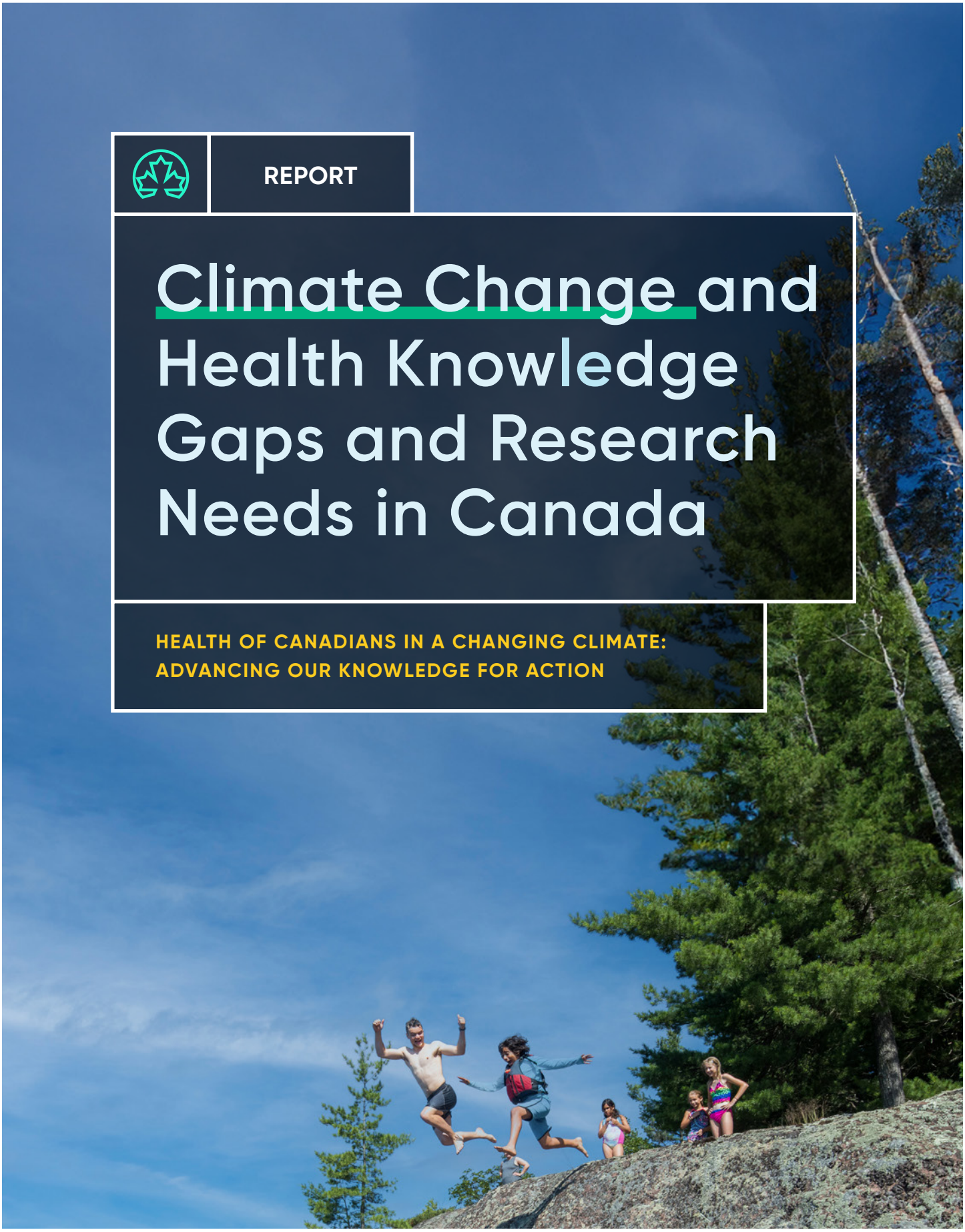
REPORT

Climate Change and Health Knowledge Gaps and Research Needs in Canada

HEALTH OF CANADIANS IN A CHANGING CLIMATE: ADVANCING OUR KNOWLEDGE FOR ACTION



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Health Canada is the federal department responsible for helping the people of Canada maintain and improve their health. Health Canada is committed to improving the lives of all of Canada's people and to making this country's population among the healthiest in the world as measured by longevity, lifestyle and effective use of the public health care system.

