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Health Policy Research Bulletin

Climate Change: Preparing for the Health Impacts

With its widespread environmental and human health impacts, climate change has become a global policy issue. Sectors at all levels are being challenged to find collective solutions that safeguard the planet's integrity and the health of its inhabitants, while enhancing the prosperity and quality of life for communities and individuals.

Countries around the world are responding through the *United Nations Framework Convention on Climate Change* and the *Kyoto Protocol* by working to better understand the future climate and to reduce the release of greenhouse gases into the atmosphere. Although crucial, mitigation measures cannot halt climate change, only slow it down or reduce its severity. Therefore, Health Canada and its partners are investigating the impacts of climate change on human health and well-being — and how Canadians can prepare for and adapt to them. This issue of the *Health Policy Research Bulletin* highlights this work and the important results that are beginning to emerge. In particular, the Bulletin:

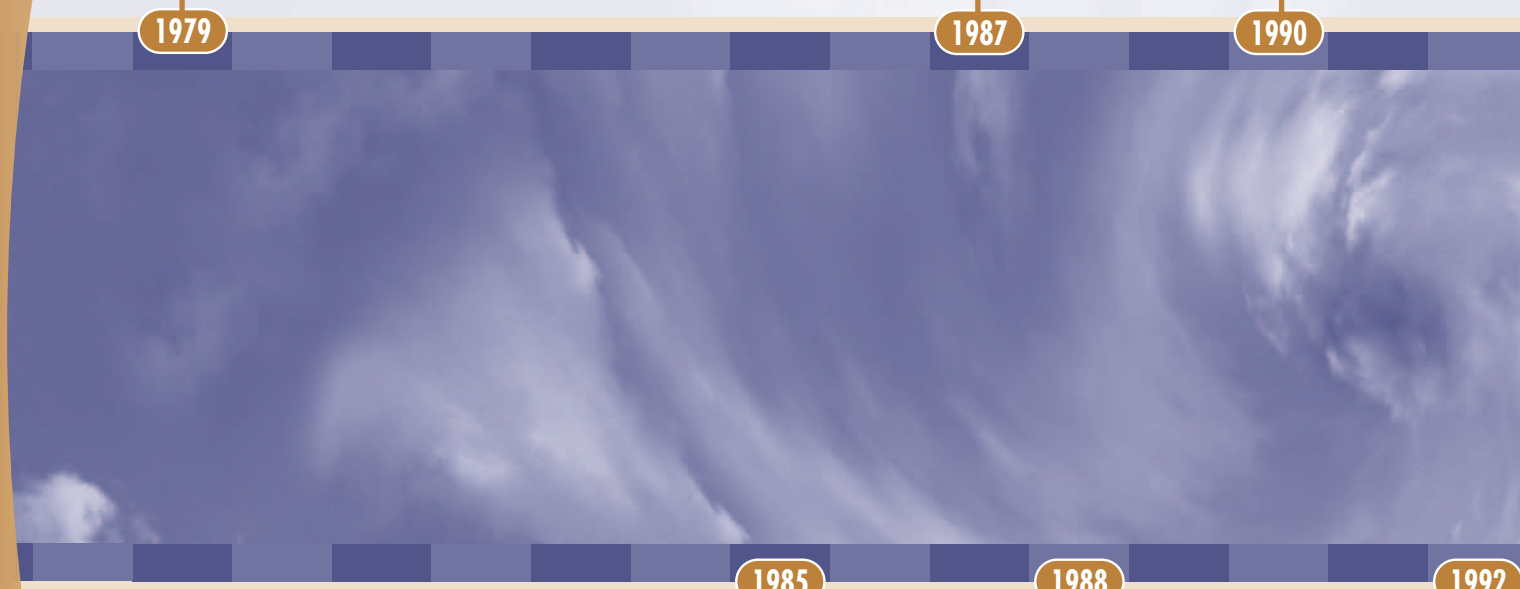
- examines the relationship between climate and health, and explores the various pathways by which climate change affects human health and well-being
- explores the type of evidence needed to assess the impacts of climate change on health, and presents the findings from some recent Canadian surveillance and research activities
- highlights the scope and magnitude of current and anticipated health impacts of climate change in Canada and around the world, and examines trends in a number of climate-related health risks
- illustrates how individuals and communities can adapt to the health impacts of climate change, and how governments, organizations and individual Canadians are working together to avoid the most severe impacts and cope with the unavoidable consequences

Certainly, questions remain about the vulnerability of Canadians and their communities to the health impacts of climate change. However, a growing body of research and the recent examples of extreme weather events around the world underscore the health and economic costs of inaction, and the importance of establishing adaptation strategies.

In this Issue

Canada

Major Milestones and Health Initiatives on Climate Change



1979

1st World Climate Conference, convened by World Meteorological Organization, calls on government to "foresee and prevent potential man-made changes in climate."

1985

1st International Conference on Greenhouse Effects suggests that greenhouse gases (GHG) will cause a rise in mean global temperature in first half of next century, with sea levels rising by up to one metre.

Vienna Convention for the Protection of the Ozone Layer outlines responsibilities for protecting human health and environment against adverse effects of ozone depletion.

1987

Montreal Protocol calls for phasing out chlorofluorocarbons (CFCs) by 2000 and methyl-chloroform by 2005.

1988

International Conference of Changing Atmosphere: Implications for Global Security calls for 20% cut in global CO_2 emissions by 2005.

United Nations (UN) Environment Program and the World Meteorological Organization establish Intergovernmental Panel on Climate Change (IPCC) to analyze and report on scientific findings.

1990

First report by IPCC indicates that the planet has warmed by 0.5°C in past century.

Canada launches *National Action Strategy on Global Warming.*

1992

UN Framework Convention on Climate Change (UNFCCC) signed by Canada and 145 other nations, setting initial target to reduce GHG emissions from industrialized countries to 1990 levels by 2000.

Canada holds first Federal/Provincial/Territorial (F/P/T) Joint Ministers Meeting to provide direction on Framework Agreement.

National Climate Change Task Group formed to develop options for national action program.

1994

Alliance of Small Island States, wary of increases in sea levels, demands 20% cut in emissions by 2005.

Canada releases *First National Report on Climate Change* required under UNFCCC.

1995

Berlin Mandate signed at first full meeting of Climate Change Convention.

IPCC releases *Second Assessment Report,* stating that "the balance of evidence suggests a discernible human influence on global climate" and predicting that, under a "business as usual" scenario, global temperatures will rise between 1°C and 3.5°C by 2100.

