# A research guide to support health sector action on climate change in British Columbia, Canada

A companion report to *Climate Change and Health in British Columbia: From Risk to Resilience*

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BRITISH COLUMBIA

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# EXECUTIVE SUMMARY

**As climate change poses increasing risks to the health and well-being of people in British Columbia (B.C.) and to the health services they rely on, research will continue to play an important role in identifying innovative procedures and practices to safeguard communities and build resilience.**

This document synthesizes research approaches, knowledge gaps and priority focus areas for health sector researchers and anyone doing or funding research at the intersection of climate change and health in B.C. The priority knowledge gaps and research needs presented in this document are informed by a document review and significant health sector engagement during the development of the report titled *Climate Change and Health in British Columbia: From Risk to Resilience*, and additional engagement with more than 30 expert researchers from across the province. The high-level themes related to research approaches and knowledge gaps that surfaced from this process are articulated in **Table A**, below, and additional detailed insights are provided throughout the report.

Addressing these knowledge gaps and investing in high-quality research will help decision-makers across the province and health sector better mitigate risks and adapt to the health consequences of a changing climate in B.C.

*Table A. Priority Climate Change and Health Research Approaches and Opportunities for British Columbia*

| PRIORITY APPROACHES | |
|---|---|
| **Integrated Research** | • Emphasize the importance of integrating multidisciplinary collaboration, Indigenous knowledge and a whole-of-society approach to create comprehensive and effective solutions for climate and health resilience. |
| **Prioritizing Equity** | • Prioritize the use of equity-informed tools, community involvement, and the dismantling of systemic barriers to ensure that climate and health resilience efforts are inclusive and responsive to the diverse needs and vulnerabilities of all population groups, particularly those most at risk. |
| **Decolonizing Research and Practice** | • Commit to decolonizing climate and health research by prioritizing Indigenous leadership, collaboration, and self-determination, while building capacity for cultural safety, humility and Indigenous data sovereignty to ensure climate action respects Indigenous knowledge and rights. |
| **Community-engaged & Place-based Approaches** | • Focus on community-engaged and place-based methods, emphasizing participatory research and citizen science to understand local climate-related health impacts, while leveraging strengths-based inquiry to honor and uplift the unique contexts and experiences of communities in culturally safe and inclusive ways. |
| **Implementation Science for Climate Action** | • Leverage insights from implementation science to support solutions-oriented research by monitoring and evaluating the real-world effectiveness of climate and health interventions, integrating solutions into existing policies, and involving communities and decision-makers to ensure the relevance and impact of research outcomes. |

| KNOWLEDGE GAPS | | |
|---|---|---|
| | **Data Needs** | • Support evidence-informed decision-making by assessing the health impacts of various climate hazards, enhancing surveillance and data collection, and exploring the physical, mental and cultural impacts of climate change on diverse populations. This evidence is critical for developing targeted, effective interventions that improve resilience and health outcomes in the face of both acute and long-term climate-related challenges. |
| | **Adaptation & Implementation Evaluation** | • Understand the effectiveness of climate-health interventions, fostering continuous learning and developing tools to support informed decision-making. |
| | **Emissions Reduction & Co-benefits for Health** | • Evaluate the effectiveness of interventions to reduce the health sector's environmental impact, understanding the health implications of climate policies, and developing tools to assess the co-benefits of reducing carbon emissions. These efforts are vital for broadening sustainability targets and integrating mitigation and adaptation strategies within the health sector, ultimately supporting both environmental sustainability and improved public health outcomes. |
| | **Health System Capacity Building** | • Explore the development of core climate competencies, training programs, and leadership initiatives to enhance the health sector's understanding of climate impacts, support health professionals in their roles, build cultural competence and foster proactive collaboration to build a resilient and responsive health system. |
| | **Emergency Planning, Response & Recovery** | • Better understand the critical role of the health sector in emergency management, the importance of fostering community resilience and equity in all phases of emergency management, and the health impacts post-emergency, including impacts of evacuations on priority populations.<br>• Explore opportunities to ensure Indigenous rights and cultural safety are prioritized in emergency management, to enhance risk communication strategies, and to support the well-being of the emergency response workforce during and after climate-related emergencies. |

# 1.0 INTRODUCTION

Climate change is a pressing health challenge for B.C.'s communities and health sector.(1–3) The health of diverse population groups is already being impacted by our changing climate, and without appropriate mitigation and adaptation, these impacts will continue to grow. Climate change is also a threat multiplier and groups that have been differentially burdened by inequities will continue to bear a disproportionate burden of illness from acute climate events (e.g., morbidity and mortality attributable to extreme heat) and related indirect impacts (e.g., changes to infectious disease transmission).(4) Without proactive action, acute climate events and long-term climate change will continue to impact population and public health, health service delivery and acute systems of care by straining health services, damaging essential infrastructure and technology, disrupting supply chains, and straining the health sector workforce.(5)

To respond to the health impacts of climate change, the B.C. Ministry of Health's Climate Resilience Unit commissioned a project to improve understanding of climate-related health impacts on B.C.'s populations and health sector. This resulted in a report titled *Climate Change and Health in British Columbia: From Risk to Resilience* (3) (herein, "the Risk to Resilience report") that addresses three inter-related objectives:

1. **Synthesize existing knowledge and information** on the impacts of climate change on health and the health system in B.C.;
2. Identify and document **promising practices, lessons learned, innovative solutions and stories** from the field that demonstrate effective and equitable adaptation measures in B.C. to inform climate-resilient health policies, programs and services; and
3. **Build public and health sector capacity and awareness** in B.C. to assess, adapt and respond to climate change.

