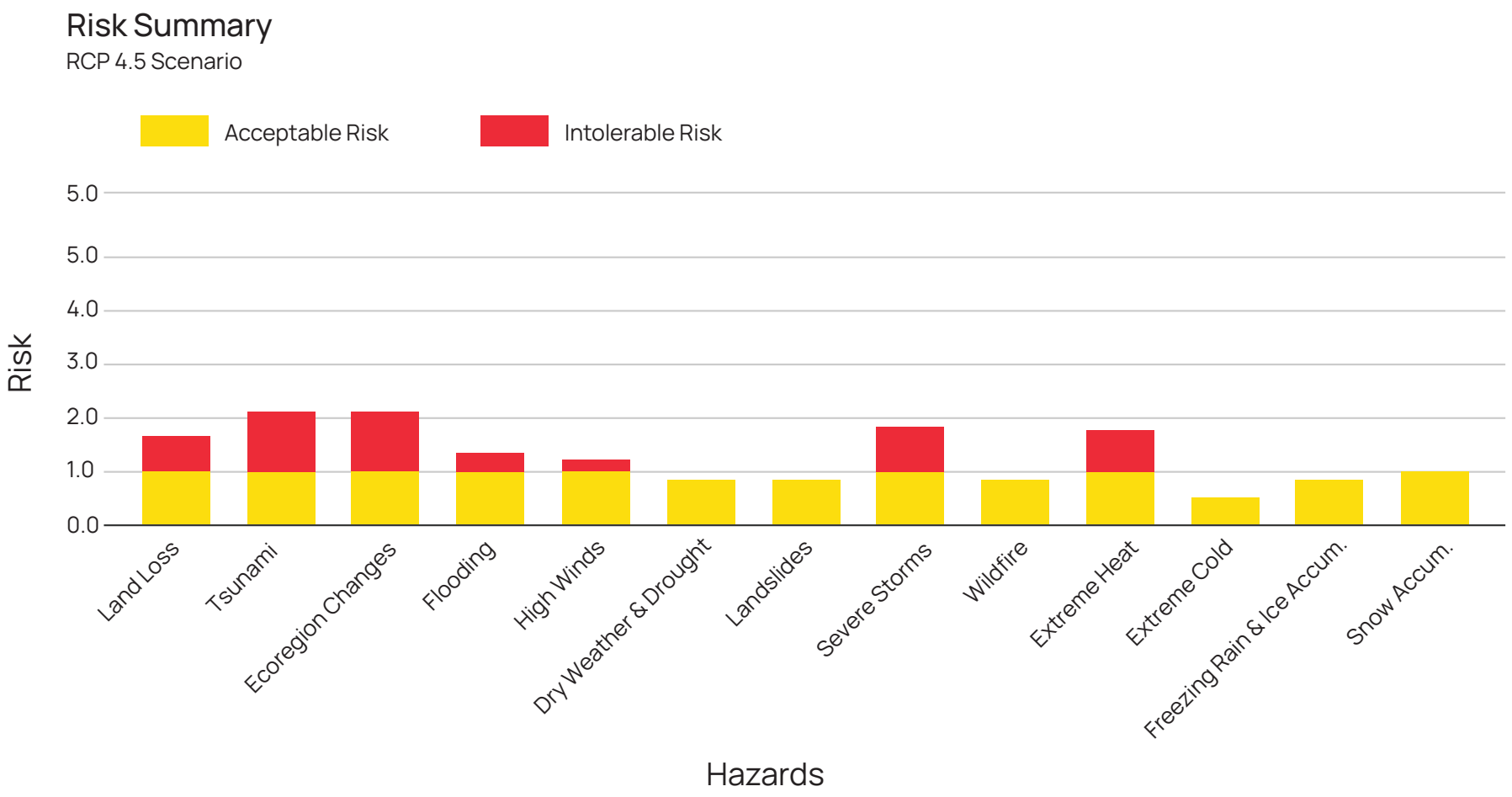
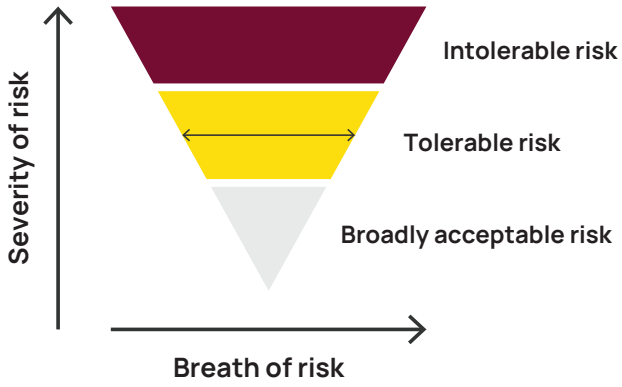


Figure 7. The risk level associated with climate hazards in Prince Rupert in the planning scenario (RCP 4.5). The level of risk exceeding the acceptable risk threshold is illustrated in red.

In some instances, this may require increasing adaptive capacity and removing assets from exposed areas. In other cases, the City may have to adopt an approach of "as low as reasonably practicable" (ALARP). This concept is illustrated in Figure 8. The height of the triangle refers to the severity of the risk (how badly people and systems are affected), and the width of the triangle reflects the extent of the risk (how many people and systems are affected). The level of tolerable risk is equivalent to the level to which risk can be reasonably reduced. The costs of reducing the risk beyond this level are disproportionate to the benefits. For example, reducing a risk to half its current level might cost a fraction of the amount it takes to reduce the risk to zero. Tolerable risks do not obstruct the day-to-day activities of the community enough to warrant extensive risk reduction intervention.



