Climate Change and Health
in British Columbia

From Risk to Resilience

May 2024

Acknowledgements

The authors gratefully recognize the First Nations traditional territories across the province on which we live and work. We also respectfully acknowledge that the writing of this report took place on the territories of the Xwsepsum (Esquimalt) and Songhees Nations, the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and Sel̓íl̓witulh (Tsleil-Waututh) Nations, and the Syilx Okanagan Nation. We are grateful to the Métis and Inuit living in B.C. and hold our hands up to the diversity of Indigenous expertise and leadership in this space.

This project was made possible by the engagement of individuals who participated in the many focus groups, interviews, and sharing circles, as well as all individuals who shared documents and data. They generously shared with us their time and valuable insights. We are grateful for their participation.

We extend our heartfelt appreciation to the dedication of health system staff who demonstrated unwavering commitment and resilience during recent challenging climate-related events in B.C. Their tenacity in the face of adversity serves to protect the safety and well-being of people who live in B.C. and is an inspiration to us all.

This project has been made possible with support from the Province of British Columbia, Health Canada, and Environment and Climate Change Canada.

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Geospatial Analysis:
We are grateful to GeoBC, Ministry of Water, Land and Resource Stewardship, for their contribution with geospatial analysis, with special acknowledgement to Trilby Buck, Helen Liang, Jesse Bennett, Ben Arril and Gurdeep Singh.

Project Support:
Alex Pysklywec, Jessica Werb Row (Double Strand Communications, Copy Editor), Mia Hansen (Design), Devon Francis, Tira Okamoto.

We would also like to recognize the support and collaboration from the Ministry of Health's Climate Resilience Unit—Mary Cameron, Anna Bunce, Rebekka Schnitter and Sally Maguet.

Suggested citation: SHIFT Collaborative. *Climate Change and Health in British Columbia: From Risk to Resilience*. Ronald, L. & Klein, K. (Eds). Prepared for the B.C. Ministry of Health. Victoria: B.C. 2024.

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Abbreviations

BCCDC	BC Centre for Disease Control
BCEHS	BC Emergency Health Services
CCHVA	Climate Change and Health Vulnerability Assessment
CPAS	Climate Preparedness and Adaptation Strategy
ECCC	Environment and Climate Change Canada
ED	Emergency Department
EMCR	Ministry of Emergency Management and Climate Readiness
EOC	Emergency Operations Centre
GHG	Greenhouse Gas
HARS	Heat Alert and Response System
HEMBC	Health Emergency Management BC
HSDA	Health Service Delivery Area
MHSU	Mental Health and Substance Use
MNBC	Métis Nation British Columbia
NCCEH	National Collaborating Centre for Environmental Health
NGO	Non-governmental Organization
PHSA	Provincial Health Services Authority
PREOC	Provincial Regional Emergency Operations Centre
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
WHO	World Health Organization

Executive Summary

British Columbia is on the frontlines of the climate crisis. In recent years, the province has experienced extreme heat events, wildfires, storms, floods, and droughts with increasing frequency and intensity.

Not only are climate change and extreme weather events having significant impacts on the physical and mental health of people in British Columbia (B.C.)—they are impacting cultural, spiritual, social, economic, and ecological determinants of health and well-being. By preparing for and adapting to a changing climate, we have a significant opportunity to improve health outcomes and increase climate resilience for all.

Climate Change and Health in British Columbia: From Risk to Resilience is a project aimed at improving our understanding of climate-related health impacts on B.C.'s populations and health system, and identifying effective and equitable measures to increase adaptive capacity and resilience. Using a variety of research methods, *Risk to Resilience* has explored the health implications of climate change in B.C. and identified measures we can take to reduce the health risks of extreme heat, wildfires, flooding, and drought {section 2.1}

In 2022, the Province released the *Climate Preparedness and Adaptation Strategy*, and the health system has been a key partner in assessing climate impacts, building knowledge and capacity, and promoting cross-sectoral collaboration grounded in cultural safety and health equity {section 11.1}. Still, there is more work to be done across all sectors of society if B.C. is to protect population health, maintain health system performance, and transition to a climate resilient and sustainable health system.

For our health workforce which is on the frontlines of other public health emergencies such as COVID-19 and the toxic drug crisis, extreme weather events have brought additional pressures. In many cases, health service providers and staff must navigate the personal impacts of these events while also caring for patients at times of heightened pressure. When multiple climate-related events have occurred in close succession or even simultaneously, health infrastructure has been damaged, demand for health services has surged, and additional stress has been placed on the health system.

By drawing insights and identifying opportunities for action, *Risk to Resilience* illuminates a path to a healthy and climate resilient B.C. that addresses health inequities and advances Indigenous reconciliation.

Kwikwasut'inuxw Haxwa'mis, Mamalilikulla Nations, Vancouver Island

Climate and Health Equity

While we are all impacted by our changing climate, we are not all affected equally. Climate change acts as a "threat multiplier." It worsens existing health disparities and creates conditions for new inequities to emerge, affecting many determinants of health and well-being, such as income, housing, food security, and social cohesion {section 3.2}. Collaboration across sectors and communities will be necessary to prevent further disparities and to achieve health equity in climate adaptation. Public health organizations and agencies have a particularly important role to play in driving this collaboration.

To enhance climate resilience for everyone in B.C., equity considerations must be integrated into climate adaptation efforts across sectors and scales {section 3.4}. We must address avoidable health disparities that are rooted in historical injustices and systems of oppression, and address key determinants of health that influence the capacity to adapt to a changing climate.

Some people and communities experience unique and disproportionate risks and impacts of climate change, such as rural, remote, and under-resourced populations; older adults; children; and individuals with chronic health conditions {section 3.2}. Indigenous communities are also uniquely impacted by climate change. Many First Nations communities in B.C. face disproportionate health risks during and after extreme climate-related events, in addition to impacts on their traditional foods, medicines, and ways of living. These impacts may resurface past and ongoing trauma from colonialism and systemic racism {section 3.3}.

Indigenous understandings of health are often holistic—including physical, emotional, psychological, and spiritual well-being—and interconnected with the health of the land, waters, and more-than-human kin. Climate impacts on the land and ecosystems are inextricably tied to the physical, emotional, and spiritual health of Indigenous Peoples in B.C. Since time immemorial, Indigenous Peoples have demonstrated strength and leadership in adapting to changing environments. Climate action offers an opportunity to advance reconciliation by recognizing and upholding Indigenous Rights, valuing Indigenous knowledge systems, and advancing Indigenous-led climate action to protect health and well-being {section 3.3}.

Nisga'a Nation gathering

Extreme Heat

Extreme heat events, also known as heat waves, are a pressing public health concern and one of the highest-risk hazards for B.C. {section 4.1}. In Canada, where average annual temperatures are rising more than twice as fast as the global average, extreme heat is a leading weather-related cause of death {section 4.1}. However, we can greatly reduce the negative impacts of heat and build community resilience through planning, preparation, and responsive adaptation.

Robust and effective climate action is needed to prevent the impacts of more frequent and prolonged extreme heat events in B.C., where temperatures in the north are rising faster than the rate of southern regions. Without significant climate action, annual average temperatures in the province are projected to rise by up to 2.7°C by the middle of this century {section 4.1}.

Population health impacts

Collaborative action is needed to prepare for future heat waves in the province, where extreme heat events are a significant threat to population and public health. Recent extreme heat events in B.C. have resulted in heat-related deaths and illness across all regions and health authorities {section 4.2.1}. Despite these impacts, targeted adaptation measures can significantly prevent heat-related deaths and illness by reducing risk, enhancing resilience, and increasing preparedness against extreme temperatures.

Acute heat-related illnesses, such as heat stress, dehydration, and heat stroke, are frequently reported during extreme heat events in B.C. Other heat-related concerns include mental health impacts, respiratory and cardiovascular illnesses, increased risk of foodborne and waterborne illness, and disruptions to community well-being (e.g., impacts on social, recreational, and community events) {section 4.2.1}.

Some of those most at-risk to extreme heat impacts include: Indigenous communities; people with mental health conditions (e.g., schizophrenia); older adults; people who are socially isolated; individuals with pre-existing health conditions (e.g., cardiovascular, respiratory, diabetes, and renal diseases); people with disabilities and/or mobility challenges; and materially disadvantaged populations {section 4.2.2}.

Health system impacts

As experienced in recent years, extreme heat events in B.C. significantly impact the health system {section 4.2.3}. During the 2021 heat dome, health care providers experienced increased workloads, mental health impacts, and/or occupational safety concerns. Patient volumes increased substantially in acute care services province-wide, and emergency medical services faced call volumes at least two times above normal, especially in the Lower Mainland and the Fraser Valley.

At long-term care homes, additional resources and operational changes were put in place during the 2021 heat dome. These included deploying portable air conditioning units, relocating residents, and increasing check-ins. Health care facilities faced challenges in maintaining indoor temperatures and had equipment malfunctions, interruptions in service delivery, and freezer failures. The 2021 heat dome also disrupted health system supply chains, affecting vaccine and medication storage, food supply, and transportation routes {section 4.2.3}.

Despite these challenges, B.C has made significant province-wide strides in extreme heat preparedness since 2021, including collaboration with local governments and First Nations communities to inform adaptations in health policies, services, and response strategies:

- Provincial structures have been developed to support coordinated planning and response, including province-wide alerting and response systems;
- Regional health authorities have actively incorporated extreme heat preparedness into their operations;
- Public health and home and continuing care teams have been developing guidance and tools for conducting check-ins for at-risk clients during extreme heat and smoke events; and,
- A number of public resources have been developed to help people prepare for a heat event. These have been published in multiple languages to address linguistic barriers {section 4.2.3}.

Opportunities for action

In B.C., there are a number of opportunities to enhance preparation and reduce the impacts of extreme heat on population health and the health system. These include:

1. Continue to clarify roles and responsibilities across sectors;
2. Continue mapping and surveillance activities to identify populations and neighbourhoods at-risk to extreme heat;
3. Engage in collaborative pre-heat season planning with local governments and First Nations;
4. Adopt an all-hazard approach that considers the interconnectedness of heat risk factors to other hazards, and develop adaptation strategies that offer health co-benefits; and,
5. Consistently update and promote targeted public heat-health messaging and communication resources for key sectors and populations {section 4.4}.

Cooling Stations across Victoria, B.C.

Wildfire

Penticton, B.C. — August 29, 2021

Severe wildfire seasons are among the greatest climate risks facing B.C. Larger, more frequent, and more intense wildfires are projected for the province, including a longer wildfire season. By 2050, without significant climate action, a severe wildfire season is projected to occur roughly once every three to 10 years in B.C. {section 5.1}.

In the 102 years of recorded wildfire history in B.C., the four most destructive wildfires (by area burned) occurred during the last decade.

The province has experienced increasing wildfire activity over time, driven in part by climate change. In the 102 years of recorded wildfire history in B.C., the four most destructive wildfires (by area burned) occurred during the last decade. Wildfires also create cascading impacts, such as increased runoff after intense rainfall or rapid snowmelt, soil erosion, floods, landslides, and drought conditions in areas that experience high burn severity {section 5.1}. These events underscore the need for collective action across sectors to protect people, communities, and the environment from more frequent and intense wildfires.

Population health impacts

Large proportions of the B.C. population are exposed to wildfire smoke each year at levels above the recommended threshold to protect human health. Wildfire smoke contains particulate matter (PM) and toxic chemicals that can pose immediate and long-term health risks. In 2021, approximately three-quarters of special air quality statements issued for B.C. by Environment and Climate Change Canada were due to wildfire smoke {section 5.1}.

In B.C., cardiorespiratory effects are some of the most frequently reported health effects of wildfire smoke. During wildfire smoke events, the province has seen increased use of asthma medication, alongside higher numbers of emergency department visits, physician visits, hospitalizations, and ambulance calls for respiratory, cardiovascular- and diabetes-related illnesses {section 5.2.1}. While wildfires are rarely a direct cause of death in B.C., deaths associated with fine particulate matter ($PM_{2.5}$) from wildfire smoke have been reported {section 5.2.1}.

In 2021, approximately three-quarters of special air quality statements issued for B.C. by Environment and Climate Change Canada were due to wildfire smoke.

Preparedness for wildfires and wildfire smoke is crucial to protecting public health, minimizing immediate and long-term health risks, and ensuring the resilience of the health care system in the face of increasingly frequent and intense wildfires. B.C. has been adapting processes and systems with successive events throughout its long history with wildfires.

Progress in recent years includes expanding collaboration of regional, provincial, and federal agencies to coordinate wildfire smoke response; using low-cost PM sensors to expand the range of air-quality monitoring; developing public health messaging and resources about wildfire smoke-related risks; and developing health facility and infrastructure adaptations {section 5.3}.

Wildfires indirectly impact the health and well-being of B.C. populations by influencing the determinants of health. When smoke levels are high, outdoor recreational and community activities are impacted. When wildfires rage, they can result in economic losses, as well as lost productivity and livelihoods. In addition, evacuees can experience impacts on mental health, isolation from friends and family, and diminished community unity {section 5.2.1}. In First Nations communities, wildfires and wildfire smoke have restricted access to sacred and cultural sites, which hold significance for community health and well-being.

Some B.C. populations are more susceptible to the health effects of wildfires in B.C., including: Indigenous communities; people with pre-existing cardiovascular and respiratory conditions; older adults and young children; low-income, marginalized and/or underhoused populations; and pregnant people and the developing fetus {section 5.2.2}.

Targeted adaptations are needed to ensure protective measures are tailored to those facing disproportionate risks to the health, environmental, and socio-economic impacts of wildfires.

Many First Nation communities in B.C. are situated in rural and remote locations where they are more likely to be exposed to wildfire risks. Uncontrolled wildfires can disrupt First Nations' spiritual and cultural connection to the land through impacts to traditional ways of life and activities, such as fishing, hunting, and trapping, with adverse consequences for community health and cultural well-being {section 5.2.2}.

Since time immemorial, First Nations in B.C. have long understood the interconnectedness of the health of forests, land, and communities. Indigenous-led adaptations, such as prescribed cultural burns, not only safeguard physical health but also the broader cultural, spiritual, and mental well-being of Indigenous communities and the land {section 5.3}.

Health system impacts

Wildfires and wildfire smoke are impacting B.C.'s health system in several ways. Increased workloads, exposure to poor air quality when smoke infiltrates health facilities and heightened mental health challenges are all among the widely reported wildfire impacts on B.C.'s health workforce {section 5.2.3}.

Supply chain challenges that affect patient care are also frequently reported {section 5.2.3}. Ensuring people and pharmacies have access to essential medications and supplies is a common concern—particularly when transportation routes into communities are cut off by wildfires, or when communities are evacuated. Adequate distribution of food can also be a challenge when wildfires damage infrastructure, lead to road closures, and/or displace residents.

Opportunities for action

Building on existing adaptations, opportunities to advance health resilience to wildfires include:

1. Continue to collaborate and clarify roles across ministries and partners;
2. Update and promote public awareness and educational resources on the health risks of wildfire smoke and protective measures, including targeting materials to key sectors and populations;
3. Work with partners to create accessible and safe indoor community clean air spaces during wildfire smoke events;
4. Explore and expand the use of low-cost air quality sensors to expand the geographical range of air-quality monitoring and to improve understanding of smoke infiltration in buildings; and,
5. Support B.C. research to better understand the short- and long-term physical health impacts (e.g., adverse birth outcomes) and mental health impacts of wildfire smoke exposure {section 5.4}.

Victoria General Hospital

Flooding

Sumas Prairie — November 2021

Flooding events have historically been the costliest and most destructive environmental disasters in Canada. B.C. has experienced a number of serious flooding events in the past decade, resulting in infrastructure damage, injuries, and even loss of life {section 6.1}. Extreme precipitation and flooding can also have cascading impacts, such as landslides and debris flows, and disruptions to vital transportation corridors.

Climate projections indicate that, without significant climate action, severe river flooding and severe coastal flooding will be up to five times more likely to occur in B.C. by the 2050s. Precipitation-related drivers of flooding are occurring more frequently and at greater magnitude over time, and this trend is projected to continue {section 6.1}.

B.C.'s coastal communities are at heightened risk for coastal flooding and storm surges, due to rising sea levels and frequent seasonal wind events and high tides. With more than 27,200 km of coastline and over 75 percent of its population living in coastal areas {section 6.1}, B.C. is home to many communities facing heightened risk of coastal flooding and its impacts to infrastructure, transportation route access, and health.

Significant provincial efforts are underway to enhance flood resilience in B.C., by better understanding flood risks and defining a strategic provincial vision and plan for flood management {section 6.3}. The health system plays a critical role in monitoring and addressing the health impacts of flooding and contributes to flood preparedness, planning, response, and recovery at the provincial, regional and local level.

Population health impacts

Flooding in B.C. can pose significant physical and mental health risks. Extreme precipitation and flooding can impact the quality of indoor air, food and drinking water, and increase the risk of exposure to physical, biological, or chemical hazards. For instance:

- Increased rates of giardiasis and cryptosporidiosis have been detected after extreme precipitation events in some parts of B.C.;
- Injuries and mould-related exposures have been associated with flooding events; and,
- Commonly reported mental health impacts from flooding include psychological distress, anxiety, depression, and post-traumatic stress disorder {section 6.2.1}.

Recent flood events in B.C. have spurred expanded action to proactively protect water quality, educate the public about staying safe in flood zones, and engage in public health planning for coastal flooding.

Flooding does not affect all populations equally. In B.C., populations disproportionately affected by floods include Indigenous communities; rural and remote communities; people living in floodplains or low-lying coastal areas; older adults, children and youth, women, and farmers and ranchers; and underhoused or low-income populations {section 6.2.2}.

Many First Nations in B.C. are situated on floodplains, as a historical outcome of the colonial placement of reserve lands in these areas, and as a result, are disproportionately affected by flooding and displacement or evacuation. First Nations have endured emotional distress and anxiety, impacts on drinking water quality, and disruptions to their

cultural and land-based practices {section 6.2.2}. Despite these challenges, First Nations communities in B.C. continue to demonstrate strong leadership in flood risk assessment, preparedness, and adaptation by drawing on First Nations knowledge systems and land-based practices.

Health system impacts

The delivery of health care is directly impacted when flooding leads to power outages, damage to water supply, and/or disruptions to transportation networks. Flooding can also cause significant loss and damage to medical equipment, health care facilities, and infrastructure—with the potential for prolonged service disruptions and patient evacuations. Health facilities situated on floodplains are particularly vulnerable, as they face increased risks for localized flooding, equipment failures, and site evacuations, for example {section 6.2.3}.

Major floods in recent years have compounded challenges for B.C.'s health workforce, resulting in increased workloads and mental health impacts. Flood-related transportation disruptions can affect service availability by hindering health care workers' ability to get to or from work {section 6.2.3} or by impacting critical supply chains.

The 2021 atmospheric river (AR)-flood events had substantial impacts on B.C.'s health supply chains, damaging transportation routes, hampering the availability and delivery of essential medical supplies, and affecting water quality monitoring. This event, the largest agricultural disaster in B.C.'s history, also significantly disrupted food supply chains, with reduced production in flooded areas and blocked transportation routes {section 6.2.3}.

Following record-breaking flood seasons in recent years, provincial and regional after-action reviews have recommended expanded preparedness and action planning. While many flood-based adaptations are led by various sectors and partners (e.g., local governments, First Nations, and multiple provincial ministries), the B.C. health system contributes to flood prevention, preparedness, response, and recovery at multiple levels. Province-wide flood adaptations include:

- Development of a provincial flood strategy;
- Enhanced flood monitoring and response structures;
- Early warning systems;
- Data-driven public risk communication tools; and,
- Support for individual preparedness and flood-risk communications {section 6.3}.

Opportunities for action

Addressing the population health and health system impacts of flooding in B.C. requires a coordinated, collaborative, and cross-sectoral approach. Specific opportunities include:

1. Strengthen community-level coordination and collaboration between health agencies, local governments, First Nations, and other partners during flood events and in flood recovery;
2. Continue to enhance water quality monitoring during and after flooding;
3. Increase public awareness and education for residents about the health risks of flooding;
4. Build capacity for flood preparedness, rapid flood response, and recovery strategies, including mental health supports;
5. Improve understanding of the short- and long-term physical and mental health impacts of flooding; and,
6. Include flood risk assessments in health facility climate risk assessments {section 6.4}.

Drought

Low water levels at Kinbasket Reservoir near Valemount, B.C. — 2022

Drought is considered a significant climate hazard for B.C. Decreased seasonal snow accumulation, warmer summers, and reduced summer rainfall are projected to increase the duration and frequency of seasonal drought in the province—particularly in the summer months {section 7.1}.

About 63 percent of B.C.'s population (2.9 million people) currently live in water-stressed areas, primarily in the Southern and Interior regions. While areas with the highest levels of water stress cover only 3.7 percent of the province, they are home to 23 percent of the population {section 7.1}.

Drought and water scarcity can impact communities in many ways—from reducing water availability and groundwater levels to warming river temperatures (affecting fish and aquatic life) and heightening food insecurity. Drought can also exacerbate other climate hazards in B.C. For example, prolonged dry spells can increase wildfire risks, while heavy rain events on dry, hydrophobic (water-repelling) soils can lead to increased overland flood risk.

When water sources are depleted, drinking water systems and other critical infrastructure are placed under increased pressure. This, in turn, can impact the availability, accessibility, and safety of drinking water—with numerous potential health impacts, such as reduced water quality and quantity {section 7.1}.

Drought and associated water shortages commonly occur during summer months. This means they can potentially coincide with extreme heat events and wildfires, where the availability of potable water and water for fire protection is critical. An all-hazard approach, one that considers the complex interactions between drought with other hazards, is critical to reducing vulnerability, building adaptive capacity, and developing strategies that enhance resilience to multiple risks.

Population health impacts

While there is little research on the direct physical health impacts of drought on populations in B.C., mental health impacts are an emerging area of concern as worries about longer-term impacts contribute to intensified climate anxiety during periods of drought {section 7.2.1}.

Health impacts of drought vary, depending on the severity and duration of drought, with many reported impacts related to the security of drinking water and food. Drought indirectly impacts health by increasing the spread of foodborne, vector-borne, airborne, dust-related, and fungal diseases. Drought-driven food insecurity can also increase the risks of undernutrition and micronutrient deficiencies {section 7.2.1}.

Drought indirectly impacts health by increasing the spread of foodborne, vector-borne, airborne, dust-related, and fungal diseases.

Targeted adaptations are needed to ensure all communities and populations have the support they need to adapt and proactively address the impacts of drought. Some populations in B.C. are at greater risk, including rural and remote communities, farmers and ranchers, and

Indigenous communities. Indigenous Peoples may face impacts on traditional food sources, such as salmon and other fish species. Many Indigenous communities also rely on local water sources for cultural practices, customs, and traditions. When these water sources run low, there can be impacts on mental, spiritual, and cultural well-being {section 7.2.2}.

Health system impacts

Limited water supply during droughts also has wide-ranging implications for hospital operations, such as sanitation, sterilization of medical equipment, and patient care {section 7.2.3}. In addition, critical systems such as cooling towers and boilers may be affected by water shortages, leading to disruptions in essential health care services {section 7.2.3}.

Multiple local, provincial, and federal agencies are responsible for drought management and response. In the context of drought, the Province follows an all-hazard approach, with public health bodies playing an essential role. The health sector acts as a key partner, offering guidance, performing water quality testing, enhancing preparedness, and mitigating risks during drought events. When a community experiences a loss, near loss, or failure in its potable water or firefighting water supplies, the drought response turns to an emergency response to protect public health and safety {section 7.3}.

B.C. health authorities recognize the risks of drought-related water shortage for health facilities and health care operations and services {section 7.2.3}. Health system adaptations are underway to address risks from drought, including:

- Reducing water usage in health care facilities by optimizing landscape irrigation, capturing/reusing rainwater, and managing sewage and wastewater;
- Improving guidance and communications on building design, landscaping, and nature-based solutions for water conservation; and,
- Working with provincial partners to disseminate information about drought to the public {section 7.3}.

Opportunities for action

Opportunities to enhance preparedness and response to the health impacts of drought in B.C. include:

1. Collaborate with local governments, First Nations, and Métis communities to develop information, resources, and support for sustainable water use practices;
2. Undertake proactive planning by including drought in health sector risk assessments and plans;
3. Develop drought management plans for health facilities located in drought-prone regions, including demand-side management of water use;
4. Collaborate with water system operators to ensure they have robust drought emergency response plans;
5. Support the continuation and expansion of water monitoring during drought events; and,
6. Continue to research the physical and mental health impacts of prolonged drought, including stress, anxiety, and depression {section 7.4}.

When a community experiences a loss, near loss, or failure in its potable water or firefighting water supplies, the drought response turns to an emergency response to protect public health and safety.


Royal Jubilee Hospital — Vernon, B.C.

Cross-Cutting Impacts and Adaptations

One climate-related event may or may not be considered extreme in isolation. But when climate events occur in tandem, they can trigger severe cascading impacts on key determinants of health—such as housing, water and food safety and security, and livelihoods.

In 2021, B.C. experienced compound climate hazards, occurring when multiple hazards contribute to societal or environmental risks in real-time. This rapid succession of extreme events caused dramatic disruptions to communities and the health system, highlighting the need for an all-hazard approach for integrated planning. This is especially urgent, given the projected increase in the severity and frequency of hotter, drier summers; warmer, wetter winters; and rising sea levels {section 8.1}.

Cross-cutting priorities related to compound climate-related events and cascading impacts in B.C. include:

Health workforce

The combined effects of COVID-19, the toxic drug crisis, and multiple years of wildfires, floods, and heatwaves have taken a considerable toll on the mental well-being of the health workforce in B.C. Staff have shouldered increased workloads during emergencies, stress from facility evacuations, and the need to balance personal impacts from disasters with increased demand for health services {section 8.2.1}.

B.C. health system staff have demonstrated unwavering commitment and resilience during recent challenging climate-related events. The health workforce has demonstrated innovation, adaptability, and teamwork in their commitment to protect the safety and well-being of communities and patients. While their continued dedication and tenacity have been vital during recent emergencies, working longer hours and "going above and beyond" in response to increasingly frequent climate-related events is unsustainable.

Health system staff rely on having adequate support in place during emergencies to successfully do their jobs in a changing climate. This includes support for mental and physical health, logistics and human resources, as well as training and capacity. All levels of government and society must take proactive actions to address the intersecting health and environmental crises, and understand what is needed to develop a prepared and climate-ready workforce {section 8.2.2}.

There are many opportunities to support B.C.'s health workforce in building adaptive capacity and climate resilience, including practical training, skill-building, and simulation exercises to practice and test emergency response plans. Cultural safety training for emergency management staff and first responders is particularly important to improve access to culturally safe care and support services for Indigenous Peoples {section 8.2.3}.

Health-related supply chains

Compound climate-related events and cascading impacts in B.C. underscore the importance of a resilient supply chain that can adapt to disruptions, ensure the availability of critical medicines and supplies (such as baby formula, air conditioners, and generators), support emergency response efforts, and keep the health system functioning {section 8.2.3}.

In recent years, damaged transportation infrastructure has disrupted the flow of essential medical supplies, equipment, medications, and

food. These impacts have been felt most acutely by populations with existing critical health challenges (e.g., patients requiring radiation, chemotherapy, or dialysis treatments), and by isolated rural and remote communities {section 8.3.1}.

The Province and health authorities are collaborating to understand supply chain vulnerabilities and develop system-wide adaptations to enhance resilience.

The Province and health authorities are collaborating to understand supply chain vulnerabilities and develop system-wide adaptations to enhance resilience. Efforts to improve emergency preparedness and resilience of B.C.'s health supply chains include distributing critical supply carts and essential medical equipment throughout the province to support the potential needs of evacuation reception centres. In addition, enhanced collaboration and planning across the health system now tracks, monitors, and manages products and sourcing by health authorities {section 8.3.2}.

To mitigate the impacts of future extreme weather events on health system supply chains, health systems and emergency management agencies will need contingency plans in place. These plans may include strategies for stockpiling medications and essential supplies, alternate supply chain routes, and emergency communication protocols with vendors {section 8.3.3}. Health agencies must also collaborate with community partners and other sectors—such as pharmacies, non-profits, provincial and federal emergency management agencies, and carrier companies—to deliver a coordinated response during extreme weather events.

Infrastructure and health-related facilities

Climate-related events are adversely affecting health facilities and infrastructure. B.C. is now experiencing impacts of aging health facilities and infrastructure that were not designed to withstand the current frequency and intensity of extreme weather events, such as:

- Strained cooling systems in hospitals and long-term care facilities during extreme heat events;
- Smoke infiltration into B.C. health facilities during wildfires;
- Increased exposure to flood-related impacts such as water infiltration and mould;
- Water restrictions during droughts; and,
- Impacts on critical infrastructure needed to deliver health services, such as roads, water, wastewater, power, and telecommunications {section 8.4.1}.

Infrastructure resilience to current and future climate risks is critically important to climate preparedness, as is mitigating greenhouse gas (GHG) emissions and the environmental footprint of health care facilities and operations {section 8.4.2}.

A systematic approach to identifying and addressing climate risk is already underway across the B.C. health system. Efforts to reduce GHG emissions through mitigation measures have been ongoing for more than a decade. Increasingly, the health system is working to ensure that the design, construction, and operation of health care facilities are reducing climate risks and GHG emissions in tandem {section 8.4.2}.

There are several opportunities to adopt a comprehensive approach that both reduces GHG emissions and enhances resilience in B.C. health facilities. In addition to system-wide changes to policy and practice, the health authorities are conducting climate risk assessments for buildings, upgrades to existing building stock and infrastructure, and measures to enhance preparedness for acute climate-related emergencies (e.g., availability of backup equipment and power sources) {section 8.4.3}.

There are also opportunities to enhance environmental health protection, which is vital to preserve water quality, ensure food safety, monitor air quality, manage waste, and mitigate environmental health risks before, during, and after extreme weather events. In B.C., numerous stakeholder bodies (e.g., councils, working groups, advisory committees) are developing ways to collaboratively improve airsheds, watersheds, and other environmental health determinants in a changing climate {section 8.6}.

Surveillance and monitoring of climate-related health risks and outcomes also plays an important role in supporting timely response {section 8.5.1}, increasing understanding of population vulnerability {section 8.5.2}, and providing data and evidence to inform policy and health system planning. By integrating climate and health data, B.C. can leverage existing environmental and population health surveillance programs to enhance the collection of standardized data {section 8.5.1}, identify people and places most susceptible to climate-related health impacts {section 8.5.2}, and convey critical information that motivates action and promotes public health in a changing climate {section 8.5.3}.

Rendering of the new St. Paul's Hospital, Vancouver, B.C.

Mental Health

There is mounting concern about the impact of climate change on mental health in B.C. As climate-related disasters occur more frequently, incidents of anxiety, depression, and post-traumatic stress disorder (PTSD) are likely to increase significantly {section 9.1}. The Province, in partnership with health authorities and non-profit service providers, has developed mental health programs, resources, and services to support individuals, families, and communities affected by climate-related disasters. As our climate continues to change, however, these supports will need to adapt accordingly.

Population health impacts

Evidence from climate-related events in B.C. indicates that mental health impacts can be lingering, long-lasting, and/or delayed {section 9.1}, while the emotional impact of these events often endures. These effects can last months, or even years.

Evacuations related to wildfires or floods can be traumatic. Displacement may be a short-term ordeal for some, but others may not return home for several weeks or months due to extensive damage. Some communities have been impacted by multiple evacuations and re-evacuations. This carries additional strain, uncertainty, and compounding stress and burnout—all of which take a toll on mental health and community unity.

People in B.C. also face slow-onset hazards, such as drought and sea-level rise, alongside growing awareness of climate threats here and around the world. Both can influence mental health and well-being, affecting one's sense of place and stirring anxiety, grief, anger, helplessness, and depression {section 9.1}.

Climate-related events in B.C. have also led to:

- Psychosocial impacts such as economic stress from loss of livelihood, substance abuse, and an increase in domestic conflict and violence. The risk of gender-based violence increased in B.C. during recent wildfire and flooding events.
- Heightened climate anxiety or "ecoanxiety"—emotional and psychological distress in response to environmental concerns and the escalating threats posed by climate change.
- Increased demand for mental health services. In the aftermath of recent heat waves, wildfires, and floods in B.C., there were measurable increases in the need for mental health services, including more emergency department visits for mental health and substance use services, and increased demand for family support, counselling, and victim services {section 9.1}.

Some populations are at a higher risk of experiencing mental health impacts from climate change, such as children and youth, women, rural and remote communities, and farmers and ranchers.

Some populations are at a higher risk of experiencing mental health impacts from climate change, such as children and youth, women, rural and remote communities, and farmers and ranchers {section 9.2}.

Significant compounding factors influence how climate change impacts the mental health and well-being of Indigenous Peoples. Historical trauma arising from the loss of ancestral lands and traditional territories, the erosion of language and culture, racism, and the painful legacy of residential schools and Indian hospitals are compounded over time.

These traumas can be triggered or exacerbated by a climate-related emergency event and how it is handled. Climate-related events also disrupt the ability of Indigenous Peoples to practice ceremony and land-based cultural activities—such as hunting, fishing, and gathering of food and medicine—that are essential to their cultural, spiritual, physical, and mental health and well-being {section 9.2}.

Opportunities for action

Community psychosocial supports during and after disasters are often provided in partnership with B.C. health authorities, non-profit service providers, and community agencies who understand the needs and strengths of local populations. Recent wildfire and flooding events have demonstrated how collective efforts and partnerships across organizations and sectors can ensure mental health supports meet diverse needs {section 9.3}. Addressing the acute and long-term mental health risks of climate change will require collaboration and coordination between public health and external agencies. Importantly, it also requires supporting community leadership and centering reconciliation and Indigenous worldviews of health and well-being.

Specific opportunities for action include:

1. Monitor the impact of climate-related events on mental health outcomes and services;
2. Ensure mental health recovery is informed and driven by community;
3. Offer rapid, sustained, and targeted psychosocial supports to impacted communities;
4. Include mental health preparedness and planning as part of climate adaptation and emergency management; and
5. Support culturally relevant and Indigenous-led mental health and wellness initiatives {section 9.4}.

Health Emergency Management, Evacuations and Health Service Delivery

B.C.'s health system has experienced concurrent, escalating, and unprecedented emergencies in recent years. Despite the strain this has placed on our health workforce, services and infrastructure, the health sector has demonstrated remarkable leadership, support, and expertise in responding to, preparing for, and adapting to these events.

Climate-related emergencies have affected multiple health authorities at once, and a coordinated health system response across the province has supported:

- Inter-health authority collaboration for evacuating hospitals, health care facilities, and long-term care/assisted living facilities;
- Transportation and logistics requests for moving pharmaceuticals, medical equipment, patients, and health staff in and out of impacted areas; and,
- Mobilization and coordination of community resources with other health-supporting sectors {section 10.3}. Strong collaborative networks have facilitated rapid information-sharing and the integration of health emergency management plans with community partners.

Health system impacts

Recent unprecedented climate-related disasters have placed significant demands on the B.C. health system.

- During evacuations, health authority staff are required to coordinate and track transportation of staff, patients, and supplies, including transporting people with complex care needs or limited mobility. The logistics of this can be especially challenging when caring for those dependent on specialized medical equipment and therapies, such as dialysis or cancer care {section 10.1}.
- In climate-related emergencies, a surge in patients creates cascading impacts on health care delivery in B.C. health facilities, such as overcrowded emergency departments, capacity strain affecting the availability of resources and equipment, and increased demand for social service and mental health programs {section 10.1}.
- Access to medications during significant wildfires and flood events has also been a significant challenge. For instance, pharmacy closures during mandatory evacuations and road closures can lead some evacuated patients to run out of medications while displaced {section 10.1}.
- Some health facilities have partially or fully closed during major wildfire and flood events in B.C., resulting in service delivery disruptions and patients having to travel longer distances to obtain care {section 10.1}.

Population health impacts

Prioritizing the unique needs of those experiencing health disparities across all phases of emergency management is critical to preventing disasters from worsening existing inequities or creating new ones. There is evidence that people disproportionately impacted by the 2021 wildfires and 2021 AR-flood events faced unfair barriers in accessing the emergency supports they needed. This included Indigenous Peoples, people with disabilities, lower-income households, older people and children, and people with complex care needs {section 10.2}.

Indigenous evacuees in B.C. were more likely than non-Indigenous evacuees to have been displaced by a combination of wildfire and flooding events in 2021 {section 10.2.1}. Their displacements were more likely to be longer in duration, and included challenges in accessing

health care, accommodation, and housing. To advance reconciliation, the needs, values, and worldviews of First Nations, Inuit, and Métis must be embedded into emergency planning and management. This requires support for Indigenous-led emergency planning, enhanced coordination and collaboration with health system partners, and embedding cultural safety in emergency health services {section 10.4}.

Opportunities for action

Health system staff and partners have identified lessons learned and opportunities to strengthen emergency preparedness and response in the future, including:

1. Continue to clarify how the health sector, including primary and community care, fits into the evolving structures of emergency management in B.C.;
2. Define the roles of health care providers and agencies in health emergency management, including disaster risk mitigation, preparedness, response, and recovery; and,
3. Prioritize the unique needs of priority populations and those experiencing health inequities in local, regional, and provincial health emergency response plans.

Effective measures to protect public health and safety before, during and after climate-related emergencies require a "whole-of-society" approach, with coordinated action across multiple sectors. While the immediate response to acute climate-related emergencies has generally been robust and nimble, more capacity is needed for proactive, long-term planning and evaluation {section 10.4}.

Indigenous evacuees in B.C. were more likely than non-Indigenous evacuees to have been displaced by a combination of wildfire and flooding events in 2021.

Merritt, after 2021 storm

Charting a Path to a Healthy and Climate Resilient B.C.

Climate change imposes significant and escalating impacts on B.C.'s communities and health system, now and into the future. Without accelerated climate action, our health system and communities will be increasingly challenged to respond to overlapping emergencies while carrying out essential core functions that keep communities healthy and safe. However, evidence indicates that early adaptation and resilience efforts offer substantial returns for B.C. They improve community well-being, lessen strain on the health system, and provide economic and environmental benefits.

While health professionals serve as key leaders and experts in protecting people in B.C. from the health risks of climate change, *they cannot shoulder it alone* {section 11.1}. The key determinants of risk and resilience must be addressed well before climate-related health effects show up at the hospital, clinic, or within the health system.

A proactive and comprehensive approach to climate-health action must consider where, why, and how risk and vulnerability occur. This requires collaboration across sectors, ministries, communities, and jurisdictions in a "whole-of-society" approach that brings together diverse expertise, lived experiences, and ways of knowing.

At this pivotal time, protecting communities from the growing health impacts of climate change will require collective action across all sectors to draw on lessons learned from recent emergencies and integrate health considerations into preparedness, response, and recovery efforts.

The following pathways offer strategic opportunities to protect against, prepare for, and respond to the health impacts of current and future climate-related events in B.C. {section 11.3}:

1. Uphold Indigenous knowledge systems, practices, and self-determination

1.1. **Advance existing commitments** to Indigenous rights and self-determination by ensuring that emergency management and climate action governance structures, policies, and guiding frameworks (e.g., the Sendai Framework for Disaster Risk Reduction) in B.C. reflect the *United Nations Declaration on the Rights of Indigenous Peoples* and the *Declaration on the Rights of Indigenous Peoples Act*, including recognizing the authority of Indigenous governing bodies in relation to emergency management.

1.2. **Embrace "two-eyed seeing" approaches** to understand and plan for climate-health outcomes, honouring and valuing the unique contributions of Indigenous knowledge systems and worldviews alongside Western science.

1.3. **Strengthen community adaptive capacity** by promoting and supporting Indigenous-led initiatives that enhance community resilience, enable skill acquisition, strengthen leadership, and improve emergency response to climate-related events.

1.4. **Enhance ecological health** by advancing Indigenous-led initiatives for habitat restoration and protection of species-at-risk to promote local climate/health resilience.

1.5. **Centre cultural safety in emergency management.** Ensure that cultural safety considerations are embedded in all aspects of emergency management, including disaster mitigation, preparedness, response and recovery, in partnership with Indigenous Peoples.

2. Strengthen the building blocks of a climate resilient health system

2.1. **Integrate climate change** into all health policies, programs, and decision-making.

2.2. **Establish governance structures** to integrate and coordinate climate action (mitigation and adaptation) across the health system.

2.3. **Continue to manage climate risks** (e.g., health care for climate-related mental and physical health impacts) alongside proactive policy and practice to address structural, social, economic, and ecological determinants of health.

2.4. **Continue reducing the ecological footprint** of B.C.'s health system, and advance strategies for low-carbon resilience.

2.5. **Provide the public with effective information** on preparing for emergencies and protecting health and well-being in a changing climate.

2.6. **Develop sustainable and transparent funding** to support near- and long-term climate resilience in health systems.

3. Collaborate across sectors to centre health in climate action

3.1. **Continue to centre and embed physical and mental health** into province-wide climate change initiatives, such as the Disaster and Climate Risk and Resilience Assessment (in development).

3.2. **Integrate health and well-being** into regional and local climate action plans, policies and programs by building on existing partnerships between regional health authorities, communities, First Nations, Métis, and other key partners.

3.3. **Continue identifying innovative ways to collaborate** across sectors, jurisdictions, and public health systems to plan and implement climate-health actions.

3.4. **Leverage health expertise** to communicate with and mobilize key audiences on climate-health action, such as health professionals, the media, and the education sector.

4. Understand the full extent of the health impacts of climate change in B.C.

4.1. **Continue conducting and promoting** equity-informed climate and health vulnerability and adaptation assessments to characterize risks, identify populations and regions at greatest risk, and understand what is needed to prepare and respond.

4.2. **Foster collaborations** with B.C. research partners to better understand climate and health impacts and adaptations, while honouring Indigenous knowledge systems and methodologies.

4.3. **Further explore** physical and mental health risks of climate change for key populations, including Indigenous Peoples and people who have been evacuated due to climate events.

4.4. **Assess future climate-health impacts** with climate modelling and simulations.

4.5. **Enhance surveillance and monitoring** of climate-health risks, and develop standardized indicators to support tracking, communications, and data sharing.

4.6. **Prioritize and support continued learning and evaluation** following climate-related events, such as participatory after-action reviews.

4.7. **Enhance collective understanding** of what interventions and adaptations work best for different population groups.

5. Build a climate-resilient health workforce

5.1. **Provide health workforce training and guidance** on assessing and managing climate-related health risks, low-carbon resilience, and raising public awareness/education.

5.2. **Conduct experiential learning**, such as simulation exercises, to test emergency planning and response to climate-related events.

5.3. **Provide cultural safety training** for emergency management staff, first responders and volunteers to build awareness and understanding of the health impacts of climate change on Indigenous people, and of the importance of Indigenous knowledge systems in climate resilience.

5.4. **Ensure adequate mental health services and supports** are available for health workers, especially those directly supporting communities to respond and recover from climate emergencies.

Conclusion

Every dimension of the B.C. health system has been impacted by climate change. Moving from risk to resilience requires a systems-wide approach—one that enhances leadership on climate-health action across the health system and across sectors, that prioritizes populations most at risk, and that respects and upholds Indigenous rights and knowledge systems.

Frequent and intense extreme heat events, wildfires, flooding, drought, and other climate hazards are disrupting the balance between the health of the environment and human health and well-being. These compounding risks amplify health inequities and present new threats to physical and mental health.

Without rapidly scaling up adaptation measures, more frequent and intense extreme weather and climate-related events will place increasing pressure on our ability to respond to and reduce health risks. In other words: the urgency, scale, and scope of our collective response must match the size of the health threat presented by climate change.

Chapter 1: Introduction

British Columbia is on the frontlines of the climate crisis. As the province experiences more extreme wildfires, heat events, storms, droughts, and floods, the health and well-being of people and communities is at risk.

The World Health Organization (WHO) identifies climate change as the single greatest health threat to humanity, posing significant and wide-ranging impacts to natural and human systems [14]. Since time immemorial, Indigenous Peoples have emphasized the vital importance of honouring the profound link between human health and the well-being of our environment [15]. In British Columbia (B.C.), the reality of recent heat waves, devastating wildfires, catastrophic floods, and prolonged droughts underscore the relevance of this connection. These events serve as a stark reminder that the climate crisis is upon us, and that strong leadership and collaboration are needed to reduce and manage climate risks.

Climate change is already measurably impacting the physical and mental health of people in B.C., with broad implications for the health system. Whether it is enduring weeks of exposure to wildfire smoke, suffering through record-setting heat waves, or being unable to hunt or harvest traditional foods, we are all impacted by a changing climate [16]. However, these health impacts are not evenly distributed within or between population groups. First Nations, Métis, and Inuit, as well as rural, remote, and under-resourced populations, experience unique and disproportionate risks and impacts, further exacerbating existing health inequities. Enhancing climate resilience[1] for everyone in B.C., regardless of where or how they live, requires actions across sectors and scales that integrate equity considerations across climate-adaptation efforts [18]. It also means respecting and upholding Indigenous Rights and knowledge systems, and ways of living in relationship with the natural world, that have sustained health and well-being for generations [19].

Definitions of climate mitigation and adaptation

MITIGATION is an intervention to reduce greenhouse gas (GHG) emissions.

ADAPTATION is the process of adjustment to the actual or expected climate and its effects, in order to moderate harm and/or uncover beneficial opportunities [20].

MALADAPTATION results from actions that may lead to an increased risk of adverse climate-related outcomes, such as increased GHG emissions, increased or shifted vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence [20].

1 Resilience as a framework and as a word has multiple definitions and understandings. For the purposes of this project, climate resilience can be understood as our collective ability to anticipate, respond to, cope with, recover from, and adapt to climate-related shocks and stresses, to bring sustained improvements in population health, despite an unstable climate [17].

While the health risks of a changing climate will increase as warming continues, efforts to prepare for climate change are also seen as the greatest opportunity to address social and environmental determinants of health, *significantly reducing* current and future impacts on individuals, communities, and health systems [18]. In 2022, the Province of B.C. released the *Climate Preparedness and Adaptation Strategy*, and the health system has been a key partner in assessing climate impacts, building knowledge and capacity to prepare and respond, and promoting cross-sectoral collaboration to ground responses in cultural safety and health equity. But there is *more work to be done* across all sectors of society if B.C. is to protect population health, maintain health system performance, and transition to a low-carbon, climate-resilient health system.

Identifying effective, equitable, and responsive health adaptation measures requires understanding the extent and nature of climate risks, and their impacts on health and the health system. This includes prioritizing hazards, understanding differences across populations and regions, identifying and filling knowledge gaps and research needs, and implementing leading practices to reduce risks and build resilience. This is what the *Climate Change and Health in British Columbia: from Risk to Resilience Project* has set out to do.

1.1 Climate and health in British Columbia: From risk to resilience

The *Risk to Resilience Project's* purpose is to improve understanding of climate-related health impacts on B.C.'s populations and health system, and identify effective and equitable measures to increase adaptative capacity and resilience. The project explores impacts and adaptations to extreme heat, wildfires, flooding, and drought, identified as key climate hazards of provincial-level significance. Given the unprecedented compounding impacts of the 2021 extreme heat, wildfire, and flooding events, and 2021-2023 drought, this project includes a further sub-analysis of these events, as well as lessons learned and opportunities for action.

The *Risk to Resilience Project* objectives included:

1. Synthesizing current knowledge and information on the impacts of climate change on health and the health system in B.C. (see Figure 1), including priority hazards, exposure pathways, and risk and resilience factors, through evidence review and partner engagement;
2. Identifying and documenting promising practices, lessons learned, innovative solutions, and stories that demonstrate effective and equitable adaptation measures in B.C., to inform climate-resilient health policies, programs, and services; and
3. Delivering knowledge translation and mobilization activities to build public- and health-sector capacity and awareness, to assess, adapt, and respond to climate change.

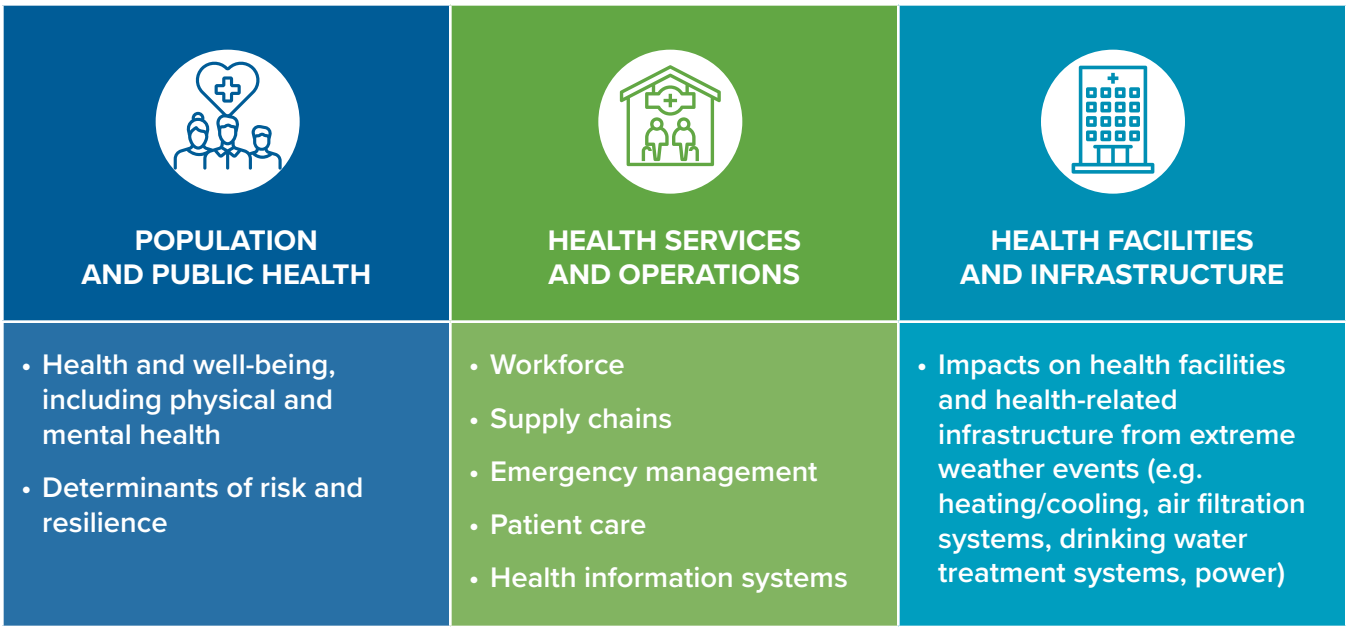


Figure 1. Risk to Resilience Project areas of focus

The health system in B.C.

A health system consists of all organizations, people, and actions whose primary intent is to promote, restore, or maintain health [21]. The *Risk to Resilience Project's* primary focus is on the B.C. Ministry of Health and the health authorities' realms of influence.

The Ministry of Health has overall responsibility for ensuring that quality, appropriate, cost effective and timely health services are available for all British Columbians, and supports and funds the activities of health authorities to deliver health services in B.C., including [22]:

- The Provincial Health Services Authority works with the five regional health authorities to plan and co-ordinate the delivery of provincial programs and specialized services. This includes programs that play a key role in climate preparedness and adaptation, such as the BC Centre for Disease Control, Health Emergency Management BC, and BC Emergency Health Services;
- Five regional health authorities govern, plan, and deliver health care services within their geographic areas, including Northern Health, Island Health, Interior Health, Fraser Health and Vancouver Coastal Health;
- The First Nations Health Authority (FNHA) works to transform health services for First Nations in B.C. and achieve a high standard of health and wellness. FNHA follows Seven Directives to design and deliver safe and equitable programs and services for First Nations families, while honouring tradition and cultures.

Stanley Park, Vancouver, B.C. — August, 2021

The *Risk to Resilience Project* takes a strengths-based approach to understanding climate risk, and highlights the assets and actions that are contributing to climate-health resilience in B.C. Aligning with principles of the B.C. *Climate Preparedness and Adaptation Strategy (2022)* [23] and the United Nations Sendai Framework for Disaster Risk Reduction (2015–2030) [24], the project is characterized by a collaborative, intersectional approach that centres health equity and honours, upholds, and respects Indigenous ways of knowing.

The *Risk to Resilience Project* intersects and builds upon other complementary climate assessments taking place in B.C. and Canada, such as the national Health of Canadians in a Changing Climate report (2022); the Ministry of Emergency Management and Climate Readiness Disaster and Climate Risk and Resilience Assessment (scheduled to be released in 2024), which includes a pillar on health and well-being; health authority climate vulnerability and adaptation assessments; and climate assessments by First Nations and Métis organizations (e.g., Métis Nation Climate and Health Vulnerability Assessment, 2020) and local governments. It also lays the groundwork for further assessments at provincial and regional levels, and will enhance health-sector expertise, knowledge, and resources. In this way, the *Risk to Resilience Project* identifies climate risks to support and inform equitable, evidence-based action to protect and promote health.

1.2 Context

Climate change is recognized as a major public health crisis in Canada [16,18], which is warming faster than the global average, and at twice the average rate of the rest of the world [25]. Climate change and acute extreme weather events are already significantly impacting the health of B.C. populations—delivering effects on physical and mental health (see Figure 2), and on the broader cultural, spiritual, and ecological facets of health and well-being [26].

Climate-related shocks and stressors are also exerting significant demands on B.C.'s health system. Recent extreme weather events have damaged health infrastructure and put additional strain on health services. Health care providers are under increasing pressure as they deal with climate-related events alongside other public health crises, such as COVID-19 [18,27] and the toxic drug crisis [28].

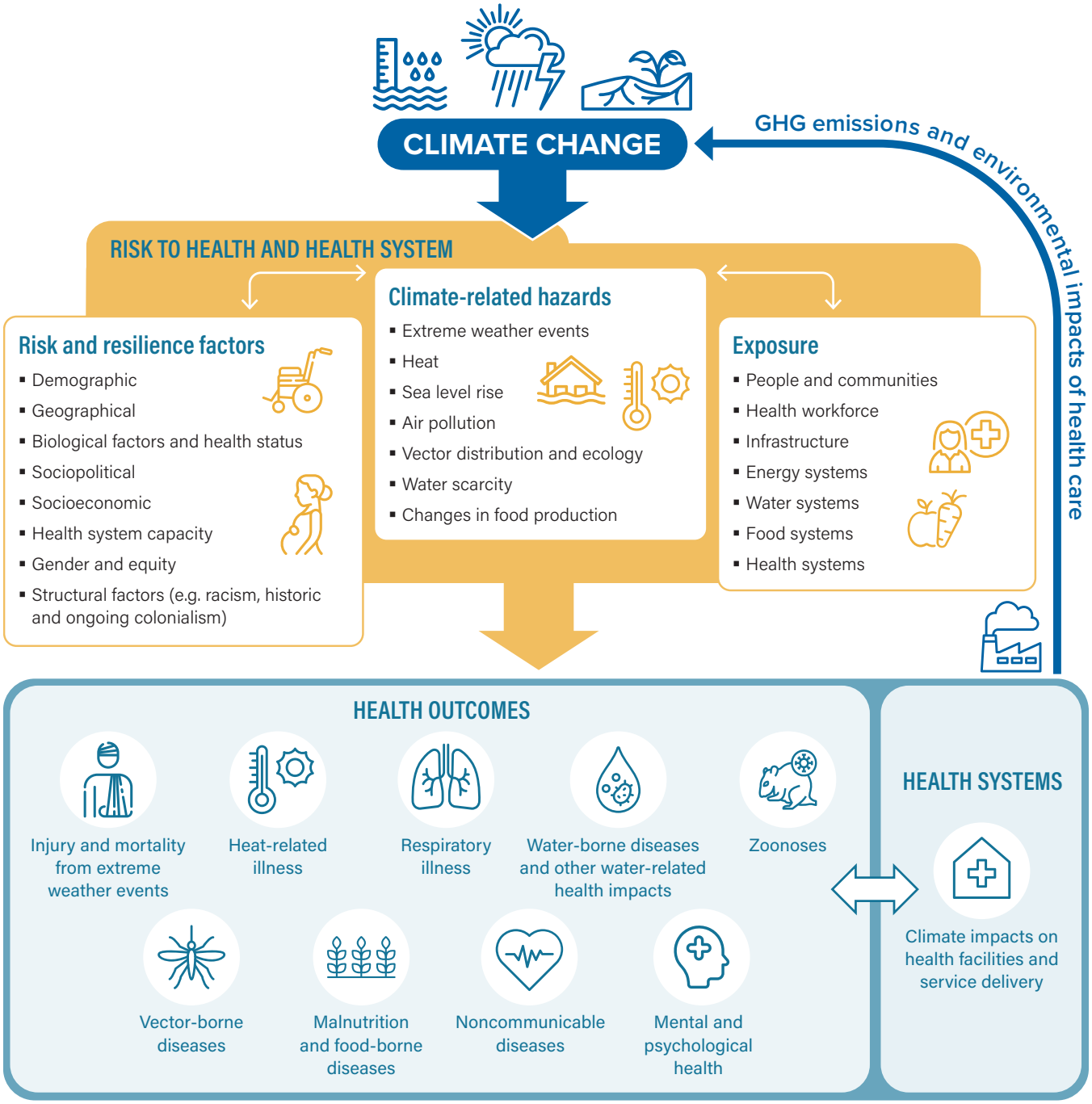


Figure 2. Climate change hazards and public health risks [29]

The 2019 Provincial Preliminary Strategic Risk Assessment [30], which assessed overall climate change risks facing B.C. by the 2050s, ranked severe wildfire seasons, seasonal water shortages, and heat waves as the greatest risks facing the province (not accounting for regional differences). The assessment examined 15 risk-event scenarios, and concluded that all but four could have "catastrophic" consequences in one or more impact areas (including loss of life, health-related, infrastructure services, natural resources, economic, and social disruption). The assessment also highlighted that climate-risk events often occur simultaneously, and noted that the consequences of coinciding or back-to-back events could be significantly greater than those of any single event alone.

There is mounting evidence that the changing climate is impacting the health of people in B.C. (e.g., population health impacts of air pollution from wildfire smoke [31]; heat-related hospitalizations [32]; and mental health impacts [33,34]). B.C.'s changing climate will continue to have significant impacts on physical and mental health, as well as on the ecological, socioeconomic, and cultural determinants of health, through multiple pathways.

1.3 Looking back at 2021: A record-breaking year for climate-related events in B.C.

2021 timeline of record-breaking climate-related events

In 2021, B.C. started the year facing multiple health emergencies, including the ongoing toxic drug crisis and the COVID-19 pandemic. The latter, which began in 2020, triggered a 16-month-long provincial state of emergency that ended in June 2021 [35].

Throughout 2021, B.C. experienced a series of record-breaking climate-related events unlike any the province had seen before. For most of the year, it was under one of three Provincial States of Emergency, as it experienced compound events and cascading impacts, including extreme heat, wildfires, extreme precipitation, flooding, landslides, and drought (see Figure 3). Climate change played a role in the 2021 heat dome [36], atmospheric-river flooding (2021 AR-flood events) [37], and wildfires [38] in B.C., as evidenced by attribution studies conducted after the events. The changing climate can create conditions that make extreme events like these more frequent and intense.

These events stretched the capacity of B.C.'s communities and its already strained health system. There were stories of loss and stories of resilience. There have also been many adaptations—some in acute response to the events as they were occurring, and some in preparation for future events.

Since the completion of the *Risk to Resilience* report, B.C. has experienced a multitude of climate-related events that had significant impacts to health and the health system. This includes the province's most severe wildfire season ever recorded, which coincided with a historic province-wide drought in 2023.

Figure 3. Timeline of 2021 climate-related events in B.C.

JUNE

53 heat warnings issued by Environment and Climate Change Canada (ECCC) for regions across the province[2]

Lytton, B.C. hits Canadian record temperature of 49.6°C [39]

Sparks Lake and **Lytton Creek** wildfires ignite [40]

Village of Lytton burned by wildfire [40]

511 heat-related deaths reported by the B.C. Coroners Service [5]

JULY

Southern B.C. affected by drought, exacerbated by extreme heat [41]

Districts of 100 Mile House and Sicamous **placed on evacuation alerts** and patients relocated [42]

Provincial **state of emergency declared** to support wildfire response [40]

White Rock Lake fire ignites [40]

ECCC issues **46 heat warnings** for regions across the province, in second heat wave of the year[3]

108 heat-related deaths reported by the B.C. Coroners Service [5]

AUG

Kettle Basin reaches drought Level 5

White Rock Lake fire burns through community of Monte Lake [40]

Evacuation alerts issued for Cities of Vernon, Armstrong, Merritt and District of Lillooet [42]

ECCC issues **23 heat warnings** for regions across the province, in third heat wave of the year[4]

SEPT

Evacuated patients and residents in Interior Health fully repatriated to their home sites [42]

Provincial **state of emergency** for wildfire response ends [40]

OCT

Atmospheric river events trigger warnings from ECCC

NOV

Three atmospheric river storms hit Southern B.C. over 48 hours, including the major event of November 14–15 [31]

Landslides and washouts force major route closures to and from Lower Mainland [31]

Evacuation orders issued for Princeton and Merritt, due to extensive damage and flooding [32]

Four Interior Health sites **evacuated** [30]

Provincial **state of emergency** declared due to flooding [33]

Provincial orders for **fuel and travel restrictions** [31]

DEC

Canadian **heat records broken** in some B.C. regions [34]

State of emergency from atmospheric river floods extended into the new year [33]

Emergency operation centres meet to address challenges being experienced in communities (e.g., food and water shortages)

Some **highways remain closed** due to flooding and landslides [31]

2 Data source: Environment and Climate Change Canada (ECCC)—see Appendix 1 for more details.
3 As above
4 As above

The *Risk to Resilience Project* has undertaken a sub-analysis of the 2021 heat dome, wildfires, AR-flood events, and 2021-2023 drought to better understand the impacts of each of these events, as well as their cascading impacts across the province and the health system. Looking back allows us to reflect on what worked well and what lessons we can learn, and identify how we can be prepared to face new climate-related events in the future.

1.4 How to read this report

This report begins by outlining the research methods used to collect and synthesize the evidence of impact on and resilience in the health system, before discussing Climate and Health Equity (Chapter 3). The bulk of the report is focused on four priority climate hazards: Extreme Heat (Chapter 4), Wildfires (Chapter 5), Floods (Chapter 6), and Drought (Chapter 7). Each hazard-specific chapter presents a timeline of the 2021 events, public health and health system impacts, adaptations, and illustrative stories.

Several key themes related to public health and health system impacts and adaptations (including workforce, supply chains, and infrastructure and facilities), across multiple events and climate hazards, are discussed in Cross-cutting Impacts, Adaptation Opportunities (Chapter 8); Mental Health Impacts (Chapter 9); and Health Emergency Management, Evacuations & Health Service Delivery (Chapter 10).

Charting a Path to a Healthy and Climate Resilient B.C. (Chapter 11) discusses leadership strides and future opportunities, laying out a path forward, guided by four key themes.

Finally, Appendix 1 contains additional data tables, and Appendix 2 presents a more detailed methodology.

Nanaimo, B.C.

Chapter 2: Methods

The ***Climate Change and Health in British Columbia: From Risk to Resilience*** Project uses a mixed-method research design (see Figure 4) that includes the collection, analysis, and synthesis of data obtained through a literature and document review (including documents provided internally by health system staff, partners and stakeholders, and documents identified through a review of academic and grey literature); and engagement with health system staff and partners.

Figure 4: Timelines for data-collection stages of the Risk to Resilience Project

2.1 Scope of climate hazards

Four priority provincially relevant climate hazards were assessed in this project: extreme heat, wildfire, flooding, and drought. Climate hazards for this assessment were scoped according to their potential for significant impacts on the health of people in B.C. and the B.C. health system on a provincial scale, as determined by the level of risk identified in the Province's 2019 Preliminary Strategic Climate Risk Assessment [30].

The *Risk to Resilience Project* also built upon and integrated findings from previous provincial engagements for the 2022 B.C. Climate Preparedness and Adaptation Strategy: results from the 2020 Partner Engagement, Indigenous Perspectives Report, 2020 Individual Submissions, and 2020 Organization submissions that identified priority concerns such as heat waves, wildfire smoke, extreme weather and flooding, seasonal water shortages, anticipated impacts of food insecurity, sea-level rise, and climate-driven displacement. Mental and physical health issues were of greatest concern overall. A sub-analysis was also prioritized for the 2021 heat dome, atmospheric river-flood events (AR-flood events), wildfire season, and drought.

2.2 Research questions

The following research questions guided the design, data collection, and analysis of the project:

1. What is known about the impacts of climate hazards on the health of B.C. populations and on the B.C. health system (including population and public health, health service delivery/operations, the health workforce, and health facilities/infrastructure)?

2. What risk or resilience factors contribute to differential or disproportionate impacts of climate hazards on the health of priority populations in B.C.? What factors contribute to the regional differences in impacts on population health or the health system in B.C.?
3. What adaptation responses and innovative adaptation strategies have been implemented by the B.C. health system, health system partners, and/or communities—directly led by, or in collaboration with, the health system—to protect population and public health and build health system resilience?

2.3 Data collection and analysis

An in-depth literature and document review, focused on B.C.-specific data, was completed for each identified priority climate hazard. Health system staff and partners, Indigenous organizations, and partners from other relevant agencies and organizations were asked to share internal documents or resources that highlighted examples of climate-change-related impacts, adaptations, or lessons learned from their respective organizations.

Over 150 participants were engaged in the *Risk to Resilience Project* research via several qualitative methods:

- 17 focus groups (see Figure 5) were convened, engaging 122 health system staff in specific divisions/roles, key health practitioners across health authorities, and service-provider partners who are responding to climate hazards.

Figure 5: Focus group areas for targeted Risk to Resilience Project health system engagement

- Health care facilities
- Emergency management
- Home support
- Long-term care operations
- Communications
- Population health epidemiology
- Supply chains
- Health system planning
- Mental health
- Physicians
- Nurses
- Provincial non-profit service providers
- Medical transport
- Hazard-specific groups (including public health):
  - Flooding
  - Extreme heat
  - Wildfire smoke
  - Drought and drinking water

- Three Indigenous sharing circles invited staff and leadership from Indigenous communities that have been impacted by recent climate-related events (18 participants), and representing different regions of B.C. (interior, Vancouver Island, central coast, and northern).[5] Preliminary results from the sharing circles were presented to the B.C. Climate Action Secretariat Indigenous Climate Adaptation Working Group for review and feedback.

5 Participants included individual Rights and Title holders from Ahousat First Nation, Halalt First Nation, Stellat'en First Nation, Ashcroft Indian Band, Kanaka Bar Indian Band, Nlaka'pamux/Lytton, Líl̓wat Nation, and Heiltsuk Nation.

- 18 key-informant interviews were held to ensure that vital perspectives across the health system and other partner agencies were represented.
- More than 700 documents were reviewed.

Data was synthesized across all collection points. The analysis included a mixed-methods approach, incorporating both qualitative and quantitative methods (see Appendix 2 for a more detailed description of methods).

The project approach and analysis were informed by an Indigenous Gender-Based Analysis Plus (IGBA+) lens. An IGBA+ approach aims to recognize the experience of Indigenous Peoples by understanding both historic and current discrimination, and to provide a lens which recognizes intersectional identities [47]. The *Risk to Resilience Project* used this lens to assess how diverse groups of people may experience climate impacts and adaptations. The "plus" in IGBA+ acknowledges that this goes beyond biological (sex) and socio-cultural (gender) differences, to include many identifying factors such as race, ethnicity, impacts of colonization, cultural identity, age, and mental health or physical ability. In the *Risk to Resilience Project*, these considerations were used to integrate considerations of disproportionate impacts, equity, and colonialism into the project design, data collection, and analysis. Throughout the project, data gaps related to IGBA+ were identified.

2.4 Project limitations

Limitations for the *Risk to Resilience Project* include:

- Due to the project scope, the research did not reflect the voices, lived experiences, or perspectives of the diverse populations/patients most impacted by the climate hazards examined (e.g., the underhoused, older adults), and was limited in the breadth of partners engaged outside of the health system. These are important voices and perspectives that should be included in future research.
- In 2023, while the *Risk to Resilience Project* was focused on a sub-analysis of 2021 climate-related events, the data-collection timeline coincided with the province's most severe wildfire season ever recorded and extreme province-wide drought conditions [48,49]. While efforts were made to include real-time analysis of some provincial documents and media stories reporting on the 2023 wildfire and drought season, a robust analysis was out of scope, and the data-collection phase concluded before a complete picture of 2023 impacts could be assessed.
- The *Risk to Resilience Project* prioritized examining the impacts on and actions from within the health system, however many adaptation actions are being led by partners in "health-determining" sectors (e.g., other ministries, communities, and service providers). It was outside the scope of this project to include a robust analysis of actions happening across all of society.
- This report illustrates key themes using examples of impacts and adaptations occurring across B.C. Examples were drawn heavily from documents submitted by health system staff and partners via a document request, along with documents identified through a review of academic and grey literature. However we may not have captured all impacts and adaptations occurring across the system.
- Lastly, there were many valuable insights shared and identified in the analysis; while the significant and overarching themes from the project are highlighted in this report, not all themes could be shared in the scope of this document.

Kwikwasut'inuxw Haxwa'mis, Mamalilikulla Nations, Vancouver Island

Chapter 3: Climate and Health Equity

KEY FINDINGS

- Climate change is **exacerbating existing health and social inequities** in B.C. and creating conditions for new inequities to emerge.
- Different populations in B.C. experience **different levels of exposure and sensitivity** to climate hazards. They experience varying barriers to taking protective measures, influenced by social and environmental determinants of health (e.g., age, living conditions, income, employment).
- People who experience poverty, racial or social inequality, and those who are impacted by colonialism and systemic racism are often **more strongly affected** by the impacts of a crisis, including the changing climate [50].
- **Indigenous communities** are disproportionately impacted by climate change, as they are witnessing the immediate impacts on First Nations territories, traditional foods and food systems, medicines, and ways of living, in ways that may resurface past and ongoing trauma from colonialism and systemic racism [51–53].
- Addressing the health impacts of climate change requires a focus on **avoidable health disparities** that are rooted in historical injustices and systems of oppression, as well as addressing the **social and environmental determinants of health**—such as access to housing, food security, and economic stability.
- Climate action offers an **opportunity to advance Indigenous reconciliation** by recognizing and upholding Indigenous rights, valuing Indigenous knowledge systems, and respecting, supporting, and advancing Indigenous-led climate action to protect health and well-being.
- To prepare and adapt to a changing climate, **adopting a holistic understanding of well-being that embraces Indigenous knowledge systems** alongside Western science is essential—not only for Indigenous communities, but for all of B.C. [50,54–56].
- **Collaboration across sectors** and communities will be necessary to prevent further disparities, and to achieve health equity in climate adaptation. Public health organizations and agencies have a particularly **important role** to play in driving this collaboration.

THE IMPORTANCE OF LANGUAGE

This report refers to those most susceptible to climate change as "priority populations"— meaning equity-denied populations[6] at greater risk from the health impacts of climate change. Note that, as language evolves, this term may not be all-encompassing.

3.1 Introduction

The legacies of colonialism, ongoing racism, discriminatory social and bureaucratic structures, and the uneven distribution of wealth all shape population health outcomes in B.C. today [58]. How we approach the health impacts of a changing climate offers an opportunity to address these disparities and strengthen climate resilience for all.

Not only can climate change worsen existing health inequities, it also creates conditions for new inequities to emerge [59,60]. Floods and wildfires in B.C. have disproportionately impacted First Nations communities, leading to evacuations, displacements from traditional territories, and cultural and mental health impacts [61]. People experiencing economic and social deprivation, who also live with mental and physical illnesses, are at the highest risk of poor health outcomes from extreme heat [5]. And poor air quality harms individuals with pre-existing health conditions and those living in areas with limited access to health care [18].

> *"[Clients most impacted during the 2021 heat dome were] typically older men with some chronic diseases, and often a chronic mental illness like schizophrenia, who were just quite isolated in their single-room occupancy. And most of those buildings that we service don't have any air conditioning. They don't have windows that can open; people are living in extreme poverty."*
>
> —*Risk to Resilience Project* focus group participant

Adaptation to a changing climate must be approached with a focus on health equity and intersectionality, considering the diverse needs of those who are most vulnerable[7] to the health impacts of climate change. As more frequent and intense climate-related events occur in B.C., a health-equity approach will help guide effective planning, policy, and health services to address climate-related health impacts—including helping to prevent worsening health inequities. Applying an "equity lens" to climate change policy and programs requires considering and addressing the structural factors which allow for inequalities to manifest in the first place, such as structural racism and discrimination, lack of adequate shelter, and economic insecurity.

6 The term "equity-denied populations" explicitly acknowledges that certain groups are systematically excluded and denied access to an equitable share of societal benefits. Within the context of climate change, equity-denied populations bear the burden of climate impacts and must adapt to these changes, despite having contributed the least to increasing carbon emissions [57].

7 Vulnerability to health impacts of climate change is determined by the exposure to climate change hazards, the sensitivity to possible impacts, and the capacity to respond to or cope with them. At the individual level, these three factors are influenced by determinants of health, such as socioeconomic status, housing quality, and education. [60]

It is also important to understand how climate change affects us as individuals and communities, and how we respond. This is rooted in our identities and experiences, and the ways in which they intersect. Because the impacts of major climate-related events, such as extreme heat, flooding, and wildfires, will vary across geographic locations and social dimensions [62], this report has been prepared and developed using the lens of intersectionality**.** In doing so, we have employed Indigenous Gender-Based Analysis Plus (IGBA+)—a tool for analysis, advocacy, and policy development that addresses intersecting inequalities, including how colonialism has contributed to ongoing and systemic discrimination against Indigenous women, girls, and gender-diverse peoples. In B.C., the need for IGBA+ analysis is clearly evidenced by the *In Plain Sight Report* that addresses Indigenous-specific racism in the B.C. health system [58].

Health equity and intersectionality

Equity is the absence of unfair, avoidable, or remediable differences among groups of people. Social and environmental inequities are drivers of inequality in health status within and between populations.

Health equity is achieved when everyone can attain their full potential for health and well-being. It involves addressing the structural and social determinants that contribute to health disparities, such as discrimination and unfair distribution of resources. This approach can help to ensure that adaptation measures are effective and equitable, and that all members of the community have fair and just opportunities to achieve good health and well-being in the face of climate change.

Intersectionality is a lens to understand how different social identities—such as race, gender, income, mental health status, housing status and ability—intersect and influence how people experience the world [63]. How climate change affects us as individuals and communities, and how we respond, is rooted in our identities and experiences.

3.2 Climate change exacerbates health inequities

Climate change acts as a "threat multiplier," worsening existing health disparities by affecting many social and environmental determinants of health and well-being [60]. Three key concepts measure the degree of climate change vulnerability experienced by priority populations:

- **Exposure:** How much a person/population is exposed to or comes into contact with climate-related hazards. For example, individuals who are underhoused face an increased risk from extreme weather due to heightened exposure, compared to those that are housed.
- **Sensitivity:** Factors such as age, pre-existing health conditions, and social and economic conditions can increase sensitivity to certain climate hazards, such as heat or wildfire smoke.
- **Adaptive capacity:** The ability to avoid, prepare for, and cope with exposure and sensitivity.

Meaningful climate equity will require addressing the downstream impacts of climate change, such as health-emergency response, but also the root causes of inequality and the social and environmental determinants of health—such as access to housing, food security, and economic stability [64]. Figure 6 illustrates the multifaceted and interconnected aspects of health equity and climate adaptation.