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Publication date: June 2025

Knechtel, E., Berry, P., Vitullo, K. (2024). Climate Change and Health Knowledge Gaps and Research Needs in Canada. With information from P. Berry & R. Schnitter (Eds.), (2022) *Health of Canadians in a Changing Climate: Advancing our Knowledge for Action.* Ottawa, ON: Government of Canada.

Cat.: H129-164/2025F-PDF
ISBN: 978-0-660-73936-6 (PDF)
Pub.: 250123

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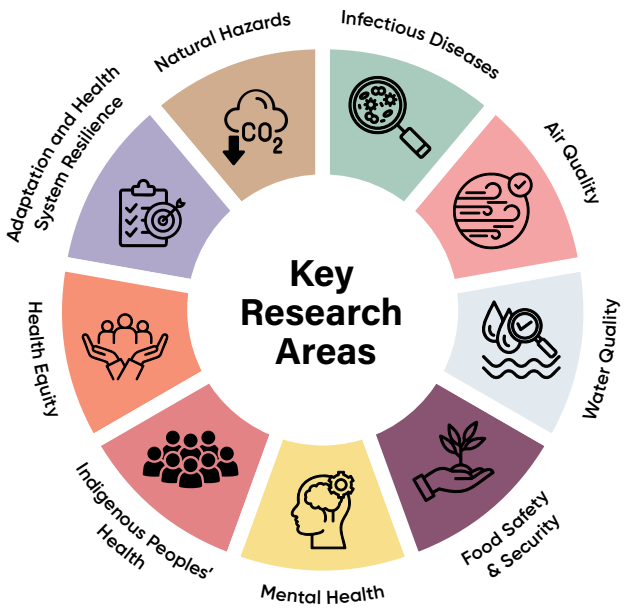
Climate Change and Health Knowledge Gaps and Research Needs in Canada

Science To Support Health Adaptation

Climate change is increasing risks to the health of Canadians and their communities and putting stresses and strains on health systems. Health authorities from local to national levels require evidence-based information to plan effective measures to protect the health of the most vulnerable in society in a manner that supports health equity.



CCHA 2022

The science assessment Health of Canadians in a Changing Climate: Advancing our Knowledge for Action (CCHA 2022), developed by over 80 experts from across Canada, highlighted 135 specific research needs in 9 key research areas requiring further investigation to better protect Canadians in a rapidly warming world. They include climate change and health risks and adaptations related to:

- Indigenous Peoples Living in Canada
- Natural Hazards
- Air Quality
- Mental Health
- Infectious Diseases
- Water Quality, Quantity and Security
- Food Safety and Security
- Health Equity
- Adaptation and Health System Resilience

Climate Science 2050

The Government of Canada report Climate Science 2050: National Priorities for Climate Change Science and Knowledge identifies the most pressing climate change science activities needed to inform effective and targeted actions to reduce GHGs emissions and adapt to impacts. It includes discussion of science needs related to supporting healthy Canadians and climate resilient health systems, which was informed by results of the CCHA 2022. Climate Science 2050 is another useful resource to guide ongoing efforts to prepare for climate change.

This brochure highlights the knowledge needs identified throughout the CCHA 2022 and is intended to be used by researchers and decision makers within and outside of the health sector.

Indigenous Peoples' Health Research Needs

Context

- There are significant knowledge gaps regarding climate change and First Nations, Inuit, and Métis Peoples' health in Canada.
- The population and geographic focus of research is uneven, with little research on Indigenous populations in the Prairies and Atlantic provinces and Métis peoples generally; the majority is focused on Inuit populations and the Canadian arctic.
- Indigenous health research is dominated by non-Indigenous researchers and Euro-Western knowledge paradigms.

Underrepresented groups

- Perspectives and information on the burden of climate change on the health of Indigenous children and youth.
- The intersection of climate change and gender, particularly the experiences of gender-diverse people.
- First Nations communities outside the north, especially First Nations communities in the Prairies and the Atlantic provinces.
- Experiences of Métis Peoples across Canada in relation to climate change research.
- Climate change in the context of urban First Nations, Inuit, and Métis populations.