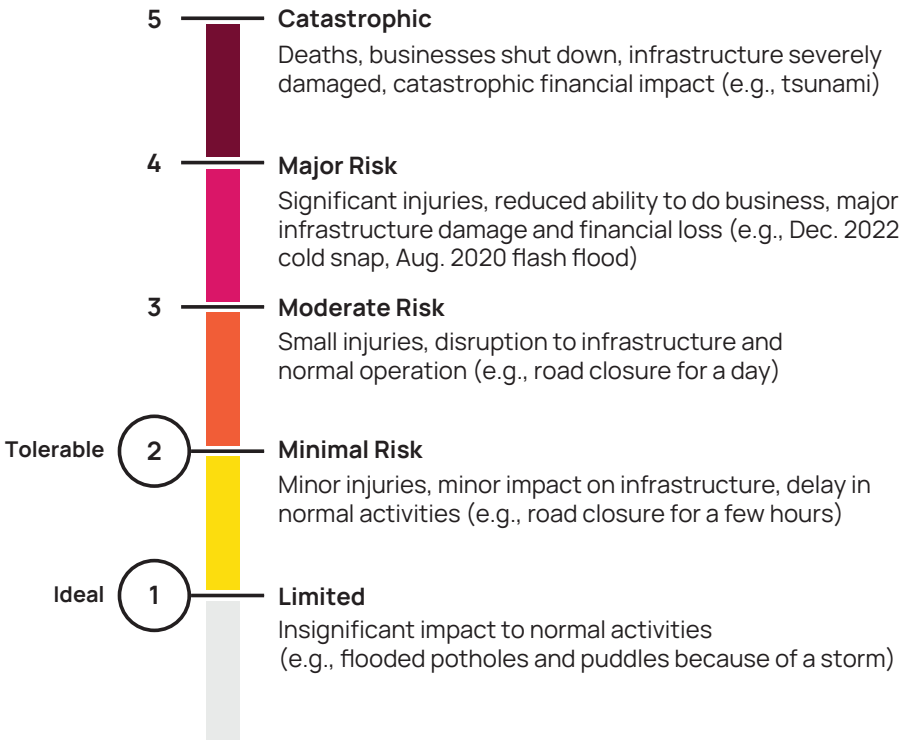


Figure 8. Illustration of the concept "as low as reasonably practicable." The tolerable risk is set at the level to which risk can reasonably be reduced.

Appendix A : Hazard Threat Assessment Summary

Table i. Summary of the hazard threat likelihood for each hazard across each time horizon considered in the RCP 4.5 and 8.5 scenarios.

		Planning Scenario: RCP 4.5			Worst-Case Scenario: RCP 8.5		
Rank	Hazard	2011–2040	2041–2070	2071– 2100	2011–2040	2041–2070	2071–2100
1	Ecoregion changes	1.8	2.4	2.8	2.0	2.6	3.6
2	Severe storms/storm surges	1.0	1.0	1.7	1.0	1.0	2.0
3	Wildfire*	1.0	1.5	1.5	1.0	1.5	2.3
4	Flooding	0.0	1.0	1.3	0.0	1.0	2.0
5	Extreme heat	0.5	0.8	1.3	0.5	1.0	2.3
6	Freezing rain/ice accumulation	0.5	1.1	1.2	0.6	0.8	1.1
7	Landslides	0.4	1.0	1.2	0.6	1.2	2.0
8	High winds	1.0	1.0	0.8	0.8	0.8	0.8
9	Extreme cold/cold snaps	0.5	0.5	0.2	0.3	0.2	0.1
10	Snow accumulation	0.1	0.8	1.0	0.2	0.7	1.1
11	Dry weather conditions/drought	0.0	0.0	0.0	0.0	0.0	1.0
12	Land loss	NA	NA	2.0	NA	NA	2.0
13	Tsunami (seismic and non-seismic)	NA	NA	2.0	NA	NA	2.0

Appendix B: Vulnerability Summary

Vulnerability Thresholds					
Sensitivity	Very High (1.0–0.81)	High (0.80–0.61)	Medium (0.60–0.41)	Low (0.40–0.21)	Very Low (0.20–0)
Exposure	Very High (1.0–0.81)	High (0.80–0.61)	Medium (0.60–0.41)	Low (0.40–0.21)	Very Low (0.20–0)
Adaptive Capacity*	Very Low (1.0–0.81)	Low (0.80–0.61)	Medium (0.60–0.41)	High (0.40–0.21)	Very High (0.20–0)
*Adaptive capacity scores are reversed to accurately measure this component of vulnerability					

Hazard	Average Score	Adaptive Capacity	Sensitivity	Susceptibility
Ecoregion changes	High 0.7	Medium (0.6)	Medium (0.6)	High (0.8)
		• The Environmentally Significant Lands Policy calls for the preservation of intertidal marshes, streams, riparian areas, and other environmentally sensitive lands.	• Currently addressing invasive species: Knotweed. • Prince Rupert Port Authority is monitoring for Didemnum Vexillum and European Green Crab. • In the future, this ecoregion profile evolves to be something unusual to North America. • Key native species: juvenile salmon, eelgrass beds, kelp, shellfish, wolves, bears.	• Seasonal temperature change is significant: 1–2°C change in the near term and up to 4°C change in the long-term future. • Once the long-term changes occur, some impacts may be irreversible. • The strategy would be to work with changes to build resilience in the current ecosystem, where possible.