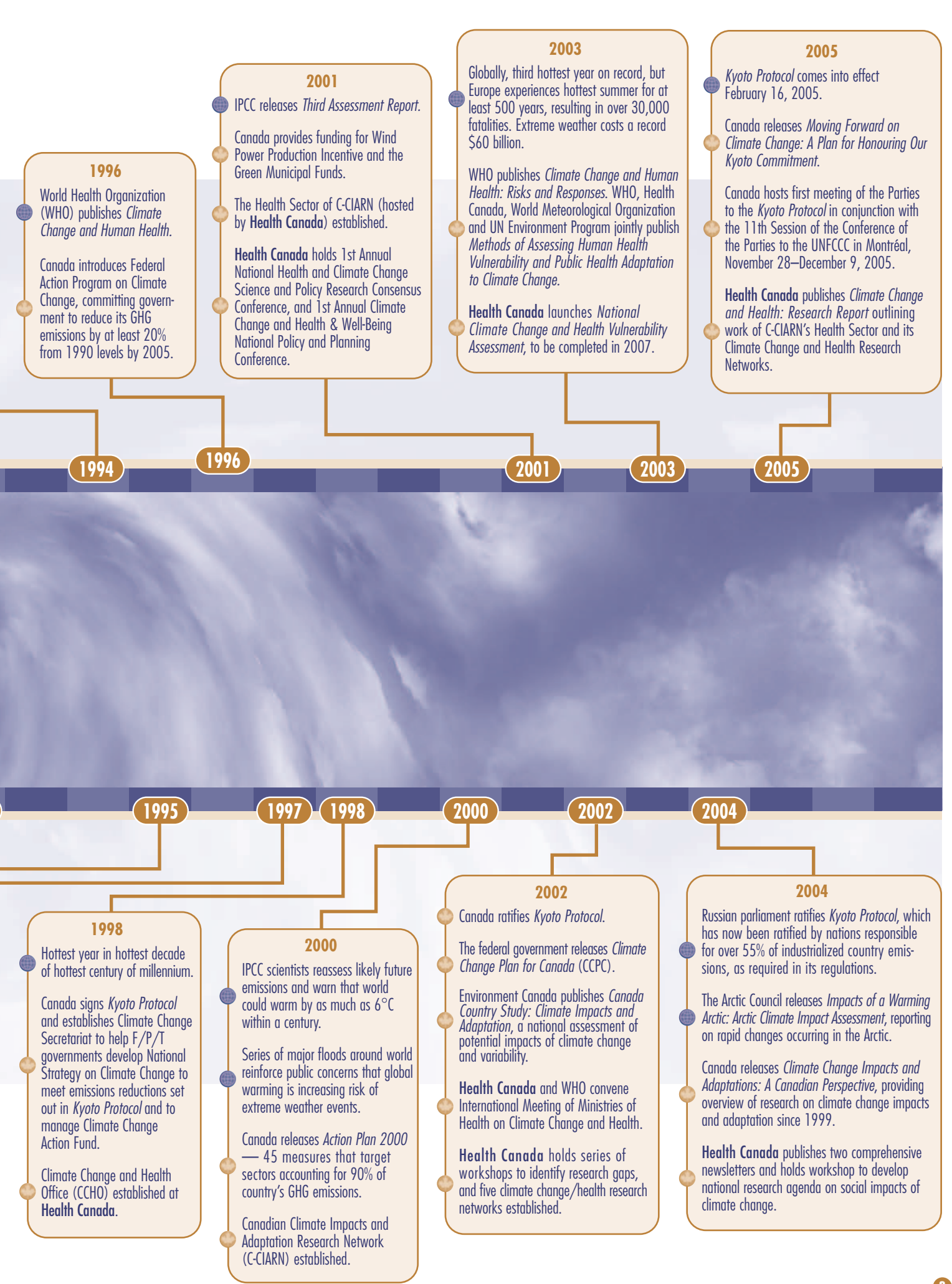
1997

Kyoto Protocol agrees to legally binding emissions cuts for industrialized nations (averaging 5%) to be met by 2012; adopts flexibility measures allowing countries to meet their targets partly by trading emissions permits, establishing carbon sinks such as forests to soak up emissions, and by investing in other countries.

Canada releases *Second National Report on Climate Change* required under UNFCCC.

Environment Canada publishes *Canada Country Study: Climate Impacts and Adaptation,* a national assessment of potential impacts of climate change and variability.

Information compiled by **Marcia Armstrong**, *Climate Change and Health Office, Health Canada*



1994

1995

1996

1996

World Health Organization (WHO) publishes *Climate Change and Human Health.*

Canada introduces Federal Action Program on Climate Change, committing government to reduce its GHG emissions by at least 20% from 1990 levels by 2005.

1997

1998

1998

Hottest year in hottest decade of hottest century of millennium.

Canada signs *Kyoto Protocol* and establishes Climate Change Secretariat to help F/P/T governments develop National Strategy on Climate Change to meet emissions reductions set out in *Kyoto Protocol* and to manage Climate Change Action Fund.

Climate Change and Health Office (CCHO) established at **Health Canada**.

2000

2000

IPCC scientists reassess likely future emissions and warn that world could warm by as much as 6°C within a century.

Series of major floods around world reinforce public concerns that global warming is increasing risk of extreme weather events.

Canada releases *Action Plan 2000* — 45 measures that target sectors accounting for 90% of country's GHG emissions.

Canadian Climate Impacts and Adaptation Research Network (C-CIARN) established.

2001

2001

IPCC releases *Third Assessment Report.*

Canada provides funding for Wind Power Production Incentive and the Green Municipal Funds.

The Health Sector of C-CIARN (hosted by **Health Canada**) established.

Health Canada holds 1st Annual National Health and Climate Change Science and Policy Research Consensus Conference, and 1st Annual Climate Change and Health & Well-Being National Policy and Planning Conference.

2002

2002

Canada ratifies *Kyoto Protocol.*

The federal government releases *Climate Change Plan for Canada* (CCPC).

Environment Canada publishes *Canada Country Study: Climate Impacts and Adaptation*, a national assessment of potential impacts of climate change and variability.

Health Canada and WHO convene International Meeting of Ministries of Health on Climate Change and Health.

Health Canada holds series of workshops to identify research gaps, and five climate change/health research networks established.

2003

2003

Globally, third hottest year on record, but Europe experiences hottest summer for at least 500 years, resulting in over 30,000 fatalities. Extreme weather costs a record $60 billion.

WHO publishes *Climate Change and Human Health: Risks and Responses.* WHO, Health Canada, World Meteorological Organization and UN Environment Program jointly publish *Methods of Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change.*

Health Canada launches *National Climate Change and Health Vulnerability Assessment*, to be completed in 2007.

2004

2004

Russian parliament ratifies *Kyoto Protocol*, which has now been ratified by nations responsible for over 55% of industrialized country emissions, as required in its regulations.

The Arctic Council releases *Impacts of a Warming Arctic: Arctic Climate Impact Assessment*, reporting on rapid changes occurring in the Arctic.

Canada releases *Climate Change Impacts and Adaptations: A Canadian Perspective*, providing overview of research on climate change impacts and adaptation since 1999.

Health Canada publishes two comprehensive newsletters and holds workshop to develop national research agenda on social impacts of climate change.

2005

2005

Kyoto Protocol comes into effect February 16, 2005.

Canada releases *Moving Forward on Climate Change: A Plan for Honouring Our Kyoto Commitment.*

Canada hosts first meeting of the Parties to the *Kyoto Protocol* in conjunction with the 11th Session of the Conference of the Parties to the UNFCCC in Montréal, November 28–December 9, 2005.

Health Canada publishes *Climate Change and Health: Research Report* outlining work of C-CIARN's Health Sector and its Climate Change and Health Research Networks.

Our mission is to help the people of Canada maintain and improve their health.

Health Canada

Some Terms Related to Climate Change and Health

Adaptive capacity: The ability of natural systems, communities, populations or individuals to adapt successfully to climate change so that the negative impacts are lessened or avoided and the potential benefits are maximized.