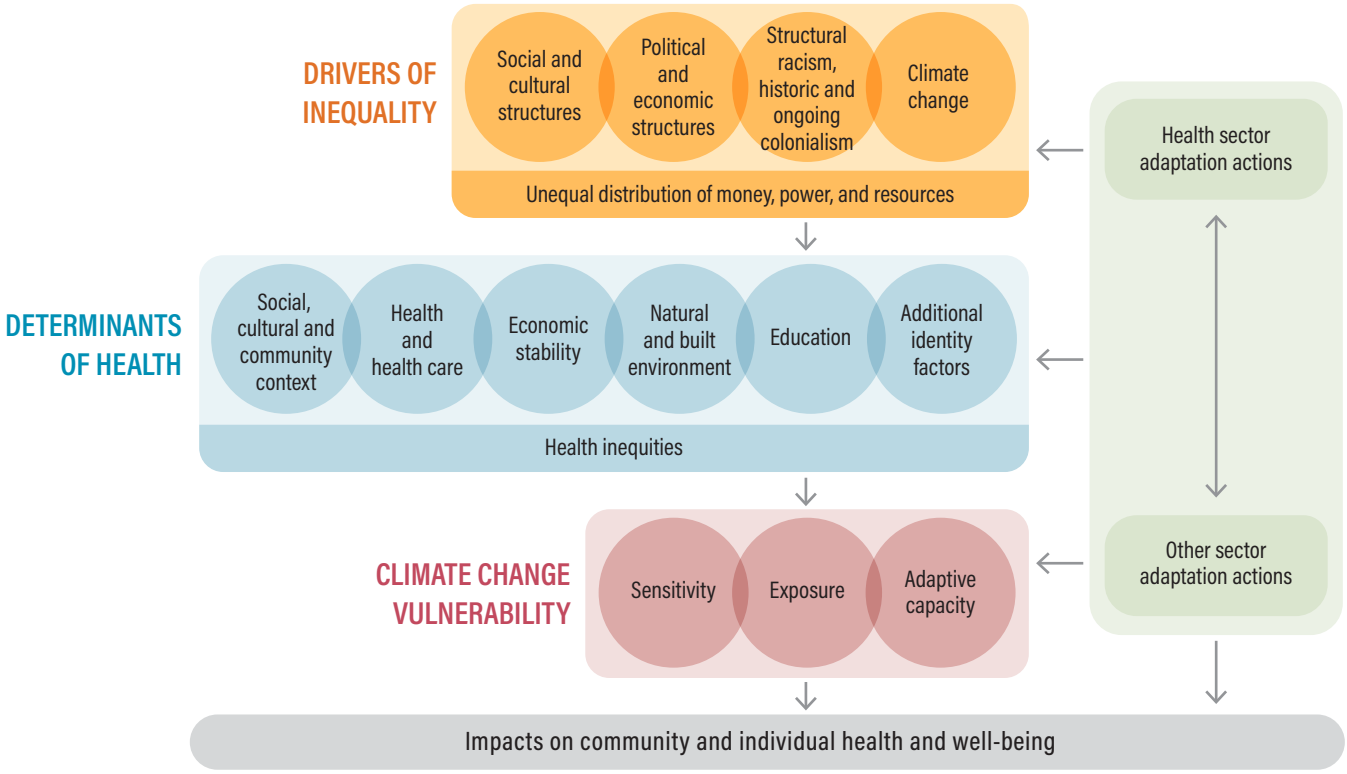


Figure 6. Climate change and health-equity framework [60]

Problematic narrative of "vulnerable" populations

In public health research and practice, the inherent negative association of the term "vulnerability" may be problematic for some populations, especially those who face systemic forms of oppression (e.g. racism, discrimination, poverty) [59]. Many underrepresented communities have demonstrated—and continue to demonstrate—resilience and adaptation to climate change, despite structural forms of oppression and unequal distributions of power and resources. No group of people is inherently vulnerable, and the *Risk to Resilience Project* recognizes the need for flexibility in the use of terminology.

In B.C., populations are likely to experience different impacts of climate change due to differential exposure, sensitivity factors, or conditions that affect their capacity to adapt. For example, older adults have a reduced ability to adapt to extreme temperatures and environmental hazards due to age-related physiological changes, higher prevalence of chronic health conditions, limited mobility, and social isolation [65,66]. Gender plays a significant role in climate-related health risks, with varying vulnerabilities tied to social roles as caregivers [62]. Poverty and social disconnection limits access to protective health measures, such as transportation during evacuations, housing quality, and access to air conditioning. Farmers face heightened impacts from climate disasters, given their increased risk of exposure and reliance on the health of the land for their livelihood [67–69]. And rural and remote communities have a heightened risk of exposure to wildfires and flooding, and to potential evacuations.

Subsequent chapters discuss disproportionate population impacts for specific climate hazards.

3.3 Climate change and Indigenous Peoples and communities in B.C.

> *"First Nations communities [in B.C.] hold thousands of years of knowledge stemming from their relationship and connections to the land, the waters, and the Earth."* [52]

Since time immemorial, Indigenous Peoples have demonstrated strength and leadership in adapting to changing environments. Indigenous understandings of health are often holistic—including physical, emotional, psychological, and spiritual well-being—and interconnected with the health of the land, waters, and more-than-human kin [26].

The direct and indirect impacts of climate change on the health and well-being of First Nations, Inuit, and Métis are interconnected and far-reaching [70,71]. Many health and socioeconomic inequities they face are being exacerbated by climate change. These include food, water and housing insecurity, alongside physical health challenges such as respiratory, infectious, and chronic diseases [52,70,72–74].

Many First Nations communities in B.C. are particularly susceptible to flooding and wildfires, and to evacuations from home territories. Evacuations can have associated impacts on cultural and mental well-being, sense of identity, and livelihood [13,75]. In addition, altered harvesting times and habitats have impacted Indigenous cultural well-being, as traditional foods, ceremonial practices, and language are all tied to the land [61].

> *"The climate crisis is inseparable from the daily experiences and realities of First Nation Peoples and their communities."* [52]

Indigenous Peoples in B.C.

There are ~269,000 Indigenous people living in B.C. of First Nations, Métis, and Inuit origin. The majority of Indigenous people (60 percent) live in cities, towns, and villages throughout the province, with the remaining living on First Nations reserve lands [76]. Each of the 204 distinct First Nations in the province has its own unique traditions and history, as does the Métis community in B.C. References in this report to Indigenous communities reflects the diversity of Indigenous Peoples across B.C. and the distinction-based approach to the Province's unique relationships with First Nations, modern and historic Treaty Nations, Indigenous governing bodies, and Métis.

The consequences of a changing climate and extreme weather events vary among First Nations, Inuit and Métis, including men, women, boys, girls, and those who identify as gender-diverse. Impacts are distinct, depending on the individual, family, community, specific Nations, chartered communities, and geography.

Indigenous Peoples face disproportionate exposure and sensitivity to climate risks. This is due to layered, ongoing, historical, and systemic inequities rooted in colonialism and institutional racism, such as the *Indian Act*, failure to uphold Treaty Rights, and the residential school system. As a result, many First Nations communities in B.C. are based in areas most impacted by extreme climate-related events, such as severe wildfires and floods [52,77].

In addition, colonialism has attempted to intentionally dismantle Indigenous communities' health systems and cultures. This has resulted in multi-generational impacts and health inequities which are further reinforced and perpetuated by ongoing systemic discrimination [56,58]. Colonialism has also attempted to undermine Indigenous sovereignty, rights, and title. This has affected the capacity of Indigenous communities across B.C. to self-determine processes for enhancing climate resilience that build on their unique assets [56].

Subsequent chapters in this report will discuss some of the significant climate-health-related impacts on Indigenous Peoples in B.C. (based on *Risk to Resilience Project* Indigenous sharing circle themes and thematic findings in the literature), including:

- **Mental health and well-being**: Indigenous Peoples in B.C. have experienced significant mental health impacts from concurrent disasters and repeated climate-related events, the impacts of which can be compounded by historic and current traumas (e.g. dispossession of land, resources, and traditional territories; loss of language and culture; residential schools; Indian hospitals[8]; COVID-19; and toxic drug crisis) [75]. Witnessing the destruction of traditional lands and wildlife during disasters, displacement, loss of homes and livelihoods, as well as separation from family and friends during evacuations, has caused intense emotional distress and long-term anxiety, grief, and embodied fear [56].
- **Food insecurity and traditional foods:** Climate-related events in B.C. have contributed to the loss of traditional foods and cultural practices that are critical to health and wellness for Indigenous communities. Loss or distress of plants and wildlife (including salmon, shellfish, bears, moose, and berries) is impacting mental, physical, and spiritual health, as Indigenous Peoples are less able to access/harvest foods and medicine [56,61].

> *"We have a medicine woman who basically is our pharmacy. For several of the communities, she began a traditional medicines garden; her garden was wiped out [due to extreme weather events]."*
>
> —*Risk to Resilience Project* sharing circle participant

- **Environmental determinants of health:** While climate-related impacts on environmental health are not unique to Indigenous populations, they are acutely experienced in many First Nations communities. For example, water sources and drinking-water quality have been impacted by wildfires, floods, and drought; creeks have disappeared; and wells have been contaminated. This has resulted in health concerns for community members and first responders [56].
- **Infectious diseases:** Various health determinants, including poverty, malnutrition, limited health care access, and socioeconomic conditions, influence an individual's ability to resist infections, the development and severity of diseases, and the efficacy of disease treatment and management [70]. Due to health inequities resulting from colonization and systemic racism, Indigenous Peoples in Canada experience significantly higher rates of infectious diseases compared to non-Indigenous populations, and are at heightened risk of climate-related infectious diseases.

8 Indian hospitals were segregated, federally operate medical facilities that operated from the 1930's to 1980's across Canada. Indian hospitals were grounded in the same policies of denial and assimilation that underpinned the residential school system. Many former patients have reported traumatic experiences in Indian hospitals [58].

- **Access to culturally safe health services:** Indigenous-specific racism in the health system [58] affects rural and remote Indigenous communities in a more acute way during climate emergencies and extreme weather events [52]. Rural and remote Indigenous communities have faced challenges in accessing health services due to barriers such as transportation, wait times, and culturally unsafe services, all of which are exacerbated during climate emergencies, particularly when communities are evacuated [56].

> *"We look at community in a very wholesome way. So, it's the river, it's the creeks, it's the forest, it's all the things that dwell there—those are our relatives, and for generations, we have stood in an observation state, and that's what really feeds into our teachings of ways of being right."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

BC First Nations Climate Strategy and Action Plan (2022)

The First Nations Leadership Council convened with First Nations in all regions of the province to develop the BC First Nations Climate Strategy and Action Plan. The Strategy provides five guiding principles (self-determination and self-government; culture and tradition; guardianship and stewardship; collaboration and partnership; and empowerment, leadership, and self-sufficiency) and four priority pathways for climate action:

- Inherent Title and Rights
- Capacity and Leadership
- Land and Water Protection
- Climate Response and Preparedness

A specific set of objectives and strategies is centered on "community health and wellness" in a changing climate.

Métis Nation Climate Change & Health Vulnerability Assessment (2020)

In June 2020 the Métis National Council released the Métis Nation Climate Change & Health Vulnerability Assessment which identifies the risks climate change poses to the health and well-being of Métis and highlights the history of resilience and unique knowledge of the Métis Nation. Following this assessment, Métis Nation BC has taken numerous actions to address the health impacts of climate change, such as:

- Conducting a survey on climate change and food access [87]
- Supporting Métis led environmental monitoring through annual Harvester Card surveying [88]
- Creating the Home Garden Project to support food security [53,89]
- Developing the MY Eco Action program to share cultural learnings focused on the environment with youth [90]

This assessment has laid the groundwork for Métis National Council, in collaboration with Métis Nation British Columbia and the other Métis Governing Members, to begin development of their own national climate change strategy [91].

3.4 Health equity in adaptation

> *"The inherent rights of B.C. First Nations can only be fully exercised when the ecosystems in which they are embedded are vibrant, biodiverse, and cared for."* [78]

It is critical that adaptation efforts prioritize populations most likely to experience climate-related health risks. By addressing the root causes of health inequities through adaptation efforts, populations most at risk can gain additional benefits related to health and resilience (e.g., improvements to the built environment, housing, access to green space, and creation of resilient networks of services/supports). In this way, climate action offers an opportunity to advance progress in many of the upstream social and environmental determinants of health. Without meaningfully integrating equity into planning and adaptation efforts, certain populations may experience worsening health inequities [60].

Commitments to an equity-informed approach to climate-health adaptation already exist at multiple levels in Canada and in B.C. Equity is a key guiding principle of:

- The Government of Canada's National Adaptation Strategy [79]
- The Province of B.C.'s Climate Preparedness and Adaptation Strategy [80],
- Building a Climate Resilient and Sustainable Health System in British Columbia: Ministry of Health Climate Action Plan [81], and
- Health authority climate change strategies and plans to date.

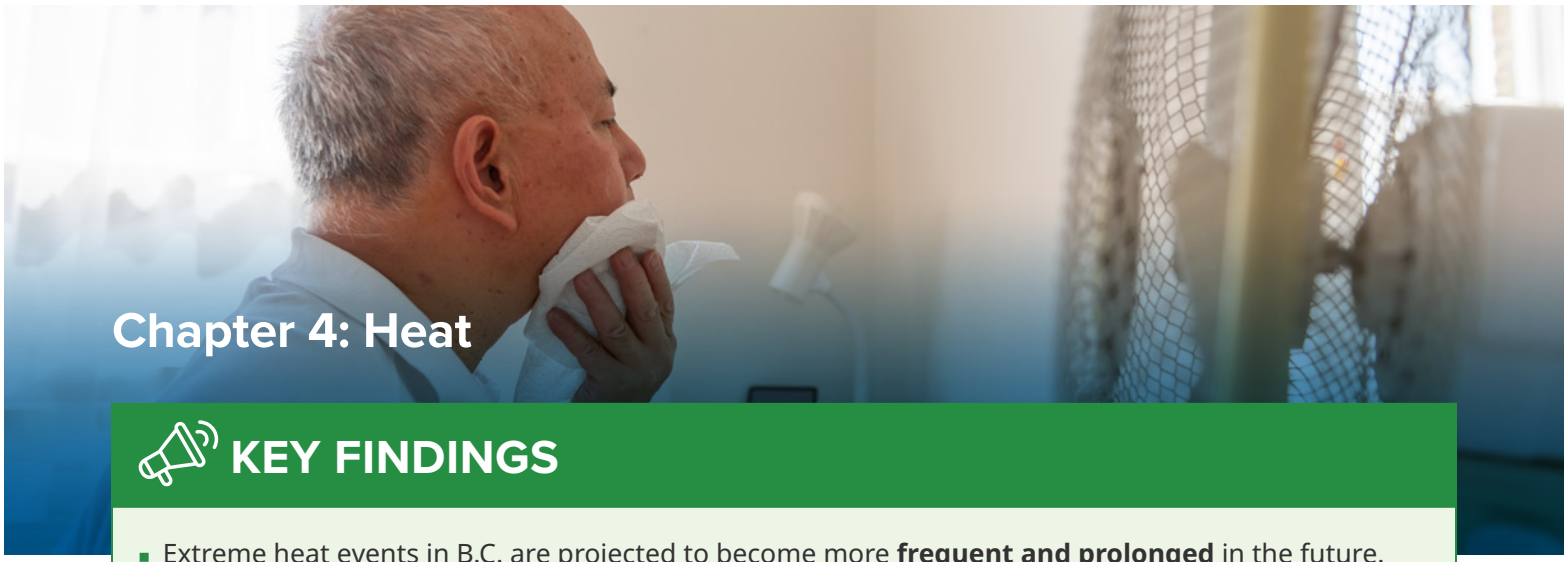
At the regional level, health authorities in B.C. are undertaking climate change and health vulnerability and risk assessments. These will support a better understanding of how specific climate hazards will impact population vulnerability in different regions of the province, as well as inform how to mobilize multi-sectoral efforts to improve community health outcomes through preparation and adaptation [82].

To understand the susceptibility of certain communities and regions in B.C. to specific climate hazards, health authorities have developed Climate Change and Community Health Maps [83,84]. Universities have also worked to map equity in Canadian cities.

The Province has led work to explore how climate change impacts diverse populations in B.C., producing the Climate Change Intersectionality and GBA+ in British Columbia [62] and Lived Experience of Extreme Heat in B.C. [85] reports.

Preparing for the health impacts of climate change also presents an opportunity to advance Indigenous reconciliation through climate action. This requires recognizing Indigenous Rights, valuing Indigenous knowledge systems, and respecting, supporting, and advancing Indigenous-led climate action to protect health and well-being. It is essential that the distinct needs of First Nations, Inuit, and Métis are valued in building climate and health resilience. The Province of B.C.'s foundational commitments to Indigenous Peoples, such as the *Declaration of the Rights of Indigenous Peoples Act* [86], recommendations on addressing racism in the health system [58], and the Office of the Provincial Health Officer's Unlearning and Undoing White Supremacy and Racism Project offer a foundation upon which to build further.

Finally, achieving health equity in climate change adaptation in B.C. requires inclusive and community-based participation. Equitable outcomes in adaptation emerge from equitable processes [60]; those most at risk of climate-related health impacts must be involved in developing adaptation strategies moving forward. This will require individuals and organizations in the health system to lead equitable adaptation planning, while supporting other sectors in incorporating considerations of health and well-being into their work.



Chapter 4: Heat

KEY FINDINGS

- Extreme heat events in B.C. are projected to become more **frequent and prolonged** in the future. Heat waves are ranked as one of the highest-risk hazards for the province, with the potential for significant consequences and a high likelihood of occurrence.
- In B.C., extreme heat events are a significant **threat to public health**. They can lead to an increased risk of mortality and adverse effects on population health, particularly among groups at risk to extreme heat.
- Certain populations, such as older adults, individuals with pre-existing health conditions, those with lower incomes, people who live alone, people experiencing mental health challenges, and Indigenous communities, are **more susceptible to the health impacts of extreme heat**. All determinants of health (including social, structural, environmental, biological, etc.) amplify these impacts on population health.
- The B.C. **health workforce**, especially during the 2021 heat dome, experienced significant impacts, including increased workload, mental health challenges, work modifications, and occupational safety concerns.
- Extreme heat events put significant **strain on the B.C. health system**, including increased patient volumes with higher acuity levels, heat-strained medical equipment, and disruptions to vaccine and medication storage, food supply chains, and essential supplies.
- B.C. has made significant progress in **adapting to extreme heat** since 2021. These adaptations encompass health policies, services, and response strategies. From establishing heat alerts and community cooling centres to engaging in collaborative efforts across various sectors, B.C. is working comprehensively to address extreme heat challenges.
- Implementation of heat **early warning systems and heat response plans** is a critical adaptation strategy to reduce the health impacts of extreme heat events. These systems help communities and organizations prepare and respond in a coordinated manner, ultimately minimizing the adverse effects of extreme heat.

THE RECORD-BREAKING B.C. 2021 HEAT DOME

In the summer of 2021, B.C. experienced the deadliest and one of the costliest weather events in its history. A powerful high-pressure ridge formed a "heat dome" over the province between June 25 and July 1.

Temperature records were shattered across the province. Victoria recorded temperatures 20°C above average [44]. The period was also characterized by very high overnight temperatures and near-peak daylight hours, meaning there was little respite from the heat overnight [92]. The Village of Lytton, on the lands of the Nlaka'pamux People in the B.C. Interior, hit 49.6°C , the highest temperature ever recorded in the country, on June 29 [93,94]. A day later, the village was consumed by one of hundreds of wildfires fuelled by the extreme heat.

Air quality declined in areas around the province, including Metro Vancouver and the central Fraser Valley, as the heat dome trapped pollutants generated by the fires [95]. The COVID-19 pandemic compounded the heat dome's impacts and some people were hesitant to gather in cooler public areas due to physical-distancing measures.

Emergency health services experienced unprecedented surges in 911 call volumes and ambulance call-outs. Emergency departments saw increased patient volumes with higher acuity levels than typically seen. In total, the BC Coroners Service directly attributed 619 deaths to the 2021 heat dome [5], but the death toll is estimated to have been higher [2].

THE 2021 HEAT DOME

60 temperature records broken in B.C. on June 27, many shattered by 5°C to 10°C [39]

49.6°C recorded in Lytton on June 29, the highest temperature ever recorded in Canada [39]

55 heat warnings issued by Environment and Climate Change Canada (ECCC) province-wide between June 25 and July 5[9]

619 deaths due to the extreme heat confirmed by the BC Coroners Service [5]

740 excess deaths during this extreme heat event reported by the BC Centre for Disease Control (BCCDC) during later analyses [2]

11,970 calls received by E-Comm 911 on June 28—almost double the call volume of preceding and following days [5,96]

Hospitals and emergency departments experienced increased patient volumes around the province, with many patients presenting with more severe illness:

- Fraser Health reported a daily average of **2,193** emergency department visits during the event [97].
- Vancouver Coastal Health emergency departments experienced **252** heat-related visits, of which 29 percent were at a severe illness (acuity) level [98].

At least **10** cases of shellfish poisoning due to *Vibrio parahaemolyticus* reported to the BCCDC, which may have been prompted by the high temperatures [99]

19 of BC Hydro's top 25 all-time summer daily peak records for system load, as demand for air conditioning skyrocketed [100]

9 Data source: Environment and Climate Change Canada (ECCC)—see Appendix 1 for more details.

4.1 Exposure to extreme heat in B.C.

Extreme heat trends in B.C.

Extreme heat events, also known as heat waves, have emerged as a pressing public health concern globally [1–3]. Extreme heat is now an expected reality of summers all around the world, leading to a number of excess, though preventable, deaths [1]. Average annual temperatures in Canada are rising more than twice as fast as the global average, with extreme heat the leading weather-related cause of death [4,5].

Similar patterns are seen in B.C., where average temperatures are rising faster than the global average, driven in large part by warming winter temperatures [25]. Temperatures are rising at the fastest rate in northern B.C., at roughly double the rate of southern regions of the province [25]. Annual average temperatures in the province are projected to rise by up to 2.7°C by the middle of this century[10] [30].

Heat-related climate projections for B.C.'s health regions by the 2050s

By the 2050s, maximum daytime and nighttime temperatures, total number of days with higher temperature and humidity, frequency, and duration of extreme heat events, and cooling demand[11] are all projected to increase in B.C.[12] Some regions may be disproportionately impacted (see Appendix 1 – Table A1.1 for more details). For example:

- Maximum temperatures ("hottest day") are projected to increase by more than 3°C across all regions;
- Number of summer days with high humidity (Humidex above 35°C) are projected to increase in most regions, with Lower Mainland and Fraser Valley regions projected to see some of the largest absolute increases;
- Number of days with temperatures greater than 30°C are projected to more than double in most regions, with some of the highest absolute increases projected in some B.C. Interior regions;
- Number of extreme heat events are projected to increase and last longer; and
- Cooling demand is expected to increase more than five-fold in most regions.

10 Compared to the historical baseline of 1961 to 1990, and based on a high-emission scenario.
11 Cooling demand estimated as cooling-degree days (CDDs). CDDs measure how warm a given location is by comparing the mean outdoor temperatures recorded each day with a standard temperature (i.e., 18°C).
12 Data extracted from ClimateData.ca portal. All estimates are for high-emissions scenario, with a comparative baseline of years 1971–2000, using CMIP6 models.

Extreme heat events are a priority for the Province. The 2019 Preliminary Strategic Climate Risk Assessment ranked heat waves[13] as a high-risk hazard for the province—third-highest in terms of consequences and likelihood of occurring by the 2050s, behind severe wildfire season and seasonal water shortage [30]. Climate change is also increasing the likelihood of extreme heat events occurring, with several modelling studies concluding that, without global warming, the 2021 heat dome event would likely not have occurred [36,93,101]. One study concluded that the global average temperature increase of 1.2°C since pre-industrial times had made the event 150 times more likely [36].

What is an extreme heat event?

An extreme heat event is defined as a period of unusually hot weather lasting for two or more days, with an extended period of high daytime and nighttime temperatures [102]. To be classed as an extreme heat event, temperatures must be outside of historical averages for a given area [102]. For the purposes of response and public communications, the Province delineates between two types of heat events in B.C.: heat warnings and extreme heat emergencies. Heat warnings pose a moderate public health risk, occurring an estimated one to three times per summer, while extreme heat emergencies pose very high risks to human health, occurring once or twice per decade [103].

High temperatures have been felt across the province in recent years. Between 2018 and 2022, there were 115 days when one or more health regions of B.C. were under ECCC heat warnings—indicating that forecasted temperatures could pose a health risk. Over the five-year period, Vancouver Coastal Health had the most days with one or more of its regions under a heat warning (101 days), followed by Interior Health (97 days) and Fraser Health (97 days). (Appendix 1 – Table A1.3). However, heat emergencies have been infrequent in B.C.; two events have met this threshold since 2009—one impacting the Metro Vancouver area in 2009 and the 2021 heat dome [103].

What is a heat dome?

A heat dome, such as the one that occurred in B.C. in 2021, is caused when a high-pressure system traps hot air beneath it, creating a dome of heat over a region [103]. Heat domes can last for days to weeks, can cover across wide geographic regions, and can move over time [104]. They are typically tied to a change in the shape of the jet stream, a band of fast winds high in the atmosphere that flow in a wave-like pattern from west to east. A taller wave in the jet stream causes air to pile up and warm as it sinks under high pressure [104].

Research also suggests regional variability in heat-health impacts in B.C., with death rates shown to increase at different temperature thresholds in different regions of the province [105,106]. In one study analyzing deaths in B.C. between 1986 and 2000, BCCDC researchers found that while most deaths during high temperature days in B.C. occurred in the southern coastal ecoregion of the province (where the majority of the B.C. population resides), the northern B.C. ecoregion was most sensitive to increases in heat—with death rates increasing at lower temperature thresholds compared to other ecoregions of

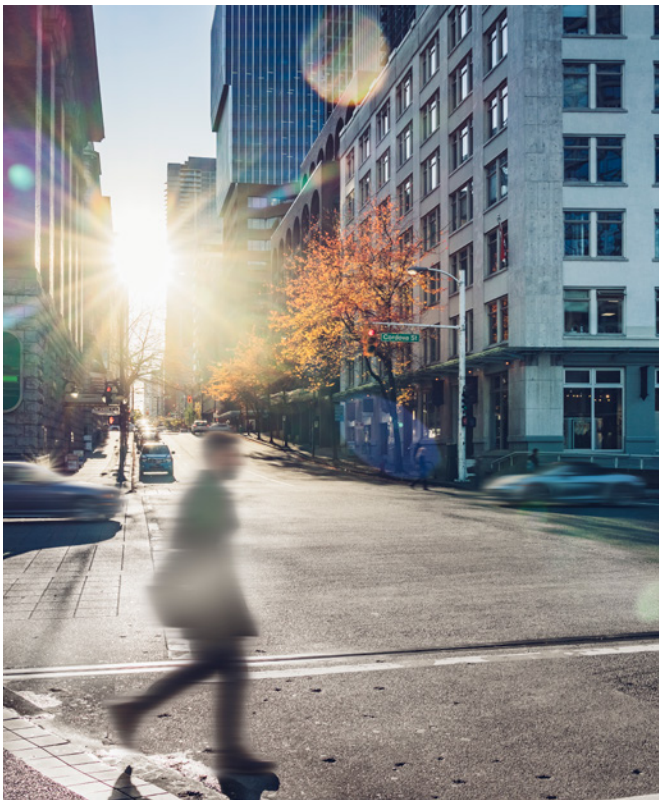
13 Heat wave defined in this assessment as extended periods of time with relatively high temperatures for a given location. The risk assessment was made for a heat wave of three or more days duration which impacts human health. A provincially significant heat wave = severe negative consequence for human health. Extreme heat wave projected to occur once every three to 10 years in B.C. by 2050 [30].

the province [106]. The authors suggested that more extensive experience with high temperatures and adaptation in some ecoregions, such as the Interior of B.C., may have been a protective factor against heat-related deaths. Acclimatization to heat has also been reported in other jurisdictions [107].

Urban heat island effect

Aspects of the built environment can increase our exposure risk to extreme heat [1]. In areas with high building density, limited green spaces, and close proximity to major roads, materials such as asphalt and concrete (e.g., in roofs, paved roads, and parking lots) can absorb large quantities of radiant heat from the sun, resulting in higher surface and air temperatures [92,108,109]. Greater population densities, with more vehicle transport and energy emitted from buildings, can further amplify this effect [1]. Higher air temperatures in urban areas, particularly at night, can limit the body's ability to cool down during extreme heat events [108]. This phenomenon has been termed "urban heat islands," however development in rural areas can create local microclimates similar to those experienced in cities, albeit smaller in scale [108].

Satellite-derived imagery illustrates the urban heat island effect in towns and cities across B.C., with wide variations in average summer temperatures in different neighbourhoods of individual municipalities—up to more than 10°C of difference in some cases [110]. Studies have mapped the urban heat island effect across the urban landscape of Vancouver, identifying large temperature variations during summer months, influenced by factors such as elevation, distance from the ocean, building coverage, and greenness [111,112].



Urban greenness is a measure of the presence and health of vegetation in urban settings and is used as a proxy measure for urban heat islands [113]. It reflects the presence of public or private vegetated areas such as parks, street trees, residential gardens, natural areas like wetlands or grasslands, and other urban green spaces [114]. In B.C., levels of urban greenness have been decreasing over time, corresponding to rapid population growth and urban spread in many of B.C.'s larger population centres [115].

B.C. is ranked sixth highest among the 10 Canadian provinces for urban greenness, with approximately 73 percent of the land area of its population centres classed as green[14] [113]. Among the five largest population centres in Canada, Vancouver has had the second-highest decline in average urban greenness since 2000, with an approximately 14-percent reduction [113]. The City of Kelowna, in the B.C. Interior, has had more than a 16-percent reduction in average urban greenness since 2000 – the third-highest percentage decrease among all 41 large population centres in Canada, and the highest in B.C. [113]

14 Greenness defined in this study as the percentage of the land area with a Normalized Difference Vegetation Index (NDVI) of 0.5 or more. Average greenness estimates reported as the differences in five-year averages of two time periods: 2000–2004 and 2018–2022. Population centres defined as having a population of at least 1,000 and a population density of 400 people or more per square kilometre, based on the Statistics Canada 2021 Census. Large urban centre = population of 100,000 or more.

What is the humidex?

Maximum, minimum, or mean temperatures, with and without humidity, have typically been used to estimate heat exposure to populations [116]. Outdoor (ambient) temperatures are often easier to measure than indoor temperatures, using data collected through such sources as monitoring stations and satellite imagery. These measures, however, may not always reflect the exposures most relevant to human health [111,117]. Apparent temperature, reflected in humidex values, is more closely related to mortality during extreme heat events than other temperature variables [117].

Humidex combines the temperature and humidity into a value that reflects how hot and humid the weather feels to the average person [117]. Higher humidity can reduce the human body's ability to cool itself through sweat evaporation, which can aggravate heat strain and the risk of adverse health outcomes [118]. Humidity levels are projected to increase by the 2050s in B.C., with Vancouver seeing some of the largest increases among B.C. municipalities (experiencing up to 10 days with high humidity each year, compared to only one day between 1981 and 2010)[15] [119].

Heat as a driver of other climate hazards in B.C.

In addition to the direct impacts of heat on health, extreme heat events (and warming average temperatures more broadly) can act as drivers for other climate hazards in B.C. Changes to the physical environment, including longer droughts, wildfires, and floods are mainly driven by the combination of rising temperatures and extreme precipitation [4]. Warming temperatures have also been linked to, for example:

- Expanded range and frequency of infectious diseases and pests [120–129];
- Increasing frequency and size of harmful algae blooms in warmer oceans and lakes [130–134];
- Reductions in food and water safety and security; [18,70]
- Increasing risk of aerosolization of waterborne pathogens, such as *Legionella*, with increased use of HVAC systems and other water spraying/cooling systems [135,136]; and
- Worsening air quality. Ground-level ozone, for example, forms when nitrogen oxides and volatile organic compounds react in sunlight and stagnant air [137]. Between 2015 and 2022, ozone advisories were issued most years in Metro Vancouver and Lower Fraser Valley Regional District during warm weather periods, including record-breaking levels experienced during the 2021 heat dome[16] [138–140]. The 2021 heat dome was also associated with increased pollen counts [141].

15 High emissions scenario (CMIP6 SSP 5-8.5), high humidity defined as a humidex > 35°C.

16 2023: Four advisories issued in Fraser Valley Regional District (FVRD); 2022 one advisory FVRD; 2020: two advisories issued Metro Vancouver; 2018: seven sites exceeded national standards (5 FVRD, 2 Metro Vancouver); 2017: 10 FVRD stations exceeded national standards; 2015: two advisories in Metro Vancouver [138,139].

Beacon Hill Park, Victoria, B.C.

Extreme cold

Climate change is leading to warmer winters overall, but is paradoxically also creating more extreme cold events, due to arctic warming driving southward dips in the jet stream [142,143]. Extreme cold events are declared when temperatures drop below a defined threshold. This temperature threshold varies across provincial regions, and is based on a region's preparedness for cold weather, the effects of wind chill, and the acclimatization of its residents [143,144].

Extreme cold can cause frostbite, windburn, and hypothermia [143,144], and lead to more hospitalizations and premature deaths, due to increased spread of infection and increased risk of respiratory or cardiovascular events up to several weeks after cold weather exposure [143]. Populations at higher risk include infants, seniors, people consuming alcohol, people with certain medical conditions (e.g., diabetes) or taking certain medications, and people experiencing homelessness or living in a home without adequate heating [143–145].

In B.C., extreme cold events can increase risk of morbidity and mortality [143,146,147], [148], increase paramedic calls [149], and cause impacts to health facilities and delivery of health care services. There are reports, for example, of extreme cold events leading to older pipes freezing and bursting; older buildings lacking proper heating, with single-pane or poor double-pane windows; and/or power outages, leading to loss of heat and hot water, and disrupting clinical flow and patient care [150]. During one B.C. extreme cold event, a hospital's water pipes burst, leading to the emergency entrance doors freezing shut, the need to haul water into the site, temporary cancellations of dialysis and lab outpatient services during repairs, and limitations on hospital visitations [151].

As one type of adaptation in B.C., communities have created public warming centres in response to extreme cold events. BC Housing, for example, manages the Extreme Weather Response program, and provides funds for temporary winter shelters and extreme-weather response shelters for unhoused populations [152]. Public health recommendations to reduce the impacts of exposure to winter weather on people experiencing homelessness in B.C. have also been published [145].

4.2 Extreme heat impacts on B.C. population health and the health system

The association between extreme heat and increased rates of death and illness is well-established in global literature [1,153,154]. Direct impacts of heat exposure can range from less severe illness, such as heat edema, rash, and cramps, to more severe illness, such as syncope (fainting), exhaustion, and heat stroke [155]. Extreme heat exposure has been associated with increased rates of death due to respiratory and cardiovascular illness (particularly strokes and coronary heart disease) [154,156], as well as higher rates of heart arrhythmias and cardiac arrest [156]. Worsening of existing mental health conditions, and increased rates of mental health-related illness and death, including suicide, have also been observed during extreme heat events [157,158].

4.2.1 Extreme heat impacts on B.C. population and public health

Heat-related deaths in B.C.

During extreme heat events in B.C., the risk of mortality increases. The highest numbers of heat-related deaths in B.C. were reported during the major extreme heat events of 2009 and 2021:

- The 2009 extreme heat event resulted in approximately 110 excess deaths, likely attributable to heat, over a seven-day period in Metro Vancouver; in comparison, only 62 deaths were attributed to the H1N1 pandemic across B.C. that same year [159].
- In total, 619 heat-related deaths were reported by the BC Coroners Service over the heat dome event of 2021 [5]. Follow-up analyses suggested that as many as 740 excess deaths may have occurred province-wide (with some deaths not specifically recorded as "heat-related," or still under investigation at the time of the BC Coroners Service report) [2]. Metro Vancouver experienced the highest number of deaths, including 434 community deaths in people aged 50+ years—a 440-percent increase over the expected total [160]. Heat-related deaths were also observed across all regions of the province and in all health authorities (Table 1).

Table 1: 2021 Coroner-reported heat-related deaths by health authority [5]

Regional health authority	Count	Percentage	Rate (per 100,00)
Fraser	312	50%	15.9
Interior	84	14%	10.2
Island	55	9%	6.3
Northern	23	4%	7.6
Vancouver Coastal	145	23%	11.6
Provincial	**619**		

Accurately estimating the number of deaths caused by heat exposure in B.C. is challenging, however. Oftentimes, the cause of death is assigned to another condition, such as one exacerbated by heat exposure, resulting in an underestimation in the number of heat-related deaths [159].

High indoor temperature is a major driver of heat-related deaths in B.C. Trapped hot air inside buildings persists over time, causing residents to experience prolonged periods of intense heat, even when outdoor

temperatures decrease overnight. During the 2009 extreme heat event in Metro Vancouver, elevated mortality was observed among those in more densely populated urban areas, living alone, having a low income, and aged 65 to 74 years. These data suggest that residential factors, in addition to a number of social and demographic factors, were associated with more severe impacts of high heat exposure [161].

Similar patterns emerged during the 2021 heat dome event. Of all coroner-reported deaths, 98 percent occurred indoors: 73 percent in private residences and 10 percent in social/supportive housing or single-room-occupancy hotels [5]. The BCCDC observed that individuals faced significant danger when indoor temperatures remained above 26°C throughout the heat event [5]. More than half of all people (53 percent) who died lived alone. Half (50 percent) of those who died were found deceased during check-ins by concerned friends, family, neighbours, care workers, or police officers [5]. However, the major factor contributing to heat-related deaths was the elevated indoor temperature [2,5,162].

Heat-related illnesses in B.C.

> *"A lot of people were having health issues. I saw a lot of people were taken away in ambulances. I never did find out if they were okay or not. I have no idea what the statistics or numbers were, but I know there was a lot more than usual. Not just overdoses, but from heat exhaustion and sun stroke."*
>
> *—Julie Chapman, Writer, Megaphone Magazine* [163]

During high heat episodes, heat stress, dehydration, and heat stroke are common heat-related illnesses in B.C. [164,165].

A majority (70 percent) of 21 service providers surveyed about their experiences during the 2021 heat dome indicated that the populations they support experienced a great deal of physical impacts during the event [85]. Others have reported that individuals with disabilities experienced symptoms including high body temperatures, migraines, disorientation, fatigue, breathing challenges, and, in some instances, passing out [166].

In the Fraser Health region, there were significant increases in emergency department visits for heat stroke during the 2021 heat dome, including 195 visits specifically attributed to these conditions on June 28 alone—roughly 100 times higher than the daily average [97].

Heat-related illness and injury rates in B.C. are also likely underestimated [98,167]. While some people, particularly those with more severe illness, may visit health care centres, such as emergency departments, many more may experience heat-related illnesses without seeking health care services.

> *"For every person who died from the heat dome, 10 or more may have suffered heat stroke, dehydration, or other complications, including permanent, life-altering injuries."*
>
> —Dr. Melissa Lem, Canadian Association of Physicians for the Environment [168]

Other types of illnesses and injuries have been reported during extreme heat events in B.C., including:

- **Mental health impacts:** There have been reports of increased anxiety and distress, incidents of aggression, and mental health emergencies during and after extreme heat events. In B.C., roughly half of 21 service providers surveyed in one study reported their clients experiencing a great deal of mental health impacts [85] during the 2021 heat dome. The Crisis Centre of BC reported an increase in calls for anxiety and other crises during the 2021 heat dome—a pattern they report seeing whenever there are heat waves [169]. The heat dome also exacerbated conditions for people with pre-existing mental health or substance use issues. See Chapter 9: Mental Health for more discussion about climate-related mental health impacts in B.C.
- **Respiratory and cardiovascular illnesses:** Extreme heat events in B.C. can lead to more frequent smog days, worsening existing respiratory and cardiovascular illnesses [170].
- **Infectious disease outbreaks**: Warmer sea surface temperatures have been associated with increased rates of Vibrio illness in B.C. [171] , a bacterial disease often associated with eating undercooked shellfish or being exposed to contaminated water [172]. The 2021 heat dome may have contributed to an outbreak of Vibrio illness. At least 10 cases of shellfish poisoning due to *Vibrio parahaemolyticus*, which may have been prompted by the high temperatures, were reported to the BCCDC, with most individuals falling sick after consuming self-harvested shellfish, or engaging in recreational activities such as swimming [99,173]. Regional health authorities issued public announcements alerting residents to the increased *Vibrio parahaemolyticus* infections across the province [174].

Heat-related impacts on social, economic, environmental, and cultural determinants of health

Extreme heat can have wide-ranging impacts across many sectors. Manufacturing, construction, transportation, and warehousing are projected to be among the highest-risk sectors in Canada for labour productivity impacts due to extreme heat [64]. Extreme heat can also adversely impact food, transportation, and electricity systems, among others [64,175].

Social, recreational, and community events have also been impacted; community events and spaces have been cancelled or closed in B.C. due to extreme heat [176,177], and some Indigenous communities have described events being cancelled in their communities, which are important for social cohesion, community connection and health and well-being [42]. Schools in some regions closed during the 2021 heat dome [178], with concerns about high temperatures in older schools and portables prompting the development of guidelines around when to close schools during extreme heat events [179,180].

4.2.2 Disproportionate impacts of extreme heat on populations in B.C.

There is a growing body of evidence globally showing how some populations are disproportionately impacted by heat exposure. Seniors and younger children are at higher risk for heat-related illness, in part due to a reduced ability to thermoregulate [153,156,181]. People with preexisting cardiovascular, respiratory, diabetes, and renal diseases are also at increased risk [1,156,181,182], as are people taking medications such as antipsychotics, antidepressants, diuretics, and illicit substances like cocaine, which can impact thermoregulation [183,184]. Exposure to extreme heat during pregnancy has been associated with adverse birth outcomes, including pre-term births, stillbirths, and low birth weight [185–187], as well as gestational diabetes, sudden infant death syndrome, and placental abruptions [188–190]. Some populations are also at increased risk due to greater exposure, including underhoused populations who lack or have limited access to shelter [191,192] and people living in densely populated urban areas [18,183]; their risks are often exacerbated by social and economic vulnerabilities like poverty and social isolation [1,2].

The health impacts of extreme heat are not evenly distributed in B.C. Certain populations are disproportionately affected due to heightened exposure, heightened sensitivity, and/or limited adaptive capacity (e.g., mobility barriers in getting to a cooling centre), among other factors. Evidence of some disproportionate impacts from heat in B.C. are described below.

Older adults

During the 2021 heat dome, more than two-thirds of all coroner-reported deaths in B.C. (67 percent, 415 deaths) occurred among those aged 70 or older, and almost all (90 percent) among people aged 60 or older [5]. Although there were no coroner-reported deaths among those under 30, some Canadian studies have reported increased emergency department visits among children during extreme heat events [5,193].

The largest increases in acute care visits for heat-sensitive conditions province-wide were seen in people over 60. In people aged 90 years and older, emergency department and hospital admissions increased 114 percent and 59 percent, respectively [194]. Older females may have been at higher risk during the heat dome, because they are more likely to live alone [5,92].

For someone who is at higher risk from heat, a check-in may be lifesaving

The Heat-Check-In Support Framework for Non-Governmental Organizations (2023) acknowledges heat-related risks for certain populations, including older adults. Developed by the Vancouver Coastal Health's Healthy Environments and Climate Change team, the document is meant to empower organizations to conduct heat check-ins by providing guidance on check-in processes and logistics, and general information on heat-related illness. [195]

People with chronic conditions

Of deaths investigated by the BC Coroners Service during the 2021 heat dome, 91 percent of the deceased had been previously diagnosed with at least one chronic disease [5]. The risk of death increased with the number of existing chronic diseases; people with 10 or more chronic diseases had double the associated risk of death of those with only one chronic disease[17] [196]. One study found a general lack of awareness of the warning signs of heat-related illness or of heat exacerbating existing conditions (e.g., cardiovascular, respiratory, and renal conditions), resulting in confusion about when to seek support [85].

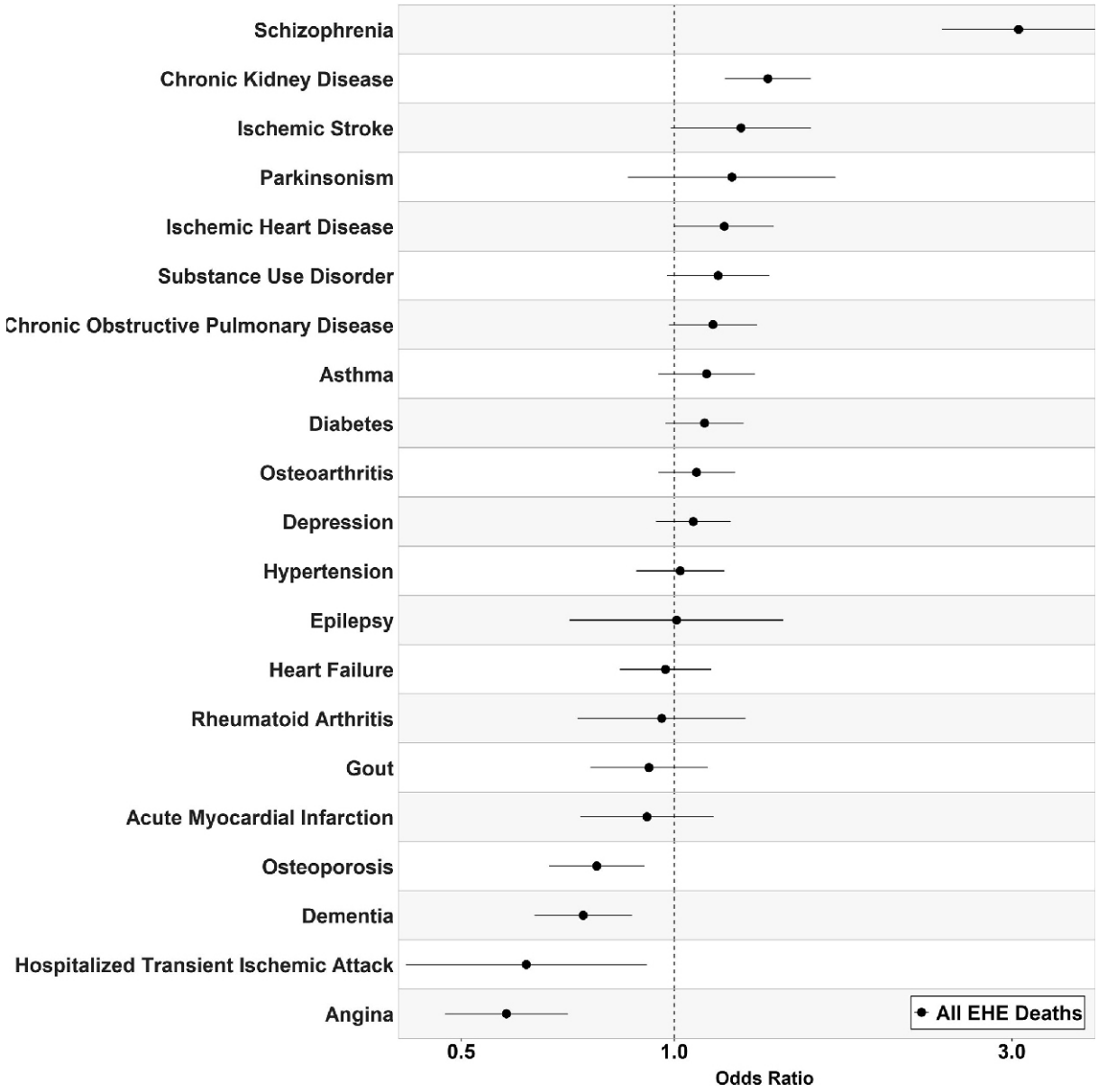


Figure 7. Chronic conditions and odds of death during the 2021 heat dome [18]

17 Risk estimated as Odds Ratios (ORs).

18 Odds ratios (ORs) and 95-percent confidence intervals, derived from conditional logistic regression, for each chronic disease (adjusted for age, sex, and all other chronic diseases) among all extreme heat event (EHE) deaths compared with typical weather deaths. The chronic diseases are ordered from top to bottom by the OR point estimates [196].

People with mental health conditions

Schizophrenia was the illness most strongly associated with the risk of extreme heat death during the 2021 heat dome (Figure 7), after accounting for 20 chronic diseases [196]. Multiple factors likely contribute to this increased risk, including limited self-awareness of health status, disorganized thinking, social isolation, economic marginalization, and the influence of co-occurring conditions and medications affecting heat perception and thermoregulation [196]. Since the 2021 heat dome, the BCCDC has developed information briefings on the risks of extreme heat events for people with schizophrenia [197], to inform heat planning for organizations and support networks that serve people with mental health challenges.

People who use substances

> *"During the heat wave, it was hard for anybody to take care of themselves. A lot of these people [have] addiction. Where I work, we had 15 overdoses within an hour."*
>
> —DJ O'Brian, a Harm Reduction Outreach Worker in Vancouver's Downtown Eastside [198]

In Vancouver's Downtown Eastside, visits to the Overdose Prevention Society spiked by 25 percent during the 2021 heat dome, rising to over 900 a day [199]. Findings from a long-term study of 4,913 people who died due to drug toxicity (cocaine, opioids, or amphetamine) in B.C. between 1998 and 2017 found that higher temperatures were associated with increased odds of death, particularly for cocaine—on its own and when combined with other drugs. The study concluded that people who use substances may not know that they are at higher risk [184]. As extreme heat events become more frequent with climate change, targeted interventions could include training staff and volunteers who work with people who use substances, and displaying and distributing heat awareness resources in areas where people who use substances gather, such as overdose prevention sites [184].

People with disabilities and/or mobility challenges

Individuals with mobility challenges can face significant difficulties staying safe and cool, due to a lack of accessible cooling centres, nearby parks equipped with seating and shade, and/or transportation options (e.g., transit) [85,199–201]. Some people with disabilities experienced fear and anxiety about seeking help during the 2021 heat dome, due to ableism, stigma, and past negative experiences with the health and social care system [168]. Measures such as specialized air-conditioned buses, curbside pickup, temporary free transit during heat events, mobile cooling centres, and cooling shuttles help to address these needs and support equitable access to cooling areas [5,168].

Materially disadvantaged populations

Populations with lower incomes are at a higher risk of adverse effects from extreme heat. They are less likely to have access to cooling measures, such as air conditioners or curtains; more likely to live in neighbourhoods with less access to green space; and may experience additional risk factors, such as transportation barriers to cooling centres [85,92,202].

During the B.C. 2021 heat dome, a higher proportion of heat-related deaths occurred in materially and socially deprived groups [92], with 28 percent of deceased individuals residing in neighbourhoods characterized as the most materially deprived, and 33 percent living in neighbourhoods considered the most socially deprived [5]. In B.C.'s urban areas, such as Vancouver and Victoria, populations living in the

hottest locations (e.g., urban heat islands) also have lower median incomes, a higher proportion of low-income people, low-income older-aged people, immigrants, and less green cover than those living in the coolest locations [85,203].

People who are underhoused face increased heat exposure, due to living outside or in older buildings without air conditioning, for example. They also face a range of other factors that influence their capacity to adapt. For example, during the 2021 heat dome:

- Individuals living on the street reported not feeling safe leaving their belongings to access cooling areas [85,204,205].
- Underhoused populations reported feeling unwelcome and facing stigma when trying to access indoor air-conditioned public spaces or shaded green areas [85].
- Some underhoused populations reported a lack of accessible drinking water, making it challenging to stay hydrated during the heat dome. Some also reported avoiding drinking water to reduce the need to use public restrooms [85].

Heat response for under-housed populations

In response to the 2021 heat dome, non-profit organizations and their partners have been implementing strategies to protect underhoused populations from future extreme weather events.

Kelowna's Pop-up Cooling Tents:
Kelowna's heat response to protect the underhoused was supported by a collective of over 50 community partners, including the Central Okanagan Journey Home Society, Interior Health, the City of Kelowna, and the Ki-Low-Na Friendship Society. Members of the Lived Experience Circle on Homelessness identified that community cooling centres were not accessible and did not meet the needs of community members experiencing unsheltered homelessness. To support equitable access to cooling locations, the collaborative mobilized partners to develop "pop-up cooling tents" at accessible downtown locations. Peer-operated Personal Belonging Storage Programs, offered by partner agencies across the downtown core, ensured that people had a secure place to leave their belongings while accessing the cooling tents during the day. Having strong structures for working together enabled partners to mobilize quickly, leveraging resources and drawing on community capacity and strengths to keep the underhoused population safe during the heat dome.
Source: Heat Response Planning for Southern Interior B.C. Communities, 2023

PHS Community Services Society's Check-ins Save Lives During Heat Dome:
PHS Community Services Society provides housing, health care, harm reduction, and health promotion to some of the most at-risk and under-served populations in Vancouver's Downtown Eastside, which has less shade and shelter than other parts of Vancouver, with summer heat magnified by the urban environment. During the 2021 heat dome, staff conducted check-ins, identifying people who were dehydrated, with some being taken to the ICU. Staff helped people keep cool by providing fans and putting air-conditioning units in common areas, and in the rooms of the most medically at-risk people. The team also planned ahead by stocking up on fans and air-conditioning units well in advance, blocking out skylights, and preparing to install misting stations on patios, courtyards, and sidewalks. "We found the most important thing with the heat dome was to increase staff supports for residents," said PHS Housing Director Tanya Fader. "If staff last summer had not been doing check-ins, there would have been deaths."
Source: PHS provides shelter from extreme weather, 2022

Renters and strata owners

Housing type and ownership status affect what actions individuals can take during heat events to protect themselves in their home. In B.C., there are reports that some strata council rules, rental agreements, or landlords have created barriers to installing cooling systems (even temporary ones), objecting to covering windows with available materials (e.g., cardboard) and/or to absorbing the increased utility costs of cooling units [85,202,206].

Strata residents, co-op members, and tenants with medical conditions impacted by heat have a right to accommodation under the BC Human Rights Code [207]. Prior to the 2021 heat dome event, two human rights tribunal cases filed by strata owners who had chronic medical conditions resulted in rulings in favour of the residents [206]. Ensuring renters can stay cool during extreme heat events requires a combination of policy and regulation (e.g., building codes requiring proper ventilation [208]); financial assistance to help renters pay for cooling; and education and awareness [209].

People living alone

Those who live alone may have limited access to social support networks (friends and family) that can check in on their well-being and provide assistance if necessary. During the 2021 heat dome, more than half (56 percent) of those who died were socially isolated and lived alone [5]. As heat illness can progress quickly, those living alone may not have had daily contact with someone who would notice early warning signs of heat illness. By comparison, those who lived in community or assisted living situations (i.e., group, senior, or long-term care homes) made up only 8 percent of deaths during the 2021 heat dome, likely due to having been checked in on by caregivers.

It is well established that social networks are key aspects of emergency preparedness and resilience during extreme heat events. Health authorities, local governments, and community-based organizations are increasingly recognizing social connection as a protective factor during hot weather [66,210]. There is an opportunity during pre-season planning to identify potentially isolated residents, clients, and patients receiving health and social services such as home care and food delivery [66].

People who work outside and/or in hot indoor environments

Heat-related illnesses have been reported among B.C. workers exposed to high working temperatures. According to WorkSafeBC, work-related heat stress claims have been rising over time in the province. From 2018 to 2020, they averaged 41 accepted claims from heat stress per year, increasing to 115 heat stress claims during the 2021 heat dome (with two-thirds among outdoor workers) [211].

In 2022, there were 11,831 temporary foreign workers working within B.C. agricultural industries [212]. The BC Fruit Growers' Association estimates that migrant workers make up more than half of their members' workforce [213]. Many faced extreme heat stress during the 2021 heat dome, working in packing sheds, greenhouses, and warehouses [44]. They faced significant exposure to heat due to long workdays; challenging working conditions in direct sunlight during the hottest days of the year; and, in some cases, accommodations lacking access to fans or air conditioning [44,214,215]. Furthermore, migrant farm workers often live in rural communities without easy access to stores to purchase fans or other cooling devices.

Essential workers, such as health care workers, cooks in social services, kitchen staff, road workers, and those in industrial settings, also faced challenges finding shelter from the heat [216,217]. Their work conditions are often intense, involving heavy machinery and protective gear, with limited access to shade or suitable uniforms [216]. A study that looked into 528 accepted lost-time claims for heat-related illness by B.C. workers between 2000 and 2020 identified the majority of illnesses (84 percent) occurred in summer months. Most occurred in male workers, younger workers, and those in occupations related to primary industry

(including trades, transport, and equipment operators; and processing, manufacturing, and utilities). The authors attributed the higher rates among younger and male workers to their disproportionate representation in occupations with higher ambient heat exposures (e.g., outdoor work) and metabolic demands (e.g., manual labour), rather than to an innate sensitivity to heat [218].

Farmers and ranchers were impacted economically and psychologically by the 2021 heat dome, due to lost crops, lengthy recovery periods, and the event overlapping with the coinciding COVID-19 crisis [219].

WorkSafeBC accepted 115 claims for heat stress in 2021—a 180-percent increase over the previous three-year average of 41 [211].

Newcomers and those with linguistic barriers

Linguistic barriers increase vulnerability to climate change due to limited access to information, reduced participation in decision-making, and heightened health and safety risks [85]. In addition, newcomers to Canada may face challenges navigating a new community to locate cooling centres [202]. During heat events, warnings must be multilingual and delivered in a variety of formats [5]. As an example, HealthlinkBC, PreparedBC and health authorities have created Extreme Heat resources available in multiple languages [220].

Impact of heat on Indigenous communities

Due to their geographical location, some First Nation communities on reserve lands are particularly exposed to extreme heat in the summer months. Some are among the hottest communities in the entire province (e.g. Nlaka'pamux Nation, T'eqt"aqtn'mux, Tl'kemtsin, Líl̓wat Nation, Osoyoos Indian Band, and Ashcroft First Nation) [221–223].

Elders, youth, and those with pre-existing health conditions in some B.C. First Nations and Métis communities report being most affected. Specific impacts discussed included:

- Cancellation of community cultural events due to heat;
- Impacts on food security, food sovereignty, access to traditional medicines, and cultural practices, such as fishing, hunting and foraging, due to the cascading impacts of inhospitable conditions for animal and plant life;

- Lack of adequate cooling systems in community housing stock;
- Lack of cooling shelters for community members;
- Hesitancy in some community members to use air conditioners due to cost; and
- Impacts to accessible cool water due to ecosystem disruptions from other hazards, such as drought.

Indigenous communities in B.C. have also demonstrated leadership in developing heat response plans and caring for community members and Elders during heat events. (See the example of Indigenous-led actions in 4.3 Health-related adaptations to extreme heat).

4.2.3 Extreme heat impacts on the B.C. health system

Extreme heat has impacted the health workforce and resulted in cascading impacts in health and long-term care facilities, as a result of strained cooling systems, medical equipment malfunctions, and disrupted medical procedures. More details about cross-cutting health system impacts from extreme heat, wildfires, flooding and drought can be found in Chapter 8: Health Emergency Management, Evacuations and Health Service Delivery, and Chapter 11: Cross-Cutting Impacts, Adaptations and Opportunities.

Heat impacts to the B.C. health workforce

> *"[The 2021 heat dome] was probably the most horrific, horrendous time that I've ever been through."*
>
> —*Risk to Resilience Project* focus group participant

The health workforce in B.C. has experienced significant impacts during extreme heat events, most notably during the 2021 heat dome. In fact, health care providers were found to be the occupational group *most impacted* by increased workload during this event due to factors such as patient surge, and staff experiencing mental health impacts, work modifications, cancellations or delays, and occupational safety concerns [219]. Emergency medical services across the province also reported being severely strained, experiencing at least a doubling of call volumes above normal [5,96]. Over the course of a single day during the 2021 heat dome (June 28), Vancouver Fire and Rescue attended 365 calls, including cardiac emergencies, heat emergencies, and overdoses [224] .

Mental health impacts to the health workforce

Emergency health service providers (e.g., paramedics, nurses, and physicians) experienced significant mental health impacts during the 2021 heat dome, including emotional trauma and burnout. Some physicians and nurses described being in "*response mode*" and needing to "*compartmentalize the trauma*," leading to delayed mental health impacts [56]. A number of health care workers reportedly left the profession in the wake of the event [217,225], and *Risk to Resilience Project* focus group participants shared stories of colleagues leaving the profession permanently.

Frontline health care workers also described the "*moral injury*" they sustained when demand for emergency care outstripped capacity, such as not having enough equipment for cardiac monitoring in overcapacity emergency departments [56]. Assisted living workers described the conflict of being expected to stay with clients while waiting for emergency services, but knowing other clients were also in need of support.

> *"I was [waiting] hours and hours for an ambulance to come. [We had to] make those decisions about what to do… Do I leave this person who is obviously in distress to go to my next client who is also most likely to be in distress? It was such a moral dilemma."*
>
> —*Risk to Resilience Project* focus group participant

Community health care workers in long-term care and assisted living described experiencing emotional trauma and guilt as a result of finding clients deceased during the heat dome—sometimes more than one in a day. Many asked themselves whether there was "*more that they could have done.*" [56]

Workplace impacts

In addition to the pressures of caring for patients during extreme heat events, health care staff working in facilities with elevated temperatures have reported physical and social impacts [226]. In a 2017 staff survey at one regional health authority—including acute care, long-term care, mental health, health centre sites, and home and community care services—more than half of the 218 respondents reported experiencing direct occupational health impacts from working in high temperatures, which contributed to low morale and motivation, and irritation [227].

> *"It's not just about the client safety, but how do we ensure our staff are safe as well?"*
>
> —*Risk to Resilience Project* focus group participant

During the 2021 heat dome, health care staff experienced many of these same impacts. In a number of facilities, complaints about high temperatures were made by staff as well as by patients and their families; temperatures in some program areas reached over 30°C [175,228]. Some staff experienced heat exhaustion, and surgeries were cancelled as high temperatures in some operating rooms created unsafe conditions for staff and patients.

Uncomfortable working conditions during the 2021 heat dome were also reported by paramedics [175] and home and community care workers, who reported elevated temperatures in clients' homes or hot vehicles [56]. As a result, some home care programs changed their protocols, requiring staff to attend home visits in pairs when temperatures hit a threshold.

> *"[During the heat dome, there] was a very significant interruption of planned services. We had to shut entire buildings. You know, the vaccine rollout was in full swing, and the buildings themselves were reaching temperatures well beyond anything that [was] sustainable to ask our staff to work in for any period of time."*
>
> —*Risk to Resilience Project* focus group participant

As the 2021 heat dome intersected with COVID-19, the impacts of high temperatures were compounded by pandemic-related occupational safety conditions. Laboratory staff reported experiencing uncomfortable working conditions when wearing impermeable personal protection gowns and gloves, and feeling additional heat generated by lab equipment [27].

Heat impacts to B.C. health service delivery

During the 2021 heat dome, acute care services in many regions of the province faced significant increases in patient volumes. Higher patient acuity levels also put additional strain on health services [97,98,230]. In one 24-hour period at the peak of the event, there were 17 patients in the Vancouver General Hospital emergency department at the highest acuity level[19]—representing the most acute and ill patients requiring immediate resuscitation (compared to an average of four to five on a typical day) [230].

> *"We had patients with temperatures of over 40°C who were presenting confused or even unconscious, and with full-on heat stroke."*
>
> —Dr. Heather Lindsay, Department Head, Emergency Medicine, Vancouver General Hospital, University of British Columbia CPD 2023 [230]

19 Acuity reported as CTAS levels on a scale of 1 to 5, with CTAS level 1 being the most severe.

Additional impacts to health service delivery included [56,150]:

- Pausing emergency department respiratory triage (during COVID-19) when indoor temperatures were too hot;
- COVID-19 protocols adding additional challenges due to it being too hot to wear personal protective equipment and the use of fans being unsupported by infectious disease protocols;
- Treatment of dialysis patients in emergency departments when other treatment areas were too hot;
- Risks of malfunctioning equipment in labs and transfusion medicine services, with resulting impacts to storage of blood products;
- Freezer failures;
- Reduction in the provision of diagnostics due to cooling problems;
- Running out of supplies such as cooling blankets and ice; and
- Impacts on the delivery of temperature-sensitive vaccines, including COVID-19 vaccines.

Challenges keeping residents cool in long-term care facilities

The heat impacts on long-term care facilities during the 2021 heat dome had significant implications for resident care across the province. Additional resources and operational changes were required at some long-term care facilities, such as bringing in portable air-conditioning units; moving residents to common cooler air spaces, such as dining rooms, disrupting normal service; ensuring residents were well-hydrated; menu changes; and serving cold foods on paper plates to reduce use of heat-generating appliances such as dishwashers. Other strategies included increasing the frequency of rounds (checking in on patients and clients), using ice packs, covering windows, and using water sprinklers to cool roofs [56].

Health Emergency Management BC (HEMBC) also worked beyond their traditional mandate, responding to gaps identified in the response to the heat event—such as supporting regional health authorities in sourcing and prioritizing equipment, like additional fans and cooling systems, for long-term care and assisted living facilities [231]. Despite a shortage of cooling units across the Lower Mainland region, HEMBC ensured priority sites received air-conditioning units and industrial fans. [232].

The Ministry of Health and health authorities have also been upgrading and installing HVAC systems in health system owned and operated facilities to meet the needs of a warming climate (see section 4.3 health-related adaptations to extreme heat for more details.)

More intensive outreach to home and community care clients

During the 2021 heat dome, home and community care services intensified outreach to clients, deployed additional staff in home care and home health programs, and expanded direct supports provided to clients and community partners in mental health and substance-use programs [233]. Health care workers in focus groups described needing to examine and adapt standard practices and protocols for extreme heat events. For example, when protocols restricted staff from transporting clients in their personal vehicles, staff tried working with families to meet client transportation needs; at times, the only option was to call an ambulance to take clients to the hospital emergency department. This was challenging due to wait times and emergency department capacity. In Vancouver, one strategy was to offer taxi vouchers to staff for transporting clients [56].

Heat impacts on health facilities and infrastructure

> *"We were caught off guard by the heat dome in 2021… We had HVAC systems [that] could not support heat of that level, for that long, at that length of time."*
>
> —*Risk to Resilience Project* focus group participant

When health infrastructure is impacted by extreme heat, a cascade of effects and impacts are felt by health staff and patients. In a 2018 survey of staff at Lower Mainland health authorities about extreme heat risks and impacts, the most commonly cited health infrastructure impact was cooling system overload, resulting in an inability to maintain normal operating temperatures (typically 26–36°C) [150].

Additional impacts included:

- Strained cooling systems, leading to disrupted medical procedures and increased workloads as a result of excess humidity and poor air quality;
- Adverse impacts on food refrigeration, mortuary use, and medical or patient material; and
- Air- and water-cooled medical devices, such as magnetic resonance imagers (MRI), being rendered inoperable, due to chillers failing or temperatures in the municipal water supply exceeding 15°C.

Similar impacts were reported during the 2021 heat dome event; medical equipment, including diagnostic computed tomography (CT) scans and MRIs, failed due to insufficient cooling capacity of chillers [175]. Following 2022 heat events, health authorities also reported heat-strained cooling systems and issues with chillers that led to unexpected replacements and additional costs, including costs to provide temporary cooling. Some sites also reported challenges maintaining indoor temperatures and set points, issues with air supply and ventilation, and higher utility costs when running cooling devices non-stop [234].

Aging health infrastructure and equipment is an ongoing challenge in B.C. and across Canada, as many buildings were not designed for extreme heat conditions [175,235]. Some older facilities, for example, cannot support HVAC or cooling systems due to limited electrical capabilities. This, in turn, leads to challenges in maintaining indoor temperatures [42,235].

During the 2021 heat dome, cooling-system failures impacted older buildings, including long-term care facilities where inadequate cooling in individual rooms required residents to move to common cooling areas. However, as reported by focus group respondents, there were also malfunctions of air conditioning in common areas. Power outages occurred when systems and power grids could not support air conditioning, requiring constant repairs by Facilities Maintenance and Operations teams. In smaller sites without around-the-clock engineering support, there were delays in restoring power [56].

> *"[Our region] is not a place that's historically had heat issues, and so there are so many older buildings that don't have the infrastructure in terms of their HVAC systems. They don't have central air conditioning, they don't have air conditioning in their rooms."*
>
> —*Risk to Resilience Project* focus group participant

Without adaptation action, many acute and long-term care facilities across B.C. are projected to have high heat failure probabilities by the year 2100[20] [194].

Heat impacts on health-related supply chains

As experienced during the 2021 heat dome, extreme heat events impact health-supply chains in B.C., including vaccines, medications, food, and essential supplies.

Vaccine and medication storage/spoilage

During the 2021 heat dome, B.C. health authorities were concerned about spoilage to essential temperature-sensitive medications—such as COVID-19 vaccines, insulin, EpiPens, and naloxone kits—and shared information with the public on how to prevent this from occurring. Some mass COVID-19 vaccination clinics in the province were forced to close when temperatures made it unfeasible to keep vaccine supplies cold [27,233].

Food storage and supply

Heat waves, including the 2021 heat dome, can create conditions that lead to spoilage of perishable foods throughout the food chain [236]. During the 2021 heat dome, impacts on food production across multiple suppliers led to a reduction in poultry and dairy products, seafood, fruits, and vegetables in the Okanagan, Kootenays, and Fraser Valley regions [44,93,175]. For example, 661,000 poultry raised for meat died, milk production declined by 17 percent, and 500,000 litres of milk were discarded because it could not be kept cold [175]. Both marine-harvesting and shellfish-farming operations experienced losses; mussel harvesting declined by 9 percent, and up to 70 percent of farmed shellfish died in some areas [175]. These losses posed a significant health impact on those who rely on food harvesting, cultivation, and production for their livelihoods, economic stability, or to feed their families.

Extreme heat can also indirectly affect food availability by disrupting transportation and distribution systems. High temperatures can damage roads, railways, or other infrastructure [237] critical for transporting food from farms to markets. Heat-related crop/livestock damage and supply chain disruptions can also cause food costs to rise, affecting access and affordability, which can lead to food insecurity in a variety of ways [238]. Messaging related to the spoilage of perishable foods was shared with the public during the 2021 heat dome event [236].

Availability of cooling devices

A shortage of portable air conditioner units was an issue during the 2021 heat dome. Lower Mainland retailers were unable to keep them stocked, and units began appearing in reseller marketplaces at inflated prices [239]. There were limited hotel vacancies in the Lower Mainland as locals searched for air-conditioned spaces [240]. Following the heat dome, shop owners began adapting by ordering more stock in advance. Supportive housing organizations, such as BC Housing and the Portland Hotel Society, began stocking up on fans and air conditioning units well in advance of summer months [241]. Similar patterns were seen during subsequent heat events in 2022 and 2023, when warmer weather alerts triggered shortages of air-conditioning units [242,243] .

20 Based on a high emissions scenario projection (RFP 8.5), with high heat failure (HF) probability defined as a HF occurring once every three years.

Disruption of transportation routes

Extreme heat events present transportation and supply-chain disruptions for remote communities that rely on air and sea traffic. For example, one remote B.C. Indigenous community found it difficult to bring in supplies during the 2021 heat dome, as their airport was impacted by flight cancellations and weight restrictions, due to the influence of extreme heat on engine performance and runway viability [244].

> *"A 19-seat plane can only really take off at [certain conditions]. There were... people in neighbouring communities who were very dependent on getting certain medications to stay alive... It was hard to get them their meds in the heat wave."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

4.3 Health-related adaptations to extreme heat in B.C.

Since 2021, B.C. has made significant strides in extreme-heat preparedness province-wide, informing adaptations in health policies, services, and response strategies. Efforts have been made to increase timely heat alerts and messaging [103] along with development of guidance for community cooling centres [245]. Yet, it's important to acknowledge the challenges that persist, such as retrofitting buildings for passive cooling within the constraints of existing infrastructure. These challenges prompt a call for a broader approach, one that encompasses both short-term actions and long-term solutions. Below are a few examples of initiatives in the province that are building resilience to extreme heat.

Public health adaptation to extreme heat

In B.C., the journey towards resilience in the face of extreme heat is marked by significant progress and collaboration. The province's approach to addressing the escalating challenges of extreme heat events encompasses health system transformation, alongside partnerships and actions led by local governments and First Nations communities. This collective commitment to health and well-being is at the forefront of action.

Cooling Stations across Victoria, B.C.

A TIMELINE OF SELECT HEALTH-RELATED EXTREME HEAT ADAPTATIONS IN B.C.

2009

2010

BCCDC initiates program of research on heat health impacts and preparedness in B.C., including informing trigger temperatures for heat emergencies in greater Vancouver

City of Vancouver publishes *Extreme Hot Weather Preparedness and Response Plan*

2011

Heat Alert and Response System (HARS) launched for greater Vancouver, with trigger temperatures set by BCCDC, Vancouver Coastal Health and Fraser Health

2012

BCCDC publishes research on temperature thresholds for heat mortality in different provincial regions, risk factors for heat mortality, and methods for identifying heat-related deaths and heat exposures

2017

BCCDC publishes guidance for *Municipal Heat Response Planning in B.C.* and a resource specific for Medium-sized Municipalities

2018

Interior Health initiates a multi-year project to support planning & response to extreme heat (including a pilot HARS in Ashcroft)

BCCDC and ECCC establish heat alert thresholds for the entire Province

2019

BCCDC *launches the B.C. Heat Impacts Prediction System*

2020

Interior Health *Heat Alert Response Toolkit* published to support local heat response planning

Fraser Health releases tailored guidance for *Extreme Heat and people experiencing homelessness*

2021

Guidance released by BCCDC and B.C. Ministry of Health on *Community Cooling Centres During B.C.'s Restart Plan*

Seasonal Readiness Committees established in Lower Mainland Health Authorities

2022

January
B.C. Health Effects of Anomalous Temperatures Coordinating Committee (*B.C. HEAT*) Committee established to support planning and response related to public health impacts of extreme heat province-wide

Province publishes *Extreme Heat Preparedness Guide* in multiple languages

June
B.C. Coroner's *Review of Heat-Related Deaths in the Summer of 2022* released

June
B.C. Heat Alert and Response System (B.C. HARS) rolled out as a two-tiered system for the Province, including: Heat Warning and Extreme Heat Emergency

Spring/Summer
Vancouver Coastal Health develops a *Heat Framework Support Guide for Non-Governmental Organizations*, a companion guide to the NCCEH/ BCCDC's *Guide to Health Checks in Extreme Heat Events*

2023

May
B.C. HARS updated, integrating lessons learned in 2022

June
Interior Health updates *Heat Response Planning for Southern Interior B.C. Communities* reflecting B.C. HARS

Provincial heat response coordination

During extreme heat emergencies, collaboration and coordination are vital. Public health crises demand an all-of-society response, with clear frameworks and communication channels between relevant partners. Following the 2021 heat dome, the B.C. Ministry of Health and BCCDC formed the B.C. Health Effects of Anomalous Temperatures Coordinating Committee (BC HEAT) to support coordinated planning and response to the public health impacts of significant heat events in B.C. [103]. This committee includes representation from each of B.C.'s regional health authorities, First Nations Health Authority, BC Emergency Health Services (BCEHS), BC Housing, the Ministry of Emergency Management and Climate Readiness (EMCR), Environment and Climate Change Canada (ECCC), Health Emergency Management B.C. (HEMBC), Office of the Provincial Health Officer, the Union of BC Municipalities, BC Hydro, and WorkSafeBC. It was initiated as a forum for heat-related planning and response activities, creating a centralized point where partner organizations can address cross-sector and systemic challenges associated with extreme heat events. BC HEAT also assesses whether forecast temperatures constitute an extreme heat emergency, and makes recommendations to other partners at the ministry, health authority, community, and non-governmental organization (NGO) level about when to take action in accordance with their own organization's extreme heat plans.

BC HEAT is responsible for developing and updating the B.C. Provincial Heat Alert and Response System (HARS) [103]. In the system's inaugural summer of 2022, it identified specific roles and responsibilities for a range of partners, including Provincial ministries, health authorities, local governments, Indigenous communities, and partner organizations, for the periods before, during, and after extreme heat events. The recommendations and guidance of the B.C. HARS focuses on coordination to support a system- and community-level response that is better prepared and equipped to protect public health and safety for populations, communities, and individuals.

Guidance has also been prepared for provincial government ministries and agencies. Extreme Heat: Preparedness for Provincial Ministries and Agencies clarifies the roles and responsibilities of various government actors in activating sector-specific response plans, as needed [102]. The Ministry of Health currently oversees the response to public health impacts, while EMCR currently coordinates the response to non-health-related impacts, following the B.C. emergency management system. BC HEAT provides recommendations from a public health perspective to support planning and response.

B.C. Provincial Heat Alert and Response System

First implemented in the summer of 2022, the B.C. Heat Alert and Response System (HARS) is structured in two tiers: **Heat Warnings** and **Extreme Heat Emergencies**. During a Heat Warning, the health and emergency management sectors are promptly alerted through Environment and Climate Change Canada (ECCC) Weather Notification emails. ECCC disseminates public Heat Warnings through platforms including the WeatherCAN app and their website. Each authority tailors its actions based on their plans and recommended protocols.

Type of Alert	Heat Warning[21]	Extreme Heat Emergency
Public health risk	Moderate (5% increase in mortality)	Very high (20% or more increase in mortality)
Descriptor	Very hot	Dangerously hot
Historic frequency	1–3 per summer season	1–2 per decade
Criteria	Southwest = 29°C–16°C– 29° C* Fraser = 33°C–17°C– 33° C* Southeast (largely Interior region of B.C.) = 35°C–18°C–35° C* Northeast = 29°C–14°C–29° C* Northwest = 28°C–13°C–28° C*	

* Tmax ≥ daytime high, Tmin ≥ nighttime high, Tmax ≥ daytime high

When there is the potential for a Heat Warning to escalate to an Extreme Heat Emergency, the B.C. Health Effects of Anomalous Temperatures Coordinating Committee (BC HEAT) coordinates a series of consultations with designated leads, ensuring representation from subject matter experts. If the decision is made to issue an Extreme Heat Emergency within the province, it will initiate a series of response actions, including coordination calls at provincial and regional levels, press releases, and activation of regional and local Emergency Operations Centres (EOCs). EMCR may also issue an emergency broadcast and/or wireless alert through the Alert Ready system to allow for the immediate and direct dissemination of critical information to protect individuals, families, friends, neighbours, and community members during the Extreme Heat Emergency.