Hazard	Average Score	Adaptive Capacity	Sensitivity	Susceptibility
Severe storms/ storm surges	High 0.7	Medium (0.6) • Pedestrian routes have low visibility, many switch to public transit, but there is limited availability in the winter. • Wet weather conditions promote reflective surfaces and can make it hard for drivers to see pedestrians. • Access is further limited for populations with accessibility needs. • The Public Works Staff actively monitor and trim/ remove tree limbs deemed dangerous. The public can report a dangerous tree to city assessors.	Medium (0.6) • There is concern for public infrastructure in storms. Stormwater separation is still required in some areas, and 33% of the infrastructure is beyond service life, which increases vulnerability to local storms. • Residential structures are sensitive to damages. There is a need for roofing and drainage contractors, as winter rain and wind warnings are significant. Currently, residents in need of repairs are waitlisted.	High (0.8) • Extent covers the entire community. • There is a strong relationship between severe storms and high winds in this area. The high winds analysis should look similar.
Flooding	Medium 0.6	Medium (0.6) • Additional interventions needed to weather-proof homes with unfinished basements; drains to be checked for seasonal clogging (including snow clogging in the winter).	Medium (0.6) • Homes have been identified for specific conditions to upgrade. • Water courses that may pool onto transportation routes are identified. • Stormwater separation is still required in some areas and 33% is beyond service life, which increases vulnerability to local flooding.	Medium (0.6) • Triggered during wet weather events, related to severe storms but also possible if there are concurrent days of wet weather.

Hazard	Average Score	Adaptive Capacity	Sensitivity	Susceptibility
Extreme Heat	Medium 0.5	Medium (0.6)	Medium (0.6)	Low (0.4)
		• Residents need to add capacity to homes for cooling (improved ventilation, shading, and HVAC). • Municipal Cooling Centers should be mapped. • Water stations should be mapped. • Vulnerable populations are identified.	• Heat stress is uncommon to the area, and it presents a new challenge to existing structures. • Mold is a rising issue when conditions are humid.	• No extreme heat days into the future, but humidity could create days that feel like 30°C.
Freezing rain/ ice accumulation	Low 0.4	Medium (0.6)	Low (0.4)	Very Low (0.2)
		• Visibility during wet weather conditions make pedestrian and cyclist paths unusable. • Additional support to de-ice roadways needed (removal of on-street parking in preparation of event. • The Public Works Staff actively monitor and trim/ remove tree limbs deemed dangerous. The public can report a dangerous tree to city assessors	• Current structures are typically able to withstand the impacts of the event; de-icing interventions are readily available. • Specific areas will be vulnerable, as related to where the water infrastructure is over its service life.	• No historical instances of freezing rain events. • Ice accumulation is not anticipated to change much from historical trends.

Hazard	Average Score	Adaptive Capacity	Sensitivity	Susceptibility
Landslides	Medium 0.5	Medium (0.6)	Low (0.4)	Low (0.4)
		• Interventions available for keeping structures away from steep slopes are noted.	• Limited structures are near steep slopes.	• Steep slopes and dry conditions directly followed by very wet conditions may trigger a landslide. • Dry conditions do not change significantly, although precipitation increases. • Soil stability will need to be reviewed.
High winds	Medium 0.6	Medium (0.6)	Low (0.4)	High (0.8)
		• Tree health needs to be monitored to remove limbs near power lines or roadways in preparation of an event. • Safety hazard for personnel working outdoors.	• Reduced air and ship transportation due to unfavourable conditions for travel.	• Extent covers the entire community. • There is a strong relationship between severe storms and high winds in this area. • High winds may also contribute to wildfire spread.

Hazard	Average Score	Adaptive Capacity	Sensitivity	Susceptibility
Extreme cold/ cold snaps	Low 0.3	High (0.2)	Medium (0.6)	Very Low (0.4)
		• Emergency Operations Centre addresses water main breaks.De-icing readily available.	• Water systems are particularly affected where water main breaks or residential water line freezing require intervention. • Current interventions (running taps to avoid freezing) may reduce water supply during the event. • Materials for pipes to be reviewed where possible.	• General warming trends reduce the extent of cold. • High winds introduce a wind chill factor, which still promotes unfavourable conditions for residents directly exposed. • Freeze/thaw Cycles are also reduced over time.
Snow accumulation	Low 0.3	High (0.4)	Low (0.4)	Very Low (0.2)
		• Snow removal on private property is harder for residents that cannot physically do this task.	• Structures like greenhouses may be impacted, as the snow is dense.	• The window for snowfall is short, and even shorter in the future.
Dry weather conditions/ drought	Low 0.3	Medium (0.6)	Very Low (0.2)	Very Low (0.2)
		• Current water supply may be stressed if events were to occur.	• Gardens and natural assets that are used for tourism or cultural events may be impacted.	• Not a likely hazard, given the amount of precipitation in the area. • No changes in the number of consecutive dry days, but warmer temperatures are expected into the future.

Hazard	Average Score	Adaptive Capacity	Sensitivity	Susceptibility
Land loss	Medium 0.5	Medium (0.6) • There is an understanding of sea level rise that will impact this shoreline community. • The tsunami risk assessment uses a 1-m change in the sea level to investigate worst-case scenario risks. • The Tsunami Risk Assessment recommends creating a Sea Level Policy.	Low (0.4) • Few homes are located directly near the shoreline. • Elevating the surface for critical structures is recommended to reduce this future risk.	Medium (0.6) • The effects of sea level rise are part of a larger global phenomena and are considered irreversible. • Impacts shoreline areas in the long-term future.
Tsunami (seismic/ non-seismic)	Medium 0.5	High (0.4) • Tsunami evacuation signs, warning sirens, and plans. • Coast Guard. • Risk Assessment completed with climate change considerations.	Medium (0.6) • Shoreline structures not elevated. Ships near shore.	Low (0.4) • It is a sheltered island, but Kaien island is adjacent to communities with a history of impact.