Climate: The average pattern of weather for a particular region.

Climate change: A sustained departure from the normal weather patterns in a particular region.

Climate change adaptation: Policies, strategies and measures that offset or reduce the effects of climate change and climate variability.

Climate change vulnerability: The degree to which a natural system, region, population, community or individual is unable to cope with the negative impacts of climate change.

Global warming: A worldwide increase in the Earth's average surface temperature.

Greenhouse effect: The warming of the Earth caused by the heat-capturing ability of certain gases in its atmosphere.

Greenhouse gas (GHG): Any of the gases, such as water vapour, carbon dioxide and methane, which absorb the Earth's radiated heat and warm the atmosphere, thereby contributing to the greenhouse effect. GHGs are released from natural sources or from human activities such as the burning of fossil fuels for electricity generation, industrial processes or transportation.

Greenhouse gas mitigation: Actions that reduce greenhouse gas emissions from human activities.

Smog: A mixture of solid and liquid fog and smoke particles formed in air under conditions of high heat and humidity.

Vector: Organisms that carry disease-causing microorganisms from one host to another.

Weather: The condition of the atmosphere at a particular time and place, as characterized by temperature, precipitation, air pressure, wind, humidity, cloudiness and other meteorological variables.

Zoonosis: A disease of animals, such as rabies, which can be transmitted to human beings.

About the Health Policy Research Bulletin

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Special thanks go to the Guest Editors for this issue, Paul Glover, Director General of the Safe Environments Programme, Healthy Environments and Consumer Safety Branch (HECSB) and Jacinthe Séguin, Manager of the Climate Change and Health Office within the Safe Environments Programme, HECSB. In addition, appreciation is extended to Marcia Armstrong and Dieter Riedel for their many contributions throughout the content development and review process.

We welcome your feedback, suggestions and requests to be added to our mailing list. Please forward your comments and any address changes to: <bulletininfo@hc-sc.gc.ca>.

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Climate Change 101

Kaila-Lea Clarke, *Climate Change and Health Office, Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada, and* **Denis Bourque**, *Meteorological Service of Canada, Environment Canada*

Climate change is the long-term shift from the usual or expected weather patterns for a particular area. Although it is not a new problem, climate change is receiving increasing attention because current changes are occurring at an alarming rate and magnitude. In this article, the authors introduce the term "climate change," explain its causes, and identify some current and future environmental impacts.

Weather, Climate and Climate Change

To understand climate change and measure its impacts, you first need to know what it is and what causes it. "Weather" and "climate" are often used interchangeably, but they are actually two distinct terms. **Weather** is defined as day-to-day atmospheric conditions, whereas **climate** is the average weather — including seasonal extremes and variations — for a specific location or a region.[1] Climate is calculated by averaging weather conditions and patterns over a long period of time — usually 30 years.[1]

Occurring over decades, **climate change** is a long-term shift from the usual or expected climate patterns for a particular area.[1] This shift is measured by changes in some or all of the features associated with average weather for an area. On a global scale, climate change means a long-term shift in the Earth's prevailing weather — for example, shifts in atmospheric and surface variables such as:

- temperature
- precipitation
- wind
- humidity
- cloud cover
- soil moisture
- sea surface temperature
- concentration and thickness of ice

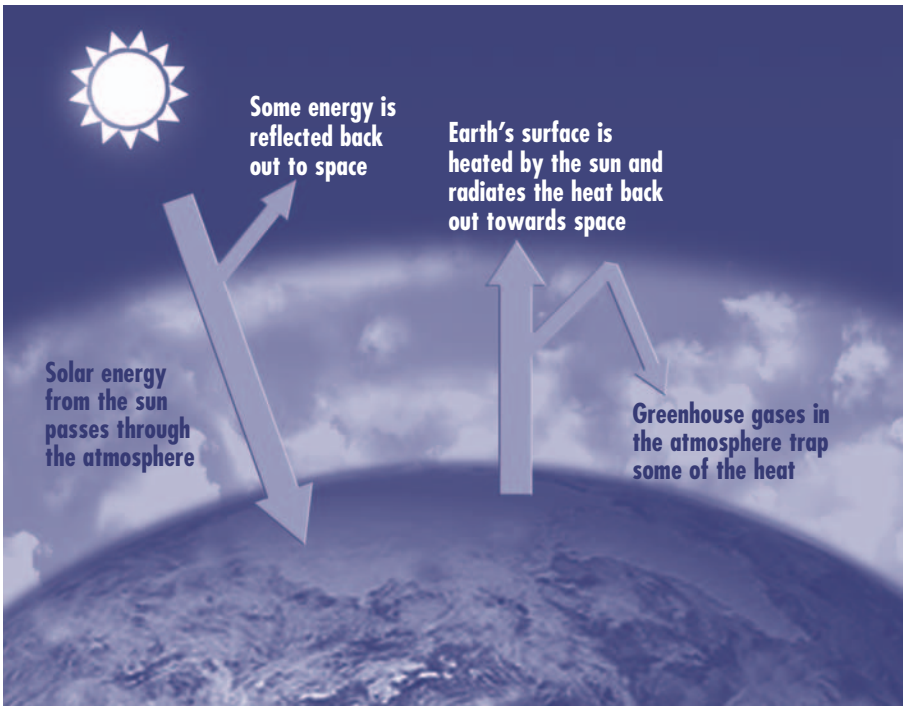
Climate change involves changes in average weather conditions, as well as changes in how much the weather varies from these averages. The latter is usually referred to as **climate variability**.[1] Climate change can result from both natural processes and human influences.

Natural processes that contribute to climate change include variations in the intensity of the sunlight and solar radiation reaching the Earth, volcanic eruptions and ocean currents.[1,2] **Human influences** include emissions of greenhouse gases and gases that deplete the stratospheric ozone layer, deforestation, local air pollution, and agricultural practices and alterations in land use.[1,2]

Climate Change and Greenhouse Gases

The Earth's climate is regulated by the amount of energy it receives from the sun and the amount that is radiated back toward space. As shown in Figure 1, the land and oceans absorb much of the energy that reaches the Earth, while the remaining energy is released back into the atmosphere in the form of heat (infrared radiation). While most of this heat escapes into space, some is absorbed by atmospheric greenhouse gases that act like an insulating blanket or the glass walls of a greenhouse — holding in the heat and helping to warm the planet.[1] The process by which the Earth's atmosphere captures and holds escaping heat is called the **greenhouse effect**. Atmospheric gases, such as carbon dioxide (CO_2), methane, nitrous oxides and water vapour, are called **greenhouse gases** (GHGs). Most GHGs occur naturally, but human activities have increased their concentrations[1-3] and introduced other GHGs, such as chlorofluorocarbons (CFCs), which also contribute to depletion of the ozone layer.

