



REPORT

Health of Canadians in a Changing Climate

ADVANCING OUR KNOWLEDGE FOR ACTION



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This Report was developed with understanding and acknowledgement that Canada was built on the original homelands of many culturally diverse and historically distinct First Nations people and Inuit. Canada also is part of the ancestral homelands of The Métis. We respectfully acknowledge all Indigenous Peoples on whose traditional lands we live and work.

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About the National Climate Change and Health Assessment

Why This Assessment Is Needed

The rapid rate of global climate change and the diminishing opportunity to keep warming below 1.5°C (IPCC, 2018) has increased awareness of the urgent need to prepare for climate change impacts on health and to mitigate climate change (WHO, 2018). Near-term reductions in greenhouse gases (GHGs) will not prevent further warming of the globe in the next few decades; increased efforts are needed to adapt to protect all Canadians from the associated health impacts (WHO, 2013; Smith et al., 2014; Watts et al., 2018). In many important areas, progress has been made globally to prepare individuals and health systems for climate change impacts, but a significant adaptation gap exists in many countries (Martinez & Berry, 2018).

Health authorities, researchers, and individual Canadians are seeking information about the way climate change is currently affecting health and is projected to do so in the future. Many local health units have undertaken assessments of climate change, health vulnerability, and adaptation and have begun taking measures to protect health. The number of decision makers requiring the latest scientific evidence of health threats from climate change is expanding, with new programs at local to national levels to support efforts to prepare for impacts. An example is Health Canada's climate change and health capacity-building program, HealthADAPT, launched in 2018 (Government of Canada, 2019).

At the same time, attribution studies have forged a causal link between climate change and health effects associated with specific events, and the urgency of efforts to better understand climate change impacts has increased, with international studies suggesting that even modest increases in temperature, expected in the next few decades, are associated with significant health impacts (IPCC, 2018). Scientists have also cautioned about possible limits to health adaptation (Watts et al., 2015; IPCC, 2018) under current rates of warming.

This assessment, [*Health of Canadians in a Changing Climate: Advancing our Knowledge for Action*](#), is the first comprehensive study of current and projected risks from climate change to the health of Canadians since 2008. It was developed by a team of more than 80 subject matter experts from regional and federal health authorities and academic institutions across Canada. It addresses the evolving knowledge needs of government decision makers, civil society organizations, and individual Canadians by providing evidence-based and, where possible, quantitative information to help people understand how Canada's climate is changing, and the effects on health and health systems, including implications for those most at risk in society. For key risks to health, it also examines current efforts to prepare for climate change, from individual to national levels, and explores what further efforts are needed. The potential for very large co-benefits to health of well-designed measures to reduce GHGs are also explored in the report.

As part of the national assessment process, *Canada in a Changing Climate* (Natural Resources Canada, 2020), this study contributes to broaden understanding of climate change impacts and adaptation by the Government of Canada, including a focus on Canada's changing climate (Bush & Lemmen, 2019), national issues, regional perspectives, and impacts on First Nations, Métis, and Inuit peoples and communities. The national assessment process is based on a broad partnership of subject-matter experts and assessment



users from all orders of government, Indigenous organizations, universities, professional and non-governmental groups, and the private sector. It includes engagement through a National Advisory Committee and the Adaptation Platform and engages the public through meetings, conferences, and online engagement tools.

Report Format

The chapters in this report discuss relevant findings from the scientific literature on priority health risks related to climate change and on adaptation options for protecting health. Where information is available, chapters include quantitative projections of future health risks from climate change (see Chapter 5: Air Quality; Chapter 6: Infectious Diseases; Chapter 7: Water Quality, Quantity, and Security). The report includes analysis of the interplay between climate change and important determinants of health, which can affect adaptive capacity and health equity to influence vulnerability to health impacts (see Chapter 9: Climate Change Impacts on Health Equity). The assessment includes a separate chapter on climate change impacts on Indigenous Peoples' health and includes information on these impacts throughout the full report (see Chapter 2: Climate Change on Indigenous Peoples' Health in Canada). All chapters include illustrative case studies of actions being undertaken by health authorities to reduce risks to Canadians from climate change.

The report is structured as follows:

[Chapter 1: Climate Change and Health Linkages](#) – provides information on how Canada's climate is changing and is projected to continue to change, to support the understanding of growing threats to health. It identifies the complex pathways through which climate change affects health and the key health risks facing Canadians.

[Chapter 2: Climate Change and Indigenous Peoples' Health in Canada](#) – explores current impacts of climate change on the health of First Nations, Inuit, and Métis peoples and communities. It highlights the role of current and legacy impacts of colonialism, racism, and discrimination in contributing to these impacts and highlights, through a number of case studies, the strengths and resilience of Indigenous Peoples in planning for the impacts.