Hazard	Average Score	Adaptive Capacity	Sensitivity	Susceptibility
Wildfire	Low 0.3	High (0.4)	Low (0.4)	Very Low (0.2)
		• Exploring options to increase firefighter equipment/training that specializes in wildland events. • In 2025, consider applying for a Fire Smart Coordinator position, with partial funding from the Province. • In 2024, participate in the Wildland Fire Summit to initiate a dialogue about how the fire department can build the resources needed to manage wildland risks.	• Large forested areas and coastal peat (when dry) are the primary fire fuel. • Emergency water supply to be identified.	• The water surrounding Kaien Island is a natural fire break. • Region is not typically dry enough to promote wildfire spread.

Appendix C: Consequence Summary

Consequence	Severe (5.0– - 4.1)	Major (4.0–3.1)	Moderate (3.0–2.1)	Minor (2.0–1.1)	Insignificant (1.0–0)

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Ecoregion changes	Moderate 2.5	Moderate(3.0)	Minor (2.0)
		Environment • Milder and wetter seasons promote growing season but may be preferred by non-native species (crop pests). • Concerns for increasing water temperature: algae blooms in freshwater and lakes risking the survivability of species there. More susceptible to ocean acidification. • Competition with native flora and fauna (attention to fish population and pollinators needed).	**Community** • Impact on local food sources due to pests and/or invasive species competing. • Cultural spaces are compromised where losses to flora are significant. • Increased threat of vectors carrying disease. **Critical Infrastructure** • Increased plant growth and/or invasive species may need additional maintenance. **Municipal Services** • Additional service required for managing invasive species. **Economy** • Increased reliance on long supply chains: higher food security risks. • If flora and fauna are significantly affected, tourism (including cruises) can be impacted. • Could impact the commercial fishing industry.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Severe Storm/ Storm Surge	**Moderate 3.0**	Minor (2.0)	Minor (2.0)
		Environment • A natural phenomenon, larger precipitation events may change future impacts. **Community** • Residential buildings in poor condition before the event may require repairs. **Municipal Services** • Clean-up of debris due to high winds. **Economy** • Lost cargo at sea during severe events. • Damage to Rushbrook Trail. **Critical Infrastructure** • Debris on roads may cause traffic. • Strong winds and reduced visibility will reduce flights and ship travel.	**Environment** • occurs, may handle more water in a single event. **Community** • Reduced visibility for outdoor activities and active modes of transit. • Population requiring additional accessibility for travel needs to be reviewed. **Municipal Services** • Public transit service delays during events. **Economy** • Tourism will experience delays and disruptions.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Flooding	**Moderate 3.0**	Moderate (3.0)	Moderate (3.0)
		Environment: • A natural phenomenon, larger precipitation events may change future impacts (similar impacts to severe storms). **Community:** • Specific locations potentially impacted: shoreline areas and beaches, Water Street, or Hays Creek. **Critical Infrastructure:** • Stormwater infrastructure to be reviewed for capacity, as future flood volumes may be hig her. **Municipal Services:** • Flooding of municipal assets close to floodplain and coastal areas. **Economy:** • Adverse conditions reduce ecotourism.	**Community:** • Limited access to pedestrian and vehicle routes. Impacts are similar to severe storm concerns. **Critical Infrastructure:** • Delays due to flooded transportation routes. **Economy:** • Delays to transport of goods due to adverse weather conditions. • Long delays may lead to shortages in local food supply and/or higher food prices.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Extreme heat	**Minor** **1.5**	Minor (2.0)	Insignificant (1.0)
		Environment: • These events are not common historically—crops, flora, and fauna may be sensitive to heat stress. (Related to patterns noted in ecoregion changes.) **Community:** • Not many homes prepared with a cooling unit. • Vulnerable populations sensitive to heat stress. **Critical Infrastructure:** • Energy security needs to be reviewed for the addition of air cooling during extreme weather events. **Municipal Services:** • Cooling centres, water stations, and forestry maintenance required to address natural assets and vulnerable communities exposed to heat stress. **Economy:** • Heat stress may affect crop yields. • Impacts to the fishing industry explored further in Ecoregion changes	**Critical Infrastructure:** • Structures may be sensitive to heat stress. Failures could lead to disruption of energy supply.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Freezing Rain/Ice Accumulation	**Minor 2.0**	Minor (2.0)	Minor (2.0)
		Environment: • Heavy ice accumulation may lead to broken tree limbs. **Community:** • Minor impact due to reduced access to pedestrian and vehicle routes during wet weather conditions (slip and fall). **Critical Infrastructure:** • De-icing required for transportation routes. **Municipal Services:** • May result in water main breaks if ice accumulation is heavy.	**Critical Infrastructure:** • Fallen tree branches on power lines may result in power loss. • Fallen tree branches on roads may result in traffic and transportation delays. **Economy:** • Minor delays where road closures occur.
Landslides	**Moderate 2.5**	Moderate (3.0)	Minor (2.0)
		Community: • Vulnerable where residential and commercial structures are located next to unstable terrain. **Critical Infrastructure:** • Vulnerable where transportation routes are in close proximity. **Economy:** • Businesses located near unstable terrain.	**Critical Infrastructure:** • Road closures to divert traffic away from high-risk areas.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
High winds/ Tornados	**Moderate 3.0**	Moderate (3.0)	Moderate (3.0)
		Environment: • High winds may cause broken tree limbs. **Community:** • Residential buildings in poor condition before event may require repairs. **Critical Infrastructure:** • History of high winds moving cargo ships and causing power outages. • Anchor-dragging events increased; higher likelihood for environmental damages (oil spills). **Municipal Services:** • Debris removal. **Economy:** Lost cargo, ship damages, and increased danger at sea. Delays in air travel.	**Community:** • Unfavourable conditions for pedestrians and vehicles. **Critical Infrastructure:** • Fallen tree branches on roads may result in traffic and transportation delays. **Municipal Services:** • Public transit service delays during events. **Economy:** • Delays on all travel routes may affect tourism and the delivery of goods.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Extreme Cold/ Cold Snaps	**Moderate 3.0**	Moderate (2.0)	Minor (3.0)
		Community: • Minor impact due to direct exposure to cold (unfavourable for pedestrians). **Critical Infrastructure:** • May result in water main breaks if the temperature fluctuates rapidly. There is a dedicated emergency response team to address this impact. • De-icing where applicable. **Municipal Services:** • De-icing required where ice accumulates on pedestrian and vehicle routes.	**Economy:** • Minor delays. **Critical Infrastructure:** • Delays on transportation routes due to slippery conditions. **Municipal Services:** • Additional protective equipment and warming stations for personnel that work outdoors.
Snow accumulation	**Minor 2.0**	Minor (2.0)	Insignificant (1.0)
		Community: • Heavy snow may impact small residential structures (greenhouses). **Municipal Services:** • Snow removal required for pedestrian paths and vehicle routes.	**Community:** • Minor delays due to reduced access to pedestrian and vehicle routes.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Dry Weather Conditions/ Drought	**Moderate 2.5**	Moderate (3.0) **Environment:** • Flora and fauna sensitive to water supply stress. **Community:** • Water supply stress. **Critical Infrastructure:** • Changes to water quality and water quantity available for water supply and treatment. **Municipal Services:** • Water delivery to vulnerable populations. **Economy:** • Agricultural sector sensitive to water supply stress.	Minor (2.0)