Figure 1: The Greenhouse Effect

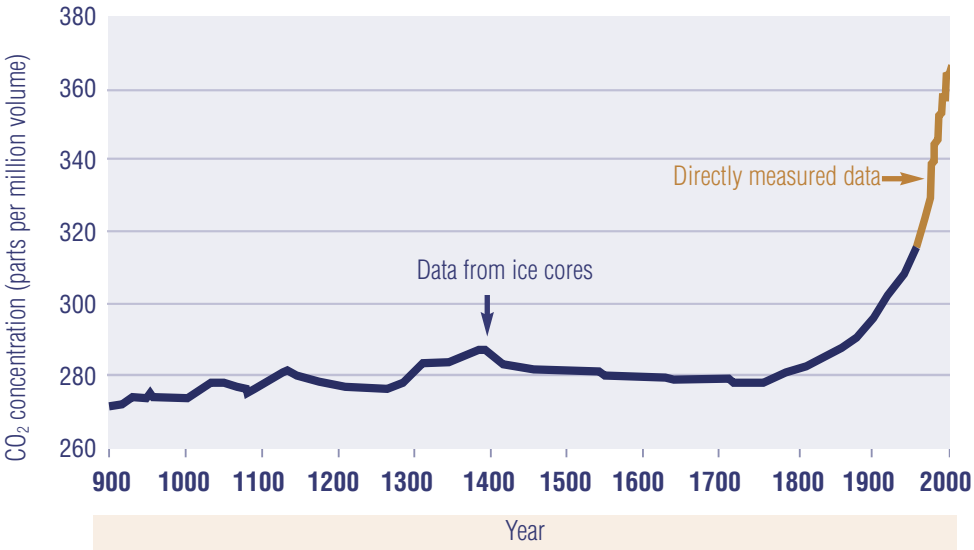


Source: Adapted with permission from Environment Canada, 2005.[4]

A Natural Phenomenon

The natural greenhouse effect is an important phenomenon. Without it, the Earth's average surface temperature would be a frigid -18°C, rather than the current temperate +15°C.[3] Although greenhouse gases have created ideal conditions for human, animal and plant life to thrive, disturbances in their natural concentrations now threaten those life-supporting conditions. Figure 2 illustrates the recent rise in CO_2.

Figure 2: Trends in Atmospheric Carbon Dioxide (CO_2) Concentration over the Past 1,000 Years



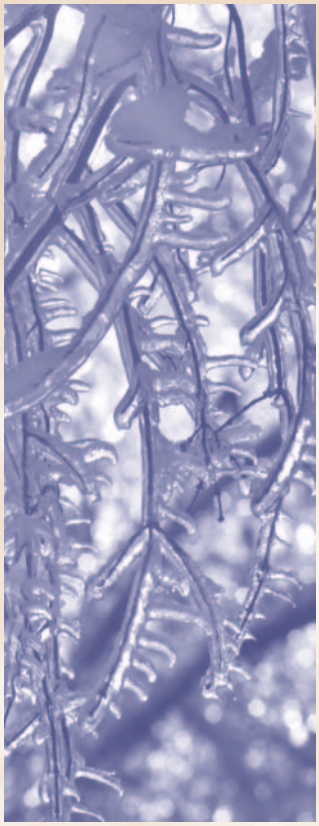
Source: Adapted with permission from Natural Resources Canada from D.S. Lemmen and F.J. Warren, 2004.[5]

Global Warming

Since the industrial revolution, humans have been burning increasingly large quantities of fossil fuels, such as coal, oil and natural gas, which increase the concentration of CO_2 in the atmosphere (CO_2 has increased approximately 30%[3]). This enhances the greenhouse effect and causes the Earth's surface temperature to rise. Other human activities, such as waste disposal and land clearing, have also contributed to the increase in GHGs.[1,2] The resulting increase in the temperature

Some Environmental Impacts of Global Warming[3]

- Changes in precipitation (some areas will get more, others less) could result in a greater incidence of flooding.
- Rising sea levels will cause increasing coastal erosion, which may damage fish spawning grounds and flood low-lying coastal areas, resulting in the loss of rich, alluvial farmlands and the displacement of populations.
- Melting glaciers and polar ice caps may further raise sea levels and possibly reduce late summer river flows in regions such as the western Prairies.



- There will be a higher incidence of forest fires and pests (tropical and boreal forests are especially vulnerable), which will likely change species composition.
- Some plant and animal species that are unable to move or adapt fast enough to the changing conditions will be lost, and others more suited to the new environments will increase.
- There will be more frequent and intense storms and tornadoes, which could result in a greater incidence of natural disasters — for example, landslides and damage from ice, waves and high winds.

of the Earth's lower atmosphere is referred to as **global warming**. This temperature increase contributes to changes in atmospheric conditions referred to as **climate change** by triggering a series of changes within the overall global climate system.[3]

Environmental Impacts of Climate Change

Knowledge about climate change is growing rapidly as organizations around the world investigate and monitor its progress and various impacts. The **Intergovernmental Panel on Climate Change** (IPCC), established by the **World Meteorological Organization** and the **United Nations Environment Program**, has drawn on the work of hundreds of scientists around the world to produce a series of publications that are now widely used by policy makers, scientists, other experts and students. In its *Third Assessment Report*, the IPCC attributed much of the increased warming over the last 50 years to GHG emissions resulting from human activities.[6] Climatologists have determined that the 20th century was likely the warmest in the past 1,000 years, that the 1980s and 1990s were likely the warmest decades since the mid-1800s, and that this general warming trend has continued through 2004.[6] The Earth's average surface temperature has increased approximately 0.6°C over the past 100 years.[5] Many mountain glaciers are also melting at alarming rates, and global sea levels have risen 10 to 25 cm in the last century.[7] Some additional environmental impacts of global warming are highlighted in the text box above.

Climate Change Projections for Regions of Canada[1-3,8]

Atlantic Canada – severe storms, increased coastal erosion, flooding of freshwater marshes.

Québec and Ontario – extreme weather events, including heat waves, flooding and droughts (causing lake and river levels to decline), and an increase in forest fires. Greater demand for electricity for air conditioning during increasingly hot summers. Air quality is likely to decrease. Frost-free seasons may permit the spread of diseases (e.g., Lyme disease, malaria, West Nile virus). Growing seasons may be extended, potentially benefiting many farmers; however, droughts, pests and crop diseases may offset any benefit.

Prairies – increased incidence of droughts and floods, resulting in both social and economic impacts.

British Columbia – forest and fish stocks may be affected, with warmer waters potentially harming aquaculture. Warmer winters may increase insect pests, while wetter springs could delay planting. There may be an increase in landslides and debris torrents in mountainous areas.

North – likely to experience the most pronounced warming, with particular problems with infrastructure, pipelines, roads and buildings associated with melting frozen ground. Seasonal forest fires may increase in some areas.

How Will Canada Be Affected?

Canada's average temperature increased approximately 1°C in the past 100 years. Since the global warming trend is strongest in the Arctic, and Canada is a northern country, Canada will likely warm more than the global average during this century — possibly by as much as 5°C to 10°C. Temperature increases will vary and certain regions — such as the North, and the southern and central areas of the Prairies — are likely to experience the most pronounced warming.[1] Canada will likely see changes in its water supplies and its ability to grow food, including potentially costly changes to agricultural methods.[3] Canadian scientists have examined the anticipated impact of climate change on human health and the environment, including water resources, industries and ecosystems.[3] Some of these impacts for specific regions of Canada are outlined in the text box.

Now and in the Future

The effects of climate change are already happening. To better understand future scenarios and impacts, scientists use elaborate computer models to predict how the Earth's climate could be influenced over time by different GHG concentrations and atmospheric conditions. These models incorporate many of the complex interactions and feedback mechanisms within the global climate system. To assess their reliability, the models are tested for their ability to simulate past climate behaviours.

