

# Chapter 9

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## Conclusion



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### 9.1 SUMMARY

As the federal department responsible for helping Canadians maintain and improve their health and well-being, Health Canada initiated this Assessment to advance the understanding of how climate change impacts the health and well-being of Canadians. Carried out in collaboration with several partnering organizations and individuals, it combines an investigation of population vulnerabilities to current weather and climate variability with an exploration of the effects of future climate change on natural hazards, air quality, and water-, food-, vector- and rodent-borne diseases.

Two regional health assessments were also conducted, investigating climate effects on residents of Canada's North and of the province of Quebec. These more in-depth regional assessments provide insights on the interactions of social, economic and environmental conditions that influence vulnerabilities and adaptive capacity in these regions. This Assessment also includes discussion of vulnerability and adaptive capacity to provide health sector and emergency management decision makers with information on key health risks to populations and the response capabilities needed to address immediate adaptation needs. It paves the way for future vulnerability assessments by applying these concepts in research in a practical way and providing guidance to decision makers at all levels of government for the investigation of the health effects of climate change.

This Assessment confirms that, in Canada, climate variability and climate change affect human health and well-being through different pathways that vary in their directness, temporal scale and complexity, causing or exacerbating a range of illnesses, injuries and, in extreme cases, death. Health can be affected *directly* as a result of exposure to climatic extremes (e.g. high temperatures causing dehydration and heat exhaustion) or sudden, intense changes in the environment such as a tornado or storm. Even when environmental impacts are immediate, health effects may not be apparent until prolonged or repeated environmental exposure has occurred.

Health can also be affected *indirectly* as a result of climate-induced changes in biological and geochemical systems, which create conditions favourable for the survival and replication of vectors and pathogens that can transmit diseases, or affect economic and social systems (e.g. loss of employment or property after a natural disaster resulting in stress and other illnesses). Health impacts can also occur in the presence of other risks or because of cumulative exposures to several hazards. In such cases, attribution to a specific cause or determination of synergistic effect (e.g. combined exposure to heat and poor air quality) is complex and, at times, not possible. Because the scope of effects from climate variability and climate change on health is broad, there is still much to be learned about the factors that combine with climate conditions to lead to illnesses and deaths among the Canadian population.

Climate change may convey benefits to the health and well-being of Canadians. However, the nature and scope of such benefits are not well understood. In fact, some of the benefits often cited in international literature, such as milder winter temperatures and lower winter mortality, may not be observed in Canada. For example, the analysis of temperature-related mortality in the province of Quebec revealed that current successful adaptation to very cold temperatures in that province means mortality does not peak under very cold conditions, as seen elsewhere in the world. The expected decrease in mortality due to future warmer winters is thus much reduced compared to other parts of the world. Furthermore, in the absence of further adaptations, summer mortality is expected to rise sharply under extreme heat conditions resulting in increases in average annual mortality in Quebec as the climate continues to warm. Additional research is needed

to understand current adaptive behaviours to temperature extremes elsewhere in Canada and the expected net impacts of climate change. The focus of current research is on avoiding and mitigating health risks and on ways to increase individual and collective capacity to do so in the future. There exists capacity to address many climate-related risks in Canada. However, Canadians must be prepared to deploy existing knowledge and resources to ensure that capacity is broadly distributed across society and that no region or part of the population is left unprepared.

Accurately predicting the health impacts associated with future climate change is not currently possible, because of uncertainty about the extent and rate of expected future warming and about trends in socio-economic and demographic factors that affect the ability of Canadians to adapt to the health impacts and reduce their risks. Other sources of uncertainty in this Assessment arise from knowledge gaps related to the biological and physical processes by which climate affects health, incomplete information on population health status and health protection practices, confounding factors in attributing causes of illnesses, and difficulties inherent in estimating health impacts associated with projected future climate trends, as well as cumulative impacts.

Even if rapid reductions of greenhouse gases can be achieved in the near term, there is virtual certainty that climate change will be experienced for decades to come because of inertia in the climate system. Despite uncertainty about the nature and expected severity of future impacts and the knowledge gaps described above, the findings of this Assessment suggest the need for immediate action to buttress efforts to protect health from current climate hazards. Planning and preparing are also required to reduce or avoid potential adverse health outcomes as the climate continues to change. Together, the various chapters provide the following key findings.



