

CLIMATE CHANGES AND THE HEALTH OF CANADIANS

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This is the first in a series of four articles on public health and climate change to be printed in EHR over the next year. The aim of this series to raise awareness about the relevance and importance of climate change to Canadians' health and to public health practice, and to promote engagement by Canada's public health community on this important health issue. This first article provides an overview of some of the key climate change-related health issues for Canadians. In subsequent articles, we will focus on public health preparedness.

One of the key messages from these consultations was to engage Canada's public health inspectors, who play an important role on a wide range of issues related to climate change, including land use planning and source water protection.

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Climate change is emerging as an important health issue for the 21st century, in Canada as in countries around the world. The World Health Organization estimated that, by the year 2000, climate change was causing approximately 150,000 deaths worldwide and an additional five million disability-adjusted life years per year (McMichael, *et al.*, 2004). No similar estimate exists for the whole of Canada, but the issue is certainly attracting attention. In October 2006, Health Minister Clement acknowledged concerns about exotic infectious diseases emerging in Canada as a result of climate change, and the need to be prepared (Canwest News Service, 2006). At the local level, there are many anecdotes of health impacts from weather and climate, along with stated concerns that such impacts may worsen in a warmer climate.

Researchers and health practitioners have amassed a compelling body of evidence on climate change in Canada, and its potential implications for our health. The evidence indicates that climate change raises important health issues, and that Canada's public health system must evolve in response to these new concerns. This article reviews some of the key health concerns and vulnerabilities for Canadians.

Canada's climate is changing

Over the last 100 years or so, Canada's climate has warmed. We have observed an approximately 1°C rise since the beginning of the 20th century (Environment Canada, 2005). We expect it to continue to rise by about 0.5°C per decade, or up to 5°C over the next century (Natural Resources Canada, 2004). This is not insignificant – by comparison, the Earth's mean temperature was only 4–5°C cooler during the last ice age (Environment Canada, 2005).

As the climate changes, we will experience more than just a gradual warming. We may also experience changes in rainfall amounts and patterns, and in weather patterns and extremes. Some areas will get more rainfall, while others will get less. Some areas will experience more extreme weather – for example, more frequent and severe storm seasons and summer droughts. Over the long-term, temperature increases will result in sea level rise and flooding of coastal areas, and in a range of ecosystem changes.

The actual changes in climate and temperature will differ across Canada:

- British Columbia's Pacific south coast cities, for example, are expected to see an increase in seasonal extremes, with warmer, wetter winters and hotter, drier summers.

- The mountainous areas of BC and Alberta will see, in the near term, an increase spring and summer melt water runoff as glaciers retreat. In the longer term, these areas may become drier as the glaciers retreat, threatening water supplies to the communities that depend on glacier-fed rivers.
- The Prairies will experience warmer, drier summers and more severe summer droughts.
- In Ontario and Quebec communities, summers will be drier with more storms, while winters will see a decrease in snow and an increase in rainfall. Great Lakes water levels are expected to drop. This may reduce groundwater supplies further inland.
- In the Atlantic provinces and other areas that experience spring flooding, ice jams and flooding could be come more common due to changes in late winter-early spring precipitation patterns.
- Canada's northern communities are likely to experience the greatest changes, with significant increases in temperature and precipitation, and losses of permafrost and sea ice.

Health and climate change – understanding the links

“Health” can be defined in several ways, including as “a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity” (WHO, 1946) and “the capacity of people to adapt to, respond to, or control life’s challenges and changes” (Frankish et al., 1996). These different notions can help us understand the different ways that people experience health and well-being, and how climate change may impact on health and well-being. The

latter definition is especially valuable, since it emphasizes the ability to cope with and adapt to change.

Canada’s climate encompasses weather conditions that affect a wide range of health outcomes, both directly and indirectly. For example, heat waves cause health problems directly, and can exacerbate poor air quality and its related health effects; and severe weather events such as tornados and ice storms cause death and injuries. Our climate also helps shape ecosystems that favour wildlife, mosquitoes and some other disease vectors, thereby changing the potential distribution of certain infectious diseases. Weather and climate are thus important determinants of health.

Weather and climate interact with many other health determinants, including individual-level factors like age and genetics and population-level factors like social and institutional environments. These interactions can produce health outcomes via diverse pathways. In some cases, the relationships are relatively direct and well-understood – e.g. the effects of temperature extremes on people. Others are far more complicated – e.g., the complex relationships between weather and climate and community health and well-being in resource-based communities. Between those two extremes lay a complex web of relationships between weather and climate, other health determinants and many possible health outcomes.

Climate change, or a shift in long-term average weather conditions, is emerging as an important determinant of health. Even small changes in climate can induce changes in the form and function of biophysical, ecological, social, economic and technological systems, all of which are also important health determinants. The implications are potentially massive.