A Final Note

Many nations are responding to climate change by trying to reduce the flow of man-made greenhouse gases and other pollutants into the atmosphere — for instance, by following the guidelines set out in the *Kyoto Protocol*. However, these measures cannot halt climate change; they will only slow it down and (perhaps) mitigate its severity. Since climate change processes are already under way, efforts must focus on assessing current and future health vulnerabilities, and identifying options for workable interventions and adaptations.

Click here for references.

Planning NOW

to Reduce the Health Impacts of Climate Change

The following interview with **Paul Glover**, *Director General of the Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada, was conducted by Jaylyn Wong, Assistant Editor,* Health Policy Research Bulletin.

Q *Recent public opinion polls show that 60% to 70% of Canadians are concerned about climate change and its impacts on them and their communities. Is climate change a new phenomenon?*

Climate change is not new, but Canadians are right to be concerned. Global temperatures have increased by about 0.6°C over the past 100 years and are predicted to continue rising over the coming century. While this increase may seem small, it is important to remember that relatively small changes in average global temperature can have enormous consequences. For example, 20,000 years ago, during the last ice age, average temperatures were only about 5°C colder than they are today.

Q *If climate change is not new, what do you think accounts for the increasing public attention and concern?*

I believe there are a number of reasons. First, although climate change is not new, research shows that the rate of change has accelerated in recent decades. We are living it. The Intergovernmental Panel on Climate Change has indicated that, globally, the 1990s was likely the warmest decade and 1998 the warmest year since 1861. Second, the severity of environmental consequences and the economic implications are becoming increasingly apparent. Furthermore, people around the world are beginning to experience the effects in their own lives and communities, including effects on their health and well-being.

Q *Given the scope and complexity of climate change and its implications, how are we working together to address this issue?*

First, it's critical to recognize that climate change is a global issue. Burning fossil fuels and other human activities that release greenhouse gases (GHGs) have been identified as the main cause of climate change, so strategies to address it must involve the international community as a whole. As well, it will need to involve the collaborative efforts of many sectors — for example, energy, health, transportation, agriculture, industry, tourism and forestry, and all levels of government — as we move forward with our plans to reduce harmful emissions.

At the international level, the world is responding to climate change through the *United Nations Framework Convention on Climate Change* (UNFCCC) and the *Kyoto Protocol* by working to reduce the release of man-made GHGs into the atmosphere. For its part, Canada ratified

the *Kyoto Protocol*, committing to reduce its GHG emissions to 6% below 1990 levels by 2008–2012. Canada reinforced the issue as a national priority when it was announced we would host the next international climate change conference — the 11th Session of the Conference of the Parties to the UNFCCC — and the first meeting of the Parties to the Protocol in December 2005.

On April 13, 2005, Canada released its climate change action plan, *Moving Forward on Climate Change: A Plan for Honouring Our Kyoto Commitment*, outlining a range of mitigation measures for GHGs, such as enhancing wind power production, developing other renewable energy technologies, increasing fuel efficiency for automobiles and improving the energy efficiency of homes and businesses. The new plan is only the first step our society needs to take to slow down the rate of change for future generations. It aims at mobilizing leadership efforts in key sectors of our economy to develop and implement new ways of sustaining quality of life. The plan also counts on individual consumers and homeowners to make smart, everyday choices to reduce their energy consumption.

Q ***You mentioned the need for collaboration among many sectors. How are the various federal departments working together to address the challenges posed by climate change?***

In the federal government, climate change is co-managed by the Minister of the Environment and the Minister of Natural Resources. Other key government players in this nationwide effort include Health Canada, the Public Health Agency of Canada, the Canadian International Development Agency (CIDA), Transport Canada, Indian and Northern Affairs Canada, Fisheries and Oceans Canada, and Agriculture and Agri-food Canada.

Environment Canada, through *Moving Forward on Climate Change*, is leading a national project to create a healthier environment and a stronger economy by combining the efforts of governments, Aboriginal peoples, non-governmental organizations, businesses and all Canadians to build a more sustainable future. Environment Canada's *One Tonne Challenge* is a good example of how the federal government is reaching out to Canadians on this issue by challenging them to reduce their annual GHG emissions by using less energy, conserving water and resources, and reducing waste.

Natural Resources Canada is leading efforts to reduce Canada's vulnerability to climate change through the Government of Canada's *Climate Change Impacts and Adaptation Program*, which supports cost-shared research to address gaps in knowledge and provide information to assist in decision making.

Finally, Health Canada is taking a lead role on aspects of climate change related to human health and well-being. Along with our partners, we are striving to enhance understanding about the impact of a changing climate on human health, so we can identify health risks and plan how to adapt successfully.

Q ***In recent years, Canadians have become more aware of climate extremes. What is Health Canada learning about the broader relationship between climate change and health?***

Before considering how climate change affects our health, we need to understand that climate itself has a direct link with health because it is a key element of our broader physical environment. While many factors influence health, research shows that our interactions with the physical environment have a multitude of direct and indirect impacts, through the air we breathe, the food we eat and the products we use (see article on page 16).

One of the most interesting aspects of our work focuses on the complex relationship between climate change and health, and the many pathways by which health is affected. As discussed throughout this issue of the Bulletin, Health Canada and researchers across the country have been exploring how climate change will affect our health — for example, through heat waves and cold snaps, water- and foodborne contamination, vector-borne and zoonotic diseases, ozone depletion, and the frequency and severity of extreme weather events.

Q ***Are all Canadians expected to experience the health effects of climate change?***

Yes, but the research suggests that while we are all touched by climate change, some of us are affected more than others. The impacts of climate change vary by geographical location and population group. For instance, the recent *Arctic Climate Impact Assessment* shows that Canada's northern populations are clearly being affected more directly than others, and changes in the North are so dramatic that cultures and livelihoods are at risk (see the article on page 22).

Extreme Weather Events in Alberta, a recently completed study funded by Health Canada's Health Policy Research Program, has helped us to better understand which population groups — for example, seniors, children, people with chronic illness and people with low incomes — are likely to be the most vulnerable to the impacts of climate change (see article on page 22).

***Q** While working to slow the rate of climate change, how can we plan for health impacts and reduce their effects?*

This is an important question because mitigation measures will not halt climate change; they are expected only to slow it down and reduce its severity. The degree to which climate change will disrupt our societies, dislocate our economies or erode our quality of life will depend on our willingness to plan for the changes and take the required actions to adapt.

Although there are still many uncertainties about the impacts of climate change on health, one thing *is* certain: the longer we wait, the more difficult the task and the greater the cost of adapting. The Government of Canada has adopted the "precautionary approach" as a policy principle. Simply put, it means that the absence of scientific certainty doesn't mean you don't act; it means that you take prudent action based on the evidence that is available.

Our first line of defence is already in place. These are the policies and programs that protect Canadians from various health risks associated with current weather, such as smog and heat health alerts, boil water advisories, vector-borne disease surveillance, health emergency response programs, and so on.

Planning for climate change means that communities, public health agencies and governments should take account of climate-related health effects in their public health policies and programs. Building healthy, resilient communities that can withstand the effects of climate change will be our best defence in coping with the many consequences of climate change.