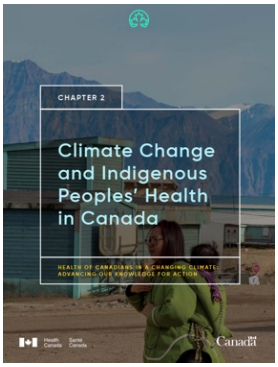
Impact on health

- The holistic and long-term impacts of changing temperature and precipitation regimes on food and water safety and security, air quality, health infrastructure, personal safety, mental health, livelihoods, and identity within and among diverse First Nations, Inuit, and Métis Peoples and communities.
- Climate-related risks in the context of health inequities and inequalities among First Nations, Inuit, Metis Peoples and related determinants of health, and related determinants of health; How increases in air pollutants and aeroallergens will affect First Nations, Inuit, and Métis Peoples.
- How infectious diseases, such as COVID-19, will affect Indigenous food systems.

Adaptation measures

- Indirect effects of potential new economic development opportunities arising from climate change and how they may mediate the negative impacts of climate change to Indigenous Peoples' economy, health, and cultures.
- Resilience and protective factors regarding climate change among Indigenous Peoples.
- Determinants of adaptive capacity, including access to financial resources, social networks, flexibility in resource management regimes, the role and potential of social learning in adaptation, and the role of government policies and programs in adaptive capacity
- Effectiveness of community-based adaptation initiatives and how Indigenous Knowledges have been used in adaptation initiatives.

For more information



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Natural Hazards Research Needs

Types of natural hazards

- Health effects of natural hazards not directly associated with temperature, infectious diseases or air quality.
- Health impacts of droughts, coastal erosion, coastal flooding, landslides, and thawing permafrost.

Indirect impacts

- Indirect impacts of natural hazards on health and their specific characteristics.
- Indirect impacts of natural hazards on mental health, particularly the impacts of hazards on social cohesion, environmental degradation, population movements, and financial insecurity.

Impacts of combined natural hazard events

- Effects of combined natural hazards occurring simultaneously or successively on population health.
- Health and social impacts of repeated exposure to hazards on the same populations.
- Climate projections and trend forecasting of combined natural hazard events.

Cascading impacts of hazards & health system impacts

- Cumulative health impacts of natural hazards e.g., likelihood of a power outage causing water or medication shortages.
- Health system ability to cope with natural hazards and avoid service disruptions.

Behaviour & lifestyle

- Effects of climate change on behaviour and lifestyle, for example the impact of hazards on physical activity, outdoor activity, travel habits, eating, social interactions, criminal behaviour, and choice of living area.

Vulnerability & protective factors

- Retrospective assessment of the health effects of measures to adapt to natural hazards.

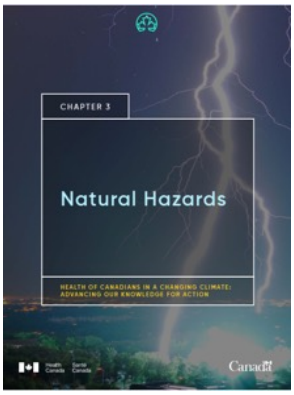
Adaptation measures

- Effectiveness of existing and possible future adaptation measures to natural hazards made worse by climate change.
- Economic impacts of health effects and of adaptation and mitigation measures.
- Canadian context of political, societal, and structural factors that support effective adaptation to natural hazards.

Communication

- Effectiveness of strategies and tools to communicate climate change risks and adaptation measures in Canada.

For more information



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Mental Health & Well-Being Research Needs

Impact of climate change on mental health

- Population-level studies on climate change impacts on mental health within Canada and globally.
- The key factors that increase risks of impacts on mental health to inform future adaptation efforts.
- The mental health impacts of climate change on specific population groups experiencing health inequities, including people of colour and racialized groups, those discriminated against because of sexual orientation or identity, and those discriminated against based on their mental or physical health.
- Surveillance and monitoring of the impacts of climate change on the burden of mental illness in Canada.

Impact of specific hazards

- The mental health complications of vector-borne diseases in Canada.
- The mental health impacts of cold temperature climate hazards, such as impacts from a polar vortex.
- Projections of the impacts of climate change on mental health under different climate scenarios.
- The mental health implications of slow-onset hazards related to climate change at the local, regional, and national levels.

Mental health outcomes

- Affirmative mental health outcomes, such as psychosocial resilience, altruism, and compassion after experiencing climate hazards, which can enhance our understanding of psychosocial adaptation.
- How awareness and communication activities about the climate change problem affect social-emotional responses, such as anxiety, fear, grief, and worry.

Adaptation measures

- The effectiveness of psychosocial adaptation opportunities to a changing climate.
- The availability and effectiveness of psychosocial interventions from a health equity perspective.
- An evaluation of the economic costs of the mental health impacts of climate.