## 2.0 ABOUT THIS DOCUMENT

This research guide is a companion document to the Risk to Resilience report. It synthesizes knowledge gaps uncovered in the production of that report and includes themes identified through additional engagement with provincial climate-health researchers. The research guide identifies B.C.-specific climate change and health research priorities that serve to [i] protect and improve the health of populations in a changing climate, and [ii] enhance health sector climate resilience. These opportunities span across disciplines and reflect the complex and multi-faceted challenges that climate change presents for public health. While the report is specific to B.C., the core priority areas are likely to be of interest to a wide range of researchers beyond B.C., and to multiple sectors. Please see Appendix A for the processes used in compiling this document.

## 3.0 OUR SHARED PATH FORWARD: ADVANCING RESEARCH TO UNDERSTAND AND RESPOND TO THE HEALTH IMPACTS OF CLIMATE CHANGE IN B.C.

The remainder of this document outlines knowledge gaps and research opportunities organized by:

1. **RESEARCH APPROACHES** that hold promise for delivering robust, engaged, and equity-informed evidence on climate and health impacts; and
2. **KNOWLEDGE GAPS** that require research to enhance understanding of climate-health impacts and pathways.

## 3.1 Priority Approaches for Climate and Health Research in B.C.

### 3.1.1 Taking an "Integrative Approach" to Climate and Health Research

Climate change is a wicked problem that demands collaboration and engagement across multiple sectors, disciplines and world views, across all stages of the research-to-action spectrum.(6,7) Mainstream health science approaches that are narrowly focused on a single clinical outcome or population, or that see climate change in isolation from other global ecological challenges, are becoming insufficient. While still necessary for addressing specific and acute climate-related events, these approaches must evolve to support the collective thinking and action required to adequately respond to intertwined climate and ecological crises.

To advance climate-health knowledge, we need research that connects previously separate areas of inquiry, to create a more **holistic and comprehensive** understanding (e.g., inter and multi-disciplinary research). This includes the integration of Indigenous and Western knowledge systems (e.g. two-eyed seeing) and honouring and respecting Indigenous worldviews and understandings of health and wellness.

In the context of climate change, integration requires a '**whole of society' and 'whole of science'** approach.(8) This is particularly true in the interactions between climate change and the determinants of health. Many health-determining sectors that operate outside the health system (e.g., housing, agriculture, resource extraction and development, etc.) both influence and are impacted by our changing climate in ways that leave lasting legacies for human health and well-being.(9) Integrated climate and health research needs to be mindful of arbitrary divisions among sectors or even specific topics.

For example, parallel research streams are emerging in the fields of climate adaptation and mitigation, and focusing only on one misses opportunities to incorporate mitigation into adaptation initiatives, and vice versa.(10) An integrated approach to health system climate action asks questions about how to unlock the collective expertise of multiple disciplines, sectors and areas of inquiry to achieve **co-benefits for health** (i.e., improvements in health that result from the reduction or elimination of greenhouse gas emissions), and health system resilience.(11)

Central to an integrative research approach is the need to leverage existing insights and strengths from work on the **structural, social and ecological determinants of health** to support climate and health research and action.(12) It should be understood that addressing long-standing challenges facing B.C. populations including the toxic drug crisis, housing affordability and supply, and income inequality are *in and of themselves* actions that will reduce

the vulnerability of population groups to acute climate emergencies and the longer-term health implications of climate change. Encouraging research that explores **upstream factors** that can affect climate health vulnerability is important and requires approaches that can meaningfully bridge sectoral and disciplinary silos and enhance collaboration.

Opportunities for integrative approaches to climate and health research:

➔ **Multi-disciplinary Research**:

- Foster cross-disciplinary research on social and ecological determinants of health, and climate-health impacts and adaptations, while honouring Indigenous knowledge systems and methodologies; and
- Develop methodologies that effectively bridge intersectoral silos and enhance collaboration across disciplines and sectors.

➔ **Multi-sector Collaboration and Partnerships**:

- Support collaboration across scales and sectors (e.g. health sector, Indigenous knowledge holders, local governments, community agencies) to reduce duplication of effort, build a more holistic and comprehensive understanding of climate-health interactions, and expand the purview of possible solutions; and
- Explore facilitators and barriers to a 'whole of society' and 'whole of government' approach to protecting population health and enhancing health system resilience in a changing climate.

➔ **Two-Eyed Seeing:** Work with Indigenous and Traditional Knowledge Holders to honour and value the unique contributions of Indigenous worldviews, knowledge systems and methods alongside Western science in climate-health research.

➔ **Health in Climate Action:**

- Generate opportunities for climate-oriented non-health researchers and sectors to learn about the health implications of their work and ensure health is a valued component of climate action across all levels of society and government;
- Explore how effectively health is integrated within climate policies and plans in B.C. including across the provincial government and Indigenous governments and organizations; and
- Explore opportunities to integrate climate-health evidence, concepts, knowledge, and tools into climate adaptation and mitigation strategies at various jurisdictional levels.