## 9.2 KEY FINDINGS

### **Climate variables and climate hazards directly and indirectly impact the health and well-being of Canadians. Climate change will increase risks to health.**

People in all segments of the population and regions of Canada are exposed to natural hazards and extreme weather associated with climate change (e.g. droughts, severe storms, hurricanes, extreme heat and cold events, avalanches and landslides, storm surges and floods). Knowledge of one's own community and individual vulnerabilities is imperative because the health risks vary across the country, the size of some vulnerable populations is growing, and the capacity to cope and adapt is uneven. Many factors affect Canadians' vulnerability to climate change such as where they live, their sensitivity to health impacts and their ability to protect themselves (e.g. availability of resources, knowledge of protective behaviours, and access to services).

The scope of weather-related natural hazards in Canada is quite broad. This Assessment inventoried 12 categories of weather events that can affect health. Because the Canadian Disaster Database tracks only those events that meet specific criteria related to costs, injuries and deaths, the full scope of health consequences of natural hazards reported is likely underestimated. Nevertheless, the number of Canadians affected by natural disasters has



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risen in recent decades. Between 1994 and 2003, approximately 578,238 people across Canada were directly affected by natural disasters. Impacts reported include deaths, illnesses and injuries, evacuations and service interruptions (power and water outages). There is also evidence that weather events can have significant short- and long-term psychosocial impacts on the health and well-being of Canadians, but these effects are often poorly documented and under-studied in Canada. Overall, with the exception of the number of cold days, there is a projected increased risk of extreme weather and weather-related hazards in the future. Risks to human health will vary across Canada according to topography, current land use and human activity patterns, regional climate systems, and adaptation measures and systems in place to minimize health risks. Future projections of impacts from climate change include increases in drought and wildfires and certain types of storms, including more intense heavy precipitation events that can increase the risk of flash floods. Heat waves are predicted to increase in frequency and severity, with the risk of heat-related deaths being the greatest in cities.

Climate change can influence air quality as demonstrated by the modelling of the effects of an increase in global average temperature of 4°C on key air quality parameters such as ozone (O<sub>3</sub>) and particulate matter (PM<sub>2.5</sub>) in Canada. While results from the atmospheric modelling conducted for this Assessment focussed only on changes in temperature and biogenic emissions, this work demonstrated the need for future work to better understand the effects of different climatic conditions on air quality. Modelling of other variables that influence air quality and different warming scenarios could lead to better understanding. There is solid evidence of the health effects of air pollution in Canada and, to a more limited extent, the health effects of extreme heat and heat waves. There is a possible additive or synergistic effect on health of combined exposures to air pollution and higher temperatures in certain groups within the population, however, evidence from epidemiological studies remains insufficient at this time. Better understanding of the implications of different climatic scenarios for air quality across regions in Canada and of the effects of combined exposures to high temperatures and air pollutants, particularly for seniors and young populations, is important for deciding on the most effective measures to protect various segments of the population.

Canadians are routinely exposed to infectious diseases that are sensitive to climate variables, such as temperature and precipitation. These include diseases transmitted by insects, ticks or animals, as well as pathogens that are water-borne, food-borne, or both. There is evidence that climate variables can influence pathogen ecology, and also the activities and behaviours of Canadians which can increase their exposure to these diseases. Climate change can be expected to create favourable conditions for pathogen and vector survival where low temperatures, low rainfall or the absence of vector habitat would have previously restricted the reproduction of hosts and transmission of diseases. For example, the expansion of the range of Lyme disease's tick vector in Canada is related to higher ambient temperatures that shorten tick lifecycles; together with more favourable conditions for host-seeking activity, this would increase the geographic range of the disease. This Assessment identifies a range of water-, food-, vector- and rodent-borne diseases whose incidence may increase under changing climate conditions; however, there remain significant gaps in knowledge of the ecology of diseases, of the burden of illness from water- and food-borne illnesses, of the geographic distribution of zoonoses in wildlife and of many other factors. A systematic risk assessment that takes into account pathogenicity, estimated number of cases and incidence rates, and the likelihood that climate change will alter the risk would be useful to identify adaptation priorities. Continued multi-level collaborations are necessary to build proactive surveillance systems that are capable of identifying changing disease patterns and emerging risks in a timely fashion. This will allow public health officials to monitor population health risks and implement measures to reduce exposure and/or introduce new treatments as required.



**The impacts of climate change can combine with other circumstances to increase health risks or create conditions for a disaster.**

Climate change has already started to affect the environment, the economy, and infrastructures that play an important role in the health status of Canadians. The scope of these changes in Canada is documented in *From Impacts to Adaptation: Canada in a Changing Climate 2007*, recently released by the Government of Canada. The study of cumulative effects and the interaction between multiple factors determining health is challenging and still in its infancy. However, past experience in Canada and elsewhere related to extreme weather events has demonstrated that risks associated with climate change combined with individual and community vulnerabilities can lead to disasters. For this reason, it is very important to understand how well existing systems can deal with current risks, how they can withstand repeated or simultaneous events, and what factors and events combine to exacerbate vulnerabilities.