The HARS plan was updated in May 2023 to address identified gaps and concerns, including "warning fatigue." The updated HARS accounts for the behavioural and physical adaptations that occur by extending the heat warning activation criteria by a day as the heat season progresses. This reduces unnecessary messaging and alerting in forecast regions that have already experienced three or more heat warnings in a given year and are likely well adapted to the heat at that point. Further consultations to inform ongoing plan development involve local authorities, Métis and First Nations leadership, NGOs, and individuals with heightened susceptibility to past heat events. This commitment to continuous development not only showcases iterative learning and adaptive management, but also demonstrates dedication to public health, resilience, and preparedness in the face of extreme heat events.

21 As of May 2023, after the first three heat events of the summer in a given forecast region, BC HEAT may recommend extending the minimum number of days for Heat Warning criteria in the region to be when three or more consecutive daytime temperatures are expected to meet or exceed the regional Tmax value, and the overnight low is expected to reach or exceed the regional Tmin value for two or more consecutive nights.

Regional extreme heat response plans

There are specific challenges to developing a HARS that addresses the needs of rural and/or remote communities. Refinement and reassessment are ongoing to more fully reflect these needs in the B.C. HARS [103]. An effective HARS in a rural setting requires drawing on existing social and community networks [103]. Since 2018, Interior Health has been leading a multi-year initiative to support planning and response to extreme heat in the communities it serves, recognizing the unique context of rural communities [246]. In 2018, Interior Health partnered with the Village of Ashcroft to develop a HARS for the community, and in 2020, the regional health authority developed a Heat Response Toolkit to support community partners, which was updated in 2023 [205]. The toolkit provides practical information and resources that support rural communities in developing strategies to prepare for and respond to extreme heat.

The Village of Ashcroft's Heat Alert and Response System [247], established in 2018, is an example of how rural heat preparedness and response can be developed in a locally relevant and strengths-based way. Drawing on the community's strong social cohesion, existing physical infrastructure, and communication channels, Ashcroft demonstrated several areas that were successful, such as designated cooling centres and outreach to older adult populations. Through this community-led strategy, a HARS was successfully integrated into municipal response plans and existing infrastructure, and proved to be a public health intervention capable of addressing the health impacts of extreme heat [246]. The learnings from Ashcroft are now shaping the planning processes of similar HARS initiatives in other rural communities across the province [246]. Since the 2021 heat season, Ashcroft has updated their HARS to include:

- Updated heat alert tiers and language to describe alert levels;
- New communication strategies, such as the Voyent Alert System; and
- Designating the Community Hub building (a central, well-known, and accessible community space) as the official cooling centre.

The BCCDC has also created guidance to support municipalities in developing heat response plans. In 2017, respondents in a small survey of regional health authorities and municipalities highlighted the need for guidance in developing heat-response plans for small and medium-sized municipalities lacking infrastructure and expertise [248]. A guide was developed, based on these consultations and a literature review, which aims to help B.C. municipalities integrate heat plans into existing emergency preparedness strategies [249].

Health-sector-specific guidance

Regional health authorities have actively incorporated extreme heat preparedness into their operations, notably through Community Care and Assisted Living licensing policy updates. For instance, Fraser Health now mandates long-term-care and assisted-living homes to have a written heat response plan, complete with standard escalation and emergency measures as temperatures rise, including requirements for temperature monitoring and regular check-ins. Resources developed by the regional health authority's community care licensing program include Community Care Facilities and Heat [250] and Preparation for Extreme Summer Heat in LTC and AL Facilities: Planning and Management for Residents and Employees [251]. They have also developed a comprehensive heat toolkit for all sites within the Fraser Health region. Similar efforts are taking place in Northern Health, which provides tailored guidance to childcare facilities to ensure the safety of children in their care [252].

Data and evidence-informed decision-making

Since 2009, the BCCDC and B.C. researchers have been engaged in an ongoing program to better understand and measure heat exposures and health impacts, and to improve heat early warning and surveillance systems. Studies have been conducted to:

- Develop more accurate methods for assessing human heat exposures in urban areas, such as
  - measures of air temperature *versus* apparent temperature, which accounts for humidity; and [111]
  - measures of urban greenness [253], which will improve exposure assessments in epidemiological studies.
- Identify temperatures where heat exposure leads to increases in death rates, with findings being used to identify thresholds for triggering heat warnings and heat emergencies [105,106,254];
- More accurately capture heat-related deaths and injuries in epidemiologic studies [159,255]; and
- Identify risk factors for heat-related illness and deaths in B.C. populations [160,161,184,196,218]

A number of data visualization dashboards also now enable the public to better prepare for extreme heat events:

- The B.C. Heat Impacts Prediction System is an interactive online mapping system, developed by the BCCDC, intended for use by members of the public to support health protection during hot weather [256]. It provides heat health risks for the current, next, and following two days, as well as a daily risk comparison using observed data from the hottest and coldest years. It is reported at the level of Local Health Area[22].
- Interactive heat mapping tools have been developed that enable communities to better understand neighbourhoods most at-risk during climate-related events, including extreme heat and others. Examples include maps created by Vancouver Coastal and Fraser Health[84] and the Interior Health[83].

Ensuring facilities and infrastructure are better prepared for extreme heat

The comprehensive review of the 2021 heat dome conducted by the BC Coroners Service noted that most deaths had occurred indoors in homes without adequate cooling, highlighting the need to update existing building codes.

22 Local Health Areas (LHAs) are administrative boundaries produced and maintained by BC Stats and the Ministry of Health. There are 89 LHAs geographically nested within 16 Health Service Selivery Areas spanning five regional health authorities in B.C. [257]

Actions are being taken by the Province to ensure homes and buildings are adapted, retrofitted, and designed to provide safer interior living environments. They include:

- Updating the BC Building Code to establish a summer design temperature using mechanical cooling, or, where possible, passive design measures. A proposed requirement is that all new residential buildings must include at least one living space designed to stay cool (below 26°C). Requirements may vary based on weather conditions and site-specific factors [208].
- Including heat considerations in renewal and expansion investments in health authority long-term care facilities. Several projects in the capital plan will include modern HVAC systems that meet standards for air circulation and temperature control, including individual room cooling [209]. Between 2021 and 2023, 47 facilities had air conditioning/HVAC installed for the first time, and 149 facilities received upgrades to existing capabilities [209].

Other provincial organizations serving priority populations in B.C. have conducted heat-readiness reviews of community-based facilities and infrastructure. After the 2021 heat dome, BC Housing completed a review of the 54 heat-related deaths that occurred in 46 of its facilities (including single-room-occupancy hotels, social housing, and supportive housing), to better understand which design features increased the risk of death for residents. While findings were inconsistent with regards to building design, all of the buildings were older and not designed for cooling. Learnings from this review informed the development of the Extreme Heat and Wildfire Smoke Action Plan for BC Housing facilities and residents, which includes updates to the BC Housing Design Guidelines and Construction Standards that incorporate passive cooling measures to address the risks of overheating.

Built environment adaptations to combat the urban heat island effect

Research conducted after the 2021 heat dome pointed to the protective effects of surrounding greenness, especially within 100 metres of living spaces [92]. Green spaces and tree canopy can reduce the impacts of the urban heat island effect through evaporative cooling and shading [112,253].

Interventions by the health system include developing guidance about the protective effects of urban greenness and the impacts of lacking green infrastructure. The Green Design for Climate Resilience & Well-being guide was developed by a multi-sector collaboration between B.C. health authorities, an advisory group, and an industry task force. It details different green-space strategies and their associated metrics to provide evidence-based guidance on integrating climate resilience and public health co-benefits[23] into urban green-space design and planning [258]. The resource is supplemented by a user-friendly checklist to help designers, engineers, facilities building owners, and health professionals assess if they have considered and applied the strategies into their design. These resources are being applied to health-facility designs and are used to support health professionals in responding to community land-use applications by, for example, advocating for expanding green elements across the built environment [259].

Social connection and check-ins

There is a need for a comprehensive approach to address adaptation to extreme heat that includes consideration for low-carbon resilience (e.g., integrating low-energy cooling solutions, such as heat pumps) and social connectedness as protective factors to extreme heat [66]. Research has demonstrated the protective benefits of supporting priority populations through check-ins—a social intervention for addressing isolation during climate emergencies [66,210,260]. For more details see the example (estimating climate-related health risks for priority populations) in Chapter 10.

23 Co-benefits are the positive effects that a policy or measure aimed at one objective might have on other objectives. For example, climate mitigation efforts across energy, infrastructure, agriculture, and transportation sectors can improve population health by way of cleaner air, improved housing standards, healthier diets, and increased physical activity [16].

Increasing access to cooling devices

Air conditioning is one of the most effective adaptation strategies to reduce heat-related mortality and morbidity [261]. Data from Statistics Canada also indicates that B.C. has had some of the lowest rates of air-conditioner use in Canada; in 2017, just 31 percent of B.C. households had air conditioning of any kind, versus 61 percent of households Canada-wide [261].

Since 2021, B.C. has been improving access to cooling devices, such as portable air-conditioning units, for individuals, communities, and within the health system. Examples include:

- During the 2021 heat dome, Fraser Health created a list of long-term-care homes with/without air conditioning, focusing efforts on high-risk sites without air conditioning in hotter subregions [56].
- In summer 2022, Fraser Health launched a 10-unit pilot program, providing air-conditioning devices to clients at highest risk for heat-related illness over a period of three months. The units were leased through a qualified vendor who managed their delivery, installation, and support. The pilot's effectiveness and scalability are currently being assessed [262].
- In June 2023, the Province allocated funding to BC Hydro to expand its Energy Conservation Assistance Program to include free, publicly funded portable air conditioners for low-income and medically at-risk individuals, with an anticipated 8,000 air-conditioning units installed over the next three years [209].
- BC Hydro partnered with Vancouver Coastal Health to invest in portable air-conditioning units for community organizations, such as seniors' centres and neighbourhood centres. BC Hydro also teamed up with Praxis Spinal Cord Institute and Technology for Living, allocating funds for portable cooling devices for individuals with spinal cord injuries and disabilities [209].
- The B.C. Ministry of Health invested in EquipCare BC through the BC Care Providers Association, supporting seniors' long-term care homes with cooling items, air conditioners, evaporative coolers, and heat pump replacements [263].

It's important to note that while air conditioning is important for providing immediate relief from extreme heat, its reliance on energy consumption has longer-term consequences for maladaptation, and experts have warned against becoming an air-conditioned society [264–266].

Community cooling spaces

During the 2021 heat dome, a lack of access to cooling spaces (or cooling centres) posed substantial health risks [92]. This was especially challenging in urban areas, where heat becomes trapped and intensified in areas that are densely populated or that have lower urban greenness. Many municipalities provided cooling spaces for people to take refuge from the heat, either with guidance from their municipal heat response plans and/or in consultation with health officials. To address the concurrent concerns of the COVID-19 pandemic and the need to safely distance from others, the BCCDC and B.C. Ministry of Health developed guidance about the safe operation of cooling centres that included infection prevention and control considerations [267], prioritizing the importance of staying cool.

The 2021 heat dome also highlighted the pressing need for additional cooling spaces in communities. In 2023, municipalities across the province reported more than 300 cooling facilities, including indoor facilities (e.g., community centres, libraries, etc.) and outdoor amenities (e.g., spray parks, public parks, drinking water fountains) [268]. EMCR established an online dashboard to share the locations of cooling spaces with the public during extreme heat conditions [269]. Access and transportation to cooling spaces was identified as a barrier during the 2021 heat dome [85].

Municipal heat response—setting up cooling spaces in Burnaby, B.C. [270,271]

The City of Burnaby activated its Extreme Heat Initial Responses Guideline in response to the 2021 heat dome. This enabled community cooling spaces to open, with complex considerations including:

- operating hours;
- being accessible to and welcoming of all members of the public;
- being reachable by pedestrians, transit, or vehicle;
- availability of amenities such as Wi-Fi, washrooms, water, seating, etc.;
- limiting disruptions to current programming at the facilities already constrained by COVID-19 restrictions;
- facility staff and security staff availability; and
- planning for occupational health and safety.

Almost 800 people visited Burnaby's cooling spaces during the heat dome. The city also opened an open-air pop-up cooling site for underhoused people, offering free water, food, juices, sunscreen, and harm-reduction supplies.

Public communications for preparing and adapting to extreme heat

Public guidance about ways to prepare and adapt to reduce the health impacts of heat has been a focus for the Province, health authorities, and other organizations since the 2021 heat dome. Examples include:

- The National Collaborating Centre for Environmental Health (NCCEH) and BCCDC created a guide for conducting heat check-ins, Health Checks During Extreme Heat Events. This resource is intended for community members without health training, and provides a plain-language description of how to check on people most at-risk during extreme heat events. To empower organizations to conduct heat check-ins, Vancouver Coastal Health developed resources complementary to the NCCEH/BCCDC guide. These include a public webinar series on extreme heat and smoke preparedness for NGOs. Fraser Health also developed a summer heat wallet card in multiple languages with tips about how to stay cool during heat and poor air quality events.
- The Province's PreparedBC Extreme Heat Preparedness Guide helps people prepare their residences for extreme heat, and includes advice on how to stay safe when temperatures rise. Created in partnership with the BCCDC, the guide is available in multiple languages.
- Additional documents have been created to target priority populations, such as:
  - People who use substances (Interior Health): Heat and Substance Use Fact Sheet
  - People who are underhoused (Fraser Health): Extreme heat and people experiencing homelessness – Fraser Health
  - Landlords and strata managers, targeting people living in rental or strata units (Fraser Health/ Vancouver Coastal Health): Summer Heat and Health: Recommended Actions for Owners and Managers of Rental and/or Strata Housing

Culturally appropriate and equity-informed

Disasters and emergencies can disproportionately impact certain populations more than others [102]. Adaptation strategies must be equity-informed and culturally safe to ensure populations have fair or enhanced opportunities to achieve good health. Examples include:

- **Translating documents**: Health authorities and the Province have been creating informational resources in multiple languages to increase accessibility for those with English-language barriers (e.g., Extreme Heat resources, BCCDC resources, the Extreme Heat Preparedness Guide, and HealthLinkBC's resources), as well as other accessibility considerations, such as reading level, visual impairment, and media (e.g. print vs social media).
- **Collaborating with Indigenous partners**: To create and deliver culturally safe messaging about heat, the First Nations Health Authority collaborated with key partners, such as Métis Nation BC, the BC Association of Aboriginal Friendship Centres, BCCDC, and the B.C. Ministry of Environment and Climate Change Strategy.
- **Community awareness**: Many First Nations communities, Métis Nation BC and other Indigenous organizations maintain newsletters and offer seasonal preparedness webinars that play a vital role in disseminating information. Band administrators are central to amplifying the reach of messages. Printed resources are also invaluable assets that enhance accessibility and inclusivity, particularly for Elders who may prefer physical materials. Trusted nurses in community are exceptional connectors who play a key role in disseminating messages to clients [56].

Community and Indigenous-led adaptations to increase resilience

Despite facing noted challenges of heat exposure, Indigenous communities are demonstrating resilience and strength-based community-centered strategies to address the impacts of extreme heat events. Many Indigenous communities have embraced adaptation solutions, such as opening cooling centres in Band offices; creating food security strategic plans that prepare for extreme heat; analyzing how Elders can mitigate heat risk in their own homes through enhanced check-ins; and/or activating kinship systems to house family members in homes with air conditioning [222]. One report found that several B.C. First Nations' experiences of the 2021 heat dome demonstrated the protective quality of culture, including respect and care for Elders, relationship to land and ecosystems, and collaborative community action [222,244].

Community-led adaptations to increase extreme heat resilience have also been developed in partnership with the B.C. health system. After the 2021 heat dome, public health and HEMBC staff collected data (e.g., questionnaires to municipal emergency managers), organized debriefs and after-action reports, and worked on special projects—such as the City of Vancouver's citizen science reporting system of indoor temperatures during subsequent heat events, supported by Vancouver Coastal Health.

First Nations-led response to extreme heat [205]

The ongoing work in the T'ít'q'et and Xeni Gwet'in First Nation communities related to heat preparedness and planning demonstrates successful local First Nations-led adaptation in B.C. These First Nations leaders and teams are taking action to protect their communities from climate risks and prioritize health and safety.

T'ít'q'et, a community that is part of the St'át'imc First Nation in B.C., has been impacted by extreme weather events that have disrupted traditional livelihoods such as fishing, hunting, and gardening. The local T'it'q'et Heat Team received funding from Health Canada to develop a heat response plan that integrates existing emergency plans and builds on local knowledge.

The Xeni Gwet'in First Nation is one of six communities that form the Tŝilhqot'in Nation, located in traditional Tŝilhqot'in territory approximately 200 kilometres west of Williams Lake, B.C. Xeni Gwet'in First Nation received funding from Health Canada to hire an Emergency Program Coordinator tasked with developing an emergency response plan with a focus on heat, and to provide educational opportunities for community members.

Both heat response plans include strategies such as:

- Regularly checking in on Elders and those most at-risk during heat events;
- Establishing cooling centres in community buildings through the installation of tinted windows and a heat pump;
- Delivering water and distributing air conditioners and fans;
- Ongoing engagement with community members about climate change, heat waves, and their health and safety needs;
- Building capacity locally through training for community members on responding to emergencies;
- Integrating heat into existing emergency response plans.

4.4 Opportunities for action

Some key opportunities for B.C. to better prepare for and mitigate the acts of extreme heat include:

Coordination

- Increase clarity on the respective roles of the health system, local governments, First Nations, Métis organizations, emergency management agencies, and community partners, in preparing for and responding to extreme heat events.
- Strengthen partnerships with community organizations that provide services to populations most at risk from extreme heat (e.g., socially isolated older adults; daycares; the unhoused), and enhance collaboration for outreach and guidance for check-ins.

Planning and interventions

- Continue to build on efforts for local seasonal readiness planning across multiple sectors in preparation for heat season.
- Take an all-hazard approach to explore strategies that could have co-benefits for extreme heat and other climate events, such as wildfire or drought.
- Tailor heat adaptations for populations and neighbourhoods that are most at risk, and adopt strategies that are accessible, inclusive, and culturally safe.
- Continue to work with local governments and Indigenous partners to promote and identify locally appropriate built and social environment interventions that aim to protect human health from extreme heat (e.g., cool housing and green infrastructure).

Communications

- Create aligned and coordinated heat messaging across the health system, and with partners and the media, using a variety of platforms to reach diverse populations.
- Develop guidance documents and targeted heat messages to specific sectors (e.g., non-profits, landlords, schools, daycares, and restaurants) and key populations in advance of the heat season.
- Deliver public health messaging for personal heat planning and advocating home heat preparedness.

Surveillance, Research and Evaluation

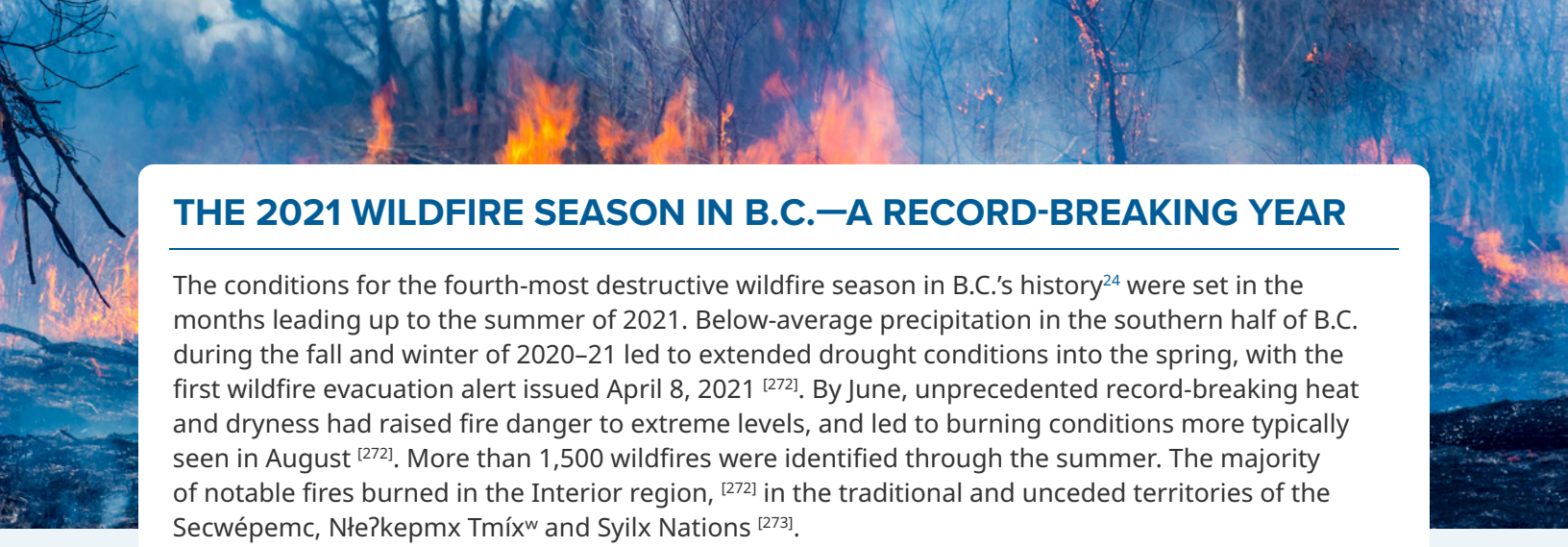
- Continue to conduct regional and local heat vulnerability mapping to determine populations most at-risk during extreme heat emergencies and identify priority areas for focused strategies.
- Continue to research the physical and mental health impacts of heat exposures on different populations, and with a focus on populations disproportionately impacted.
- Continue to explore the combined effects of heat and wildfire smoke on public health.
- Continue to work collaboratively across agencies to facilitate more accurate assessment of the burden of heat-attributable deaths and illnesses.
- Collaborate across the health system, local governments, and community partners to evaluate the effectiveness of heat-mitigation strategies and community-based adaptations (e.g., utilization of cooling centres, shade structures), and the differential effects of actions on different population groups.
- Evaluate the effectiveness of heat communications with target populations and sectors, being mindful of the potential for messaging fatigue.

Penticton, B.C. — August 29, 2021

Chapter 5: Wildfires

KEY FINDINGS

- Severe wildfire seasons are among the greatest climate risks facing B.C., with the **intensity and frequency of wildfire activity increasing** over time.
- Wildfires in B.C. significantly **impact population health**, primarily due to wildfire smoke. Evidence demonstrates associations of wildfire smoke with respiratory issues, emergency department visits, hospitalizations, and deaths. Asthma exacerbations are a consistent outcome, with emerging evidence of cardiovascular and birth-related effects, and repercussions for individuals with diabetes and end-stage renal disease.
- **Wildfire evacuations** in B.C. disrupt access to health care, medications, and supplies; influence community social cohesion; and have impacted mental health through increased stress and emotional trauma.
- Wildfires can indirectly impact the health and well-being of B.C. populations by influencing the **determinants of health**, such as access to cultural sites, economic productivity, and outdoor activities.
- Wildfires in B.C. **disproportionately affect specific populations**, driven by factors such as greater exposure to wildfires, reduced adaptive capacity, and increased susceptibility. Children, older adults, individuals with cardiorespiratory conditions, pregnant individuals, and marginalized communities are at higher risk of health impacts from wildfire smoke.
- **Many First Nations communities** in B.C. are particularly susceptible to the effects of wildfires, due to their proximity to wildland areas. Uncontrolled wildfires disrupt traditional activities and ways of life, compounding emotional trauma. Additionally, First Nations communities face greater challenges in recovery.
- **Wildfire adaptation strategies** to protect public health, enhance disaster preparedness and build resilience in the face of increasingly severe wildfire events include:
  - improved coordination and collaboration within the health care system;
  - the use of low-cost sensors to monitor air quality and smoke infiltration;
  - enhancements in wildfire smoke monitoring, warning systems, and public-risk communications;
  - patient-care adaptations;
  - facility and infrastructure upgrades; and
  - Indigenous-led adaptations, such as prescribed cultural burns.



THE 2021 WILDFIRE SEASON IN B.C.—A RECORD-BREAKING YEAR

The conditions for the fourth-most destructive wildfire season in B.C.'s history[24] were set in the months leading up to the summer of 2021. Below-average precipitation in the southern half of B.C. during the fall and winter of 2020–21 led to extended drought conditions into the spring, with the first wildfire evacuation alert issued April 8, 2021 [272]. By June, unprecedented record-breaking heat and dryness had raised fire danger to extreme levels, and led to burning conditions more typically seen in August [272]. More than 1,500 wildfires were identified through the summer. The majority of notable fires burned in the Interior region, [272] in the traditional and unceded territories of the Secwépemc, Nłeʔkepmx Tmíxʷ and Syilx Nations [273].

The communities of Lytton, Lytton First Nation, and Monte Lake were completely or partially burned by wildfires. Thousands of people were evacuated from communities and health facilities, some for long-term periods of months and even years [274,275]. Two community members tragically lost their lives trying to escape the rapidly moving Lytton fire [276].

2021 WILDFIRE SEASON BY THE NUMBERS

~869,000 hectares burned, making this the fourth-most destructive wildfire season in B.C. history [272]

300+ active wildfires burned simultaneously in the province, at the peak [273]

1,642 wildfires burned over the season; 67 categorized as "wildfires of note"—meaning they were highly visible or posed a potential threat to public safety [272]

137 wildfire-smoke related special air quality statements were issued by ECCC for B.C.[25]

527 structures destroyed, including primary residences, seasonal homes, and commercial buildings [277]

~90 percent of the Village of Lytton destroyed by the Lytton Creek fire, including most homes and structures, the local ambulance station, health clinic, and RCMP detachment [276]

56 days of a provincial state of emergency for wildfire response [272]

181 evacuation orders and **304** evacuation alerts triggered [272]

~32,000 people displaced by the fires [278].

1,151 patients/residents from Acute, Long-Term Care, Assisted Living, and Home and Community Care evacuated in the Interior Health region [42]

2 people tragically lost their lives fleeing the Lytton Creek fire [276]

$719 million in fire-suppression costs to the Province [272]

$1.7 billion–$2.5 billion in total economic costs to the Province [44]

24 Based on total area burned.
25 Data source: Environment and Climate Change Canada (ECCC)—see Appendix 1 for more details.

5.1 Exposure to wildfires in B.C.

Wildfire trends in B.C.

Severe wildfire seasons are among the greatest climate risks facing B.C. [30]. Due to prolonged extreme-fire weather conditions and longer fire seasons, wildfires are projected to increase in number, size, and intensity, particularly in northern boreal forest regions [279]. The 2019 Preliminary Strategic Climate Risk Assessment ranked severe wildfire season as having both an increasing likelihood of occurring and the highest level of consequences (considering health, economic, social, cultural, and ecosystem consequences), compared to 14 other assessed climate hazards [30] [26]. It projected that a severe wildfire season would occur roughly once every three to 10 years in B.C. by 2050 [30].

Data shows increasing wildfire activity in B.C. over time, driven in part by climate change [280,281]. In line with globally observed trends, B.C. is seeing an increase in mega-fires, which are often described as ecological disasters; they burn vast areas of land and are characterized by high intensity outside of observed historical ranges [282,283]. In the 102 years of recorded wildfire history in B.C., the four most destructive (by area burned) occurred during the last decade (Table 2): 2017 (1.2 million hectares), 2018 (1.3 million hectares), 2021 (0.9 million hectares), and 2023 (2.8 million hectares) [272,284].

Table 2. Record-breaking wildfire seasons in B.C. since 2009 [272,285]

Indicator	B.C. Wildfire Year							
	2009	2010	2014	2015	2017	2018	2021	2023
Historic ranking in terms of area burned	8th	6th	5th	7th	3rd	2nd	4th	1st
Total area burned (thousand hectares)	>247	>337	>369	>280	>1216	>1354	>869	>2841
Number of fires	3,064	1,672	1,481	1,858	1,353	2,117	1,647	2,245
Provincial state of emergency (# of days)	0	0	0	0	70	23	56	28
Number of people evacuated / displaced	20,000	1,383	4,500	3,432	65,000	3,200	32,882	~48,000
Total costs fire suppression (million dollars)	382	212	298	277	649	615	719	817

Direct exposure to wildfires occurs when communities and infrastructure are in close proximity to wildland areas. A large proportion of B.C.'s land mass is in the "wildland human interface" zone[27], with the highest percentages in the Interior and Northern regions of the province [279].

26 Severe wildfire season was defined as at least one million hectares burned that affect human settlements and significant infrastructure. Possible consequences included negative acute and long-term impacts to health due to smoke exposure, displacement, loss of possessions and livelihoods, severe psychological distress, economic impacts, and disruption to industries (such as tourism, timber, mining, and agriculture), operations and infrastructure (such as transportation, electricity supply, telecommunications, water treatment, and sewage systems).

27 The wildland urban interface (WUI) is typically described as the area where communities meet or intermingle with the natural environment. When we live, work, and play in WUI zones, we become more exposed to the danger of wildfire. [286]

Wildfire smoke exposure in B.C.

What is in wildfire smoke?

Wildfire smoke is complex and can change over time, depending on what materials are burning and other factors [287]. Major smoke constituents include carbon monoxide, volatile organic compounds, mercury, ozone, pollutant mixtures, and particulate matter (PM) [287], with fine particulate matter ($PM_{2.5}$) posing the greatest risk to human health [288]. Wildfire smoke is not the only source of $PM_{2.5}$ in B.C.; other major sources include wood-burning stoves and fireplaces, heavy-duty equipment, industry, and traffic [289]. However, over time, wildfire smoke is accounting for an increasing proportion of $PM_{2.5}$ exposure in B.C. [138].

Wildfire smoke can travel large distances, sometimes moving hundreds or thousands of kilometres from the fire zone [290], impacting communities far away [291,292]. B.C. communities have experienced some of the worst air quality rankings in the world during periods of high wildfire activity, even being impacted by active fires outside the province [6,7,10]. Air quality modelling for B.C. has found that, while concentrations of wildfire-$PM_{2.5}$ are greatest in areas closest to wildfire activity, wildfire-$PM_{2.5}$ can be widely dispersed [292]. During the 2017 western Canadian wildfires, smoke was injected high (up to 23 kilometres) into the stratosphere, and was detectable by satellites for more than eight months [291].

Peachland, B.C.

Because of the transboundary nature of wildfire smoke, large proportions of the B.C. population are exposed to wildfire smoke each year at levels above the recommended threshold to protect human health [292]. During the 2017 wildfire season, approximately 70 percent of the B.C. population and 32 percent of the B.C. landmass was exposed to wildfire-$PM_{2.5}$ above a seasonal average of 10.0 ug/m^3 (May–September)[28] (Appendix 1 – Table A1.4).

Additional analyses by Statistics Canada for the 2018 wildfire season found many B.C. communities were exposed to poor air quality at levels representing a high risk to human health; Prince George in Northern B.C. ranked highest, experiencing 32 high-risk days[29], followed by Castlegar in the Southern Interior, with 30 days [293] (Figure 8). This Air Quality Health Index (AQHI) figure highlights the regional differences in exposure to wildfire smoke in B.C. At a national level, the 10 Canadian communities with the highest average exposures to wildfire-$PM_{2.5}$ in Canada from 2013–2015 and 2017–2018 were all in B.C., particularly in the B.C. Interior and Northern regions [292]. During this period, the population in the B.C. Cariboo region had the highest average exposure to wildfire smoke of all regions in Canada, with wildfire-$PM_{2.5}$ driving much of the overall $PM_{2.5}$ exposure from May to September (Appendix 1 – Table A1.5) [292].

28 The threshold of 10.0 ug/m3 represented the Canadian Ambient Air Quality Standard (CAAQS) for annual $PM_{2.5}$ for the study time period. The annual threshold was used as a proxy threshold in this study, though seasonal averages may not be directly comparable to the annual CAAQS threshold.

29 High risk was defined as an Air Quality Health Index (AQHI) of 7 or higher.

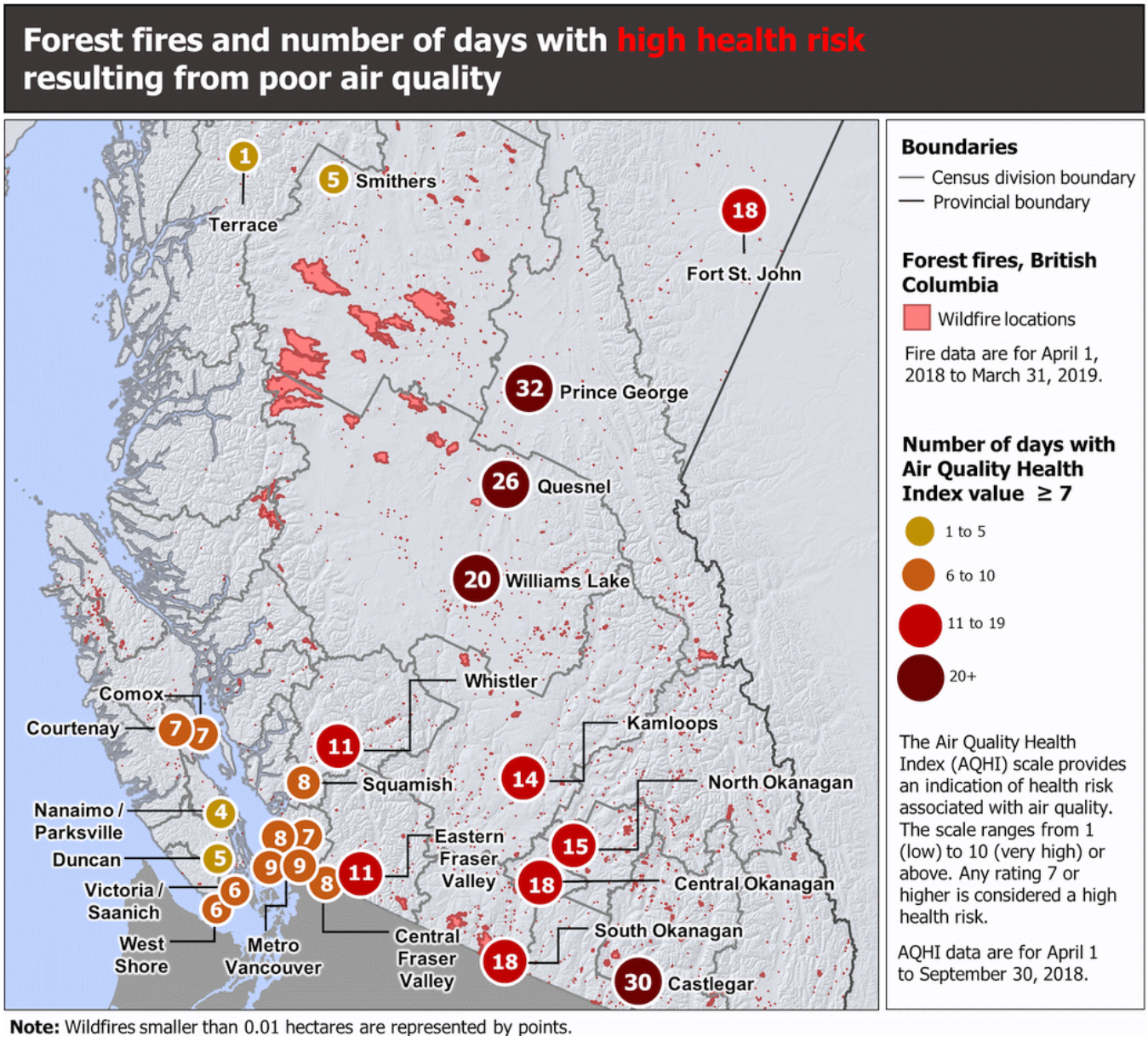


Figure 8. Number of days with high health risk resulting from poor air quality in B.C. communities during the 2018 wildfire season [293]

In 2021, 137 (77 percent) of the 177 special air quality statements (SAQS) [30] issued for B.C. by ECCC were due to wildfire smoke, and the province had one or more regions under an advisory for wildfire smoke for a total of 77 days. Interior Health had the most days with one or more regions under a SAQS (77 days), followed by Fraser Health (particularly the Fraser East health service delivery area, with 57 days) (see Appendix 1 – Table A1.7).

30 Special Air Quality Statements (SAQS) are issued by Environment and Climate Change Canada based on air quality advisories from the B.C. Ministry of Environment and Metro Vancouver.

Cascading impacts of wildfires in B.C.

Wildfires can result in cascading impacts, with implications for health and well-being:

- Severe wildfires damage the forest canopy, the vegetation, and the soil, which can lead to soils becoming more hydrophobic (i.e., less able to absorb moisture), resulting in increased runoff after intense rainfall or rapid snowmelt [294,295]. Particularly in areas that experienced high burn severity, the chances of soil erosion, floods, landslides, rock falls, snow avalanches, and drought increase [296], which can put infrastructure and communities below and downstream from a burned area at risk [295]. After the 2017 Elephant Hill wildfire in B.C., for example, severely damaged vegetation in the area created hydrophobic soils, and several intense rainfalls following the fire caused damage, flooding, and drainage issues [297]. After the 2017 wildfires, Tl'etinqox experienced numerous floods [34].
- Wildfires can impact freshwater availability [298], with impacts to drinking water quality and quantity through factors such as more hydrophobic soil; damaged water infrastructure; the build-up of ash, soil erosion and debris; and a rise in soil and water chemical levels (e.g., phosphate, nitrate, nitrite) if fire retardant is used [299] or if pipes, meters, and wellheads are burned. After Alberta's 2016 Fort McMurray wildfire, for example, levels of suspended sediment, nutrients (nitrogen, phosphorus), and metals (lead and others) from impacted rivers were 1.2 to 10 times greater than from those draining unburned regions [300].
- Air quality after a wildfire can also be impacted, due to contamination from burned structures and materials. After wildfires burned structures in Lytton (2021) and Telegraph Creek (2018), for example, contaminants such as asbestos and lead were reported in ash samples and debris [301–303].
- Wildfire smoke can influence ozone levels; the long-range transport of wildfire smoke from Siberia in 2012, and wildfires from B.C. and the western United States in 2017 and 2018, for example, are believed to have led to the higher ozone levels in these years [138].
- Wildfire impacts on a range of ecosystems can also have downstream effects on human health. For example, wildfire ash deposition on marine and freshwater systems can be toxic to organisms and can lead to increased growth of harmful algae blooms [304]. This can in turn can significantly affect fish and shellfish populations, which can have impacts on food security [305]. Wildfires are also associated with mercury contamination in downstream aquatic ecosystems, including increased mercury concentrations in fish [306,307]. Wildfires can weaken, damage, or stress trees (including fruit-bearing trees) and make them more susceptible to insect attack [308]. Further, wildfires have also been shown to be directly responsible for permafrost peatland melt in Western Canada (including areas of Northeastern B.C.) [309], which has cascading food security impacts for Indigenous Peoples that rely on permafrost regions for traditional hunting, fishing and gathering activities. For more details on how wildfires have impacted food supply chain, see pop-out box in section 5.3 of wildfire-influenced food supply impacts in B.C.

5.2 Wildfire impacts on B.C. population health and the health system

There is growing evidence globally that wildfires impact health through multiple pathways [310]. A large body of research shows that wildfire smoke (and $PM_{2.5}$ exposure more broadly) increases rates of respiratory medication use, ambulance calls, emergency department visits, hospital admissions, and deaths [311–314].

Respiratory health impacts of wildfire smoke are among the most consistently reported in the literature, with the clearest evidence for exacerbations of asthma, and mixed evidence for an association with chronic obstructive pulmonary disease (COPD) and respiratory infections [311,315,316]. There is also growing evidence of acute cardiovascular health impacts from short-term wildfire smoke exposures [310,311], and emerging evidence of impacts on outcomes among people with diabetes and end-stage renal disease [311]. In addition, there is emerging evidence of exposure during pregnancy impacting adverse birth outcomes [317,318].

In addition to morbidity and mortality, wildfires are having broad impacts on the social, economic, and cultural determinants of health in B.C.

5.2.1 Wildfire impacts on B.C. population and public health

Wildfire-related deaths in B.C.

Deaths occurring directly due to wildfires in B.C. rarely occur. According to the Canadian Disaster Database and media reports, there were nine wildfire deaths reported in B.C. between the years 2003 and 2023, with six occurring among wildfire crews working on the frontlines [285,319,320]. In 2021, two people in the community of Lytton lost their lives trying to escape the rapidly approaching fire [276], marking the first year since 2003 in which community members perished due to wildfire.

Deaths in B.C. have also been associated with wildfire-smoke related $PM_{2.5}$, with reported increases in the number of deaths due to any cause [321] and deaths occurring prematurely [292]. In 2023, a young boy tragically lost his life following a severe asthma attack exacerbated by wildfire smoke in an Interior B.C. community [322]. Modelling by Health Canada estimated that between 2013-15 and 2017-2018 , $PM_{2.5}$ from wildfires resulted in 293 premature deaths from acute exposure, and 2,979 premature deaths from chronic exposure in B.C. (Appendix 1 – Table A1.6). These findings suggest that, on average, B.C. has the largest proportion of estimated premature deaths due to acute and chronic wildfire smoke exposure of all Canadian provinces, accounting for roughly half of all estimated wildfire-smoke associated premature deaths in the country over the study period [292][31].

Vancouver, B.C. — July 5, 2015

31 These are estimates derived using statistical models.

Wildfire-related illnesses in B.C.

Wildfire smoke

B.C. community members surveyed during and after wildfire smoke events frequently report respiratory health impacts, for example:

- In a survey about the 2017 wildfire smoke impacts on residents of the Interior B.C. community of Kamloops, more than half of 641 respondents said their lifestyles had been severely affected by the smoke. More than three-quarters reported eye and throat irritation, headache/irritability, fatigue/malaise, cough/phlegm/asthma, and nose irritation, and many reported increased medication use [323].
- During the 2017 Elephant Hill wildfire, some evacuees reported experiencing respiratory illnesses such as bronchitis or pneumonia, with respiratory symptoms exacerbated by conducting daily activities outdoors in the high smoke conditions [324] [32].
- The 2019 First Nations Leadership Council Climate Emergency Survey, which included 139 First Nations and Tribal Councils across B.C., asked participants what health problems they or others in their community have experienced that may be related to climate change impacts (e.g., warming temperatures, wildfires, etc.). Of the 221 respondents, 63% indicated "respiratory disease" caused by exposure to indoor or outdoor air pollutants or allergens. It was second only in frequency to mental health impacts (65%) [61].

> *"We drove through the flames. I was just crying watching my whole valley burn. All the berry picking. All gone. We grew up in those mountains... I needed to go to the hospital right away. I have my inhalers and they're not even doing anything at this point. My nose and my throat is full of soot and I'm trying to get it out... I needed oxygen and fluids. They said if I was there any longer, my lungs would give out."*
>
> —Suzanne Kilroy/Huculak, community member of Downtown Eastside, interview in Megaphone Magazine [325]

Cardiorespiratory health impacts are also among the most frequently reported health impacts of wildfire smoke in B.C. population-based studies, evidenced by:

- Increased asthma medication use in multiple wildfire years [321,326–328]; and
- Increased health care utilization, including visits to the emergency department [329] and physicians [327,328,330]; hospitalizations [326] and ambulance calls [321] for respiratory illnesses during wildfire smoke events; and cardiovascular- and diabetes-related illnesses in some studies. (See Chapter 10: Health Emergency Management, Evacuations and Health Service Delivery for more details about health service use during wildfire events in B.C.).

32 These data were collected through in-depth interviews of seven members of the Ashcroft Indian Band as part of a case-study analysis of the impacts of long-term evacuations from the Elephant Hill Wildfire of 2017.

Work is ongoing to investigate impacts of wildfire smoke on birth outcomes and infant health in B.C. [331,332]. One Canadian study found that long-term exposure to wildfire smoke may increase the risk of certain cancers. Compared to populations that were never exposed to wildfire smoke, incidence of lung cancer and brain tumors were elevated for populations who were exposed to wildfire smoke in Canada. The authors caution, however, that further research is required before causation can be assumed. [333]

Wildfire evacuations

The process of evacuation has impacted the health of B.C. populations in different ways: limiting peoples' access to health care, medications, supplies; reducing their access to healthy and sufficient food sources; and impacting mental health through increased stress and trauma.

Exacerbations and increases in diagnoses of chronic physical illnesses have also been reported among long-term evacuees in B.C. Some long-term evacuees from the 2017 Elephant Hill wildfire, for example, reported increased chronic physical health conditions, such as asthma and diabetes, and infectious diseases [324]. Mental health impacts have also been among the most frequently reported health impacts of wildfires for community members in B.C., particularly in association with evacuations. More discussion about the impacts of wildfire-related evacuations in B.C. is included in Chapter 9: Mental Health Impacts and Chapter 10: Health Emergency Management, Evacuations, and Health Service Delivery.

Wildfire impacts to social, economic, cultural, and environmental determinants of health

In addition to their direct impacts, wildfires also indirectly impact the health and well-being of B.C. populations by influencing the determinants of health. For example:

- Displacement can result in social fragmentation from friends and family and diminished community cohesion, especially when community members are evacuated for several weeks or months [273].
- Wildfires have contributed to reduced access to sacred and cultural sites among First Nations communities in B.C. [61] They have also contributed to reduced social connection in some Indigenous communities, due to people staying indoors during wildfire smoke periods and community events being cancelled [223].
- Economic losses, loss of livelihoods, and loss of productivity due to wildfire damage—and time spent away during evacuations—have impacted many workers and industries. People living in areas impacted by smoke have also reported a reduced ability to focus on work and disruption to work routines [323].
- Smoke exposure impacts outdoor recreational and community activities when sporting events or regular physical activity routines are cancelled. During the 2017 wildfires, for example, many recreational games were cancelled and outdoor exercise was severely affected, according to 346 (54.8 percent) of respondents to a Kamloops community survey [323]. Road closures, including forest-service roads and recreation trails [334], have also curbed recreational travel [335].

Pop-up camps for kids affected by 2021 wildfires

As a result of the 2021 wildfire season, many evacuated children had been stuck in hotel rooms for days on end, unable to play outside due to poor air quality or to access indoor recreational opportunities due to affordability. BGC (formerly Boys and Girls Club) Okanagan partnered with the United Way B.C. to provide a pop-up recreation program for children of families evacuated by the wildfires.

BGC's free pop-up recreation program provided children with a safe and friendly environment to participate in a range of activities and receive the help of supportive adults. The staff at BGC witnessed many signs of the trauma and stress that children had experienced. The program helped turn a stressful and chaotic introduction into a new community into a safe, supportive and fun experience. [336]

Source: United for BC Wildfire Recovery Fund 2021, United Way B.C.

5.2.2 Disproportionate impacts of wildfires on populations in B.C.

Some B.C. populations are disproportionately impacted by wildfires due to a combination of increased exposure (e.g., proximity to wildfires), reduced adaptive capacity (e.g., access to emergency services), and/or increased sensitivity (e.g., pre-existing health conditions).

Populations at increased risk from wildfire smoke

As reported in the global literature, those most susceptible to the health effects of air pollution also appear to be more susceptible to wildfire smoke. They include children, older adults, people with cardiopulmonary diseases (including asthma, COPD, and ischemic heart disease), and pregnant people as well as the developing fetus [311,337]. Additional evidence suggests people experiencing socioeconomic disadvantage, racialized populations, and Indigenous communities may be more impacted by wildfire smoke exposure [312,315,316]. Women are shown to be more impacted by wildfire smoke in some studies [312,315,337,338], due to possible factors such as higher susceptibility (e.g., asthma-related airway restriction due to having relatively smaller respiratory airways) [315] or greater exposure [338].

Evidence of some of these risk factors in B.C. include:

- ***Pre-existing health conditions:*** During wildfire smoke events, rates of hospitalizations, salbutamol (inhaler) prescriptions, physician visits, and ambulance dispatches are consistently found to be significantly higher for people with pre-existing cardiovascular and respiratory conditions, particularly asthma. There is also evidence suggesting higher rates of ambulance dispatches for people with diabetes during wildfire smoke events in B.C. [[326–330]
- ***Age:*** Older adults and young children have heightened sensitivity to wildfire smoke. In a B.C. study of the 2003 fire season, people over 70 years of age were disproportionately represented in hospitalizations for respiratory illnesses, making up 49 percent of hospitalizations even though they

make up just 17 percent of the population [326]. B.C. health care providers also report seeing significant increases in asthma exacerbations in children during smoke events [56].

- ***Low-income, marginalized and/or underhoused populations:*** B.C. health care clinicians who provide care to people who are marginalized, low-income, and/or underhoused in Vancouver's Downtown Eastside report significant and disproportionate increases in patient volumes and hospitalizations during wildfire smoke events [56]. They report exacerbations of asthma, COPD, and other respiratory issues, as well as increased frequency of strokes and heart attacks [56]. *Risk to Resilience Project* focus group participants noted that a large proportion of underhoused populations have baseline COPD and/or tobacco use disorder, and live in conditions with poor ventilation, such as in single-room-occupancy (SRO) hotels and supportive living facilities.

> *"A lot of [marginalized and homeless populations] are experiencing asthma, COPD, and respiratory issues…during the smoke…and exacerbation of their current symptoms…You couldn't really send them out because you would send them back out on the street."*
>
> —*Risk to Resilience Project* focus group participant

Overall, more research is needed to understand which populations are most susceptible to wildfire smoke exposure [315,316].

Wildfire impacts on Indigenous communities

Many First Nation communities are located close to the wildland-human interface, which increases the risk of wildfire exposure [279]. The Province's 2017 Freshet and Wildfires Provincial After-Action Review highlighted that many First Nations communities throughout the Central Interior of B.C. were disproportionately affected by the massive scale of the 2017 fires; 23 First Nation communities were directly impacted by wildfires, and as many as 1,800 Indigenous persons were impacted by evacuation orders. Significant damage and loss occurred to community infrastructure and First Nations traditional territories [75].

Due to their impact on traditional activities like fishing, hunting, and trapping, uncontrolled wildfires have significant direct consequences for Indigenous communities [44]. As highlighted in a review of the 2017 wildfires, many First Nations communities face greater challenges than non-Indigenous communities to recover from wildfire disasters [34]. The impacts on traditional ways of life, land, wildlife, and livestock also compound emotional trauma for many Indigenous communities.

First Nations communities in B.C. are more frequently evacuated from wildfires than other communities, as they are often situated in remote and forested areas. Of 253 wildfire-related evacuations in B.C. between 2009 and 2019 [339], more than one-quarter (26 percent) were from First Nations communities, primarily within Interior Health and Northern Health regions.[33]

First Nations in B.C. have long understood the interconnectedness of the health of forests, land, and communities since time immemorial. They are also leading wildfire adaptation practices, such as prescribed cultural burns, across the province (see example in section 5.3 Health-related adaptations to wildfire.)

33 Data obtained from the Canadian wildfire evacuation database [339]

Other disproportionate impacts from wildfires

Some B.C. populations are also disproportionately impacted by wildfires due to their geographic location (e.g., rural or remote communities), their reliance on essential health medications or treatments (e.g., people with complex care needs), or their occupation (e.g., farmers, ranchers, and firefighters). For example:

- ***Migrant farm workers:*** More than 8,600 people work on thousands of farms in B.C., many coming from countries including Mexico and Guatemala [340]. Migrant farm workers often live and work in or near areas frequently affected by wildfire smoke. They may also experience poor living and working conditions, face language barriers to understanding public health messaging, and have limited social supports and connections [341]. There are reports of migrant farm workers in B.C. becoming sick when working outside during wildfire smoke episodes [340].
- ***Farmers and ranchers:*** There are numerous reports of stress, burnout, and trauma among B.C. food producers, as a result of the loss of livestock and crops due to wildfires [67,68,342]. For example, over 500 breeding livestock died in B.C. wildfires in 2017 and 2018, according to one estimate [67].
- ***Wildland firefighters:*** Those on the firefighting frontlines are at increased risk for physical and mental health impacts, due to long, strenuous shifts and close proximity to wildfire activity [343]. Several recent studies and reports of wildland firefighters in B.C. found they had increased occupational exposures to toxic chemicals, such as polycyclic aromatic hydrocarbons [344]; high levels of fatigue and sleep disruption [345,346]; injuries such as burns, fractures, and sprains during their shifts; and longer-term mental health impacts [347]. One survey reported many B.C. wildland firefighters feeling concerned about the unknown physical and mental impacts of their jobs, with more research needed on the effects of smoke inhalation on respiratory health, fatigue and sleep, mental health, stress, and long-term risk of disease [348].

5.2.3 Wildfire impacts on the B.C. health system

The B.C. health system experiences impacts directly due to wildfires, evacuation response, and wildfire smoke.

> *"If [we] are working 16 hours, are [we] really showing up as our best self?... Because if we're in continuous response mode, [we] cannot continue to show up...in the way that [we] need to."*
>
> —*Risk to Resilience Project* focus group participant

Increased workloads, exposure to poor air quality, and heightened mental health challenges are all among the widely reported wildfire impacts on B.C.'s health workforce. Health care workers who live in wildfire-affected communities are additionally impacted by concerns for the safety of their own families and homes [56,349]. At the same time, health workers have demonstrated their resilience in working together during wildfire events to troubleshoot, come up with innovative solutions, and offer support for communities and each other [349–352].

During wildfire evacuations, in particular, health care providers have gone to exceptional lengths to keep patients safe and updated about their home communities [353]—even helping evacuated residents stay in contact with friends and family through phone and video calls [354]. (See the pop-out box "All Hands on Deck".)

Workplace and mental health impacts

Health system staff have reported increased workloads, longer hours, and a heightened pace of work during wildfire events, which can lead to burnout and fatigue [96,349,352,354–356]. (See Chapter 8: Cross-Cutting Impacts, for more details.)

Wildfire smoke exposure can also be a health hazard to emergency response workers [357], and its health impacts are not confined to the frontline. During recent B.C. wildfires, staff and patients complained about smoke smell within some facilities [227,228].

> *"Every summer...you never know if you're going to be on alert and not be able to return home... [Our community] is one of the most likely cities to burn in Canada. So, we're always kind of wondering when we're going to be evacuated."*
>
> —*Risk to Resilience Project* Interview participant

Providing care during a wildfire crisis can be emotionally taxing for health care workers who witness environmental destruction while supporting psychologically distressed populations. Some health care workers report that they now dread the coming summer season, because of uncertainties about potential wildfire activity, and not knowing where and when they will be deployed next [349]. Some describe "losing their summer" to the demands of multiple facility evacuations over the course of the season [56,354].

> *"What a lot of people in health don't realize is that you have to have your own personal stuff really well organized, because the emergency room is kind of the last thing to close in a facility, right? When it's in a town [being] evacuated, [physicians] are the last people out."*
>
> —*Risk to Resilience Project* Interview participant

For health workers in affected areas, it can be emotionally challenging to balance professional responsibilities with personal concerns about evacuating their own families [56,349]. In addition, because they are designated as essential workers, health care providers in hospitals have responsibilities that can prevent them from leaving quickly in the event of an evacuation alert.

One physician described health care providers as having to be "*super well-prepared for themselves, because they might not be able to help evacuate their family if they're dealing with emergencies at the hospital and there is a code orange/code green event.*"

Wildfire impacts on health facilities and infrastructure in B.C.

Damage to facilities

Damage or destruction of health facilities by wildfire directly is infrequently reported in B.C., but has occurred. In 2021, the Lytton Creek wildfire destroyed the BC Emergency Health Services (BCEHS) – Ambulance Station [96] and community health centre [358] in the Village of Lytton. This impacted the availability of health services for communities in the immediate and long-term aftermath of the event.

Wildfires in the Interior region also destroyed an assisted-living facility in 2017 [56]. While the residents were successfully relocated, the community has been unable to replace the facility.

> *"We still have no assisted-living site to replace the one that was lost. So, we've lost that resource; we're still providing it in an alternate location in an alternate city, alternate community. So, there's a real gap there…for how [to] return a health care resource to a community that has lost it due to a [wildfire] event."*
>
> —*Risk to Resilience Project* focus group participant

Damage to infrastructure

Wildfires can also threaten critical infrastructure, such as power and gas distribution systems, and telecommunications infrastructure. This can impede emergency response and impact the health system's ability to deliver timely and quality care.

In 2023, B.C. wildfires downed hundreds of power poles, electrical lines, and transformers in the community of West Kelowna [359]. In Osoyoos, damage to telecommunications infrastructure led to a loss of landline services for some communities, including disrupted access to 911 services [360]. And during the 2021 wildfire season, communication systems were no longer operating in some B.C. communities [361].

When BC Hydro transmission lines are threatened, essential services such as hospitals, fire halls, and police stations are prioritized, as there may not be enough capacity to meet the electricity needs of all customers [362–364]. When health facilities experience power outages, their ability to provide services can be compromised, sometimes requiring the evacuation of residents and patients to another location [56].

Smoke infiltration into facilities

Smoke infiltration into B.C. health facilities during wildfire smoke events impacts indoor air quality for patients and staff. One recent study, conducted in collaboration with Lower Mainland Facilities Management [which provides services for Fraser Health, Providence Health, Vancouver Coastal Health, and Provincial Health Services Authority (PHSA)] and the BC Centre for Disease Control (BCCDC) evaluated wildfire smoke infiltration into a large Lower Mainland rehabilitation hospital during the 2020 wildfire

season. The results indicated that smoke can quickly infiltrate a health facility; during the event, indoor $PM_{2.5}$ concentrations were elevated by an average of 19 percent throughout the building [365]. These levels were not uniform across the facility, however, suggesting that certain operating features could help to reduce smoke exposures.

Smoke events can also increase demands on health facility air-filtration systems [42]. During the 2017 wildfires, for example, Interior Health reported changing more than 2,000 air filters every two to three weeks throughout the B.C. Southern Interior, due to smoky conditions. Despite there being several air scrubbers in each hospital, a dozen more high efficiency particulate air (HEPA) scrubbers were purchased for the Thompson-Cariboo region to mitigate poor air quality [355].

Additional costs are incurred when extra filtration is needed. One regional health authority spent approximately $15,000 to add carbon filters to air-handling units during a 2019 wildfire smoke event, for instance. Enhanced filtration also strains aged infrastructure that either cannot keep up with air exchanges or fails, due to an inability to sustain heavier filters [150]. Identifying alternate means of ventilation, especially for sites that only use outdoor air, has been recognized as a challenge for facilities teams [42,56].

Wildfire impacts on supply chains in B.C.

Health-related supply-chain impacts are frequently reported during wildfire events in B.C. Ensuring people and pharmacies have access to essential medications and supplies is a common concern, particularly when transportation routes into communities are cut off by wildfires, or when communities are evacuated. For example, due to road closures in the 2017 wildfire season, some remote and isolated communities in Northern and Interior regions of B.C. were cut off for weeks from access to life-saving prescription medications, such as insulin, cardiac medications, and anticoagulants, as well as to essential supplies such as diapers, baby formula, and ostomy supplies. Health care providers went to great lengths to ensure patients received medications by airplane, helicopter, and even horseback [352,366–369].

Pharmacists and other health care providers ensure access to essential medications

During the 2017 wildfires, there were immense challenges in connecting people with basic health care and lifesaving prescription medications. In many communities, road closures meant the usual methods of accessing prescription medications were no longer viable for weeks on end. When the town of Williams Lake was evacuated, one pharmacist drove 240 kilometres to Prince George and back to bring in essential medications for patients trapped nearby [367].

Knowing their patients were running low on essential medications, such as insulin, cardiac medications, and anticoagulants, some remote physicians continued to provide care to eight remote and isolated communities spread across 350 kilometres of rugged, rocky terrain [368]. When the wildfires disrupted regular transportation, physicians worked with a Vancouver pharmacy to package and transport supplies to the airport. In the face of flight cancellations and road closures, a military helicopter was arranged to deliver supplies to isolated communities. In one remarkable instance, a physician rode a horse through smoky forests to reach an off-grid patient who would otherwise have been unreachable.

Food shortages

During wildfires, challenges arise in providing and distributing food to communities due to road closures, damaged infrastructure, and displaced residents. For instance, the 2021 Lytton wildfire led to the loss of grocery stores, inaccessible roads, and prolonged power outages, raising food safety concerns for many families. To address these issues, food donation centres were established, but the adequacy of supply, diversity, and quality varied with the donations. Traveling to urban stores became an expensive necessity for those who could afford it [370]. Focus group participants described the response to the Lytton wildfire where, in some cases:

> *"[They] were flying food in there working with food banks. You know, they had to get helicopters to take food into the location. And [they are] still delivering food there on a regular basis, fresh food and non-perishables, simply for the food security of everyone in that area."*
>
> —*Risk to Resilience Project* focus group participant

Strengthening food supply chains, especially for rural communities, is being championed at the local level through innovative transportation methods. But these stop-gap measures are rife with compound challenges, such as:

> *"The walking bridge connecting the west side of the Lytton First Nation to the village itself is no longer in use, due to the level of destruction, leaving just a two-vehicle ferry for general access, including for people from the First Nation to get groceries from the village store. With spring freshets, this ferry will stop running once the river debris gets too significant, effectively cutting it off from supplies and resources."* [371]

However, these learnings and experiences are now being addressed with provincial investment to streamline logistics, storage, and transportation options to increase food security and affordability, strengthening local economies [372].

Story of impact: Wildfires impact supply of food for those most in need on Vancouver Island [373]

Highway 4 is the only paved route to the 18,000-resident City of Port Alberni—as well as to Tofino, Ucluelet, and most communities in the Nuu-Chah-Nulth Nation on Vancouver Island. During the summer of 2023, food banks and charities in Port Alberni were impacted by the 17-day closure of Highway 4 (June 6-23, 2023) due to the Lake Cameron wildfire. Local charities, such as the Alberni Valley Salvation Army Community Food Bank and a local soup kitchen, reported food donations decreased by about 25 percent due to concerns about food shortages. A local soup kitchen staff member shared, "*It's sad to see, because people come in and they definitely are noticing the drop-off in food*." In addition, some local grocery stores implemented restrictions on the purchase of certain items, while others struggled to keep their shelves stocked while they experienced delivery delays. As a result of the wildfire-related road closure, local charities relied more on non-perishable staples and individual donations to help replace what stores could not provide.

This example illustrates that how those already experiencing food insecurity are disproportionately impacted by disruptions to food supply chains during emergency events.

Supply of adaptation technologies

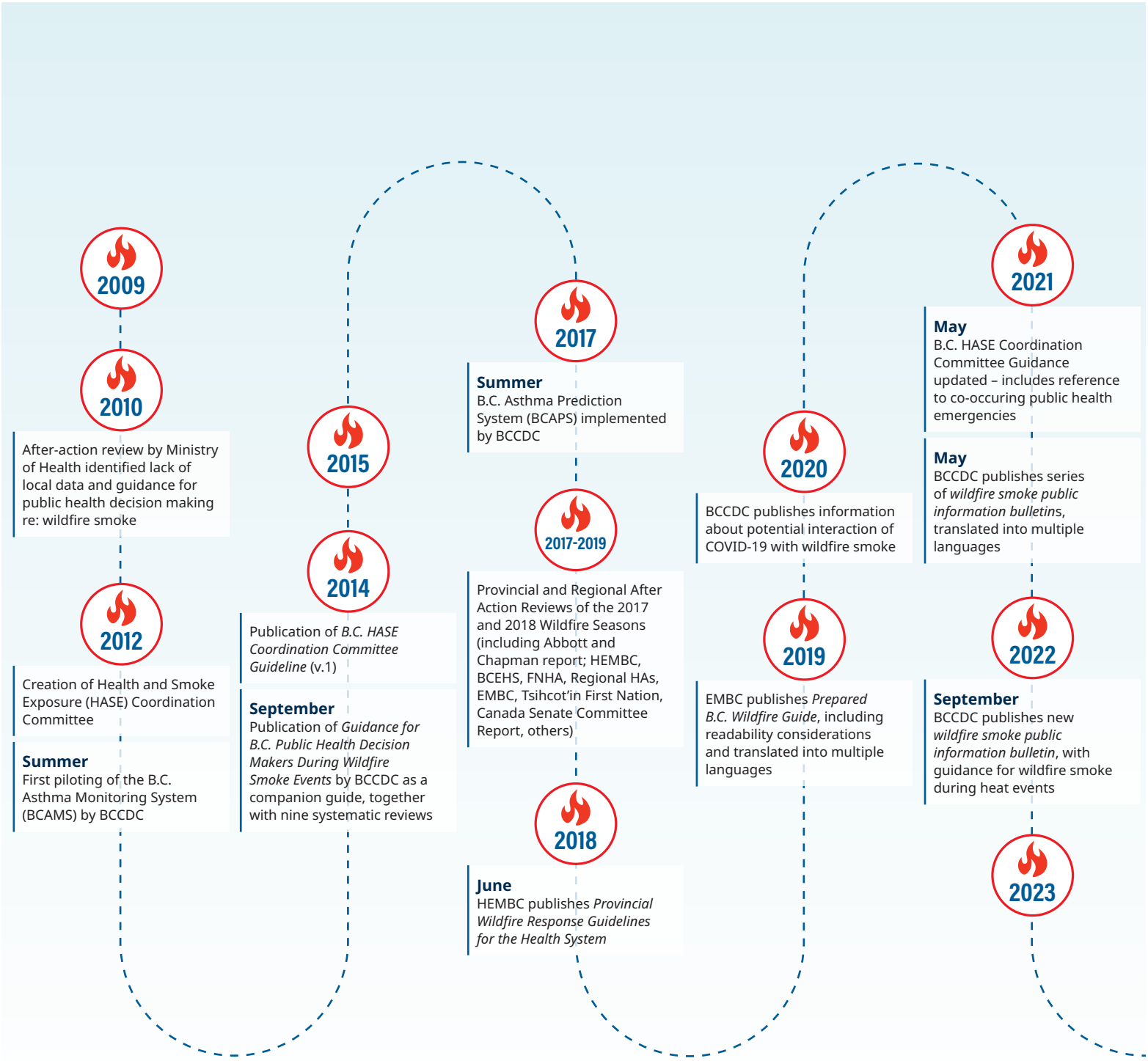
A high demand for air purifiers was another supply chain-related impact reported during wildfire seasons in B.C. As people sought ways to reduce their exposure to wildfire smoke, there were reports of some retailers selling out of air purifiers, with long restocking wait times [374,375]. Public health agencies such as the BCCDC provided guidance on how individuals can make their own box fan air purifiers using common items found at a hardware store [375].

5.3 Health-related adaptations to wildfires in B.C.

B.C. has a long history of wildfires and has been adapting processes and systems with successive wildfire seasons. Post-event learning processes, such as after-action reviews, enable an iterative process to identify what worked well, what challenges were faced, and discuss implications to adjust response strategies for the next wildfire season. Evidence reviews also assess current knowledge and identify knowledge gaps about the effectiveness of different wildfire-related adaptations to protect public health [376].

In response to the severe wildfire seasons in B.C. in 2009 and 2010, there was a recognized need to provide more public health guidance related to wildfire smoke and to health system preparedness and response [377]. A number of structures and committees were established to provide provincial coordination and guidance on preparedness and response to wildfires and wildfire smoke, as well as on developing systems to monitor health effects associated with forest-fire smoke. These adaptations support public health and emergency-management decision-making by providing valuable data to local health authorities [328,378]. Furthermore, the BCCDC initiated an ongoing program aimed at synthesizing and generating evidence to assist public health decision-makers during wildfire smoke events, with an emphasis on preparedness and response [377].

A TIMELINE OF SELECT HEALTH-RELATED WILDFIRE ADAPTATIONS IN B.C.



Preparedness for wildfires and wildfire smoke is crucial for protecting public health, minimizing immediate and long-term health risks, and ensuring the resilience of health care systems in the face of increasingly frequent and intense wildfire events. Some examples of adaptations specific to wildfires in B.C. are summarized below.

Expanded coordination and collaboration within and with the B.C. health system

After-action reviews of the 2017 wildfire season highlighted the need for more clarity around roles and responsibilities of health system organizations and partners. This has led to a wide range of adaptations in B.C., including:

- In June 2018, the B.C. Health System Wildfire Response Plan, was published which details roles, responsibilities, and expectations of the health system during wildfire response. It outlines the emergency response structure of the provincial health system, and details the coordination processes and information required for supporting wildfire response across the health system [379]. This builds on the 2012 Public Health and Medical Services Annex, which provides a framework for how the health system is organized during an emergency like severe wildfires.
- The BC Health and Smoke Exposure (HASE) Coordination Committee brings together a range of regional, provincial, and federal agencies to coordinate wildfire smoke response in B.C. The associated BC HASE Coordination Committee Guideline outlines how the Committee will convene to support the local response, describes the roles and responsibilities of HASE Committee members, and provides guidance on assessing the population health risk and considerations for public health interventions [380]. The Guidance was last updated in June 2023 with new information, technologies, and activities, including considerations for multiple concurrent hazards, such as pandemics and other climate hazards.

Partnership and collaboration with the B.C. health system also includes bringing broad groups of stakeholders and partners together to network and exchange knowledge, and to better prepare individuals and communities for wildfire events. For instance:

- In May 2019, the BCCDC hosted a Practical Smoke Preparedness Workshop in Prince George. The workshop was aimed at agencies involved in wildfire planning and management, including the Northern Health Authority, First Nations Health Authority, municipalities, NGOs, and air quality roundtables [381]. The event was part of a larger objective to promote coordination and collaboration among health authorities, municipalities, and NGOs in the face of disaster events such as wildfires.

Use of low-cost particulate matter (PM) sensors to improve air-quality monitoring and understanding of smoke infiltration into buildings

One developing area of research in B.C. and other jurisdictions is assessing indoor infiltration of outdoor wildfire smoke. This research is helping to evaluate the effectiveness of staying indoors during smoke events, and to more efficiently design buildings, such as health care facilities and residences [365].

In some cases, low-cost PM sensors are being used to monitor wildfire smoke infiltration. One recent study piloted the use of low-cost $PM_{2.5}$ monitors in a large rehabilitation hospital during a wildfire smoke event in Vancouver [365]. It concluded that long-term use of low-cost sensors could aid health-facility operators in testing and optimizing actions to protect occupants from wildfire smoke infiltration, and inform local health authority guidelines for new construction and renovation of health care facilities.

Another area being explored in B.C. is how low-cost air quality sensors can expand the geographical range of air-quality monitoring, particularly in more rural and remote areas where monitoring may be more

sparse [382]. For example, Vancouver Coastal Health has sent low-cost air quality monitors that measure fine particulate matter to communities to improve monitoring of the impact of wildfire smoke on a wider geographic scale. Monitors were sent to sites within Metro Vancouver as well as to remote communities, and included places like libraries, community centres, and neighbourhood houses. Vancouver Coastal Health has also partnered with the University of British Columbia to pilot the use of these monitors in daycares to study smoke infiltration. In addition, the First Nations Health Authority has been providing PurpleAir monitors to communities. As the technology is tested, lessons are being learned on overcoming barriers and building capacity for use [56].

Air quality monitor (photo: PurpleAir.com)

Adaptation in Action: Low-cost PM sensor pilot project [138]

A pilot project initiated in 2018 by Environment Climate Change Canada (ECCC) examined the use of low-cost PM sensors to measure $PM_{2.5}$ during high PM events, such as forest fires, in collaboration with universities, provinces and territories, communities, First Nations, and air quality groups. The project started in Western Canada and has now expanded to a nationwide study. A mapping tool for the low-cost PM sensor data is improving spatial coverage by adding the data from the low-cost PM monitors to current regulatory monitors. The tool—developed through a collaboration between the University of Northern British Columbia, Dr. Peter Jackson, and ECCC scientists—includes real-time observations, time series, model outputs, health messaging, and other information to support people in making informed decisions about air quality.

Improvements in wildfire smoke monitoring, warning systems, and public-risk communications

Adaptations for expanded monitoring of wildfire smoke, advancements in smoke forecasting and surveillance, and communication to the public about wildfire smoke are a key focus for practitioners and researchers in B.C. [383]

- Between 2012 and 2014, the BCCDC launched the B.C. Asthma Monitoring System (BCAMS), as well as a series of nine systematic reviews about wildfire smoke. Research led by the BCCDC better characterized the health risks of wildfire smoke for B.C. populations. The BCAMS was updated in 2016 to the B.C. Asthma Prediction System (BCAPS), to better capture forecasting. The models continue to be tested and refined after each wildfire season.
- An amended AQHI (AQHI+) that more accurately accounts for wildfire $PM_{2.5}$ during wildfire smoke events in B.C. was piloted in 2018, through consultation with researchers at the BCCDC[321]. In 2021, AQHI+ was permanently adopted by the Province [384].
- Researchers at BCCDC and the University of British Columbia (UBC), in collaboration with federal and provincial governments, are working to improve wildfire smoke forecasting models and smoke-related health surveillance and warning systems for B.C. This includes developing models with better spatial and temporal resolution [e.g., the Canadian Optimized Statistical Smoke Exposure Model (CanOSSEM) [385]].
- Tools for communicating with both decision-makers and the public about wildfire-smoke-related risks include publicly available map and data dashboards. These provide current and forecasted air-quality information, and subscription services (i.e., Air Quality Subscription Service and Metro Vancouver Air Quality Alerts) with public alerts for poor air quality [386,387]. Regional health authorities also publish information about wildfire smoke (e.g. Fraser Health shares information through social media and their website about the risks of wildfire smoke and how to reduce them). Examples of available public wildfire-related communication tools in B.C. include (Table 3):

Table 3. Examples of tools for public communication of wildfire smoke risks to health and preparedness

Name of resource	Description of resource
Air Quality Health Index (AQHI) [388]	The AQHI is a public communication tool that provides hourly air quality readings and related health messages, based on three major pollutants (PM, ground-level ozone, and nitrogen dioxide). It was the first tool internationally to recognize the cumulative nature of poor air quality on health [389]. The AQHI for B.C. (AQHI+) provides targeted health messaging to at-risk populations and the general public, indexed on a scale from one to 10 and four health-risk levels. An online public interactive map provides observed and 48 hours of forecasted AQHI levels [390]. The AQHI is available for 25 communities in B.C., accounting for more than 80 percent of the B.C. population [391].
Smoky Skies Bulletins [386]	Smoky Skies Bulletins are issued by the Province when regions are, or have reasonable potential to be, impacted by wildfire smoke within 24 to 48 hours. They are issued province-wide [392] with the exception of Metro Vancouver and the Fraser Valley Regional District, which issue advisories rather than smoky skies bulletins.[34] They are based on available information on pollutant concentrations, satellite data, smoke forecast models, and visual observations. These public advisories communicate information about wildfire smoke, including regions at risk of exposure, and include public health messaging about ways to reduce exposure and monitor symptoms. [386]
Special Air Quality Statements (SAQS)	Air Quality Advisories are issued by the Province for 37 communities in B.C. [386], while Air Quality Advisories/Bulletins are issued for the Metro Vancouver and Fraser Valley Regional District regions [387]. SAQS are then issued by ECCC, relayed as a public communication about poor air quality for specific regions when advisories are in place [396]. Weather Information – Environment Canada
B.C. Asthma Prediction System (BCAPS) [378]	BCAPS is a framework that forecasts and visualizes the population health impacts of wildfire smoke over the next 24-hour and 48-hour periods using five modules [378]. An interactive online map is also available to the public to support health protection during wildfire smoke events [397].
FireWork and *BlueSky Canada* – smoke forecast maps	Other resources available for the public include ECCC's FireWork forecast [398], and the BlueSky Canada forecast, developed by researchers at UBC [399]. These wildfire smoke prediction systems show maps of predicted smoke forecasts across Canada over the next 72 hours and 48 hours, respectively.
BCCDC Wildfire Smoke Fact Sheets [400]	BCCDC publishes wildfire smoke fact sheets, available in multiple languages, with information on: • the health effects of wildfire smoke; • how to prepare for wildfire smoke season; • portable air cleaners; • wildfire smoke and air quality; • composition of wildfire smoke; • wildfire smoke and outdoor exercise; • wildfire smoke and AQHI; • home-made box air filters; and • face masks for wildfire smoke.

34 Metro Vancouver operates 20 continuous air-quality monitoring stations (of the 100 province-wide) [393] and manages advisories for the region [394]. Fraser Valley Regional District shares the Lower Fraser Valley airshed with Metro Vancouver [395].

Some challenges identified with wildfire smoke monitoring and warning systems include the lack of air-quality monitoring stations in rural and remote locations of B.C., and the need for targeted messaging for specific sectors (e.g., schools) or populations [56]. *Risk to Resilience Project* focus groups recommended promising health adaptations such as aligning wildfire smoke models and tools for consistent messaging, enhancing air quality surveillance, and more research on indoor/outdoor air quality and messaging during wildfire smoke events.