### 3.1.2 Prioritizing Equity-Informed Approaches to Climate and Health Research

Climate change is a threat multiplier, and individuals and communities that are least able to adapt to changing climate conditions are more likely to be impacted.(4) Indeed, populations that are differentially burdened by broader societal inequities and power imbalances (e.g., colonialism, racism, sexism, ableism, etc.) may be more likely to be differentially exposed to climate-related determinants of ill-health, more physiologically susceptible (e.g., through pre-existing chronic conditions), and have fewer material resources to support risk mitigation through adaptation initiatives or behaviour change.(4,13–15)

Prioritizing equity in preparedness and response requires climate and health researchers to acknowledge how societal systems replicate privilege and disadvantage across society. Research approaches should focus on ensuring a fair, just and equitable response to the health impacts of climate change.(16,17) This requires understanding and implementing processes that **support community needs** and **prioritize and centre community voices and lived experiences**.

Building **community capacity** and supporting **equity-oriented analysis** using intersectional tools, such as gender-based analysis plus (GBA+) (18–20), may enable researchers to identify and challenge processes and structures of privilege and discrimination that may hinder effective climate solutions. By using equity-oriented approaches researchers can strive for fair and just outcomes without replicating harmful structures. Additionally, researchers have an opportunity to leverage new research funding to support community capacity, enhance community initiatives, and align research with local contexts.

An equity-informed approach to climate-health research requires understanding the distribution and clustering of climate and health impacts across **regional differences** (e.g. urban, rural and remote communities) and **diverse populations**, exploring the role of age, ability, sex, gender, race and housing status (to name a few) as well as differential impacts on Indigenous Peoples.(7,21). Understanding the **root causes of differential risk** and the complex direct and indirect pathways between the social and ecological determinants of health and climate-health outcomes is critical to developing effective interventions.(21) In addition, there is an opportunity for researchers to **analyze where health disparities may worsen** without concerted action, and focus on **developing, testing and scaling** climate mitigation and adaptation interventions that can create more equitable health outcomes over time.

Key opportunities for prioritizing equity-informed approaches to climate and health research include:

➔ **Equity-Informed Tools:** Explore the adaptation of existing health equity-informed tools to assess risks of climate change on differentially burdened populations.

➔ **Health Equity Outcomes:**

- 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.
- Use an **intersectional lens**, considering factors such as gender (e.g. women, transgender people), socio-economic status, and race (e.g. people of colour) and how they influence health impacts from climate change and capacity to adapt.
- Explore how health equity-oriented public health approaches can address climate-related vulnerabilities in diverse populations.
- Evaluate the health equity impacts and outcomes of climate-related interventions to ensure the benefits of new programs and policies are distributed to the people who need them most.

➔ **Community Involvement and Lived Experience:**

- Involve community members with lived experience across the spectrum of research-to-action, including in research governance, to ensure alignment with community needs and priorities and to anticipate maladaptive outcomes of climate action.
- Ensure research reflects the voices and perspectives of diverse populations differentially affected by climate hazards (e.g., Indigenous Peoples, insecurely housed individuals, older adults, those with disabilities, etc.).
- Integrate perspectives and intersectional experiences of priority populations when addressing psychological, social, and behavioral impacts of climate change.

➔ **Overcoming Systemic Barriers:**

- Identify barriers to implementing equity-informed approaches across all systems of care, including emergency management and response.

## 3.1.3 Decolonizing Climate and Health Research and Climate Action

Canada's history of colonization and ongoing colonial structures have left a multi-generational impact on First Nations, Inuit and Métis populations.(22,23) Concerted attention to decolonizing climate and health research is required to build and maintain foundations of trust and centre a relational ethic of care between settlers and Indigenous Peoples.(24) Health services and research in B.C. have a documented history of racism and discrimination towards Indigenous people,(25) and the persistence of 'colonial knots' in our health system and society create barriers to reconciliatory action.(26) All researchers have a responsibility to respect self-determination and uphold Indigenous-led research that directly reflects local priorities, fostering meaningful relationships with interested communities. Indigenous-led research not only addresses local priorities but also provides opportunities to enhance and expand education on Indigenous histories, cultures and ways of knowing. (27,28) It is a necessary priority to focus on how we 'unsettle' and 'unlearn' within academia and the broader health sector to advance health and climate research and action.(29)

Key opportunities for decolonizing climate and health research in B.C.:

➔ **Indigenous Leadership and Collaboration:**

- Conduct research in collaboration with and/or led by First Nations, Inuit and Métis Peoples and communities to support inclusion and prioritization of diverse Indigenous worldviews and knowledge systems with respect to climate change and health;(7)

- Strengthen community adaptive capacity by leveraging research opportunities and resources to promote and support Indigenous-led climate initiatives and enhance community resilience, enable skill acquisition, strengthen leadership, and improve emergency response to climate-related events;

- emphasize the importance of researchers listening to wisdom from Traditional Ecological Knowledge as a crucial form of longitudinal data to support climate action and reconciliation (e.g. through the application of "Two-eyed Seeing" as an approach to bridge Indigenous and Western scientific knowledge systems and methods (30,31); and

- Utilize existing priority-setting activities (23,32) undertaken by and for Indigenous communities to advance a next generation of collaborative research on the health impacts of climate change and the health system response.