[Chapter 3: Natural Hazards](#) – reviews evidence of how natural hazards are affected by climate change and their impacts on the mental, social, and physical health of Canadians. It then provides information about effective adaptation strategies for reducing risks and the co-benefits of undertaking these measures. It proposes research directions to address key knowledge gaps in this field.

[Chapter 4: Mental Health and Well-Being](#) – discusses current evidence of the mental health impacts of climate variability and change on Canadians, including regions and populations at higher risk for such impacts. It highlights important factors that support psychosocial well-being and adaptation options for preparing for climate change and limiting impacts from current hazards.

[Chapter 5: Air Quality](#) – examines the linkages between climate change and air quality in Canada, including how the health of populations could be affected by changes in air quality under various climate scenarios. The chapter also discusses the health co-benefits associated with efforts to mitigate GHG emissions and adaptation options for protecting Canadians from climate change impacts.



[Chapter 6: Infectious Diseases](#) – highlights the impacts of climate change on risks from infectious diseases of importance for public health in Canada, including those that are current, known disease risks (e.g., Lyme disease, West Nile virus) and new risks that may emerge. It then discusses adaptation to reduce climate-related infectious diseases, including their importance for populations at increased risk and the capacity of health systems to take needed actions. Existing research gaps are highlighted for the reader.

[Chapter 7: Water Quality, Quantity, and Security](#) – describes the relationship between climate change and the water cycle in Canada and attendant risks to the health of Canadians from impacts on water contamination, safety, and security. The vulnerability of drinking water systems, private wells, and Indigenous water systems is examined, and projected health risks from climate change are discussed. The chapter presents possible adaptations to reduce risks and important knowledge gaps in efforts to take actions.

[Chapter 8: Food Safety and Security](#) – presents existing evidence on the impacts of climate change on health through effects on food safety and security. It describes the nexus among climate change, the food system, and human health, as well as key drivers of poor health outcomes in Canada. Populations and regions at higher risk from impacts are discussed, along with options for adapting to future impacts.

[Chapter 9: Climate Change and Health Equity](#) – examines how important factors and trends at the individual, community, and health system levels can increase or decrease climate change risks to the health of Canadians. The implications of climate change for health equity are explored, along with measures to empower specific population groups to adapt. The chapter also provides tools and resources that support the integration of health equity considerations into climate change and health activities, such as vulnerability and adaptation assessments, and the adaptation design and evaluation process.

[Chapter 10: Adaptation and Health System Resilience](#) – provides an overview of adaptation as the key response to climate change impacts on the health of Canadians and discusses the importance of mainstreaming climate information into existing policies and planning, adaptation to future climate change conditions, and measures to address adaptation challenges. The status of health adaptation in Canada is investigated, along with evidence of climate change impacts on health systems, trends in health system vulnerability, and new tools that health authorities can use to build resilience.



Headline Statements

- **Climate change is already negatively impacting the health of Canadians.**

Climate change has been a driver of recent health effects related to rising temperatures and extreme heat, wildfires, and the expansion of zoonotic diseases into Canada, such as Lyme disease (see [Chapter 3: Natural Hazards](#); [Chapter 5: Air Quality](#); [Chapter 6: Infectious Diseases](#)).

- **Health risks will increase as warming continues, and the greater the warming, the greater the threats to health.**

Projected increases in the frequency and severity of intense precipitation events, urban flood risk, droughts, extreme heat, wildfires, and storms will directly affect health by causing more illness, injuries, and deaths, without greater adaptation efforts. The current burden of mental ill health in Canada is likely to rise as a result of climate change. Disruptions to food systems and water resources; worsening of air pollution; the emergence and re-emergence of climate sensitive infectious diseases; and increasing demands on health systems will continue to threaten Canadians' health (see [Chapter 2: Climate Change and Indigenous Peoples' Health in Canada](#); [Chapter 3: Natural Hazards](#); [Chapter 4: Mental Health and Well-Being](#); [Chapter 5: Air Quality](#); [Chapter 6: Infectious Diseases](#); [Chapter 7: Water Quality, Quantity, and Security](#); [Chapter 8: Food Safety and Security](#)).

- **Some Canadians are affected more severely by climate change, as exposure and sensitivity to hazards and the ability to take protective measures varies across and within populations and communities.**

Growing climate change impacts worsen socio-economic conditions harmful to health, such as poverty, and amplify health inequities. Combined with increasing rates of chronic diseases, social isolation and an aging population, climate change augments impacts on health. People disproportionately affected by climate change include children; pregnant people; First Nations, Inuit, and Métis peoples; people with chronic illnesses; outdoor workers; low income individuals; and people with disabilities (see [Chapter 2: Climate Change and Indigenous Peoples' Health in Canada](#); [Chapter 3: Natural Hazards](#); [Chapter 9: Climate Change and Health Equity](#)).