This Assessment found that Canada's expected population growth, aging population, increasing urbanization, aging of public infrastructures and trends in health status indicators may amplify the impacts of a changing climate on Canadians. In the absence of effective adaptations, the combined effects of projected health, demographic and climate trends in Canada are expected to increase the vulnerability of Canadians to the health impacts of climate change. The proportion

of Canadians highly sensitive to these impacts is expected to grow, although this will vary from one region to another. The number of Canadian seniors is growing dramatically; this population cohort is expected to almost double in size by 2031 when it will account for between 23 and 25% of the population. The number of Canadians suffering from chronic illnesses, such as heart disease, cancer and respiratory disease, is also on the rise. These illnesses and their management can be rendered more difficult by climatic factors.

**Regional assessments highlighted the vulnerability of specific population groups and confirmed the importance of developing adaptations tailored to local and regional needs.**

This Assessment confirmed that regional-scale assessments are essential for understanding climate change and health vulnerabilities within a population as well as the factors that increase or contribute to an individual's or community's vulnerability. Compared to national-scale assessments, they require smaller data sets and can more easily take into account the context within which these risks occur. For example, when conducting a vulnerability analysis, they are better able to integrate relevant information such as local risk management practices, individual perceptions and behaviours, and socio-demographic information. In sum, regional assessments can more precisely identify the factors that influence vulnerability (e.g. exposure, sensitivity and ability to manage risks) and make specific recommendations on how to reduce risk and exposure, and how to increase the availability of response measures. Regional assessments face the same methodological challenges relating to the treatment of uncertainty as national studies. However, because they can undertake detailed assessments of current capacity to manage the risks and adaptive capacity, they can be more successful in demonstrating the need to take action despite uncertainty in the assessment of risks.



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The investigation of climate change impacts on health in Quebec revealed that as average temperatures continue to increase, heat-related mortality in Quebec is expected to rise in the absence of further adaptations. A detailed survey of adaptive behaviours indicated that Quebecers are taking many actions to reduce health risks related to heat waves and cold snaps, but that some groups have not adopted, or do not have access to, the necessary protective measures and services. It also showed that most respondents strongly support the rapid implementation of vigorous adaptive measures in many economic sectors, including mitigation of greenhouse gases.

This Assessment also advanced knowledge of public health and other local decision makers' awareness of the health risks of climate change as well as what they regard as potential barriers to adaptation. Based on a review of current measures and systems in place, adaptation to climate change is well underway in the province of Quebec and to some extent in northern Canada. However, key areas for further improvements have been identified based on the literature review and studies commissioned for this Assessment. Some of the identified deficiencies are already being addressed in the health component of the Quebec 2006–2012 action plan on climate change notably regarding surveillance systems and adaptation of health services and infrastructure.

In Canada's North, people are already reporting dramatic environmental and climatic changes and are concerned about growing risks to their health and well-being. However, climate change is not manifesting itself uniformly across the North. For example, temperature and precipitation trends vary such that regions are warming at different rates, some regions are getting drier while others are getting wetter. Awareness of climate change and its impacts is high among Northerners and local observations play an important role in gathering information about these changes. Many communities report an increase in uncharacteristic weather events, which is compromising their travel safety. Livelihoods and diets that depend on subsistence activities (i.e. hunting, fishing, gathering) already appear to be impacted in many regions, and nutritional effects from such changes are of primary concern. The importance and immediacy of these health impacts are motivating Northerners to adapt, using new and locally developed technologies, practices and innovations. However, access to support and resources for adaptation is uneven and many individuals and communities remain vulnerable to the health impacts of climate change.

Northerners are also experiencing other important societal changes that can compound the impacts of climate change. While individuals and communities are leading the way in adapting to climate change, collaborative and coordinated efforts from public and private sectors are needed to accompany local and individual efforts. Improvements in surveillance of a broad range of health impacts (e.g. water-, food-, rodent- and vector-borne diseases, ultraviolet radiation exposure, travel injuries, etc.) are required to better inform adaptation strategies, and to reduce risks to health through local interventions.

**Developing the adaptive capacity of individuals, communities and governments is essential in order to address growing health risks and avoid unnecessary strain on health care and social systems.**

Without effective adaptation strategies, the impacts of climate change on health are expected to increase pressure on a range of health and social service programs at all levels of government, and therefore the costs of climate change could extend beyond the health impacts (e.g. increased incidence of illness, injury, disease, death) to include increased economic costs to health care and social systems.