➔ **Indigenous Rights and Self-Determination:** Explore how to 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. (33,34)

➔ **Capacity Building for Cultural Safety and Humility:** Develop knowledge and capacity among B.C. climate and health researchers on cultural safety and humility to support respectful engagement with Indigenous communities.

➔ **Indigenous Data Sovereignty and Governance**:

- Build understanding amongst researchers related to Indigenous data sovereignty and governance, including culturally appropriate and respectful collection, use, disclosure and stewardship of that information;(35,36) and
- Create opportunities for Indigenous-led data collection and community control over Indigenous-specific health data according to established data sovereignty principles (e.g. First Nations' Ownership, Control, Access and Possession (OCAPÔ) guidelines).(37,38)

### 3.1.4 Community-Engaged and Place-based Research

Equity-informed and de-colonizing research approaches require a 'bottom-up' methodology that prioritizes community-driven and place-based inquiry. Creating spaces where communities, local interest holders, and Indigenous rightsholders can co-create, design and implement research enhances engagement, acceptability and application of results. It also increases the relevance and effectiveness of identified solutions. By grounding research in the specific realities and context of place, climate and health research can more accurately reflect local nuances including values, health status, climate impacts, adaptations and trends. Importantly, place-based research recognizes that what is true for one community may not be true for another. This approach emphasizes the importance of valuing and uplifting the insights of the local community through a strengths/assets-based inquiry. Drawing from participatory-action research and citizen-science tools offers opportunities to advance community and patient-centred data collection for the next generation.

Key opportunities for community-engaged and place-based climate and health research:

➔ Conduct participatory research and utilize citizen science tools with communities to understand local, place-based climate-related health impacts and effective adaptation measures.

➔ Leverage strengths-based and asset-based inquiry to honour and uplift local community context and experience in culturally safe, inclusive and meaningful ways.

### 3.1.5 Support Solutions-Oriented Research

Cultivating assets and strengths-based approaches rather than focusing on deficits and 'vulnerabilities' is critical to fostering hope, social connection and healthy communities in a changing climate. This includes employing research practices that recognize and uphold existing resilience factors already embedded in and practiced by communities and across populations. This re-framing was identified by researchers and in the literature as a necessary cognitive shift among B.C.'s research community to begin supporting and stewarding solutions-oriented work in addition to tracking the rising incidence of climate-related health risks and disease outcomes, or quantifying damages and health system costs associated with extreme climate events or emergencies.

Indeed, there is a demonstrable and urgent need to scale up interventions that protect and promote the health of communities, while mitigating emissions and climate-proofing our health system and health-determining sectors. **Implementation science**—or the study of the uptake of evidence by decision-makers and communities—is a necessary lens to ensure that research findings are adopted and applied in practice by decision-makers and communities.(39) Utilizing implementation science and evaluation of rapid pilots may help identify and overcome barriers to climate action, while also stewarding the next generation of climate and health interventions that are scalable and capable of fostering hope and optimism for a healthy and climate-resilient B.C.

Key opportunities to leverage implementation science and support solutions-oriented research:

- Explore and develop opportunities for monitoring and evaluating the uptake, fidelity, and outcomes of climate and health evidence and interventions in real-world settings (e.g. policy, planning, programs);
- Examine the processes and outcomes of integrating climate and health solutions into existing policies and decision-making frameworks, including understanding the challenges and successes of policy integration, and providing insights into how effective interventions can become part of standard practice; and
- Involve/support communities and decision-makers in the design and conduct of research to enhance the relevance, validity and uptake of research results.

## 3.2 Topical Knowledge Gaps and Opportunities for Research on the Impacts of Climate Change on Health and the Health System

The approaches presented above describe leading practices on the *how* of climate and health research, highlighting opportunities for equity-informed, participatory and community-led research to support multi-solving[1] across a variety of climate-related challenges and the dismantling of structural barriers to health and well-being including colonialism, systemic discrimination and health inequities. The following sections name several discrete and hazard-specific knowledge gaps, as identified by the Risk to Resilience report. As this companion research guide is not intended to be a comprehensive list of research opportunities, but rather a guide that can structure future research processes, a full articulation of hazard-specific gaps is out of scope. Thus, the remainder of this guide takes an all-hazard approach to describe high-level knowledge gaps pertaining to several broad categories including: data; adaptation; mitigation; health system capacity-building; and emergency preparedness and response.

### 3.2.1 Supporting Evidence-Informed Decision-Making

The Risk to Resilience report identified numerous data gaps and opportunities to enhance evidence-informed decision-making. Access to and integration of **climate and health data**—such as modelling future impacts, damage and loss, and cost-benefit analyses—is critical to advancing the field of climate and health research in B.C. This includes access to **disaggregated data** (36) that can support climate and health assessments, public health surveillance of climate-sensitive health risks and determinants,(40) and equity-informed analyses to identify and support populations facing unique or disproportionate health impacts. It also includes **longitudinal surveillance** to understand the long-term health impacts of climate change (e.g. the long-term health risks of wildfire smoke exposure and the mental health implications of climate-driven disasters and evacuations).

Tailoring and testing health risk communication and intervention design requires disaggregated surveillance data to investigate and analyze **epidemiological trends** as they relate to climate data and to explore the **disproportionate health impacts** of climate hazards on diverse population groups through an intersectional lens. While climate and health surveillance currently focus on acute hazards (e.g., heat and smoke exposure), greater attention on the health impacts of **chronic and long-term hazards** such as drought, food security and sea-level rise will be vital to supporting proactive planning and resilience.

