A Global Issue

Knowledge about the health impacts of climate change is growing, as organizations around the world share research and identify ways to manage the risks of climate change. The Intergovernmental Panel on Climate Change (IPCC), the World Health Organization (WHO), various regional and national assessments, and the Arctic Climate Impact Assessment (ACIA) have highlighted the current and future health impacts of climate change on populations around the world. The widespread consensus is that climate change, and specifically changes to temperature and precipitation levels, has the potential to significantly affect human health, as well as economies, and physical and social environments in every region of the world. Canada is no exception.1-3

Climate Change and Health: A Complex Relationship

Health and well-being are inextricably linked with the state of the natural and built environments. As an integral component of the physical environment, climate can affect health both directly and indirectly, causing physical and mental illness, injury and, in extreme cases, even death.1-3

A growing body of research shows climate change can affect health through different pathways that vary in their directness, temporal scale and complexity. Climate change can affect health directly as a result of exposure to climatic extremes (e.g., high temperatures causing dehydration and heat stroke) or sudden, intense changes in the environment (e.g., tornadoes causing injury). While direct pathways such as these often result in immediate health impacts, in some cases the impacts are not apparent until years of prolonged environmental exposure (e.g., ultraviolet (UV) radiation and skin cancer).4

Health can also be affected indirectly as a result of climate-induced changes in biological and geochemical systems, for instance by creating conditions favourable for
disease (e.g., warmer, wetter weather favours the life cycle of mosquitoes, influencing the spread of the West Nile virus). Climate change can also indirectly have an impact through economic and social systems, for example, through loss of employment or property after a natural disaster resulting in stress and other illnesses. These indirect pathways generally result in longer term health impacts.4

Virtually all aspects of life, from food production and water management, and energy production and consumption, to storm sewer, drainage and sanitation systems, and housing and health infrastructures, including disease surveillance and control, are designed for a specific climate. Health risks arise when any one of these systems fails or becomes compromised — as they may in a changing climate. Additionally, the risks can be exacerbated when any of the “determinants of health” (see article on page 22) become compromised or inadequate to meet the needs posed by a changing climate.

**Key Climate-Related Health Concerns**

The IPCC’s Third Assessment Report on the impacts of climate change documents the global climate changes that are expected to affect human health around the world. Many of these impacts have a medium to high level of certainty. For example:

- More frequent and intense heat waves are expected to increase mortality and morbidity.1
- Changes in the magnitude and frequency of extreme weather events will likely cause physical and mental illness, injury, death, economic losses, property damage and population displacement.1

- Increased temperatures and changing precipitation patterns will have negative effects on food production and the availability and quality of fresh water, increasing the risks of infectious disease epidemics.1

Research shows that Canada can expect similar impacts, but these will vary depending on geographic location.2 To guide research and respond to the impacts of climate change in Canada, Health Canada has identified several climate-related health concerns and vulnerabilities (see Table 1).

**Table 1: Canada’s Health Concerns from Climate Change and Variability**

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<th>Health Concerns</th>
<th>Examples of Health Vulnerabilities</th>
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<td>Temperature-related morbidity and mortality</td>
<td>• Cold- and heat-related illness • Respiratory and cardiovascular illness • Increased occupational health risks</td>
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<tr>
<td>Health effects of extreme weather events</td>
<td>• Damaged public health infrastructure • Injury and illness • Social and mental stress due to disaster • Occupational health hazards • Population displacement</td>
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<td>Air pollution-related health effects</td>
<td>• Changed exposure to outdoor and indoor air pollutants and allergens • Asthma and other respiratory disease • Heart attacks, strokes and other cardiovascular disease • Cancer</td>
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<td>Health effects of water- and foodborne contamination</td>
<td>• Diarrhea and intoxication caused by chemical and biological contaminants</td>
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<td>Vector-borne and zoonotic disease</td>
<td>• Changed patterns of disease caused by bacteria, viruses and other pathogens carried by mosquitoes, ticks and other vectors</td>
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<td>Health effects of exposure to ultraviolet rays</td>
<td>• Skin damage and skin cancer • Cataracts • Disturbed immune function</td>
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<td>Population vulnerabilities in rural and urban communities</td>
<td>• Older people • Children • People with compromised health status • People with lower incomes • People without shelter • Northern residents and Aboriginal people • People with disabilities • People living off the land</td>
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<tr>
<td>Socioeconomic impacts on community health and well-being</td>
<td>• Loss of income and productivity • Social disruption • Diminished quality of life • Increased costs to health care • Health effects of mitigation technologies</td>
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Source: Adapted with permission from Health Canada, Climate Change and Health Office, 2005.5
Temperature Extremes