Canada’s public health infrastructure is also an important health determinant. Over time, it has evolved in response to the weather and climate conditions and associated health risks that we have typically faced. For example, we have developed:

- Heat and cold alert systems in response to extreme temperature conditions;
- Flood protection protocols and disaster preparedness in response to heavy precipitation and other storm events; and
- West Nile surveillance, risk assessment, mosquito control and public education activities in response to risks from West Nile virus.

Thanks to these and many other examples, Canadians are generally well protected from weather - and climate - related health risks.

Existing public health infrastructure offers the foundation for dealing with health impacts of climate change. But as our climate changes, it may reach or exceed the limits of their effectiveness. It will no longer provide the level of health protection for which it was designed, to which we are accustomed, and that we have come to expect.

Health risks for Canadians

With this in mind, we review some of the key climate change-related health concerns for Canadians, which are summarized in Table 1 and described below.

Air quality and air pollution

Smog and air pollution are already serious public health issues in parts of Canada, especially in large urban areas.

Table 1

<i>Direct health effects</i>
• Air quality and air pollution
• Effects of temperature and extreme heat events
• Effects of other extreme events
• Increased precipitation and waterborne disease risk
• Increased vector-borne and zoonotic infectious disease risk
<i>Indirect health impacts</i>
• Reduced water availability
• Socio-economic and community impacts

They cause at least 5,900 premature deaths per year in eight Canadian cities (Health Canada, 2004), and 1,700 deaths per year in Toronto alone (Toronto Public Health, 2005). Air pollution is expected to worsen as a result of climate change, since the warmer temperatures will tend to favour ground-level ozone production and increased urban smog. Toronto Public Health (2005) projected a 20% increase in air-pollution related deaths in the city by 2050.

Effects of temperature and extreme heat events

Warmer winters and hotter summers are anticipated to affect temperature-related morbidity and mortality. Warmer winters will reduce the number of deaths associated with cold temperatures – this is one of the projected health benefits from climate change.

Extreme heat events, which can exacerbate a range of pre-existing health conditions or cause death directly, are expected to become more frequent, longer lasting, and more intense (McMichael *et al.*, 2001; Natural Resources Canada, 2004). Heat waves were responsible for over five hundred deaths in Chicago during a 5-day period in 1995 (Kunkel *et al.*, 1996) and at least 50,000 deaths in Europe in 2003 (Bucker, 2005). Toronto Public Health projected impacts of climate change include a

doubling of heat-related mortality by 2050 (Toronto Public Health, 2005).

More frequent extreme heat and smog days in urban areas may result in a greater number of days declared unsafe for outdoor activity. This, in turn, may reduce outdoor and exercise activities and their associated health benefits.

Effects of other extreme events

Extreme weather events (e.g. severe rainstorms, hurricanes, droughts) are associated with a wide range of health outcomes, including direct injuries and deaths, outbreaks of waterborne and other infectious diseases, and mental health effects (e.g. stress, suicides, etc.) and economic losses.

Extreme events could become more frequent or intense in parts of Canada. Canada's increasingly urban and aging population, combined with deteriorating infrastructure, make us more vulnerable to health and other impacts from extreme weather. Making matters worse, many Canadians live in highly exposed areas – in flood plains, low-lying coastal zones and mountain valleys.

Increased precipitation and waterborne disease risk

Extreme precipitation events are projected to become more common in some areas. These, combined with warm temperatures, tend to increase risks of various waterborne illnesses.

They can also cause flooding and its associated social and economic hardship.

Thomas *et al.* (2006) found that the risk of a waterborne disease outbreak in Canada doubled following an extreme rainfall event. Similar findings have been reported in the United States (Curriero *et al.*, 2001). A prolonged drought followed by a high rainfall event – such as a summer storm – can pick up surface contaminants and flush them into local waterways, causing a 'pulse' in the contaminant load of local water treatment facilities. This scenario was determined to be one of the factors contributing to the *E. Coli* outbreak in Walkerton, Ontario in 2000 (Auld *et al.*, 2001; BGOSHU, 2000). Increased rainfall also contributed to a toxoplasmosis outbreak in Victoria, BC in 1994/5 (Bowie *et al.*, 1997) and an outbreak of *Cryptosporidium* in Milwaukee, WI in 1993 (Bowie *et al.*, 1997; MacKenzie *et al.*, 1994).

Higher than normal rainfall events may exceed expected norms for sewage treatment facilities, overwhelming treatment systems. In the Inuit community of Arctic Bay, for example, increased rainfall has been observed to overflow the local sewage ponds, contaminating local rivers and roads (Ford, 2006). In November 2006, nearly a million people in Vancouver were forced to boil their water for nearly close to two weeks due to unacceptably high silt levels in water source reservoirs following a major rainstorm (CBC News, 2006).