Another priority is to enhance **standardized reporting and surveillance** across climate hazards. This includes cost projections of current and future health impacts on the health system, as well as analyses of how factors like sex/gender (including 2SLGBTQIA+), age, race/ethnicity, and others influence the varying climate-health impacts, preparedness and adaptive capacity across B.C. populations. Generating priority standardized indicators and outcomes for climate-specific hazards, including clinical and population health outcomes (e.g. consistent

1 Multisolving is the process of creating solutions that address multiple challenges at once, such as improving health and equity outcomes while also tackling climate change.

use of International Classification of Diseases codes for Heat and Light-related exposures in epidemiological analysis to ensure consistent reporting across geographies for heat-related morbidity and mortality), would further support comparative analyses of impacts within and between communities across the province. Additionally, the application of real-time data for key climate-related exposures (e.g. hourly wildfire smoke exposure) may enable the study of exposure-response relationships to improve public health risk communication and facilitate behaviour change.

The Risk to Resilience report also demonstrated the value and need for **qualitative data on lived experience**. This is especially important for populations experiencing greater exposure to and harm from climate-related hazards, and with limited adaptive capacity, support and resources to prepare, adapt and respond. Place-based and equity-oriented research can serve to document, measure, and reinforce community and individual assets and inform localized climate resilience planning in a way that mitigates systemic biases in emergency and health service delivery.

Finally, the Risk to Resilience report highlighted the need to better understand the connection between climate change and mental health in B.C.(41) As one example, the report suggests that affirmative mental health outcomes (e.g., altruism and compassion) following climate disasters could play a role in enhancing psychosocial adaptation. Further research in this area may help to contextualize the importance of social connectedness in climate change adaptation.(42,43)

Key **climate and health data needs** that require multi-sector collaboration include:

**➔ All hazards:**

- Explore the health effects of compounding and cascading climate-related changes, including events that occur simultaneously or successively (e.g. wildfire, heat and drought);
- Develop longitudinal assessments to track health trends over time, related to climate data and events (with a specific focus on chronic slow-onset hazards such as drought and sea-level rise, as well as long-term impacts like mental health and food insecurity);
- Assess physical and mental health impacts through disaggregated data to better understand differential impacts on discrete population groups, wherever possible;
- Enhance surveillance and monitoring of climate-health risks, disaggregated across social determinants of health, and develop standardized indicators to support coherent tracking, communications, and data sharing;
- Develop high-resolution geospatial risk data for multiple climate hazards (particularly localized flood risk maps);
- Explore qualitative data on the lived experience of populations differentially impacted from acute climate-related emergencies as well as long-term, ongoing and overlapping climate and health impacts;
- Assess future climate-health impacts by using B.C. climate modelling and simulations, including projecting future climate-related health outcomes over different timescales; and
- Project the future cost of climate change on the B.C. health system.

**➔ Hazard-specific data and research needs:**

- **Wildfires:**
  - Explore 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;
  - Better understand the short- and long-term physical and mental health impacts of wildfire smoke exposure (e.g., adverse birth outcomes, respiratory health, incidence of cancer, anxiety and depression);
  - Understand the effectiveness of wildfire smoke communications, e.g., indoor/outdoor air quality messaging during wildfire smoke events, including targeting materials to key sectors and populations; and
  - Research the enablers/barriers to create accessible, equitable (design and distribution) and safe indoor community clean air spaces during wildfire smoke events.

- **Flooding:**
  - Enhance 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 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; and
  - Explore innovative strategies (e.g., point-of-use testing) for timely water sampling during emergency flood events.

- **Heat:**
  - Continue to improve data to provide an accurate assessment of the burden of heat-attributable deaths and illnesses in B.C.;
  - Conduct regional and local heat vulnerability mapping to determine populations most at risk during extreme heat emergencies and identify priority areas for focused strategies;
  - Generate real-time urban heat island exposure data for urban areas and smaller municipalities; and
  - 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.

- **Drought:**
  - Explore the population and health system impacts of drought (including health impacts of prolonged drought for certain populations) in B.C. (the Risk to Resilience report found this to be a major gap in the literature);
  - 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.
  - Explore co-benefits and maladaptations for drought adaptations (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).

**➔ Mental health:**

- Enhance understanding of the mental health impacts of acute climate-related events and slower onset longer-term impacts in B.C., including populations disproportionately impacted (e.g. children and youth, Indigenous populations, farmers and ranchers);
- Explore the psychosocial impacts of compounding emergencies on individuals and communities;
- Increase surveillance of mental health indicators, such as tracking emergency department visits for mood or behavioural disorders after extreme weather events, and explore how to integrate mental health indicators into future climate change plans and policies;
- Continue to explore the mental health impacts of compounding climate events on the health workforce;
- Enhance data on the mental health conditions that may influence risks for people during climate emergencies;
- Project the economic costs of the mental health impacts related to climate change in B.C.;
- Explore opportunities for culturally relevant and Indigenous-led mental health and wellness initiatives to support population and community resilience; and
- Explore affirmative mental health outcomes (e.g., altruism and compassion) following climate disasters, and how they play a role in enhancing psychosocial adaptation.