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Land loss	**Minor** **2.0**	Moderate (3.0)	Moderate (3.0)
		Environment: • Shoreline loss. **Community:** • Impact to shoreline residents (structures like docks that are not elevated are at higher risk of impact; houseboats at high risk of impact). **Critical Infrastructure:** • Ports may be impacted. **Municipal Services:** • Service buildings located close to the shoreline may be impacted.	**Economy:** • Moderate delays may be incurred to address inundation.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Tsunami (seismic/ non-seismic)	**Severe 4.5**	Severe (5.0) **Environment:** • High-velocity waves and surge may lead to erosion or flooding along shoreline. **Community:** • Shoreline residents/businesses may need to protect homes from wave impact. Evacuation may be required. **Critical Infrastructure:** • Ports and access roads not elevated will be impacted. • Potential damage to ships near shore. **Municipal Services:** • Emergency response at capacity to address direct impacts and preparatory actions for evacuation.	Major (4.0) **Economy:** • Severe delays as community recovers from impact.

Hazard	Score (Average)	Direct Impacts	Indirect Impacts
Wildfire	**Moderate*** **2.5**	Moderate (3.0)	Minor (2.0)
		Community: • Evacuation of Kaien Island would be needed to reduce impact if the fire spreads. • Identified vulnerable populations would be individuals unable to evacuate on their own (lack of transportation, ability to evacuate, accessibility). • Air quality (PM 2.5) is affected due to wildfires occurring in adjacent areas. **Municipal Services:** • At capacity for local emergency services to manage air quality/public health concerns and immediate damages. • Nearby towns may rely on emergency response from Prince Rupert.	**Critical Infrastructure:** • Major delays if roadways or bridges become inaccessible. **Economy:** • Minor delays to transportation if Highway 16 or railways are blocked due to wildfire.

Appendix D: Identified Vulnerable Elements

The table below presents vulnerable elements identified through community engagement, including input from the Advisory Committee and focus groups.

Table i. Identified vulnerable elements.

Sector	Element	Engagement Feedback	Associated Risk Component(s)	Associated Hazard(s)
Community	Boat commuters and houseboats	• Increased risk to navigation due to heavy rain/ wind/snow/ice. • Snow is particularly heavy.	Indirect impact	Snow accumulation Severe storms/storm surges High winds Freezing rain/ice accumulation Tsunami
Community	Cyclists	• Increased risk of injury/delays due to decreased visibility on bike paths. • Increased risk of injury/delays due to obstructions on bike paths. • Increased risks of slips and falls during wet weather conditions. • Flying debris during high winds.	Direct impact Indirect impact	Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation

Sector	Element	Engagement Feedback	Associated Risk Component(s)	Associated Hazard(s)
Community	Drivers	• Decreased visibility on roads. • Decreased visibility of cyclists, pedestrians, and others sharing roads. • Obstructions on transportation routes and bridges.	Indirect impact	Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation Flooding Landslides
Community	Homeowners	• Many homes require repairs to roofs to make them secure shelters during hazard events. • Limited skilled workers to complete work.	Direct impact Sensitivity	Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation
Community	Low-income population	• Transportation and logistics delays may result in local food shortages. This may cause panic and concern about increased food prices.	Indirect impact	Flooding
Community	Metlakatla First Nation	• Metlakatla First Nation once had 100 ocean gardens. • Restoring local food supplies is harder due to climate change's influence on the severity and frequency of hazards.	Direct impact	Severe storms/storm surges Tsunami Land loss