Increased vector-borne and zoonotic infectious disease risk

The precise effects of climate change on vectorborne disease risks in Canada are unclear, but there are certainly legitimate concerns that some disease risks may increase. Warmer year-round temperatures and longer summers

favour increased population size and biting activity of disease vectors like mosquitoes and ticks. Lyme disease-transmitting ticks could expand northward and westward, from the few areas where they are presently endemic, along the northern shores of Lake Erie and Lake Ontario, and on the southeast coast of Nova Scotia (Ogden et al., 2006). Prolonged hot weather can favour increased mosquito activity and West Nile virus replication – both of which may increase WNV transmission risks to humans (Kunkel et al., 2006).

The effects of climate change on other infectious diseases risks to Canadians are even more difficult to predict. The occurrence of diseases such as malaria and hantavirus, while extremely rare in Canada, are affected by climatic variability (Health Canada, 2004), and could conceivably increase. Climate change is projected to expand the global distribution of endemic Dengue Fever and malaria (Sutherst, 2004). This may alter health risks for Canadian travelers abroad, and increase the potential for imported cases and small, localized outbreaks.

Reduced water availability

Climate change may exacerbate water availability concerns in some areas. In many cases, concerns over water arise from increasing demand for water from growing populations. Climate change will often make matters worse. In Victoria, BC, for example, summer water shortages have been an on-going municipal challenge. This area is predicted to have reduced summer precipitation, resulting in lower reservoir levels for water distribution during the summer water deficit. A similar trend is expected in Ontario and Quebec.

Socio-economic and community impacts

Climate change is anticipated to impact across many sectors in Canada. In turn, these impacts may have significant effects on health, both positive and negative.

On the positive side, warmer temperatures will extend growing seasons and agricultural areas in some regions (Natural Resources Canada, 2004). Some industries will benefit. Agricultural crops, such as Canada's cranberry industry, may benefit dramatically from increasing temperatures. Warmer temperatures will reduce costs of heating in the winter and associated economic benefits. The possibility of the Northwest passage opening to regular sea traffic may have positive economic benefits to some groups and sectors; although there are also a range of social, community, and security concerns with this scenario (Kerr, 2002).

Examples from the fisheries and forest sectors demonstrate the potential for negative health effects:

- Fisheries: Warmer waters will reduce the sustainable harvest of some economically valuable fish species. This could be a major burden on some communities that are reliant on the fisheries. We need only look at the impact of the East coast cod moratorium on Newfoundland communities, to appreciate the massive potential for a major environmental change to affect the health of communities. The moratorium resulted in about 30,000 lost fishery jobs in and many more in related employment.
- Forests: Increases in insect infestations such as spruce budworm and the mountain pine beetle have been linked to climate changes. The mountain pine beetle populations of British Columbia, for example, have

doubled every year for the past several years and expanded rapidly in their range (Stone, 2003). Pine beetle damage, which was estimated at approximately two million hectares of forest pine in 2002 alone (Stone, 2003), is now a huge concern for the BC forest industry and forest-dependent communities.

Climate change is likely to increase forest fire risks in many regions, again with important implications for the health of forest-based communities. Increased forest fire smoke events will reduce air quality and impact on health directly, and increase the need for evacuation alerts and dislocation.

Similar examples exist from other resource sectors. In all of these sectors, climate change is likely to force a number of ecosystem changes that can have major implications for the industries, communities and individuals that rely on them.

Vulnerable populations – Not everyone is the same

Health effects from climate change are expected to disproportionately affect a number of vulnerable populations. For example:

- Children, the elderly and the poor will be especially vulnerable to extreme heat, for a variety of reasons. The elderly, for example, are vulnerable due to many reasons, including: impaired homeostasis (due to intrinsic changes in the regulatory system and/or use of certain medications), obesity and low fitness, living in institutions like residential care facilities, and the higher percentage of people with pre-existing health conditions that may be exacerbated by heat (NRCan, 2004; WHO, 2004).

Northern communities, especially the Inuit populations in the eastern Arctic, will be particularly vulnerable. Many of these communities have traditional livelihoods that are strongly linked to the land and weather conditions (Kerr, 2002; Ford *et al.*, 2006; Furgal and Séguin, 2006;), and it is here where climate changes will be most pronounced.

Canada's Aboriginal peoples may be especially vulnerable to climate changes in the forest sector. More than 90% of Aboriginal peoples' reserves are on forested lands, and forests play a vital economic and cultural role for Aboriginal peoples' communities. Their vulnerability is worsened by their relative immobility, which is the result of a host of complex, interacting legal, economic and cultural reasons. If climate change causes significant

changes to their local environments, and they are unable to relocate, the health implications could be magnified.