***Q** Acting now to prevent or adapt to climate change seems key to protecting our health. What is Health Canada doing to advance research in this area and to transform research into action?*

Climate change touches many parts of the federal health portfolio, and requires a collaborative approach with research institutions and all levels of government across the country. The Department plays an important role in setting the research agenda, developing strategies and making sure they are reflected in government policy and programs, and informing Canadians and industry so they can react accordingly.

To help expand the knowledge base, Health Canada has established five external climate change and health research networks as part of the Canadian Climate Impacts and Adaptation Research Network (C-CIARN), which is led by Natural Resources Canada. Additionally, under its Health Policy Research Program, Health Canada has issued two calls for proposals for policy research on climate change, one in 2003 and the other in May 2005. These collaborative efforts are generating important advancements in our understanding of climate change and health issues. Once we have the information, we have a collective responsibility to translate it into policies, strategies and actions.

Measures we adopt to reduce greenhouse gas emissions will also bring changes in our society and in the environment. As we move forward to adopt new technologies and processes, such as bio-diesel fuels, carbon sequestration, clean coal technology, wind power and domestic emission trading, it is important that we fully understand them so there are no unforeseen or unintended threats to human health. The new climate change plan for Canada calls for a federal framework or mechanism to ensure that the health impacts of new technologies or other mitigation measures are adequately assessed before they are widely deployed or commercialized.

There are still many uncertainties, however, which is why the Climate Change and Health Office in Health Canada's Safe Environments Programme is leading the *Canadian Climate Change and Health Vulnerability Assessment 2007*. This project will encourage experts across Canada to contribute to a better understanding of just how vulnerable communities and individuals are to climate change, to gauge the capacity of Canadians and their institutions — particularly the health sector — to adapt to the risks associated with increased climate change, and to report on our efforts internationally as part of Canada's commitment to this issue.

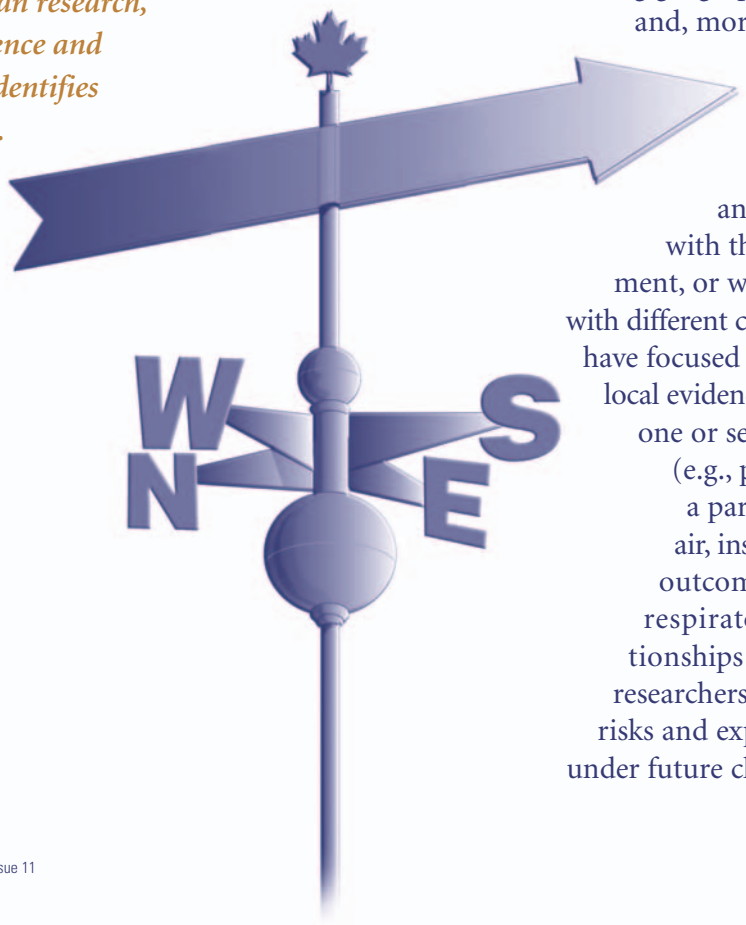
Canada's Evidence Base: *Where Are We Now, Where Are We Going?*

Jacinthe Séguin, *Climate Change and Health Office, Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada*

In Canada, as elsewhere in the world, research on the impacts of climate change is a relatively new field. However, a patchwork of evidence is emerging, both here and internationally, on how climate change can affect human health, and it is providing the basis for initiatives designed to protect vulnerable populations. This article provides an overview of Canadian research, including current evidence and future directions, and identifies some of the major gaps. It also explores the challenges for policy makers as they move from research to action in this area.

Health and Climate Change: An Emerging Domain

Since many factors interact to determine health, one of the challenges for health researchers is to consider all of these factors and evaluate the relative importance of environmental risks in influencing disease or causing death. In the case of complex environmental issues like climate change, no one discipline can find all the answers. In Canada, climate change has traditionally been the domain of the physical sciences. But the policy momentum of the 1990s, combined with targeted funding, has drawn researchers from many disciplines including geography, economics, health sciences and, more recently, the social sciences and humanities.



Limitations in data, methods and funding have not permitted a full analysis of how climate interacts with the physical and social environment, or what health risks are associated with different climate scenarios. Instead, studies have focused on establishing regional or local evidence of the relationship among one or several aspects of climate (e.g., precipitation, temperature), a particular pathway (e.g., water, air, insects), and one or more health outcomes (e.g., enteric diseases, respiratory illnesses). As these relationships become better understood, researchers are beginning to explore how risks and exposures are likely to change under future climatic scenarios.

What is the Evidence Telling Us?

Canadian and international research shows that climate change will increase the incidence of some diseases, affect the well-being and security of individuals, and influence the type and delivery of health services.[1-3]

There is undeniable evidence that environmental changes in the Arctic have already caused — and will continue to cause — significant disruptions in the northern way of life, particularly among Canada's indigenous groups.[4] Nowhere in Canada is the evidence of climate change and the immediate biophysical impacts, including health, more compelling for action. Scientific evidence, corroborated by traditional (indigenous) knowledge and local observations, suggests a wide range of health impacts as a result of exposure to increased levels of ultraviolet radiation, loss of traditional foods, unsafe ice and winter road conditions, contamination of drinking water and culture changes (see also article on page 22).

The effect of heat and cold stress on morbidity and mortality is one of the better understood environment-health interactions (see article on page 16). A solid body of international work documents the physiological responses to temperature. As well, there are some epidemiological studies of heat episodes, and work has progressed on the development and application of methods for calculating heat stress indicators and heat health warning systems.[5] In Canada, recent work on developing baseline data from hospital administrative records[6] has been instrumental in identifying and quantifying the health effects of temperature-related stress — including who may be vulnerable and under what conditions. The strength of the international evidence, coupled with recent incidences of heat waves in some cities, has convinced public health officials in Toronto and Montréal to implement measures for populations at risk.[7,8] Ongoing Canadian studies and future work — in particular, on the combined effects of heat and air pollution — will help public health officials refine these approaches, identify thresholds, better understand adaptive behaviours and determine long-term adaptation strategies.