Public health messaging during wildfire smoke events

Providing wildfire-smoke related messages in multiple languages and in accessible formats supports health equity by enabling diverse populations to prepare for and respond to wildfire smoke events. Expanding the range, content, and outreach of public wildfire smoke messaging—and understanding the effectiveness of different communications methods—is an active area of focus for researchers and practitioners in B.C.

A recent survey about wildfire messaging in B.C., with 757 respondents, found that people receive wildfire smoke messages from diverse sources, including websites, social media, radio, and television. Radio was identified as the most important source of information for populations that may have increased exposure or health risks, including Indigenous respondents and those working in the trades. Respondents with lower educational attainment expressed that messaging should be simplified [341].

More recent public health messaging around wildfire smoke in B.C. is focused on ways to reduce exposure [401], as well as providing guidance on protecting health during coinciding hazard events, such as how to prioritize actions when wildfires coincide with extreme heat events [402].

Adaptations in patient care

B.C. care providers are adapting the ways they support patients before and during wildfire smoke events. For example, physicians and health care providers are improving advanced planning for wildfire events for patients with asthma and COPD [56]. The B.C. clinical guidelines for Asthma Diagnosis, Education and Management were also recently updated with a climate lens, a broad-reaching and powerful adaptation guiding the practice of clinicians across B.C.

> *"I also asked my patients to register for the B.C. Air Quality [Health] Index so that they can get alerts on their phone, to get a bit of a trigger warning before air quality specs get bad in the area. They can make sure they have their inhalers and that they've got prednisone on hand if needed. I also talked to them a lot about air filters."*
>
> —*Risk to Resilience Project* focus group participant

Health facility and infrastructure adaptations

Wildfire smoke can infiltrate health care facilities, affecting indoor air quality and compromising the health and safety of patients, staff, and visitors. Health-facility staff have responded by upgrading and maintaining HEPA filters and ventilation systems to remove fine particulate matter ($PM_{2.5}$) and other pollutants from indoor air. Some have also deployed portable air purifiers equipped with HEPA filters in areas with particularly at-risk patients, or in spaces with compromised indoor air quality [56]. More details on cross-cutting impacts and adaptations to health care facilities and infrastructure can be found in Chapter 8: Cross-Cutting Impacts, Adaptations, and Opportunities.

Adaptation in Action: Protecting hospital air quality [355]

During the 2017 wildfires, facilities staff at Royal Inland Hospital in Kamloops acted quickly to ensure patients and staff were protected from wildfire smoke; 400 air filters were swapped out every two to three weeks to manage air quality throughout the building. In total, maintenance personnel changed more than 2,000 filters every two to three weeks at facilities throughout the Southern Interior. They also purchased additional HEPA air scrubbers for the Thompson-Cariboo region facilities to mitigate poor air quality.

Expanded availability of home and community cleaner air spaces

Adaptations to protect public health from wildfire smoke require leadership and collaboration from multiple sectors. Across B.C., cleaner air spaces (also referred to as clean air shelters) are community-led examples of adaptations to protect population health from wildfire smoke [383,403]. These are areas, rooms, or buildings equipped with a filtration system that traps particulates generated by wildfire smoke. The BCCDC and Health Canada have published detailed guidance on considerations for the effective operation and use of home and community clean air shelters [404,405].

Communities across the province have been increasingly designating locations which can operate as cleaner air spaces during wildfire smoke events. The City of Vancouver, for example, has designated a number of public facilities as cleaner air spaces, including libraries and community centres, all of which have high-efficiency particulate air filtering, or MERV 13 filters [406]. They provide an interactive map identifying locations of cleaner air spaces, with and without air conditioning.

It is critical to ensure that local strategies for clean air shelters consider issues such as awareness, accessibility, and transportation for populations who may be most at risk (e.g., individuals with respiratory or cardiovascular conditions, pregnant women, children, older adults, the underhoused, and those with limited mobility). In B.C., community considerations for the equitable design and distribution of clean air shelters is an emerging area of research [407].

Portable and do-it-yourself air cleaners

Portable air cleaners are units equipped with HEPA filters or electrostatic precipitators designed for use in a single room. They offer an alternative when access to community cleaner air spaces is limited and recommended by public health guidance in B.C. [408]. In B.C., the First Nations Health Authority has provided support for individuals at high risk from wildfire smoke to obtain air purifiers and replace HEPA filters since 2017 [409]. Priority is given to individuals and communities who are unable to access a clean air shelter due to limited transportation/mobility, or that live in a home without a ventilation system that can recirculate air.

Evidence suggests that do-it-yourself (DIY) air cleaners can also be a valuable supplementary tool to improve indoor air quality during wildfire smoke events [410,411]. When used appropriately, DIY cleaners can offer a safe and effective alternative to more expensive commercially available portable air cleaners [411]. The BCCDC partnered with UBC researchers to test a DIY air filter, and published a step-by-step guide to assembling an inexpensive DIY box-fan filter [410]. Over the summer of 2023, the BC Lung Foundation, together with community partners, also hosted free DIY air cleaner workshops for people at greater risk from air pollution impacts, including older adults, people on a limited budget, and those living with lung conditions such as COPD, asthma, and pulmonary fibrosis [412]. Similarly, Métis Nation BC worked with researchers at Simon Fraser University to take a train-the-trainer approach on building DIY air-cleaner systems with Métis regional health coordinators and collaborated with Fraser Health to disseminate information on DIY air-cleaner systems to Métis Chartered Communities [91].

Indigenous-led adaptations

Indigenous-led adaptations to wildfire value traditional ecological knowledge, and honour the holistic, culturally-rooted, and sustainable strategies that not only safeguard physical health, but also the broader cultural, spiritual, and mental well-being of Indigenous communities and the land. Adaptations, such as prescribed cultural burns, recognize the interconnectedness of the health of forests, land, and communities, and the importance of preserving traditional knowledge and practices. Prescribed burns are also one of the strategies recommended by the BC First Nations Climate Strategy and Action Plan (2022) [52].

Fighting fire with fire [413]

As wildfire seasons grow longer and more intense, many First Nations communities emphasize the importance of prescribed burns to prevent uncontrolled forest fires. For the ʔaq'am, a member community of the Ktunaxa Nation, the revitalization of traditional fire knowledge and practices has emerged as a crucial adaptation strategy, reintroducing fire to their land-management practices by drawing on cultural and traditional burning practices.

Collaboration between diverse groups is often necessary for prescribed burns to succeed. The BC Wildfire Service planned about 65 prescribed burns in the region in 2022, with a significant portion of these projects involving collaboration with First Nations.

Controlled brush fire lit with a drip torch, B.C.

5.4 Opportunities for action

Key opportunities for integrated action to address immediate health impacts and build long-term resilience to wildfire and wildfire smoke include:

Coordination and collaboration

- Clarify roles, responsibilities, and mandates of health agencies (e.g., HEMBC, Ministry of Health, health authorities) relative to those of other ministries (e.g., EMCR) and other partners to address both immediate physical and mental health impacts and long-term resilience to wildfire events.
- Collaborate with Indigenous organizations and communities to embed traditional knowledge and practices in wildfire preparedness and management approaches that reflect the unique health challenges faced by Indigenous Peoples.

Planning and interventions

- Work in partnership with local governments, First Nations, Métis, and community partners to explore the creation of safe indoor accessible community cleaner air spaces during wildfire smoke events.
- Examine ways to improve the accessibility of cleaner air spaces for priority populations in B.C.

- Continue to explore the value of low-cost air quality sensors to improve understanding of indoor smoke exposure and to expand the range of $PM_{2.5}$ measurement, particularly in areas with reduced coverage (e.g., more rural and remote regions).
- Promote the use of appropriate air cleaners, industrial air scrubbers, and HEPA filters before and during wildfire seasons.

Communications

- Continue to promote and update public awareness and education materials about the risks of poor air quality during wildfire smoke events and about adaptive behaviours (e.g., using air filters and box fan filters, wearing masks).
- Develop culturally and linguistically-tailored wildfire smoke risk communications, using diverse modes of communication and targeting messages to higher-risk populations.
- Develop targeted sector messaging and promotional strategies for AQHI+ and Smoky Sky Bulletins (e.g., schools, landlords).
- Evaluate the effectiveness of wildfire smoke communications with target populations and sectors, being mindful of the potential for messaging fatigue.

Surveillance and research

- Work across ministries and with partners to strengthen and expand air quality monitoring practices that enable more accurate and real-time data on air-pollution levels during wildfire events.
- Continue to research the combined impacts of heat and wildfire smoke.
- Enhance research on the short- and long-term mental and physical health impacts (e.g., adverse birth effects) of wildfire smoke exposure.
- Further explore the differential impacts of wildfire smoke exposure for priority populations in B.C. (e.g., older adults, pregnant women, those with chronic conditions, underhoused populations, etc.).

Health system capacity

- Enhance health care system training and capacity building to respond to the increased demand for health services during wildfire events.

Sumas Prairie — November 2021

Chapter 6: Floods

KEY FINDINGS

- Flooding events have historically been the **costliest and most destructive environmental disasters** in Canada. The atmospheric river event of November 2021 is estimated to have caused upwards of $8.7 billion in damage in B.C., with catastrophic impacts to communities, the economy, the environment, and critical infrastructure.
- **Flood risks to people living in B.C. are substantial and continue to grow**, due to land-use pressures and climate change. Larger and more frequent extreme precipitation events are projected to further increase flooding risks in B.C. Riverine flooding and coastal flooding are predicted to have high overall health, social, environmental, and economic consequences.
- Extreme precipitation and flooding can **also have cascading impacts**, such as landslides and debris flows, and impacts to vital transportation corridors, drinking water safety and quality, food safety and security, indoor air quality, and infectious diseases.
- Flooding impacts the short- and long-term **mental health** of a population, including psychological distress, anxiety, depression, and post-traumatic stress disorder (PTSD).
- Flooding **does not affect all populations equally**. Considerable socioeconomic differences exist between populations living in high and low flood risk areas. In B.C., some of the most impacted include Indigenous Peoples, women, older adults, low-income and underhoused people, farmers, and migrant farm workers.
- Flooding **impacts the health system** by directly disrupting the delivery of health care due to power outages and damage to water supply and transportation networks. Loss and damage to medical equipment, health care facilities, and infrastructure can lead to longer-term disruptions in service delivery and, in some cases, evacuation of patients.
- Many of the levers to increase flood resilience lie outside the health system and **rely on strong local leadership and partnerships across sectors and scales**. Several provincial adaptations to improve flood resilience are underway, spanning strategy, monitoring, mapping, and communications.

6.1 Exposure to floods in B.C.

Flooding events have historically been the costliest and most destructive environmental disasters in Canada [13], accounting for 37 percent of all environmental disaster costs in the Canadian Natural Disaster Database since 1970 [414]. Floods are common in B.C. and can happen at any time of year [415]. The province has experienced several flooding events in the past decade, leading to significant impacts to communities, the economy, the environment, critical infrastructure, and, in some cases, loss of life (Table 4).

Table 4: Timeline of major flooding events in B.C. since 2016

Year	Description of flood event
2016	Northeastern B.C. (June)—Severe flooding for Dawson Creek and Chetwynd. [416,417]
2017	Interior B.C. (April–June)—Widespread flooding of Okanagan and Nicola Lakes, impacting more than 73 communities, including 15 First Nations communities [75]. Tragically, one person lost their life [418] and one person was reported missing and presumed deceased [419]. Northwestern B.C. (October)—Widespread flooding of the Skeena River, with significant damage and evacuations [420,421].
2018	Southern Interior B.C. (May)—Extensive flooding in the Interior Kootenay Boundary and Okanagan-Similkameen regions. Lakes flooded, including Okanagan Lake, Kalamalka Lake, and several smaller lakes in the Okanagan, as well as Stump Lake in the Nicola Valley and Shuswap Lake in the Columbia-Shuswap region. More than 4,000 people evacuated (including 2,600 in Grand Forks and Osoyoos). Grand Forks experienced devastating damage, with 400 homes and 100 businesses destroyed [422–424]. Evacuation orders and alerts impacted six other regional districts and eight First Nations around the province [422].
2020	South Coast B.C. (February)—Flooding and landslides on the B.C. South Coast, including Cowichan Valley Regional District, which declared a local state of emergency after flooding shut down roads and prompted the evacuation of around 30 residents [425]. Interior B.C. (April and July)—Flooding impacts Village of Cache Creek, with multiple properties on evacuation order [426,427]. Southeastern and Northwestern B.C. (July)—Heavy precipitation leads to flooding and landslides across the province, closing major highways in Southeastern B.C. and Northwestern B.C., and completely cutting off Telegraph Creek when a landslide closes the only road into the remote community [428].
2021	Northwestern B.C. (June)—Flooding due to a rising Skeena River. Damages and evacuations reported for the communities of Old and New Remo, and one fatality reported [429]. Southwestern and Central B.C. (November)—Atmospheric river events cause destructive flooding in many communities (Abbotsford, Merritt, Princeton), landslides, and the failure of multiple highways and bridges across the province, triggering a province-wide state of emergency.
2023	Northwestern B.C. (May)—Flooding along the Skeena River, with 90 properties evacuated and impacts to waterways across Wet'suwet'en and Gitxsan territories [430]. Interior B.C. (April-May)—Village of Cache Creek flooded, destroying homes and inundating the firehall and many businesses, closing Highway 97 and Highway 1 [431]

The B.C. Flood Strategy's From Flood Risk to Resilience: An Intentions Paper identifies four major types of floods in B.C., and their causes of flooding can vary [13] (Figure 9).

Flood Type	Description	Causes
 **Riverine Floods**	Water levels in a river, lake, or stream overflow onto adjacent lands or infrastructure. Erosion is also typical during these types of floods.	Intense rainfall, atmospheric rivers
		Rapid snowmelt
		Ice jams
		Structural/operational dam failure
		Natural dam failure/glacial outburst
		Debris floods in steep terrain
		Two or more of the above (e.g., rain-on-snow events)
 **Coastal Floods**	Seawater inundates lands in coastal zones.	Storm surge wind and wave action
		Tsunamis
		High tides
		Sea level rise
 **Local Pluvial/ Stormwater Floods**	Extreme rainfall creates local flooding away from water bodies.	Heavy rainfall exceeds the capacity of stormwater sewers, culverts, and landscapes to absorb + convey flows
		Blocked urban drainage systems
 **Groundwater Floods**	Rising underground water table floods basements or parkades.	Regional flood events Areas with high water tables

Figure 9: Major causes of floods in B.C. [13]

Between 2007 and June 2023, the province experienced 264 days with one or more water basins under flood warning and 579 days under flood watch (Appendix 1 – Table A1.8 and Table A1.9)[35]. Over this period of approximately 16 years, Northern Health and Interior Health experienced the most days with one of more water basins under flood warning (179 and 173 days, respectively) and flood watch (449 and 383 days, respectively); the Northern Interior and Thompson Cariboo Shuswap health service delivery areas (HSDAs) were particularly affected. During the 2021 AR-flood events (November 14– December 1, 2021), one or more water basins in the province were under flood warning for 18 days (with the most days in Interior Health, Fraser Health, and Vancouver Island Health regions) and under flood watch for 12 days.

The 2019 Preliminary Strategic Climate Risk Assessment projected that severe riverine flooding and severe coastal flooding[36] could be up to five times more likely to occur in B.C. by the 2050s, with high overall consequences[37] relative to other climate hazards assessed. Moderate local-level flooding risk was also projected to increase due to rises in extreme precipitation and snowmelt, though with lower overall consequences [30]. Precipitation-related drivers of flooding are projected to increase in B.C. by the 2050s as well, including more frequent and greater-magnitude heavy precipitation events [433].

35 Flood warnings (level 3) are issued when river levels have exceeded bankfull or will do so imminently, with flooding of adjacent areas. Flood watches (level 2) are issued when river levels are rising and will approach or may exceed bankfull, with potential for flooding of adjacent areas [432].
36 Severe riverine flooding defined as a 500-year flood of the Fraser River. Severe coastal flooding defined as 3.9 m storm surge during a king tide and 500-year winter storm along the B.C. coast.
37 Overall consequences including impacts to health, social functioning, natural resources, and economic vitality

Precipitation-related climate projections for B.C.'s health regions by the 2050's

Across B.C.'s health service delivery areas (health regions), the magnitude and frequency of heavy precipitation events each year are projected to increase [433]. Some regions may be disproportionately impacted (see Appendix 1 – Table A1.2 for more details). For example, projections include rises in:

- Maximum one-day total precipitation, with the highest total increases projected for some southwestern B.C. regions.
- Total number of days with heavy precipitation (>20 mm), with the largest total increases projected for some southwestern B.C. regions.

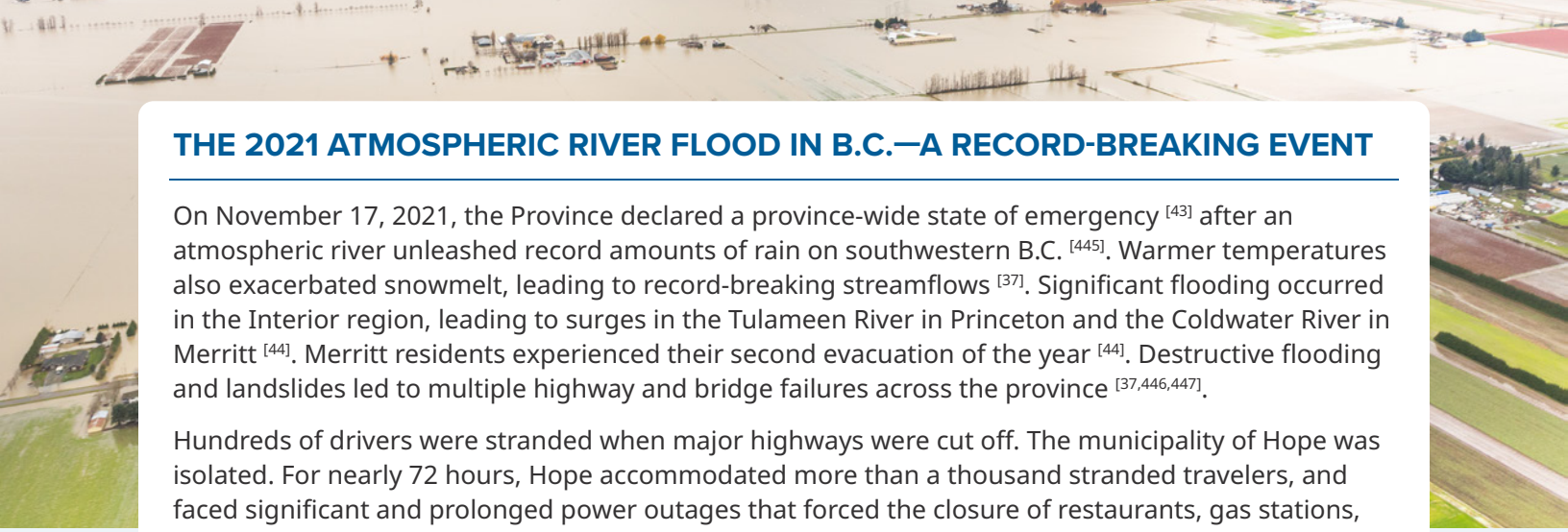
Atmospheric rivers as drivers of extreme precipitation and flooding

Atmospheric rivers (ARs) are key drivers of precipitation and extreme precipitation in B.C., particularly in coastal areas. ARs are long (averaging more than 1,000 kilometres) and narrow (averaging 400 kilometres) flows of moisture-laden air [434] which transport water vapor from the warmer tropical regions towards the poles [434,435][38]. These "rivers" of moist air are carried by strong winds, travelling over B.C.'s coastal mountain ranges where the air cools and condenses, resulting in rain or snow [435,438].

Between 1948 and 2016, the coast of B.C. and southeastern Alaska experienced 35 ARs per year, on average. They were most frequent in the fall months (with more than one-third of all ARs), and least frequent (~14 percent) in spring [439]. ARs contribute up to one-third of total annual precipitation in B.C., accounting for almost all (up to 94 percent)[39] of the annual extreme precipitation along the coastal regions of B.C., and up to 60 percent of extreme precipitation in the Columbia and Rocky Mountains [440]. AR conditions occurred during 25 of 32 (78 percent) flood-related environmental disasters in B.C. between 1979 and 2016 [441].

The probability of AR-related precipitation, extreme precipitation and frequency of ARs has been increasing over time in B.C. [439,440], and future projections indicate a continuation of this trend. An increase in the frequency, duration, and magnitude of ARs and associated extreme precipitation is projected for B.C.'s coastal regions [442,443], including a fourfold increase in the frequency of ARs and associated flood events in the Fraser River Basin by the 2080s [444][40]. Climate change is shown to be driving these trends; one study estimated that B.C.'s 2021 AR-flood events were at least 60-percent more likely to have happened due to climate change [37].

38 ARs have sometimes also been dubbed "Pineapple Expresses," referring to ARs originating from the tropics around Hawaii, though not all ARs impacting B.C.'s Pacific coast originate from this region [436,437].
39 Based on analysis of data between 1979 and 2012.
40 Based on RFP8.5 high emissions scenario, historical (1980–2009) vs future (2070–2099).



THE 2021 ATMOSPHERIC RIVER FLOOD IN B.C.—A RECORD-BREAKING EVENT

On November 17, 2021, the Province declared a province-wide state of emergency [43] after an atmospheric river unleashed record amounts of rain on southwestern B.C. [445]. Warmer temperatures also exacerbated snowmelt, leading to record-breaking streamflows [37]. Significant flooding occurred in the Interior region, leading to surges in the Tulameen River in Princeton and the Coldwater River in Merritt [44]. Merritt residents experienced their second evacuation of the year [44]. Destructive flooding and landslides led to multiple highway and bridge failures across the province [37,446,447].

Hundreds of drivers were stranded when major highways were cut off. The municipality of Hope was isolated. For nearly 72 hours, Hope accommodated more than a thousand stranded travelers, and faced significant and prolonged power outages that forced the closure of restaurants, gas stations, and businesses [448]. Fraser Canyon Hospital was one of the few structures equipped with backup generator power, and served as a temporary location for Hope's municipal Emergency Operations Centre [448].

Highway 1 and all direct road connections between Chilliwack and Abbotsford were closed. The Lower Mainland and southwestern B.C. were effectively cut off from the rest of Canada for several days [37]. The destruction of Highway 8 through the Nicola Valley caused significant damage and cut off access for many First Nations communities, including the Shackan Indian Band, Cook's Ferry, and Nooaitch First Nations (see Figure 10) [449–451].

THE 2021 ATMOSPHERIC RIVER FLOOD EVENTS BY THE NUMBERS

Health-related impacts:

- **320** Interior Health staff were placed on evacuation order or alert [42,358]
- **~300** patients were evacuated from 5 Interior Health facilities [358]
- EOCs in the Fraser Health region were activated for a total of **23** days to support over **10** communities, two acute facilities, and Mental Health & Substance Use and long-term care clients [448]
- **> 100** flights were coordinated by the health system with their partners to move patients, staff equipment, medical supplies, and specimens throughout the Fraser East Corridor [448]
- **6** people tragically lost their lives [44,446,452]

Broad impacts:

- **63**-day-long provincial state of emergency [45]
- In many areas, monthly precipitation totals were more than **200**-percent above average [446][41]
- **4** water basins under flood warnings for up to 20 days[42]
- **5,610** people impacted by evacuation orders and alerts in the Fraser Valley [454]
- **7,000+** people impacted by a city-wide evacuation order in Merritt due to a wastewater plant failure caused by rising waters [44]
- **24** highways closed due to damage or landslides/ debris flows, including highways connecting Vancouver to the rest of Canada [44,455]
- **275+** drivers stranded by landslides and debris flows between Agassiz and Hope [446].
- **1,100+** farms impacted in the Sumas Prairie in Abbotsford [44]
- **>2.5** million livestock affected [456], including an estimated 630,000 chickens, 12,000 pigs and 450 cows lost [44]
- **258,000+** BC Hydro customers impacted by power outages [457]
- An estimated **$675 million** in insured damages [458] and up to **$13.5 billion** in non-insured damages, income losses, and public expenditures [44] made it the costliest severe weather event in B.C. history [459]

41 Two-day precipitation totals reached 312 mm on southwest Vancouver Island, and more than 400 mm north of the Fraser Valley, making this a 1-in-50 to 1-in-100 year event [37]. In many areas, monthly precipitation totals were more than 200-percent above average [446]. Note: a 1-in-50 year event reflects the probability of an event occurring; e.g., for a 50-year flood event, there is a two-percent probability of it occurring in any given year (or once in every 50 years) [453].

42 Data source: B.C. River Forecast Centre (see Appendix 1 for more details)

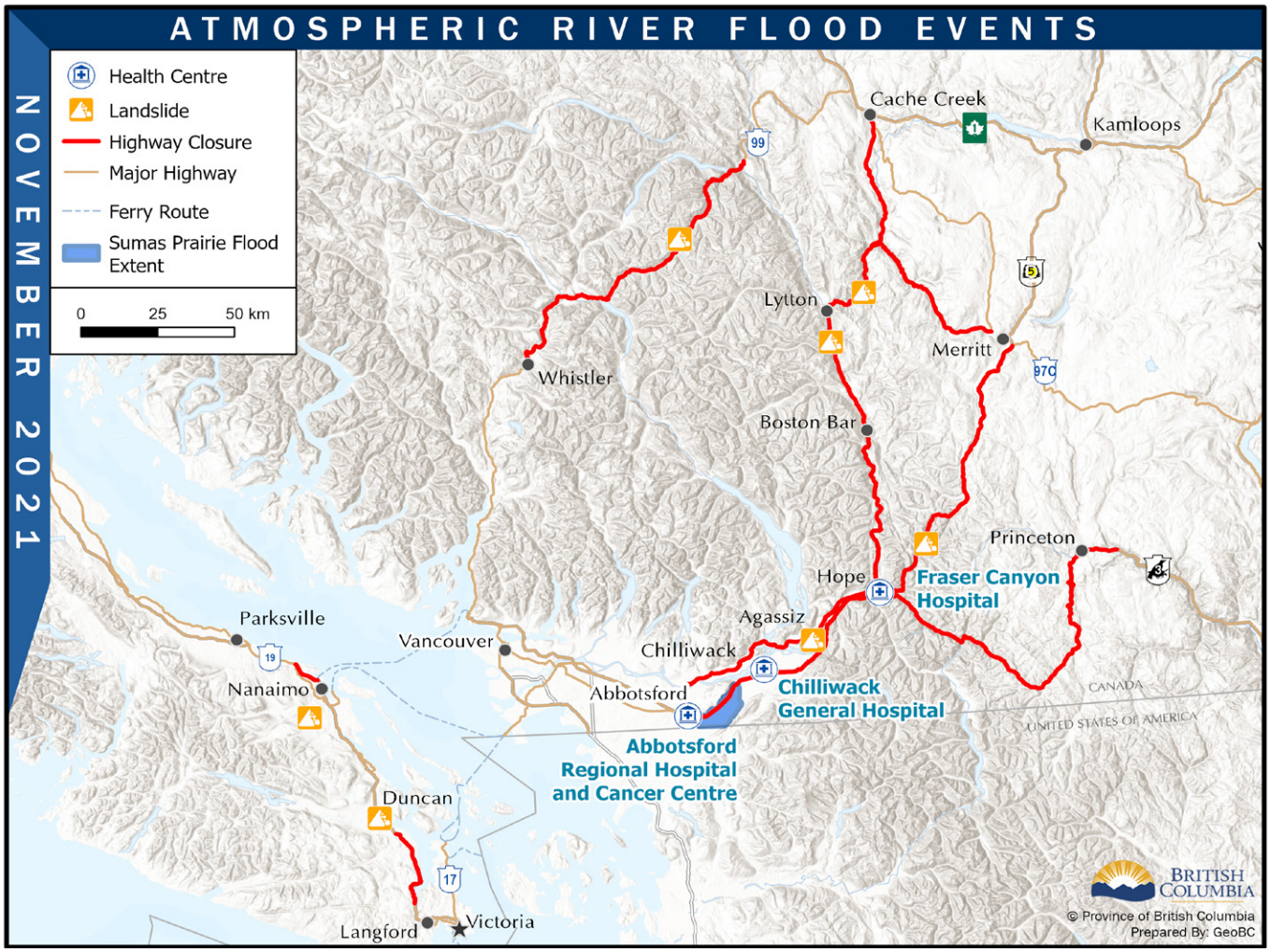


Figure 10: Highway closures and landslides impacting access to health facilities during the 2021 atmospheric river-flood event

Sea-level rise and storm surges as drivers of coastal flooding

Rising sea levels, with more frequent seasonal wind events and high tides, are increasing the risk for coastal flooding in B.C.'s coastal communities [11–13]. Coastal flooding poses a threat to infrastructure, transportation route access, and health for many B.C. communities; there are more than 27,200 kilometres of coastline in B.C., and more than 75 percent of the provincial population lives in coastal areas [11–13,460,461].

Communities on the southern tip of Vancouver Island, on Haida Gwaii, in Squamish, and in the metropolitan area of Vancouver are among the most exposed to sea-level rise in Canada, with an increased risk of coastal flooding [11]. According to estimates prepared for the Lower Mainland Flood Management Strategy, a major Fraser River flood could displace more than 311,000 B.C. residents, while a major coastal flood could displace 261,000 residents, if sea-level rise meets the average forecast of one metre by 2100 [462]. Health-related infrastructure, including a number of hospitals and ambulance stations, would also be at risk of inundation [462].

Storm surges arise when severe storms and high tides coincide at the same time, and strong winds can cause flooding inland [463,464]. Extremely high tides, known scientifically as spring tides (and sometimes referred to as king tides), can occur at any time throughout the year, but most frequently impact B.C. during winter months (December–January) [463–465]. They typically occur once or twice per year in B.C. [466], and have led to significant damage and put lives put at risk [467–471].

Cascading impacts from extreme precipitation and flooding

Extreme precipitation and flooding can have cascading impacts such as landslides and debris flows, with impacts to drinking water safety and quality, food safety and security, indoor air quality, and increases in infectious diseases. Some B.C. examples are described below.

Landslides and debris flows are sometimes associated with extreme precipitation and flooding events in B.C. [472–475]. Other factors that can increase landslide risks include melting permafrost, wildfires (with damaged root systems and hydrophobic soils leading to unstable slopes), and drought [476–478]. Climate change may increase landslide frequency in B.C. by up to one-third by 2050, according to projections [479].

Impacts to the safety and quality of indoor air, water, and food: Extreme precipitation events can increase the incidence of gastrointestinal illnesses such as cryptosporidiosis and giardiasis (caused by parasites *Giardia lamblia* and *Cryptosporidium parvum*) [480,481]. Heavy precipitation can also lead to more soil and debris being transported into surface water supplies, elevating turbidity and diminishing water quality [482].

When evacuated residents return to flood-damaged homes and communities, they also face numerous potential hazards [483,484], such as:

- Flooding can saturate insulation, carpets, and furniture, creating favourable environments for mould development. Exposure can lead to health impacts when people inhale mould in indoor air (and less frequently through ingestion or direct skin contact), including illnesses due to allergic or hypersensitivity reactions; eye, nose and throat irritation; and respiratory infections in people with compromised immune systems [485,486].
- Perishable foods can become spoiled if electricity has been off, and non-perishable foods can have water contamination [487], increasing health risks from foodborne illness.

Princeton, B.C. cleanup after November 2021 flood event

- Contaminants can infiltrate the environment, increasing the risk of infectious disease and harm to crops, plants, and animals, if concentrations exceed unsafe limits. An assessment in December 2021, after the AR-flood event, identified a number of contaminants in soil, sediment, and surface water samples in the Fraser River and Sumas Prairie areas, including total coliforms, fecal coliform, arsenic, *E.coli*, chromium, nickel, and phenanthrene [488]. The assessment concluded that the concentration of contaminants was unlikely to pose a risk to human health. Water samples from a separate risk assessment at Sumas Prairie also identified multiple contaminants, with excess water spilling debris flow, animal carcasses, and diesel fuel into salmon habitats. Contaminants included fecal coliform, pesticides, pharmaceuticals, illicit drugs such as cocaine, hydrocarbons, metals, and excess nitrogen and phosphorus, with implications for salmon habitats in the region [489].
- Flooding can damage essential water treatment and sanitation infrastructure. During the 2021 AR-flood events, the City of Merritt's sanitary sewer system, wastewater treatment plant, rapid infiltration basins, and water-supply system were damaged. When some water lines broke and some water-system areas were depressurized, the City issued a Contaminated Drinking Water notice. Interior Health issued a do-not-consume advisory, and Merritt was placed under a boil-water advisory for almost three weeks [491].

Disease-associated total coliforms, fecal coliforms, and *E. coli* were found in soil and undisturbed sediment deposited on land by the flood, while total coliforms and *E. coli* were found in groundwater samples. These contaminants are a concern for people that have private water wells, or people that use surface water for drinking, irrigation, or for livestock [491]. Presence of total coliforms, fecal coliforms, and *E. coli* can indicate contamination of drinking water sources, such as pathogens that can cause gastrointestinal illnesses [492,493].

6.2 Flood impacts on B.C. population health and the health system

A wide range of potential exposures can lead to short- and long-term health impacts of flooding [494–499] (Figure 11). In global literature, flooding is also shown to impact the mental health of a population, with psychological distress, anxiety, depression, and post-traumatic stress disorder (PTSD) most commonly identified [154,495,500–503]. There are often longer-term impacts resulting from broader disruptions in the community as well, such as limited access to health and social care [501,504].

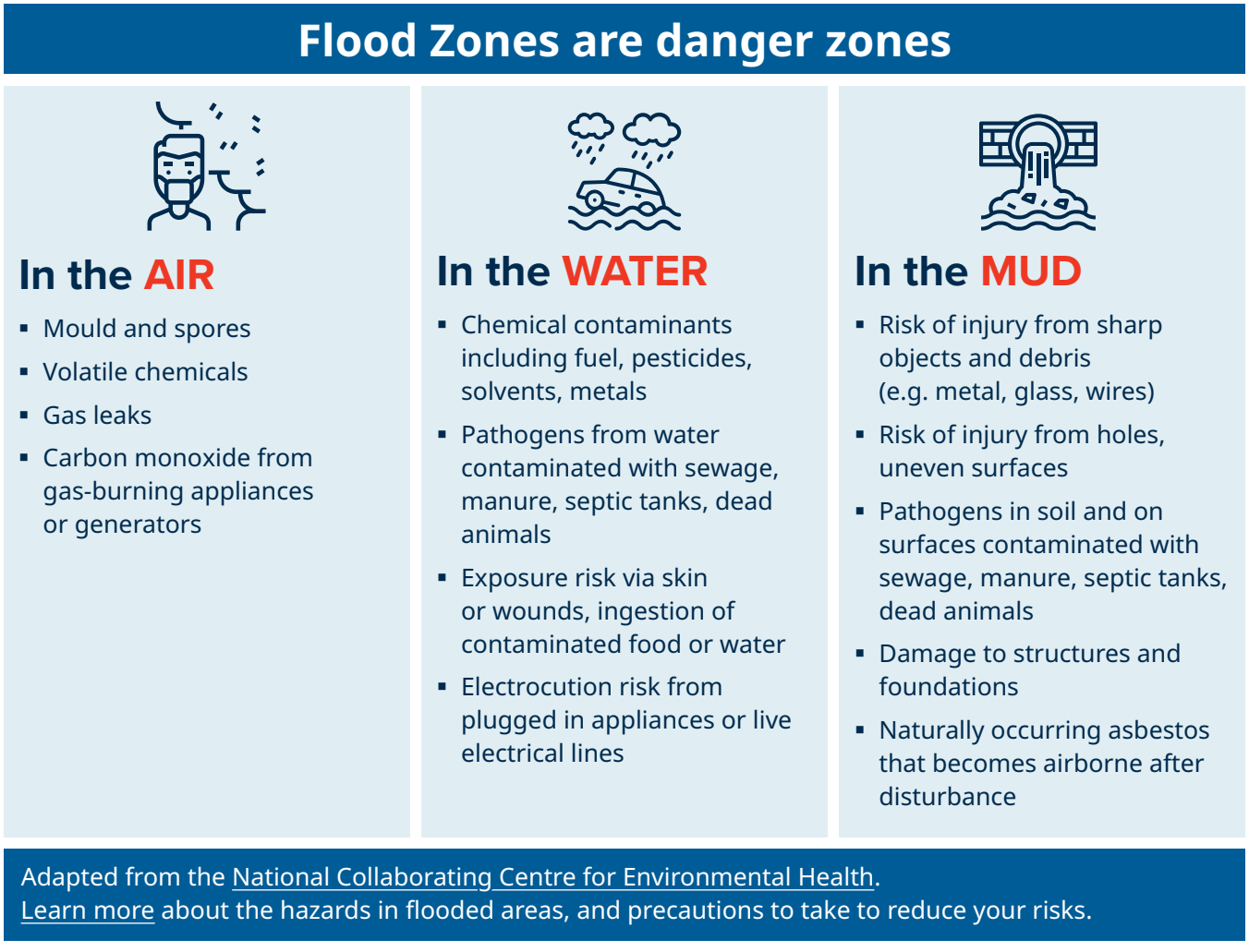


Figure 11: Potential hazard exposures in flooded areas [505]

Landslides and debris flows can cause death and injuries from rapidly flowing water and debris [476]. Broken power lines and/or water, gas, and/or sewage pipes can also result in injury or illness, such as waterborne diseases, electrocution or lacerations from falling debris, while short- and long-term mental health effects can occur due to loss of family, property, livestock or crops [476]. Landslides can also impact health and the health system through damage to critical infrastructure, such as power and communications lines, municipal water facilities, wastewater facilities, and hazardous materials storage sites [476].

Mud and rock slide on Highway 16 near Terrace, B.C. — May 2007

6.2.1 Flood impacts on B.C. population and public health

Though infrequently reported, deaths have been directly attributed to flooding events in B.C. [285,418,429,446] There have also been reports of injuries, mould-related exposures, and illnesses associated with flooding events in B.C. [506–508] Six months after the 2018 Grand Forks flood, for example, some residents reported experiencing health impacts, along with reports of mould and standing water [509]. However, the incidence of flood-related injuries and illnesses is currently not well-described in B.C., as there is no targeted surveillance for flood-related morbidity.

Landslides are rarely fatal, and rates of death due to landslides have been declining in B.C. since the early 1960's [472]. However, there have been reports of deaths and injuries due to landslide and debris flow events across all regions of the province, often associated with heavy precipitation events and flooding [510–518]. B.C. has the highest number of deaths due to landslides among Canadian provinces, with almost half (45 percent) of all 786 fatal landslides in Canada occurring in B.C. [43] [519,520]. From 2007 to 2019, there has been an estimated one death per year due to landslides in B.C. [472]. Debris flows cause most landslide deaths, and those killed tend to be members of the public travelling on highways or at home [472]. Other deaths have been reported among workers during logging operations, when landslides were triggered by heavy precipitation and extreme weather conditions [512,521]. Injuries have also been reported due to landslide and debris flow events. In 2021, for example, serious injuries were reported among people caught in the debris flow on Highway 99, including a youth who was critically injured [522,523].

43 As recorded in the Canadian Disaster Database up to 2019.

Extreme precipitation events have also been associated with increased rates of illness due to waterborne pathogens in B.C., with increased rates of giardiasis and cryptosporidiosis detected four to six weeks after extreme precipitation events in the greater Vancouver region [480]. The annual rates of cryptosporidiosis and giardiasis are projected to increase in the greater Vancouver region by approximately 16 percent by the 2080s (corresponding to 55–136 additional cases each year), due to projected increases in extreme precipitation events [481].

6.2.2 Disproportionate impacts of floods on populations in B.C.

Flooding does not affect all populations equally. In the global literature, evidence shows that a number of intersecting factors are associated with increased health risks from flooding, including: flood exposure (e.g., those living on floodplains, and the duration and number of severe storm events experienced [524]); having pre-existing cardiovascular and gastrointestinal conditions; pregnancy; housing status (e.g., unhoused or renting); and certain occupational types (e.g., outdoor workers) [525]. Evidence shows links between stress in pregnant women affected by flood disasters and lower birth weights [526], and impaired social functioning in their children [495]. Lower socioeconomic status[44] can increase the risk of adverse health impacts [527,528].

Intersecting risk factors were evident in recent B.C. floods, where those most impacted included women; older adults; Indigenous Peoples; and low-income, unhoused or precariously housed people [509]. In general, these groups were more likely to lack financial or housing security, live in the floodplain, and have lower capacity to personally respond to the flood because of financial insecurity [273]. Many of the disproportionate risks from flooding are mental health related and are discussed in more detail in Chapter 9: Mental Health.

In B.C., populations that have been disproportionately affected by floods include:

People living in floodplains or low-lying coastal areas: Over 500,000 people in B.C. (roughly 10 percent of the population) live in floodplains and are therefore more exposed to floods. The greatest number of people living on floodplains is in southwestern B.C., around the Fraser River, and the population centres of Duncan, Nanaimo, Kamloops, Squamish, Osoyoos, Prince George, and Terrace [529].

Rural and remote communities: When roads are washed out, rural and remote communities can become isolated, creating challenges for accessing critical supplies, medicine, and health services. During the 2018 Grand Forks flood, some community members had to shelter in place when the only access road was impassable [424]. In 2017 and 2021, the Fraser Canyon community of Boston Bar became inaccessible due to landslides and bridge washouts, and alternative methods of delivering health care, including virtual care and flying in supplies, were employed [82,530]. Flood-related damage to infrastructure can also have long-lasting impacts in rural communities, as they do not often have access to the same resources as urban centres.

Women: A study of the Social Impacts of the Grand Forks Flood [509] found that women (particularly single mothers and older women) were significantly impacted by the floods, as they often played a caregiving role for family and community members in times of crisis. There were also reports of an increased demand for transition housing for women escaping domestic violence [509]. Lack of available transition spaces to support women needing safe spaces from domestic violence was also reported in some communities impacted by the 2021 AR-flood events, when hotel spaces became unavailable [531]. During the 2021 AR-flood events,

44 In Canada, a Social Vulnerability Index for flood risk calculates local socioeconomic characteristics that influence a community's resilience to disaster events [524]. Considerable socioeconomic differences exist between populations living in high and low flood risk areas; populations living in areas of high flood risk in urban centres are more likely to be populated by racialized groups and consist of poorly built or maintained infrastructure [524].

there were also concerns about pregnant women and new mothers being isolated from their health care provider or other critical supports systems [532] [533].

Children and youth: Evidence from the 2021 AR-flood events showed that children and youth faced mental health impacts, including post-traumatic stress, and some experienced challenges with processing their experiences [534–536].

Older adults: Older adults living in low-cost housing were significantly impacted by the 2021 AR-flood events. In Princeton, three apartment buildings were severely damaged by the flood, including one housing many older adults. Some remained without secure housing for over a year after the event. Temporary modular seniors housing was set up for those who had been displaced for months, so that they could return to their community and support networks [537–539]. After the 2021 AR-flood events, older adults with health or mobility challenges faced unique barriers related to transportation to medical appointments and meal delivery [534], access to financial support for recovery [273], and post-flood waste removal [534].

Farmers and ranchers: The Sumas Prairie dyke breach during the 2021 AR-flood events led to 1,100 farms being placed on evacuation order or alert, and significant losses of farmland and animals [44]. Farmers and ranchers experienced significant mental health impacts [67].

Migrant farm workers: Many of the farms in the Fraser Valley impacted by the 2021 AR-flood events employed migrant farm workers. The flood exacerbated and exposed pre-existing systemic issues for migrant workers, including language barriers to accessing emergency service supports, limited social safety nets, and greater difficulty accessing disaster response funding [44,534,540–542].

> *"Probably the biggest [concern] was the migrant workers. [They] definitely had a language barrier, they were probably the most [in] need of help. They were away from home, and [had] no job because of the flood, and really didn't know where they were going next. So, I think... probably the biggest [group] to look after was migrant workers."*
>
> *—Survey respondent, After the Flood report (2023)* [534]

Underhoused and low-income populations: Recent flooding events in B.C. led to disproportionate impacts to underhoused and low-income populations. These populations were more likely to live in the floodplain, more reliant on public transport (and therefore lacked transportation when transit was disrupted by the flood), and more likely to live in sub-standard conditions prior to the flood [509,534]. Renters also experienced unique impacts. For example, the 2018 Grand Forks flood resulted in decreased supply of affordable rental properties, increased rents, and more stringent "vetting" practices, making it difficult to access housing for those already at risk before the flood [509].

People with complex care needs: Patients requiring life-saving cancer therapies, hemodialysis, transplants, and other treatments were significantly impacted by transportation disruptions from the 2021 AR-flood events [543–545] (discussed further in Chapter 10: Health Emergency Management, Evacuations and Health Service Delivery).

People with mental health and substance use conditions: Direct health impacts of the 2021 AR-flood events included increased hospital admission rates for alcohol withdrawal, lack of access to harm-reduction supplies for substance users, and delays in accessing opioid-substitution medications or treatment [56,546,547]. A *Risk to Resilience Project* focus group participant stressed the need to better prepare and support those with pre-existing mental health conditions during disasters.

> *"What struck me most were people who have diagnosed mental health illness; in these [flood] situations, they require even more care, whether it be their medication management or the need for additional services to debrief all this."*
>
> —*Risk to Resilience Project* focus group participant

Disproportionate impacts of flooding on Indigenous communities

Many First Nations communities are situated on floodplains, where they are disproportionately affected by flooding, a historical outcome influenced by the colonial placement of reserve lands that were more marginal in nature [548]. Indigenous Peoples also face a greater risk of flood-related displacement and evacuations, enduring disruptions to cultural and land-based practices, emotional distress and anxiety, and impacts on drinking water quality [549–551] (see Chapter 9: Mental Health for more details). Indigenous communities in B.C. are demonstrating strong leadership in flood risk assessment and flood preparedness and adaptation, drawing on Indigenous knowledge systems and land-based practices.

B.C. First Nations communities provide leadership for flood preparedness

Dzawada'enuxw flood preparedness increases adaptation

A 2011 flood had devastating impacts in the community of the Dzawada'enuxw people of Kingcome Inlet [552]. Community members identified flood-related physical, mental, and spiritual impacts, especially youth and Elders, and exacerbated safe-housing concerns as houses were destroyed by floods [552]. Following the flood, the Musgamagw Dzawada'enuxw community installed a river-gate system to monitor floodwater levels and identify when belongings have to be moved to higher ground [553]. The community also adapted by raising homes one metre above the ground. The Musgamagw Dzawada'enuxw community's strong adaption responses [553] helped to mitigate impacts from subsequent flooding in the Fall of 2017.

Integrated flood risk assessment in the Syilx Okanagan territory

In 2017, the Syilx Okanagan territory was impacted by extreme flooding, threatening community and ecosystem health. Recognizing a lack of a basin-wide approach to flood risk management, the Okanagan Nation Alliance led the Syilx Okanagan Flood and Debris Flow Risk Assessment in 2018, prepared with direction from Syilx knowledge keepers [554]. The project took an integrated approach to risk management, combining Syilx land-based knowledge of water with western watershed management practices. The process utilized Syilx processes of decision-making and traditional knowledge to centre the story and lessons of respecting siwɬk^{w} (water) [554].

B.C. ranked fourth among Canadian provinces for the most First Nations flood evacuees by Indigenous Service Canada region between 2013 and 2023, with 1,866 evacuees, including 253 long-term (more than three months) evacuees [555]. One study found that 81 percent of the 985 Indigenous land reserves in Canada had some flood exposure that impacted either population or residential properties. Out of 40 flood risk "hotspots" in Canada (census subdivisions where high social vulnerability coincides with high exposure to a 100-year flood), B.C. has the most flood risk hotspots (13) of all provinces [549].

The 2021 AR-flood events impacted 70 First Nations, with 15 needing to be partially or fully evacuated [524]. Members of the Shackan Indian Band near Merritt were displaced for three months due to the 2021 AR-flood events, soon after being displaced for one month in the summer due to wildfires [44]. In 2017, B.C. First Nations communities were among the most impacted by the record-setting freshet flooding, which damaged homes and infrastructure in 15 First Nations communities and resulted in multiple evacuations [556].

6.2.3 Flood impacts on the B.C. health system

Flooding impacts the health system by directly disrupting the delivery of health care, often due to power outages and damage to water supply and transportation networks [498]. Additionally, there can be significant loss of and damage to medical equipment, health care facilities, and infrastructure, which can lead to longer-term disruptions in service delivery and, in some cases, patient evacuations [498,557].

Flood impacts on the B.C. health workforce

> *"Everybody was showing signs of burnout [during the 2021 atmospheric river]... It's the compounding impact of response [on health workers]."*
>
> —*Risk to Resilience Project* focus group participant

During major floods in recent years (e.g., 2021 AR-flood events, 2018 Grand Forks, 2016 Dawson Creek), B.C.'s health care workers have experienced cascading impacts. As in other climate events, physicians, nurses, environmental health officers, and emergency responders face increased workloads during and following the floods, challenges in accessing transportation routes to and from their places of work, and mental health impacts.

Workplace impacts

During flooding events, increased health system staff capacity is required for emergency response, treating flood-related injuries, conducting water testing/monitoring, and providing mental health services and supports. During the 2021 AR-flood events, health system staff experienced emotional and physical fatigue due to the length of the emergency itself, increased working hours, and prolonged periods away from home [448]. Many health care providers worked tirelessly to support evacuations of health care facilities and ensure patients with urgent needs (e.g., dialysis, radiation, chemotherapy) received life-saving care [558,559]. (See Chapter 10: Health Emergency Management, Evacuations and Health Service Delivery for more discussion.)

Commuting impacts

When transportation routes were closed due to flooding during the 2021 AR-flood events, the event highlighted a significant staffing challenge for many health authorities: *many staff do not live in the communities in which they work.* During floods, the inability of staff to commute to their places of work can significantly alter the availability of workers to provide short- and long-term coverage [448]. For example:

Resiliency Centre, Merritt, B.C. — November 2021

- In 2021, flooding on the Malahat highway on Vancouver Island cut off the Capital Regional District from the central part of the Island. One *Risk to Resilience Project* focus group participant recalled, "*As the Malahat was closed, it was really difficult for a lot of health care providers who live in more remote areas to commute down. So, we're working with limited staffing and those of us who live close to the hospitals had to pull extra shifts and cover for colleagues."* In the Fraser Valley, the 2021 AR-flood events also cut off commuter access routes to hospitals in Chilliwack, Abbotsford, and Surrey. These route closures also meant some staff were unable to return to their home communities from the hospitals [96,448,560,561]. When they were finally able to get home, some workers expressed reluctance about returning to work while transportation routes were still uncertain.

> *"We had a lot of nurses that either work in Chilliwack or Abbotsford. They either couldn't make it back to Surrey or were in Surrey and now no longer could get back to their home sites. And so they felt an immense amount of guilt that they weren't there to help their colleagues in this disaster."*
>
> —*Risk to Resilience Project* focus group participant

- In 2016, the Dawson Creek flood cut the community in half, isolating the hospital and firehall from one other. During this event, the hospital was only accessible to roughly half of the community and its staff [562].

Flood impacts on health emergency management and health service delivery in B.C.

Emergency Operations Centres[45] (EOCs) were activated across impacted regions of the province during the 2021 AR-flood event:

- Local and regional EOCs were activated at Fraser Health (November 14–15) to support staff, ensure continuity of care, and assist sites impacted by the events [448]. A logistics coordination centre was also stood up to support the movement of clients, staff, equipment, medical supplies and specimens, and other supplies through the Fraser corridor, when traditional modes of transportation were not accessible [448]. Health Emergency Management BC (HEMBC)'s Lower Mainland team was focused on supporting Fraser Health's response and had to cease providing all other services [448];
- Interior Health activated an EOC and two regional Incident Commands (November 15) [42].

45 An ***Emergency Operations Centre*** (***EOC***) functions as a centralized location for the overall coordination of emergency response activities.

BC Cancer in action: Continuity of care for cancer patients during the 2021 floods

The Abbotsford BC Cancer team faced challenges when road closures during the 2021 AR-flood events impacted the delivery of urgent radiation therapy for patients. To ensure critical patient appointments continued without interruption, staff arranged transport and lodgings for those in need. The clinic remained open on the weekend to serve patients who had missed treatments during the week due to flooding impacts. Staff coordinated air and land transportation, hotel accommodations, a food voucher system for patients, and ensured staff from affected areas were able to safely make it to work. As the road closures continued and ground-commute times extended beyond six hours for round trips, additional air transport options were arranged for patients with mobility or pain-management issues [563].

After the November 2021atmospheric river flood event in Merritt, B.C.

Flood impacts on health facilities and infrastructure in B.C.

Flooding is projected to be a dominant hazard for a number of acute care and long-term care facilities by 2100, according to an assessment of climate risks to health facilities in B.C. [194]. Health facility buildings built on floodplains in B.C. are at increased risk of flooding-related impacts, including foundation destabilization. In some cases, critical building infrastructure and maintenance equipment are located below floodplain levels—these include boilers, electrical systems, fuel pumps, and main telecommunication and electrical lines. Floods in these areas would cause loss of heat and sterilization capacity, localized flooding, and, in the worst case, equipment failures and even site evacuation [150].

When protective dykes are destabilized, pump stations, electrical sub-stations, sewage and water treatment plants, and other dependent infrastructure can be inundated with flood water, with cascading impacts on health facilities [150]. Flooding events can further affect roadways and impact civil infrastructure, which can impact health facility access and operations. Extreme precipitation events can also lead to water infiltration through building envelope leaks, increasing the risk of mould; while stormwater and sewer backflow can reduce water quality [150]. Storms may damage roofs and external building cladding, and cause power outages [150].

A recent flood-risk assessment for developing the Lower Mainland Flood Strategy estimated that a number of Lower Mainland health care facilities (hospitals, ambulatory health, and nursing care) would be exposed to floodwaters in the event of a major flood—13 exposed facilities during a major coastal flood and 18 facilities during a major Fraser River flood [564] [46]. In Vancouver, where most hospitals and care facilities are located outside the flood zone, a major flood may limit access to care [461].

During the AR-flood events of 2021, reported impacts included issues with electrical, clinical communications, piping systems, boilers and pressure vessels, building envelopes, and standby power generators [228]. Health facilities in different regions of the province experienced flooding as well as communications and power outages—including sites in the Lower Mainland, the Interior, and on Vancouver Island [565]. The Fraser Canyon Hospital in Hope turned to generator power when the community lost its electrical supply, and was placed on evacuation alert due to riverbank erosion [566,567], with concerns that its basement-located laboratory would flood [568]. At Saanich Peninsula Hospital on Vancouver Island, flooding of the ambulance bay area led to temporary closure of its emergency department and diversion of ambulances to another regional hospital [569].

Heavy precipitation and high winds also have led to water penetration in B.C. health care facilities, with reported impacts including [150]:

- high groundwater levels leading to water ingress, sump pumps failing, and the potential for evacuation in the event of elevators failing;
- single-pane windows failing, leading to moisture accumulation inside buildings;
- roof membranes failing, leading to service delivery impacts (such as appointment cancellations and moving of patients), and potential evacuation; and
- concerns about trees—already stressed from extreme heat events and drought conditions —falling on-site.

Flood impacts on supply chains in B.C.

The 2021 AR-flood events had substantial impacts on B.C. supply chains [570]. The extreme precipitation and subsequent flooding and landslides heavily damaged highways and railways across southwestern B.C., effectively cutting off all road and rail access routes into and out of the B.C. south coast for several days. Some highways remained closed for multiple weeks. Rail and road operations also experienced significant delays at the Port of Vancouver, impacting the movement of grain, wheat, and gas, among other products [571].

Fuel shortages

> *"We had nursing staff waiting for two hours for the one gas station that had fuel in the area that they were in, to make sure that they could continue their shift and get out to other community-based clients."*
>
> —*Risk to Resilience Project* focus group participant

46 Major flood defined as a 500-year flood

Dozens of gas stations in the Lower Mainland and Vancouver Island ran low or dry during the 2021 AR-flood events, and the price of fuel skyrocketed with increased demand [572,573]. For close to one month, provincial state of emergency orders prompted mandatory fuel rationing for the public across southwestern B.C. [573]. The critical fuel shortages impacted health service delivery and operations in B.C., and health care services were prioritized for fuel as essential services under the Provincial order [233]. Among the reported health-sector challenges was ensuring ambulance fleets and health care workers, including those providing home care, had enough fuel to deliver care or commute to their places of work [233].

Essential medications and supplies

> *"You just get into emergency management mode and you start thinking about how we're going to get supplies in and out, who's there, who's vulnerable, who's stuck on this side, and how you're going to manage those logistics."*
>
> *—Rick McLean, Chief of the Tahltan Band Council, interviewed on CBC* [428]

While supply-chain impacts of the 2021 AR-flood events were unprecedented, it was not the first time flooding events in B.C. had impacted the delivery of essential supplies, particularly to rural and remote communities. In 2020, for example, flooding and the resulting debris flows led to the closure of the single road into and out of the remote northwestern B.C. community of Telegraph Creek [428]. *Risk to Resilience Project* focus group participants described waiting more than one month for the road to reopen, and having food brought in by helicopter. It marked the third extreme weather event in as many years to impact the community; a major wildfire in 2018 destroyed structures and forced the community to evacuate, and a debris flow event in 2019 closed the road and cut off the community from food and essential supplies [574].

The 2021 AR-flood events also significantly impacted provincial supply chains of medications and essential supplies to rural and remote communities located in flooded areas or cut off from road access to the Lower Mainland. In the days and weeks following the flood, some patients were reported to be quickly running out of medications and essential supplies, such as chemotherapy, colostomy supplies, psychiatric medications, transplant medications, and oxygen cylinders [233,530,561,575,576]. *Risk to Resilience Project* focus groups recounted stories of patients sharing supplies with other patients, with the critical support of nurses.

> *"We had patients on peritoneal dialysis at home, and we had other patients sharing supplies with them because they didn't have enough supplies to do their treatments. So, we had a nurse who was stranded in Chilliwack moving from one house to another."*
>
> *—Risk to Resilience Project* focus group participant

Story of collaboration: Delivering supplies and medicine to affected communities

While the most impacted areas of the Fraser Valley flood of November 2021 received significant resources and assistance, isolated, rural and remote communities such as Boston Bar and Hope were left without essential supplies or medications. Every road to and from Hope was impassable. The community's population of 6,700 grew by nearly 25 percent as it filled with ~1,500 stranded motorists. As the state of emergency went on for days, Hope ran out of hotel rooms, food, baby formula, hospital supplies, and drugs—both pharmaceutical and illicit—creating dire situations for some people trapped there.

During the flood, health system staff arranged alternate means of delivering medications and supplies to patients, health facilities, and lab testing facilities cut off by the floodwaters and landslides—including transport by helicopter and boat [530,576].

- The Ministry of Health Emergency Management Unit worked tirelessly with a team of health professionals, including Dr. Aseem Grover (senior medical director for Fraser Canyon Hospital), emergency managers, Boston Bar First Nation, and volunteers. They arranged a Canadian Armed Forces helicopter to transport medical help and supplies, including chemotherapy, colostomy supplies, and psychiatric medication, to the community of Boston Bar. [530]
- When patients stranded in Hope could not access their transplant medications, staff at a local pharmacy drove medications to a helicopter pad and coordinated flights to pick up the medications on the other side of the floodwaters [575].
- In order to maintain continuity of laboratory services at Fraser Canyon Hospital, staff coordinated helicopter transportation for courier runs that delivered supplies and picked up samples for distribution to other labs for specialized testing [577].
- Helicopters, along with extensive shipping and packaging protocols, were used to ship critical blood products to Abbotsford General Hospital for testing, as couriers could no longer deliver to patients at Fraser Canyon Hospital or Chilliwack General Hospital. Hospitals in Abbotsford and Chilliwack also increased their inventory of blood products (e.g., platelets) and extended expiry dates to 10 days. The Transparent Blood Inventory, which is part of the BC Blood Contingency Plan [578,579], enabled labs to see inventory levels across the region and move products as needed, with minimal site involvement [568].

Dr. Aseem Grover (fourth from left) with the Hope-based team of medical doctors and family physicians (source)

NewGen Pharmachoice in Abbotsford, B.C.—part of the BC Transplant team

Climate events have required iterative and continuous improvement. Thanks to lessons learned from the 2021 flood, improvements are being made for future disasters. Fraser Canyon Hospital now stockpiles more food, and a steel bin in its parking lot holds emergency supplies, including lanterns and batteries, gloves and gowns, disposable bowls and water, bedpans and urinals, extra stretchers, linens, and IV pumps [566]. These experiences and learnings can help other rural communities be better prepared for future disasters, just as previous disasters helped inform responses in 2021.

While the 2021 AR-flood events impacted Fraser Health and Interior Health Authorities most directly, focus group participants noted that the impacts rippled across the health system province-wide. For example, other health authorities experienced cascading effects due to blocked supply transportation routes between health authorities. Some *Risk to Resilience Project* focus group participants described realizing "*that events are not just siloed to one [health] authority. [There was an] increase of utilization across health authorities supporting each other.*"

Food shortages

The flooding was the biggest agricultural disaster in B.C.'s history, – with more than 1100 farms and 2.5 million livestock affected, along with severe losses for dairy, poultry, swine, beef, horticulture, fruit and vegetable growers, and land-based fish producers [456]. There were significant impacts on food supply chains as a result of this reduced production in flooded areas, and the disruptions to food cold supply chains and blocked transportation routes [456,580]. Disrupted food supply chains triggered public panic and hoarding of food and essential supplies, leading to empty shelves in some grocery stores across the province [572,581,582].

Water quality

> *"[Water] sampling was a real challenge with the breakdown of transportation infrastructure; it really impacted the ability for access to laboratories within the 30-hour window, because the transportation networks that couriers would usually use were wiped out."*
>
> —*Risk to Resilience Project* focus group participant

The 2021 AR-flood events also impacted the continuity of some diagnostic laboratory services [577]. The breakdown in transportation impacted time-sensitive laboratory testing, and provincial laboratories in Vancouver faced challenges delivering timely water-quality testing [583].

Princeton, B.C. after November 2021 flood event

Collaboration was key to support innovative drinking water solution for residents affected by the floods [583]

Extreme rainfall and flooding from the 2021 AR disrupted drinking water testing, posing challenges for communities like Hope and those along the Fraser Canyon. The B.C. Drinking Water Protection Act requires water testing within 30 hours of sample collection, but challenging road conditions made it difficult to transport samples to the BC Centre for Disease Control (BCCDC) Public Health Laboratory in Vancouver in time. Obtaining necessary testing supplies and training was also a challenge, complicated by intermittent internet access and power outages.

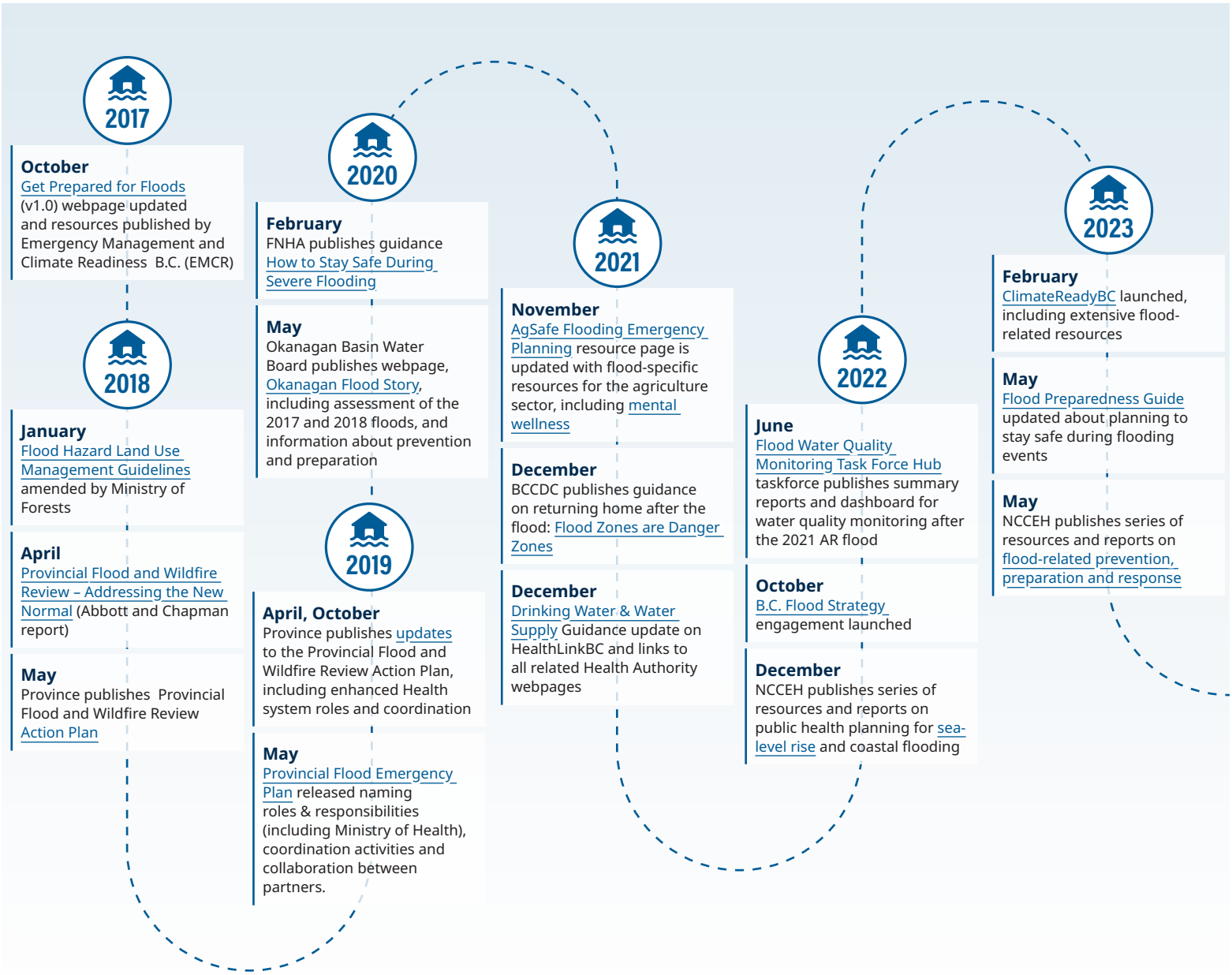
In response, a "Lab in a Box" solution, officially called Point of Use Testing (POUT), was developed. This innovative approach enables local utility staff to sample and test water daily for contaminants (e.g. total coliforms and E. coli) on site, without transporting samples to the BCCDC. Collaboration between various partners, including Fraser Health and the Provincial Drinking Water Officer, has been instrumental in implementing this solution to ensure the reliability of water quality during emergencies.


Point of Use Testing (photo: Environmental Microbiology, BC Centre for Disease Control Public Health Laboratory)

6.3 Health-related adaptations to floods in B.C.

Following the record-breaking flood seasons in 2017 and 2018, and the AR flood in 2021, provincial and regional after-action reviews have led to expanded action planning for flooding in B.C. While many flood-based adaptations are led by various sectors and partners (e.g. local governments, First Nations, and multiple provincial ministries), the B.C. health system is involved in prevention, preparedness, response to, and recovery from flood events. Some examples of health-related adaptations to flooding in B.C. are summarized in the timeline below.

A TIMELINE OF SELECT HEALTH-RELATED FLOOD ADAPTATIONS IN B.C.



Provincial flood strategy

Following the AR events of November 2021, the Province focused efforts on the development of a B.C. Flood Strategy, to be followed by a B.C. Flood Resilience (implementation) Plan. First Nations, local governments, provincial ministries (including the Ministry of Health), health authorities, federal agencies, technical experts, and community partners were engaged to provide feedback on how the vision and principles outlined in the B.C. Flood Strategy Intentions Paper [13] would be achieved over time through priority actions. Following this engagement, three What We Heard reports were developed to guide development of the B.C. Flood Strategy. Key takeaways, as communicated by participants, included a need for mental health and community well-being planning, food security (including considerations regarding impacts to transportation corridors), and strengthened flood risk governance [584,585].

The B.C. Flood Strategy, informed by the United Nations Sendai Framework on Disaster Risk Reduction, will provide a foundation and roadmap for implementing significant improvements to integrated flood hazard management over time. The Province has made efforts to collaboratively develop the flood strategy in partnership with First Nations and in consideration of the Declaration on the Rights of Indigenous Peoples Act, which aligns with the federal United Nations Declaration on the Rights of Indigenous Peoples Act.

Provincial structures and teams for flood-related monitoring and response

After the 2021 AR-flood event, a multi-agency provincial task force was formed to address concerns about water quality and inform provincial and local decision-makers. The Interagency Flood Monitoring Task Force has played a pivotal role in coordinating efforts among key governmental agencies led by the B.C. Ministry of Environment and Climate Change Strategy, and health-sector participants from provincial and regional health authorities and agencies.

The task force is actively engaged in establishing interconnected health system structures, working collaboratively to bolster health-response capabilities and share timely information. The task force supported water-quality assessments related to the floods through conceptual site models, using human health and ecological risk assessment methodology for flood-impacted areas of the Sumas Prairie, Merritt, and Princeton.

Emergency response teams for critical water and wastewater infrastructure

During flooding events, Environmental Operators work to minimize impacts of damage to water and wastewater infrastructure. The Environmental Operators Certification Program's mission is to protect human health and the environment by investing in wastewater treatment plant operators and facilities through increased knowledge, skill, and proficiency in all matters related to the water cycle. *"It's not a matter of if, it's a matter of when. When it comes to emergency response and critical water and wastewater infrastructure, we can be reactive, or we can be proactive. Let's stop being reactive. Let's learn, let's adapt, let's act now."* [586,587]

The disruption of food supply chains during the 2021 AR-flood events created an urgent need for food security coordination. A Food Security Working Group, chaired by the Ministry of Health with membership from across government, non-profit and private sector partners, coordinated and triaged immediate and urgent food security needs in the wake of the 2021 AR-flood events. Communication pathways were established to coordinate response efforts to address food security concerns, establish tracking and reporting mechanisms to ensure effective communication with the Emergency Operations Centre, and support food security strategies from response to recovery [56].

Early warning systems and data-driven public-risk communication tools

There are several interactive dashboard and mapping tools available in B.C. which provide information to the public about current flooding-related hazards. These include:

- B.C. River Forecast Centre's Flood Warning and Advisory Notification Map, providing information about current flood warnings and watches;
- The Ministry of Emergency Management and Climate Readiness (EMCR)'s EmergencyMapBC, showing locations of current flood warnings and watches, landslides, tsunamis, and flood and landslide evacuation orders and alerts;
- B.C. Flood Debris Explorer, offering resources and tools for identifying and locating flood debris; and
- Vancouver Coastal Health/Fraser Health and Interior Health have studied and modelled some of the variables that are likely to determine community-level vulnerability to health impacts associated with flooding [83,84].

Early warning systems are being used to forecast flooding and flooding-related risk factors in B.C. The B.C. Storm Surge Forecasting System, for example, offers six-day forecasts of storm surge and total water levels in Southern B.C., and in 2024, Environment and Climate Change Canada (ECCC) is developing the capacity to issue impact-based coastal flooding warnings [466,588]. ECCC is also exploring a ranking system for ARs to communicate potential impacts to the public [589,590].

Teamwork and innovating solutions

As with other challenging climate events, health care workers have shown many instances of teamwork, problem-solving, and resilience during flooding events. There are many examples of health care teams troubleshooting and rapidly developing and testing innovative solutions.

In many cases during the 2021 AR-flood events, health care workers went above and beyond to ensure patients, such as dialysis and transplant patients, received the critical care they needed—developing and coordinating plans to get life-saving medicines to stranded patients and, in some cases, travelling to attend to these patients themselves [560,575,576,591]. Teams worked together to design creative solutions for critical needs, including virtual care for renal peritoneal dialysis patients [592]; partnering across health authorities and with other organizations to provide helicopter care for patients; and ensuring patients received their needed medicine and supplies in the flood zone [560].

While health care teams should be commended for their dedication and tenacity, it is also important to recognize that these efforts can result in fatigue, burnout, and mental health impacts (summarized in Chapter 8), and it is unsustainable to rely on staff to go "above and beyond" during increasingly frequent climate events. Long-term health system adaptations are needed, as detailed in Chapters 8, 9, and 10.

Individual-preparedness and flood-risk communications

A number of guidance documents have been developed to support individuals and communities in B.C. be better prepared in advance of a flood, and to return safely to their homes after the floodwaters recede. Provincial and regional health authorities have also developed guidance and supported community flood preparation through community-resilience funding streams. Some examples in B.C. include:

- The Flood Preparedness Guide, released in 2020 and updated in 2023, is a toolkit developed by EMCR. It provides guidance on flood preparation, such as creating a plan, having a meeting place in the community, and protecting homes and property. It highlights where to find information on advisories, such as High Streamflow, Flood Watches and Flood Warnings, where to go during evacuation stages, and coping with flood stress. It also provides guidance for after flooding, where health-related risks and concerns include dealing with receding contaminated waters, compromised structures, and addressing and mitigating mould growth in the home.
- ClimateReadyBC, a public-facing portal developed by the B.C. government, provides information to the public on natural hazards, including revised floodplain maps anticipated in 2024.
- The First Nations Health Authority has published guidance on staying safe before, during, and after severe flooding for First Nations individuals and communities, including considerations for water quality, food safety and septic systems [593,594].
- In 2023, the National Collaborating Centre for Environmental Health [hosted within the BCCDC] published a series of reports and catalogues identifying resources and information about flood prevention, preparedness, response, and recovery; mould assessment, remediation, and building for resilience; and supporting community psychosocial well-being after a flood.
- BCCDC published a list of resources about returning to flooded areas, including information about hazards (such as contaminants, moulds, unstable structures, and carbon monoxide exposure) to consider before entering a flood zone, measures to reduce mould growth, and drinking water considerations [483].
- Interior Health [595] has developed and compiled extensive flood- and landslide-related guidance, including targeted guidance for food establishments and long-term care and child-care facilities.

Health authorities supporting preparedness for priority populations in B.C. communities

The Hope Citizens Emergency Disaster Planning Committee (HCEDPC) launched the Ready-Set-Go! Seniors campaign in response to the 2021 AR-flood events. They developed 200 senior-specific emergency kits with the support of a Fraser Health micro-grant. The kits include essential items, such as a blanket, flashlight, whistle, first-aid kit, water bottle, notepad, pen, and informational materials on emergency preparedness. Distribution occurs at various events, targeting housebound older adults. HCEDPC is dedicated to raising awareness and advocating for community emergency plans and encourages the community to prioritize emergency preparedness so that everyone, especially older adults, are equipped for unforeseen situations [596].

Floodplain mapping

Effectively addressing flood risks in a community requires a comprehensive understanding of the flood hazard's likelihood, and the community's resilience, vulnerability, and exposure. Floodplain mapping is used to assess flood risks by identifying the modelled flood extent (i.e., areas that would be affected by a given flood) [597,598].

Many communities in B.C. lack, or have outdated, floodplain maps [599]. In a December 2020 survey, researchers found that only 39 percent of the 109 B.C. local government and First Nations respondents[47] had either created or updated floodplain maps within the past 10 years, and more than half (56 percent) lacked knowledge of in-house flood management. Inadequate resources and in-house expertise were noted as significant barriers to conducting floodplain mapping [600,601]. Since 2015, federal and provincial funding programs have enhanced support for local governments [601–604] and updating floodplain mapping is a priority across Canada [605].

Examples of B.C. floodplain maps and tools include:

- B.C. Flood Study Explorer: This dashboard showcases B.C. flood hazard studies funded by the province to better understand flood risks and related research.
- Flood Maps in B.C. by Floodwise: This dashboard includes access to a range of flood maps, including floodplain, hazard, vulnerability, and risk maps; community-specific maps for river and coastal flood hazards; emergency planning maps; and regional-scale maps for the Lower Mainland flood management strategy.
- The BC Floodplain Mapping Initiative: This initiative is collaboration with the Fraser Basin Council, with funding from the Province of B.C. and Government of Canada via the Flood Hazard Identification and Mapping Program. It focuses on producing high-quality floodplain maps for communities facing riverine, lakeshore, and coastal flood hazards, particularly in six high-risk areas, including the Lower Fraser and Coquihalla Rivers, Nicola and Coldwater Rivers, Upper Fraser and Nechako Rivers, Bulkley and Skeena Rivers, Shuswap Lake Region, and the Upper Columbia River.

47 Response rate to the survey was 32.3 percent.

Community- and First Nation-led adaptations

Key adaptations to reduce flood risk for communities include physical flood protection measures, such as dykes and levees, and nature-based solutions, such as widening natural floodplains, protecting and expanding wetlands, and investing in urban green spaces to reduce run-off [606–611].