Generally, human beings have a narrow temperature tolerance zone. Although thermoregulatory mechanisms help compensate for changes in temperature and humidity, beyond certain temperatures, these mechanisms can become overburdened and no longer be adequate.6 As a result, extreme temperatures — both hot and cold — can cause physiological disturbances and organ damage leading to illness and death.6

Canadians can expect a more variable climate with generally hotter summers, more frequent and severe heat waves, and milder winters.1-3 Increases in the frequency and intensity of summer heat waves, when combined with factors such as electricity shortages, may overwhelm the ability to protect human health in some parts of Canada.

High temperatures can lead to increased illness and deaths due to heat stroke and dehydration. As well, heat may exacerbate cardiovascular illnesses, respiratory illnesses, diabetes, strokes and accidents.1-3 Other adverse effects include heat cramps and edema, fainting, mental confusion, heat rash and heat exhaustion (see Figure 1).1,2 Interestingly, temperature increases are also associated with increased violence and homicide.7,8 For example, in the Montréal area, researchers found that the crime rate tended to increase along with daily temperatures.2

Because of the urban heat-island effect, urban centres have been shown to be more vulnerable than rural areas to the heat-related impacts of climate change. (See Myth?, p. 20.) Pengelly suggests that as temperatures rise, heat-related mortality will double in some Canadian cities by about 2050.10 There is already evidence linking summer heat to increased illness and death, especially in cities in southern Ontario and along the St. Lawrence River.11 Internationally, it is also not difficult to find heat-related events with devastating effects. For instance, the intense heat wave in France during the summer of 2003 resulted in over 15,000 premature deaths, and has recently been linked to human influences on climate.12,13

In Canada, cold weather continues to be a more significant contributor to excess deaths (by 10% to 25%)1 than has hot weather, where an average of 100 people die from extreme cold and winter storms each year.10 Fortunately, the number of cold-related deaths may be attenuated, as there may be warmer overall temperatures and fewer cold snaps with climate change.1

Extreme Weather Events and Natural Disasters

As global temperatures rise, so does the amount of moisture and energy driving storm systems. While not all extreme weather events and natural disasters are related to climate change, in a warmer climate there is an increased likelihood that events such as electrical storms, storm surges, floods, hurricanes, tornadoes, droughts and forest fires will be more frequent and intense.

According to the IPCC, the 1990s were marked by an unusually high number of weather-related disasters. Figure 2 shows the number of weather-related and other natural disasters recorded in Canada between 1900 and 2002. It is estimated that the number of extreme weather-related events increased from two to four per year in the 1970s and 1980s, to 12 per year in the 1990s.14 The human impact has clearly been felt — the 2004 World Disasters Report estimated that the total number of Canadians affected by natural disasters increased from 79,066 between 1984 and 1993, to 578,238 between 1994 and 2003.15

Extreme weather events have the capacity to harm Canadians’ health by leading to an increased risk of injury, illness, stress-related disorders and death.1,2,16 In addition, long-term health effects can occur as a result of destroyed or contaminated food and water supplies, diminished air quality, damaged health services and civic infrastructure, disrupted community life and employment and, in some cases, displacement of entire groups of people.1,2,16 As well, large-scale
weather events can result in large numbers of people crowded into shelters, increasing the risk of infectious disease outbreaks.\textsuperscript{1,4} A study led by the University of Alberta also found that such disasters result in a wide range of mental health impacts, including stress and depression from financial losses, injuries and relocation.\textsuperscript{16}