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As the article on page 27 illustrates, researchers in Canada are also breaking ground on Canadian concerns, such as the relationship between climatic conditions (e.g., temperature, moisture conditions) and the incidence of gastrointestinal illnesses,[9] as well as the distribution and ecology of vectors such as those carrying Lyme disease.[10] The long-term effects of natural disasters have received less attention as the ability to gather data is limited by their infrequent occurrence. The fact that they often occur in very different social settings further limits the comparability of results. However, some interesting studies have been conducted, such as one of the 1998 ice storm in Québec and Eastern Ontario that explored the effect of women's exposure to stress during pregnancy on the general intellectual development of children born shortly after the storm.[11]

While Canadian research is largely focused on defining climate-related hazards based on the climatic status quo,[2] some studies incorporate future climate modelling and scenario-based hypotheses in their research methodologies (e.g., the work by Garneau on trends in airborne allergens, Waltner-Toews on the relationship between the incidence of gastrointestinal illnesses and precipitation, and Charron on modelling the relationship of foodborne illnesses and temperature).[9,12,13]

Research Gaps and Future Directions

Gaps in knowledge about the potential health impacts of climate change are almost as well defined as the evidence. Over the past five years, researchers have identified knowledge needs that cut across key health issues.[14] Several of these gaps are worth highlighting:

Participatory Research

Climate change will affect all of Canada, but its impact will vary across regions and populations (see article on page 5). This presents a tremendous challenge in determining what areas will require attention at a

national or even a provincial level, and calls for locally-based and participatory research that can mobilize interest, raise awareness and, ultimately, bring about change. Methods are needed to systematize and incorporate local and traditional knowledge into research approaches. Because change often comes about only when people are faced with the inevitable or after an event has occurred, participatory research can act as an early warning system and trigger change in policies and practices at all levels.

Short- and Long-Term Impacts

Just as responses to climate change must account for varying impacts at different geopolitical levels, they must also recognize short- and long-term impacts. Factors producing the most noticeable changes in near-term disease rates may not be the same as those causing long-term changes. Long-term impacts are more difficult to discern, measure and attribute to a particular cause. In particular, long-term psychosocial effects from natural disasters[11,15,16] can have a pervasive impact on communities or specific population groups. For this reason, there is a need to broaden the base of disciplines studying the long-term social impacts of climate change.

Methods, Modelling and Integrated Assessments

Assessments of climate change impacts are based on assumptions about the state of a future world. This type of research involves a certain level of uncertainty, whether about the status quo or predictions based on trends or scenario analyses.[1] Because different studies pose different questions about the same potential risk, it can be hard to compare studies. This presents particular problems for decision makers, who want to base their choices on a clear picture. At the same time, studies with varying perspectives are often necessary to support decision making in different sectors. The World Health Organization recognizes two valuable approaches to climate change research that can lead to different conclusions based on the same evidence: one involves traditional hypothesis testing; the other is a "what if" analysis that can be useful for risk management decisions and contributes to the "weight-of-evidence" argument.[1] To further develop the Canadian evidence base, there is a need to build experience on both these fronts, as well as to adapt existing methods.

Coping Ability and Adaptive Capacity

Variation in adaptive capacity needs to be better understood as it has a considerable effect on health outcomes, even when exposure to risk is the same. As discussed in the article on page 22, adaptive capacity is influenced by a range of other determinants of health (e.g., income and social status, education, gender, biology, genetics and culture). To be effective, adaptations need to take into account behavioural responses to stress, social context and economic factors.[17]

Myth?

The warming trend experienced in Canada's Arctic would have only positive impacts for northern residents.

False

The impacts of climate change can be seen as negative or positive, depending on one's interests. Reduced sea ice in the Arctic as a result of climate change will likely be devastating for polar bears and ice-dependent seals, with repercussions on local people who depend upon these animals as a food source. At the same time, reduced sea ice provides expanded opportunities for shipping, and offshore oil exploration and extraction. But environmental damages from these activities could harm the marine habitat and negatively affect the health and traditional lifestyles of northern people.[1] Some of the **positive** health impacts of climate change may include a reduction in cold-induced injuries and cold stress. Among the **direct negative** impacts on health are increased heat stress and accidents associated with unusual ice and weather conditions. **Indirect negative** impacts include changes in the availability of traditional foods, increased stress related to changes in environment and lifestyle, outbreaks of mosquito-borne disease, decreased access to good quality drinking water and illnesses resulting from poor sanitation systems.

Myths *appearing throughout this issue contributed by Marcia Armstrong, Climate Change and Health Office, Health Canada*

Increased understanding about the behavioural aspects of adaptation, such as the influence of risk perception, is needed to develop better measures for reducing and mitigating risks.

Social Impacts and Transdisciplinary Approaches

Climate change can place additional strain on other key determinants of health, such as employment rates, the provision of social and health care services, and support networks. Current research on these determinants of health may need to consider the predicted impacts of climate change. One way to stimulate a more comprehensive assessment of climate change risks is to encourage transdisciplinary approaches that incorporate a range of disciplinary strengths and methods into formulating and testing hypotheses. This type of research usually consists of multidisciplinary teams developing and applying best methods and approaches to answer complex research questions.

Technologies and Climate Change Mitigation Measures

Little work has been done in Canada on the possible health costs and benefits of technologies and measures to reduce Canada's greenhouse gas emissions (e.g., new fuels, engine technologies, energy efficient building technologies, carbon sequestration techniques). However, research in the United States[1,18] indicates that some technologies may pose risks to human health. More work is needed to determine if these risks outweigh the benefits of reducing greenhouse gases, and whether they can be reduced to an acceptable level. Although this field of research is very uncertain, predictive modelling of potential future exposures and risks is needed to guide current investments and strategies designed to stem the rate of global climatic change.

When and how individuals, communities and governments need to change current practices or put new measures in place depends, in large part, on the perceived vulnerability of populations, including their adaptive capacity. If systems are currently in place to mitigate these risks, the perception may be that further action is not required. However, it is only once they are put to the test that we can truly know whether particular populations have an acceptable degree of resiliency and if adjustments are necessary.

From Impacts to Adaptation: Designing Effective Policies

Policy makers are poised to consider evidence that will support action to reduce the risks of climate change (see also article on page 35). Yet we are only beginning to understand how the relationship between climate change and our uniquely Canadian natural and social environments can affect health outcomes. Many unresolved questions remain about how particular health outcomes are affected by weather, climate variability and climate-induced environmental conditions. When and how individuals, communities and governments need to change current practices or put new measures in place depends, in large part, on the perceived vulnerability of populations, including their adaptive capacity. If systems are currently in place to mitigate these risks, the perception may be that further action is not required. However, it is only once they are put to the test that we can truly know whether particular populations have an acceptable degree of resiliency and if adjustments are necessary.

That being said, enough information is currently available for researchers to begin examining the vulnerability of key populations and developing suitable adaptation options. Early efforts can focus on developing policies and other measures that address vulnerabilities to current climate conditions, and offer flexibility for future scenarios. The challenge for public health decision makers will be to balance efforts to alleviate today's stresses with the need to prepare for the unexpected.

Click here for references.