As most impacts and adaptations to floods are place-based, many of the levers to increase flood resilience are outside the health system and rely on strong local leadership and partnerships across sectors and scales. Community and/or Indigenous-led adaptations in B.C. have included:

- The Okanagan Basin Water Board supported a valley-wide partnership of local governments and Indigenous communities to update the region's floodplain mapping. Funded by the Province, the project's goal was to enhance community understanding of flood hazards in the Okanagan watershed through information-sharing after high-water events in 2017 and 2018. The project included floodplain maps, historical accounts of flooding, information on the impact of changing climate, mitigation strategies, flood-preparedness resources, response guidelines, and recovery assistance. A similar provincially-funded initiative was completed by the Fraser Basin Council between 2018 and 2023 for the Thompson River watershed [610].
- The Sea2City Design Challenge was a collaborative effort to facilitate collective learning and capacity building among project partners and design teams. It involved multi-disciplinary design teams; City of Vancouver staff; local coastal adaptation experts; Host Nation representatives, knowledge keepers, and designers from Musqueam, Squamish, and Tsleil-Waututh Nations. It was guided by the values of the Host Nations, community, and design principles identified through earlier engagement, with a focus on increasing public awareness of sea-level rise and coastal flooding; promoting a reconciliation-centered coastal adaptation approach; addressing social equity, economic, and ecological challenges related to sea-level rise; and exploring adaptation options for a minimum two-metre sea-level rise along key sites of Vancouver's False Creek shoreline.
- Across the entire Lower Mainland, a First Nations-led action plan focused on flood adaptation strategies is underway. The president and tribal chief of Stólō Tribal Council also chairs the Emergency Planning Secretariat with representatives from 31 First Nations communities. The goal of the Secretariat is to implement a Coast-Salish-led flood management strategy for the entire region, from Yale to Tsawwassen to Squamish [612].

Other key flood resilience priorities identified by the Canadian National Risk Profile include enhancing whole-of-society collaboration and governance to strengthen resilience, improving our understanding of disaster risks in all sectors of society, and expanding the focus on whole-of-society disaster prevention and mitigation [605].

6.4 Opportunities for action

Addressing the population health and health system impacts of flooding in B.C. requires a multifaceted and collaborative approach. Some key opportunities for action include:

Coordination and collaboration

- Increase clarity on roles and responsibilities between health system agencies and other ministries, including who is responsible for communicating to the public regarding flood preparedness, impacts and recovery.
- Build capacity and guidance for health- and non-health-related actors to support rapid flood response during times of acute flood events (e.g., Flood Water Quality Monitoring Task Force).
- Enhance community-level coordination and collaboration between health agencies, local governments, First Nations, and other partners during flood events and flood recovery.

Surveillance and research

- Utilize spatial data (e.g., location of critical infrastructure related to drinking water, stormwater, and wastewater) to better understand potential water-related health impacts during flooding.
- Enhance understanding of the short- and long-term physical and mental health impacts of flooding, such as anxiety, emotional trauma, and PTSD.
- Research the differential health impacts of flooding in B.C. on priority populations.
- Explore the cascading impacts of flooding on food security.

Management of environmental determinants of health

- Continue to enhance water quality monitoring to detect contamination in water supplies during and after flooding, including sampling of water supply systems and encouraging sampling to those responsible for private wells.

- Encourage the continued use of innovative strategies (e.g., point-of-use testing) for timely water sampling during emergency flood events.
- Promote rapid response to conduct health housing inspections after a flooding event.

Communications

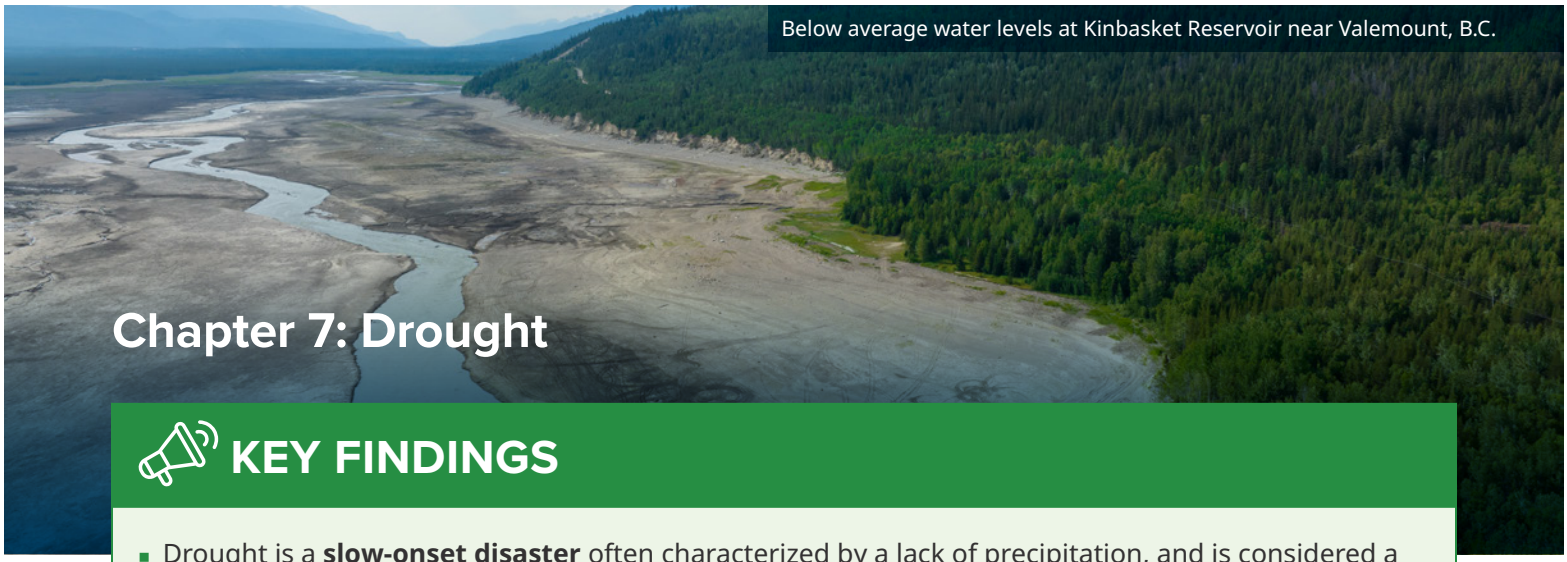
- Conduct public awareness campaigns to educate residents about the health risks of flooding (e.g., mould exposure, mental health) and to promote preparedness measures.
- Support timely communication of water-quality data to community partners and the public during and after flooding.

Mental health services

- Enable timely and adequate mental health services and community support programs to mitigate the adverse psychosocial effects of flooding.
- Integrate mental health support services into emergency response plans to address the psychological impacts of flooding on health care staff.

Health facility preparedness

- Include flood risk considerations in health facility climate risk assessments.
- Integrate flood risk and exposure considerations in site selection for health facilities, utilizing the most up-to-date climate data.
- Plan for flood resilience in the retrofit and design of health infrastructure, considering elevation, waterproofing, and other resilience measures.

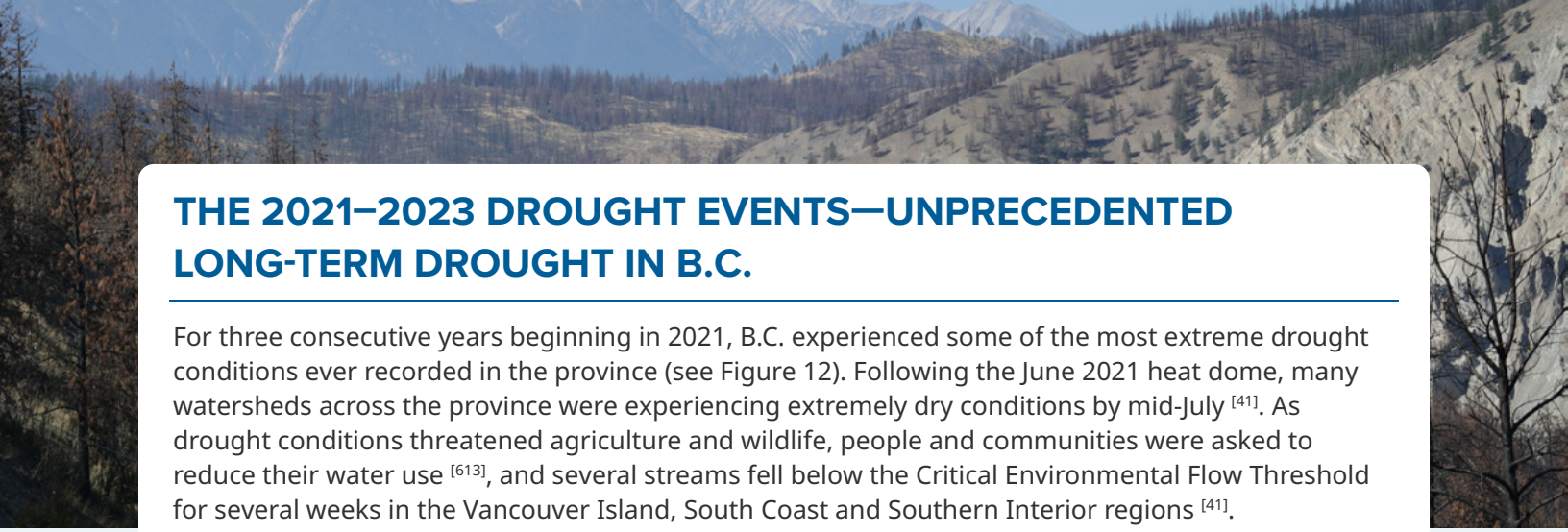


Below average water levels at Kinbasket Reservoir near Valemount, B.C.

Chapter 7: Drought

KEY FINDINGS

- Drought is a **slow-onset disaster** often characterized by a lack of precipitation, and is considered a **high-risk climate hazard for B.C.**, leading to seasonal and long-term water shortages.
- An **increase in the duration and frequency** of seasonal drought—particularly summer drought—is projected for B.C., as a result of declining seasonal snow accumulation, warmer summers, and reduced summer rainfall.
- The **health impacts from drought** in B.C. include a reduction in the availability, quality, and safety of drinking water, including the intrusion of salt water in coastal areas. Lowered quality and quantity of aquatic habitat due to low flow conditions can also impact the numbers of fish and wildlife species available for subsequent harvest and consumption.
- Drought can **lower the quantity of water** in groundwater levels/aquifers needed for drinking and sanitation, and decrease water stores used for fire suppression.
- **Mental health impacts** of drought described by people in B.C. include feeling worried and concerned during periods of high drought levels. Some report experiencing increased climate anxiety due to worries about the longer-term impacts of drought.
- In B.C., drought has had **disproportionate health impacts** on some populations including Indigenous, rural, and remote communities; farmers and ranchers; and those who rely on forestry and fishing for their livelihoods.
- **Health care facilities in B.C. are at risk** of drought-related impacts, such as damage to landscaping and limited available water for essential needs—including for medical equipment sanitization and sterilization, and patient drinking, washing, and bathing. In addition, critical systems, such as cooling towers and boilers, may be affected by water shortages, leading to disruptions in essential health care services.
- **Drought adaptations in B.C**. include enhancing leadership and collaboration for emergency preparedness and response across the province and the health system, strengthening drought monitoring and public awareness, reducing reliance on water in B.C. health care facilities, and promoting nature-based adaptation solutions**.**



THE 2021–2023 DROUGHT EVENTS—UNPRECEDENTED LONG-TERM DROUGHT IN B.C.

For three consecutive years beginning in 2021, B.C. experienced some of the most extreme drought conditions ever recorded in the province (see Figure 12). Following the June 2021 heat dome, many watersheds across the province were experiencing extremely dry conditions by mid-July [41]. As drought conditions threatened agriculture and wildlife, people and communities were asked to reduce their water use [613], and several streams fell below the Critical Environmental Flow Threshold for several weeks in the Vancouver Island, South Coast and Southern Interior regions [41].

River flows and groundwater levels in B.C. were initially at closer to normal levels in 2022 due to heavy precipitation from multiple atmospheric rivers in the fall of 2021 [41]. These back-to-back atmospheric rivers wiped out portions of snowpack, however. The drought season of late summer 2022 started after a cold, wet spring with a very delayed freshet [41]. There was hot and dry weather through the summer and into the fall of 2022, and multiple regions hit drought Levels 4 and 5 by October 2022. Rivers and groundwater remained below normal levels through the end of the year [41].

In 2023, B.C. experienced some of the most severe drought conditions on record. Level 4 and 5 drought conditions blanketed much of the province by August, and water restrictions were imposed on specific sectors. Farmers and ranchers had to make extremely tough decisions, such as culling cattle or buying hay at uneconomical prices as a result of the dry conditions [614]. Conservation and local water restrictions, regulatory action, and emergency preparedness efforts took place across many regions of the province.

KEY STATISTICS

By August and September 2021, drought conditions in one or more water basins within 13 of 16 health service delivery areas (HSDAs) had reached **Level 4** or higher—at which adverse socioeconomic or ecosystem impacts are likely or almost certain[48].

In October 2022, the Lower Mainland, Sunshine Coast, and West Vancouver Island water basins reached **Level 5** drought conditions [41].

Also in October 2022, the Sunshine Coast Regional District declared a local **state of emergency** due to the ongoing drought and associated risk to the Chapman Water System [615].

By summer 2023, B.C. had experienced its earliest mountain snowpack melt since 1988, and precipitation ranged from **40 to 85 percent of normal**, depending on the region [41].

In 2023, 26 of B.C.'s 34 water basins experienced at least one week with **Level 5** drought [41].

48 Data source: Water Management Branch, B.C. Ministry of Water, Land and Resource Stewardship (see Appendix 1 for more details)

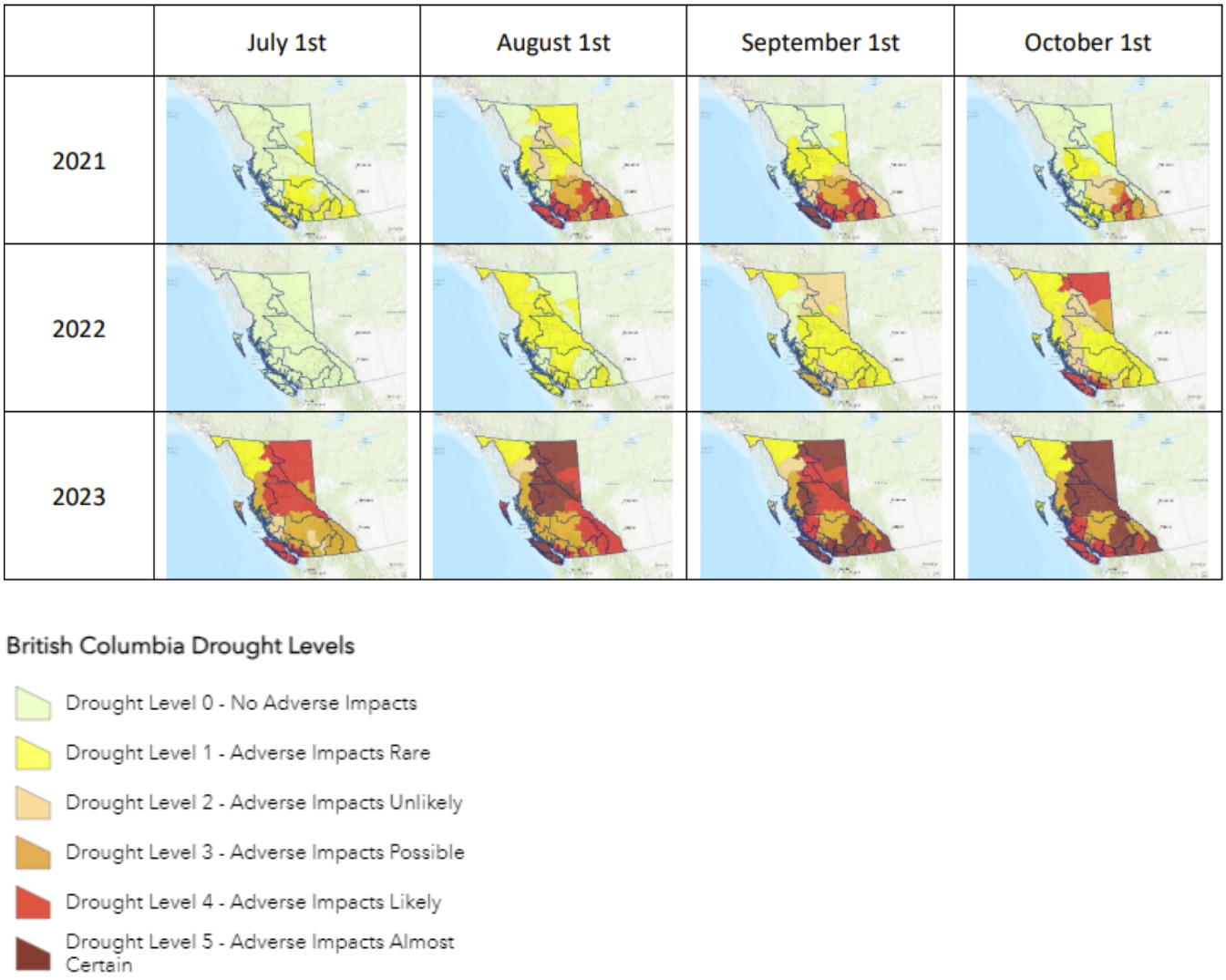


Figure 12. Drought levels between 2021 and 2023 in B.C., by health service delivery area (HSDA)[49]

49 Map created by GeoBC. Note: for this panel of drought maps, the date requested for the drought levels may not coincide with the drought update day for some time periods. In those cases, the latest drought status during those time periods are used.

7.1 Exposure to drought in B.C.

Drought trends in B.C.

Drought is often described as a slow-onset disaster characterized by a lack of precipitation, resulting in water shortages [616]. Droughts are different from other climate hazards in that they can last several weeks, extend to several years, and often lack a clear beginning and end [617]. They can also vary in their geographic scales from highly localized to regional [617].

It can be challenging to identify and monitor drought, as it can be defined in different ways [618,619]. The B.C. Drought and Water Scarcity Response Plan defines five types of drought: meteorologic, hydrologic, agricultural, socioeconomic, and ecologic [618]. These are interconnected, and can have cascading impacts on health, livelihoods, and ecosystems through a range of pathways [619].

Drought is considered a significant climate hazard for B.C. In the 2019 Preliminary Strategic Climate Risk Assessment, the Province ranked seasonal water shortage[50] and long-term water shortage [51] at high risk for B.C. by the year 2050 (ranking second and sixth overall when compared to all risks) [30]. Seasonal water shortages could occur once every two years, or more frequently, by 2050. Predictions for longer-term water shortages are less certain [30]. Decreased seasonal snow accumulation, warmer summers, and reduced summer rainfall are projected to increase the duration and frequency of seasonal—particularly summer—drought in B.C. [30]

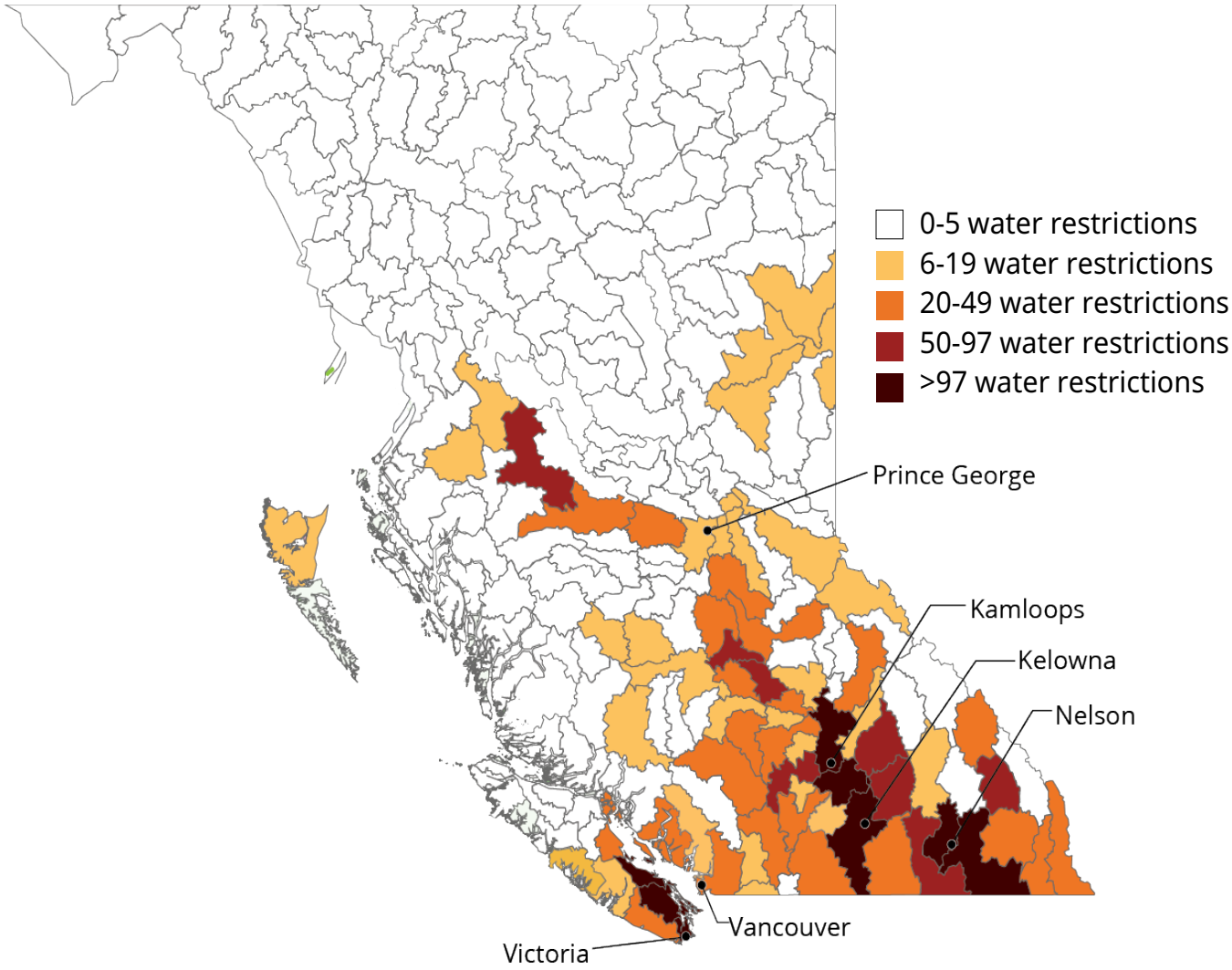
For more than a decade, B.C. watersheds and aquifers have been experiencing longer and more geographically extensive droughts [620]. Since 2021, one or more regional health authorities have had at least one water basin at drought Level 3 or higher for a total of 59 weeks—meaning that adverse impacts on both communities and ecosystems are possible to almost certain (Appendix 1 – Table A1.10).

Much of the B.C. population (approximately 63 percent, or 2.9 million people) currently live in water-stressed areas[52], particularly in the Southern and Interior regions [621] (Figure 13). Areas with the highest levels of water stress cover only 3.7 percent of the province but are home to 23 percent of the population. B.C.'s population has doubled since the 1970s; some water-stressed areas have higher-than-average growth rates, which puts additional strain on water infrastructure [621]. Rising population density can also exacerbate the strain on areas already grappling with sustainable water supply, particularly in water-stressed regions of the province, as illustrated in Figure 14.

50 Seasonal water shortage was defined as a summer water shortage affecting two or more regions of the province and lasting two or more months. The magnitude of this water shortage was equal to drought Level 4 as defined in the B.C. Drought Response Plan (the highest level where water supply is insufficient to meet socioeconomic and ecosystem needs)—with cause dependent on hydrology of streams in the region.

51 Long-term water shortage was defined as a water shortage lasting for two or more years, affecting one or more regions of B.C., and characterized by insufficient supplies of both blue water and green water (i.e., liquid water in reservoirs, lakes, aquifers, rivers, etc., and moisture in the soil and vegetation)—driven by a year-on-year decrease in precipitation and increase in temperature.

52 Defined by the Province's designations used to support water licensing decisions (i.e., water allocation restrictions that are fully recorded or fully recorded with exceptions) as a proxy for water scarcity. Water-scarce area is defined as a watershed in which three or more surface-water sources are under restrictions.



Major B.C. watersheds or regions categorized by number of water restrictions (Fully Recorded and Fully Recorded with Exceptions). The darkest areas are the most water stressed and encompass 3.7% of the province.

Figure 13. Major B.C. watersheds categorized by number of water allocation restrictions [621]

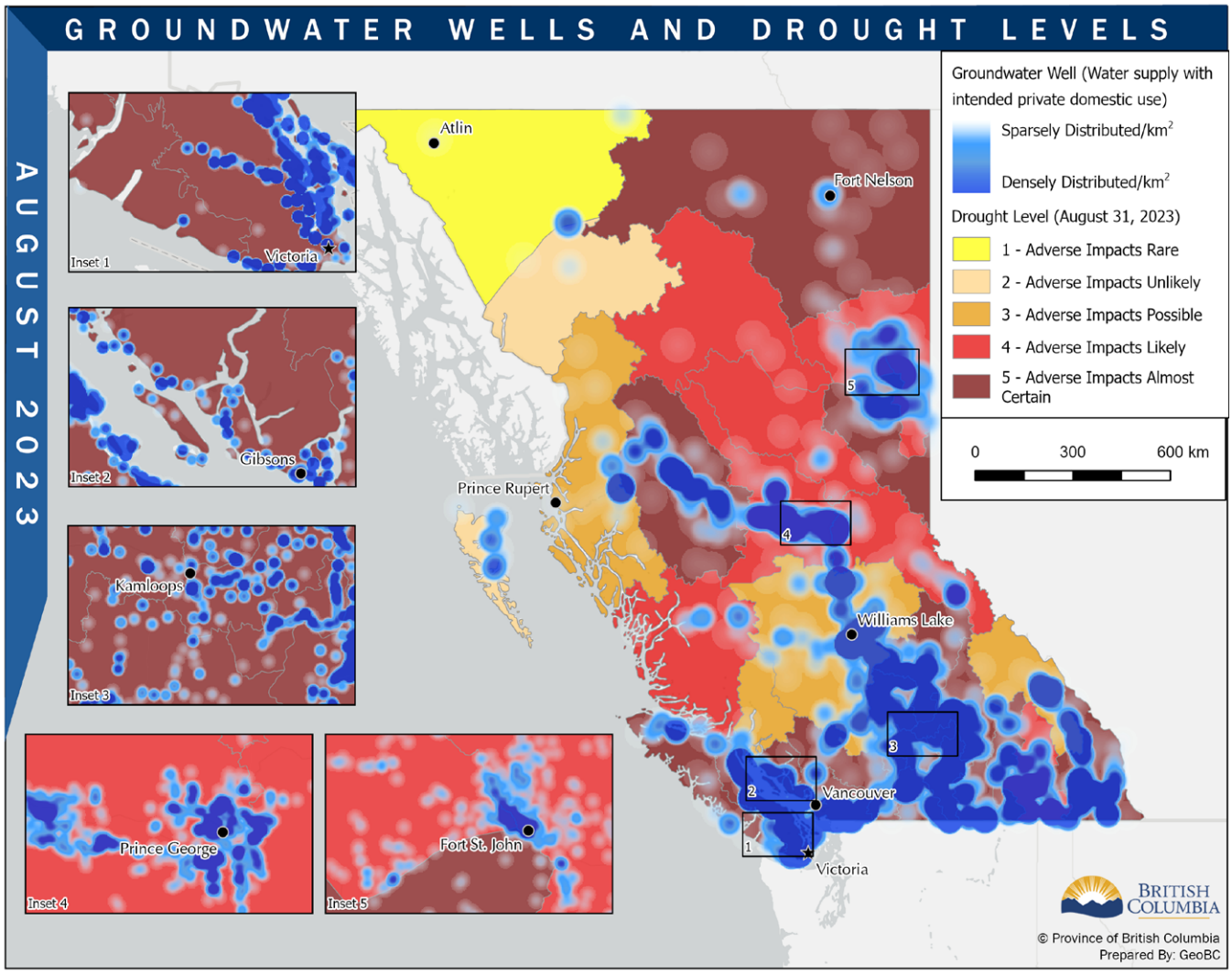


Figure 14. Groundwater well density and drought levels in B.C. health service delivery areas, August 2023

7.2 Drought impacts on B.C. population health and the health system

Drought can have cascading impacts in B.C. Prolonged dry spells can increase wildfire risks [622], while heavy rain events on soils that have become hydrophobic (i.e., water repelling) from drought can lead to increased overland flood risk [623] and landslides [624]. Drought can also worsen air quality due to dust and fine particulate matter from airborne dry soil [625]. Crops can become more susceptible to mycotoxin contamination and insect attacks, leading to reduced agricultural yields and ultimately impacting food quantity and quality [618]. Drought can also lead to ecological impacts and environmental degradation [625]—such as vegetation loss and lower stream flows leading to warmer river temperatures, which affect fish and aquatic life [618]. In addition, breeding conditions for mosquito vectors can proliferate when water sources become stagnant [124].

Drought can also impact the availability, accessibility, quality, and safety of drinking water, as a result of depleting water sources putting pressure on critical infrastructure [625]. These drinking water impacts lead directly to health impacts:

- **Reduced water quality and safety:** During drought, there may be a greater risk of turbidity and need for enhanced water treatment to reduce risk of adverse health outcomes[53]. Lower water levels and reduced stream flows can result in stagnation and lower dilution at contaminant (or discharge) sources, increasing the concentration of contaminants in ground and surface waters [625], such as total coliforms[54] or arsenic, leading to a decline in water quality [626,629]. Drought can also lead to increased development of harmful algae blooms [630].

  In coastal areas, increased groundwater extraction and decreased recharge during droughts can lead to salt water being drawn into aquifers used as drinking water sources. This intrusion of salt water into the aquifer will progress inland with additional water withdrawals, permanently contaminating the aquifer and those wells drawing from it [631]**.** This problem is exacerbated on small islands with increasing population and associated water withdrawals, but limited fresh water aquifer recharge. Increasing well density and groundwater extraction on the B.C. Gulf Islands has led to saltwater intrusion and potential contamination of wells nearest to the coast [632].

  Water scarcity directly impacts public health by reducing water quality and straining sanitation systems. Diminished water levels in water bodies, coupled with stagnant flows, can elevate concentrations of pollutants and pathogens. [633] Drought can also create conditions in which organic matter is carried to water bodies during subsequent rainfall [631].

- **Reduced water quantity***:* Aquifers are recharged through infiltration of water from precipitation and surface water bodies. Low stream flows and extended periods of low precipitation can impact groundwater levels. Aquifers, particularly those at shallow depths or along stream systems, can develop a lower water table during a drought year. If the aquifer is not fully recharged year over year, there will be a cumulative result. [618]. If natural water sources or adequate storage are not available in a community, drought may lead to insufficient supplies for firefighting and for human use and sanitation. When wells run dry or have been contaminated with salt water, people who rely on those wells must obtain potable water for drinking, bathing, sanitation, and cooking elsewhere. Other water sources, like bottled water, can also have considerable economic and environmental impacts [618].

Drought also indirectly impacts health by increasing vulnerability [634–636]. For example, drought can accelerate the spread of foodborne, vector-borne, airborne, dust-related, and fungal diseases [631,635]. Additionally, drought-driven food insecurity can increase the risks of undernutrition and micronutrient deficiencies [635], and of mental health impacts [637,638]. While the health impacts of drought vary depending on its severity and duration, populations that rely on land- or water-based industries for their livelihoods (such as farming, forestry, or fishing), hold local water sources in cultural significance, and/or lack the capacity to address water scarcity are at greater risk of direct impacts [625].

53 Turbidity refers to the amount of substance concentration (i.e., silt, clay, fine particles of organic and inorganic matter, soluble organic compounds, plankton, and other microbial pathogens) that impacts water clarity [626].

54 Total coliforms are bacteria commonly found in soil, surface water, and the intestinal tracts of animals [627]. The presence of total coliforms, including E. Coli and fecal coliforms, in drinking water may indicate bacterial contamination of regrowth in water-distribution systems that can have potential health risks to humans [626,627]. Viruses, bacteria, and parasites can attach to suspended particles in turbid water, and particles can interfere with the disinfection process, limiting chlorine's ability to remove or inactivate the contaminants and reducing water quality [628].

7.2.1 Drought impacts on B.C. population and public health

The physical health impacts of drought on B.C.'s population health have not been widely investigated. There is some evidence of an association between drought and cases of gastrointestinal illness in B.C., with Metro Vancouver experiencing a significant rise in *Cryptosporidium* and *Giardia* cases up to six weeks after heavy rainfall that followed severe drought [480]. Mental health impacts have been described in B.C., with people reporting feeling concern during periods of high drought levels and intensified climate anxiety due to worry about the longer-term impacts of drought [639,640]. Many of the reported health impacts of drought on B.C. populations are related to impacts on the security of drinking water and food [641,642].

Water restrictions have been implemented in response to drought conditions in some B.C. communities. While they are an important adaptation, water restrictions can impact both social and physical determinants of health in a community. For example, in Stage 4 watering restrictions, all outdoor water use is halted. In Sechelt on the Sunshine Coast, for example, operations for some businesses were impacted and the community delayed opening recreational facilities such as pools and its local ice rink, amid concerns about retaining sufficient water for homes, fire protection, and hospitals [643].

In addition to water restrictions, concerns about drought and high temperatures increasing wildfire risks in B.C. also impact communities. In the summer of 2023, the Interior municipality of Kamloops took the unprecedented step of closing all nature parks in and around the community because of the heat and drought, and put strict watering restrictions in place. These steps were taken to ensure that, in the event of a fire, firefighters would have enough water pressure and be able to access trails [644].

7.2.2 Disproportionate impacts of drought on populations in B.C.

Drought has also had disproportionate health impacts on B.C.'s Indigenous, rural, and remote communities; farmers and ranchers; and those who rely on forestry and fishing for their livelihoods. The greater the severity and length of the drought, the greater the likelihood that it will increase the vulnerability of communities and populations to future extreme weather events—particularly a future drought or flood—if there is not adequate time for community recovery due to water insecurity, mental health issues, and/or displacement [635].

Impacts of drought on Indigenous communities

Drought was named as one of the top three climate concerns in the 2019 BC First Nations Leadership Council Climate Leadership Survey [61], which included a sample of respondents from 139 First Nations and Tribal Councils across B.C. Drought is having significant impacts on Indigenous communities:

- Drought is impacting traditional food sources for Indigenous Peoples in B.C., including through loss of salmon and other fish species. Higher water temperatures during summer months often coincide with drought conditions in B.C. Salmon have a low thermal tolerance threshold and warmer water temperatures can cause en-route mortalities for adult salmon returning to their freshwater spawning grounds. Warmer temperatures associated with droughts can also accelerate snowmelt, increase freshet river discharges, and create "hydraulic barriers" for upstream fish migration, increasing fish mortality rates. Drought conditions can also impact salmon survival by reducing both the quantity and quality of water [645]. For example, in Bella Bella on B.C.'s Central Coast, over 65,000 dead salmon were found washed up on the shore in October 2022, an event attributed to the severe drought conditions. One researcher estimated that hundreds of thousands of fish could have died along rivers and streams in Heiltsuk territory in 2022 due to the warm temperatures and low water levels, with the full impacts to be realized over four to five years [646]. Similar extreme drought conditions on Vancouver Island have also created dire conditions for salmon habitats [647].
- Drought-induced water scarcity is creating concerns about a lack of safe drinking water or adequate water stores for fire suppression in many B.C. First Nations communities [648]. As reported in 2023, some water wells have nearly run dry in the Penticton Indian Band due to record low water quantities. In response to low water levels, tiger dams (large water-filled tubes typically used to offset flood impacts) are being used to store water for fire protection for Kitasoo/Xaixais First Nation [648].
- Many B.C. First Nations rely on local water sources for cultural practices, customs, and traditions [649]. With water quality impacting fish abundance, associated indirect risks on fishing can create cascading impacts on cultural determinants of health that impact mental health and well-being.

Indigenous communities in B.C. are demonstrating leadership to address the cultural, ecological, and health impacts of drought by taking a collaborative watershed-based approach to ecosystem management (see the example of the Cowichan Watershed Board's Collaborative Governance model).

Rural and remote communities

As droughts become more frequent in B.C., rural and remote communities may struggle with water security. These communities have less capacity to effectively monitor and regulate their water resources, which can create barriers to drought adaptation [650]. Rural communities are typically less economically diversified than urban regions, with a heavy reliance on key industries that require a sustainable and reliable water supply, such as agriculture or natural resource extraction. Impacts on small, rural, and remote areas are compounded by existing challenges, such as limited financial, administrative, and management capacity of their water supply and related system infrastructure [651].

Rural B.C. residents protect water in the face of drought

The East Vancouver Island water basin (including Quadra Island and the Gulf Islands) has experienced Level 5 droughts three summers in a row (2021–2023) [41]. Most of Quadra Island's 2,700 residents depend on groundwater from shallow or deep drilled wells to meet their water needs [652]. As B.C.'s summers become hotter and drier, the vulnerability of the island's deeper water wells and groundwater resources are a growing concern. As with many rural communities in B.C., more research and monitoring are needed to understand the impact of drought on Quadra's groundwater resources and the community's water security. Quadra Island's Climate Action Network (I-CAN) water security team has launched an ambitious project to gather data on the health of the island's aquifers, collecting information on how much water is being extracted and if they are recovering or not. The ultimate aim is to determine sustainable water-use thresholds, boost the community's climate resilience, and avoid a water crisis [652].

Farmers and ranchers

Drought has economic impacts for farmers and ranchers who depend on water and rainfall for their livelihoods. Recent droughts in B.C. resulted in failure of hay crops and subsequent rising hay prices, which led to inadequate access to feed for livestock [653]. Some B.C. farmers are having to truck in water to feed livestock [654], while others have been forced into early selling and culling of cattle to deal with feed shortages [655]. In 2023, some farmers abandoned crops due to water shortages [656]. The impacts of climate change, including drought-related impacts have been associated with mental health impacts among farmers and ranchers, such as increased depression, anxiety, and suicide [657]. See Chapter 9: Mental Health for more discussion of mental health impacts on farmers and ranchers, as well as on workers in other sectors, who may be unable to access water or their worksites during drought conditions.

7.2.3 Drought impacts on the B.C. health system

Drought impacts on health facilities and infrastructure

> *"Soon we will have more drought problems, more wildfire, and more and more water restrictions, and that will lead to the prioritization of water projects."*
>
> —Lower Mainland Facilities Energy and Environmental Sustainability team member [658]

Sechelt District Hospital (photo: Vancouver Coastal Health)

Impact of drought on Sechelt District Hospital and Sunshine Coast communities

Limited water supply during droughts has wide-ranging implications for hospital operations, such as sanitation, sterilization of medical equipment, and patient care.

In 2022, amidst severe drought conditions and Stage 4 water restrictions, numerous initiatives were implemented across the Sunshine Coast Regional District (SCRD) to keep water flowing to communities between West Howe Sound and Secret Cove. These efforts were the focal point of an Emergency Operations Centre implemented by the SCRD on September 27, 2022, and water supply was prioritized for essential services, including the Sechelt Hospital and fire suppression [615].

Many community members and institutions helped conserve water; the Sechelt Hospital sent their laundry off-coast, and the regional district prepared to truck in water to fill critical system reservoirs, including the one supplying the hospital [659].

Currently, the community of Sechelt is exploring several adaptation options to protect water supply during drought conditions. These include modifying siphoning systems, installing additional pumps, and tapping new sources of water. BC Emergency Health Services is also looking to install a water storage tank at the community ambulance station, to supplement the water supply during periods of drought [660].

Lions Gate Hospital emergency care in North Vancouver

Droughts are slow-onset phenomena, which generally develop over an extended period of time and lack highly visible and structural impact [661]. However, the increasing frequency and intensity of drought in B.C. are noted as concerns in health care facility risk assessments, and adaptation strategies are needed to ensure continuity of care during water shortages.

> *"There are multiple conversations going on now for how to plan, but it's not until something happens like [water loss or loss of pressure at a health care site] that those conversations really come to light."*
>
> —*Risk to Resilience Project* focus group participant

Health care facilities in B.C. are recognizing the risks associated with drought-related water shortages [662], citing impacts such as reduced availability of water to support processes, damage to landscaping, and increased irrigation needs [234]. In one Lower Mainland health authority, 26 percent of 630 staff survey respondents reported negative regional impacts as a result of drought and water shortages [663]. Other drought-related concerns raised in B.C. health facility climate risk assessments include:

- ***Design:*** The design of health care facilities may not account for water shortages during prolonged dry periods, putting the reliability of crucial water services for health care operations at risk [150].
- ***Landscaping:*** Landscaping around health care sites can be vulnerable to drought, necessitating adjustments to maintenance plans—such as reducing water usage by irrigation and using more drought-resistant plants (xeriscaping) [150].
- ***Operations:*** Water restrictions during droughts can limit the availability of essential sanitation and sterilization supplies for medical equipment, as well as for patient drinking, washing, and bathing. In addition, critical systems, such as cooling towers and boilers, may be affected by water shortages, leading to disruptions in essential health care services [150]. In some cases, water shortages may become severe enough to require water to be trucked in for essential health services [150].

> *"There are a number of procedures [in health care facilities] that need water, such as infection prevention and control, sanitation, food service, and laundry."*
>
> —*Risk to Resilience Project* focus group participant

- ***Energy supply:*** Droughts have the potential to impact energy supply, particularly in communities relying on hydropower. Reduced snowpack and receding glaciers, which feed storage reservoirs, can lead to decreased hydropower capacity. This can pose supply challenges, especially during climate-related events (e.g., extreme heat events, storms) when increased electrical loading may require backup energy [150].
- ***Compound risks:*** Drought and associated water shortages often occur during summer months, potentially coinciding with extreme heat events, when the availability of potable drinking water is vital, and wildfires, when the availability of water for fire protection is critical. Some regional health authorities have noted heightened risks from drought-induced water shortages, such as interrupted water supply for long-term care residents or reduced fire protection [150] during summer months. In recent years, communities such as the Sunshine Coast (2022) [664] and McBride (2023) [665] have declared states of emergency due to severe drought conditions. To ensure adequate water supply for drinking, fire protection, and sanitary services, residents were prohibited from washing vehicles or building exteriors, filling up swimming pools, or watering lawns and gardens.

Upstream impacts and adaptations to protect vital water supply systems

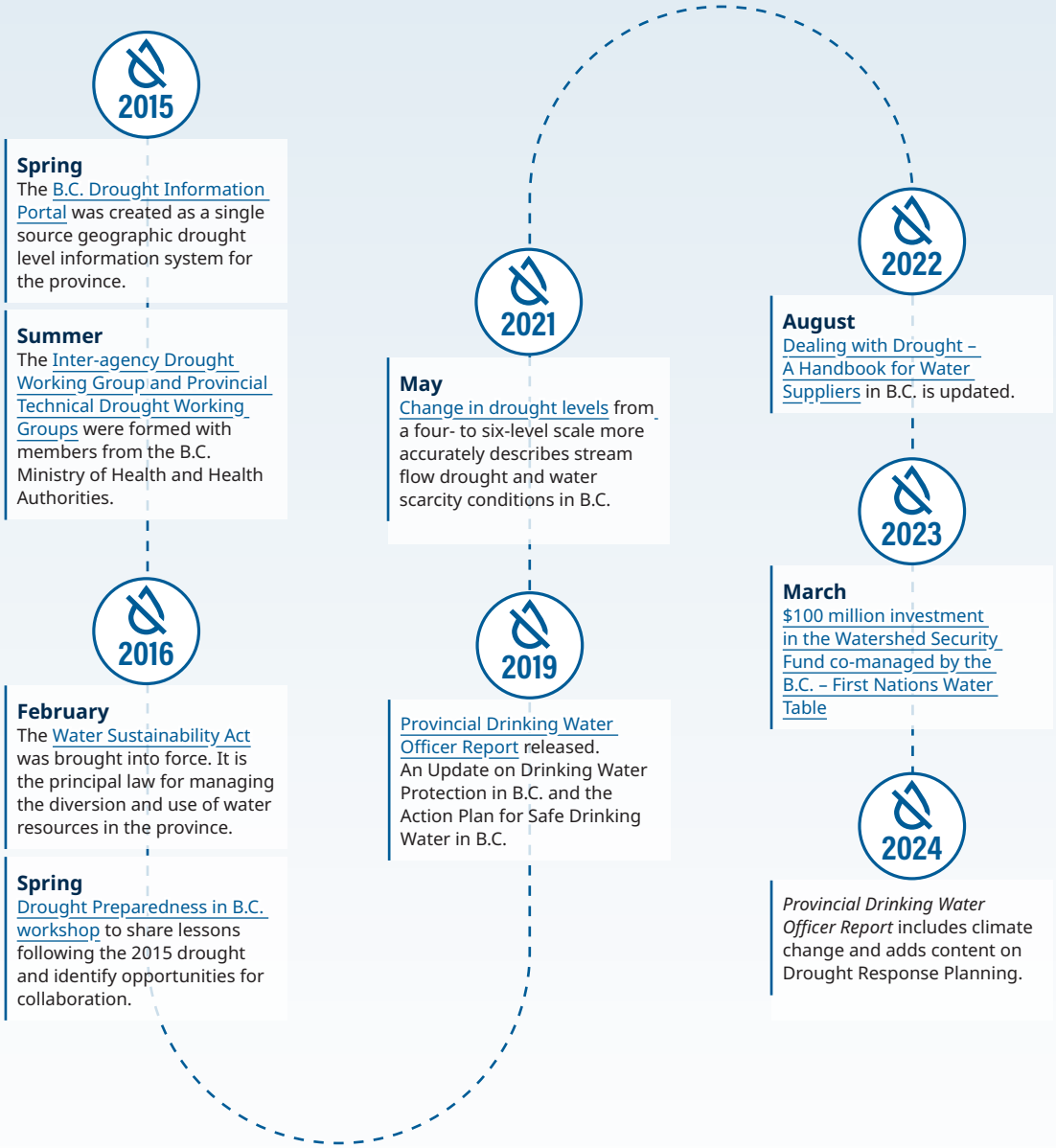
Drought's impacts on infrastructure begin at the source: the lakes, rivers, streams, creeks, and aquifers that supply our water systems with raw freshwater. There are more than 100,000 wells in B.C.; the majority are used domestically, followed by use by municipalities, agriculture and industry [666]. During periods of water scarcity, well pumps may be at risk of pumping dry (cavitation) and being damaged [667,668]. There are also over 32,000 kilometres of water pipes serving communities in B.C., much of which is aging [669]. Leaks in this infrastructure may contribute to water security problems.

Water supply systems across every sector (e.g., irrigation pipelines, municipal distribution systems, residences, and the health system) should undertake leak detection and repair programs, as outlined in the Handbook for Water Suppliers in B.C. [670]. Health facility building sites can enhance resilience to drought through on-site water storage and retention, guided by the B.C. Ministry of Health's Guidance for Treatment of Rainwater Harvested for Potable Use, released in 2020 [671].

Coquitlam Lake Reservoir

7.3 Health-related adaptations to drought in B.C.

A TIMELINE OF SELECT HEALTH-RELATED DROUGHT ADAPTATIONS IN B.C.



Leadership and collaboration across the system

In 2010, the B.C. Drought and Water Scarcity Response Plan was first published, establishing a governance structure that includes inter-agency working groups and committees. The B.C. Drought and Water Scarcity Response Plan is reviewed and updated annually to maintain accurate and current approaches to drought response. In 2015, drought committees were formed for response and planning. Regional drought teams were also created to coordinate regional responses. Health representatives sit on the inter-agency committee and in Regional Technical Drought Working Group meetings to address implications on human health and well-being, with a particular focus on drinking water.

- ***Inter-Agency Drought Working Group:*** Formed in 2015, this group has a broad membership from provincial and federal agencies, including the Ministry of Health. It reports to the Assistant Deputy Ministers' Committee on Disaster Risk and Emergency Management and focuses on strategic tasks such as legislation, risk assessment, economic impact evaluation, and communications. Projects include the maintenance of the B.C. Drought and Water Scarcity Response Plan, engaging with First Nations, improving drought management tools, and enhancing communications through social media bulletins and drought status reports.
- ***Provincial Technical Drought Working Group:*** Also formed in 2015, this group reports to the Inter-Agency Drought Working Group and is made up of staff from various agencies, including the Ministry of Health. Its responsibilities involve monitoring stream flows, aquatic ecosystems, community water supplies, and agriculture sectors, to ensure adequate water supply across the province. It plays a key role in setting provincial drought levels and sharing information. It also monitors precipitation and groundwater levels, and snowpack and seasonal volume forecasts (early-season indicators).

Multiple local, provincial, and federal agencies bear the responsibility for drought management and response. The composition of working groups and committees may vary over time. Figure 15 below illustrates regional and local collaborative efforts underway to respond to drought [618].

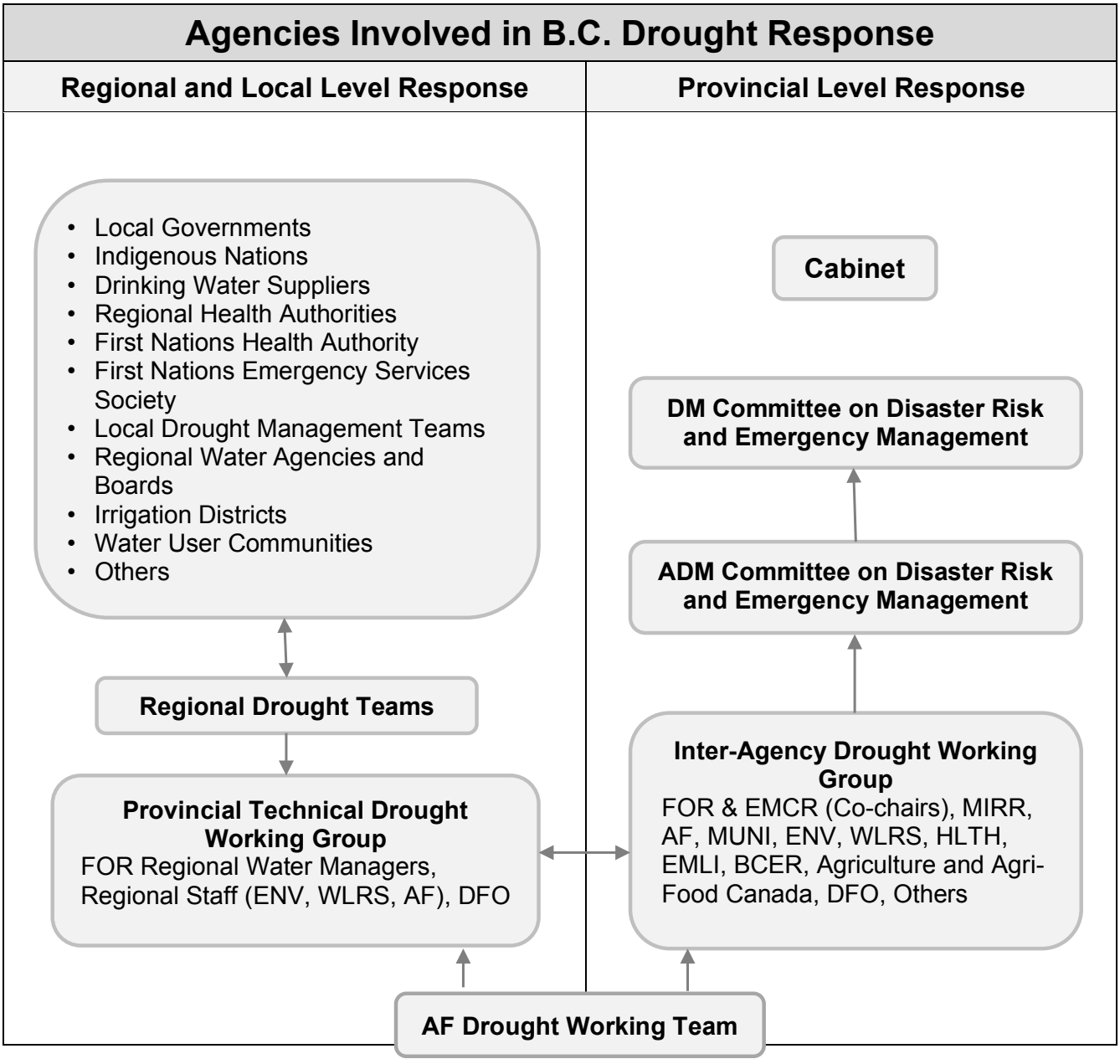


Figure 15. Key coordinating bodies and groups involved in B.C. drought response [618][55]

55 ADM=Assistant Deputy Minister, DM=Deputy Minister

The Cowichan Watershed Board: Indigenous collaborative governance


Lake Cowichan

Recent droughts, heat waves, and aging infrastructure challenges have underscored the vital need for collaborative governance within the Cowichan Watershed to address ecological and health risks. The Cowichan Watershed Board (CWB) is a collaborative co-governance structure focused on the Cowichan and Koksilah watersheds. The Board is co-chaired by the Chief of Cowichan Tribes First Nation, and the Chair of the Cowichan Valley Regional District, with 10 to 12 other members appointed jointly by those partners and nominees from the federal and provincial governments [672]. The CWB recognizes the profound connection between our health and the health of the watersheds. The well-being of the rivers, salmon, and water quality directly affects the community, people, well-being, and economic security of the Cowichan Valley and Estuary. The CWB members embrace this watershed-centered approach, prioritizing the needs of a healthy environment and engaging in decision-making that transcends boundaries, while sharing knowledge, stories and experiences [673]. Trust, collaboration, and meaningful partnerships have been vital to taking rapid action while embodying the core principle of Nutsamat kws syaay's tthu qa', meaning "coming together to work as a whole for the sake of our people and for the health of the watershed" [674].

Creating policy-enabling environments and role clarity

> *"Right now, our [focus] is to make sure that all of our drinking-water systems have robust emergency response plans that specifically address the loss of source due to drought."*
>
> —*Risk to Resilience Project* focus group participant

In the context of drought, B.C. follows an all-hazard approach, with responsibilities across multiple agencies and sectors. During periods of drought, the Ministry of Emergency Management and Climate Readiness (EMCR) supports provincial emergency response coordination under the *Emergency and Disaster Management Act* [618]. The Ministry of Water Land and Resource Stewardship plays a key role in the coordination of drought response and in developing policy to protect drinking water sources from risks including drought. WLRS is also responsible for maintaining the B.C. Drought and Water Scarcity Response Plan. The health sector acts as a key partner, offering guidance, enhancing preparedness, and mitigating risks during drought events. HEMBC works to reduce and respond to impacts on health care services, while the Provincial Health Officer, Medical Health Officers, Environmental Health Officers, and/or Drinking Water Officers provide oversight on drinking-water systems (under the *Drinking Water Protection Act*). Health Officers focus on addressing population-wide impacts, prioritizing at-risk facilities (e.g., schools, long-term care and childcare operations) and sub-groups [675].

As identified in the B.C. Drought and Water Scarcity Response Plan (2023), when there is a loss, near loss, or failure of a community's potable water or water supply for firefighting, the drought response turns to an emergency response to protect public health and safety. Water suppliers remain responsible for ensuring adequate water supplies to maintain public health and safety. See the story below on drinking-water system resiliency to drought that illustrates how Environmental Health Officers work with water system operators on emergency response and contingency planning.

Island Health—Drinking-water system resilience to drought

In 2015, the Island Health region experienced increasingly frequent localized droughts, which raised concerns about the capacity of drinking water supplies. While many local governments were actively engaged in provincial emergency preparedness activities, water-supply systems not operated by municipal or regional governments were excluded. Adequate water quantity falls outside the scope of the current *Drinking Water Protection Act*, but it remains crucial for public health, sanitation, fire suppression, and food security. The Island Health Environmental Public Health team responded by initiating a drought assessment survey for water-supply systems and encouraging conservation efforts.

In 2021, Vancouver Island experienced Level 4 or Level 5 drought for 72 consecutive days, from June 1 to October 1 [676]. Since then, drought on the island has been increasing in severity and duration—even pushing into the winter months [677]. In 2021 and 2022, Island Health re-launched the drought survey to evaluate the impact of drought on water systems and assess system capacity and mitigation plans. Of the water systems surveyed, some key survey findings were:

- 16 percent of water systems have experienced shortages in the past, and 53 percent of systems have included water loss as part of their Emergency Response and Contingency Plans (ERCP). Only 55 percent of water systems have their water usage measured.
- Of the water system operators surveyed, only a small majority (54 percent) have a Water Conservation Plan in place. About 75 percent of water systems rely on voluntary water-use reductions to curb overuse, and about 15 percent of operators rely on bylaws [678].

Island Health has now distributed the survey findings to over 1,000 water operators and emphasized the importance of having an ERCP to address drought risk. Constant monitoring, contingency planning, and proactive adaptation are highly recommended [678]. More specifically, Drinking Water Officers continue to provide guidance, review existing plans, and advise on water conservation to support the resiliency of drinking water systems [678].

In 2023, the emergency management landscape in B.C. was updated with specific reference to a changing climate through the updated *Emergency Management and Disaster Act*. In 2023, states of emergency were declared in response to the province-wide drought conditions and concurrent wildfires [679]; this exceptional situation "stress tested" emergency response [680] to a combined drought and extreme wildfire season.

Using bulk water haulers to maintain vital infrastructure during droughts

Known for its lush surroundings, the town of Tofino on the west coast of Vancouver Island found itself on the precipice of a water crisis in the summer of 2023. The community faced an unprecedented drought due to record-low precipitation that would require drastic measures to protect its local water supply. Measures discussed included declaring a local state of emergency, suspending some businesses, limiting tourism, and relying on tanker trucks to bring in water [681,682].

The availability of water haulers during droughts improves access to clean and safe drinking water for those needing to supplement their water supply. In some areas, bulk water shipments have become necessary to satisfy water demand [641]. In 2017, 190 bulk water haulers in B.C. were permitted to carry and deliver potable water to users, the vast majority (138) located in the Northern Health region [651]. During recent droughts, some communities experienced a shortage of haulers due to increased transportation costs.

Enhancing monitoring and growing awareness

Setting up clear leadership structures and policy-enabling environments has paved the way for improved access to technical information across provincial, regional, and local levels of government and the public. The following platforms support information dissemination and indicate areas where messaging and monitoring can be enhanced:

- **ClimateReadyBC** is an online portal and central repository of information to support communities in understanding both climate risk and the potential for adaptation. It provides climate and disaster-risk data, details on how B.C. is responding to drought, alongside information and resources to assist in identifying, understanding, and effectively managing drought-related risks. In 2023, it added a dedicated drought and water scarcity webpage.
- **EmergencyInfoBC** is a communications platform that provides crisis communications directly to the public during major emergencies and disasters, including drought.
- **B.C. Drought Information Portal** was created in 2015 as a single-source geographic drought-level information system for people in B.C. The portal consists of multiple maps embedded with information on provincial drought levels, historical drought time-lapse information, and other drought information. Drought levels are tracked from May to November and regularly updated on an approximately weekly basis [41].
- **Water Data & Tools**, a webpage of resources hosted by the Province, includes a number of detailed data sets, such as the location of groundwater wells and related water-use licenses, for example. Although administrative boundaries, like HSDAs, do not align well with watershed boundaries, there is powerful potential to better connect environmental data sets to inform health decision-making.
- **B.C. Ministry of Agriculture's Drought in Agriculture** webpage provides information on financial assistance, health and wellness supports, and drought management strategies for producers.

Reducing water usage in B.C. health care facilities

Health facilities teams have been actively working to identify ways to reduce water usage. Vancouver Coastal Health's Water Management Program, as one example, seeks to actively optimize the use and possible reuse of water resources by Lower Mainland health care sites [662]. Focused largely on conservation, this program promotes measures such as optimizing landscape irrigation, capturing/reusing rainwater, and managing sewage and wastewater [662]. In 2021, researchers at the University of British Columbia, in collaboration with Provincial Health Services Authority, completed a research project [683] that explored water-saving opportunities applicable to health care settings.

Improving communications on built environment and nature-based solutions

While health agencies have not historically developed guidance on built environment and nature-based solutions specifically for drought, drought messaging and interventions are increasingly being recommended to the public, communities, and facilities. For instance:

- **The First Nations Health Authority** has developed fact sheets on Drought Planning and Response Guide for Communities and Severe Drought and How to Cope with a Hot and Dry Summer.
- **Island Health** has posted on social media, published articles, and created a video to support water conservation efforts.
- **Interior Health** has created the Drinking Water for Everyone website. While not specific to drought, it offers an awareness-raising platform to enhance public knowledge on where their drinking water comes from.

The messages in these resources are clear and consistent, emphasizing the importance of environmental sustainability through water conservation. They advise installing water meters in communities to efficiently detect leaks and identify high water consumers.

7.4 Opportunities for action

Addressing the population health and health system impacts of drought in B.C. requires a comprehensive and collaborative approach. Some key opportunities for action include:

Collaboration and communications

- Clarify roles, responsibilities, and mandates of health agencies relative to those of other sectors and ministries to develop and share public messaging about the health risks associated with drought, and to promote preventive measures.
- Collaborate with local governments, First Nations, Métis, and communities to prepare for drought by providing information, resources, and support for sustainable water-use practices.

Surveillance and research

- Explore the cross-cutting impacts of drought alongside other hazards (heat, wildfires).
- Seek out co-benefits for drought adaptations, and be aware of maladaptation where actions to respond to one hazard create vulnerabilities for another (e.g., implications of using water for misting tents or water wagons during simultaneous heat and drought events; planning for water needed for fire suppression in wildfire/drought events).

- Support the continuation and expansion of water monitoring to include:
  - Saltwater intrusion testing for water systems on the coast;
  - Enhanced watershed monitoring; and
  - Enhanced drought-related water testing for groundwater and provincially monitored wells.
- Research the long-term health impacts of drought on different population groups (e.g., farmers and ranchers).
- Research the mental health impacts of prolonged drought, including stress, anxiety, and depression.

Proactive planning

- Ensure drought is included in health sector risk assessments and plans, including assessing implications on critical infrastructure and health facility operations.
- Develop drought management plans for health facilities that include demand-side management for water use.
- Collaborate with water system operators to ensure they have robust emergency response plans, and to support the implementation of water sustainability plans that address the loss of source water due to drought.
- Encourage and support communities to form partnerships with bulk water haulers to keep up with water demand, especially for rural and remote communities.
- Develop strategies to safeguard food security during drought periods (e.g., providing information to food premises during times of water scarcity).

Capacity building

- Training and information resources for health care professionals to recognize and manage drought-related health conditions.

Health facility preparedness

- Implement water conservation measures within health care facilities, including the use of water-efficient technologies, recycling, and reuse systems, as permitted by legislation.

Royal Jubilee Hospital — Vernon, B.C.

Chapter 8: Cross-Cutting Impacts and Adaptations

KEY FINDINGS

- Extreme weather events in B.C., such as the 2021 heat dome, wildfires, and 2021 atmospheric river (AR) flood events, as well as COVID-19, resulted in **cascading impacts on the health workforce, supply chains and facilities/infrastructure**.
- Cascading impacts of climate-related events on the **health workforce** include mental health impacts from increased workloads, evacuations of staff leading to prolonged periods away from home, and the need to balance personal needs with the needs of patients during an emergency event.
- **Capacity-building efforts** across the health system include awareness-raising, learning and skills-building opportunities, emergency-simulation exercises, and research partnerships. **Cultural safety training programs** for the health workforce are a priority, to build awareness and understanding of the health impacts of climate change on Indigenous populations and how Indigenous knowledge systems are critical to climate resilience.
- B.C. climate-related events have **damaged transportation infrastructure,** disrupting the flow of essential medical supplies (including COVID-19 vaccines), equipment, medications, food, and supplies for maintaining safe water supply.
- System-wide initiatives have been developed to improve emergency preparedness and **resilience of the supply chain in B.C**., such as critical supply carts, deployable alternate care sites, and coordinating ordering, distribution and re-direction of medical supplies, equipment, and medicines during emergency events.
- Opportunities to enhance the **resilience of B.C.'s supply chains** during climate-related emergencies include stockpiling medications and essential supplies; exploring alternate supply-chain routes; emergency communication protocols with vendors; and collaborating with community partners and other sectors, such as pharmacies, non-profits, and carrier companies, to ensure a coordinated response during extreme weather events.
- Climate change hazards impact **health facilities**, for example, through damage to buildings, equipment and "off-site" interdependent infrastructure that provides critical services (e.g., roads, sewer water, communications). Older buildings are particularly at risk as they are often unable to withstand current climate exposures.
- Efforts are underway across the health system to ensure that the design, construction, and operation of health care facilities are **reducing climate risks and GHG emissions in tandem**, including anticipating exposure and reducing the risk of impacts of climate hazards on facilities; maintaining critical operations and essential services in the event of a climate shock or stress; and minimizing cascading impacts among systems and scales (e.g., building, site, and off-site).

8.1 Compound climate hazards

As climate-related events become more frequent and intense, they are occurring at the same time and place, with rippling effects leading to more pronounced and/or longer-term physical and mental health impacts [684]. Extreme heat events, wildfires, floods, and droughts, for example, often result from a combination of factors across multiple spatial and temporal scales. In isolation, one event may not be considered extreme, but when they coincide , they result in significant impacts in communities [685]. Initial extreme weather events can trigger cascading impacts on key determinants of health, such as poverty, water and food safety, food security, and livelihoods, to name a few [684,686]. B.C.'s 2023 water shortage [48] and wildfires [687] serve as a warning that the province is particularly vulnerable to compound events, especially given the projected increase in the severity and frequency of hotter, drier summers; warmer, wetter winters; and rising sea levels [23] (see Figure 16).

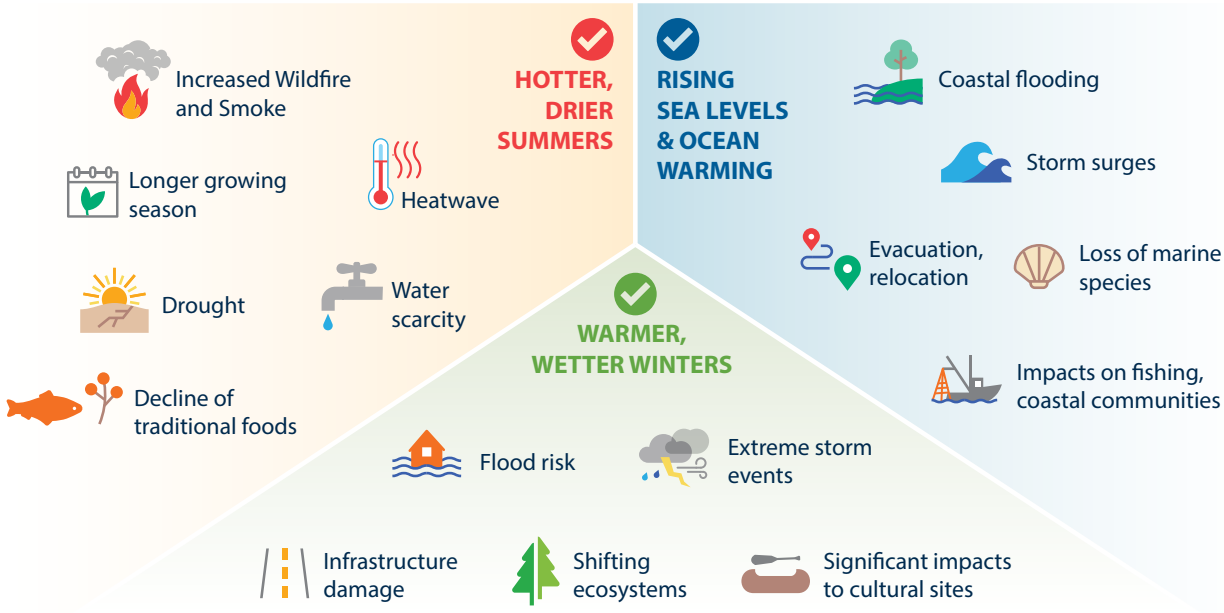


Figure 16. B.C. climate change impacts on our communities, economy, and health and well-being [23]

In 2021, B.C. experienced compound climate hazards and cascading impacts in real-time. The rapid succession of extreme events caused dramatic disruptions in B.C. communities and in the health system. Wildfires can increase the risk and severity of flooding, whereby burned slopes no longer effectively absorb rainfall and snowmelt; flooding and landslides are often part of the "cascading effects" of wildfires. These cascading impacts can further lead to infrastructure and supply chain issues [294]. In addition, each of the 2021 emergencies (2021 heat dome, wildfires, drought, and 2021 AR-flood events) was compounded by the COVID-19 pandemic and the toxic drug crisis, resulting in additional strain on the health system and added barriers for the public to adaptions (e.g., accessing public cooling centres or safe supply of opioid treatments for evacuees).

The year 2021 underscores the enormous challenges of collectively responding to compound and cascading emergencies, and the need for an all-hazard approach to identify interdependencies that can inform integrated planning [50]. Aligning with the United Nations (2015–2030) [24], a holistic resilience lens can create coherence across policies, plans, and goals, linking adaptation and disaster risk reduction across coinciding and cascading events. It also supports a proactive multi-hazard approach that can address broader impacts on social and ecological health in communities [50].

Kanaka Bar—leadership for resilience to compound climate-related events [370]

The Fraser Canyon region is located in the territory of the Nlaka'pamux, and the town of Lytton is at the geographical centre of the Nation. In 2021, a spring and early summer drought was a precursor to the 2021 heat dome which resulted in a recorded high of 49.6° C in Lytton on June 29. The next day, Lytton was devastated by fire [688]. Five months later, a regional atmospheric river wiped out all but one access road and, in December 2021, an extreme cold and deep snow paralyzed the region.

Recognizing that the Fraser Canyon region will continue to face more intense and frequent compound climate-events in the future, the community of Kanaka Bar saw this as an opportunity to "build back better," placing resilience, and a renewed focus on clean air, water, food, and shelter, at the centre of recovery efforts. Much can be learned from Kanaka Bar Indian Band (T'eqt''aqtn'mux), one of the 15 communities that make up the Nlaka'pamux Nation, located 18 kilometres south of Lytton. Kanaka Bar has a long history of being a leader in climate action in B.C. Years before the 2021 wildfires, they completed a Community Watershed Land Use Plan (2015), Community Food Assessment Plan (2016), a Climate Change Assessment and Transition Plan (2018) and a Community Resilience Plan (2021) [689] that addresses seven core planning themes, including health, culture, land, education and resources. Together, all of these plans prepare the community to be resilient to the weather of today and tomorrow. Prior to 2021, Kanaka Bar also invested in three weather stations, seven water gauging stations, and an air quality monitor. These tools generate daily site-specific community data for air quality, wind speed and direction, temperature, precipitation, and water quantity, complementing Indigenous knowledge systems and assisting with community forecasting, early warning systems, emergency preparedness, and response planning.

Since the 2021 wildfires, Kanaka Bar has demonstrated courage and leadership in recovery. In 2022, they partnered with researchers at Calgary's Southern Alberta Institute of Technology to build homes that can withstand fire, floods, and extreme heat and cold events. The research project will involve building four to eight homes that will be closely monitored to assess their resilience to future climate-related events [690].

Having experienced multiple extreme weather events in a very short time frame, the Kanaka Bar community is demonstrating a path to resilience guided by Indigenous knowledge and leadership.

This chapter addresses the cross-cutting impacts of compound climate-related events and cascading impacts in B.C. communities and in the health system. Specific themes discussed include impacts on the health workforce, in supply chains (for communities and the health system), and on health infrastructure and facilities. Each section includes a discussion of adaptations and opportunities for action.

Further cross-cutting impacts and adaptations are discussed in Chapter 9: Mental Health and Chapter 10: Health Emergency Management, Evacuations, and Health Service Delivery.

8.2 Health Workforce

8.2.1 Impacts on the B.C. health workforce

> *"It's really difficult to respond to a climate [related] event when you're continually functioning at 110-percent capacity... We don't have a lot of resilience built within the system, because we're so overstretched, and our staff are already exhausted from the entire pandemic. And then we have this series of event upon event upon event, and it's just really, really difficult."*
>
> —*Risk to Resilience Project* focus group participant

The combined effects of COVID-19, the toxic drug crisis, and year after year of climate-related emergencies such as wildfires, floods, and heat waves have taken a considerable toll on the mental well-being of the health care workforce in B.C. Workers have reported feeling the need for more staffing to prepare for and respond to the increasing frequency and intensity of climate emergencies in B.C., as they are stretched to capacity. They describe feeling overburdened, "jumping from emergency to emergency," without the dedicated space or time to work on climate resilience (e.g., doing this work "off the side of our desks") [56]. Many First Nations and local government staff and officials also find themselves in a similar position, responding to multiple compound events while also dealing with competing priorities and local government business.

Factors influencing the compounding impacts of climate change on the health workforce include:

- Increased workloads and longer hours to respond to multiple emergencies;
- During evacuations, staff often spend prolonged periods away from home and also experience uncertainty around knowing when or where they will be deployed to offer emergency support;
- Staff also play an enhanced role during evacuations, often going above and beyond to accompany patients/residents during evacuations; and
- Staff are also personally impacted by these disaster events, and are often balancing the needs of their own families and friends with the needs of their patients and clients during a crisis.

While dealing with the multiple challenges and impacts of wildfire events, B.C.'s health care workers have drawn strength and support from one another. As recounted in numerous stories and reports, colleagues have stepped in to help one another, ensuring the continuation of programs and services—even volunteering to help when they see a need. [349–352,366,367]

> *"The Williams Lake dialysis unit shut down [due to wildfires]…They had to bring all the patients up to Prince George and support them while they were there. And the [health care] teams also went with them to follow and care for the patients. It's really great to see how, as health care professionals, when there's a need, we will jump in and we will respond…and how well we can work together when there is a need like that."*
>
> —*Risk to Resilience Project* focus group participant

When evacuated to another health authority, health workers have been welcomed and supported by colleagues in the receiving health authority, and felt integrated into their teams [350,354].

All Hands on deck: Health care workers in wildfire zones spend summers on high alert

Health care workers in B.C. have been on the frontlines of caring for patients and residents during wildfire evacuations, and time and again have demonstrated their dedication to providing quality care and support to at-risk populations—even as they dealt with their own personal stresses and trauma.

Michelle, a care aide from Ashcroft, accompanied residents during evacuation alerts and orders in 2017 and again in 2021, when she was deployed to Kamloops for more than three weeks. Packing people up to get on the road was itself a massive task, she recalled, but there was an emotional component as well. "For our patients who were more cognitively there, it was just reassuring them that I was going with them, we weren't going to abandon them," she shared.

Angie, a care aid in Prince George, shared how, in 2017, she and her colleagues welcomed more than 100 residents who had been evacuated from care homes in Williams Lake. She described how everyone pulled together over a two-day period, preparing for the influx of evacuated residents.

"It was truly remarkable… It was all hands on deck," she said. For health care workers, it also meant working "exceptional" overtime, including 20-hour shifts, preparing for an unknown number of evacuees. "We simply rolled up our sleeves and we got it done," said Angie, adding how impressed she was by the clerks doing the administrative work.

Source: Hospital Employees' Union 2022 [349]

While the continued dedication and tenacity of health system staff has been vital during recent emergencies, it also is not sustainable for staff to work longer hours and "go above and beyond" in response to increasingly frequent climate-related events.

It is critical that all levels of government take proactive actions to address the intersecting health and environmental crises and consider the implications of developing a prepared and response-ready workforce. Health system staff have stressed the need for reliable support during emergencies, including mental/physical health support, logistical or human resources support, and capacity building, in order to successfully do their jobs in a changing climate. As stated by the president of the Paramedic Association of Canada, *"Extreme weather events, like last summer's [2021] deadly heat wave in B.C., have highlighted the need for more staff and better mental health supports for first responders."* [27]

Health system staff must be able to care for their own mental health in order to care for others. Enhancing mental and occupational health supports for the health workforce impacted by and responding to climate hazards and other stressors is a priority. Programs such as Care for Caregivers' Care to Speak, established in response to the COVID-19 pandemic to provide mental health support to the health workforce, may offer a model to support staff and frontline responders impacted by climate-related events.

8.2.2 Adaptations for the B.C. health workforce

A strong theme emerging from after-action reviews following emergencies and crises in B.C. has been the continuous dedication, teamwork, and flexibility of health system staff—across multiple significant climate-related events, as well as the COVID-19 pandemic and toxic drug crisis. These strengths offer a foundation upon which to build specific responses and adaptations.

Workforce Redeployment

During emergency events such as wildfires, floods, and extreme heat events, frontline health system staff and leaders in B.C. have worked tirelessly to protect the health and well-being of the communities and people they serve, at times redeploying to offer support in other workplaces and communities when needed [448].