In recent years, a range of impacts of extreme weather events have been studied during the 1997 Red River flood in Manitoba, the 1998 ice storm in eastern Ontario and southern Québec, and Hurricane Juan in 2003. The ice storm alone cost over $5 billion, and resulted in 28 deaths, 945 injuries and the evacuation of 600,000 people.\textsuperscript{17} Drought also affects communities, often for sustained periods of time, as demonstrated when low rainfall devastated the Prairies from 1990 to 1993, with damages estimated at more than $1 billion.\textsuperscript{17} Unfortunately, more frequent drought disasters are expected in Canada,\textsuperscript{2} together with increased risks to human health and well-being, primarily by damaging rural economies, affecting water supplies and increasing the number of forest and grass fires.\textsuperscript{16}

**Decreasing Air Quality**

According to the WHO’s burden of illness study, outdoor air pollution is the most important environmental health problem in developed countries.\textsuperscript{3} Air pollution in the form of smog, acid precipitation, airborne dust and ground-level ozone are all likely to worsen as the climate changes. Some regional studies predict increases in air pollution-related excess deaths and emergency room visits exacerbated by new climatic conditions.\textsuperscript{10,19}

Unfortunately, many of the same pollutants that are responsible for climate change also contribute to air pollution.\textsuperscript{1} Climate change is likely to influence air quality in several ways, as summarized in the text box.

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**How Climate Change Is Likely to Affect Air Quality**

- The chemical reactions that generate certain air contaminants will be accelerated with higher temperatures, producing more air pollution (ground-level ozone and smog).\textsuperscript{1}
- Climate change will affect local weather patterns and vegetation, which can influence the transportation of airborne pollutants, pollen production and the rate of industrial/household emissions (by altering the demand for heating and cooling, for example).\textsuperscript{4}
- A hotter climate will lead to drier soils which, when combined with wind gusts, can increase the amount of dust in the air.\textsuperscript{17}
- A warmer, wetter climate will be favourable to moulds and other airborne allergens.\textsuperscript{20}
- Milder winters will mean less snow cover to suppress outdoor moulds.\textsuperscript{21,22}
- Hot, humid weather may encourage people to stay indoors, where levels of certain pollutants (e.g., toxic moulds) can actually be higher.\textsuperscript{23}
- Hot, dry weather could result in more forest fires, increasing air pollution in some areas.\textsuperscript{2,17}
Since the majority of Canadians are exposed to some degree of air pollution, everyone’s health could potentially be affected. The specific health outcomes, however, will depend on the nature and concentration of the pollutant, the type and degree of exposure, the individual’s overall health and the combined effects of other pollutants, as well as other factors. Broadly speaking, the health impacts range from eye and throat irritation, shortness of breath and other temporary respiratory symptoms, allergies, impaired lung function and respiratory disease, to heart attack, stroke and other cardiovascular diseases, and lung cancer and premature death.\(^{23,24}\)

The Ontario Medical Association estimates that air pollution is associated with approximately 17,000 hospital admissions and 60,000 emergency room visits per year in Ontario.\(^ {25}\) According to Health Canada, there are 5,900 premature deaths annually in Canada from air pollution.\(^ {26}\) These numbers can be expected to rise as the climate changes and the Canadian population ages and increases in size.