Other vulnerable populations include resource-dependent rural communities, the immuno-compromised (e.g. to certain infectious diseases) and those with underlying heart disease or chronic respiratory conditions (e.g. to heat- and smog-related illnesses).

These examples demonstrate the range and complexity of causal factors that contribute to vulnerabilities and health risks. These are important considerations to our efforts to prevent or minimize disease.

Engaging the health community

Rising greenhouse gas (GHG)

concentrations in the atmosphere is causing climatic changes that can impact health. Reducing GHGs is viewed as an important, and *unavoidable*, primary preventive measure. At the same time, we are "locked in" to a certain amount of climate change, irrespective of how successfully we reduce GHGs. The climate will continue to change, so we must respond.

Health experts and stakeholders from across Canada first met in 2000 to help identify how the health sector should respond to climate change. They identified five core program areas where actions were required, and developed an organizing framework (Figure 1) for a national public health response.

Since then, we have made some tremendous progress. We produced high-quality research and surveillance programs, we have raised awareness amongst important target audiences, and we have put health effects from climate change on policy agendas. Many of the basic public health infrastructure improvements, like those undertaken in the wake of the 2003 SARS outbreak, strengthen our ability to manage climate change related risks. In the year ahead, three major reports - the Intergovernmental Panel on Climate Change's Fourth Assessment Report, the Canadian National Impact Assessment and the Canadian Health Vulnerability Assessment - will be released. These reports may draw more attention to the climate change issue, and create favourable conditions for continued progress on health preparedness.

We still have far to go. The climate change and health issue is still relative new. Amongst the health community, awareness about the health effects of climate change is still low, in general. Amongst the general public, it is even

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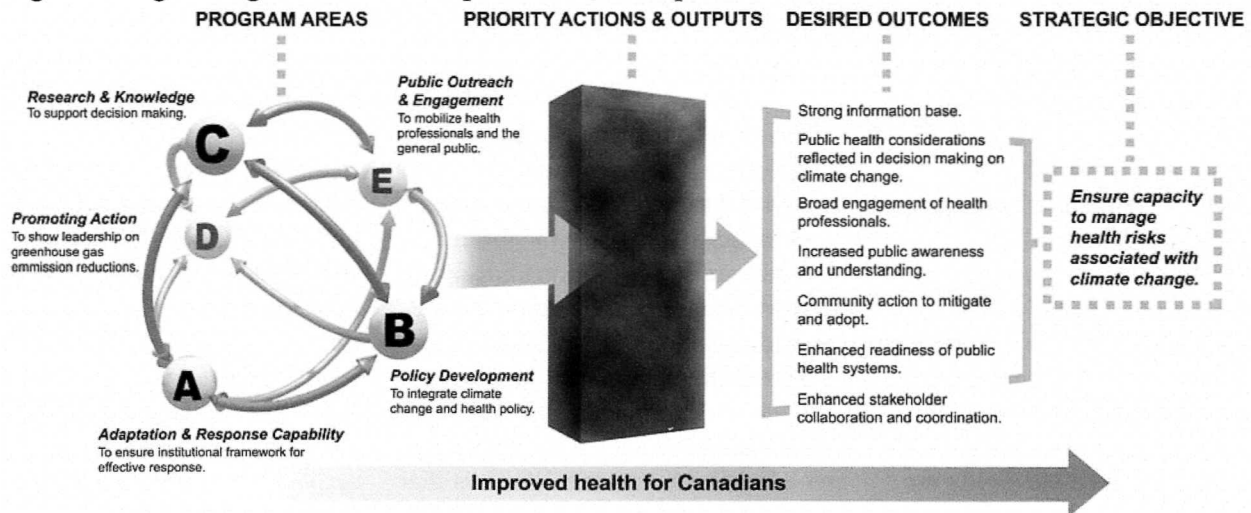
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Figure 1 Organizing framework for public health response



[based on CPHA Strategic Plan on Health and Climate Change, (CPHA, 2001)]

lower. Climate change is generally viewed as an environmental, energy or economic problem but not generally as a health problem. This needs to change. Formal consultations with over 60 health professionals in 2006, and informal discussions with others revealed that not all health stakeholders are at 'the right tables' at 'the right time'; clear on their roles and responsibilities; that not all partnerships are in place; and that in some cases, the dialogue has not even started. This also needs to change.

One of the key messages from these consultations was to engage Canada's public health inspectors, who play an important role on a wide range of issues related to climate change, including land use planning and source water protection. Hence the forth-coming series of climate change articles in EHR. Stay tuned!

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All the best in 2007 from Debra Losito at the CIPHI National Office!