Currently, active practicing and retired/former health sector workers (including point-of-care staff, administrators, and support staff) can register through the online Emergency Health Provider Registry (EHPR) to support proactive and voluntary deployment to communities across B.C. during emergency events, including wildfires, floods, and pandemics [691]. The EHPR was first developed to support B.C.'s response to the 2017 wildfire season and was updated again in 2020 during the COVID-19 pandemic.

The EHPR continues to evolve and improve, and it is critical that additional strategies and contingencies for staffing shortages and deployments be developed and tested. This will be essential to reducing future strain on the workforce, given the compounding impacts of multiple emergencies and more frequent climate-related emergencies.

Health workforce training, learning, and capacity building

> *"What I'm spending a lot of time doing is actually trying to raise the awareness of nurses that this is a really big, important facet of what we're going to face in nursing practice, and that we need to be prepared. And I'm talking about all climate change-related things: the increase in vector-borne diseases, extreme weather events, etc., and that we will have more fatalities, more injuries, more of these kinds of events."*
>
> —*Risk to Resilience Project* focus group participant

Emergency management staff, B.C.

In a changing climate, a well-trained and prepared workforce that can undertake effective planning, prevention, and management of climate and health-related risks is critical to ensuring health-service continuity and resilience. To support a climate-resilient health system, B.C.'s health workforce will require ongoing training, experience, and opportunities to practice skills by "learning through action." [692]

The provincial government and regional health authorities are already taking steps to assess and enhance the expertise and capacity of the health workforce in addressing climate-related issues. These include specific training initiatives, capacity-building interventions, and collaborative learning platforms tailored to address identified knowledge gaps and needs.

Capacity-building efforts across the health system include:

- Staff are participating in webinars, learning exchanges, and communities of practice led by the Ministry of Health, BC Centre for Disease Control (BCCDC), health authorities, universities, and other organizations (e.g., CASCADES or the Canadian Association of Physicians for the Environment) [693,694] about climate change and health [56].
- Emergency simulation exercises (e.g., tabletop exercises) are preparing staff for climate-related emergency events.
- Through the Ministry of Health's Research and Knowledge Management Strategy, collaborations with post-secondary institutions and other research organizations are enabling climate health research through seed grants, practicums, and knowledge exchange events [695].
- Organizations such as Doctors of BC are raising physician awareness of training and leadership opportunities in health emergency management, including those provided by Health Emergency Management BC (HEMBC) [368].
- Frontline care providers are raising awareness with their colleagues about the health impacts of climate change, and how their professional practice must adapt to be more prepared.

Capacity Building: B.C. Mobile Medical Unit

Nanaimo Regional General Hospital used the B.C. Mobile Medical Unit (MMU) to conduct an applied disaster medicine course. For two days in June 2018, the MMU was set up outside the hospital to provide training to physicians, nurses, unit clerks, and social workers, without disrupting the emergency department or hospital operations. Clinicians received customized education and simulation disaster exercises to be applied to climate-related events such as wildfires or floods [368].

Capacity Building: BC Public Health Climate Preparedness and Adaptation Program Community of Practice

The BC Public Health Climate Preparedness and Adaptation Program Community of Practice is led by the BCCDC. It promotes public health sector collaboration on innovative solutions to build staff/workforce capacity and knowledge related to preparing for and adapting to the health impacts of climate change in B.C. It serves as a hub for collaboration across the health system, information sharing, and hosting practical workshops and webinars to build skills, awareness, and knowledge on climate-health adaptation.

There are signs that awareness and knowledge about climate change are growing within the health workforce. For example, a 2021 survey of B.C. health system staff found that, compared to a 2013 survey of B.C. regional health authorities, self-reported knowledge about climate change and health impacts has increased among B.C. health authority staff (94 percent agreed or strongly agreed that they are knowledgeable about potential health impacts of climate change in the 2021 survey, compared to 66 percent in 2013) [194].

8.2.3 Opportunities for action

Opportunities to continue building on the work underway in B.C. include:

- Workforce training and guidance on adopting low-carbon, sustainable practices;
- Training and guidance on assessing and managing climate-related health risks, raising awareness, and sharing information;
- Training and skills-building through opportunities like professional development, communities of practice, conferences, and workshops;
- Promoting existing training modules and tools, such as health system training by CASCADES, CAPE's Climate Change Toolkit for Health Professionals [696], and Columbia University's Global Consortium on Climate Health Education Resource Bank;
- Simulation exercises to test emergency planning and response;
- Experiential learning for staff in various roles, including frontline health care providers [56,232,368,692]; and
- Annual training requirements in key areas (such as hospital and community evacuations and the Incident Command System), ideally scheduled for early spring, before the wildfire season begins [232].

Cultural Safety Training

Cultural safety for emergency management staff, first responders and volunteers in B.C. has been identified as a critical step for capacity-building efforts in B.C. since the 2017 wildfires [75]. The First Nations Health Authority and the B.C. Ministry of Emergency Management and Climate Readiness (EMCR) are collaborating to ensure cultural safety in emergency management services for First Nations people [697]. Health system staff in B.C. are able to take part in cultural safety training programs [e.g., the Provincial Health Services Authority (PHSA) San'yas Anti-Racism Indigenous Cultural Safety Program [698]], which continue to be updated, improved, and built upon. These programs should also prioritize building awareness and understanding about the health impacts of climate change on Indigenous populations, and how Indigenous knowledge systems are critical to climate resilience.

8.3 Health-related supply chains in B.C.

8.3.1 Impacts on health-related supply chains

Recent wildfires, floods, extreme heat and drought events in B.C. created acute and cascading impacts on health system supply chains, as damaged transportation infrastructure disrupted the flow of essential medical supplies, equipment, medications, and food. Some of the most significant impacts discussed in this report include:

Disruption of distribution of essential medicines, therapies, and medical equipment

The 2017, 2018, and 2021 wildfires, the 2021 AR-flood events, and the 2021 heat dome all created challenges to distributing medicine and supplies, such as ventilators, oxygen cylinders, chemotherapy, colostomy supplies, psychiatric medications, and transplant medications [56]. These impacts were felt most acutely by populations with existing critical health challenges (e.g., patients requiring radiation,

chemotherapy, or dialysis treatments) and by isolated rural and remote communities, who are most at-risk of supply-chain disruptions when transportation routes are limited.

In 2021, climate-related events also impacted the distribution of COVID-19 vaccines across the province. The 2021 heat dome posed challenges for vaccine cold storage, and the 2021 AR-flood events disrupted transportation routes for vaccine distribution chains. During wildfires and floods, significant issues were also reported in transporting Opioid Agonist Treatments (OAT) due to several factors, such as strictly enforced security measures and regulations around the shipment of classified drugs such as methadone or Suboxone, and the controlled temperatures required for some OAT medications [56]. For those with opioid use disorder, delays in accessing OAT medications can result in withdrawal symptoms and other complications. As a result of the 2021 AR-flood events, numerous requests for alternate therapies were submitted [233]. Both vaccine and OAT medication supply-chain disruptions point to cascading impacts from coinciding crises (e.g., climate emergency events, COVID-19 pandemic, and toxic drug crisis).

Faced with supply disruptions, health system staff responded by finding alternative transportation modes to deliver essential medicine and supplies to affected populations and communities, whether by helicopter, boat, drones, or even horseback [368]. *Risk to Resilience Project* focus group participants described finding creative solutions to ship essential supplies, sometimes pivoting to ship through Alberta or the U.S.

> *"We had to pivot those suppliers very quickly to get things rerouted through Alberta. It's quite a trek to come from Alberta all the way up to Rupert. So that was challenging, very challenging."*
>
> —*Risk to Resilience Project* focus group participant

Disruption to food supply

Wildfires, floods, extreme heat, and drought have acute and cascading impacts on the supply of food to communities across B.C. During climate-related events, food supply chains have been impacted "upstream" at the production stage, with damage to agricultural infrastructure, loss of livestock, and destruction of locally grown crops. As a result of the 2021 heat dome and 2021 AR-flood events, for example, there was significantly reduced production and quality of various products, including poultry, dairy, seafood, fruits, and vegetables.

Food safety cold chains were also compromised during the 2021 AR-flood events, due to power outages and heat gain during commercial transportation. As a result, there were severe delays in getting food to market and cascading disruptions to food supply chains. Public panic and hoarding of food and essential supplies led to limited supplies on grocery store shelves across the province [572,581,582].

During the 2021 wildfires and 2021 AR-flood events, non-profit organizations, emergency responders, and all levels of government collaborated to provide emergency food supplies to communities that were cut off—supplying thousands of meals to impacted communities, evacuees, and first responders during response and recovery efforts [371,699].

Collaboration across sectors for food supply during 2021 wildfires

To fill gaps in food availability for evacuees and first responders during the 2021 wildfires, programs delivered by non-profit organizations played a critical role, working together to distribute food to impacted communities. For example:

Salvation Army Emergency Disaster Services Team feeding firefighters in Kelowna, B.C. 2023 (photo: CBC)

- The Salvation Army's Emergency Disaster Services distributed 6,000 meals, 10,000 drinks, and 5,500 snacks across B.C. [699]. In partnership with Food Banks BC, they had an ongoing operation in the flood-impacted area, delivering food and supplies to more than 500 people in six Indigenous communities located around Lytton. In Kamloops, The Salvation Army provided weekly feeding relief to the Tk'emlúps te Secwépemc First Nation as they hosted wildfire evacuees and Indigenous firefighters [699].
- United Way B.C. provided food supplies for evacuees and first responders during the acute phase of the response, working through existing Food Hubs, new partners, and longer-term support [371].
- Truckers in Prince George filled a semi-trailer with supplies to send down to distribution centres, and the Sikh Society sent a shipping container with another 46,000 pounds of supplies [700].
- BC General Employees' Union staff coordinated and dropped off truckloads of donations, including food, water, and other essential supplies [700].

Disruption to other supplies and adaptation technology

Recent wildfires, floods, and extreme heat events have also had cascading impacts on the demand and supply of essential supplies and adaptation technologies. Air purifiers and air conditioners were in short supply during recent extreme heat and wildfire events, and retailers could not keep up with demand [242].

> *"Getting an ETA for when supplies would arrive was really challenging. We [health service providers] were sending management out to Costco and London Drugs and Canadian Tire and trying to get the last item on the shelf, the same as everybody else."*
>
> —*Risk to Resilience Project* focus group participant

Extreme weather events have also impacted access to essential supplies, such as fuel, causing prices to inflate. During the 2021 AR-flood events, a provincial state of emergency order prompted mandatory fuel rationing for the public across southwestern B.C. for close to one month, to ensure essential services had access to the fuel needed to perform their role [573].

Cascading supply-chain impacts from multiple emergencies

As a result of lessons learned during the COVID-19 pandemic and recent climate-related emergencies, the Province has been collaborating with health authorities to understand supply-chain vulnerabilities and develop system-wide adaptations to enhance resilience. *Risk to Resilience Project* focus group participants shared that emergencies have system-wide cascading impacts and implications for managing supply chains across the health system:

- **Contractor availability:** During large-scale emergencies, such as wildfires and floods, there is often a need to move patients between communities (and sometimes between health authorities). This, along with increased demand for certain medical supplies, requires more contractor availability to support inventory movement [556]. A *Risk to Resilience Project* focus group participant shared, "*You needed bonded carriers, and at that time, everybody was looking for a bonded carrier. So, I think, it was just a competition… for the bonded carriers.*"
- **Regional access points for supplies:** During emergencies, *Risk to Resilience Project* focus group participants emphasized the need for timely access to essential supplies at a regional and sub-regional scale, particularly for large regions with diverse geographical terrain most at-risk of experiencing disrupted transportation routes due to wildfires or floods. In addition, the pandemic and climate-related emergencies have demonstrated the need to increase the storage capacity of regional facilities to accommodate shipping disruptions to essential supplies [56].

> *"Aside from the floods and the wildfires, the pandemic itself identified how critical it is to have greater days [of supplies] on hand than maybe we've been comfortable with over the most of the last decade."*
>
> – *Risk to Resilience Project* focus group participant

> *"We have one regional warehouse for [our health authority]. And we saw that as being a significant challenge, especially during the [2021 AR] floods, when the transportation links were limited. We had discussed…early during the pandemic, so before the floods, about having a separate regional warehouse, in a different part of our region. Just try to consider the disparity [within our health authority]. We have a couple of mountain ranges, we have different waterways, we just have so many risks in [this region], let alone wildfires that shut off transportation links."*
>
> —*Risk to Resilience Project* focus group participant

- **Identifying and tracking supplies across health authorities**: Without a centralized provincial tracking system, it has historically been a challenge to monitor and manage the products and sourcing by health authorities' inventories. This was highlighted during the B.C. pandemic, when the decentralization of procurement and inventory management policies resulted in different levels of efficiency [701]. Experiences during the pandemic and multiple wildfire and flood events support a centralized procurement and supply-chain process.

Merritt, B.C. area after 2021 storm

8.3.2 Adaptations for health-related supply chains in B.C.

> *"[A strength was] the way we got to work directly with some of our First Nations partners and with the First Nations Health Authority in order to try and assist in moving vaccine, PPE, etc. to those areas and trying to create new links."*
>
> —*Risk to Resilience Project* focus group participant

Coinciding climate-related events and cascading impacts in B.C. underscore the importance of a resilient supply chain that can adapt to disruptions, ensure the availability of critical medicines and supplies, support emergency response efforts, and keep the health system functioning. In the face of increasingly frequent and severe climate-related events, access to food, water, and essential supplies—such as baby formula, air conditioners, generators, and fuel—are essential to ensuring the well-being and resilience of individuals and communities.

A number of health system-wide initiatives have been developed to improve the emergency preparedness and resilience of the supply chain in B.C., including:

- **Critical supply carts** have been assembled and strategically positioned throughout the province to support the potential needs of evacuation reception centres. These mobile units contain essential medical supplies, medications, and equipment that are readily accessible and used in health care settings, especially during emergencies.

- **Deployable Alternate Care Site (DACS)** are shipping containers equipped with beds and essential medical equipment strategically located across the province. They enable the expansion of in-patient capacity at acute sites and/or the establishment of temporary health care facilities in locations such as school gyms or community centres during crises.
- **Advanced planning with shipping agencies and vendors** has also been established to ensure the uninterrupted delivery of supplies to health facilities impacted during emergencies [702].
- Provincial Health Care Supply Chain works with health authorities and the Provincial Blood Coordination Office to **manage the ordering, re-distribution and re-direction** of medical supplies, equipment, and medicines during emergency events. They assist in coordinating between warehouse and health authority vendors to track and redirect shipments, and provide services including inventory management and transportation support [379].
- The Province and PHSA are collaborating with health authorities on **Provincial Supply Chain Modernization** (2022) aimed at promoting province-wide coordination in the modernization of the provincial supply chain. The project is considering how to incorporate the ability to track, monitor, and manage products and sourcing done by health authorities [233]. As one *Risk to Resilience Project* focus group participant shared, "Having *a more streamlined, centralized approach to the supply chain will result in significant cost savings, as well as a more efficient process or approach throughout… This more standardized approach will really help us… It's got a number of different significant benefits to it."*
- During COVID-19**,** relationships and networks were formed with First Nations, communities, and between health agencies to distribute personal protective equipment and vaccines throughout the province. Assets such as freezers were also set up for vaccine depots. During the wildfire and flood seasons of 2021, these **processes and relationships were mobilized** to distribute medicines and essential supplies, and the vaccine-storage assets helped support the resilience of the health system supply chain overall.

> *"During the beginning of the pandemic, we actually set up for vaccine depots… e.g., ultra-cold freezers… throughout the region. And now we are able to use those as our depots for more than just COVID vaccines. So that turned out to be a positive after-effect; now we actually have that capacity to hold stores of our vaccines in a more distributed model."*
>
> —*Risk to Resilience Project* focus group participant

HEMBC team member opening the Deployable Alternate Care Settings (DACS) containers that were designed and assembled for four different health authorities in a matter of months. (Photo: PHSA Corporate Communications)

How sea cans can help rural B.C. communities through the next big emergency [703]

As climate change continues to intensify extreme weather events, innovative and timely adaptation efforts in the health system are needed to ensure future emergencies do not cut off essential medicines and supplies from communities. Health Emergency Management BC has begun using shipping containers to store health care supplies and equipment for five rural regions in B.C. where supply chain disruptions are likely to occur. These regions include Bella Coola, Bella Bella, Sechelt, Powell River, and Fraser Canyon Hospital [704]. The 20-foot containers, otherwise known as Deployable Alternate Care Sites (DACS), each hold:

- 40 patient beds with hand-crank height adjustment and elevating back/footrests, IV poles, and attachable patient tables.
- medical equipment and supplies for up to 72 hours.
- standard and advanced resuscitation clinical equipment.
- patient supports and transfer.
- clinical supplies and PPE.
- facility equipment (i.e., generator, electrical distribution system, mobile internet, tools).

Safeguarding rural health care with the help of drones [705]

An innovative project is using drone technology to build health care systems that are more resilient, responsive, and adaptable in the context of a changing climate. The University of British Columbia (UBC) Faculty of Medicine's Remote Communities Drone Transport Initiative is helping deliver vital health care supplies to rural, remote, and Indigenous communities most at-risk to supply-chain disruptions from climate change, including Stellat'en First Nation and the Village of Fraser Lake, near Prince George. The project, one of the first of its kind, flies drone deliveries along a short, simple route to understand how the technology can be best used in challenging conditions.

"Residents of rural, remote and Indigenous communities face much greater health care disparities than other people in B.C.," says Dr. John Pawlovich, the Rural Doctors' UBC Chair of Rural Health and Drone Initiative lead. "When wildfires and pandemics happen, these communities are hardest hit and those disparities grow bigger." The initiative originated in Rwanda, where it has successfully delivered vaccines and essential medicines to remote and rural communities.

Members of the Chilliwack Fire Department load a vehicle with supply's flown in by air, the result of being cut off of land access due to flooding in the region on November 17, 2021

8.3.3 Opportunities for action

There are a number of opportunities to enhance the resilience of health system supply chains during climate-related events. The following are based on lessons learned from multiple emergencies, including innovations to alleviate supply-chain challenges during the COVID-19 pandemic:

- Continue working towards Provincial Supply Chain Modernization, including exploring a centralized procurement and supply-chain process to:
  i. pre-identify supplies needed to support large-scale patient movement during an emergency (including beds, medications and other essentials);
  ii. develop a centralized robust tracking system for larger, cross-health system emergency events; and
  iii. enhance awareness of provincial assets that are available to health authorities during emergencies, including information about how assets can best be used, deployment timelines, and the process for making requests [56].
- Develop comprehensive communication and educational materials to provide health authorities with detailed information about available deployable assets.
- Create a strategic plan for the pre-deployment of specific assets, with a primary focus on supporting patient and client evacuations, and addressing the needs of rural and remote areas.
- A large proportion of health care's GHG emissions also reside in the supply chain—in manufacturing, transportation, and in the use and disposal of products and materials [706]. There is an opportunity to build on work underway provincially and within health authorities to create low-carbon and resilient supply chains, especially in the purchasing of products and services, staff and business travel, and operations.

To mitigate the impacts of future extreme weather events on health system supply chains, health systems and emergency management agencies will need to have contingency plans in place. These plans may include strategies for stockpiling medications and essential supplies; alternate supply-chain routes; emergency communication protocols with vendors; and collaboration with community partners and other sectors, such as pharmacies, non-profits, and carrier companies, to ensure a coordinated response during extreme weather events.

8.4 Infrastructure and facilities

8.4.1 Impacts on health-related facilities and infrastructure in B.C.

Increased shocks and stressors such as extreme weather events, rising temperatures, shifting precipitation patterns, increased wildfires, and other climate hazards pose challenges to health facilities and services across B.C. Climate-related events are having compounding impacts on health facilities and infrastructure due to older facilities and infrastructure being unable to withstand current climate impacts, damage to facilities and equipment as a result of acute hazards and events, and damage to "off-site" interdependent infrastructure that provides critical services (e.g., roads, sewer water, communications). A survey of impacts of climate-related events on provincial and regional health authorities found that all had experienced negative impacts from climate-related events in 2022, including negative impacts to assets, services, and financial impacts, including increased utility costs and capital costs [234].

Many of B.C.'s health facilities were designed decades ago, when the climate looked much different than it does today. As major health infrastructure is expected to be operational for approximately 80 years [707], we are now experiencing the impacts of aging facilities and infrastructure that was not designed to withstand the current frequency and intensity of extreme weather events. In addition, as climate-related events intensify, more health care facilities are exposed to climate hazards such as heat, wildfires, flooding, and drought. A summary of impacts discussed in this report include:

- Extreme heat events result in strained cooling systems in hospitals and long-term care facilities, and impact the operation of medical equipment and technologies.
- Some older facilities have limited electrical capabilities, which inhibits the ability to install or upgrade HVAC or cooling systems.
- Smoke infiltration into B.C. health facilities during wildfire events can infiltrate through building envelopes, impacting the ability of HVAC systems to maintain adequate indoor environmental quality.
- Some health care facilities were built on floodplains, leading to increased exposure to flood-related impacts, such as water infiltration and mould.
- Strong winds, heavy rainfall, flooding, or wildfires can cause structural damage to health care facilities, leading to the closure of certain areas within facilities, compromising patient care, and requiring costs for repair work.
- Water restrictions during droughts can limit the availability of supplies essential for sanitation and sterilization of medical equipment.
- Climate-related events are impacting interdependent infrastructure that provides critical services to health facilities and services, and may transfer risk in the event of failure (e.g., roads, water, wastewater, power, telecommunications, sewer) [708]. For example, extreme weather events can disrupt electrical grids, leading to power outages. Hospitals rely heavily on electricity for critical equipment, lighting, climate control, and electronic medical records.
- Critical energy suppliers, such as BC Hydro, report all-time records for peak demand during winter extreme cold and summer extreme heat events [100].

"The actual age of some of our [health service] buildings—there needs to be a really big effort to retrofit them [to be] ready for these different climate-related events. And that's a multi-million-dollar asset across the province. That's really something we found...that our buildings just weren't equipped for this."

—*Risk to Resilience Project* focus group participant

2021, a record-breaking year for electricity demand [100]

From extreme heat and cold to unprecedented rainfall, B.C. experienced wild and devastating weather in 2021. BC Hydro's hydroelectric system is directly impacted by variations in weather, and in 2021 more electricity demand records were broken than in any other year prior, largely because of the back-to-back extreme temperatures lasting for days and weeks on end.

- In 2021, BC Hydro experienced more record system-peak loads—the hour in a day that customers use the most electricity—than ever before, including breaking its all-time summer peak hourly demand record.
- The 2021 holiday season saw extremely cold temperatures and heavy snow throughout B.C. that resulted in the highest and longest sustained load levels ever experienced on the BC Hydro system.

To meet increased demand, including from electrification, BC Hydro is preparing its system for increasingly challenging and unpredictable weather brought on by climate change.

In addition, health authority facilities staff emphasize how climate-related hazards exacerbate the existing challenges of aging facilities and infrastructure by putting additional strain on already limited resources and magnifying existing building deficiencies [56,234]. There are significant costs to repair infrastructure damaged during climate-related events, and to adapt facilities in both the short and long term. For example, additional operational costs are required to run backup generators during power outages, to stock and use filters to reduce wildfire smoke, and to repair landscape and building facades due to extreme weather events. And, as our climate risk increases, there are increased insurance premiums for health care facilities. Overall, the need for facility repairs due to climate-related events not only diverts attention but also redirects resources away from proactive upgrades that are essential for long-term sustainability. The financial burden of preparing health facilities for long-term climate change, while addressing near-term extreme weather events, cannot be overlooked [234].

St Paul's Hospital, Vancouver, B.C.

Performance assessment of acute care facilities during extreme weather events—Fraser Health's Asset Risk and Quality: Technical Services [709]

After experiencing the extreme weather events of 2021, Fraser Health's Asset Risk and Quality: Technical Services (ARQTS) and health authority partners initiated a series of assessments of the performance of acute care facilities in extreme weather conditions. Through gap analyses and workshops for each site, the team identified 13 critical asset categories, including building envelopes, heating and cooling systems, and standby power generators, which were most severely impacted during extreme weather events. The top three most urgent concerns were extreme heat, extreme cold, and heavy precipitation—highlighting the need for reliable cooling systems and temperature control measures, robust heating and humidification infrastructure, and effective drainage systems and flood-management strategies.

The ARQTS worked collaboratively and presented data and findings to relevant departments in Fraser Health. This helped to foster a better understanding of the risks, enabled informed action, and helped to prioritize certain capital upgrades. It also demonstrated the dedication of facilities management staff in delivering exceptional care during challenging circumstances. Identifying vulnerabilities, monitoring risks, and planning essential upgrades are pivotal steps towards constructing a health care system that can withstand and adapt to the ever-evolving challenges presented by climate change.

> *"When extreme weather strikes, the FMO team jumps into action, evaluating the performance of our facilities and identifying the areas that took the biggest hit... It's like solving a puzzle where building envelopes, heating, ventilation, air conditioning systems, and power generators are the crucial pieces."*
>
> —Gavin Lovitt, Technical Asset Manager with ARQTS [709]

8.4.2 Adaptations for health-related facilities and infrastructure in B.C.

Climate shocks and stresses to critical infrastructure and health assets are already creating cascading impacts in hospitals, long-term care homes, and other types of health facilities. Infrastructure resilience to current and future climate risks is critically important to climate preparedness, as is the need to mitigate GHG emissions and environmental impacts of health care facilities and operations.

Undertaking a low-carbon resilience approach will not only enhance preparedness and sustainability, but also support cost-effective and innovation strategies for the future. This approach will also guard against unintended negative consequences associated with maladaptation—such as installing energy-intensive air-conditioning systems without considering their long-term sustainability and emissions. A systematic approach to identifying and addressing climate risks and, at the same time, integrating low-carbon resilience measures into the long-term lifespan (60–100 years) of facilities [710], is already underway across the health system.

Climate change mitigation in health facilities

Efforts to reduce GHG emissions through mitigation measures have been ongoing in B.C. for more than a decade, with effective leadership and well-defined policies and mandates. The health care system has had the opportunity to experiment, acquire knowledge, and create more sustainable and resilient health care facilities through design, operations, and service delivery.

Mandatory reporting obligations, such as those outlined in the 2007 Climate Change Accountability Act [711], are playing a crucial role in encouraging the reduction of GHG emissions and advancement toward provincial goals. The Province and all public sector organizations, including health authorities, report on their emission reduction progress in annual Climate Change Accountability Reports [662]. For example, the PHSA's 2022 Climate Change Accountability Report identified a 20-percent reduction in GHG emissions since 2007, with 95 percent of its in-scope emissions [i.e., stationary fuel consumption, mobile fuel consumption, and supplies (paper)] attributed to the building portfolio [662].

As of 2020, all public sector organizations, including health authorities, report on GHG emission reductions post-2007, either in total or per-usable space. In B.C., there have been several strides taken to provide direction and guidance for the health system, such as:

- The Province and health authorities have been required to be carbon-neutral since 2010, under the *Carbon Neutral Government Regulation* [712]. The provincial Carbon Neutral Government Program requires all provincial public sector organizations, including health authorities, to engage in GHG emissions reduction planning and actions [713].
- Annual Strategic Energy Management Plans (SEMP) require health authorities to report on past, current, and forecasted energy consumption, and to outline organizational strategies for energy optimization, including energy retrofits for existing buildings and energy efficiency strategies for new buildings. Energy Management teams are collaborating with Plant Services and Capital Projects and Planning teams to develop more efficient operations [56]. Energy-efficiency projects within health authorities include for example:
  - waste heat recovery;
  - higher-efficiency boiler and chiller upgrades and retrofits;
  - lighting upgrades to more efficient light-emitting diode (LED) lights;
  - more efficient building envelopes;
  - more efficient energy exchange systems [714,715], and
  - renewable energy and low carbon storage.
- Additions to the Ministry of Health's Health Capital Policy Manual [716] have set a strong foundation and guidelines for sustainable and resilient design in health care facilities, particularly for new builds. These include Chapter 11 (Environmental Sustainability and LEED Gold Certification) and Chapter 12 (Carbon Neutral and Climate Resilient Health Care Facilities).
- Health care facility teams are collaborating with community partners to develop urban greenspace design strategies that enhance the health co-benefits of hospital planning, design, and operations within their respective communities. In the Lower Mainland, facility teams worked with universities, the City of Surrey, and other partners to create climate resilience and community well-being design guidelines. These guidelines propose strategies for implementing strategic green space retrofits at the neighborhood and block scale, promoting both environmental resilience and community health [717].

- In Lower Mainland health authorities, targets and key performance indicators (KPIs) for environmental sustainability are reported in the Environmental Performance Accountability Reports [662], with indicators for strategic areas such as transportation, energy, water, waste and materials.

Building climate resilience in B.C. health facilities

Increasingly, efforts are underway across the health system to ensure that the design, construction, and operation of health care facilities incorporate climate resilience, while reducing climate impacts and GHG emissions in tandem. This is a nascent field, with metrics and targets still in development. However, the Climate Resilience Guidelines for BC Health Facility Planning & Design [708], among other resources, provide a strategic framework for the transition to a low-carbon and climate-resilient health system. These guidelines offer ways to anticipate exposure and reduce the risk of impacts of climate hazards on people, services, and facilities; maintain critical operations and essential services in the event of a climate shock or stress; and minimize cascading impacts among systems and scales (e.g., building, site, and off-site) [708]. In addition, the B.C. Environmental, Social and Governance (ESG) Summary Report (2022) demonstrates how new capital investments (including hospitals) consider CleanBC objectives (both reducing emissions and building climate resilience), and BC's Climate Resilience Framework and Standards for Public Sector Buildings includes health system buildings, such as hospitals.

The Low Carbon Resilience and Environmental Sustainability Guidelines for Health Care New Construction [718] informs the planning and design of new and replacement construction for acute and long-term care facilities, based on the current and projected future conditions (see Figure 17). Current design parameters and building codes based on B.C.'s historical climate are no longer suitable for the current (and future) climate, and evolving conditions and design requirements are needed [707].

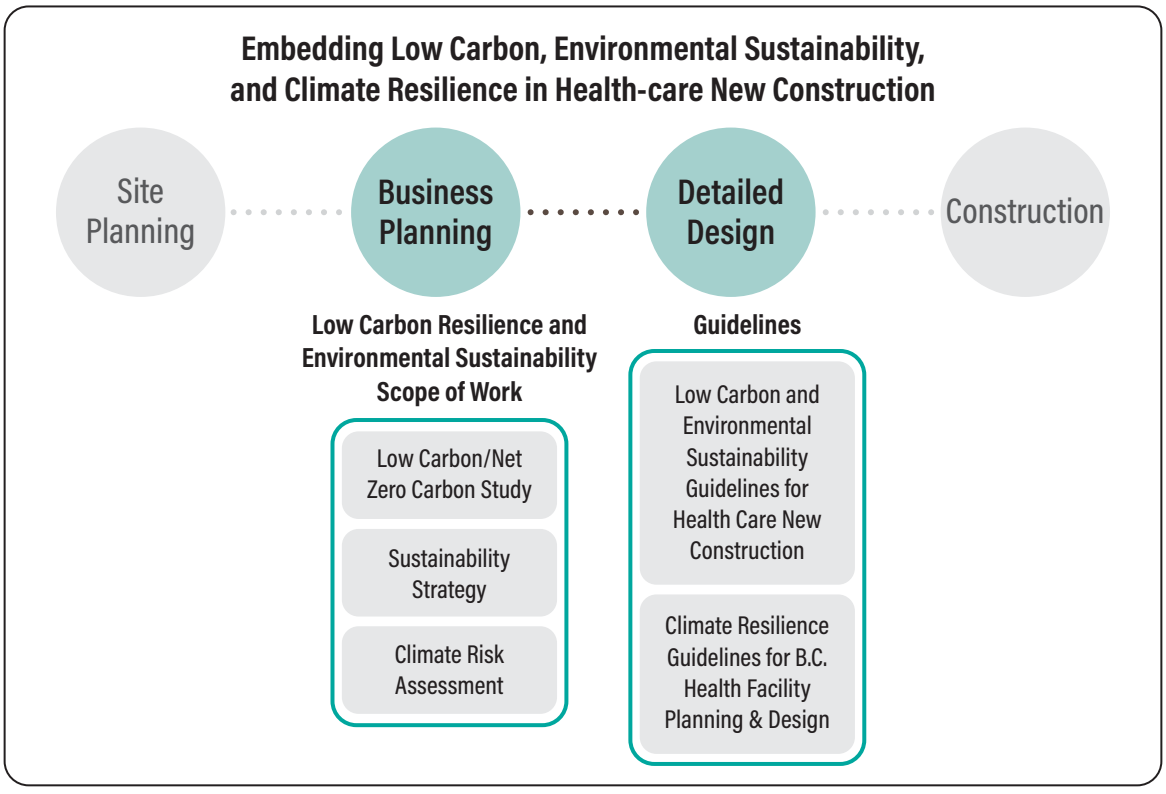


Figure 17. Avenues by which Low Carbon, Environmental Sustainability, and Climate Resilience are embedded in different phases of capital project delivery in the B.C. health system [718]

Adaptation in action: Assessing climate risks and adaptation at B.C. health care facilities

Climate risk assessments have been completed for an increasing number of health care facilities. This has led to greater awareness of potential climate risks and an increased capacity for climate adaptation in Facilities Management and Operations teams. Between 2018 and 2020, for example, Interior Health piloted a climate risk vulnerability assessment at one of its facilities. Interior Health then compiled high-level climate projections data for several facility locations, identifying sites with potentially high-risk climate vulnerability. With this data, Interior Health can prioritize future vulnerability and adaptation assessments [42].

Lower Mainland Health Facilities teams have also been conducting vulnerability and adaptation assessments of facilities. These include compiling climate projections for numerous health facility sites and identifying potential vulnerabilities. With a better understanding of how extreme climate-related events have impacted and could impact their facilities, they can identify and implement adaptation strategies.

Provincial and regional health authorities are now including risk and resilience assessments for planned and existing health care facilities. A climate risk assessment is a strategic tool that provides the basis for planning, implementation, monitoring and evaluation of a facility over its 60- to 100-year lifecycle. Several health authorities are now conducting portfolio-level climate hazard exposure screens. These are aimed at:

- identifying the exposure of a group of facilities to priority hazards (e.g., extreme heat, wildfire, and flooding);
- considering the sensitivity of facilities to these hazards (e.g., age of facility, occupancy);
- determining the adaptive capacity of facilities (e.g., backup power, remotes of the site); and
- providing future climate projections for priority hazards [234].

8.4.3 Opportunities for action

B.C. has made significant progress in addressing climate mitigation in health care facilities and operations. This progress can be deepened by adopting a comprehensive "low-carbon resilience" approach that emphasizes reducing carbon emissions and enhancing resilience together. A positive step in this direction is in the CleanBC Roadmap to 2030; the Province has committed to developing a comprehensive strategy in 2024 to transform existing public sector buildings portfolios to a low-carbon and resiliency standard. Across the health system, opportunities to integrate mitigation and adaptation together include:

- Integrate mitigation and adaptation policy, reporting, and accountabilities;
- Screen health facility sites (both new builds and existing stock), and prioritizing those that are higher risk for climate risk assessments;
- Continue to identify and develop strategies that address higher emissions sources in health care operations and service delivery;
- Develop policy and guidance on maintenance and renovations of existing buildings and leased facilities to make them more climate resilient;

- Ensure adaptation technologies are not also increasing emissions;
- Assess capacity and funding needs to upgrade existing building stock and infrastructure to adapt to a changing climate; and
- Assess capacity and funding needs to undertake risk, resilience, and adaptation planning for all facilities, rather than solely on major new capital projects.

In addition to system-wide changes to policy and practice that increase climate resilience of health infrastructure, opportunities to enhance preparedness for climate-related emergencies include:

- Ensure the availability of backup equipment and power sources for critical health facilities;
- Forward-planning and formalized relationships with fuel and transportation suppliers who can deliver needed supplies during emergencies (e.g., water, generators, fans);
- Emergency response plans for facilities, and stress-testing protocols and practices with facilities management and operations staff (perhaps using recent past events as example scenarios);
- Compile building inventories that map out which facilities have air conditioning (for example) and are able to meet the needs of patients during emergencies or evacuations;
- Identify which medical devices (e.g., in hospitals) may malfunction in extreme ambient working temperatures, and including strategies for medical devices and equipment in emergency preparedness plans; and
- Collaborate with privately owned/operated long-term care facilities to ensure they are working to improve climate resilience and preparedness.

8.5 Health information systems

8.5.1 Surveillance and monitoring

Surveillance and monitoring climate-related health risks and outcomes is important for timely response, assessing population vulnerability, and providing data and evidence to inform policy and health system planning. Climate projection and monitoring data in B.C. are becoming more available and accessible, supporting the expansion of integrated surveillance systems and program planning. Examples include:

- Real-time forecasting of climate-related health risks, such as BCCDC's BC Asthma Prediction System (BCAPS), Air Quality Health Index (AQHI), and the BC Heat Impacts Prediction Map (BCHIPS).
- Regional health authorities are using analyses including statistical modelling and mapping to better understand the health and health system impacts of climate-related events in B.C.—such as the Fraser Health Authority's analysis of emergency department visits and deaths during the 2021 heat dome event, one of the collaborations between the BC Observatory for Population & Public Health and regional health authorities.
- Several regional health authorities have developed community health and climate change maps to raise awareness about the differential and community-specific impacts of climate change on health, including Vancouver Coastal Health/Fraser Health and Interior Health;

- The Local Environmental Observer (LEO) Network is an online interactive mapping and data tool raising awareness about unusual environmental changes within Indigenous communities and lands. It complements other surveillance and monitoring efforts led by the First Nations Health Authority, particularly the WATCH Project.
- The Ministry of Health is developing a Population and Environmental Risk Characteristics file, featuring individual-level data on health, socioeconomic factors, and precise geographic information. This resource can help determine the number of people impacted by a climate-driven event or emergency, and identify those who may require additional support and services [194].
- The Office of the Provincial Health Officer's epidemiology team is leading analyses to quantify exposure to extreme heat and cold temperatures and attributed deaths in B.C. They will also begin examining population exposure and attributed deaths to wildfire smoke-associated air pollution [194].
- The Ministry of Health's Health Data Platform (HDP) supports research and analysis both within the health sector and in academia, by allowing access to health data from multiple sources to be brought together as required (on-demand), linked, de-identified, and analyzed on a single secure platform. The HDP provides more timely, secure, and consistent access to integrated "big" health data, and increases process transparency and efficiency for data providers and data consumers [720].

Outside the health system, the provincial government has advanced an expansion of online dashboards and monitoring systems that provide real-time geospatial information and data on climate-related hazards, such as:

- EmergencyMapBC, overseen by EmergencyInfoBC, serves as a general guide for current public safety conditions during emergencies. It provides information on evacuation alerts and orders related to wildfires, floods, and landslides; a snapshot of current wildfires burning (under control, out of control and being held); flood watches and warnings; as well as the location of cooling facilities in communities across B.C.
- The interactive Flood Water Quality Monitoring Task Force Hub highlights risk assessment findings, and features a spatial planning tool for ongoing and future flood assessments to support data-driven decision-making.
- The British Columbia Drought Information Portal provides geographic drought-level information for people in B.C.

Regional, community, Indigenous-led, and academic data projects are also essential to developing a more accurate depiction of climate-health impacts and adaptations within B.C. Examples include Vancouver Coastal Health and Fraser Health's My Health My Community Survey, BCCDC's COVID-19 Speak survey, the Capital Regional District's Extreme Heat resilience survey, MNBC and OPHO's Métis Public Health Surveillance Program [721], and Indigenous-led mapping from WatershedsBC.

Adaptation in action: Integrating climate and health data for enhanced disease surveillance and analysis

The BC Observatory for Population & Public Health is a partnership between BCCDC, the Office of the Provincial Health Officer (PHO), Ministry of Health, the First Nations Health Authority, and regional health authorities. It supports the PHO and regional health authorities to systematically report on their populations' health status and is working to integrate these activities with existing disease surveillance systems.

Among its range of activities, the Observatory is helping coordinate the scale-up of environmental health indicators and information-sharing among the partners. Other work includes supporting regional health authorities with epidemiologic analyses of climate-related events, such as impacts of extreme heat and flooding events, to better understand the impacts on population health and health services in their regions.

The Observatory was created based on recommendations from the Population and Public Health Surveillance Plan for B.C. to provide collaborative leadership in the development of provincial and regional surveillance capacity with respect to non-communicable diseases, injuries, risk and protective factors, and environmental health.

Opportunities for surveillance and monitoring

While there are regional variations in the availability of data to inform health adaptation and planning, B.C. has a robust array of climate, health, and demographic information that could be leveraged to:

- **Develop standardized indicators**: Standardized climate-health indicators can be applied across the province to track progress and communicate about climate-related health risks and action [56].
- **Enhance data sharing**: Distributed access and sharing of epidemiological and environmental health data across the health system can facilitate timely communications and early warnings systems to inform adaptation planning and emergency preparedness [232]. Lessons can be learned from the successful data dashboards created for surveillance and public reporting during the COVID-19 pandemic (e.g., the BCCDC's COVID-19 Dashboard).
- **Modernize data**: Electronic data can enhance resilience, providing access to patient records during evacuations and reducing the risk of lost records during disaster events. At the same time, backups and redundancies should be incorporated into the system to ensure access to records during power outages [56].
- **Collect regional and locally-relevant data**: Collecting regional- and locally-relevant data can improve health system and community awareness of known climate risks while driving adaptation. There are opportunities to enhance climate-health data collection through existing community health surveys (e.g., COVID Speak and the My Health, My Community survey), for example, by including mental health indicators related to climate change [56].
- **Collect evacuation-specific data:** Identifying and tracking trends in evacuation data and priority populations can inform emergency plans and programs to better support those who in need of enhanced support during evacuations.

8.5.2 Climate change and health vulnerability assessments

Climate change and health vulnerability assessments (CCHVA) support regional health authorities in identifying the people and places most at-risk of adverse health impacts from climate change. These tools help inform targeted strategies for increasing resilience and reducing risks to population health.

The CCHVA process engages multiple departments and community partners, raising awareness of health risks associated with a changing climate, and building internal capacity for taking the next steps in adaptation planning. All regional health authorities in B.C. have either completed or are initiating CCHVAs, synthesizing a range of available evidence and providing a platform for engagement internally and with partners. With support from the federal HealthADAPT program, Vancouver Coastal Health and Fraser Health completed a CCHVA in 2022 [82], and used it to develop their first-ever Climate Change and Health Adaptation Framework [722].

8.5.3 Awareness and communications

Effective messaging is an essential component of climate and health preparedness and response efforts. Communications resources play an important role in conveying critical information, motivating action, promoting population and public health, and enhancing community resilience. Efforts to enhance climate-health awareness in B.C. include:

- ClimateReadyBC is a central, open information portal to help the public and communities understand climate and disaster risks, and find funding and supports. An initiative of the Province, it provides information and links to resources, tools, and guides related to extreme heat, wildfires, flooding, and drought.
- In partnership with regional health authorities, the Province is creating culturally and locally relevant climate-health preparedness materials for the public. It is also working to create centralized online hubs for information and resources related to climate and health, covering various priority hazards including extreme heat, wildfires, floods, vector-borne diseases, and waterborne illnesses [194].

- All health authorities have, or are developing, public-facing webpages dedicated to climate change and related risks, with a focus on preparedness and illness prevention for communities and at-risk populations. These include the First Nations Health Authority's Indigenous Climate Health Action Program; the Provincial Health Authority's Climate Change and Health Page; Interior Health 's Climate Change Resource Page; and Vancouver Coastal Health's Climate Change and Health Page.
- Health authorities have developed targeted public health messaging on climate hazards for specific populations. For instance, the First Nations Health Authority has developed culturally appropriate communications materials for Indigenous Populations on extreme heat preparedness, and Vancouver Coastal Health and Fraser Health have translated extreme heat resources into multiple languages.
- The BCCDC and several regional health authorities have produced public awareness materials related to specific hazards, such as posters on extreme heat and preparing for wildfire smoke. They have also produced materials targeted to community partners, such as a guide for NGOs on conducting check-ins during extreme heat events and a toolkit on heat preparedness for local governments.
- HEMBC has developed a series of informational videos for the health workforce and the public about how to prepare for various hazards, including wildfires, floods, extreme weather, and extreme heat.
- HealthLinkBC 8-1-1 fields calls from the public and produces materials related to environmental/climate hazards, including extreme heat, and acts as an important frontline information source for the public.

Opportunities for awareness and communication

> *"I think we could do a better job of finding creative ways for our media partners to cover or to package [preparedness] reminders and information as we're heading into a season."*
>
> —*Risk to Resilience Project* focus group participant

A coordinated approach to public awareness and communications in B.C. will ensure the public is well-informed, engaged, and prepared to address the health impacts of climate change. Opportunities to do so include:

- Take a provincially-coordinated approach to developing consistent key messages across the health system that address specific hazards and co-occurring emergency events (e.g., smoke and heat).
- Tailor public health messaging to specific regions and specific priority populations, such as older adults, Indigenous populations, newcomers, and those who are underhoused.
- Assess the potential for messaging fatigue, especially during seasons with multiple heat and wildfire smoke alerts.
- Explore opportunities for collaboration, coordination, and consistency in messaging between the health sector, media, partner agencies, First Nations, Métis, and local governments, with clarity around roles.

In summary, climate-resilience health information systems require multifaceted adaptations. These include:

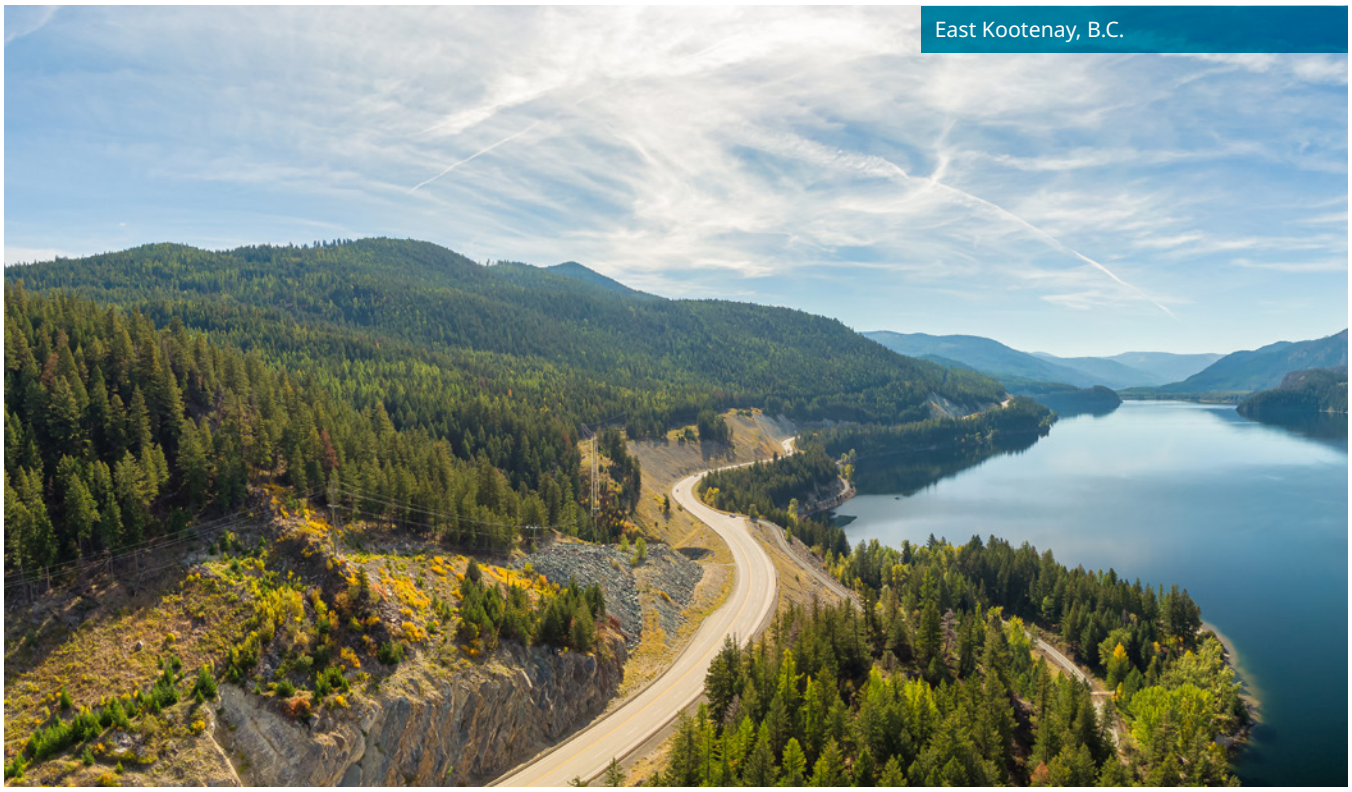
- Enhancing the ways in which climate-health data is tracked, shared, and used.
- Providing the public with effective information on preparing for emergencies and protecting their health and well-being in a changing climate.
- Applying information from regional and provincial CCHVAs to inform health system planning and quality improvements for priority populations most at-risk.

As health information systems adapt to the changing climate, they should be evaluated to understand what is working and gain insights into lessons learned. This will also help determine which international or national programs for enhancing resilience are most applicable to B.C.

8.6 Environmental health

Environmental health protection is vital before, during, and after extreme heat, wildfires, flooding, or drought. Environmental Health Officers, as defined by the *Public Health Act*, work in conjunction with Medical Health Officers, and are instrumental in preserving water quality, ensuring food safety, monitoring air quality, managing waste, and mitigating environmental health risks. Health authority staff possess the necessary training and expertise to address immediate risks within the community during climate-related events. They are also responsive to medium to longer-term effects, such as when residents return home or rebuild their communities. Environmental health teams extend their efforts to collaborate with the Province and a diverse array of partners, including local communities, governments, regional districts, Indigenous leaders, and communities, to protect and address environmental determinants in forward-thinking planning processes:

- Numerous councils, working groups, advisory committees, and regional roundtables across the province are developing ways to collaboratively improve airsheds, watersheds, and other environmental health determinants;
- Regional health authorities are engaging and participating in environmental assessments and land-use planning projects through the BCCDC's Healthy Built Environment programs;
- Regional health authorities are collaborating with communities on climate mitigation and adaptation and planning for specific climate hazards, such as urban-interfacing wildfires, flood and storm surge events, and extreme heat events. They are participating in climate risk assessments, community surveying to address water scarcity, and local food policy and agriculture planning to alleviate food safety and insecurity risk factors.
- Following flooding events, health system staff are working with water operators to identify vulnerabilities and integrate them into their emergency response plans [232,723].
- During and following recent wildfire events, Health Protection teams in regional health authorities—typically made up of environmental health officers, drinking water officers, and licensing officers—have worked in impacted communities to ensure the ongoing safety of residents [724].



East Kootenay, B.C.

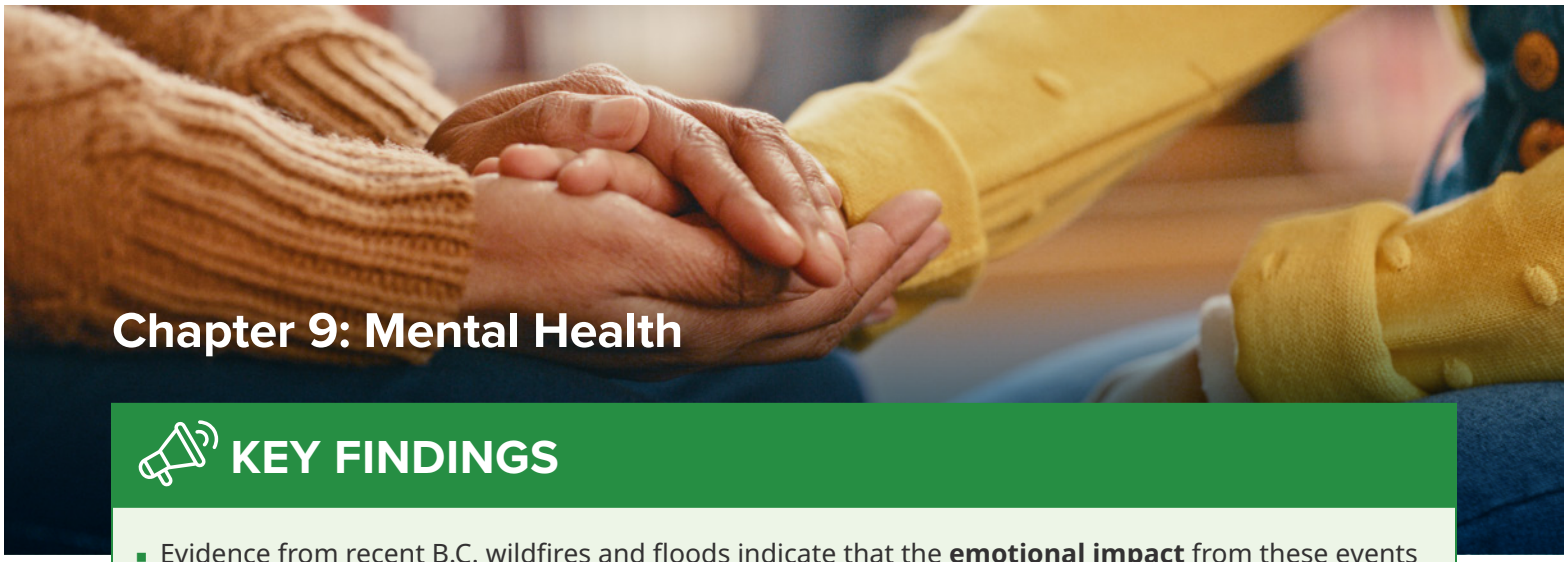
Health Protection teams ensure wildfire evacuees can safely return home

During the 2017 wildfires, Interior Health's Health Protection team inspected Emergency Social Services Reception Centres and BC Wildlife Service fire camps across the region, often daily, to review housing and food safety. After evacuation orders were lifted for the communities of Williams Lake, Cache Creek, Clinton, and 100 Mile House, they ensured returning residents had clean drinking water and safe food supplies, identifying and prioritizing regulated care facilities for inspection. Williams Lake, for example, had nine licensed residential care facilities, 34 licensed day care centres, 27 water systems, 107 restaurants, 23 food retailers, and eight recreational water facilities. Drinking Water Officers worked with the municipality and small water suppliers to ensure safe drinking water was in place.

To ensure that evacuees could return home safely, Health Protection teams also collaborated with their communications teams to distribute information and attend community meetings to answer questions about food and water safety and air quality [724]. B.C. now has a Guide for Owners of Property Impacted by Wildfire Contaminants.

Opportunities for environmental health

Climate change has placed greater pressure on community and small water supplies [232]. Ensuring clean and safe drinking water during and following climate-related events is essential to prevent waterborne disease. *Risk to Resilience Project* focus groups identified the opportunity to collaborate with communities and water suppliers to prioritize water-supply protection and quality during and after wildfire events.



Chapter 9: Mental Health

KEY FINDINGS

- Evidence from recent B.C. wildfires and floods indicate that the **emotional impact** from these events persists long after the immediate threat subsides. Individuals may experience emotional trauma, worry or grief, stress from the financial strain of recovery, and anxiety about returning to normalcy or the possibility of future catastrophes.
- Evacuations during these events can be **traumatic experiences**, with factors such as lack of preparation, loss of belongings, and separation from family compounding stress. Some communities have been impacted by **multiple evacuations**, leading to increased mental health challenges.
- The **slower onset and longer-term impacts** of climate change on mental health are significant and showing up differently for youth, who are thinking about what their future will look like, and for Indigenous Peoples, who are experiencing profound changes to their relationship with the land, cultural well-being, and identity.
- **Indigenous Peoples in B.C. are at higher risk** of experiencing mental health impacts from climate-related disasters due to increased exposure, ongoing impacts of colonialism and systemic discrimination, compounding trauma, and psychosocial impacts during evacuations. Providing specialized mental health services and culturally appropriate support is crucial.
- Climate-related events in B.C. and growing awareness of the urgency, scale, and complexity of climate change are causing **heightened climate anxiety**, also known as "ecoanxiety," represented by heightened feelings of helplessness, grief, and fear in response to escalating climate-related threats.
- Indigenous Peoples, children and youth, women, rural and remote communities, farmers and ranchers, and those with existing mental health and substance use issues are **disproportionately affected** by the mental health impacts of climate change.
- A comprehensive, cross-governmental approach is essential for building climate-resilient mental health systems. **Opportunities for action** include:
  - Improve monitoring of mental health indicators for climate-related events;
  - Develop mental health preparedness and recovery strategies through community capacity building;
  - Community gatherings for healing, rapid and sustained psychosocial support
  - Enhance capacity for mental health programs; and
  - Improve access to culturally relevant, Nation-led mental health and wellness support.

9.1 Mental health impacts

With the increasing frequency and intensity of climate-related events in B.C., there is mounting concern about the impact that climate change is having on mental health, and an interest in finding psychosocial[56] adaptations to protect mental health and social well-being. A significant body of research links both acute (e.g., wildfires, floods, extreme heat) and slow onset (e.g., drought, sea-level rise) climate-related events with impacts on mental health [548,725]. Many individuals are experiencing feelings of anxiety, worry, and grief as their awareness of and experiences with climate change grows [726]. Incidents of anxiety, depression, and post-traumatic stress disorder (PTSD) are likely to increase significantly during climate-related disasters [500,548,725,727].

Grand Forks after 2018 flood event

Following climate-related events (e.g., wildfires or floods), the majority of affected individuals will benefit from basic mental health support, but a smaller fraction may eventually require more specialized health care services [75]. Among those particularly at-risk are individuals with severe mental health issues and those who require extra support during emergencies (e.g., older adults, young people, or those at higher risk of climate impacts). Also at higher risk of mental health impacts are Indigenous Peoples, who continue to experience the ongoing impacts of colonialism, systemic discrimination, and racism [273].

In B.C., mental health impacts are frequently reported following extreme climate-related events, including extreme heat [728], wildfires [75], flooding [500], and drought [729]. The 2017, 2018, and 2021 wildfire seasons were all followed by reports of PTSD [730–733], depression, emotional trauma [342], and anxiety and fear [34]. One study found that exposure to wildfire smoke may have mental health impacts such as depression and anxiety, particularly during episodes of chronic and persistent smoke events [734], but more research is needed to tease out the mental health impact of exposure to wildfire smoke, the impact of evacuation, and exposure to wildfires overall.

In communities impacted by these events, there were measurable increases in the need for mental health services, including increased emergency department visits for mental health and substance use services, and increased demand for family support, counselling, and victim services [75]. In the aftermath of recent heat waves, wildfires, and floods, mental health case workers have also identified a notable increase in substance use/overdose, gender-based violence, and children's behavioural disruptions [34,75,509,735]. However, climate-related events can also lead to positive mental health outcomes, such as a sense of community cohesion or connectedness as communities come together to support each other in the aftermath of disasters [509].

People in B.C. also face slow-onset hazards, such as drought and sea-level rise, and increasing knowledge and awareness of climate threats here and around the world; both can influence mental health and well-being by affecting one's sense of place and triggering emotional responses of anxiety, grief, anger, helplessness and depression [548].

56 Mental health is one aspect of the broader definition of psychosocial health. Psychosocial health is defined as the interplay between social well-being —which arises from relationships with others and one's context and culture—and psychological well-being, which includes thoughts, feelings, and behaviours. [548]

Lingering and long-lasting mental health impacts

> *"We need to think differently about recovery. In many cases, we learned that almost one year after the events, be they flood/debris flows or wildfires, those who lived through these life-altering events continue to rebuild. This rebuilding extends beyond homes and physical structures to include the emotional trauma that lingers long after such events." – Addressing the New Normal: 21st Century Disaster Management in British Columbia* [75]

Even after the flames subside or flood waters recede, the emotional impact of these events often endures—manifesting in survivor guilt [548], stress from the financial strain of rebuilding [736], concerns about returning to a sense of normalcy or talking about the event [737], and deep-seated anxiety that a similar catastrophe could occur [738]. Sometimes, the smell of smoke or heavy rain may trigger renewed fear and anxiety [56,349,731].

For many, these responses to trauma tend to subside once security and safety are established. But for others, longer-lasting effects can include a lost sense of place alongside ongoing mood and behavioural disorders that can last months—or even years [500,739].

> *"The amount of grief that was triggered from the first flood to the second flood... I have a lot of Elders that reach out to me as a trauma therapist for residential school students, that want to talk about the anxiety that they have every time it rains."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

B.C. residents experience short -and long-term mental health impacts from flooding

Following the 2021 atmospheric river (AR) flood events, numerous reports have described how people impacted by floods or injured in associated landslides have experienced longer-term post-traumatic stress disorder (PTSD) [506,523,534,740–743].

Findings from a survey of 107 Abbotsford residents indicated high levels of probable PTSD, and persistent lower levels of resilience even 18 months after the 2021 AR-flood events [534]. Similarly, after the 2018 Grand Forks flood, Interior Health and local service providers reported increased anxiety, depression, and PTSD, along with a substantial increase in demands for mental health supports, including school-based mental health services [509]. And following the 2018 flood in the Regional District of Kootenay Boundary, the Canadian Red Cross reported 318 referrals to external mental health and well-being supports [744].

> *"When you say atmospheric river, there are people that go into panic mode, because they think they're gonna lose everything again… People are still trying to cope with what happened."*
>
> —Mayor Spencer Coyne, Town of Princeton [742]

Delayed mental health impacts

> *"When I worked in community, I was so busy taking care of everyone else…I never really dealt with the impact [the wildfire] had on me … [When] I finally had a breather from all these compounding emergencies…[I realized] it was the trauma I had experienced for the past four years or five years, and [I was] just finally being able to work through that."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

Some community members may not feel that they need mental health support for months, or even years, after an event. *Risk to Resilience Project* focus group and Indigenous sharing circle participants described how the initial shock and adrenaline rush during a wildfire or flood event can mask the emotional toll. However, as time goes on and the immediate danger subsides, the full extent of the mental health impacts (such as depression, anxiety, and grief) may become more apparent, resulting in delayed mental health impacts. Evidence shows that after an environmental disaster event, suicides peak at around two years post-event [745].

Grand Forks after 2018 flood event

Evacuation-related mental health impacts

Evacuations can be traumatic experiences during which a number of factors, identified by the *Risk to Resilience Project*, can contribute to and compound stress. These include lack of preparation time, loss of belongings, length of time displaced, and differences between home and host communities [746]. In B.C., mental health impacts reported during wildfire or flood evacuations included acute stress and fear [324,347], as well as emotional trauma [275,352,731,736].

Evacuees report feeling unprepared and confused about where to go [275], and stress at being separated from family and friends [324]. They also express concerns about property loss [276,747]. Many report having difficulty coping with sickness, loneliness, and loss after being separated from their families, friends, and communities [748].

Some communities have been impacted by multiple evacuations and re-evacuations, which carry additional strain, uncertainty, and compound mental health impacts. In 2021, some wildfire evacuees from Lytton were evacuated from their host communities under new wildfire evacuation orders [275], and again during the November 2021 flood event [748]. That same year, Merritt residents were on evacuation alert twice in three months: on August 15 due to wildfires, and again on November 15 due to floods [44]. The trauma of experiencing multiple climate-related events, sometimes in the same year, and subsequent compounding impacts, can lead to stress and burnout, with a toll on individual and community mental health and well-being.

> *"The amount of compounded trauma out there just keeps increasing all the time, which means they're coming to us more and more for resources."*
>
> —*Risk to Resilience Project* focus group participant

For some, displacement is a short-term ordeal, but others may not return home for several weeks or months due to extensive damage. Many individuals remain displaced from the 2021 AR-flood events, including residents from the Nicola Valley, Merritt, and Princeton [273], and many residents from Lytton remain displaced due to the 2021 wildfires [749]. Some face the prospect of permanent relocation. There are substantial cascading psychosocial consequences of prolonged displacement, as the erosion of community unity and mental health impacts are compounded by the challenges of accessing education and employment.

Adaptation in action: Information for psychological support during and after disasters

The Canadian Mental Health Association (CMHA) in B.C. has developed a public resource of mental health tips to cope in an evacuation due to an environmental disaster, which includes information on the mental health of children and youth, and the First Nations Health Authority has developed a resource on Recognizing and Addressing Trauma and Anxiety During Disasters. The CMHA also launched a telehealth program (Talk in Tough Times) following the 2017 wildfires in B.C. to support adults and teens experiencing depression, stress, or anxiety following the fires.

Psychosocial Impacts

> *"We know that whenever people are out of their homes for an extended period of time…the domestic violence numbers go way off the charts."*
>
> —*Risk to Resilience Project* focus group participant

Climate-related disasters in B.C. have also led to secondary impacts, such as economic stress from loss of livelihood [342], substance abuse [727], and an increase in domestic conflict and violence [735,750]. As a result of the increase in stress and substance use, the risk of gender-based violence increased in B.C. during wildfire and flooding events [342,509,735], compounded by the disruption of social support networks and resources that can provide protection from violence in the home [751].

Following the 2017 and 2018 wildfire seasons in the B.C. Interior, one impacted community had a 32-percent increase in domestic violence referrals and a 77-percent increase in domestic violence reports in May, June, and July 2019 [735]. Higher rates of gender-based violence have also been reported after flood events in B.C., along with increased shelter rates and higher levels and intensity of violence in the community [56,509].

> *"We noticed…that need for shelters just skyrocketed…being displaced because of the floods…[and] domestic violence increasing."*
>
> —*Risk to Resilience Project* focus group participant

Across B.C., many women's transition houses have reported unique security and safety concerns for women at risk of violence, whose confidentiality may be compromised when accessing emergency/evacuation centres and support during wildfires and flooding [56]. In addition, there are impacts on the facilities themselves and their ability to maintain service continuity. To address these concerns, a pilot project with women's transition houses is underway to increase preparedness for climate hazards.

Adaptation in action: BC Society of Transition Houses [752]

Over recent years, wildfires, flooding, and extreme heat have impacted the ability of transition houses across B.C. to provide services to those at risk of gender-based violence during and after disasters. As a result, the BC Society of Transition Houses (BCSTH), a member-based provincial organization, has undertaken a one-year project to support its members in preventing, mitigating, preparing for, responding to, and recovering from emergencies due to extreme weather events, in partnership with the Canadian Red Cross Society. Five BCSTH member programs in wildfire/flood-impacted communities across B.C. will serve as pilot sites to develop accessible risk assessment tools and Service Continuity Planning templates. These sites will help guide the development of a comprehensive Service Continuity Planning Strategy to assist members in maintaining functional levels of service when experiencing disruptions from climate hazards.

Climate anxiety

Climate anxiety, or "ecoanxiety," encapsulates the emotional and psychological distress individuals experience in response to environmental concerns and the escalating threats posed by climate change. The growing awareness of the urgency, scale, and complexity of climate change is leading to growing climate anxiety, with feelings of helplessness, grief, and fear in response to environmental concerns and escalating climate-related threats [548,728,753]. While some literature describes climate anxiety as a potentially adaptive, motivating, and healthy response to the environmental changes being experienced [754,755], other studies link climate anxiety to poorer mental health [756].

Two recent surveys demonstrate growing climate anxiety in B.C. One online survey of 439 people in B.C. aged 16 years and older reported experiencing notably higher climate change anxiety following the 2021 heat dome event [728]. A majority of the respondents reported being more worried about climate change due to the heat dome. They also reported concerns that climate change will affect their employment industry, and fears that the region in which they live will be devastated by climate change events, such as floods or forest fires [728]. In addition, a 2020 survey of 11th grade students (age 16–17) from two B.C. school districts (N=2306) found that 49.7 percent "agreed a lot" that they are worried about the consequences of climate change [757].

There is growing evidence that climate emotions are also connected to climate action and resilience, and therefore should be considered in preparedness, response, and adaptation strategies [753]. Addressing climate anxiety requires a holistic approach that includes raising awareness and understanding of the mental health impacts of climate change, improving mental health literacy and training, and providing culturally relevant mental health services to support people in need [548].

9.2 Disproportionate mental health impacts

Mental health impacts on Indigenous populations/communities

First Nations people living on reserve in Canada are 18 times more likely to be evacuated due to environmental disasters than people living off-reserve [758]. According to Indigenous Services Canada, between April 2013 and March 2022, there were 8,802 people evacuated from First Nations communities in B.C., with roughly one in 10 people evacuated for more than three months—the highest proportion of long-term evacuees among Canadian provinces [555].

The 2019 First Nations Leadership Council Climate Leadership Survey found that stress/anxiety are one of the top two most common health concerns related to climate change identified by respondents (the other was respiratory challenges) [61].

Métis Nation B.C. has identified mental health impacts of climate change as impacting their citizens and, as a result, held a Climate Change and Mental Health Forum in February 2020 [759], as well as discussions on climate change and mental health at their February 2022 Métis Climate Resilience Gathering.

Indigenous Peoples (First Nations, Inuit, and Métis), often find themselves at the forefront of climate-related emergencies in B.C. because their communities are frequently situated in remote and rural areas, which can be more exposed to environmental hazards such as wildfires and floods. This is a historical outcome influenced by the colonial placement of reserve lands that were more marginal in nature [75,548]. As a result, they face disproportionate mental health risks from climate-related events. In addition, there are significant compounding factors that influence how climate change impacts the mental health and well-being of Indigenous Peoples, such as:

- **Historic and compounding trauma:** In addition to the impacts of a changing climate, the enduring, ongoing, and compounding trauma arising from the loss of ancestral lands and traditional territories, the erosion of language and culture, racism, and the painful legacy of residential schools and Indian hospitals, has led to the intergenerational transfer of trauma [34,500,548].
- **Triggering of past traumas during emergencies:** Inter-generational trauma can be triggered or exacerbated by an emergency event and how it is handled. The institutionalized approach to emergency responses, including evacuation procedures, might evoke memories of the disempowering experiences faced by First Nations and Métis people during residential school and other colonial processes. Upon returning to their home communities, the process of healing for Indigenous Peoples extends beyond addressing the immediate emergency; it may also entail addressing the resurgence of past traumas [75,760] .

> *"The way that the fire department came in to evacuate was very reminiscent of when they were taken away to residential school."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

- **Disruption of cultural and land-based practices***:* Climate-related events disrupt the ability of Indigenous Peoples to practice ceremony and land-based cultural activities, such as hunting, fishing, and gathering of food and medicine, that are essential to their cultural, spiritual, and mental health and well-being [500]. In B.C., nearly 50 percent of the First Nations Leadership Council Climate Emergency Survey participants identified impacts to sacred and cultural sites, due to either disappearance, damage, or loss of access due to climate-related events [61].
- **Compounding psychosocial impacts from evacuations:** During evacuations, Indigenous Peoples have reported inadequate consideration of mental health and cultural safety during emergency responses. Factors such as communication breakdowns across jurisdictions, limited cultural support systems, and insufficient spaces for cultural healing practices such as traditional food provision can further compound these challenges [75,77,244]. In addition, Indigenous evacuees have reported exacerbated mental health issues through experiences of increased racism, family violence, substance use and misuse, and suicide among displaced First Nation youth [34,500]. For example, in recent wildfire events in B.C., some people did not return to their home communities after evacuation, leading to increased homelessness in urban centres.

> *"In our community, everyone had to leave for Prince George… And many people say now, there are so many people on the streets here in Prince George, because…many of them stayed in Prince George and some became addicted to drugs and alcohol."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

Indigenous sharing circle participants spoke about land-based healing approaches that have been supportive for community members to connect to the land and engage in culturally restorative practices in response to a changing climate. They also spoke about how culture, community, and traditional foods play a role in healing from mental health impacts of climate change.

> *"I got clams, oyster, salmon. I got Elders and community. I love how in our villages, people come together to support each other [after 2021 heat dome and droughts]."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

First Nations Health Authority (FHNA) provides culturally appropriate mental health supports during 2018 wildfires [761]

During the 2018 wildfire crisis in B.C., the First Nations Health Authority Northern regional team played a crucial role in supporting wildfire evacuees at the evacuation centre in Prince George. Their efforts included providing navigation, clinical, and mental health support to ensure Indigenous individuals and families could access culturally appropriate and holistic services. Traditional healing practices, such as smudging and the presence of traditional healers and drum groups, were made available to support evacuees' spiritual well-being. A Cultural Support tent was set up to offer traditional healing methods to address the mental, emotional, and spiritual well-being of both evacuees and frontline staff (e.g. firefighters) during times of crisis.

The First Nations Health Authority funds or administers funds to support mental health counselling, land-based healing, cultural supports, wellness, and crisis grants following climate-related disasters in B.C. First Nations communities.

Children and youth

> *"As an organization that's on the frontlines, I would have to say that the impact on mental health that we've seen is there's a lot more fear, there's a lot more panic within people. Children have been affected greatly."*
>
> —*Risk to Resilience Project* focus group participant

Climate change presents significant mental health and well-being challenges for young people. Children and youth can be particularly at risk of experiencing sadness, anger, fear, and a sense of powerlessness regarding climate change and its impacts (i.e., "climate anxiety") [726] as they consider implications for their future. Young people are more likely to experience the impacts of climate-related events in their lifetime, either directly by exposure to specific hazards, indirectly through impacts on determinants of health, or through news and media consumption about climate impacts elsewhere in the world [757]. Children and youth who experience climate-related disasters such as wildfires or floods are also at greater risk of psychosocial impacts, and are more likely to have mental health disorders (particularly anxiety) later in life [534,726]. It is important to understand the mental health impacts of climate-related events on children and youth, and to provide appropriate support to impacted families and children to mitigate future mental health problems.

> *"I know [after the 2021 wildfire] Lytton was especially hit [by requests for mental health support]. The youth, the amount of calls saying that the youth are having such a terrible time."*
>
> —*Risk to Resilience Project* focus group participant

First Nations Health Authority example of adaptation

The First Nations Health Authority has developed a public resource with helpful tips for "Recognizing and Resolving Trauma in Children During Disasters" to support families affected by disaster-related trauma.

Gender

Evidence suggests that women are experiencing anxiety and worry related to a changing climate at higher levels than men [753], and that women are more prone to PTSD from experiencing climate hazards [548]. For example, a study examining the health impacts of evacuated workers from the 2016 Fort McMurray wildfire in Alberta suggests that women who had been evacuated during the fire had higher anxiety and depression scores [762]. Women are also at greater risk of experiencing compassion fatigue during or after a climate-related hazard occurs, due to the role they play as caregivers. For example, a study of the social impacts of the 2018 flood in Grand Forks found that the mental health of women, particularly women living in poverty and older women, was disproportionately affected due to the stress of supporting family and community members [509]. Overall, there is a need for targeted mental health supports for those socialized to engage in caretaking roles in families and communities (regardless of gender) to help them cope with, manage, and process emotional distress from climate-related events.

Men also experience unique mental health impacts from climate change, particularly Indigenous men who hunt to provide traditional foods for their family, and men that are farmers and ranchers [548]. In B.C., further research and data is needed to better understand the mental health impacts of climate change on Two-Spirit, lesbian, gay, bisexual, transgender, queer, questioning, intersex, and asexual (LGBTQ2S+) people and communities, reinforcing existing calls for more robust equity-informed data to be gathered provincially.

Rural and remote communities

Rural and remote communities in B.C. are often more exposed to climate-related events such as wildfires and flooding, but also may not have access to mental health care practitioners and facilities on-site. Mental health supports are often brought into the community after the event for a short period of time, however challenges remain for meeting long-term mental health care needs for impacted communities [548].

> *"Because the communities are smaller, there are less resources available. So, if there is some kind of disaster, the impact on the community is greater. Especially with the wildfires and some of the flooding—when it hits a small community, it's just a very significant impact. It hits everyone."*
>
> —*Risk to Resilience Project* focus group Participant

Farmers and ranchers

People involved in the agricultural industry are among those most affected by mental health impacts of extreme weather events because their economic livelihoods depend on environmental conditions. Coinciding heat, wildfire, flood, and drought events in B.C. have disrupted farming practices and resulted in significant stress and burnout for B.C. farmers and ranchers, due to the loss of livestock and crops [67,68]. For example, the province's Mental Health Support Line reported a 15- to 20-percent increase in calls following the November 2021 AR-flood events, with hard-hit farmers making up the bulk of those new calls [763]. Farmers and ranchers also face unique barriers to accessing mental health support. For many farmers living in rural communities, there can be a lack of access to mental health practitioners, stigma surrounding mental health, and/or the perception that farmers are self-sufficient and stoic [534,764].

AgSafe BC example of adaptation

AgSafe BC has developed mental health programs that are tailored to the unique needs and challenges that farmers and ranchers face. "In the Know," for example, is a free, four-hour mental health literacy program made for agricultural producers and their community, designed with farmers to support farmers in identifying, understanding, and coping with mental health challenges. They have also partnered members of BC Agriculture with mental health practitioners for free counselling services.