Approximately two thirds of Canadians live in regions that experience high smog levels in the summer, including the Windsor-Québec City Corridor and the southern Atlantic region.\(^ {2}\) As a result, cities like Toronto issue smog alerts, advising residents to take precautions to avoid the adverse health impacts from air pollution. Many rural areas also suffer from smog and particulate matter that have been transported long distances from cities in Canada and the United States.\(^ {27}\)

**Contaminated Food and Water**

Climate helps determine the abundance, range, growth and survival of many infectious agents. Therefore, climate change is expected to alter the incidence and distribution of waterborne infections resulting from contaminated drinking water, recreational water, coastal water and food (see article on page 27). Heavy rainfall will be a factor in the contamination of public water supplies as surface discharge (bacteria, sewage, fertilizers) flows into rivers and reservoirs, causing outbreaks of parasitic, bacterial and viral infections.\(^ {2}\) Dangerous or toxic chemicals from storage or waste disposal sites can also contaminate water supplies as a result of flooding.\(^ {1}\) Drought, on the other hand, can increase the concentration of pollutants and pathogens in a shrinking water supply. Communities in all regions of Canada are at risk from future water- and foodborne contamination related to changes in precipitation regimes.

**Myth?**

**Heat waves tend to have a greater impact in urban areas than in rural areas.**

**True**

Urban areas are more prone to heat waves than rural areas because of the urban heat-island effect (see figure). The large amounts of paved and dark coloured surfaces in cities, such as roofs, roads and parking lots, absorb the sun’s heat. As a result, surface and ambient air temperatures are generally up to three degrees Celsius warmer than in surrounding areas.\(^ {2}\) Research also suggests that heat waves occurring earlier in the summer cause more deaths than those later in the season, as people have not yet acclimatized to warmer weather.\(^ {3}\)
Vector-Borne and Zoonotic Diseases

Although zoonotic diseases can be transmitted directly from an animal to a person, they can also be transmitted indirectly when a disease vector (e.g., mosquito or tick) carries a disease agent (e.g., protozoa, bacteria, virus) from the host species (e.g., deer or mice) to humans. As temperatures and precipitation increase, climatic zones may shift, and conditions may become more favourable for certain vector- and rodent-borne diseases to flourish in areas that have never experienced them before. As one example, Lyme disease is rare in Canada outside parts of southern Ontario, and coastal and central British Columbia. A warmer climate could encourage species of ticks transmitting the disease to establish themselves in other parts of Canada.28 For vector-, zoonotic- and waterborne diseases, strengthening surveillance will be crucial in preventing and limiting health hazards.

Stratospheric Ozone Depletion

Ozone in the stratosphere (the upper atmosphere, 10–50 km above the Earth) protects the Earth's surface from high levels of biologically damaging UV radiation, which is known to be a significant risk factor for skin cancers, eye cataracts and immune system suppression.2,4 Anthropogenic chlorofluorocarbon (CFC) and volatile bromine compound emissions have reduced stratospheric ozone levels, increasing the amount of UV radiation to reach the Earth. However, conditions on Earth strongly influence the levels of surface UV as well, including amount of cloud cover, angle of the sun's rays, altitude, presence of aerosols in the atmosphere, and the reflectivity of the surface (determined largely by the amount of snowcover). Canadians’ exposure to UV radiation is expected to increase, due to ozone depletion and longer summer recreational seasons brought about by warmer temperatures. Health impacts depend on the degree of exposure, as well as individual susceptibility and age, since the effects of exposure to UV radiation are cumulative.2 However, all Canadians are potentially at risk from the health impacts of UV radiation and should take precautions.

Facing the Future

Canadians are already experiencing the impacts of climate change on their health and well-being. As the climate continues to change, it is likely that the risks will increase, although where and who will face these risks remains uncertain. Whether this potential translates into harmful health outcomes depends on how quickly the climate changes and how successfully individuals, governments and other organizations respond to the new environmental conditions. As a nation, Canada has the capacity to meet the challenges associated with climate change. However, as discussed in the next article, certain populations and regions may be more at risk than others and will require sustained intervention and planning to maintain and protect their health.

Click here for references.


**References for Health in a Changing Climate (p. 16)**


References for Vulnerability: Who’s Most at Risk? (p. 22)