Sector	Element	Engagement Feedback	Associated Risk Component(s)	Associated Hazard(s)
Community	Pedestrians	• Increased risk of injury/delays due to poor visibility on crosswalks and poor visibility for drivers. • Increased risk of injury/delays due to flying debris/obstructions on crosswalks and snow plows throwing snow on sidewalks. • Increased risk of injury during wet weather conditions (i.e., slipping and falling). • Decreased accessibility of pedestrian routes and school zones.	Direct impact Indirect impact	Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation
Community	Population managing chronic disease, illness, or recent injury	• Decreased accessibility to healthcare due to the consolidation of medical services in Terrace, which is difficult to travel to in adverse weather. • Increased risk of heat stress and exacerbation of existing health conditions during extreme heat events without adequate cooling.	Direct impact	Extreme heat Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation Flooding Landslides
Community	Population without cooling	• Increased risk of heat stress due to lower thermal comfort during extreme heat days. Humidity and tropical nights can extend thermal discomfort. • Lack of options/service/affordability to retrofit older buildings to prepare for extreme heat. • Increased risk to energy security if the electric grid is not prepared for increased AC units.	Direct impact	Extreme heat

Sector	Element	Engagement Feedback	Associated Risk Component(s)	Associated Hazard(s)
Community	Residents	• Increased risk of water insecurity due to frozen water lines (need to keep taps running to prevent freezing, resulting in wasted water). • Increased risk of mental illness (isolation, panic) during stay-in-shelter events. • If cooling is expensive, it potentially decreases affordability. • Increased risk of food insecurity due to delays in logistics.	Direct impact Indirect impact	Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation
Community	Residents in low-lying areas	• Sites of concern: Hays Creek, Skeena River. • Increased risk of basement flooding for residents with half or unfinished basements in areas below the water table where the building foundation is built against rock and water flows through.	Direct impact	Severe storms/storm surges Flooding
Community	Residents near shoreline	• Increased risk of off-shore anchor-dragging events causing oil spills.	Direct impact	Tsunami Land loss Severe storms/storm surges Flooding
Community	Secondary structures (on residential properties)	• Increased risk of damage due to heavy snow accumulation. • Greenhouses are particularly affected.	Direct impact	Snow accumulation
Community	Unhoused population	• Limited shelter and limited funding to expand. • Displaced families (e.g., during wildfires) can be placed on a small scale, but larger events would create housing difficulties.	Direct impact	All

Sector	Element	Engagement Feedback	Associated Risk Component(s)	Associated Hazard(s)
Critical infrastructure and essential services	Emergency management	• Staffing shortages and structures could affect responses to emergencies. • Local knowledge transfer needs to be digitized and more accessible. • Additional volunteers needed. • 911 dispatch delays. • Fire radio reach needs more investigation to remove blindspots. • Storage facilities needed for emergency resources. • Back-up water resources for firefighters need to be identified.	Indirect impact	All
Critical infrastructure and essential services	Public transit	• Increased risk to service due to snow/rain/ice/ high winds. • Transportation is limited in winter. • Buses stop running at certain times after dark. Buses do not run in certain places. May want to look at enhanced bus service for severe rain (alternate transportation for pedestrians).	Indirect impact	Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation
Critical infrastructure and essential services	Stormwater drains	• Garbage clogging.	Direct impact	Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation Flooding

Sector	Element	Engagement Feedback	Associated Risk Component(s)	Associated Hazard(s)
Critical infrastructure and essential services	Transportation and logistics	• Increased risk of delays in transporting of goods. When the Skeena river flooded, access to roads and railway was affected. Typically a Hwy 16 issue between Rupert and Terrace affects travel and shipping. • Increased risk of economic insecurity due to inactivity at ports when sea conditions are poor. • Increased risk to navigation to due heavy rain/wind/snow/ice (reduced visibility, slower travel). • Snow is particularly heavy. • Increased risk of delays due to reduced air transport where wind conditions are poor.	Direct impact Indirect impact	Severe storms/storm surges High winds Freezing rain/ice accumulation Snow accumulation Flooding Landslides
Critical infrastructure and essential services	Water supply mains	• Increased risk of water insecurity due to water main breaks.	Indirect impact	Freezing rain/ice accumulation Extreme cold/cold snaps
Economy	Aquatic nature tourism	• Increased risk of financial insecurity related to reduced aquatic attractions due to the effects of ocean acidification.	Indirect impact	Ecoregion changes
Economy	Commercial fishing industry	• Increased risk of ocean acidification reducing aquatic food supply. • Increased risk of delay due to unfavourable conditions at sea (high winds, heavy rain).	Indirect impact	Ecoregion changes Tsunami Severe storms/storm surges Freezing rain/ice accumulation High winds