### 3.2.2 Understanding what works, for whom and in what context: Adaptation planning, implementation and evaluation

There is a global need to understand the effectiveness of interventions for building resilience, preparedness and/or prevention of specific and concurrent climate risks. This requires understanding what works, for whom, and in what context(s) by evaluating the effectiveness of novel interventions in health and health-determining sectors over time and space.(21,44) For instance, there is a need to better understand who uses cooling centres and clean air shelters (e.g. how effective they are at reducing risk, whether they are appropriately located, and how they can connect people to other services) or the effectiveness of public health messaging and emergency alerts (e.g., the degree to which people change their behaviour to reduce exposure, as well as understanding what guidance is appropriate during concurrent climate hazards).

Evaluating health-supporting climate adaptations can include cost-benefit analyses of specific actions and modelling economic and health system impacts—such as surge capacity, staffing, and infrastructure damage—against 'business-as-usual' scenarios where no action is taken.(45) This enables decision-makers to compare the success and socioeconomic impacts of climate adaptation interventions against inaction, which is already proving more costly (46,47). By identifying actions that are more cost-effective than doing nothing, it builds a strong business case for climate action.

Understanding the health co-benefits of both adaptation and mitigation efforts at a population scale offers another lens to determine who benefits from particular interventions, and why. An essential area of research involves creating decision-support tools that encourage

multisolving to achieve health co-benefits. Decision-support tools that aim to maximize co-benefits should assess intervention options, compare trade-offs, incorporate projected demographic changes, model forecasted changes to both built and natural environments due to climate change, and align geospatial data. Decision-support tools will be useful to inform policy decisions at relevant scales, across jurisdictions, while maximizing the benefits of both adaptation and mitigation activities.

Opportunities for adaptation planning, intervention and evaluation include:

- Explore what climate-health interventions work, for whom, and under what conditions, contributing to the evidence base for successful implementation;
- Prioritize and support continued learning and evaluation following climate-related events, such as through participatory after-action reviews;
- Develop evaluative evidence of health sector adaptations by modelling economic and health impacts against 'business-as-usual' scenarios that assume no climate action;
- Study the effectiveness of communications related to awareness of climate change and health, climate hazards and associated behaviour change;
- Develop decision-support tools that evaluate health-specific adaptation interventions, compare trade-offs, incorporate future demographic change, and model forecasted climate impacts on natural and built environments; and
- Develop and enhance programs that foster social connectedness and undertake research on the development and evaluation of effective strategies to address the mental health impacts of climate change, particularly for children and youth.

### 3.2.3 Climate Mitigation and the Health Co-benefits

Health systems account for a significant portion (approximately 5%) of Canada's total greenhouse gas emissions and play an important role in achieving national and provincial emission reduction targets(48). In B.C., the *Climate Change Accountability Act* requires public sector organizations, including provincial ministries and health authorities, to report on Scope 1 and 2[2] greenhouse gas emissions, which include emissions from buildings and fleet vehicles. In addition to quantifying carbon emissions, health systems are beginning to define broader targets to monitor and reduce their overall environmental footprint, including the environmental impact from health service delivery, facilities and supply chains. This includes looking beyond emissions to consider the health system's impacts in terms of energy use and efficiency, water use and reuse, and waste reduction.

Relatedly, there are significant research opportunities to understand the health co-benefits of mitigation activities from a variety of health-determining sectors. These include:

- ➔ Continue to evaluate the effectiveness of health sector interventions to reduce environmental impact (energy, waste, water, materials);
- ➔ Enhance understanding of the health implications of B.C.'s climate change policies and greenhouse gas reduction plans;
- ➔ Evaluate and develop tools to help decision-makers assess the direct and indirect health co-benefits of reducing carbon emissions (e.g., how air quality improvements from cleaner energy sources can reduce mortality from cardiovascular and respiratory diseases) and adaptation strategies;
- ➔ Broaden the analysis of environmental impacts of the health sector beyond Scope 1 and 2 emissions to include broader sustainability targets for the adoption of renewable energy, energy efficiency, and waste and water reduction; and
- ➔ Explore evidence-based approaches to integrate and align health sector mitigation and adaptation strategies.

2 Scope 1 emissions are direct emissions from owned or controlled sources (e.g. buildings, vehicles), Scope 2 emissions are indirect emissions from the generation of purchased energy, and Scope 3 emissions encompass all other indirect emissions in the value chain, both upstream and downstream.

### 3.2.4 Health Sector Capacity-Building to Respond to Climate Change

There is a growing body of research focused on enhancing health sector climate literacy and capacity. This includes research that informs the development of core climate competencies for the health workforce as well as training, curriculum and resources that support current and prospective health system staff to integrate climate considerations across multiple departments and service streams.

Building a climate-ready health workforce now and into the future will require shifts to university and college curriculum and training programs, alongside ongoing professional development of health professionals. Relatedly, understanding how climate change is impacting various health system roles, including occupational health and safety considerations, and adapting policy and practice accordingly will also be critical to maintaining a climate-resilient and sustainable health system. Equally as important, First Nations, Inuit, and Métis knowledges, leadership and cultural practices are critical to advancing health sector climate literacy and capacity in a way that upholds health system commitments to cultural safety and humility in B.C. health services. There is a need for further education on Indigenous knowledge, colonization, reconciliation, and anti-Indigenous racism in public health education and training.(21)

Several health authorities across the province are leveraging a 'planetary health' frame to support ongoing preparedness and planning related to climate change. Evaluating the role and effectiveness of this lens in program development and its ability to shift attention towards upstream and proactive prevention to mitigate climate risks and enhance the environmental sustainability of health care may help to determine the value and business case for planetary health's application in other health regions.