- **The effects of climate change on health systems in Canada – for example, damage to health facilities and disruptions to health services and operations – are already evident and will increase in the absence of strong adaptation measures.**

Health infrastructure, operations, health financing, health care, public health programming, supply chains, and the health workforce can be impacted by extreme weather events and by chronic stresses from longer-term warming, reducing access to and quality of care to Canadians. Health facilities and services in rural and remote areas, and health systems that have not assessed and managed risks, face the greatest threats. Compounding climate change hazards that can arise – for example, when extreme heat occurs with drought and a wildfire – pose severe risks to individuals and the health systems they rely on (see [Chapter 10: Adaptation and Health System Resilience](#)).

- **Efforts to prepare for climate change are known to reduce risks and protect health. We must take action now.**

Many health authorities are working with decision makers in other sectors, such as emergency management, to take actions to protect people, communities, and health systems. This is called adaptation. Adaptation measures must be scaled up rapidly and substantially if current and future health impacts are to be reduced (see [Chapter 10: Adaptation and Health System Resilience](#)).

- **The health impacts of climate change on First Nations, Inuit, and Métis peoples are far-reaching, with disproportionate impacts on their communities, including food and water security and safety, air quality, infrastructure, personal safety, mental health and wellness, livelihoods, culture, and identity.**

Indigenous Peoples have been adapting to changing environments since time immemorial. Indigenous knowledge systems and practices are equal to Western scientific knowledge and contribute to Indigenous Peoples' survival, adaptation, and resilience. Preparing for climate change requires addressing determinants of health and ongoing health inequities. It also requires that Indigenous Peoples' rights and responsibilities over their lands, natural resources, and ways of life are respected, protected, and advanced through Indigenous-led climate change mitigation, adaptation, policy, and research (see [Chapter 2: Climate Change and Indigenous Peoples' Health in Canada](#)).

- **To successfully protect all Canadians from the health impacts of climate change, decision makers must pursue adaptation actions that are inclusive and equitable and consider the needs of racialized, marginalized, and low income populations.**

Existing health inequities could be made worse unless future adaptation and greenhouse gas mitigation efforts are designed to address them. Redressing inequities and strengthening determinants of good health, such as improving access to health care and housing quality, can help reduce the impacts of climate change on individual health (see [Chapter 2: Climate Change and Indigenous Peoples' Health in Canada](#); [Chapter 9: Climate Change and Health Equity](#)).



- **Increased efforts to reduce greenhouse gas emissions are required to help protect the health of Canadians.**

The continued emission of greenhouse gases into the atmosphere will impose limits on our ability to adapt and lead to more severe impacts on health. The health sector can show leadership in reducing its carbon footprint and improving environmental sustainability while building resilience to future climate change impacts (see [Chapter 10: Adaptation and Health System Resilience](#)).

- **Reducing greenhouse gas emissions can provide very large and immediate health co-benefits to Canadians.**

The economic value of the health co-benefits can help to offset the implementation costs of measures. Health co-benefits of taking actions on air pollution are estimated to include thousands of avoided premature deaths annually in Canada by the middle of the century (see [Chapter 5: Air Quality](#); [Chapter 10: Adaptation and Health System Resilience](#)).



Guide to the Report

This assessment builds on previous scientific studies and reports on risks to the health of Canadians so that government decision makers, health practitioners, researchers, and individual Canadians can take effective measures to protect health now and to prepare for future impacts. The [Executive Summary](#) provides an overview of key findings from each chapter of the report to help readers to easily access information most relevant to their efforts to prepare for climate change.

Assessment Approach and Methods

Beginning in 2017, Health Canada led focus groups and bilateral meetings with health sector decision makers, civil society organizations, researchers, National Indigenous Organizations, and youth to receive input on conducting the assessment. Advice was provided on key health issues to be addressed in the report, effective engagement processes during the assessment, and communicating the final results. The discussions revealed a strong interest in gaining a greater understanding of emerging issues related to climate change impacts on mental health, health equity, and Canada's health systems. In addition, partners highlighted the need for a strong focus on climate change impacts on the health of First Nations, Inuit, and Métis peoples and their communities; the importance of Indigenous knowledge systems for adapting; and the requirement for full and meaningful engagement, inclusion, and leadership of First Nations, Inuit, and Métis peoples to address climate change impacts. Partners also highlighted the strong desire to have this report include discussion of reducing GHG emissions as the key preventive approach to protecting health from climate change and of capturing the large health co-benefits of well-designed policies and measures.