Sector	Element	Engagement Feedback	Associated Risk Component(s)	Associated Hazard(s)
Economy	Terrestrial nature tourism	• Increased risk of delay due to debris and damages to Rushbrook Trail. • Increased risk of financial insecurity if the Sunken Gardens tourist attraction suffers from heat stress/ drought.	Direct impact Indirect impact	Severe storms/storm surges High winds Extreme heat Dry spells/drought
Environment	Air quality	• Increased risk of dust particulate in air during dry winters. • Increased risk of poor conditions due to winds bringing wildfire smoke from nearby.	Direct impact (health)	Extreme heat Dry spells/drought Wildfire
Environment	Freshwater aquatic species (eelgrass beds and juvenile salmon)	• Increased risk of Biological Oxygen Demand (BOD) due to warming water temperatures promoting algal blooms competing for oxygen with other native species in freshwater and lakes. • Concerns for the survival of salmon due to the impact of drought, a lack of snowfall, and heavy rains on spawning pathways.	Direct Impact	Ecoregion changes Dry spells/drought
Environment	Large fauna (wolves)	• Potential increase in human-animal interface (dog/wolf interactions).	Direct impact	Ecoregion changes
Environment	Pests	• Cucumber beetle	Direct impact	
Environment	Saltwater aquatic species	• Ocean acidification • Concerns for the survival of local kelp and shellfish (local food supply). • Concerns for large aquatic mammals (local tourism). • Concerns about invasives such as starfish and crabs in the region.	Direct impact Sensitivity	

Sector	Element	Engagement Feedback	Associated Risk Component(s)	Associated Hazard(s)
Environment	Shoreline	• Increased risk of environmental damages to private property due to offshore anchor-dragging events causing oil spills.	Direct impact	High winds
Environment	Trees	• Increased risk of broken limbs during high winds, dry, and/or icy conditions. • Increased risk of heat stress during excessive hot days. • Increased risk of water stress during dry spells.	Direct impact Sensitivity	Severe storms/storm surges High winds Freezing rain/ice accumulation Dry spells/drought Ecoregion changes
Municipal assets and Services	Outdoor recreation, parks, and open spaces	• Increased risk of heat stress or heat stroke : • Outdoor runners • Outdoor sports • Camps • Outdoor Programming • Increased risk of injury due to flying debris during high winds.	Direct impact	Extreme heat Extreme cold/cold snaps Tsunami Land loss Severe storms/storm surges High winds
Municipal assets and services	Outdoor workers	• Increased risk of heat stress, heat stroke. • Increased risk of injury due to flying debris during high winds. • Increased risk of frostbite during cold snaps. • Increased risk of injury due to high-velocity water during floods. • Increased risk of lost wages due to delays during adverse weather.	Direct impact Indirect impact	Extreme heat Extreme cold/cold snaps Tsunami Flood Severe storms/storm surges High winds