For more information

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Air Quality Research Needs

Data & modeling

- Integrated modelling of climate change and air quality, including the effects of climate parameters on $PM_{2.5}$ levels, to improve understanding of the population health impacts associated with the climate penalty and the potentially large air quality health co-benefits of GHG mitigation measures.
- Impact of changing climatic conditions on biogenic emissions and incorporation into air quality models.
- Synthesis and comparison of the potential air quality co-benefits of multiple IPCC climate mitigation pathways.

Wildfire smoke

- Modeling of wildfire smoke exposure and the interactions between climate and wildfire risk, to inform projections of wildfire smoke health impacts under climate change.
- The range of adverse health effects associated with air pollution exposure, including whether the health effects of wildfire smoke are different from those of ambient air pollution, an assessment of the population health impacts and identification of populations at higher risk.

Indoor air quality

- Characterizing pollutant exposures indoors and their associated health risks with an assessment of the health implications of changing environmental conditions to guide healthy building design, energy saving, ventilation, and material selection.

Aeroallergens

- Whether the health impacts associated with airborne allergen exposure go beyond respiratory outcomes, and the identification of new susceptible groups.
- Aeroallergen distribution and interactions with air pollutants and green space, to inform urban greening initiatives and adaptation measures.

Adaptation measures

- Effective adaptation and risk mitigation strategies for wildfire smoke, indoor air quality, and aeroallergens under a changing climate.

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Infectious Diseases Research Needs

Ecology & epidemiology

- The ecology and epidemiology of infectious diseases and arthropod vectors to support development of risk assessments and early warning systems.
- Systematic surveillance of human cases, arthropod vectors, infected sentinel animals, and environmental samples, as well as use of citizen science methods and spatiotemporal scales to identify emerging diseases and vectors.
- Surveillance methods, such as metagenomics, that detect multiple, possibly emerging pathogens and vectors to address broad ranges of pathogens and vectors that threaten Canadians.
- Development of infectious disease diagnostic methods and algorithms.
- Long-term surveillance to support attribution of the effects of climate change.

Strengthening data

- Analysis of statistical strength of association, consistency among studies, specificity of effects of climate, temporally appropriate timescales of climate change and disease emergence, biological gradient (greater effects of greater changes in climate), and plausibility, to attribute emergence and re-emergence of infectious diseases in Canada to climate change.

Vulnerability assessment

- Validation of early warning systems for those infectious diseases, such as mosquito-borne diseases, that may become more epidemic with climate change.
- Comprehensive assessments of vulnerability to the effects of climate change on all aspects of health, such as heat-related illnesses and deaths, chronic diseases, and risks from infectious diseases.

Vulnerability to chronic diseases

- Linkages between public health efforts responding to infectious and chronic diseases.
- How socio-economic status affects vulnerability to both infectious and chronic diseases as well as perceptions of risk, and knowledge of and willingness to use protective measures.
- How the changing age demographic in Canada, as in other high-income countries, coupled with increasing incidence of chronic diseases in these populations, interacts with the anticipated effects of climate change on both infectious and chronic diseases.

Assessment

- Assessments of sensitivity to weather and climate change for a broad range of infectious diseases, including human-to-human-transmitted diseases.

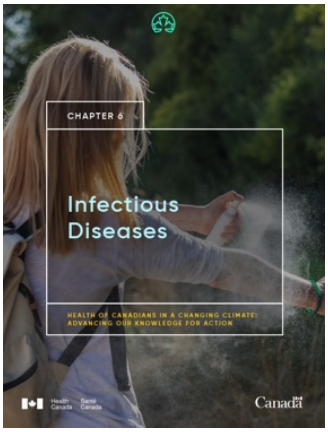
Prevention & control

- Effective measures to control vectors in the environment and for people to protect themselves.
- Established protocols for vector-borne disease control programs for front-line public health responders.

Adaptation measures

- Effective and collaborative adaptation measures for responding to emerging disease threats.

For more information



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Water Quality, Quantity and Security Research Needs

Climate change impacts on water resources & health

- Relationships between temperature and precipitation on Canadian flow regimes (e.g., switch in river basins from snow-dominated to rain-dominated regimes).
- Impacts of changes in the cryosphere on water resources (e.g., effects of changes in albedo on permafrost and downstream water quality and quantity).
- Effects of changes in the cryosphere on releases of chemical contaminant burdens (e.g., persistent organic pollutants and heavy metals) and subsequent impacts on food and water supplies.
- Impacts of wildfires on source water quality and availability, and how they vary across forest ecosystems.
- Effects of ocean and freshwater acidification and nutrient runoff from land on algal blooms.