Decision makers rely on access to material and financial resources, technology, information and skills, institutional arrangements and public health infrastructure to address health risks due to climate change. Adaptive capacity fluctuates over time, as the ability of individuals, institutions and governments within Canada to manage these health risks changes. This Assessment identifies important gaps in current capacity to address climate change health risks. In recent years, significant strides have been

made in improving the ability of public health and emergency management officials to prepare for and respond to a range of climate-related hazards including extreme weather events (e.g. heat waves), air pollution, and water-, food-, vector- and rodent-borne infectious disease outbreaks. Building upon these efforts will ensure that the critical activities and partnerships necessary for reducing health risks are identified, and made the focus of future collaborative adaptation efforts.

Differences in access to social services, infrastructures and resources to reduce risks from climate change mean that the capacity to cope and adapt in Canada is uneven. Rural communities face unique challenges, such as limited resources for adaptation, less developed public infrastructures and, in some cases, isolation. Urban areas are becoming more sophisticated in their public health programming, but the complexity of issues facing them is increasing as are climate change adaptation needs.

Climate change is expected to increase illnesses and deaths in Canada if public health authorities and their partners do not examine their respective vulnerabilities, and develop and implement adaptations that afford adequate protection to vulnerable groups. Regional- and community-level assessments play a useful role in identifying key health vulnerabilities in the context of other changes occurring in the population under study. They are also better positioned to assess the magnitude and urgency of key health risks, and thus can guide decisions on when and where to focus efforts. Several tools and approaches exist to assess adaptation options and best practices are beginning to emerge. These are necessary to increase decision makers' support for implementing adaptation measures and to reduce population health risks.

### 9.3 KNOWLEDGE GAPS

**Research and knowledge from a broad range of disciplines is required to advance understanding of the effects of climate change on health and to support adaptive measures.**

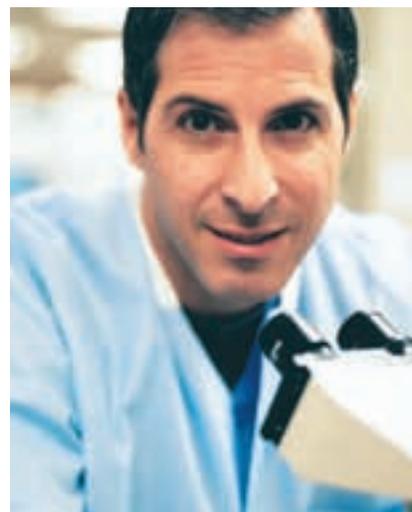
This Assessment highlighted the many sources of empirical data necessary for assessing the health impacts of climate change on Canadians. Surveillance and monitoring systems that public health and emergency management authorities rely upon are maintained at local, provincial and national levels and this can place limits on data aggregation and comparability. Non-empirical information, drawn from case studies and reports using local observations and personal experiences, is also important, particularly in the analysis of capacity. In each area studied, authors have identified knowledge needs that would



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help to reduce uncertainty, expand the applicability of findings, identify vulnerable segments of the population and further the understanding of barriers to adaptation. Overall, knowledge needs fall under the following broad categories:

- biological and physical processes by which climate affects health;
- climate scenarios and models for estimating future health risks;
- current and future exposure of Canadians to climate-related hazards;
- identification of adaptation measures needed to reduce health risks due to climate change, including cost-benefit analyses of measures;
- perception of health risks from climate change by individual Canadians and by public and private decision makers including motivations and barriers to adaptation; and
- processes of adaptation and integration of climate change considerations into current risk management practices.



### 9.4 MOVING FORWARD TOGETHER

This Assessment highlighted current impacts on health from a range of climate-related hazards and the potential health vulnerabilities to climate change for specific regions, communities and populations in Canada. Health sector and emergency management decision makers are beginning to draw upon existing knowledge to address the risks posed by climate change. This is being accomplished through a wide range of actions such as the development of heat alert systems, enhanced emergency management planning, and the monitoring and surveillance of emerging infectious diseases. They are developing new practices and innovative approaches and measures to reduce risks to health. Supporting the dissemination and application of best practices is central to ensuring the broad protection of Canadians.

Future investigation of the effects of climate change on health and the implementation of needed adaptations will benefit from the multidisciplinary collaboration that has begun among many research organizations. These include Canadian and international centres of expertise, such as Health Canada, the Public Health Agency of Canada, Environment Canada, Ouranos, several Canadian universities, Quebec's Institut national de santé publique du Québec, the World Health Organization and the U.S. Centers for Disease Control and Prevention. Continued investments in multidisciplinary research and policy development are necessary to build on the increased awareness about health risks associated with climate change and on the current momentum within research agencies, professional organizations and local governments in order to take action to protect the health of Canadians.