In addition, the Risk to Resilience report recognizes that 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 while substantially reducing greenhouse gas emissions and environmental impact. It is clear that the health system cannot do this alone. Intersectoral collaboration and a whole-of-society approach is critical—bringing together diverse expertise, lived experiences, and ways of knowing to address the key determinants of risk and resilience.

Academics and the research community play a pivotal role in strengthening the health system's capacity to address climate change by contributing to an evidence base that can guide policymaking, planning and program development. In addition, academic institutions are crucial in cultivating a climate-ready health workforce by designing and implementing training programs that prepare the workforce for the future climate. These programs equip future health professionals with the knowledge, skills, and expertise needed to enhance climate-health resilience and sustainability, ensuring B.C. has a robust pathway of trained professionals ready to meet emerging challenges. Internationally, there are several examples of graduate and professional development programs such as the Yale School of Public Health's Climate and Health Certificate Program, Columbia University's Centre for Climate and Health, the UNITAR Climate and Health Course, WHO Academy Climate and Health Course, and the UN-CC e-learn platform on climate and health, among others.

Key research opportunities to address health sector capacity building for climate resilience include:

- Identify core climate competencies to support foundational training and continued health workforce professional development;
- Develop curriculum, courses and training/ learning opportunities for the health workforce. This could include opportunities related to assessing and managing climate-related health risks, planetary health, low-carbon resilience, raising public awareness/ education, and experiential learning, such as simulation exercises, to test emergency planning and response to climate-related events;
- Develop cultural safety training and awareness within the health workforce, recognizing the importance of Indigenous knowledge systems in climate resilience, and looking for guidance from Indigenous scholars and Knowledge Holders;
- Enhance understanding of how climate change impacts discrete roles and portfolios across the health sector;
- Evaluate planetary health frameworks and their ability to shift health sector focus to upstream and proactive prevention; and
- Explore the types of services and supports needed for health professionals (e.g. mental health supports), especially those directly supporting communities to respond and recover from climate-related emergencies.

### 3.2.6 Emergency Management

In recent years, B.C.'s health system has faced a series of unprecedented and concurrent climate-related emergencies, placing immense strain on health services, infrastructure and the workforce. The Risk to Resilience report found that the impacts of climate-related emergencies have been multifaceted, affecting everything from the logistics of evacuations—especially for patients with complex care needs—to overcrowded emergency departments, service disruptions and challenges in accessing essential medications.

The Risk to Resilience report also found that climate-related emergencies disproportionately affect certain populations, including Indigenous Peoples, those being evacuated, those with complex care needs, and those with disabilities, to name a few. Prioritizing the unique needs of those experiencing health disparities across all phases of emergency management is critical to prevent disasters from worsening existing inequities or creating new ones. Research opportunities focused on inclusive emergency management, such as meaningful community engagement and local knowledge in all phases of emergency management (mitigation, preparedness, response, recovery). Prioritizing the needs of priority populations and exploring unintended health outcomes of emergency response interventions can help to ensure individuals, especially those facing health inequities, receive the care and support they need during climate-related emergencies.

Understanding the patient trajectory after a climate-related emergency is also important, especially in terms of how they stay connected to additional services after being discharged in emergency settings, and how continuity of care can be provided for patients, especially those with

complex care needs. Studying lived experience during and after climate-related emergencies could also provide insight into the role of social media and other digital communication technologies as tools for enhancing the flow of essential information and risk communication to evacuees.

The Risk to Resilience report also found that Indigenous communities in particular have faced prolonged displacements and significant barriers in accessing culturally safe health care and other cultural services. Addressing these disparities requires a concerted effort to support Indigenous-led emergency planning, centering cultural safety and humility in all aspects of emergency management, and advancing commitments to Indigenous rights and self-determination in emergency management governance.

Domestic evacuations and migration undoubtedly create challenges for service delivery across the province's health system. Additionally, a topic that has received less research attention is the impacts that evacuations and temporary relocation of populations from other provinces, territories and countries have on health and emergency services in B.C. Understanding the health needs of out-of-province evacuees, patterns of temporary and permanent relocation, and impacts on service delivery will go a long way to enhancing the preparedness of our systems of care. This applies to domestic climate events, but also supports those who seek refuge in B.C. during climate events in their home provinces/territories.

Key research opportunities to address emergency management include:

### Health Sector's Role in Emergency Management

- ➔ Examine and clarify how the health sector, including primary and community care and public health, fits into the broader emergency management structures in B.C.;
- ➔ Explore how a whole-of-government approach to health promotion can be integrated into emergency management efforts; and
- ➔ Better understand how patients interact with and experience systems of care during acute climate-related emergencies, and how to maintain continuity of care, especially for those with complex care needs.

### Community Resilience and Equity in Emergency Management

- ➔ Explore how health emergency preparedness and response can promote community resilience and equity, addressing the varying needs of different population groups; specifically:
  - Explore how supportive environments can be fostered and sustained to increase community resilience during emergencies, including efforts to foster social cohesion, social infrastructure, and community action during disruptions; and
  - Enhance health emergency response plans to prioritize the unique needs of key populations and those experiencing health inequities at local, regional, and provincial levels.