Water resource management & source water protection

- Effects of climate change and land-use change on groundwater recharge over short and long timescales.
- Effective measures for protecting drinking water systems from increased flooding-related health concerns (e.g., increases in bacterial contamination).
- Impacts of projected drought extremes on water resources and the most effective adaptations to protect health (e.g., individual storage capacity; water sharing across multiple jurisdictions).
- Effective government, management, and partnership models, including those with First Nations, Inuit, and Métis communities.

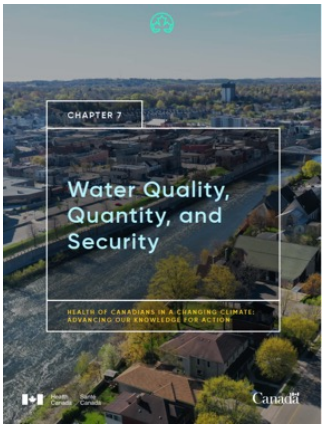
Public health & health care

- Health risks associated with water contaminated by residue from burned residential, industrial, and commercial materials as a result of wildfires.
- Health risks of harmful algal blooms, and how they might increase with climate change.
- Emerging new or previously rare water-borne pathogens (e.g., northward-moving naegleria fowleri) and effective measures to protect health.
- Impacts of changes in animal (e.g., waterfowl) and other vector populations on the distribution and transmission of water-borne diseases as the climate continues to change.
- Health risks associated with water reuse and effective measures to protect health.
- Effective technologies for producing potable water in future water-stress scenarios.

Drinking water & drinking water systems

- Factors that make water systems vulnerable to extreme rain events, and effective adaptation measures.
- Health ramifications and possible DWS stresses from wildfire impacts on source water, particularly for untreated drinking water sources (e.g., “gathered water”).
- Cost-effective adaptations for DWSs to address emerging contaminants (e.g., harmful algal blooms), which are expected to increase under climate change.

For more information



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Food Safety & Security Research Needs

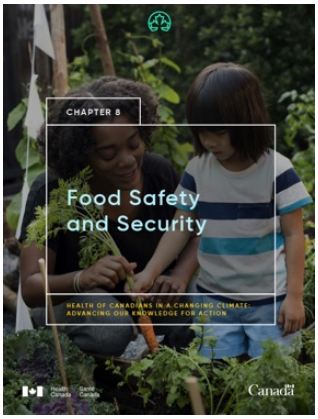
Food security

- Impacts of climate change on key components of food systems (i.e. food processing, distribution, preparation, and consumption).
- Risks and vulnerabilities facing populations in regions south of 60 degrees north latitude, including rural and remote communities as well as urban centres.
- Regional and local food system assessments and analyses of unique vulnerabilities, with particular consideration for individuals who will face disproportionate impacts and may already face nutritional risk and food insecurity (e.g., low-income households, Indigenous Peoples, households headed by single women).
- Critical vulnerabilities and points of adaptation intervention from a climate change, food security, and human health nexus, and food system perspective.
- Identify processing and distribution facilities in Canada that are most vulnerable to disruption from extreme weather events.
- Map food transportation and distribution networks across Canada and identify important facilities to assess climate change risks and implement adaptation actions.
- How food distribution systems might adapt to short-term disruptions and longer-term challenges caused by climate change.
- Climate change impacts on nutrition in a Canadian context, including the impact elevated CO_2 concentrations will have on nutritional content of key crops.
- Potential climate-related diet shifts and implications for Canadians, and potential food substitutions and implications for dietary guidelines.
- The effectiveness of current measures to reduce health risks from impacts of climate change on food insecurity.
- Key factors that contribute to food insecurity, including compounding, intersecting vulnerability factors and the impact climate change will have on this relationship.
- The impacts climate change may have on food security specifically for First Nations, Inuit and Métis Peoples.

Food safety

- Review of Canadian food inspection regulations and policies to ensure that they are robust enough to cover emerging food safety issues, both in Canada and in countries from which food is imported.
- How climate change adaptation measures may affect food safety and human health — for example, potential food safety issues and associated adaptations related to traditional preparation and storage methods used by Indigenous Peoples and how climate change may influence these practices.
- Food safety surveillance systems that include climate variables and integrated monitoring of animals and the environment.
- Models and risk projections for food-borne illnesses in the context of climate change.
- The impact of climate change on the fate of chemical contaminants in the environment.