The University of the Fraser Valley has created the Flood Stories Project to engage farmers who were affected by the November 2021 flooding events. The project uses a narrative therapy approach to better understand how farmers have been affected by floods and what they need to thrive again.

9.3 Mental health service use and adaptations

Mental health recovery is best understood in the context of the phases of a disaster (see Figure 18), with the need for varying degrees of psychosocial support[57] over the weeks, months, and years following a climate-related event. For many, the road to recovery can be longer than anticipated. Community members may suffer setbacks months and even years after a climate event [75].

There has been a significant and growing need for mental health support for the public and frontline workers following climate-related events [27]. A survey of community members involved in recovery efforts from the 2021 Lytton wildfire found that more than 80 percent of respondents felt there were not enough mental health support resources to meet community needs [766]. Crisis Centre BC and BC Crisis Line Network report a 10- to 25-percent increase in crisis-line call volumes following disasters, such as extreme heat or wildfires, with waves of calls during the event and for weeks after [727]. Community wellness workers have reported an "overwhelming need for counsellors" following significant B.C. wildfire events [727], and *Risk to Resilience Project* focus group participants have emphasized the need for immediate, as well as longer-term, mental health support in impacted communities, given often-delayed mental health impacts.

57 Psychosocial support consists of all processes and actions that promote the holistic well-being of people in their social world, including supports provided by family, friends and the wider community [765].

After a major disaster event, access to mental health practitioners and culturally relevant mental health supports and information is critical in a community's reconstruction, as the mental health of its members affects every other facet of recovery [727].

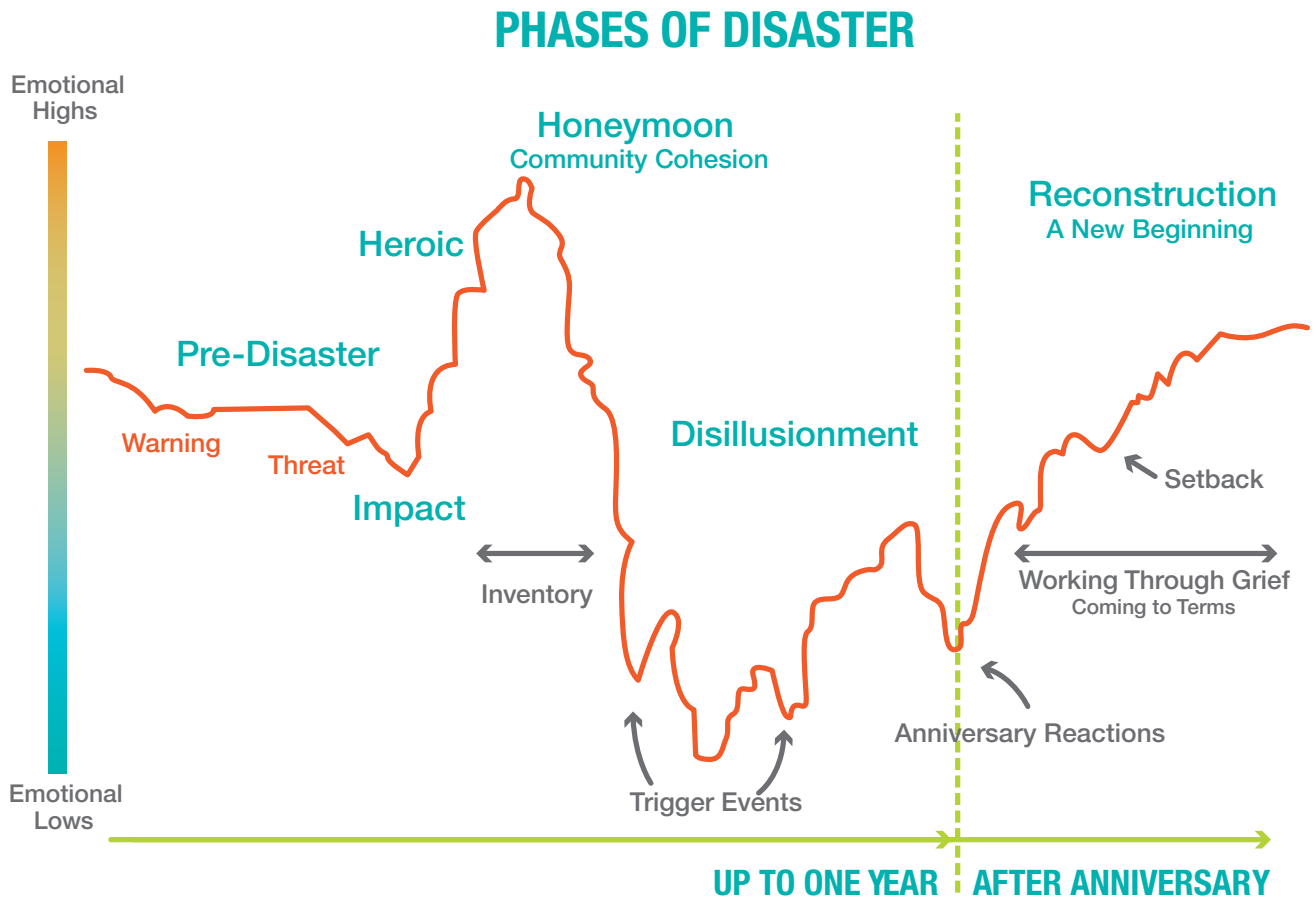


Figure 18. Disaster emotional response timeline [767]

Community psychosocial supports during and after disasters are often provided in partnership with the Provincial Health Services Authority (PHSA), regional health authorities, non-profit service providers, and community agencies who understand the needs and strengths of local populations. Recent wildfire and flooding events have demonstrated how collective efforts and partnerships across organizations and sectors can ensure mental health supports meet diverse needs.

The Province of B.C., in partnership with PHSA, the First Nations Health Authority, regional health authorities, and non-profit service providers, has developed a number of mental health programs, resources, and services to support individuals, families, and communities affected by climate-related disasters:

- The Disaster Psychological Services (DPS) program, overseen by PHSA, provides a continuum of psychosocial supportive services for the public and responders affected by an emergency or disaster [768]. The program includes the DPS Services Volunteer Network, comprised of over 200 registered clinicians, social workers, and victim service support workers. The Provincial Mobile Response Team (MRT) may act as an extension of DPS when needed to provide support for first responders such as fire services, police, military, and non-government organization personnel [232].

B.C. Disaster Psychosocial Services program in response to climate-related events

The Disaster Psychosocial Services (DPS) program has provided services such as helping evacuees at reception centres, working with residents at resilience centres during disaster recovery, and helping frontline staff and community members after suicides [56]. DPS volunteers have also been embedded in several Emergency Operations Centres (EOCs), providing care through activities such as resilience-building strategies for those in impacted communities, including leaders, hotel workers, business owners, and volunteers.

Requests for the DPS program during recent wildfires and flood events were substantial, particularly for support to evacuated residents in many different settings. During recent wildfire and flood events, its volunteers, casuals, and mobile response team staff provided:

- 2017: 2,234 psychosocial field hours deployed (134 for floods and 2,200 for wildfires)
- 2018: 876 psychosocial field hours deployed (316 for floods and 876 for wildfires)
- 2021: 2,755 psychosocial field hours deployed (1,580 for the atmospheric river and 1,175 for wildfires) [769].

In 2021, the DPS program was continuously deployed in some capacity for 64 days, to support evacuees in Kamloops, Merritt, Vernon and Lytton, while maintaining a wellness support line [358].

- HEMBC created the B.C. Mental Health and Wellness Recovery Toolkit, informed by lessons learned from the 2017/18 flood and wildfire seasons, to help community leaders, health practitioners, and community members plan for mental health supports after a disaster [765]. The toolkit supports recommendations of the 2018 report, Addressing the New Normal: 21st Century Disaster Management in BC, led by Chief Maureen Chapman and George Abbott, to "*develop stable and sustainable mental health recovery programs that acknowledge cultural linkages to the land and the compounding challenge of historical trauma*." [75]
- Mental health practitioners can sign up for the Emergency Health Provider Registry, a database of volunteer health care providers willing to temporarily relocate between health authorities to alleviate health provider burnout during and after an emergency event [691].

Collaboration for mental wellness in Thompson Nicola Cariboo [770]

Following the 2017 wildfire season in the Cariboo and Thompson-Nicola Regional Districts, United Way B.C. developed a wildfire recovery team that successfully increased awareness of the mental health impacts of wildfire disasters, reduced silos between community organizations, fostered community through events and workshops, and integrated mental health into future emergency planning.

Community collaboration to address isolation and loneliness

Following the devastating wildfires and floods of 2021, the United Way B.C. expanded its Hi Neighbour initiative to seven wildfire- and flood-impacted communities across the province. The program aims to support at-risk populations who may feel alone and not know where to go for urgent help in the face of a community emergency. The program hires staff who live and work in the communities they serve, identifies community champions, and makes vital links between support services, partners and individuals in need.

9.4 Opportunities for action

Addressing the acute and long-term mental health risks of climate change will require collaboration and coordination between public health and external agencies. Importantly, it also requires supporting community leadership and centering reconciliation and Indigenous worldviews of health and well-being [56]. Opportunities for action include:

- **Monitoring mental health in climate-related events:** Tracking the psychosocial impacts of climate-related events [50] is challenging; there are interconnected and compounding factors that influence mental health, time lags for impacts to emerge, a lack of baseline data, underreporting and stigma related to mental health [56]. Despite these challenges, there are opportunities to increase surveillance of mental health indicators, such as tracking emergency department visits for mood or behavioural disorders after extreme weather events [548], and to integrate mental health indicators into future climate change plans and policies [728].
- **Community capacity building and ownership:** Following climate-related events, local mental health recovery plans can build on existing programs, services, and supports of impacted communities, to ensure mental health recovery is community-informed and driven. The leadership of community-led recovery committees and mental health working groups is particularly valuable in informing the recovery management process and the withdrawal of outside mental health services [765].

> *"When you have the community taking on mental health recovery planning, real things happen; it's got to be owned by the community."*
>
> —*Risk to Resilience Project* focus group participant

Grand Forks mental wellness flood recovery (2018)

The most effective approaches to recovery can be supported by mobilizing community strengths. When Grand Forks experienced a significant flood in 2018, a local mental health recovery working group was formed. In partnership with Interior Health, they developed an innovative mental health assessment process to determine what mental health and wellness supports were required by key populations [509].

- **Community gatherings as a pathway to healing:** After a disaster, community members can heal by gathering to share experiences and support each other [500]. *Risk to Resilience Project* sharing circle participants described the importance of convening friends and families through dinners, traditional healing circles, cultural events, and arts-based activities after fire and flood events. It is important to offer resources and support for these types of gatherings.

> *"What I lost was my sense of place, because we were displaced from our home. But because of communication, we're able to at least maintain a sense of community identity. And critical to our overall health and well-being was the ability to gather (on social media or live streams) and also to come together."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

- **Mental health preparedness and planning:** Evidence shows that when communities are more prepared for extreme weather events, they are able to respond and mobilize more quickly to meet psychosocial and mental health needs [500]. *Risk to Resilience Project* focus group participants emphasized the need to include psychosocial well-being in climate adaptation planning from the outset, and for mental health practitioners to be included early on in preparedness and response planning, rather than being brought in during the recovery phase [75].

- **Rapid, sustained, and targeted psychosocial supports:** How psychological response to a disaster is managed may be the defining factor in how well a community recovers [771]. Interventions require rapid, culturally appropriate, and sustained mental health support that leverage strengths across public health, emergency management, and social service agencies. *Risk to Resilience Project* focus group participants emphasized the importance of early and sustained mental health interventions, including targeted/specialized interventions for those experiencing significant mental health issues (e.g., farmers/ranchers) and/or addiction issues related to the disaster.

> *"What matters, really, is: What kind of [mental health] resources can we get for them in that first year in particular?"*
>
> —*Risk to Resilience Project* focus group participant

- **Explore opportunities to enhance disaster psychosocial support services:** As climate disasters have become more frequent, there is growing awareness and demand for programs such as **the Disaster Psychosocial Services (DPS) program**. An analysis of the 2021 wildfire and flood events found there were not enough DPS volunteers to meet the mental health care needs of evacuees [273]. To prepare for future climate emergencies, programs such as DPS should be examined to determine capacity to support large provincial emergency events, and to identify limitations, solutions, and/or additional requirements [232].
- **Culturally safe and Nation-led mental health and wellness:** Special attention should be given to enhance the cultural safety of mental health and wellness supports during response and recovery periods are culturally safe[58], including connected to traditional approaches to healing. Indigenous wellness practices must be valued and supported alongside Western medicine, integrating Indigenous-led ceremony, culture, language, and land-based healing practices.

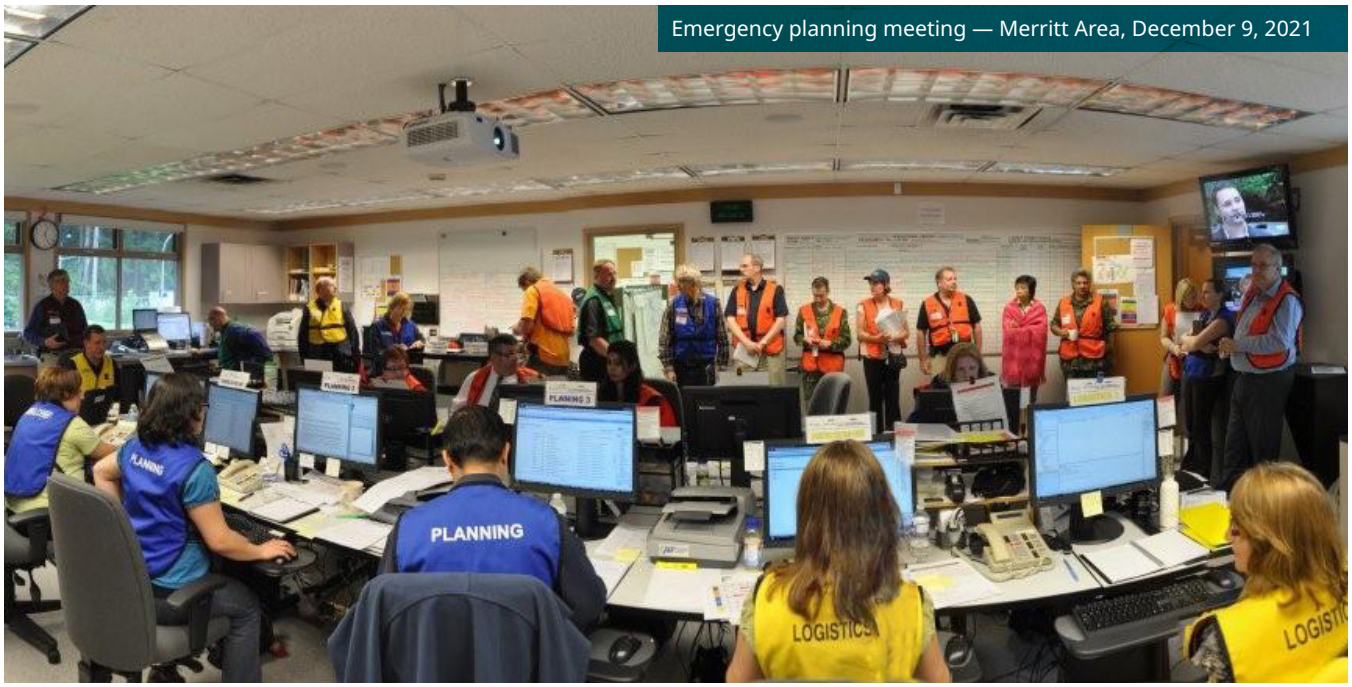
To effectively incorporate mental health and social support services into a climate-resilient health system, a coordinated, cross-governmental, and "all-of-society" approach is essential. This approach should prioritize the well-being of impacted residents and communities, and leverage the expertise and resources of the Ministry of Health, the First Nations Health Authority, PHSA, and regional health authorities, as well as non-profit service providers provincially and locally. Working together offers an opportunity to develop a comprehensive strategy that builds long-term resilience and prioritizes proactive action to understand and address mental health impacts of climate change.

58 Cultural safety is an outcome based on respectful engagement that recognizes and strives to address power imbalances inherent in the health care system. It results in an environment free of racism and discrimination, where people feel safe when receiving health care [75]

Chapter 10: Health Emergency Management, Evacuations, and Health Service Delivery

KEY FINDINGS

- Compound extreme weather events and cascading impacts in B.C. have led to **thousands being displaced** due to evacuations, **increased demand** for health services and programs, and **closures and disruptions** of health care facilities or departments.
- Responding to **multiple concurrent emergencies**, including climate-related disasters, the ongoing COVID-19 pandemic, and the toxic drug crisis, has resulted in staff burnout and reduced capacity in the health care system. The relentless pace of emergency response **limits time for reflection, preparedness, and planning**.
- Evacuations and extreme weather conditions **disrupt the continuity of care**, causing delays in access to appointments, diagnostics, surgeries, and medications. Patients with specialized medical needs, such as dialysis or opioid addiction treatment, face unique challenges, and the health system must adapt to ensure the continuity of their care during emergencies.
- Recent climate-related events emphasize the need for more comprehensive Emergency Support Services (ESS) and response plans that **address the unique needs of priority populations**, particularly Indigenous Peoples, those with mental health conditions, substance use disorders, older adults, and underhoused populations, **ensuring equitable access** to support during climate disasters.
- Health emergency management practices impacting Indigenous Peoples depend on cultural safety, collaboration, and Indigenous leadership. Cultural safety in reception centres, clear communication, and addressing racism are essential. **Centering Indigenous needs and values in emergency planning is vital for reconciliation and improving emergency management**.
- Opportunities for action include **improving clarity in emergency management** roles and responsibilities, fostering collaboration across various sectors, ensuring health systems are integrated into emergency planning, and **prioritizing cultural safety and anti-racism,** while simultaneously improving climate-health data collection, data sharing, and standardized indicators for better planning and response.



Emergency planning meeting — Merritt Area, December 9, 2021

10.1 Cross-cutting impacts

Climate-related emergencies have significantly impacted people living in British Columbia, displacing thousands from their homes and communities. They have resulted in increased demand for health services and programs, and led to closures and disruptions of health care facilities or departments. Due to system overload and evacuations, some patients have been unable to access health care providers, such as pharmacists, ambulances, or physicians, during emergencies.

Recent unprecedented emergencies, including the ongoing COVID-19 pandemic, the ongoing toxic drug crisis, and multiple climate-related disasters, have placed significant demands on emergency management teams across the health system. For example:

- When Emergency Operation Centres (EOCs) are activated across the province in response to heat, wildfires, and floods, they require health system staff time and capacity—sometimes multiple times per year. First Nations and local governments (municipalities and regional districts)—critical partners for health protection—also experience significant impacts on staff time and resources during emergencies.
- During disaster events, health emergency management teams support organizations across the health system with their emergency preparedness and response—assisting with coordination of transportation and supply, patient/staff transport, and collaboration across regional health authorities and with other partners.
- Health system staff and partners are challenged with transporting people with complex care needs or mobility issues during evacuations, or helping them access community shelters.

To enhance climate resilience in the health system, efforts are being made to integrate climate change into health emergency management, acute systems of care, public health programming, and health-service planning through monitoring and surveillance.

Responding to multiple emergencies

> *"Within the past couple of years, we've had back-to-back responses…We haven't had that moment to not be in an emergency. So, there's the compounding effect… We don't have time to build back right now… We haven't actually had time to reflect on those learnings."*
>
> —*Risk to Resilience Project* focus group participant

The relentless pace of emergency response and recovery from overlapping health and climate emergencies is leading to staff burnout and capacity challenges in the health system. With staff and partners in constant "response mode," routine work for emergency preparedness and readiness is being deferred [232]. Significantly more time and resources are being spent responding to and recovering from immediate impacts of climate-related events, leaving less capacity for preparedness and planning. Staff also report lacking the time and capacity to systematically reflect on lessons learned and integrate learnings into planning and operations.

Back-to-back emergency response

- **2017 wildfire season:** The evacuation of communities required tens of thousands of hours of work by health system staff. For example, Interior Health staff worked more than 32,000 staff hours. Northern Health staff worked more than 11,000 hours (with non-Northern Health employees working more than 12,000 hours) to support the Northern Health wildfire response, including more than 2,500 shifts at EOCs and more than 5,000 overtime hours [356, 772].
- **2021 heat dome:** With at least 619 heat-related deaths and a dramatic increase in emergency call volumes, the 2021 heat dome event overwhelmed ambulance and emergency room services across the province, resulting in EOC activations.
- **2021 wildfire season:** For 61 days, five regional EOCs were in operation in the Interior Health region [358]. The 2021 wildfire season resulted in the destruction of the Village of Lytton, and required the evacuation of hundreds of long-term care and assisted living clients from across the Interior by ground and air.
- **2021 atmospheric river (AR)-flood events:** A provincial state of emergency was in place for 62 days, during which health emergency management teams helped facilitate:
  - Evacuating 277 patients/residents from five Interior Health sites;
  - Coordinating 100+ flights to support moving patients, staff, physicians, and supplies in the Lower Mainland; and
  - Transporting 85 dialysis patients by ground and air over 13 days [358].

See Figure 19 for a map of 2021 evacuation order and alerts due to wildfire and floods in B.C.

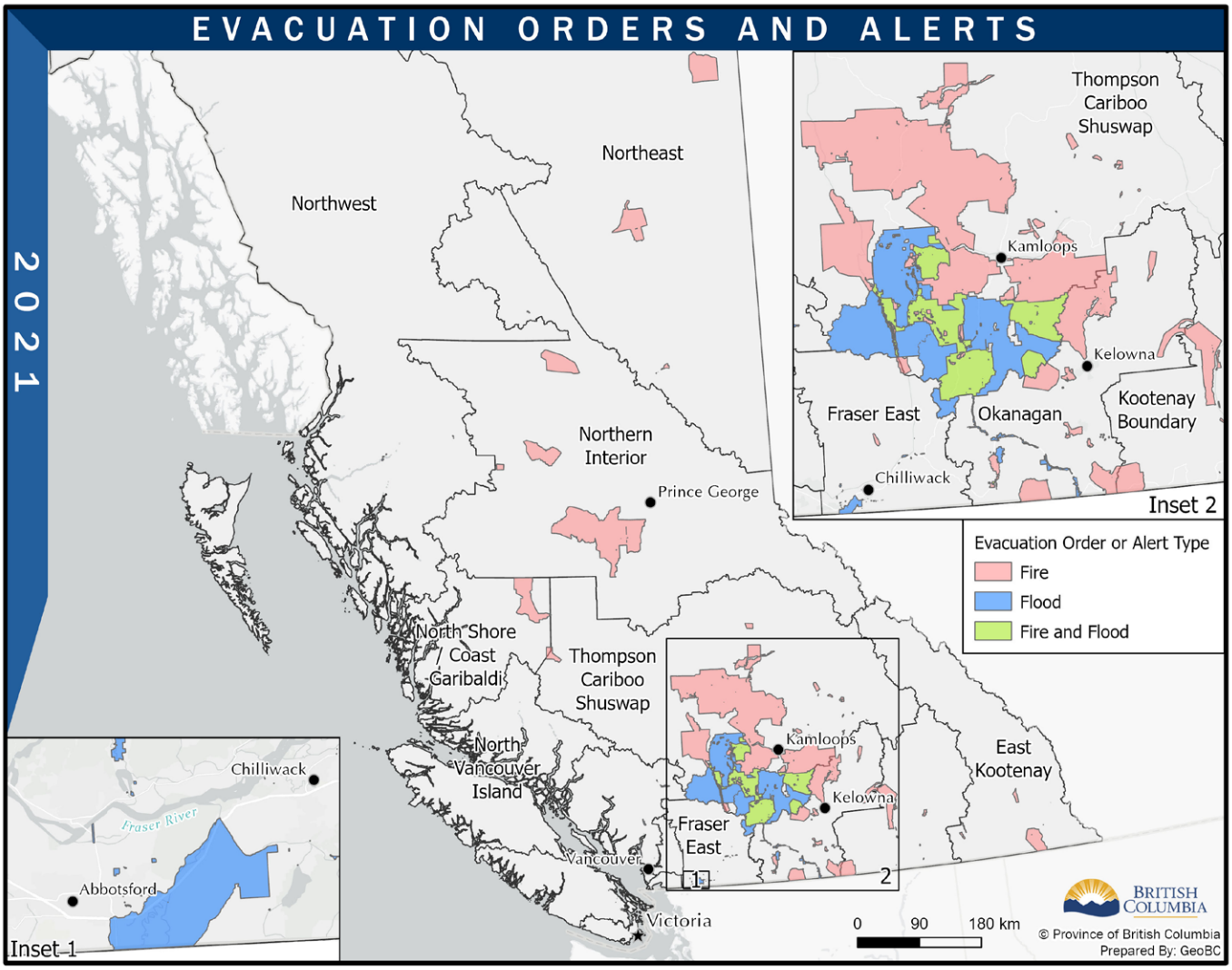


Figure 19. Evacuations orders and alerts in B.C. in 2021 for fires and floods

Patient surge and demand for health services

In climate-related events, a surge in patients creates cascading impacts on health care delivery in B.C. hospitals, affecting various aspects of care and hospital operations:

- Overcrowded emergency departments, inpatient units, and waiting areas hinder the provision of timely care;
- Capacity strain affects the supply of resources such as beds, medical equipment, medications, and supplies (e.g., cooling blankets or ice);
- Resources are diverted from non-emergent or elective procedures to prioritize urgent and critical care;
- Public social service and mental health programs come under increased demand, especially in impacted communities [34,342,773];
- Overcrowding makes discharging patients difficult, resulting in delays in transitioning care to post-acute care settings; and
- Hospitals and/or clinics are less able to respond to other emergencies or disasters [56].

During the 2021 heat dome event, acute care services experienced a significant surge, leading to overcapacity issues in emergency departments and in-hospital settings. Patients seeking care during this period exhibited higher levels of illness and urgency for intervention, further straining health care resources. Province-wide, there was a 21-percent increase in heat-related emergency department visits (853 excess visits) and a corresponding 21-percent rise in heat-related hospital admissions (estimated 900 excess admissions) compared to similar time periods in previous years [194].

All health regions reported increased emergency department visits [42,774]. The Fraser Health Authority had a particularly substantial spike in highly acute heat- or sunstroke-related visits—195 visits were attributed to these conditions on just one day: June 28, 2021 [97]. Similarly, Vancouver Coastal Health experienced over 200 heat-related emergency department visits, with a doubling of cases requiring critical care [230,775].

Extremely poor air quality during recent wildfires in B.C. also led to a significant increase in emergency department and doctor visits, and a spike in prescriptions for respiratory-related illnesses. Studies have reported more prescriptions for asthma medications being filled during smoke events in B.C. in multiple wildfire years [327,328,330,378,776].

For example, during the 2018 wildfire season in B.C., there were 30-percent more salbutamol (inhaler) prescriptions filled than during a similar period in 2016 without high smoke levels—with the highest increases in the Northern Interior and Okanagan regions [378]. Studies have also recorded more visits to physicians and emergency departments, hospitalizations, and ambulance calls for respiratory illnesses during wildfire smoke events—as well as cardiovascular and diabetes-related illnesses [326–330].

The 2021 AR-flood events overwhelmed hospitals in affected rural communities. At the Fraser Canyon Hospital in Hope, the emergency department filled to capacity [566]. *Risk to Resilience Project* focus group participants described needing to discharge patients from acute care in Abbotsford hospitals, but being unable to send them home due to road closures. As a result, there was an increase in demand for health services at evacuation centres that received the patients.

> *"There was a moment where the hospital was [discharging patients], because they no longer needed to be in the hospital. But a lot of these patients lived outside of Abbotsford. And because there was no way to get out of Abbotsford, they sent them to the group lodging facility, which was the evacuation centre. And we were not set up to be able to accommodate some of these folks as needed. A lot of them were still very ill and still needed 24-hour care and attention. And so that was a challenge that we faced in terms of not being able to support people with special health needs that came to the centre."*
>
> —*Risk to Resilience Project* focus group participant

B.C. doctor makes international headlines for "climate change diagnosis"

Dr. Kyle Merritt, a family doctor in Nelson, B.C., gained global attention [777] for diagnosing a patient in 2021 with "climate change" during a summer marked by extreme heat and wildfires. Dr. Merritt had witnessed an increase in patients coming into his office with similar symptoms, such as heatstroke, dehydration, and breathing issues from wildfire smoke, leading him to connect these health issues to the changing climate. These symptoms particularly affected those who couldn't afford air conditioning or worked outdoors.

> *"A patient I saw in the emergency department was suffering from the effects of heat. Of course, there's no such thing as a 'climate change diagnosis'—it's just listed as one of the precipitating events resulting in the [hospital] admission. But I thought that climate change was having an impact on this person's health quite directly."*
>
> —Dr. Kyle Merritt, *Risk to Resilience Project* interview

Risk to Resilience Project focus group participants shared that it was difficult to identify climate-related events as a "cause of injury," given the compounding factors involved. Entangled stressors, such as extreme temperatures and substance use, made it challenging to attribute delayed mental health impacts to climate-related events, or to link health outcomes to climate-related events. For instance, how should the "cause of death" be recorded when there is an overdose due to toxic drugs during an extreme temperature event? Work remains to refine surveillance and analytical techniques for monitoring and attribution.

> *"When we get the coroner's report, it's recorded that [an underhoused individual] died from a toxic drug overdose poisoning, rather than from cold weather. And we are hoping that there's a way to disentangle that. So, [we are] trying to figure out how to tease apart that data—whether they died because of exposure to cold, or whether the main contributing factor was illicit toxic drugs."*
>
> —*Risk to Resilience Project* focus group participant

Facility closures and service disruption

Health facilities have partially or fully closed during major wildfire and flood events in B.C., leading to disruptions in service delivery and patients needing to travel further distances to obtain care.

- During the 2017 wildfires, reported delays or cancellations in the Interior Health region included chemotherapy and oncology services, maternity services, home support, community nursing and wound clinics, lab and diagnostic services, ambulatory care, telehealth services, and urology [356,778].
- During the 2021 AR-flood events, there were service closures or disruptions in the Interior Health region, including at emergency departments, inpatient units, and outpatient services of Merritt and Princeton hospitals [233].

Evacuations, continuity of care, and patient transport

> *"In 2021, how many facilities [did we] evacuate? About 31 [in our health region]. Imagine tracking all those patients, and their conditions change every day."*
>
> —*Risk to Resilience Project* focus group participant

During a climate-related emergency evacuation, there are particular requirements and considerations for health care facilities housing vulnerable and frail patients and residents, many of whom have complex medical needs.

In addition to tracking hundreds of patients from an entire hospital or long-term care home, there is the logistical challenge of coordinating transportation, especially for those dependent on specialized medical equipment and therapies. For instance:

- Helicopter transportation during wildfires and floods presented obstacles for those with mobility challenges, and at times was not appropriate for patients needing specialized beds [56]; and
- Clinicians were needed at transport hubs to identify the physical abilities of patients to be transferred safely, while at the same time maintaining continuity of complex medical care and preserving patient records throughout patient transfers [56].

Figure 20 shows escape routes during 2021 wildfire season in Interior Health. It demonstrates the complex planning, logistical coordination, and consideration that went into transporting patients, sometimes more than once, during wildfire evacuations.

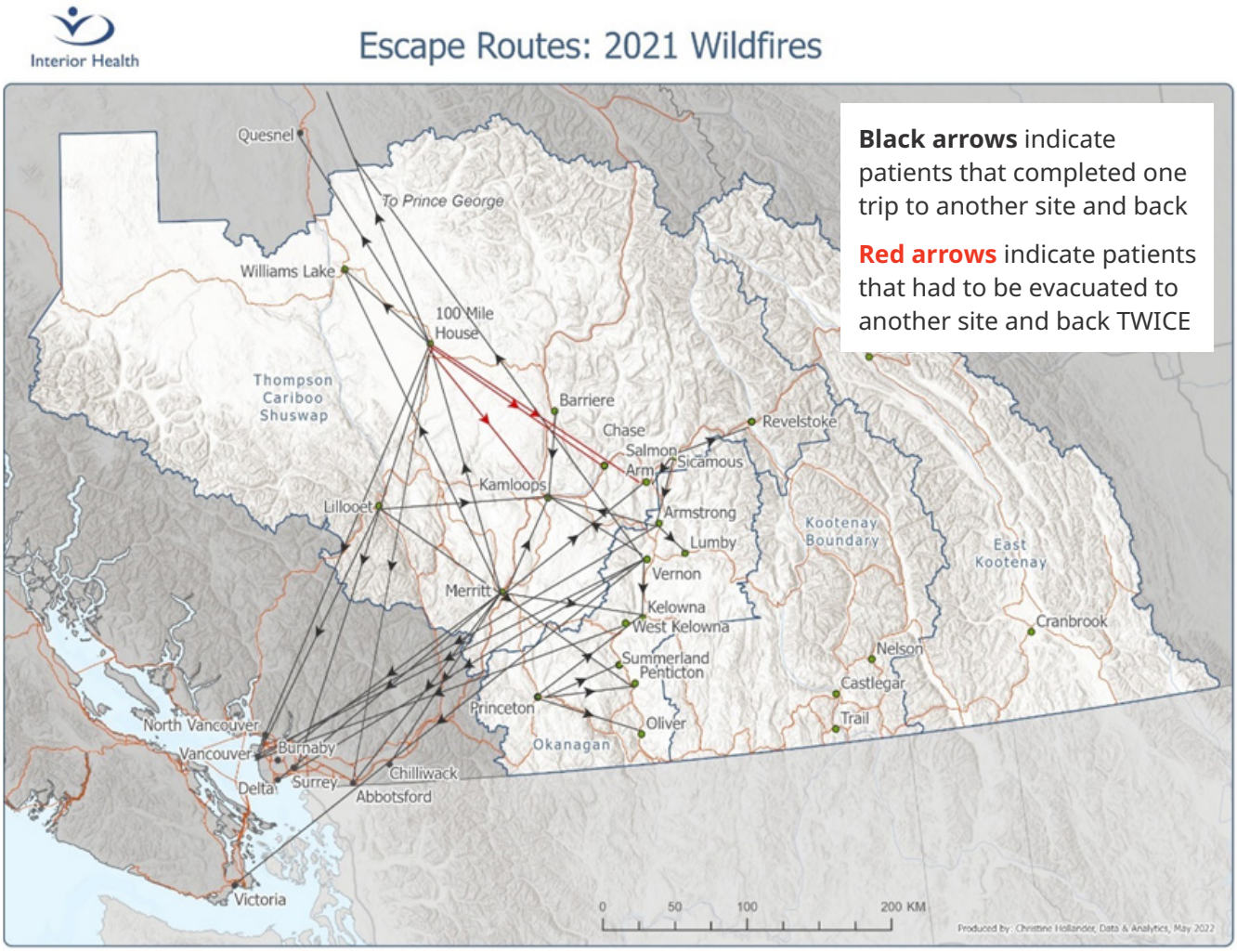


Figure 20. Escape routes for Interior Health patients and residents during the 2021 wildfire season [779]

Evacuating patients/residents with specialized needs

Residents of long-term care, assisted living, and mental health facilities often have complex medical conditions requiring specialized care, including assistance with activities of daily living, medication administration, and the use of medical equipment. During emergencies, sufficient staff are needed to assist with evacuations or patient transfers, especially if residents require one-on-one care.

> *"Just imagine you've got a long-term care home—150 people cognitively impaired, very, very frail, they're totally dependent... And the staff at the site, who probably struggle at the best of times with their staffing levels to meet the basic needs, are now asked to coordinate the evacuation of all those citizens. So, what we've learned is you need external support that you can bring to the site and direct traffic."*
>
> —*Risk to Resilience Project* focus group participant

Quality care, in the form of reassurance and comfort for patients and their families during evacuations, many of whom are scared and confused, is critical in any emergency response. During the 2021 wildfires and floods, nurses and caregivers demonstrated unwavering dedication as they calmly guided vulnerable individuals through the evacuation process [354]. Community home health nurses have leveraged the close relationships that care aides have with clients to build evacuation preparedness plans, working with clients and their families to identify contact people and safe places to go [56].

> *"We received a group of residents at the airport, and I was on the ground chatting with them and trying to figure out who they were and where their stuff was and where they were going. And they were so disoriented and confused… The impact on the residents, I think, cannot be understated… That was incredibly, incredibly stressful for everyone."*
>
> —*Risk to Resilience Project* focus group participant

Long-term care residents evacuated due to 2021 wildfires

During the 2021 wildfire season, over 1,000 long-term-care, assisted living, acute care, and home and community care residents and patients were evacuated and repatriated from the Interior Health region to the Lower Mainland. Some facilities were evacuated more than once [779]. Dedicated staff worked long hours, overseeing the coordination of transportation, medications, and records, while providing support and comfort to patients and keeping patient families updated. All the while, they were also dealing with their own personal impacts from the wildfires [354,780].

- Just four days after returning from a one-month stay in Salmon Arm due to a wildfire evacuation, 30 residents and staff had to evacuate once again when heavy smoke surrounded the long-term care homes of Fisher Place and Mill Site Lodge in 100 Mile House during the 2021 Flat Lake fire. Some residents were confused and anxious as they boarded the bus to the south coast without their staff caregivers, who were following behind in a carpool to support them. Residents were evacuated for three weeks to different facilities in Chilliwack, Burnaby, New Westminster, Surrey, Aldergrove, and Abbotsford [354].
- In August of 2021, the Brookhaven Care Centre team in West Kelowna safely evacuated all 104 of their residents from a surrounding wildfire. Residents boarded a series of buses and an airplane to arrive safely in Vancouver. Several staff accompanied the residents on the journey, a few working 24 hours straight to ensure residents were safe and settled into their temporary homes. Multiple team members continued to live on-site with their residents, while others travelled back and forth between the Interior and the coast for several weeks. Staff decorated the residents' bedrooms with posters and comfort items, and even hosted an 80th birthday party and 60th wedding anniversary celebration during the evacuation [780].

Evacuation of Abbotsford mental health facility

Flooding from the 2021 atmospheric river (AR)-flood events placed Abbotsford's Mountain View Home, a 25-bed licensed mental health facility providing 24-hour care to adults with mental health conditions, on evacuation alert. The evacuation required a patient-centered and trauma-informed approach, with a focus on communication, safety, and continued care. Fraser Health led the coordination of mental health support for residents—including nursing, psychiatry, and pharmacy services—as well as the delivery of all meals, medication, and social and recreational services. When roads were blocked, Mountain View and Fraser Health staff demonstrated an extraordinary team effort to provide continued support for residents, including arranging transportation and ongoing communication with families alongside service delivery [559].

Continuity of care during emergencies

Continuity of care is critical for patients requiring specialized treatment, such as dialysis and cancer care. During the 2021 AR-flood events, 54 hemodialysis patients in the Fraser Health region were cut off from access to dialysis, and more than 20 peritoneal dialysis patients in the region were impacted, many with limited supplies. Service delivery also affected post-transplant patients and those transitioning to home dialysis.

Continuity of care for B.C. renal patients

Dialysis patients were significantly impacted by road closures during the 2021 AR-flood events. Over 50 hemodialysis patients in the Chilliwack area were unable to access to dialysis, with some not able to dialyze for five days. Others were without proper medical supplies or power to dialyze at home. The Community Dialysis Team at Abbotsford Regional Hospital set their emergency response plan in motion, determining the needs of all hemodialysis patients and locating patients east of the flood zone.

The team coordinated with various health system emergency management teams, arranging helicopter transportation for vulnerable patients who required immediate care through the BC Wildfire Service and the Canadian Armed Forces. Complex decisions were made about who would require dialysis first and who might be able to wait. The team had to assess patients' level of frailty and ability to ride in a helicopter, and renal pharmacists partnered with community pharmacists to assemble and package vital medications to be delivered to patients in Chilliwack and Hope [543,558,591].

In 2023, BC Renal and regional health authority renal programs jointly produced a Provincial Renal Emergency Management and Business Continuity Plan that supports collaborative health emergency management planning between BC Renal, its regional health authority partners, and patients. The plan ensures hazard, risk, and vulnerability assessments are conducted regularly to identify potential impacts for BC Renal or its partner facilities, and details the structures required for an organized, comprehensive, and effective provincial response to a major emergency or disaster [781].

Patients unable to access/attend appointments

> *"When major events happen, we get cut off [from] very simple things like preventive health care (e.g., mammograms). When there are actual disasters, and you need critical care…you can't always [air] transfer. It's mostly road [transfer] that we do… So, it just gets a lot harder to deliver care."*
>
> —*Risk to Resilience Project* Interview participant

During emergency events, evacuations and patient inaccessibility lead to temporary closures of community clinics. Road closures or dangerous weather conditions can prevent patients from accessing or attending appointments, diagnostic tests, and surgeries, with ambulances/non-urgent medical transport services becoming unavailable. Focus group participants reported that patients missed CT scans and follow-up appointments in flood-hit regions of the Interior. Adding complexity, health care providers may not know why people missed appointments or when they may be able to reschedule [56].

In some cases, virtual care was successfully delivered when patients could not make it to appointments [592]. However, during extreme weather events, virtual care may not be accessible to everyone due to interrupted internet and phone services.

> *"It's not as hot here, or it's not raining [in the north]…but we will see impacts in our services and programs. The atmospheric river being a really good example; [it] completely shut down our Northern Health Connections, medical travel buses, and ability to get to facilities in the Lower Mainland."*
>
> —*Risk to Resilience Project* focus group participant

Access to medication and pharmacist support

> *"When Chilliwack and Hope were cut off by floods, there was no pharmacist in Hope. There were two pharmacies that had power, but there was no way for them to be open. And with the town having a lot of overflow, people needed diabetes medications and other prescriptions. So, we had to fly in a pharmacist from out of town."*
>
> —*Risk to Resilience Project* focus group participant

Access to medications during significant wildfire and flood events has been a significant challenge, impacted by:

- Pharmacy closures as a result of mandatory evacuations and road closures;
- Evacuated patients leaving home without prescriptions or medications, or running out of medications while displaced; and
- Limited access to prescribing physicians and/or to pharmacists in communities receiving evacuees [534].

> *"One of the things that we found when we had to evacuate 100 Mile House is our home health clients and our street entrenched clients, or those that didn't have a fixed address, didn't actually have a pharmacy to get their prescriptions renewed. Coming out of that, [we provided] direction that there needs to be some sort of a temporary ability to stand up an emergency pharmacy."*
>
> —*Risk to Resilience Project* focus group participant

Patients who cannot access their prescription medications during an emergency are at risk of health complications, stress, anxiety, and, in some cases, withdrawal. During recent wildfire and flood events, patients receiving opioid agonist therapy (OAT), such as methadone or Suboxone, were particularly at risk; missing even one day of medication can cause withdrawal symptoms, and missing several days increases the risk of relapse for otherwise stable patients [782]. Community nurses expressed concerns about the toxic drug crisis overlapping with climate-related events, as relapsed evacuees are at greater risk of dying from the toxic street drug supply [56].

> *"What struck me was the number of opioid cases… How many people had deceased during [the 2021 AR flood] because they could not get a clean supply?"*
>
> —*Risk to Resilience Project* focus group participant

Pharmacists ensure continuity of care during disasters

When recent wildfires and floods displaced many B.C. residents, including patients and pharmacy staff, it could have easily led to patients missing medication treatments or medication errors [576]. However, pharmacies across the province came together to ensure patients received their medications on time.

The BC Cancer pharmacy team has built safe medication systems to ensure patients receive the intended and best care possible. Some pharmacies send prescriptions on paper, but when hospitals closed due to 2021 wildfires, these paper-based documents were left behind. Provincial pharmacy leads connected to pharmacists at affected community oncology network sites, contacted patients to assess needs, and then connected with physicians and nurses to facilitate their care [576].

In 2021, cancer patients living in Chilliwack were cut off from Abbotsford's BC Cancer centre due to floods, and could not access their medications due to interrupted supply chains and washed-out highways. Pharmacists arranged for some medications to be transported by helicopter, and drugs with specific shipping requirements to be safely transported from locations in Edmonton and Calgary [561,576].

Similarly, when wildfires impacted B.C.'s Interior region in 2017, pharmacists welcomed evacuees and arranged for patients to get emergency fills of prescriptions, glucose strips, and inhalers [352]. Pharmacies donated supplies such as first aid materials, over-the-counter medicines, EpiPens, glucometers, needle and sharps containers, and wound dressings. Pharmacist volunteers helped patients at the evacuation centre with diabetes treatments, heart medication, and methadone. Back at their stores, colleagues changed shifts to ensure the evacuation centre had pharmacist coverage.

A robust pharmacy response is crucial during the early phases of an emergency, especially during evacuations. Pharmacies collaborated with health authorities during recent wildfires and floods to provide an uninterrupted supply of medications for patients. Examples of actions include:

- The BC Centre for Disease Control (BCCDC) has released a set of tips for the public, Accessing Prescriptions During Extreme Weather (2022), which also apply to patients prescribed opioids or safer supply [783];
- The College of Pharmacists of British Columbia has implemented Professional Practice Policy 31—Emergency Supply for Continuity of Care to guide pharmacists on providing an emergency supply of prescription drugs for continuity of care in exceptional circumstances, such as an evacuation due to wildfires or flooding [784].

- A Pharmacy infrastructure team is working across Vancouver Coastal Health, Provincial Health Services Authority (PHSA), and Providence Health Care sites to upgrade and install automated dispensing cabinets in patient care areas [785]. The cabinets play a crucial role during emergencies by providing rapid and secure access to medications, ensuring proper medication management, and reducing the risk of errors.

Evacuation impacts on health workforce

Health system staff are also displaced when there are evacuation orders in their home communities (see Table 5). Staff relocating with patients and residents during facility evacuations may be away from home and family. They may be worried about suffering their own losses, while continuing to provide care and services to patients [96,349,367]. They must also navigate a learning curve when deployed to a different health authority with different ways of operating [349,350,354]. Health system staff have also experienced challenges finding their own accommodations when accompanying residents in an evacuation [349].

*Table 5. Interior Health patient and staff wildfire evacuations in 2021 and 2017**

	Interior Health 2021	Interior Health 2017
Patients/residents evacuated	1,151	880
Health sites evacuated	21	19
Staff displaced	2000+	700+

*Source: [42,355]

Shelter in place or evacuate

The decision of whether to shelter in place or evacuate a facility must take into consideration the stress and anxiety of evacuations on patients and residents, and the additional burden on the health system. Leadership teams are required to consider patient risks (e.g., mental health, risk of falls), complexity of care required, transportation and mobility needs (e.g., stretchers, wheelchairs), proximity to the threat (e.g., escape routes and distance to safety), and staffing capacity.

Staff have created a number of tools to support decision-making and coordination in evacuations, including:

- A risk-benefit matrix to support decisions about whether to shelter in place or evacuate;
- Evacuation dashboards for tracking clients; and
- Processes to track the details of specialized equipment and medications [56].

Interior Health Handbook for Establishing Portable Primary Care [42]

To effectively and safely deal with an unplanned surge of people requiring primary care during an emergency, Interior Health developed the Handbook for Establishing Portable Primary Care Services (2021). The document provides guidance to local Incident Command and partners on options such as developing portable primary care sites (e.g., in Emergency Support Services reception centres, schools, or arenas) or securing a mobile medical unit—a "hospital on wheels" that can adapt to a broad range of care needs.

Evacuations between health authority regions

Effective and timely partnerships between health authorities are key to facilitating safe and well-coordinated patient transport during evacuations. During recent wildfire events, some health authorities received large numbers of evacuated patients in a short period of time, placing increased demand on health services, human resources, and financial costs in the receiving communities [353,772]. During the 2017 Cariboo wildfires, for example, the Northern Health region provided services to more than 300 evacuees from the Interior Health region over a 47-day period—including home care nursing and home support, acute care and diagnostic services, and community clinic services such as medical visits and drug prescriptions [772].

For Indigenous communities, evacuations due to wildfire or floods can also result in the loss of community-based culturally safe health services. Some participants stressed that, during evacuations and long-term displacements, they were cut off from the culturally appropriate, trusted health services and practitioners (e.g., healers and culturally safe counsellors) of their home community. This left them without culturally safe health supports and services for the duration of the emergency, and sometimes for years into recovery [56].

> *"When I think about health [service] impacts, I think about that from a cultural perspective. Because nothing compares to getting the brushing from an Elder who's safe, from a cultural worker who's safe."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

Indigenous organizations and health authorities in B.C. are finding collaborative ways to support the well-being and continuity of care for evacuees. During the Northwest Territories (NWT) 2023 wildfire evacuations, for example, information sharing between the Government of the Northwest Territories and regional health authorities enabled NWT Métis Nation to offer support to Métis evacuees transferring into B.C.'s medical system. This experience may offer lessons for enhanced collaboration between B.C. health authorities and Métis Nation BC, and opportunities to provide culturally safe emergency support, community cohesion, and kinship for Métis citizens during evacuation, intake, and discharge [786].

10.2 Equity lens in emergency management

The unique needs of those experiencing health inequities must be specifically addressed in emergency response plans, so that disasters do not worsen existing inequalities or create new ones [368]. A 2023 BC Ombudsperson's report, *Fairness in a Changing Climate*, concluded that people disproportionately impacted by extreme weather during the 2021 wildfires and 2021 AR-flood events—including Indigenous Peoples, people with disabilities, lower-income households, older people and children, and people with complex care needs—faced unfair barriers in accessing the emergency supports they needed [273]. For example, long waits at reception centres posed significant challenges for people with disabilities and/or existing mental and physical health conditions.

During recent climate-related events, health system staff identified opportunities for emergency support services (ESS) models to provide enhanced wrap-around supports and cultural services—especially for

Indigenous Peoples, those with mental health challenges, those with substance use disorders, and underhoused populations [233].

> *"We did not, at the time [in 2021], have a good systematic way of identifying the highest risk clients. So, it was very much relying on the clinicians and the staff and what they knew about their clients, and then proactively reaching out and identifying those that they were concerned about."*
>
> —*Risk to Resilience Project* focus group participant

In response to lessons learned during climate-related events, such as the 2021 AR-flood events, hospital staff began keeping lists of contacts of at-risk patients (e.g., those requiring palliative care or receiving chemotherapy) to make it easier to check on them during future disasters.

> *"We were scrambling at that time but now we have it all in place. And it's instantaneous: we know their addresses, we know to check in with them… I think every community should have this."*
>
> —Dr. Aseem Grover, Medical Director, Fraser Canyon Hospital, as quoted in After 2021's trial by flood, Hope's hospital prepares the for the next disaster [566]

Public Health and home and continuing care teams have been developing guidance notes and tools for community health workers and non-profit partners on conducting check-ins for at-risk clients during extreme heat and smoke events [195]. They also have been piloting new client intake risk assessments for home health clients that include questions on environmental vulnerabilities [56].

In preparation for climate emergencies, there have been important advances within the health system to adapt practices for more equitable care. Still, building sustained adaptative capacity to support priority populations will also require addressing the structural factors, across multiple scales, that perpetuate inequities in the first place.

Adaptation in action: Estimating climate-related health risks for priority populations

In preparation for extreme weather events, home health workers across multiple health authorities now proactively inquire about their clients' mental health, physical environment, cooling/ventilation infrastructure, and how prepared they are for heat or smoke events [56].

Some also use the Canadian Institute for Health Information's Vulnerable Persons at Risk Scale, which identifies persons receiving home care most in need of support during emergencies. The algorithm calculates a risk score based on a number of criteria, such as time alone, medications, ability, social interactions, and use of essential medical services, such as dialysis or oxygen therapy.

This tool helps home care workers prioritize supports in a disaster, supports emergency planning, and promotes consistent decision-making among home care staff [787].

10.2.1 Indigenous cultural safety in emergency management

The impacts of health emergency management practices on Indigenous Peoples in B.C. are influenced by factors such as the level of collaboration, cultural safety, and Indigenous leadership:

Culturally safe emergency management processes and supports: A recent report found Indigenous evacuees in B.C. were more likely than non-Indigenous evacuees to have been displaced by a combination of wildfire and flooding events in 2021. Their displacements were more likely to be longer, with more instances of challenges in accessing to health care, accommodation, and housing than non-Indigenous evacuees [273]. Other reports have described culturally unsafe services at reception centres, highlighting the critical importance of ESS supports and facilities that foster and prioritize cultural safety [702].

In addition, *Risk to Resilience Project* Indigenous sharing circle participants shared that a "command and control" approach to emergency management can, hinder self-determination, agency, and cultural safety for Indigenous communities affected by climate-related emergencies. As a result, community staff trained in cultural safety (e.g., health directors) have had to "step in" to support the emergency management process, which prevented them from providing other needed community health support.

> *"This health director felt like she was carrying the burden and load that should be carried by the emergency manager. But because they were so out of touch with the cultural and community-based needs, she was stepping in and wrapping around everything."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

Evacuation coordination and communications: *Risk to Resilience Project* Indigenous sharing circle participants also shared stories about the need for clearer communications across levels of government and within communities with respect to evacuations (for instance: Where to evacuate to? Where to stay when you get there? How to find each other?). They also cited challenges in in tracking community members who had been evacuated, and confusion around funding and roles. Some participants stressed that many of these same challenges were experienced in previous wildfire years (2017/2018) and that recommendations had not been implemented [56].

> *"Each time, there was no real plan. So, the big thing here was…there was no real plan in 2017 that saw this occur and there's no real plan in 2021."*
>
> – *Risk to Resilience Project* Indigenous sharing circle participant

Racism experienced by evacuees: Several participants shared that they had experienced racism during the evacuation process, in the reception centres, and/or in the hotels and restaurants to which they were evacuated. As a result, community members took on an advocacy role with staff and volunteers.

> *"Well, in our community, we had to deal with racism as well, when the fires were nearby… We had to get a lady from our community to go there and advocate for our people because they were being mistreated in the line."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

> *"We had some people who had really strong leadership skills and were able to help our Elders to get in the right places and address some of the racism that was happening with some of the hotels."*
>
> —*Risk to Resilience Project* Indigenous sharing circle participant

10.3 Cross-cutting adaptations for health emergency management

While B.C.'s health system has experienced concurrent, escalating, and unprecedented emergencies in recent years, it has also demonstrated strong leadership, support, and expertise in responding to, preparing for, and adapting to these events. There are inspiring examples from across the health system of emergency response and recovery to acute events, and of building long-term capacity for disaster preparedness and planning—from frontline health care providers working on the ground in communities, to health emergency management leadership across the province.

Modernizing health emergency management in B.C.

Emergency management in the B.C. health system is influenced by provincial emergency management guidelines and legislation. The Province adopted the United Nations Sendai Framework for Disaster Risk Reduction in 2018 [788], and the *Declaration on the Rights of Indigenous Peoples Act* became law in 2019 [86]. Both have guided the modernization of B.C.'s emergency management approach (2019–2024), shifting the focus from emergency response to all four phases of emergency management (mitigation, preparation, response, and recovery), improving cultural safety supports, and ensuring that planning is attentive to the disproportionate impacts on priority populations [789]. In alignment with the new *Emergency and Disaster Management Act* [790], the Ministry of Health is modernizing its Health Emergency Management policies, plans, protocols and regulations to account for current and future climate conditions.

The Ministry of Health and Health Emergency Management BC (HEMBC) work collaboratively with regional health authorities to enhance health system resilience to effectively mitigate, prepare for, respond to, and recover from the impacts of emergency events [368,791]. During climate-related events, health emergency management teams support and coordinate the activation of provincial response structures, support multi-jurisdictional alignment and deploy emergency medical equipment, supplies, and temporary facilities [791].

Regionally and locally, health emergency management teams support seasonal readiness planning committees, established in response to extreme weather events in 2021. These committees identify gaps in emergency preparedness and develop plans to ensure delivery of health services and the protection of priority populations during future extreme weather events—including those in residential care facilities, home care, outpatient settings, and communities. By producing after-action reports and implementing measures to improve service continuity and health protection, these committees have provided valuable insights and lessons to enhance overall readiness [234].

Coordination and collaboration for emergency preparedness, response, and recovery

Climate-related emergencies increasingly impact multiple health authorities at once, requiring a coordinated health system response across the province. Currently, the Health Emergency Coordination Centre is responsible for central coordination for emergency management across the B.C. health system, including regional health authorities and other health system partners. The Inter/Intra-Health Authority Response (IIHAR) Working Group has also played an important role in supporting coordination and information sharing related to preparedness and response.

Within each health region, internal coordination is critical for managing emergency response and service impacts across programs—including mental health and substance use, pharmacy, dialysis, home health/home support, and long-term care/assisted living [56]. Regional health authority staff indicated that the connections with programs and partners established during COVID-19 were leveraged to "be prepared and connected to one another" during recent climate-related events [56]. For example, during the pandemic, health authorities developed communication mechanisms (e.g., contact lists and regular town halls) to quickly disseminate information to public and privately operated long-term care sites, which were also employed during 2021 climate-related events [56].

Mobilizing and coordinating community resources across various sectors—including engaging with sectors outside the health system—is integral for supporting readiness, response, and recovery [692]. Strong collaborative networks facilitate rapid information-sharing and the integration of emergency management plans with community partners. Health system staff have reported strengths in emergency response collaborations and partnerships with:

- Local governments and First Nations, specifically in providing health expertise and navigation support to local emergency management partners;
- Provincial and federal partners, such as the B.C. Ministry of Emergency Management and Climate Readiness, Ministry of Environment and Climate Change Strategy, the River Forecast Centre, BC Wildfire Service, Canadian Armed Forces, and CN Rail; and
- Non-profit partners, such as the Canadian Red Cross, United Way, Salvation Army, Food Banks BC, and St. John's Ambulance.

Non-profit partners, in particular, have played an important role in working alongside local governments, First Nations, and health authorities to "fill the gaps" in emergency response. They have provided supplies, food, funding, volunteers, and mental/social support to impacted emergency responders and community members, including priority populations such as low-income, underhoused, and newcomers [56]. Often,

they play an important role in long-term recovery, supporting resilience and helping to rebuild the social infrastructure of an affected community [792].

EOCs serve as a central hub during emergencies and disasters, and are important for coordinating partners in the response of emergency management. They facilitate effective and efficient response and recovery efforts by providing a centralized location for decision-making, communication, resource allocation, and coordination among various agencies and organizations involved in emergency management. Regional health authority staff report that EOCs are important for connecting agencies and services, for delivering situational awareness, and for exchanging information at a rapid rate [56]. The familiarity of a health region's executive leadership with the EOC response was identified as a key factor in mobilizing quick responses across the region, sharing information across programs, and streamlining decision-making.

> *"We have learned that EOCs can be very effective tools for coordinating regional responses, whatever the event (wildfire, flooding, congestions in the system)."*
>
> —*Risk to Resilience Project* Focus Group participant

> *"We've been able to pull together the EOC group where people report in from acute and mental health and long-term care and assisted living, and everybody's on the call, and everybody at least has some idea of what is happening... Just having some experience with that structure and running through that structure has been beneficial for us."*
>
> —*Risk to Resilience Project* focus group participant

The COVID-19 response has increased collaboration between program leaders throughout regional health authorities; these relationships enabled more streamlined coordination during the response to the extreme heat event of 2021. Health system staff report that, during the COVID-19 response, they became familiar and confident using coordination centres and EOCs, enabling them to rapidly implement emergency response structures and processes in other emergency events [232].

While essential, EOCs can be time-intensive for health staff. Some have recommended the development of an EOC program/participant list for different types of emergency responses, including support services, intra-health authority programs, as well as programs/agencies that serve in-community patients with urgent medical and/or diagnostic needs (e.g., BC Renal dialysis program, BC Cancer, BC Transplant, BC Children's Hospital, home health/home support, cardiac services, home oxygen, Mental Health & Substance Use Services, Medical Imaging) [232].

> *" [If you] factor multiple EOCs being triggered across multiple emergencies, it weighs heavily on staff capacity."*
>
> —*Risk to Resilience Project* focus group participant

Virtual care

Virtual health care and telehealth present opportunities to enhance climate resilience by, enabling remote patient care and consultations and continuity of care when health care facilities are evacuated or damaged in disaster events. Virtual care is also considered more environmentally sustainable than in-person visits by reducing travel-related greenhouse gas (GHG) emissions. Telehealth was tested and rapidly scaled-up in B.C. during the COVID-19 pandemic, and has since been leveraged to increase climate resilience in a number of instances:

- Health authorities are increasingly implementing telehealth strategies to connect patients to health care services, regardless of where they live. Examples include the First Nations Health Authority (FHNA)'s First Nations Virtual Doctor of the Day program and Northern Health's Virtual Primary and Community Care Clinic.
- The provincial Digital Health Strategy is decreasing GHG emissions in the health care sector and enabling service continuity during climate-driven emergencies by expanding virtual health care and emergency services, developing mobile apps and digital health technologies, promoting telecommuting, and conducting virtual public health inspections.
- Island Health's Hospital at Home program, launched during the pandemic, provides acute care to patients in their own home. Patients receive in-person daily visits from program staff, supplemented by virtual visits. There may be an opportunity to leverage the program during emergencies and to reduce health care provider travel by offering real-time virtual support.

Virtual supports for peritoneal dialysis patients during the 2021 AR-flood events [592]

Peritoneal dialysis (PD) patients in Fraser Health typically visit a hospital for ~12 hours of training with a PD nurse on managing their conditions at home. When the 2021 AR-flood events closed roads and made travel to Abbotsford Hospital impossible, a Fraser Health PD nurse and patient successfully conducted home-based dialysis training via Zoom.

"The biggest benefit was starting dialysis without waiting," the patient shared. *"It was a huge relief in the midst of flooding and being cut off from renal support. It was definitely also directly beneficial to my health—I very much needed dialysis!"*

The training also took place during pandemic restrictions, which continued into 2022. This allowed for patient-nurse interaction while maintaining physical isolation—preferable for dialysis patients who were clinically extremely vulnerable to COVID-19.

10.4 Opportunities for action

Despite the challenges of responding to multiple climate-related emergencies year after year, health system staff and partners have identified a number of promising practices, lessons learned and opportunities to strengthen emergency preparedness and response in the future:

Leadership, roles, and responsibilities

Given the multi-sectoral nature of emergency management, **a provincial health emergency management framework** would serve to:

- Continue to clarify how the health sector, including primary and community care, fits into the evolving structures of emergency management in B.C.;
- Define the roles of health care providers and agencies in health emergency management, including preparedness, response, and recovery; and
- Prioritize the unique needs of priority populations and those experiencing health inequities in local, regional, and provincial health emergency response plans [56,368],[232].

Collaboration for a whole-of-society approach

Effective responses to protect public health and safety during climate-related emergencies require collective and coordinated action. Opportunities include:

- **Enhancing community partnerships:** Strong emergency preparedness and response requires developing collaborative emergency response plans with health services that operate outside the authority of the provincial health system, such as Divisions of Family Practice; pharmacies; privately operated long-term care, assisted living, and Mental Health and Substance Use affiliates; local governments; First Nations; Métis organizations; and nonprofit service providers [232]. Health system staff highlighted the need to proactively build and formalize these relationships in advance of an emergency [56].
- **Ensuring health is "at the table" for emergency planning:** By inviting health partners to the table early on in the emergency planning process, emergency management partners can better understand health sector roles, needs and perspectives [56]. This includes joint emergency response exercises that bring together all emergency management roles [232], including those of community and facility-based physicians [368].
- **Ensuring planning, implementation, and response are grounded in anti-racism and decolonization:** All health system players and community members have a role to play in advancing emergency response procedures that are culturally safe and anti-racist. This includes advancing commitments to decolonization in the Declaration of the Rights of Indigenous Peoples Act and B.C.'s Modernized Emergency Management Legislation (2023), which recognize the authority of Indigenous governing bodies in relation to emergency management. In addition to these legislated changes, there are opportunities to build effective relationships with Indigenous communities and provide anti-racism training across health system roles [61].

Capacity building for health emergency management planning

While the immediate response to climate-related emergencies has generally been robust and nimble, skills and capacity are needed for evaluation and long-term emergency preparedness planning [232]. To support continuous improvement, a provincial health emergency management learning framework is being designed to identify and act on lessons learned from emergency events.

There is a recognized need to modernize training for health emergency management staff, and to support continuous skills development in the context of a changing climate, particularly in areas experiencing increased wildfire and flood exposure. These needs are amplified in rural, remote, and Indigenous communities that are differentially impacted, but have fewer resources and lower capacity to adapt, prepare, or plan.

Building capacity for emergency planning in long-term care and assisted living facilities, both public and private, is also a priority. During the pandemic and recent climate-related events, contracted or affiliate long-term care and assisted living facilities—distinct from those owned and operated by health authorities—experienced impacts to residents and capacity challenges with preparedness and response [56]. While the *Community Care and Assisted Living Act*'s Residential Care Regulation [793] requires all long-term care facilities to have an emergency plan, this necessitates staff skills and training in emergency management (or support from emergency management professionals).

> *"I think we're missing things because we are a health care people at the end of the day. We are not emergency planners or emergency management folks. I think overarching support would…help us ultimately get down to that level where we're mitigating physical and mental health impacts when more of these events happen."*
>
> —*Risk to Resilience Project* focus group participant

Opportunities for evacuation, continuity of care, and patient transport

Multiple emergency events have provided valuable lessons for evacuations, within and across regional health authorities. Opportunities to enhance evacuation preparation and management include:

- **Provincial guidelines for pre-emptive patient evacuations**: Faced with the threat of disaster, determining whether to shelter in place or evacuate frail patients/residents from a health care facility involves complex decision-making. Provincial guidelines could support health authorities in identifying when patients should be pre-emptively transferred out of high-risk areas that are not under evacuation order [702].
- **Provincial guidelines on health facility evacuations:** Provincial guidance could provide clarity around evacuation roles and responsibilities for private residential care/assisted living facilities, service providers, health authorities, and local governments [702]. Focus group participants indicated they would benefit from clearer expectations of staff and physicians personally impacted by evacuation alerts or orders [56].

- **Support for self-evacuees:** It is not uncommon for residents with pre-existing health conditions to self-evacuate in advance of an evacuation order, due to unfavourable conditions. This presents an opportunity to further develop clear and consistent guidelines and messaging about the process and types of support available to self-evacuees who choose to leave their home communities [702].
- **Health support services for evacuated residents and evacuated communities**: Recent climate-related events displace tens of thousands of residents at the same time, requiring health support at reception centres and lodging facilities throughout the province. There is an opportunity to provide clarity on the appropriate types and levels of health services for evacuees in these settings, particularly during large-scale disasters [794].
- **Re-entry and recovery for evacuated communities:** Providing adequate mental health and trauma support for residents and frontline workers when evacuees re-enter impacted communities requires in-depth planning and coordination across the health system. There is an opportunity to develop a provincial health system recovery framework for determining the services, coordination processes, and resources needed for health care recovery in communities following disasters [794].

Opportunities for cultural safety and honouring Indigenous self-determination

To advance reconciliation, Indigenous needs, values, and worldviews should be embedded into emergency planning and management. A positive step in this direction is the integration of the First Nations Emergency Services Society (FNESS) into the provincial emergency management system. This will improve the turnaround time for providing supports to members of B.C. First Nations who are evacuated and need to access ESS [795]. Other opportunities raised by *Risk to Resilience Project* sharing circle participants include:

- **Support Indigenous-led emergency planning:** All too often, emergency plans and decisions are being made on Indigenous communities' behalf. Indigenous-led planning requires adequate funding and capacity. Many First Nations communities and Indigenous organizations are understaffed and need dedicated trained staff (e.g., emergency coordinators) to support the creation of emergency plans.
- **Enhance coordination and collaboration for emergency planning and response:** Enhanced coordination is needed across sectors and scales—with Indigenous communities, First Nations communities, the First Nations Health Authority, regional health authorities, and other ministries. Relationships are also critical for preparedness; trusting relations between response organizations, health organizations, and Indigenous communities must be developed in advance of an emergency event.
- **Centre cultural safety in emergency management:** Ensure that cultural safety considerations are embedded in all aspects of emergency management, including disaster risk mitigation, preparedness, response and recovery. This includes culturally relevant training for professionals and volunteers engaged in community evacuations, co-designed and led by Indigenous cultural navigators.
- **Advance existing commitments to Indigenous Rights and self-determination:** Ensure that emergency management governance structures, policies, and guiding frameworks (e.g., United Nations Sendai Framework for Disaster Risk Reduction) in B.C. reflect United Nations Declaration on the Rights of Indigenous Peoples and the *Declaration on the Rights of Indigenous Peoples Act* commitments, including recognizing the authority of Indigenous governing bodies in relation to emergency management.

Qualicum, B.C.

Cultural safety in health emergency management

The Ministry of Emergency Management and Climate Readiness (EMCR) and First Nations Health Authority have made a shared commitment to embed cultural safety and humility across all four pillars of emergency management, including mitigation, preparedness, response, and recovery. This shared intention recognizes that the manner in which emergency management is conducted can have a lasting impact on the health and wellness of First Nations. The work between the First Nations Health Authority and EMCR is enabled through a signed Letter of Understanding, outlining commitments and expectations across several key areas of mutual interest, including anti-racism, cultural safety, and humility. These shared priorities for service and system improvement have been informed by operational experiences of both organizations, formal after-action reviews, as well as through direct feedback from First Nations Chiefs, leaders, and health directors during town hall meetings.

In 2022, two policies were created to advance this commitment:

- Policy 2.14 First Nations Community Navigator for Emergency Support Services
  When communities evacuate to unfamiliar host communities, there may be challenges in meeting evacuees' cultural and specialized needs. To address this, a **First Nations Community Navigator** for First Nations evacuees bridges the gap by connecting evacuees with culturally appropriate support services not typically available at emergency reception centres. This ensures that service delivery aligns with First Nations perspectives on health and wellness, fostering cultural safety and respect during evacuations. First Nations Community Navigators are often well-known within their communities, possess in-depth cultural knowledge, and have established trust-based relationships with community members, enhancing their effectiveness in providing support during crises [796].
- Policy 2.15 Cultural Activity Locations Support
  Large-scale evacuations may be deeply distressing for First Nations communities. Trauma-informed and culturally appropriate services are needed to mitigate further impacts and facilitate the transition into recovery. A **Cultural Activity Location Support** (CALS) can be used to facilitate the delivery of First Nations health, wellness, and cultural services. The CALS is a safe space in which evacuees can come together and access culturally sensitive care services. These services are often delivered in partnership with organizations like the First Nations Health Authority, community health societies, or other support agencies [797].

Chapter 11: Charting a Path to a Healthy and Climate Resilient B.C.

Climate change imposes significant and escalating impacts on B.C.'s communities and health system, now and into the future. There are lost lives and livelihoods, disrupted communities, tens of thousands of displaced residents, and strained health services left in the wake of recent extreme heat waves, wildfires, floods, droughts, and other climate-related events. These events have impacted supply chains, limiting access to essential supplies, health care, and medications. Delaying action comes at a high cost, as B.C.'s health system and communities will be increasingly challenged to respond to overlapping emergencies or carry out essential core functions that keep communities healthy and safe.

Climate action is undeniably beneficial for our health and the environment [16]. As climate-related events increase in frequency and intensity, it is imperative to prioritize health through climate action, while also taking steps that yield immediate and long-term health and environmental benefits. In B.C., there is evidence that early adaptation and resilience efforts offer substantial returns in improved community well-being, lessen strain on the health system, and provide economic and environmental benefits [798]. We are at a pivotal moment. To protect communities from the growing health impacts of climate change, all sectors must draw on lessons learned from recent emergencies and work together to integrate health considerations into climate preparedness and emergency management.

11.1 The role of the health sector

The B.C. health system plays a critical role in managing the health risks that stem from climate change. Recent extreme weather events have underscored the pervasive impact of climate change on all facets of health. Action is needed to mitigate and manage climate risks across the health system—from clinical care to health emergency management, to mental health and substance use, to population and public health.

A proactive and comprehensive approach must address the social and ecological determinants of health that influence where, why, and how risk and vulnerability occur [16]. It must also include efforts to build healthy public policy, create supportive and healthy environments, and strengthen community action [798]. Continued leadership is also needed to address urgent climate-related health threats with immediate action—including health emergency management, warning systems, and preparedness plans—alongside public education and risk communication on reducing both physical and mental health impacts [799].

There are many opportunities for action noted in this report, as well as numerous examples of the ways the Province and health authorities are already working to address the challenges presented by climate change. While health professionals can serve as key leaders and experts in protecting people in B.C. from the health risks of climate change, *they cannot shoulder it alone*. Coordinated intersectoral collaboration is needed to build climate-health resilience at the local, provincial, and federal levels by working across ministries, communities, and jurisdictions.

A whole-of-society approach

Many of the health risks of climate change are mediated by a wide range of determinants, including access to clean water, nutritious food, safe shelter, and economic stability. Addressing these requires intersectoral collaboration and a whole-of-society approach—bringing together diverse expertise, lived experiences, and ways of knowing to address the key determinants of risk and resilience—well before climate-related health effects show up at the hospital, clinic, or within the health care system.

Preparing for and building resilience to health risks from climate change requires leadership from all sectors, levels of government, Indigenous partners, health professionals, service providers, researchers, and communities. Working together through a coordinated effort, B.C. can better understand the health implications of climate change and collaboratively develop creative solutions to prepare and adapt.

B.C. leadership for climate-health resilience

Across the province, the complex and long-term nature of climate change is being addressed through leadership and governance, alongside policy, plans, and programs that provide foundational, cross-cutting guidance.

Within the B.C. health system, and across multiple sectors, leadership and governance capacity is being developed to build a shared vision among partners; engage in strategic planning; and to take coordinated action in anticipating, preventing, preparing for, and managing climate-related health risks.

Provincially, climate change health system leadership has been driven by the *Climate Change Accountability Act* (2019), the CleanBC Roadmap to 2030 (2021), and in mandate letters received by each of the province's five regional health authorities and the Provincial Health Services Authority (PHSA). Legislation, policies, and mandates are laying a foundation for clearer expectations on climate action, supported by guidelines, protocols, and tools for health-sector operations, supply chains, and facilities.

In 2022, B.C. released the Climate Preparedness and Adaptation Strategy (CPAS) [23]. There has since been strong provincial leadership and momentum to support the shift towards a low-carbon, climate-resilient health system, with the Ministry of Health leading the integration and coordination of its climate initiatives:

- In 2022, a new Climate Resilience program was established within the Ministry of Health, to coordinate the implementation of health actions under the CPAS, in collaboration with health authorities, and to support the integration of climate considerations into health policies, programs, and services.
- In 2022, a comprehensive review of climate actions was conducted to better understand climate resilience across B.C.'s health system, identifying areas of progress and opportunities for action [194]. The First Nations Health Authority is undertaking a similar assessment of its current climate change-related responsibilities and portfolios, including a review of how recent climate-related emergencies have impacted its services to B.C. First Nations.
- In 2023, the Ministry of Health developed a Climate Action Plan to support Ministry-wide climate action and reinforce health authority climate plans.

Regionally, several health authorities now integrate a planetary health lens into planning for sustainability and climate adaptation and mitigation. This approach recognizes the links between natural systems, health care system operations, service delivery, and their overall impacts on human health [800]. Some regional health authorities have established leadership roles related to planetary health, such as the Regional Medical Director of Planetary Health at Vancouver Coastal Health. Others have formed steering committees to guide the development of planetary health strategic plans that take an organization-wide approach to addressing climate change and improving environmental sustainability [801].

In addition, all regional health authorities are supported under the CPAS to create climate and health-specific positions. These positions are working to advance climate leadership capacity across the health system, including seasonal-readiness planning and partnerships with communities, First Nations and Métis on climate-health preparedness. With this enhanced capacity:

- Regional climate change and health vulnerability and adaptation assessments are underway or complete in each health authority;
- Climate change adaptation frameworks (e.g., Vancouver Coastal Health/Fraser Health 2022-2026 [722]) as well as planetary health and sustainability strategies (e.g., Interior Health 2023 and Fraser Health 2023 [800,801]) have been developed by some regional health authorities to advance health-focused climate action in the region; and
- Health authorities are bringing their expertise to regional or locally-led plans or adaptation strategies, contributing as a trusted voice on climate-health risks, health equity, evidence for action, and opportunities for co-benefits.

Beyond efforts in organizational leadership, collaborative structures and forums are enabling sharing of information and best practices, coordinated planning, and greater efficiency across the health system. Examples include:

- **Provincial:** The Ministry of Health chairs cross-ministry as well as interagency tables to support CPAS implementation and broader collaboration on climate action across the health system. The BCCDC Climate Preparedness and Adaptation Program's Community of Practice is building public health workforce capacity and collaboration on innovative solutions to prepare for and adapt to the health impacts of climate change in B.C.
- **Regional:** BC GreenCare is a network of Sustainability and Facilities Management teams across Lower Mainland health authorities (Fraser Health, Vancouver Coastal Health, PHSA, and Providence Health Care) that collaborates and shares best practices on energy and carbon emissions within the health system and advances low-carbon solutions, among other sustainability initiatives. The University of British Columbia's Planetary Healthcare Lab is working with Vancouver Coastal Health and other partners to examine the environmental effects of health care delivery and services in B.C., and generate solutions to chart a path forward to net zero emissions.
- **Broader health sector:** Organizations such as the Canadian Coalition for Green Health Care, Canadian Association of Physicians for the Environment, Canadian Associations of Nurses for the Environment and CASCADES offer resources and opportunities for health sector partners to advance sustainable, climate resilient health care.