### Understanding the Impacts of Evacuations

- Monitor and assess the physical and mental health impacts of evacuation and displacement on priority populations, with attention to those with complex care needs;
- Understand the mental health and community health needs and supports available to evacuees over time;
- Explore unintended outcomes of emergency response interventions, such as evacuation and social isolation, on social structures, mental health and well-being; and
- Research the needs and service impacts of evacuees seeking refuge in B.C. from other provinces and territories.

### Indigenous Rights and Cultural Safety

- Explore opportunities for coordination and collaboration in emergency planning, build trusting relationships between Indigenous communities, health organizations, and response organizations before emergencies occur; and
- Work with Indigenous scholars and Knowledge Holders to develop cultural safety training for professionals and volunteers, for all phases of emergency management, including disaster risk mitigation, preparedness, response, and recovery.

### Risk Communication

- Investigate effective communication mechanisms in health system emergency management, particularly in engaging specific populations; and
- Study the role of social media and other digital communication technologies as tools for enhancing the flow of essential information and risk communication to evacuees.

### Monitoring Long-term Impacts

- Monitor long-term impacts on physical, mental, social, and cultural health after emergencies, including the trajectory of recovery and the ongoing needs of affected communities.

### Health and Emergency Response Workforce

- Understand the physical and mental health impacts of the emergency response workforce and explore strategies to support the well-being of health and emergency responders during and after climate-related emergencies.

## 4.0 CONCLUSION: MOBILIZING RESEARCH TO SUPPORT HEALTH SECTOR CLIMATE ACTION AND A WHOLE-OF-SOCIETY RESPONSE TO THE CLIMATE CHANGE

To effectively address the health impacts of climate change and build a resilient health system in B.C., collaboration with the research community is vital. This guide underscores the importance of a whole-of-society approach, where diverse sectors, disciplines, and communities work together to generate evidence-based solutions grounded in cultural safety and health equity. By elevating the knowledge and expertise of Indigenous Peoples, researchers, policymakers, the health sector, and community members, we can ensure that climate resilience efforts are inclusive, culturally-informed, and capable of addressing the unique challenges facing our province. Building on the Risk to Resilience report findings, there are several opportunities to advance coordinated research and knowledge mobilization to protect and promote health in B.C. in the face of a changing climate, and support the shift to a the climate-resilient and sustainable health system.

## APPENDIX A: PROCESSES UTILIZED TO COMPILE THIS DOCUMENT

The Risk to Resilience report was developed using data collection activities, including:

- a document review of more than 700 documents that were public or shared internally by supporting health sector and provincial agencies;
- three Indigenous Sharing Circles with Rights and Title Holders across different regions of B.C.;
- 17 focus groups and 17 interviews that engaged more than 150 people from across the health system; and
- the identification of stories of impacts and adaptations from across the province.

Data collection highlighted impacts and adaptations occurring across multiple domains of the health system, including:

- health care facilities;
- emergency management;
- long-term care;
- purchasing and supply chains; communications;
- population and public health;
- health system planning;
- mental health; physicians;
- nurses; provincial non-profit service providers;
- medical transport; and
- hazard-specific groups.

Limitations of the Risk to Resilience report were that it was out of scope for data collection to include: the voices, lived experiences and/or perspectives of populations and patients most impacted by climate hazards; 2023 wildfire and flood events; and a robust analysis of adaptive actions led by 'health-determining sectors' (i.e. those beyond the health system itself that influence health, such as housing, energy, transportation, etc.).

The project team—which includes all contributing authors to the Risk to Resilience report—undertook a gap analysis to document key areas of impact, unanswered questions, and data needs emerging from the project's consultations and document review. The project team subsequently hosted a focus group on January 25, 2024 that was attended by more than 30 researchers from across the province with an interest in climate and health. This included researchers from the University of British Columbia Vancouver and Okanagan campuses, Simon Fraser University, Royal Roads University, the University of Victoria, and the University of Northern British Columbia, as well as staff from across the Ministry of Health and the Provincial Health Services Authority. Workshop invitees, including those

who were unable to attend, were subsequently invited to provide written feedback on a draft version of this document. Feedback was synthesized thematically and compared against initial knowledge gaps identified in the Risk to Resilience report.

This document is the result of that process and offers important consideration of outstanding priorities for those doing or funding B.C.-focused research at the intersection of climate and health in terms of both topic-specific knowledge gaps, and considerations for a research approach to enhancing the overall resilience of individuals, communities and the provincial health system. This report is not intended to be exhaustive or necessarily prescriptive. It aims to reflect on known near-term research priorities to protect and promote health and enhance health system resilience in a changing climate. Readers are encouraged to consult other key documents that outline research, practice and policy opportunities, including, but not limited to, the Climate and Health in B.C.: From Risk to Resilience report,(3) Health Canada's *Health of Canadians in a Changing Climate* report,(49) and the Chief Public Health Officer of Canada's reports titled *Mobilizing Public Health Action on Climate Change in Canada* (21), *Creating the Conditions for Resilient Communities: A Public Health Approach to Emergencies*.(50) and *Climate Science 2050: Advancing Science and Knowledge on Climate Change*. Importantly, these priorities will be enhanced by better integrating Indigenous and Western knowledge.

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