For more information



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Health Equity Research Needs

Understanding vulnerability

- How the status of determinants of health and multiple existing health inequities can influence current and future climate change and health vulnerability in Canada.
- Analysis of upstream drivers of inequities, including social, cultural, economic, and political structures and systems, and how these interact with climate change to create and exacerbate differential health risks and impacts.
- How determinants of health and other identity factors individually influence vulnerability to climate change impacts on health, and the compounding effect they may have when taken together.
- The relationship between the geographic distribution of populations disproportionately affected by climate change, and health system capacity. For example, analysis of health system capacity relative to where disproportionately affected populations live.
- How various GHG mitigation and adaptation strategies led by the health sector as well as other sectors can affect determinants of health and existing health inequities, in positive or negative ways.

Data & assessment

- Data collection, including sex-, race-, and gender-disaggregated data, as well as other demographic data (e.g., socio-economic status) and analysis of how various identity factors and existing inequities intersect to shape climate change vulnerability.
- New frameworks and tools for assessing individual and community health impacts of climate change that account for multiple, simultaneous drivers of vulnerability, including methods to capture information on the broader social, cultural, political, and economic conditions and systems that construct inequities, and analysis of how these may further compound vulnerability.
- Bridging of theoretical approaches (e.g., intersectionality) and practice to enhance knowledge of how to better account for and integrate health equity considerations into climate change and health activities, such as climate change and health assessments and adaptation plans.

Adaptation measures

- Guidance for development of cross-jurisdictional, and multisectoral adaptation measures to protect health and promote health equity.
- Examples, including case studies, of health adaptation measures that promote health equity.

For more information

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Adaptation & Health System Resilience Research Needs

Adaptation measures

- Identification of equitable, effective (including cost-effective) adaptation measures for reducing health risks from current climate variability and projected climate change.
- Adaptation measures to address the health challenges and capacity issues First Nations, Inuit and Métis Peoples face from climate change, including rural, remote, and northern communities.
- Adaptation measures tailored for specific populations, for example, people experiencing homelessness, children, and older populations.
- Adaptation measures to reduce risks to individuals and health systems from compounding and cascading events.
- Technical and operational synergies among actions to reduce disaster risk and options to adapt to climate change and health.
- Novel, integrated, and multidisciplinary surveillance and monitoring for climate change and health.
- Standardized indicators of health risks posed by climate change.
- Identification of risk trade-offs associated with various health adaptations.
- Identification of effective tools, dissemination methods, and approaches to communicate climate change and health to decision makers and the public.
- Effective strategies for aligning climate change and health promotion efforts with communication activities to support the reduction of GHGs.

Health system resilience

- Current and projected climate-related impacts, vulnerabilities, and costs to health systems and facilities.
- Effective resilience-building measures for health systems and facilities, including rural, remote, and northern health systems and those serving First Nations, Inuit and Métis communities.
- Standardized GHG measurement methodologies for tracking health system and hospital GHG emissions.
- Best approaches for reducing the carbon footprint of the health sector and health sector supply chain.
- Accessible cooling technologies and practices that are not fossil-fuel-based for health care facilities, public cooling centres, and cooling for homes, both for new-builds and for retrofits of existing buildings.

Health co-benefits and risks of measures

- Synergistic health co-benefits of various strategies to reduce GHG emissions to national targets that also reduce air pollution.
- Direct and indirect health co-benefits and risks of measures taken by other sectors (e.g., water, agriculture, housing, transportation, insurance, energy, urban planning) to adapt to impacts, including for First Nations, Inuit and Métis Peoples and rural, remote, and northern communities.
- Strategies that support health, including those that address the root causes of vulnerability and health inequities, and support the transition to a low-carbon economy in energy, agriculture, transportation, manufacturing, buildings, and other sectors.

Economic costs and benefits

- Economic costs of the impacts of current climate variability and projected climate change on human health and health systems in Canada, as well as on social services that support the determinants of health.
- Synergies between actions that support climate change resilience, adaptation, and environmental sustainability in the health system and those that support financial sustainability.
- Assessments of the economic costs and health co-benefits of GHG mitigation and adaptation activities.
- Economic, social and health benefits of actions to build climate-resilient health systems.

For more information

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