The assessment builds on knowledge from the previous Government of Canada report, [Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation](#) (Chapter 7: Human Health; Berry et al., 2014), as well as the previous comprehensive national climate change assessment, [Human Health in a Changing Climate: A Canadian Assessment of Vulnerabilities and Adaptive Capacity](#) (Séguin, 2008). The report draws from a large body of scientific peer-reviewed research and other publicly available sources and is an evidence-based, mixed-methods study of the health and health system impacts from climate change in Canada. Authors compiled and assessed research to summarize the current state of science on priority health risks facing Canadians. The sources that informed this assessment included peer reviewed and grey literature in both English and French. There was no set cut-off period for the literature, although precedence was given to recent peer-reviewed literature and to seminal literature on the topic area published since the previous national climate change and health assessment, released in 2014.

While the geographic focus of this assessment is Canada, the authors draw upon the increasing number of studies at the local or regional levels in Canada and from analysis in other countries that are relevant for understanding impacts and adaptation options in Canada. The report was extensively reviewed by Canadian and international experts and federal health-portfolio partner departments; and a public review of the chapters was also undertaken.



Intersecting Factors that Increase Climate Change Vulnerability

Identifying intersecting factors that increase vulnerability to climate change impacts on health was a key objective of this assessment. Knowledge of these factors allows for the development of targeted adaptation measures that address challenges for individuals or health sector decision makers in protecting health from climate change. Each chapter includes discussion of factors that increase the risk of climate-related health impacts, and a full chapter is dedicated to this topic (see Chapter 9: Climate Change and Health Equity).

Uncertainty in the Analysis

Studies of climate change impacts on health are challenged by complex pathways and determinants – for example, factors related to personal behaviours, socio-economic conditions, and health system capacity. Through these pathways and determinants, individuals are exposed to climate hazards, respond to the threats, and experience effects on health. Exposures may be short-term and direct, as in the case of extreme heat events, or occur over longer time scales and be mediated by indirect factors related to physiological sensitivity and adaptive capacity. Analysis in this and previous Canadian assessments was hampered by Canada's large geography and diverse population centres, including smaller populations in remote and Northern communities, and limitations associated with the completeness, comparability, and usability of available health and climate data (Seguin, 2008; Berry et al., 2014). Understanding the potentially severe health impacts of compounding, cascading, or cumulative climate change impacts (for example, the floods and wildfires that struck parts of British Columbia in quick succession in 2017) is a larger and even more complex challenge and was beyond the scope of this report.

The number of studies that project risks to the health of Canadians from climate-related hazards, such as wildfires, extreme heat, air pollution, infectious diseases, and water-borne diseases, have increased in the last decade. However, some health outcomes related to climate change, including impacts on mental health, health equity, health systems, and food insecurity, remain difficult to model because of complex and dynamic drivers or data limitations. Studies of projected health risks from climate change reported in this assessment often included new analysis or existing studies of future health outcomes based on low Representative Concentration Pathway (RCP 2.6), medium (RCP 4.5), and/or high (RCP 8.5) emissions scenarios. Projections from the Coupled Model Intercomparison Project 5 (CMIP5) using the RCPs 2.6, 4.5, and 8.5 are widely used and have undergone robust evaluation by the science community. Where possible, authors drew upon results of climate scenarios, models, and projections reported in [Canada's Changing Climate Report](#) (Bush & Lemmen, 2019).

Economic estimates of climate change impacts on the health of populations and health systems, and of the costs of needed adaptation measures, are required for cost-benefit and cost-effectiveness analysis of measures to address climate change. This includes measures to adapt to health impacts and actions to prevent future climate change through GHG mitigation that may result in health co-benefits. A paucity of data still precludes rigorous economic analysis along the spectrum of health concerns facing Canadians from climate change. Selected examples and case studies of economic impacts (Chapter 5: Air Quality; Chapter 10: Adaptation and Health System Resilience) are included in this assessment report.



Assessment of confidence and uncertainty are critical elements of climate change and health scientific assessments. Uncertainty arose from data limitations related to a lack of spatial or temporal fit between climate and health information. It also arose from limitations or lack of models of relationships between climate and health (e.g., future mental health impacts), and lack of data integrated across disciplines and from projections of human behaviour (e.g., future adaptation actions by individuals). In this report, authors used standard language to communicate their confidence in the results, and the level of certainty or uncertainty. This was generally based on the amount of existing evidence to support a statement (e.g., number of studies), the quality of the evidence (e.g., based on an assessment of the credibility of the source authors and literature), and the relationships between observed and projected trends.

Research Needs

The assessment revealed that significant knowledge gaps remain about climate change impacts on health, vulnerabilities, and needed adaptations to reduce current impacts and avoid much more severe impacts in the future. Each chapter provides information on research needed to build the integrated knowledge base to inform future policy decisions by local, regional, provincial, territorial, and national governments as they prepare for climate change.