11.2 Climate-health leadership outside of the health sector

Great gains can be made in protecting populations by integrating health considerations into climate action outside of the health sector, as many of the contributing factors for climate risk and resilience are determined by decisions and actions outside the health system [798,802].

Recent provincial climate assessments and strategies in B.C. have specifically identified health as an integral component of climate adaptation. The recognition of climate change as an important determinant of health highlights the growing acknowledgement that climate and health are inextricably linked. For

example, the Preliminary Strategic Climate Risk Assessment for B.C. (2019) [30] included analyses of health impacts across distinct climate hazards (e.g., morbidity, injury, disease, hospitalization, loss of life, and psychological impacts); and the Climate Preparedness and Adaptation Strategy (2022) [23] named "health and well-being" and "equity" among its guiding principles. As climate action in B.C. has historically focused on mitigation, natural resources, and infrastructure, these developments are important signals that adaptation strategies are gaining momentum with health and well-being as a core priority.

Promising work is underway in B.C. to address health within the wider realm of climate action. Across the province, progress is being made through intersectoral collaboration and leadership that puts health at the table for climate action decision-making and planning at multiple scales [16,798]:

- The 2024 Provincial Disaster and Climate Risk and Resilience Assessment will include an explicit focus on health and well-being in its categories of focus, in parallel to the economy, the built environment, and the natural environment.
- BC Housing has been leading multiple projects to build resilience and protect residents from extreme heat and wildfire smoke in the nonprofit housing sector. These include:
  - training and resources to develop extreme heat and wildfire response plans;
  - tenant/client vulnerability assessments and check-in plans;
  - guidance for on-site cooling options;
  - resources to support planning and communications with tenants; and
  - collaborative research projects to better understand how building design and other factors influence indoor air temperatures.
- The Ministry of Water Land and Resource Stewardship has developed a draft Biodiversity and Ecosystem Health Framework (2023) that formalizes a holistic approach to stewarding land and water resources to ensure they are healthy and resilient for future generations.
- Under the BC Drought and Water Scarcity Response Plan, the Ministry of Water, Land and Resource Stewardship coordinates provincial drought response and planning in collaboration with the Ministry of Health, the Office of the Provincial Health Officer and other agencies to protect public health and safety [651].
- The Ministry of Agriculture is advancing several health-supporting climate initiatives, including:
  - a food security strategy in collaboration with the Ministry of Health and through engagement with First Nations;
  - regional climate change strategies to strengthen the resilience of food production and security;
  - mental health resources for farmers who have experienced a disaster;
- The Ministry of Transportation and Infrastructure's Active Transportation Design Guide (2019) was developed in collaboration with the Ministry of Health to realize co-benefits for effective active transportation strategies that also reduce GHG emissions.
- Metro Vancouver is working with multiple partners, including health authorities, to develop a roadmap for human health and well-being as part of its Climate 2050 Strategic Framework.
- The Tsleil-Waututh Nation has developed a Climate Change and Community Health Action Plan (2022) that identifies proactive actions to build community health and climate resilience.

Tsleil-Waututh Nation leading climate change readiness

Tsleil-Waututh Nation (TWN) has been taking direct action to understand and address climate change impacts in their territory, including impacts to holistic health and wellness. The Nation developed a Climate Change and Community Health Action Plan (2022) that builds on extensive health, land use, and environmental planning initiatives over the past decade, including a Climate Change Resilience Action Plan published in 2021.

The initiative resulted in a set of proactive actions to build TWN community health and resilience to climate change. Supported by the First Nations Health Authority's Indigenous Climate Health Action Program, community members and leadership created a unique framework that includes the full spectrum of community health and well-being.

11.3 The pathway forward

Urgent, coordinated action is required to protect against, prepare for, and respond to the health impacts of current and future climate-related events. If well executed, this climate action can also advance health, equity, justice, and reconciliation [16].

The pathway forward will require leadership across scales and sectors, so that organizations are specialized in their expertise and actions, yet coordinated in their approach. A comprehensive and coherent approach to building a health and climate resilient B.C. will require:

i. Centering reconciliation and valuing Indigenous knowledge systems alongside Western science;

ii. An equity-oriented approach that prioritizes protecting populations most at risk;

iii. Applying a "planetary health" lens that recognizes that our health and well-being is intimately dependent on the health of our environment. [803]. While this term is gaining broader recognition, Indigenous Peoples have known and respected the interconnections between humans, animals, plants, and their shared environments since time immemorial. Planetary health offers a collaborative, multi-sectoral, and transdisciplinary approach to climate action, promoting the ecological determinants of health—such as clean air, water, food, and energy—while supporting ecosystem resilience [803] and,

iv. A commitment to low-carbon resilience that integrates mitigation and adaptation, rather than treating them as separate, siloed areas of climate action.

Although the health sector cannot do it alone, it has a unique, dual role to play: ensuring B.C.'s health system is sustainable and prepared for the projected rise in climate risks, and also collaborating with other sectors and partners to drive transformation. The following strategic opportunities build on progress to date to enhance climate-health resilience within the B.C. health system and communities:

Theme 1: Uphold Indigenous knowledge systems, practices, and self-determination

Indigenous knowledge systems have long recognized and respected the inextricable connections between human and environmental health. Since time immemorial, this knowledge has informed adaptation to changing climates and conditions, and sustained the health and well-being of communities, cultures, environments, and economies for countless generations. Valuing the unique and diverse contributions of Indigenous knowledge systems and worldviews alongside Western science can help us to better understand the connection between climate change and health and create more robust adaptation strategies, while also supporting decolonial approaches essential to self-determination.

To make progress on the commitments of the *Declaration on the Rights of Indigenous Peoples Act (Declaration Act)* [86] and Truth and Reconciliation Calls to Action [804], climate action must respect self-determination and governance structures, actively involve Indigenous Peoples in decision-making, and foster genuine engagement and co-development. It must do so while upholding nation-specific principles rooted in ownership, control, access, stewardship, and possession of data and knowledge. It is also imperative that climate action within the health system addresses systemic racism by implementing the recommendations from In Plain Sight (2020) [58]; following the B.C. Cultural Safety and Humility Standard (2022) [805]; and continuing to pursue initiatives, such as the Office of the Provincial Health Officer's Unlearning and Undoing White Supremacy and Racism Project [78].

Specific opportunities for action include:

- Advance existing commitments to Indigenous Rights and self-determination by ensuring that emergency management and climate action governance structures, policies, and guiding frameworks (e.g., United Nations Sendai Framework for Disaster Risk Reduction) in B.C. reflect the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and the *Declaration on the Rights of Indigenous Peoples Act*, including recognizing the authority of Indigenous governing bodies in relation to emergency management.
- Embrace "two-eyed seeing" approaches to understand and plan for climate-health outcomes, honouring and including the unique contributions of Indigenous knowledge systems and worldviews.
- Strengthen community capacity by promoting and supporting Indigenous-led initiatives that enhance community resilience, enable skill acquisition, strengthen leadership, and improve emergency responses to climate-related events.
- Enhance ecological health by advancing Indigenous-led initiatives for habitat restoration and protection of species-at-risk, to promote local climate/health resilience.
- Centre culturally safe emergency response and mental health supports and services. Ensure that cultural safety training for professionals and volunteers engaged in community evacuations is co-designed and led by Indigenous Peoples.

Theme 2: Strengthen the building blocks for a climate-resilient health system

A strong climate-health response in B.C. starts with a provincial health system that is prepared for and resilient to the projected rise in climate risks. This means integrating climate change considerations into all health policies, programs, and decision-making, and establishing governance structures that can coordinate climate action across the health system. The World Health Organization (WHO)'s Operational Framework for Building Climate Resilient and Low Carbon Health Systems [17] focuses on six core "building blocks" (see Figure 21) necessary for delivering low-carbon, quality health services and improving health outcomes in a changing climate.

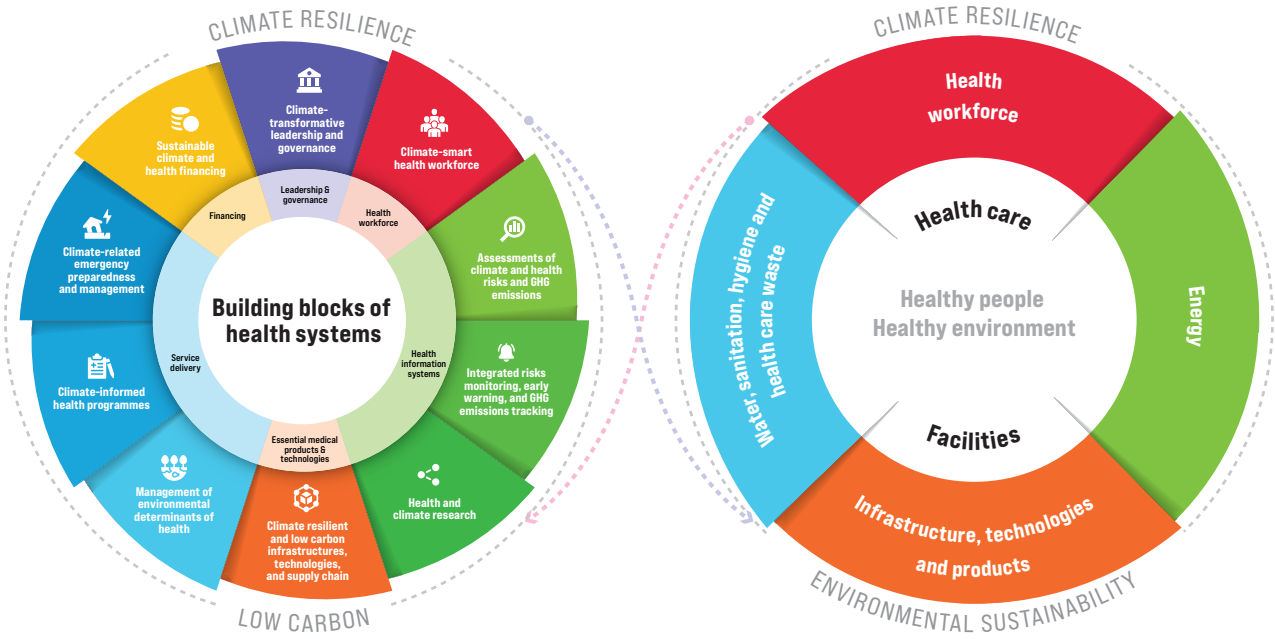


Figure 21. Building climate resilience and low carbon interventions in health facilities [17]

This report has detailed many examples of heroic actions by health system staff (e.g., riding a horse to deliver supplies and medications to remote communities cut off by wildfires; working extended hours to support patients to evacuate). While these responsive actions were courageous and vital during an emergency, relying on the heroism of health professionals is not a long-term sustainable adaptation in a changing climate.

As detailed in this report, climate change has and will continue to touch every aspect of B.C.'s health system, from emergency preparedness and response to health system planning, occupational health, and surveillance and monitoring. Addressing the full array of climate emergencies on population health, health services, and infrastructure requires a coordinated, systems approach.

Strong leadership and clear governance structures will be critical to embedding climate change considerations across the foundational building blocks and programs of the health system. This includes integrating a climate lens across interventions to address immediate downstream health challenges (e.g., treatment of climate-related illness) and to prevent future health risks and inequities that could arise from a changing climate [16] (see Figure 22). Proactive, upstream actions, in particular, can help to avert maladaptation—when policies, plans or strategies unintentionally increase exposure and risk, and exacerbate existing inequalities [16].

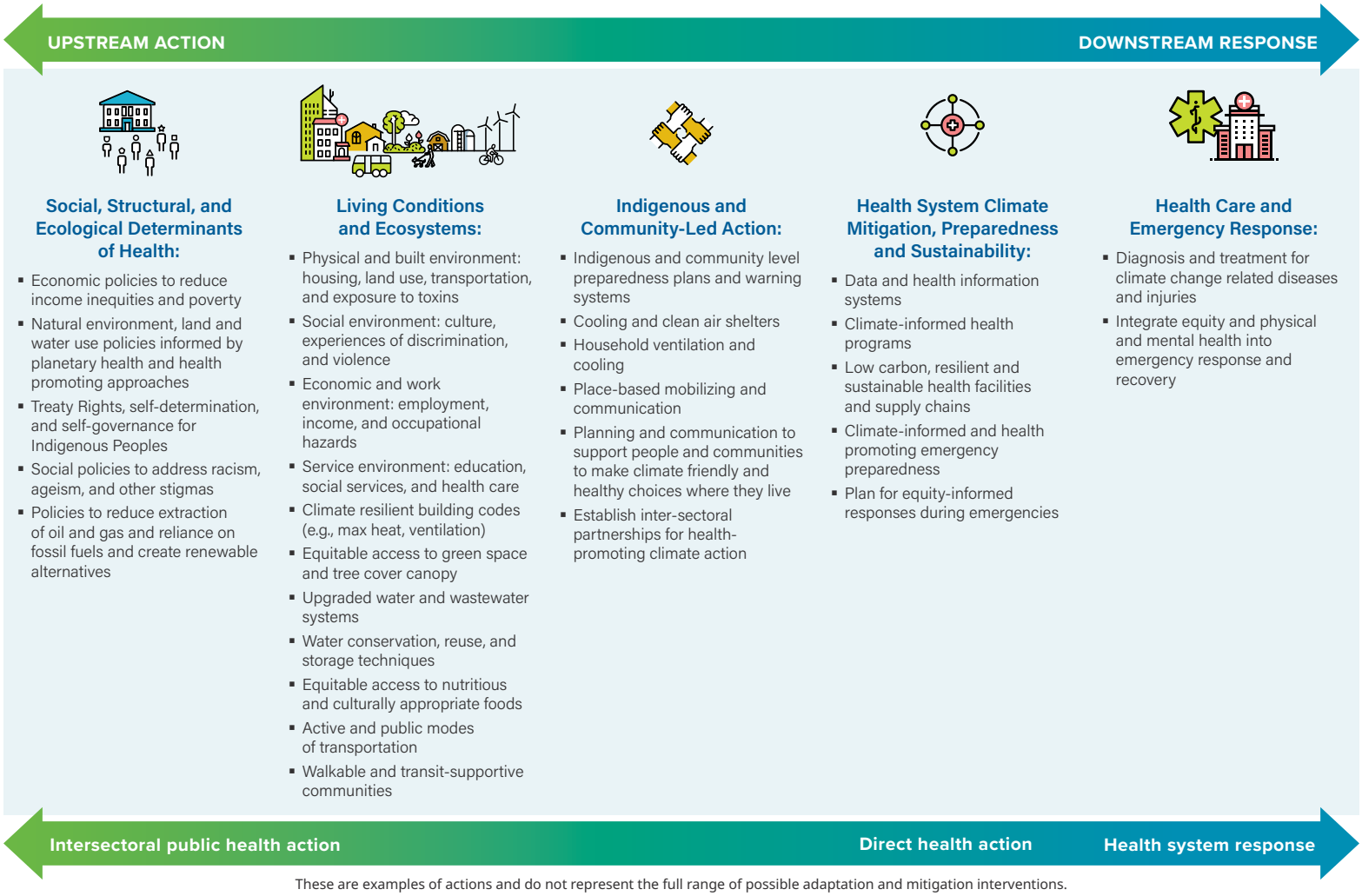


Figure 22. Upstream to downstream—a continuum of climate-health action [16]

If climate risks continue to intensify, there are limits to how much climate adaptation measures can protect the health of people in B.C. Adaptation must go hand-in-hand with mitigation—a concerted effort to substantially reduce GHG emissions. Leadership in low-carbon resilience means integrating and harmonizing mitigation and adaptation, rather than treating them as separate, siloed areas of climate action.

Strategically aligning adaptation and mitigation can also provide health co-benefits (see Figure 23). Simply put, co-benefits can occur when climate mitigation and adaptation actions are coordinated, resulting in advances to social, economic, and ecological goals such as improved health, equity, sustainability, and livability. Examples of potential co-benefits from aligning mitigation and adaptation strategies include:

- Energy-efficient designs and technologies that reduce GHG emissions, improve air quality, and subsequently decrease cardiorespiratory issues;
- Community greening and forest practices that lead to cooler environments and carbon sequestration; and
- Climate-resilient agricultural practices that reduce emissions while increasing food security.

Demonstrating and emphasizing health co-benefits can help communities and decision-makers understand the direct and tangible advantages of integrated climate action.

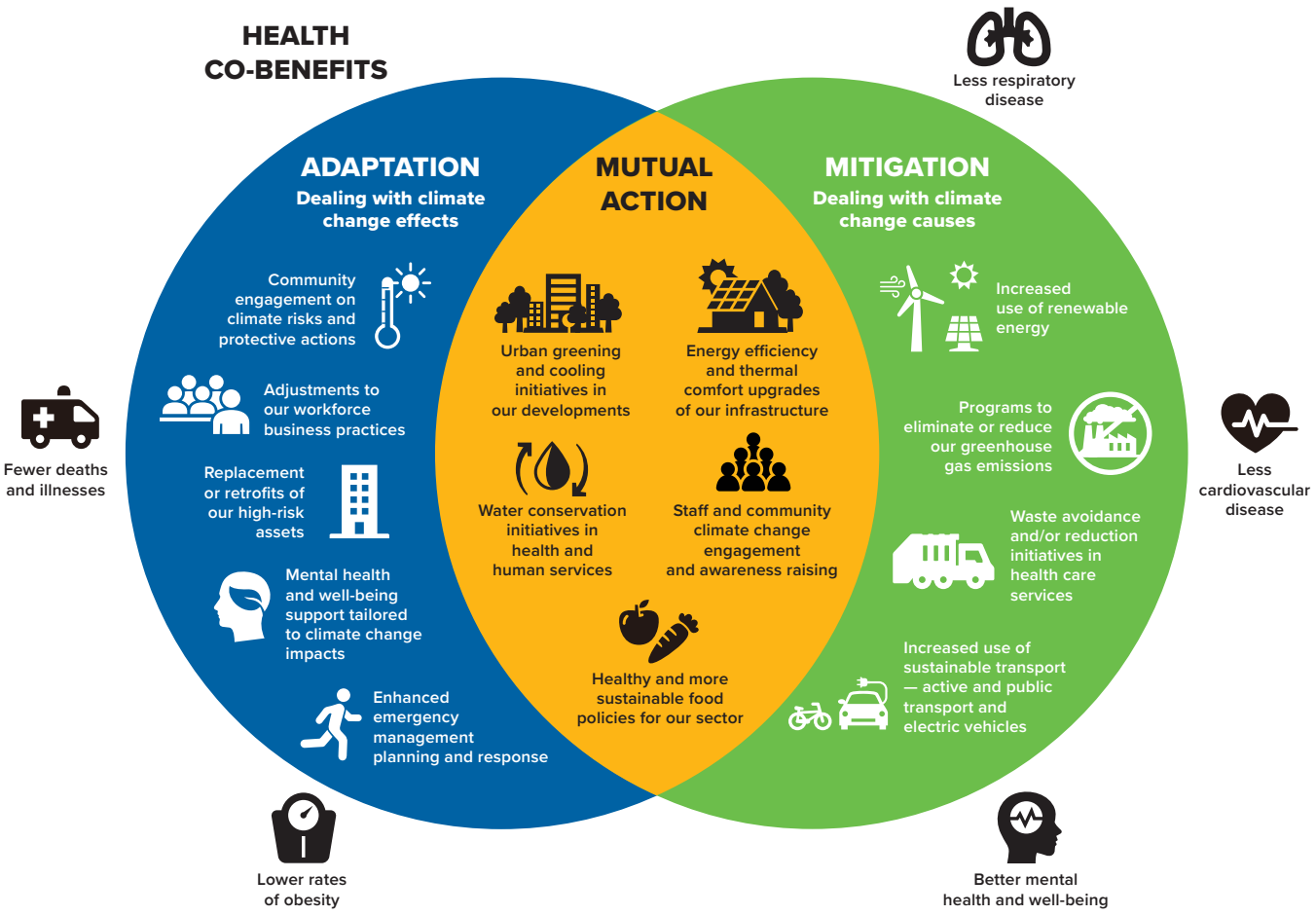


Figure 23. Interconnectedness of climate adaptation and mitigation, and health co-benefits of climate action [806]

Opportunities for action include:

- Integrate climate change considerations into all health policies, programs, and decision-making; go beyond facilities and public health to include business continuity, health system planning, emergency management, and acute care.
- Establish governance structures across agencies and scales, to integrate and coordinate climate action—mitigation and adaptation—across the health system.
- Continue to manage climate risks (e.g., support for climate-related mental and physical health impacts) alongside proactive policy and practice to address structural, social, economic, and ecological determinants of health.
- Continue to reduce the ecological footprint of B.C.'s health system, and advance strategies for environmental sustainability and low-carbon resilience.
- Empower people and communities in B.C. with information on effective measures to protect themselves and those in their care from the health risks of climate change.
- Develop sustainable and transparent funding supports in ways that build near- and long-term climate resilience in health systems.

Theme 3: Collaborate across sectors to centre health in climate change action

Centering health in climate action through collaboration across sectors, ministries, and levels of government presents an opportunity to enhance climate and health resilience for all. This includes, for example, integrating health and well-being into provincial, regional, and local climate risk and resilience assessments; conducting health guidance and impact assessments of climate policies within key sectors such as energy, transport, and food systems; and promoting interventions that offer co-benefits for climate and health [798]. The health sector has a critical role to play in bringing expertise, evidence-informed advice, and a trusted voice to climate change and emergency preparedness policy and planning—in "health-determining" sectors as well as communities. Evidence shows that health care providers are among the most trusted voices and sources of information on climate change, and that health can be a motivating factor for climate action [807]. As climate adaptation requires responses that are context-specific and community-driven, the health sector can support community leadership with preparedness and recovery that maximizes health co-benefits and is based on local knowledge, needs, and assets.

When supported by enabling policy environments and leadership across multiple levels of government and society, individuals and families in B.C. are more empowered and supported to take action and prepare for a changing climate. This can include building personal climate resilience by learning about hazards in their region and making a plan to stay safe; creating home preparedness plans; working with neighbours and local communities to build resilience through strengthened social connections and networks; and taking actions to reduce GHG emissions.

Opportunities for action include:

- Centre and embed physical and mental health in the Province's shared understanding of climate change by leveraging province-wide initiatives underway, such as the Disaster and Climate Change Resilience and Risk Assessment (2024).
- Integrate health and well-being into regional and local climate action plans, policies, and programs by building on existing partnerships between regional health authorities, communities, First Nations, and other key partners.
- Continue to identify innovative ways to collaborate across sectors, jurisdictions, and public health systems to plan and implement health-promoting climate actions.
- Leverage health expertise to communicate with and mobilize key audiences on climate-health action, such as health professionals, the media, and the education sector [16].

Theme 4: Understand the full extent of the health impacts of climate change in B.C.

B.C. has made significant strides in understanding the population health impacts of climate change, through initiatives such as regional health Vulnerability and Adaptation Assessments (e.g., Vancouver Coastal Health/Fraser Health, 2022 [722]). Still, work remains to understand the complex direct and indirect pathways through which climate change impacts health outcomes. While much existing research has focused on respiratory or cardiovascular health outcomes [808], broader and deeper knowledge is needed for a fuller picture of climate-related physical and mental health impacts, their distribution across regions and populations, and how best to address them [16].

Historically, an equity lens has not consistently been applied to climate change [809]. Several projects have cited the need for a more in-depth understanding of B.C.-specific impacts on gender, 2SLGBTQIA+ people, people with disabilities, low-income and underhoused populations, racialized populations, as well as evacuees and Indigenous Peoples [50,62,273]. A better understanding of future climate-health impacts, based on climate and health modelling, is also needed.

Knowledge gaps can be filled through surveillance and monitoring of climate-health impacts using disaggregated equity-informed data. There is an opportunity to enhance timely forecasting of climate-related health risks by advancing analysis and statistical modelling and mapping to better understand climate impacts; developing standardized linked indicators to track and communicate climate-health risks and actions; and enhancing data sharing.

Finally, understanding climate-health impacts is only part of the picture. As governments, regional health authorities, and communities develop, test, and learn from climate-health adaptations, it is critical to also understand the effectiveness of interventions. Learning and evaluation is, itself, a strategy to build resilience [802]; assessments of successes and lessons learned will support recovery, help in building back better, and foster a culture of innovation.

Opportunities for action include:

- Continue to conduct and promote equity-informed climate and health vulnerability and adaptation assessments to characterize climate risks to health and the health system, identify populations and regions at greatest risk, and understand capacity to prepare and respond.
- Foster collaborations and forums with B.C. research partners to better understand cross-disciplinary climate and health impacts and adaptations, while honouring Indigenous knowledge systems and methodologies.
- More fully explore the physical and mental health risks of climate change for key populations, including Indigenous Peoples and people who have been evacuated due to climate events.
- Assess future climate-health impacts by using B.C. climate modelling and simulations.
- Enhance surveillance and monitoring of climate-health risks, and develop standardized indicators to support coherent tracking, communications, and data sharing.
- Prioritize and support continued learning and evaluation following climate-related events, such as through participatory after-action reviews.
- Enhance the collective understanding of what interventions and adaptations work best for different population groups.

Theme 5: Build a climate-resilient workforce

Building climate resilience in the health system requires new skills, knowledge, and capacities—not to mention new roles, teams, and responsibilities. Promising signs in the B.C. health workforce include greater knowledge of climate and health impacts [56], and new climate-change-focused positions or teams.

Still, without iterative adaptation, overlapping and concurrent climate and public health crises will continue to challenge the capacity and health and well-being of B.C.'s health workforce. As B.C.'s climate continues to change, a climate-resilient health workforce will require knowledge, skills, and capacity to assess and address the health impacts of current and future extreme weather and climate-related events.

Opportunities for action include:

- Provide health workforce training, skills-building, and guidance on assessing and managing climate-related health risks, low-carbon resilience, climate communications, and sharing information through professional development, communities of practice, conferences, and workshops.
- Conduct experiential learning, such as simulation exercises, to test emergency planning and response to climate-related events.
- Provide cultural safety training for health emergency management staff and first responders in B.C. to build awareness and understanding of the health impacts of climate change on Indigenous populations, and of the importance of Indigenous knowledge systems in climate resilience.
- Ensure adequate mental health services and supports are available for health-sector staff, especially those working on the frontlines in communities responding to and recovering from climate emergencies.

Conclusion

The *Risk to Resilience Project* has shown that frequent and intense extreme heat events, wildfires, flooding, drought, and other climate hazards are disrupting the balance between the health of the environment and human health and well-being. These hazards and their cascading impacts amplify health inequities and present new threats to physical and mental health, and the broader determinants of health. Moreover, every dimension of the B.C. health system has been impacted by climate change. Moving from "risk to resilience" requires a system-wide approach that coordinates and maximizes climate leadership and action across the health system and across sectors, prioritizing populations most at risk, and respecting and upholding Indigenous Rights and knowledge systems.

The good news is that progress is being made. This project has documented innovative stories and promising climate-health adaptations from across all levels of the health system, in health-determining sectors, and in communities and First Nations. This work must be leveraged, expanded on, and learned from to strengthen capacities and advance leadership for climate-health action at multiple scales. Without rapidly scaling-up adaptation measures, however, more frequent and intense extreme weather and climate-related events will place increasing pressure on our ability to respond and reduce health impacts. In other words, the urgency, scale, and scope of our collective response must match the size of the health threat presented by climate change.

2021 was a defining year for climate change impacts in B.C., testing our readiness on all fronts and motivating us into action. We are at a pivotal moment in B.C. to future-proof our health and health care, with the supportive policy context of the B.C.'s Climate Preparedness and Adaptation Strategy [23] and Canada's National Adaptation Strategy [79]. When appropriately designed and implemented, climate change activities that reduce health risks, build resilience, and reduce GHG emissions, can also provide broader societal benefits, or example, by redressing health and social inequities, advancing reconciliation, and enhancing community well-being. Now is the time to advance a healthy and climate resilient B.C., as countless lives depend on it.

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Appendix 1: Data Tables

*Table A1.1. Summary of select heat-related climate projections to the 2050's for B.C.'s Health Service Delivery Areas **

	Max temp (hottest day) (C°)		Number of days with Humidex >35 C°		Number of days with Tmax >30 C°		Cooling degree days	
	Total	**Change**	**Total**	**Change**	**Total**	**Change**	**Total**	**Change**
Interior Health								
11- East Kootenay	31.9 (30.5, 34.7)	+4.5 (+3.2, +7.6)	1 (0, 1)	+1 (0, +1)	12 (8, 23)	+10 (+6, +21)	98 (59, 195)	+83 (+47, +183)
12- Kootenay Boundary	33.6 (32.1, 36.7)	+4.4 (+3.1, +7.7)	2 (1. 3)	+2 (+1, +3)	19 (12, 33)	+15 (+9, +30)	149 (95, 287)	+124 (+71, +264)
13- Okanagan	34.5 (33.2, 37.5)	+4.3 (+3.1, +7.5)	2 (2. 4)	+2 (+2, +4)	21 (15, 37)	+16 (+10, +32)	168 (116, 316)	+132 (+83, +284)
14- Thompson Cariboo Shuswap	33.1 (31.7, 35.9)	+4.4 (+2.5, +7.4)	1 (1, 2)	+1 (0, +2)	13 (9, 26)	+11 (+6, +24)	97 (60, 206)	+82 (+45, +193)
Fraser Health								
21- Fraser East	34.2 (33.3, 37.0)	+4.1 (+3.0, +7.1)	3 (2, 5)	+3 (+2, +5)	15 (11, 28)	+12 (8, +26)	154 (107, 294)	+123 (+77, +265)
22- Fraser North	33.7 (32.7, 36.1)	+4.1 (+2.8, +6.8)	4 (3. 8)	+4 (+3, +7)	13 (9, 24)	+10 (+6, +22)	157 (112, 287)	+124 (+79, +256)
23- Fraser South	34.5 (33.6, 37.0)	+4.0 (+2.5, +6.6)	16 (13, 25)	+14 (+11, +23)	16 (11, 34)	+13 (+8, +31)	282 (213, 523)	+216 (+151, +464)
Vancouver Coastal Health								
31- Richmond	32.4 (31.6, 34.9)	+3.8 (+2.5, +6.5)	10 (7, 17)	+9 (+7, +17)	8 (5, 23)	+7 (+4, +22)	54 (34, 124)	+209 (+146, +456)
32- Vancouver	33.1 (32.3, 35.5)	+3.8 (+2.6, +6.5)	10 (7, 17)	+9 (+7, +17)	11 (6, 28)	+10 (+5, +27)	290 (221, 536)	+224 (+158, +479)
33- North Shore-Coast Garibaldi	30.2 (29.2, 32.4)	+3.7 (+2.4, +6.4)	1 (1, 1)	+1 (+1, +1)	3 (2, 7)	+4 (+2, +10)	263 (195, 501)	+47 (+26, +118)
Vancouver Island Health								
41- South Vancouver Island	32.2 (31.5, 34.3)	+3.3 (+2.1, +5.8)	2 (1, 4)	+2 (+1, +3)	8 (5, 15)	+5 (+3, +13)	132, 98, 259)	+106 (+75, +238)
42- Central Vancouver Island	32.6 (31.8, 34.3)	+3.2 (+1.8, +5.4)	3 (2, 5)	+3 (+2, +5)	8 (5, 15)	+6 (+3, +13)	115 (92, 221)	+90 (+66, +200)
43- North Vancouver Island	29.6 (28.7, 31.6)	+3.4 (+2.2, +5.8)	1 (1, 2)	+1 (+1, +2)	3 (2, 7)	+2 (+1, +7)	54 (33, 122)	+45 (+27, +116)
Northern Health								
51- Northwest	28.4 (27.4, 31.0)	+4.1 (+2.8, +6.4)	0 (0, 0)	0 (0, 0)	2, (1, 6)	+2 (+1, +6)	25 (11, 62)	+24 (+9, +60)
52- Northern Interior	31.4 (30.2, 34.1)	+4.0 (+2.6, +7.1)	0 (0, 1)	0 (0, +1)	6 (4, 15)	+5 (+3, +14)	58 (32, 129)	+51 (+26, +123)
53- Northeast	31.7 (30.5, 34.3)	+3.8 (+2.5, +6.5)	1 (1, 2)	+1 (+1, +2)	6 (4, 16)	+6 (+3, +16)	89 (59, 180)	+74 (+47, +169)

*All values reported as median (range). Projections are for 2041-2070 (i.e., 2050s), high emissions scenario (SSP5-8.5), CMIP6. Change measured against a baseline of 1971-2000 (1980s). Aggregation to health authority boundaries may mask some regional differences. Data source: ClimateData.ca

Table A1.2 Summary of select precipitation-related climate projections to the 2050's for B.C.'s Health Service Delivery Areas

	Max 1-day total precipitation (in mm) in 2050s		Total annual precipitation (in mm) in 2050s**		Days with >20 mm precipitation in 2050s	
	Total*	**Change***	**Total***	**Change***	**Total***	**Change***
Interior Health						
11- East Kootenay	30 (27, 32)	+3 (1, 6)	867 (823, 916)	+60 (+11, 117)	3 (3, 4)	+1 (+0, 2)
12- Kootenay Boundary	26 (24, 27)	+3 (1, 5)	910 (874, 960)	+56 (+6, 108)	2 (2, 3)	+1 (+0, 1)
13- Okanagan	24 (22, 25)	+2 (1, 4)	709 (683, 744)	+41 (+10, 68)	1 (1, 2)	+0 (+0, 1)
14- Thompson Cariboo Shuswap	25 (23, 26)	+3 (2, 6)	685 (656, 730)	+52 (+20, 93)	2 (1, 2)	+1 (+0, 1)
Fraser Health						
21- Fraser East	52 (50, 56)	+5 (3, 11)	1349 (1296, 1406)	+70 (+10, 124)	12 (11, 13)	+2 (+1, 3)
22- Fraser North	77 (73, 80)	+9 (4, 15)	2027 (1944, 2122)	+85 (+4, 200)	28 (27, 30)	+3 (+1, 5)
23- Fraser South	60 (73, 80)	+6 (1, 12)	1464 (1385, 1521)	+51 (-14, +130)	18 (16, 19)	+2 (+0, 4)
Vancouver Coastal Health						
31- Richmond	46 (44, 49)	+4 (0, 9)	1141 (1074, 1188)	+52 (-12, +109)	11 (10, 12)	+2 (+0, 3)
32- Vancouver	61 (58, 64)	+7 (1, 12)	1515 (1436, 1582)	+62 (-7, +146)	19 (18, 20)	+2 (+0, 4)
33- North Shore-Coast Garibaldi	53 (51, 57)	+7 (4, 10)	1541 (1465, 1595)	+97 (+8, +152)	16 (15, 17)	+3 (+1, 4)
Vancouver Island Health						
41- South Vancouver Island	78 (72, 83)	+8 (1, 16)	1703 (1631, 1814)	+68 (-32, +187)	24 (22, 26)	+3 (+0, 4)
42- Central Vancouver Island	90 (84, 95)	+9 (5, 18)	2420 (2304, 2544)	+138 (-9, +252)	39 (37, 41)	+4 (+1, 5)
43- North Vancouver Island	67 (63, 71)	+8 (4, 13)	1943 (1825, 2018)	+116 (-4, +196)	25 (23, 26)	+3 (+1, 5)
Northern Health						
51- Northwest	35 (33, 38)	+5 (3, 8)	1060 (1017, 1108)	+111 (+80, +169)	7 (6, 8)	+2 (+1, 2)
52- Northern Interior	25 (24, 27)	+4 (2, 6)	670 (652, 722)	+62 (+37, +124)	1 (1, 2)	+1 (+0, 1)
53- Northeast	28 (26, 32)	+3 (1, 7)	531 (506, 567)	+58 (+25, +99)	2 (1, 2)	+1 (+0, 1)

*All values reported as median (range). Projections are for 2041-2070 (i.e., 2050s), high emissions scenario (SSP5-8.5), CMIP6. Change measured against a baseline of 1971-2000 (1980s). Aggregation to health authority boundaries may mask some regional differences. Source: ClimateData.ca.
** Total annual precipitation may not be homogenous across land mass or seasons.

*Table A1.3: Number of unique days with heat warnings in place, by Health Service Delivery Areas (HSDA), Health Authorities (HA), and province-wide (years 2018-2022)**

	Number of days with heat warnings in place, by year					
	2018	**2019**	**2020**	**2021**	**2022**	**Total days (2018-2022)****
Interior Health	**18**	**4**	**16**	**29**	**30**	**97**
11- East Kootenay	6	0	9	13	11	39
12- Kootenay Boundary	9	0	12	21	12	54
13- Okanagan	9	0	9	21	12	51
14- Thompson Cariboo Shuswap	18	4	16	29	30	97
Fraser Health	**20**	**4**	**12**	**32**	**29**	**97**
21- Fraser East	19	4	12	30	27	92
22- Fraser North	17	0	0	22	22	61
23- Fraser South	16	0	0	19	13	48
Vancouver Coastal Health	**21**	**5**	**12**	**32**	**31**	**101**
31- Richmond	16	0	0	19	13	48
32- Vancouver	16	0	0	20	21	57
33- North Shore-Coast Garibaldi	21	5	12	32	31	101
Vancouver Island Health	**17**	**4**	**0**	**23**	**28**	**72**
41- South Vancouver Island	15	0	0	23	20	58
42- Central Vancouver Island	15	0	0	23	20	58
43- North Vancouver Island	17	4	0	23	28	72
Northern Health	**19**	**4**	**12**	**28**	**27**	**90**
51- Northwest	13	4	0	18	23	58
52- Northern Interior	10	0	12	18	7	47
53- Northeast	10	0	3	17	12	42
Total unique days province-wide	23	5	16	36	35	115

*Data source: Environment and Climate Change Canada (personal communication). Note: ECCC forecast regions may overlap multiple HA/HSDA boundaries but each unique date counted only once per respective health region. Counts not weighted by population. Aggregation to health authority boundaries may mask some regional differences.
** Row totals (columns do not add to 100%)

*Table A1.4: Percent of B.C. population and landmass exposure to average annual wildfire-$PM_{2.5}$ levels above specific thresholds**

Year	Percent of B.C. population exposed to wildfire smoke-$PM_{2.5}$ above seasonal average threshold of:			Percent of B.C. landmass exposed to wildfire smoke-$PM_{2.5}$ above seasonal average threshold of:		
	1.0 ug/m3	5.0 ug/m3	10.0 ug/m3	1.0 ug/m3	5.0 ug/m3	10.0 ug/m3
2013	8.9%	0%	0%	12.5%	0%	0%
2014	84.5%	2.9%	0%	59.8%	9.4%	2.4%
2015	17.1%	11.4%	2.5%	24.1%	8.6%	2.0%
2017	99.5%	95.9%	70.2%	78.6%	43.6%	32.4%
2018	99.5%	21.2%	5.6%	24.8%	6.4%	2.0%

* Source: [292]. Includes years 2013-2015 and 2017-2018 (May to September). Note: the year 2016 was not included in this study. Seasonal average calculated for the period May to September for each study year.

Table A1.5: Canadian Census Districts with the highest average wildfire-$PM_{2.5}$ exposures and proportions of wildfire smoke-$PM_{2.5}$ to total $PM_{2.5}$[1]

Statistics Canada Census District (Province)	Average wildfire-$PM_{2.5}$ exposure ($\mu g/m^3$)	Proportion of wildfire-$PM_{2.5}$ to total $PM_{2.5}$ exposure (%)
Cariboo (BC)	5.3	65.9
Okanagan-Similkameen (BC)	4.4	65.3
Kootenay Boundary (BC)	4.0	67.4
Thompson-Nicola (BC)	3.7	58.2
Central Okanagan (BC)	3.1	45.2
Central Kootenay (BC)	3.0	70.7
Bulkley-Nechako (BC)	3.0	63.2
North Okanagan (BC)	2.9	57.9
East Kootenay (BC)	2.7	66.0
Squamish-Lillooet (BC)	2.3	66.8

* Source: [292] Includes years 2013-2015 and 2017-2018 (May to September). Note: the year 2016 was not included in this study.

*Table A1.6: Estimated premature deaths in B.C. associated with acute and chronic exposure to wildfire smoke-$PM_{2.5}$ between the years 2013-2015 and 2017-2018**

Year	Estimated number (95% confidence interval) of premature deaths in B.C. annually associated with exposure to wildfire smoke	
	Acute exposures	Chronic exposures
2013	6 (2-9)	59 (30-87)
2014	23 (9-37)	240 (129-357)
2015	25 (10-40)	260 (135-380)
2017	170 (67-275)	1700 (915-2544)
2018	69 (27-110)	(82-1054)
Annual average 2013-2015 and 2017-2018, B.C.	59	596
Annual average 2013-2015 and 2017-2018, Canada	118	1233

* Source: [292]. Note that year 2016 was not included in this study

*Table A1.7: Total days under a Special Air Quality Statement (SAQS), 2021**

	Total days, by SAQ type						Total unique days**
	Smoke-wildfire	Smoke-residential	Summer smog	Winter smog	Dust	Other	
Interior Health	**77**	**2**	**0**	**1**	**26**	**7**	**113**
11- East Kootenay	48	0	0	0	13	0	61
12- Kootenay Boundary	71	0	0	0	16	3	90
13- Okanagan	73	0	0	0	16	0	92
14- Thompson Cariboo Shuswap	76	1	0	0	24	2	107
Fraser Health	**57**	**0**	**5**	**0**	**0**	**0**	**60**
21- Fraser East	57	0	5	0	0	0	60
22- Fraser North	8	0	5	0	0	0	12
23- Fraser South	7	0	5	0	0	0	12
Vancouver Coastal Health	**47**	**1**	**6**	**1**	**9**	**2**	**64**
31- Richmond	7	0	5	0	0	0	12
32- Vancouver	7	0	5	0	0	0	13
33- North Shore-Coast Garibaldi	47	1	6	1	9	2	64
Vancouver Island Health	5	0	2	0	0	0	7
41- South Vancouver Island	4	0	0	0	0	0	4
42- Central Vancouver Island	4	0	0	0	0	0	4
43- North Vancouver Island	5	0	2	0	0	0	7
Northern Health	**40**	**8**	**1**	**1**	**19**	**4**	**72**
51- Northwest	17	1	0	1	9	2	30
52- Northern Interior	40	8	1	1	19	4	72
53- Northeast	27	0	0	0	1	0	28
Total unique days province-wide	77	8	6	1	27	7	122

*Data source: Environment and Climate Change Canada (personal communication). Note: ECCC forecast regions may overlap multiple Health Authorities/ Health Service Delivery Areas boundaries but each unique date counted only once per respective health region. Counts not weighted by population. Aggregation to health authority boundaries may mask some regional differences.
** Row totals (columns do not add to 100%)

Table A1.8: Number of days with flood warnings (level 3) in place, by Health Authority, Health Service Delivery Areas (HSDA) and province-wide (January 1, 2007-June 6, 2023)

	Number of days with flood warnings in place (level 3)																	
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023 (Jan 1-Jun 6)**	**Total (Jan 1 2007-Jun 6 2023)**
Interior Health	**6**	**0**	**1**	**6**	**10**	**23**	**2**	**2**	**1**	**1**	**1**	**23**	**5**	**26**	**36**	**17**	**13**	**173**
11- East Kootenay	4	0	0	0	2	1	2	0	0	0	0	4	0	2	0	1	0	16
12- Kootenay Boundary	0	0	0	0	3	0	0	0	0	0	0	13	0	2	0	0	6	24
13- Okanagan	0	0	0	0	1	21	0	0	0	0	0	13	0	0	7	0	6	48
14- Thompson Cariboo Shuswap	6	0	1	6	8	23	0	2	1	1	1	23	5	24	36	16	13	166
Fraser Health	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**20**	**0**	**0**	**24**
21- Fraser East	2	0	0	0	0	0	0	0	1	1	0	0	0	0	20	0	0	24
22- Fraser North	2	0	0	0	0	0	0	0	1	1	0	0	0	0	20	0	0	24
23- Fraser South	2	0	0	0	0	0	0	0	1	1	0	0	0	0	20	0	0	24
Vancouver Coastal Health	**5**	**0**	**5**	**12**	**9**	**6**	**0**	**2**	**1**	**10**	**3**	**11**	**5**	**26**	**36**	**16**	**0**	**147**
31- Richmond	2	0	0	0	0	0	0	0	1	1	0	0	0	0	20	0	0	24
32- Vancouver	2	0	0	0	0	0	0	0	1	1	0	0	0	0	20	0	0	24
33- North Shore-Coast Garibaldi	5	0	5	12	9	6	0	2	1	10	3	11	5	26	36	16	0	147
Vancouver Island Health	**5**	**0**	**5**	**12**	**3**	**1**	**0**	**2**	**1**	**10**	**3**	**1**	**0**	**2**	**1**	**0**	**0**	**46**
41- South Vancouver Island	3	0	4	7	1	1	0	2	0	10	2	1	0	2	1	0	0	34
42- Central Vancouver Island	5	0	4	7	1	1	0	2	1	10	3	2	0	2	1	0	0	39
43- North Vancouver Island	5	0	5	12	3	1	0	2	1	10	3	1	0	2	1	0	0	46
Northern Health	**10**	**4**	**1**	**6**	**25**	**13**	**2**	**0**	**0**	**5**	**2**	**24**	**5**	**24**	**25**	**28**	**5**	**179**
51- Northwest	9	0	1	6	11	3	0	0	0	0	1	12	0	0	2	12	0	57
52- Northern Interior	8	4	0	0	23	11	2	0	0	5	2	24	5	24	24	16	0	148
53- Northeast	6	0	0	0	5	3	0	0	0	5	1	2	0	0	0	12	0	34
Total unique days province-wide	**15**	**4**	**5**	**12**	**27**	**29**	**4**	**4**	**1**	**15**	**4**	**26**	**5**	**28**	**39**	**28**	**18**	**264**

*Data source: B.C. River Forecast Centre. Excluding water basins when there was no population (0%) residing in an overlapping HSDA region.
**May include overlapping dates with multiple flood warnings issued for HSDA region. Aggregation to health authority boundaries may mask some regional differences.
For the specific dates of the 2021 AR-flood event November 14-December 1, 2021: Interior (18 days), Fraser (18), Vancouver Coastal (5), Vancouver Island (18), Northern (1); Province-wide (18)

Table A1.9: Number of days with flood watches (level 2) in place, by Health Authority, Health Service Delivery Areas (HSDA), and province-wide (January 1, 2007-June 6, 2023)

	Number of days with flood watches in place (level 2)																	
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021***	**2022**	**2023 (Jan 1-Jun 6)**	**Total (Jan 1 2007-Jun 6 2023)**
Interior Health	**14**	**10**	**15**	**5**	**23**	**26**	**6**	**8**	**4**	**1**	**49**	**25**	**2**	**53**	**33**	**75**	**34**	**383**
11- East Kootenay	5	5	0	0	10	9	6	0	0	0	5	13	0	3	3	3	15	77
12- Kootenay Boundary	0	5	0	0	3	14	4	0	0	0	19	15	0	4	0	4	15	83
13- Okanagan	0	10	0	0	4	16	1	0	0	0	38	21	0	17	1	27	24	159
14- Thompson Cariboo Shuswap	14	10	15	5	16	25	2	8	4	1	49	25	2	53	33	75	34	371
Fraser Health	**5**	**1**	**15**	**5**	**1**	**0**	**1**	**2**	**1**	**1**	**2**	**2**	**0**	**2**	**18**	**30**	**3**	**89**
21- Fraser East	5	1	3	2	1	0	1	2	0	0	0	2	0	0	6	30	5	58
22- Fraser North	5	1	15	5	1	0	1	2	1	1	2	2	0	2	18	30	3	89
23- Fraser South	5	1	3	2	1	0	1	2	0	0	0	2	0	0	6	30	0	53
Vancouver Coastal Health	13	7	15	7	13	9	1	8	8	8	27	18	3	47	34	70	28	316
31- Richmond	5	1	3	2	1	0	1	2	0	0	0	2	0	0	6	30	0	53
32- Vancouver	5	1	15	5	1	0	1	2	1	1	2	2	0	2	18	30	3	89
33- North Shore-Coast Garibaldi	13	7	15	7	13	9	1	8	8	8	27	18	3	47	34	70	28	316
Vancouver Island Health	**12**	**0**	**15**	**7**	**3**	**2**	**0**	**3**	**8**	**8**	**8**	**13**	**2**	**7**	**18**	**17**	**8**	**131**
41- South Vancouver Island	7	0	4	4	1	0	0	1	5	7	3	1	1	2	9	8	3	56
42- Central Vancouver Island	10	0	15	7	1	0	0	3	5	8	5	3	1	3	17	8	3	89
43- North Vancouver Island	12	0	15	7	3	2	0	3	8	8	8	13	2	7	18	17	8	131
Northern Health	**39**	**15**	**15**	**0**	**27**	**38**	**6**	**7**	**46**	**5**	**30**	**20**	**2**	**56**	**33**	**85**	**25**	**449**
51- Northwest	10	6	15	0	15	7	4	2	16	3	9	14	1	9	16	32	6	165
52- Northern Interior	37	9	8	0	25	36	2	5	43	3	26	20	1	52	28	72	21	388
53- Northeast	6	6	14	0	11	7	4	0	0	5	8	1	0	5	3	27	4	101
Total unique days province-wide	**47**	**16**	**29**	**7**	**32**	**45**	**11**	**9**	**51**	**13**	**50**	**27**	**3**	**61**	**44**	**100**	**34**	**579**

*Data source: B.C. River Forecast Centre. Excluding water basins when there was no population (0%) residing in an overlapping HSDA region. Aggregation to health authority boundaries may mask some regional differences.
**May include overlapping dates with multiple flood warnings issued for HSDA region. November 14-December 1, 2021: Interior (9 days), Fraser (9), Vancouver Coastal (10), Vancouver Island (10), Northern (6); Province-wide (12)

Table A1.10: Number of weeks under drought level 3+, by Health Service Delivery Areas (HSDA), Health Authority (HA), and province-wide, 2015-2023

	Drought level 3+ (Historic drought level system)							Drought level 3+ (Current drought level system)			
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**Row total (2015-2020)**	**2021**	**2022**	**2023**	**Row total (2021-2023)**
Interior Health	**15**	**5**	**12**	**13**	**14**	**8**	**67**	**17**	**15**	**26**	**58**
11- East Kootenay	6	0	6	6	6	0	24	12	3	25	40
12- Kootenay Boundary	13	0	10	4	6	0	33	16	15	25	56
13- Okanagan	13	0	11	4	11	0	39	15	15	26	56
14- Thompson Cariboo Shuswap	15	5	12	13	14	8	67	17	13	26	56
Fraser Health	**14**	**0**	**10**	**7**	**14**	**2**	**47**	**15**	**13**	**26**	**54**
21- Fraser East	14	0	10	7	14	2	47	15	13	26	54
22- Fraser North	12	0	7	7	14	2	42	10	12	19	41
23- Fraser South	12	0	7	7	14	2	42	9	12	19	40
Vancouver Coastal Health	**16**	**0**	**11**	**13**	**16**	**3**	**59**	**11**	**13**	**26**	**50**
31- Richmond	12	0	7	7	14	2	42	9	12	19	40
32- Vancouver	16	17	11	13	16	3	76	11	12	19	42
33- North Shore-Coast Garibaldi	16	0	11	13	14	2	56	11	13	26	50
Vancouver Island Health	**16**	**17**	**7**	**13**	**16**	**3**	**72**	**11**	**15**	**19**	**45**
41- South Vancouver Island	16	17	7	7	10	3	60	11	15	19	45
42- Central Vancouver Island	16	17	7	7	10	3	60	11	15	19	45
43- North Vancouver Island	16	17	7	13	16	3	72	11	15	19	45
Northern Health	**16**	**7**	**11**	**15**	**16**	**0**	**65**	**11**	**14**	**27**	**52**
51- Northwest	12	7	0	15	14	0	48	0	10	25	35
52- Northern Interior	6	3	11	15	12	0	47	11	25	25	61
53- Northeast	0	0	6	11	14	0	31	0	13	27	40
Total unique weeks province-wide	**19**	**17**	**12**	**15**	**16**	**8**	**87**	**17**	**15**	**27**	**59**

*Data source: Water Management Branch - Ministry of Water, Land and Resource Stewardship. Note: ECCC forecast regions may overlap multiple HA/HSDA boundaries but each unique date counted only once per respective health region. Drought severity classification system changed in 2021: for years 2021-2023, is a 6-point scale (0-5) with 3+ indicating that adverse impacts to socioeconomic or ecosystem values are possible, likely or almost certain; for years 2015-2021, is a 4-point scale with 3+ indicating very dry to extremely dry conditions.
** Row totals (columns do not add to 100%)

Appendix 2: Detailed Risk to Resilience Project Methods

The *Risk to Resilience Project* used a mixed methods design with multiple data collection methods, including data obtained through a literature and document review, and engagement with health system and external partners. The primary research questions guiding the project were:

1. What are the impacts of climate hazards on the health of B.C. populations and on the B.C. health system (including population and public health, health service delivery/operations, health workforce, and health facilities/infrastructure), with specific attention to the 2021 events of extreme heat, wildfire, flooding, and drought?
2. What risk or resilience factors contribute to disproportionate impacts of climate hazards on the health of sub-populations in B.C., or regional differences on population health or the health system in B.C.?
3. What adaptation responses and strategies have been implemented by the B.C. health system, health system partners, and/or communities—to protect population and public health, and health system functioning in the context of a changing climate? What successes or challenges were experienced? What lessons were learned?

A2.1 Guiding Framework(s)

Data collection and analysis was based on an underlying analytic framework defined for the project *a priori*, guided primarily by the World Health Organization's (WHO) Conceptual Framework for Climate Change and Health [810], as well as internationally recognized frameworks, including the WHO Operational Framework for Climate Resilient and Low Carbon Health Systems; WHO Guidance for Climate Resilient and Environmentally Sustainable Health Care Facilities (and accompanying WHO Checklists to Assess Vulnerabilities in Health Care Facilities in the Context of Climate Change); WHO After-Action Review Guidance; the Health Canada Climate Change and Health Vulnerability and Adaptation Assessment Workbook for the Canadian Health Sector; the WHO Climate Change and Health: Vulnerability and Adaptation Assessment guidelines; and the United Nations Sendai Framework for Disaster Risk Reduction.

Three key pillars were prioritized within the *Risk to Resilience Project* analytic framework for data collection and analysis:

i. **Population and Public Health** (including physical health, mental health, as well as determinants of risk and resilience);

ii. **Health Services and Operations** (including health emergency preparedness and management, patient care, management of environmental determinants of health, health workforce (including occupational health), health information systems, health system related supply chains, and operations; and,

iii. **Health Facilities and Infrastructure** (including impacts to health facilities and health-related infrastructure from extreme weather events, such as heating/cooling, air filtration systems, drinking water treatment systems, power, etc.).

In addition, the following lens and approaches informed the data collection and analysis approach:

i. ***Resilience:*** An overarching framework of this project is based on the notion of transitioning from risk to resilience. Resilience as a framework and as a word has multiple definitions and understandings. For the purposes of this project, climate resilience can be understood as our collective ability to anticipate, respond to, cope with, recover from and adapt to climate-related shocks and stresses, to bring sustained improvements in population health, despite an unstable climate [17].

ii. ***Appreciative inquiry:*** An appreciative approach centres on identifying and exploring assets, strengths and potential, and inquiring into what worked in the response, what can be learned, and opportunities for building on strengths in the future. While impacts, gaps, and challenges are also explored, they are viewed through a generative lens.

iii. ***Valuing lived experience as expertise:*** The experiences of Indigenous knowledge keepers and First Nations health partners, frontline health staff and health service providers is upheld as expertise and evidence. This includes integrating meaningful qualitative data collection through 'storytelling as methodology' to uncover and value lived experience.

iv. ***Trauma-informed:*** Experiences of climate events can be traumatizing for people with lived experience, including staff and health system partners. Project engagement intentionally worked to create an enabling environment for psychological and cultural safety for participants by using trauma-informed practice including realizing how trauma may have affected participants, recognizing the signs of trauma, and resisting re-traumatization [811].

v. ***Indigenous cultural safety:*** This project invited and upheld Indigenous knowledge systems, perspectives, and experiences, recognizing and respecting the role of knowledge keepers and Elders in data collection. This includes offering paid honorariums to Indigenous knowledge keepers participating in the *Risk to Resilience Project*. Project approaches were guided by a commitment to provincial mandates to implement the *Declaration on the Rights of Indigenous Peoples Act* in the data collection and engagement for this project. Principles of Indigenous data sovereignty were respected by ensuring Indigenous participants could review and provide consent for the collection and use of data gathered during sharing circles or interviews. Further, our team worked to uphold the Ministry of Health's commitment to cultural safety and humility.

vi. ***Gender Based Analysis Plus (GBA+):*** We used GBA+ as a framework to bring an intersectional analysis of the complex issues of vulnerability, risk and resilience related to climate change impacts. A GBA+ analysis helped us to better understand how diverse populations in the province may experience health impacts of climate change and understand how multiple identity factors interact and amplify an individual and/or group's experiences of health-related climate impacts.

A2.2 Method for Scoping of Climate Hazards

Climate hazards for this assessment were scoped according to the following four criteria:

1. Recent significant impacts on the health of people who live in B.C. and the B.C. health system, with specific attention to the 2021 heat dome, flooding events and wildfire season;
2. Provincial in scale, with multiple health regions implicated;
3. Priorities as expressed during Climate Preparedness and Adaptation Strategy (CPAS) engagement sessions; and,
4. Level of risk identified in the 2019 Preliminary Provincial Strategic Climate Risk Assessment, with prioritization of hazards that would have major or catastrophic consequences for health (mortality or morbidity), and with additional medium to high overall likelihood.

Evidence used for scoping the *Risk to Resilience Project* included:

Recent significant impacts and provincial in scale:

- 2021 atmospheric river (AR) flooding and landslides were the costliest climate event in Canadian history, including catastrophic impacts to infrastructure, supply chains, agricultural lands, loss of life, and ongoing mental health impacts, with impacts in multiple health regions [44].
- 2021 heat dome event was the deadliest climate event in Canadian history and caused significant morbidity and mortality, strain to the health system, and broader impacts to the economy, agricultural sector, marine life, crops, etc., with impacts in multiple health regions [44].
- 2021 wildfire season was the third worst in B.C. history at the time of *Risk to Resilience Project* scoping (in terms of area burned). It led to catastrophic damage and loss of life in the community of Lytton, catastrophic damages to the community of Monte Lake, and a significant smoke event impacting air quality in multiple regions. Supply chains were significantly impacted as well, and there are ongoing mental health impacts; impacts were felt in multiple health regions [32 2017 and 2018 wildfire seasons were also record-breaking, with significant wildfire smoke events leading to some of the worst air quality in the world, and with impacts felt in multiple health regions.
- By 2022 drought affected multiple regions of the province, which were under severe drought conditions for months, impacting water availability with risks to communities and health care facilities. There were impacts to agriculture and biodiversity, including salmon and their habitats, as well as increasing risks for more severe flooding, wildfires, and storm impacts, for example, drought weakened vegetation is more susceptible to falling in storm conditions.

CPAS Engagement

- Results from the 2020 Partner Engagement, 2020 Individual Submissions, and 2020 Organization submissions identified priority concerns as: wildfire smoke, extreme weather and flooding , as well as changes to forests and ecosystems, seasonal water shortages, heat waves, anticipated impacts of food insecurity, sea level rise, and climate-driven displacement. Mental and physical health issues were of greatest concern overall;
- Key concerns identified by Indigenous Peoples during CPAS engagement and in surveys conducted by the First Nations Leadership Council and Métis Nation BC [80] included:
    - An increase in intensity and frequency of extreme weather events;

- Damage, disappearance or loss of access to sacred and cultural sites;
- Decline in the number of salmon, moose and other animals as well as changes in migration routes;
- Decline in the number of medicinal, ceremonial and land-based plants as well as an increase in the number of invasive plants, animals and insects;
- Warm water fish species appearing in places never seen before, and insect lifecycles occurring earlier;
- Decrease in water quality and generally lower water levels; and,
- Physical and mental health impacts.

4) Provincial Strategic Climate Risk Assessment (2019)

Note: hazards that would have major or catastrophic consequences for health (mortality or morbidity), and with additional medium to high overall risk are: severe wildfire season, seasonal water shortage, heat wave, long-term water shortage, moderate flooding, severe riverine flooding, and severe coastal storm surge (Table A1.2).

Table A2.1: Health-related results in the Preliminary Strategic Climate Risk Assessment for B.C. (2019)

Hazard	Definition	Risk	Likelihood	Consequence – Health (Mortality, Morbidity)	Consequence – Social Functioning (Psychological, Social Cohesion)
1. Severe wildfire season	At least one million hectares burned that affect human settlements and significant infrastructure	High	Likely	Major, Catastrophic	Catastrophic, Catastrophic
2. Seasonal water shortage	Months-long summer water shortage affecting two or more regions of the province	High	Almost certain	Minor, Major	Moderate, Major
3. Heat wave	Heat wave of at least three days that affects human health	High	Likely	Catastrophic, Catastrophic	Catastrophic, Moderate
4. Ocean acidification	0.15 reduction in pH by 2050	High	Almost certain	Insignificant, Insignificant	Catastrophic, Catastrophic

Hazard	Definition	Risk	Likelihood	Consequence – Health (Mortality, Morbidity)	Consequence – Social Functioning (Psychological, Social Cohesion)
5. Glacier mass loss	25% decline in glacier area by 2050, relative to 2005	High	Almost certain	Minor, Minor	Minor, Moderate
6. Long-term water shortage	Multi-year water shortage that results in insufficient supplies of both blue water (i.e., liquid surface water) and green water (i.e., moisture in soil and vegetation) in at least one region of the province	High	Possible	Minor, Major	Major, Catastrophic
7. Reduction in ecosystem connectivity	Reduction in ecosystem connectivity in the Okanagan-Kettle region by 2050	Med	Likely	Insignificant, Insignificant	Minor, Major
8. Saltwater intrusion	At least seasonal saltwater intrusion into the Fraser River delta and surrounding communities by 2050	Med	Likely	Insignificant, Insignificant	Minor, Moderate
9. Loss of forest resources	25% decline in timber growing stock by 2050	Med	Possible	Insignificant, Minor	Minor, Major

Hazard	Definition	Risk	Likelihood	Consequence – Health (Mortality, Morbidity)	Consequence – Social Functioning (Psychological, Social Cohesion)
10. Increase in invasive species	Expansion of knotweed by 2050	Med	Almost certain	Insignificant, Minor	Minor, Minor
11. Moderate flooding	Moderate flood in a single community (repeat flooding in a single community, or more frequent flooding events across multiple communities)	Med	Possible	Major, Major	Minor, Major
12. Severe riverine flooding	500-year flood on Fraser River, affecting more than 30% of BC population	Med	Unlikely	Major, Major	Catastrophic, Catastrophic
13. Severe coastal storm surge	3.9 m storm surge during a king tide along the B.C. coast	Med	Unlikely	Major, Major	Catastrophic, Catastrophic
14. Extreme precipitation and landslide	Significant landslide in Hope triggered by extreme precipitation (affects transportation across the province)	Med	Possible	Minor, Moderate	Minor, Minor

Hazard	Definition	Risk	Likelihood	Consequence – Health (Mortality, Morbidity)	Consequence – Social Functioning (Psychological, Social Cohesion)
15. Increased incidence of vector-borne disease	At least a doubling of Lyme disease cases within B.C. over three years, occurring before 2050	Low	Unlikely	Minor, Major	Major, Minor

*Colour coding assigned according to highest assessed consequence within a given category:

	Catastrophic
	Major
	Moderate
	Minor or Insignificant

A2.3 Data Collection and Analysis

Engagement Methods

An iterative approach was used to determine the specific roles and partners to engage with during the data collection phase. Forms of engagement included:

- *Partner Mapping:* Partner and participant identification was done collaboratively by SHIFT, the Ministry of Health, and partners. Contacts were identified via recommendations from the Ministry of Health's Climate Resilience Unit and Emergency Management Unit, and snowball sampling. The *Risk to Resilience Project* collaborated with regional health authorities to determine activities for engagement and the priority individuals, roles, and partners to engage.
- *Scoping Interviews:* 13 scoping interviews were conducted early in the project, with individuals from the Ministry of Health's Climate Resilience Unit, and Emergency Management Unit, First Nations Health Authority, regional health authorities, Public Health Services Association, B.C. Centre for Disease Control, Health Emergency Management B.C., and B.C. Emergency Health Services, from December 2022 to January 2023.
- *Focus Groups:* 17 focus groups were convened in February–May 2023 with 133 health system staff in specific divisions and roles, key health practitioners across health authorities, and service providers that have partnered with the health system to prepare and respond to climate hazards. Focus groups dug deeper into questions related to impacts on health and the health system as well as existing assets, resilience factors, and lessons learned from response and adaptation to specific hazards and the 2021 events.

- *Key Informant Interviews:* Following preliminary literature review and focus group analysis, another round of interviews was conducted to dig deeper into key themes (late April - May, 2023). 5 key informant interviews were conducted across the health system and other external partners, including the BC Society of Women's Transition Houses, the Office of the Provincial Health Officer, a physician, and regional health authority staff.
- *Indigenous Engagement:* The *Risk to Resilience Project* involved an Indigenous engagement advisor, Dr. Lilia Yumagulova, to support the development of an approach and strategies for Indigenous engagement. The approach leveraged existing engagement of Indigenous organizations in climate-related projects, to avoid overburdening organizations with multiple engagement requests. Three **I**ndigenous sharing circles were convened with 18 individuals in key roles in emergency services, community health-related professionals from Indigenous organizations in rural and remote parts of B.C., and Indigenous knowledge keepers. Participants included individual Rights and Title holders from Ahousat First Nation, Halalt First Nation, Stellat'en First Nation, Ashcroft Indian Band, Kanaka Bar Indian Band, Nlaka'pamux/Lytton, Líl̓wat Nation, and Heiltsuk Nation. Emergency services and community health staff were invited to share their experiences with the impacts of recent wildfire, flooding, heat and drought events on health and well-being, the health services, and systems on which their communities rely, and community health-related infrastructure. Questions were reviewed by participants prior to the circle to ensure that Rights Holders' priorities are reflected and a summary of key themes was sent for review after. The preliminary results of the sharing circles were presented for review and discussion to the B.C. Climate Action Secretariat Indigenous Climate Action Working Group.

Literature and document review

In-depth reviews were completed for the four priority hazards (extreme heat, wildfires, flooding and drought). Documents and literature were identified using multiple sources including:

- *Peer-reviewed publications:* with search terms identified through published reviews [812,813], key reports [18,814], and librarian consultation, with searches run on OVID Medline, Web of Science, and CINAHL databases;
- *Internet search:* for public-facing documents, targeting health authority and Ministry of Health webpages, and other B.C. and national climate- and health-related organizations, as well as media stories;
- *Hand-searches of reference lists:* from key reports and resources; and,
- *Requests for internal documents:* Documents were requested from internal and external health system partners (e.g., health authorities, services providers), Indigenous organizations (e.g., BCAFN, UBCIC, MNBC), and other key provincial and federal partners (e.g., Climate Action Secretariat, Health Canada). Examples of eligible document types included vulnerability/risk and adaptation assessments, epidemiological analyses, partner engagement, after-action reviews, and program evaluations.

Documents and literature were eligible for inclusion if they included:

- Data on the impacts of climate hazards on population and public health in B.C., or on the B.C. health system, provincially or regionally;
- Health adaptation responses and innovative adaptation strategies (particularly measures implemented by the B.C. health system, health system partners, or communities in collaboration or partnership with the B.C. health system) to respond to climate hazards in relation to population health and well-being;

- Key initiatives and resources (e.g., implemented by local or regional governments; provincial initiatives; BCCDC; communities of practice and other leaders, etc.); or,
- Stories of health sector or community resilience in the face of climate hazards.

Resources prioritized for full review were documents that had B.C.-specific data, published from 2014 onwards[59], and included:

- Landmark resources (e.g., first of its kind publication, first policy, first research evidence relevant to B.C., or led to changes in policy or decision-making in B.C.);
- Provincial-level information, addressing multiple health regions or scalable to multiple health regions;
- Data about impacts of climate exposures in B.C. on priority populations;
- Unique adaptation strategies to climate exposures in B.C., aimed at reducing vulnerability and improving B.C. population and public health or B.C. health system functioning in a changing climate; or,
- Information related to the 2021 extreme heat, wildfire, flooding or 2021-2023 drought events.

Data from documents and literature prioritized for full detailed review were extracted into data extraction forms developed for the *Risk to Resilience Project*.

Data analysis

Data from the interviews, focus groups and document review were thematically coded using NVivo software to identify key themes and sub-themes. Triangulation of evidence was conducted with synthesis of findings across all data sources. All team members participated in several meaning-making sessions to identify and extract major themes according to categories including impacts on population health; populations disproportionately impacted; impacts on the health system; response successes; response gaps; and response opportunities.

An additional more detailed sub-analysis of the 2021 climate events was also included, with the objective to summarize the scenario and timelines, health impacts, adaptations, and stories of resilience during and after B.C.'s 2021 heat dome, the 2021 wildfires, 2021 AR-flood events and the 2021-2023 drought.

A database of over 75 stories was also developed to feature examples of lived experience, adaptation and response, including the context and lessons learned across diverse regions, and roles in relation to these hazards. Throughout the data collection stages team members identified potential 'lived/practical experience' stories, relative to the climate hazards. Stories were selected to illustrate key findings in the project and demonstrate a variety of identities and that bring health equity to the fore.

Geospatial data analysis

Historical Environmental Hazard Assignment: A geographic information science analysis methodology was used to summarize historical hazard events within health service delivery areas (HSDAs) and regional health authorities. Where historical hazard regions overlapped two HSDAs, an assignment methodology was implemented to gauge the significance of the overlap in terms of size and population impact. This methodology was applied to datasets: Flood Advisories, Watches and Warnings, Drought Levels, and Heat Warnings and Special Air Quality Statements (SAQs). Both heat warnings and SAQs were spatially delineated by weather warnings and statement regions.

59 2014 selected to align with the IPCC AR5 report (2014)

The assignment of HSDAs involved the utilization of a statistics assignment script. This script allocated each 2021 Canadian federal government Census Dissemination Block to its corresponding HSDA and environmental region reporting boundary. Dissemination blocks, integral to census geographies, are maintained by Statistics Canada, while HSDAs are overseen by the Ministry of Health . Drought, flood, and weather warnings and statement regions fall under the management of the Provincial Water Management Branch, River Forecast Centre, and Environment and Climate Change Canada, respectively. In cases where a dissemination block intersected with multiple HSDAs or hazard boundaries, the methodology included calculating the percentage of the population within the overlapping area. In the case where notification region boundaries changed over the years, each boundary configuration was run separately through the HSDA assignment.

For the calculation of days under risk of hazards, a distinct count of unique calendar dates was employed to eliminate duplications arising from overlapping environmental regions within an HSDA. The same method was applied for unique weeks under drought. In scenarios necessitating the count of unique environmental events impacting an HSDA, any overlapping environmental region with that HSDA contributed to the overall count. For example, the Chilcotin weather region overlapping with Thompson Cariboo Shuswap, North Shore/Coast Garibaldi, and Northern Interior HSDAs resulted in the inclusion of all heat warnings and special air quality statements from the Chilcotin in the count of all three HSDAs (Figure A2.1). It is crucial to acknowledge that each dataset possesses a distinctive historical range influenced by the collection and archiving methods of the respective data custodians. Some datasets may commence or conclude mid-year, necessitating careful consideration of the time range when interpreting event counts by year (Table A2.2).

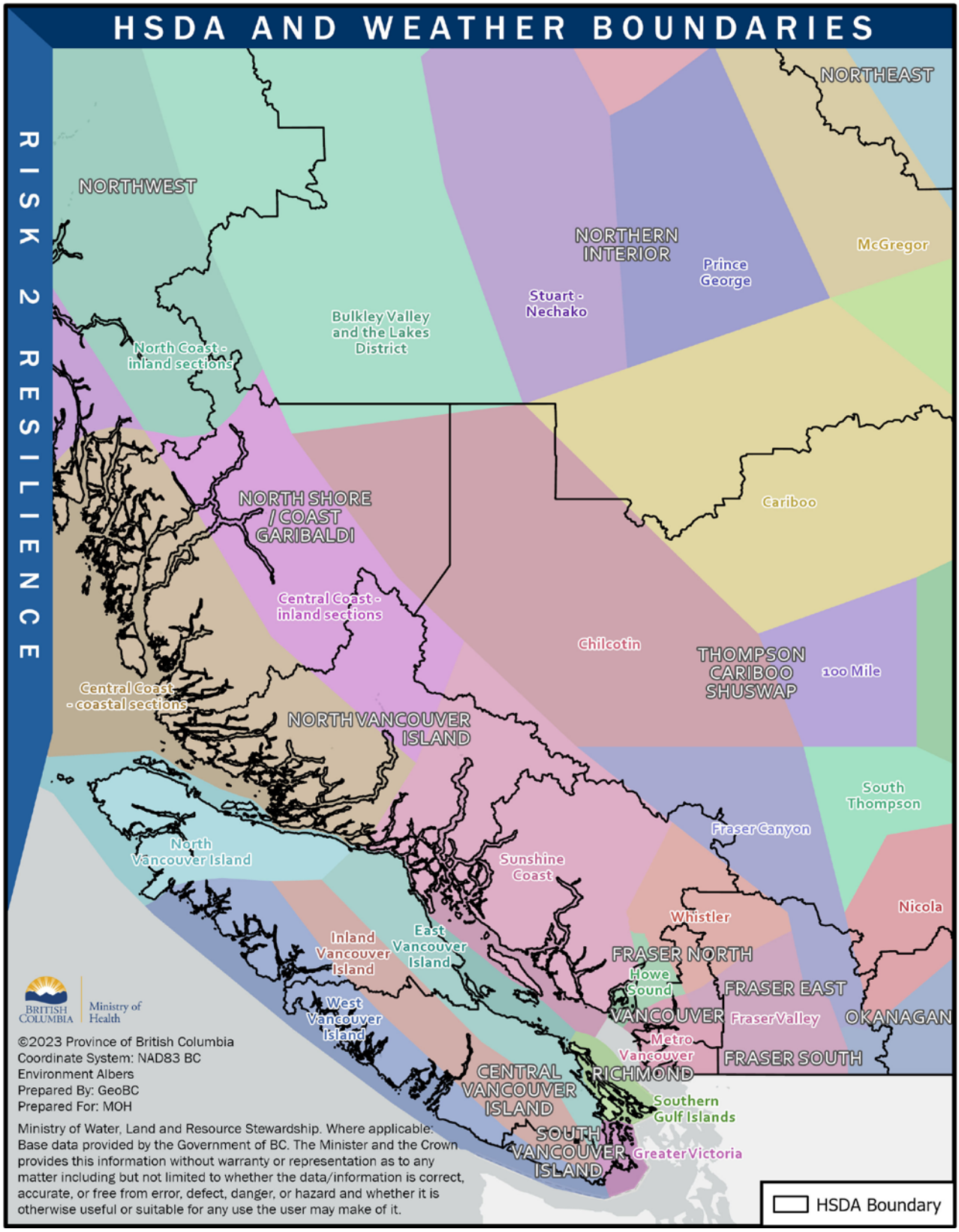

Figure A2.1 Overlaying weather notifications with health service delivery areas (HSDAs) illustrates the complexity of assigning environmental event counts to specific HSDAs

Table A2.2: Data sources and historical date ranges

Dataset	Source Agency	Historical Range
Historical Flood Advisories, Watches and Warnings	River Forecast Centre, Ministry of Water, Land and Resource Stewardship	January 1, 2007- June 6, 2023
Evacuation Orders and Alerts Population	GeoBC, Ministry of Water, Land and Resource Stewardship	April 17, 2017 - November 9, 2023
Evacuation Orders and Alerts Duration	GeoBC, Ministry of Water, Land and Resource Stewardship	April 17, 2017 - November 20, 2023
Heat Warnings	Environment and Climate Change Canada	June 18, 2018 – Sept 2, 2022
Drought Levels	Water Management Branch, Ministry of Water, Land and Resource Stewardship	2015 –2023
Special Air Quality Statements	Environment and Climate Change Canada	2021


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