Appendix E: Wildland Urban Interface

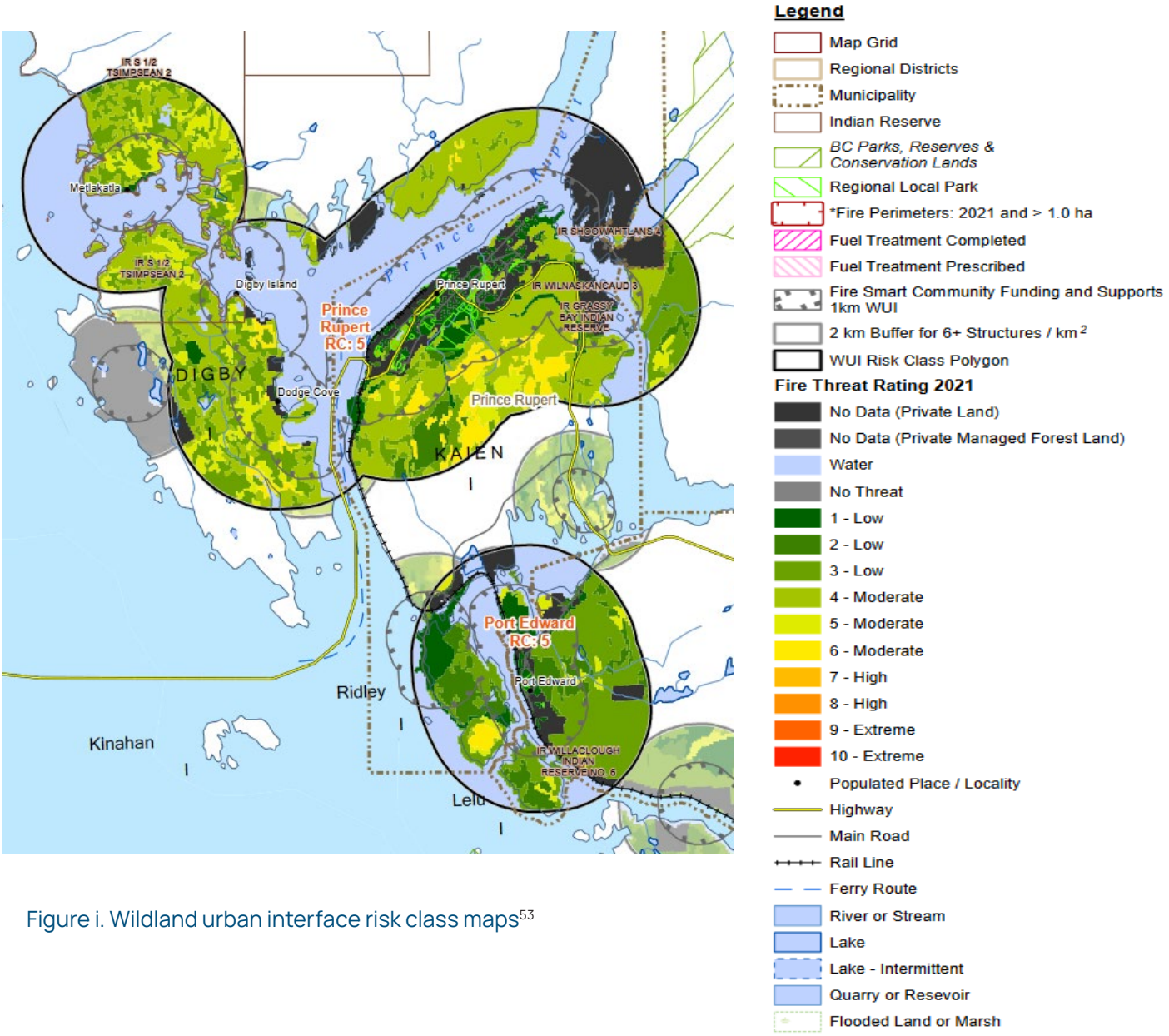
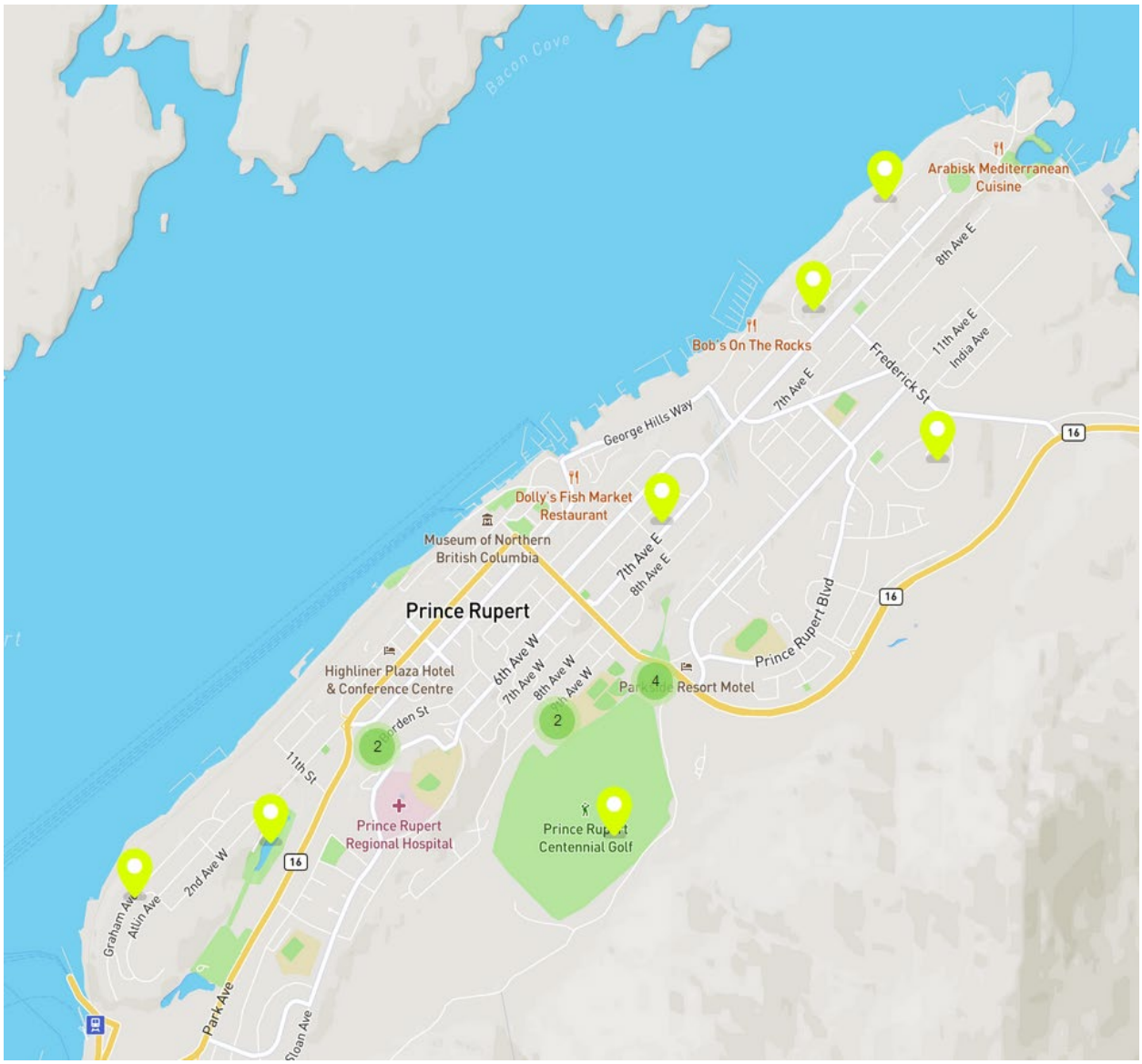


Figure i. Wildland urban interface risk class maps[53]

[53] Government of British Columbia. Wildland Urban Interface Risk Class Maps. Provincial Strategic Threat Analysis 2021 Update, https://www2.gov.bc.ca/gov/content/safety/

Appendix 4: Community Interactive Map

Mapping of climate risks and vulnerabilities, a public perception of risk.[54] The green pins refer to areas identified by the community as potentially vulnerable to climate risk. Where more than one community member reported a potential risk, a number icon identifies the area and the number of comments.



[54] City of Prince Rupert. "Help Us Build a Climate Hazard Map." Rupert Talks, https://engage.princerupert.ca/climateplan/maps/

The city of

Prince Rupert

Climate Change Adaptation Plan

January 2025