Health in a Changing Climate

Kaila-Lea Clarke, *Climate Change and Health Office, Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada*

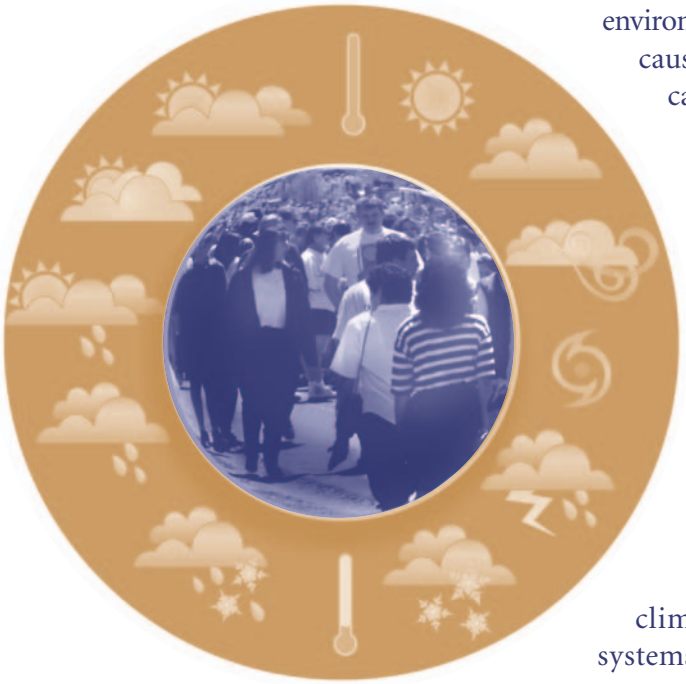
Given its widespread environmental consequences, it is not surprising that climate change also affects human health and well-being. More surprising, however, is the range of health impacts being experienced and expected, as well as the number of different pathways by which our health is affected. This article identifies the key pathways through which climate change and health interact, and presents some evidence about the scope and magnitude of the health impacts.

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

Health Concerns	Examples of Health Vulnerabilities
Temperature-related morbidity and mortality	• Cold- and heat-related illness • Respiratory and cardiovascular illness • Increased occupational health risks
Health effects of extreme weather events	• Damaged public health infrastructure • Injury and illness • Social and mental stress due to disaster • Occupational health hazards • Population displacement
Air pollution-related health effects	• Changed exposure to outdoor and indoor air pollutants and allergens • Asthma and other respiratory disease • Heart attacks, strokes and other cardiovascular disease • Cancer
Health effects of water- and foodborne contamination	• Diarrhea and intoxication caused by chemical and biological contaminants
Vector-borne and zoonotic disease	• Changed patterns of disease caused by bacteria, viruses and other pathogens carried by mosquitoes, ticks and other vectors
Health effects of exposure to ultraviolet rays	• Skin damage and skin cancer • Cataracts • Disturbed immune function
Population vulnerabilities in rural and urban communities	• 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
Socioeconomic impacts on community health and well-being	• Loss of income and productivity • Social disruption • Diminished quality of life • Increased costs to health care • Health effects of mitigation technologies

Source: Adapted with permission from Health Canada, Climate Change and Health Office, 2005.[5]

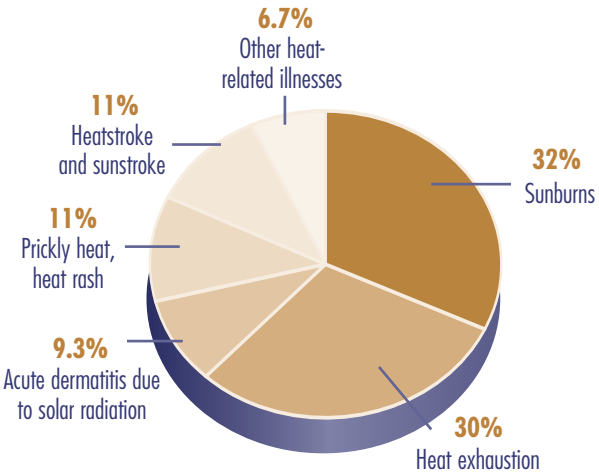
Temperature Extremes

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]

Figure 1: **Heat-Related Illnesses Treated in Emergency Rooms in Ottawa, 1996-1999**



Source: Thompson et al., 2001.[9]

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.

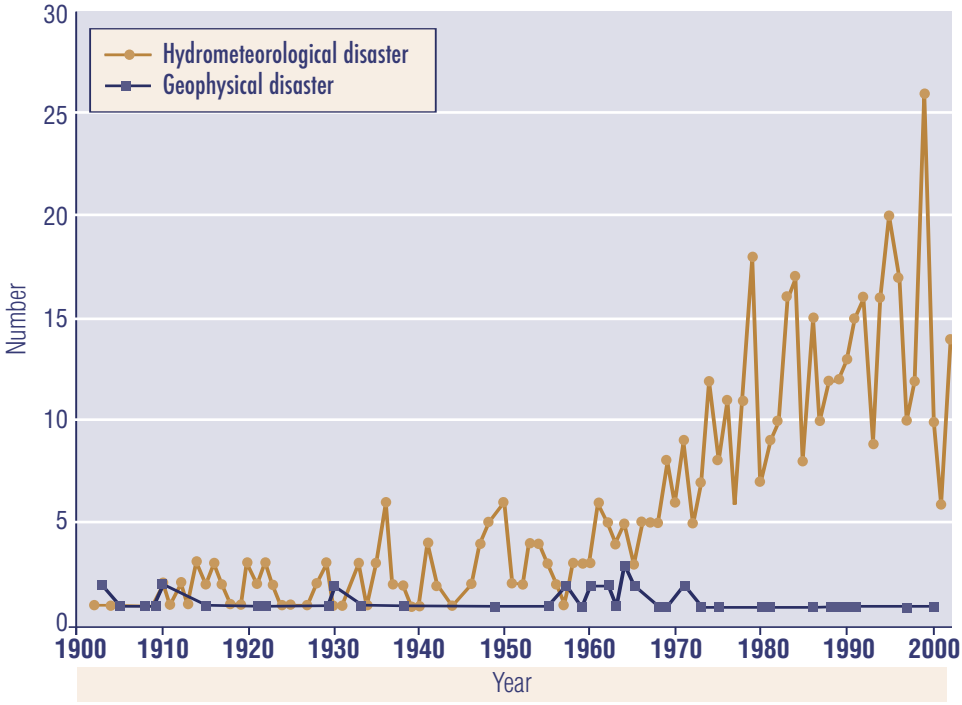
According to the IPCC, the 1990s were marked by an unusually high number of weather-related disasters. Figure 2 shows the number of weather-related and other natural disasters recorded in Canada between 1900 and 2002. It is estimated that the number of extreme weather-related events increased from two 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.[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.[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.[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.[17] Unfortunately, more frequent drought disasters are expected in Canada,[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.[16]

Figure 2: **Number of Natural Disasters in Canada, 1900–2002**



Note: Only hydrometeorological disasters are weather-related.
Source: D. Etkin et al., 2004.[18]

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.[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.[10,19]

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

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).[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).[4]
- A hotter climate will lead to drier soils which, when combined with wind gusts, can increase the amount of dust in the air.[17]
- A warmer, wetter climate will be favourable to moulds and other airborne allergens.[20]
- Milder winters will mean less snow cover to suppress outdoor moulds.[21,22]
- Hot, humid weather may encourage people to stay indoors, where levels of certain pollutants (e.g., toxic moulds) can actually be higher.[23]
- Hot, dry weather could result in more forest fires, increasing air pollution in some areas.[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]

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.

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.

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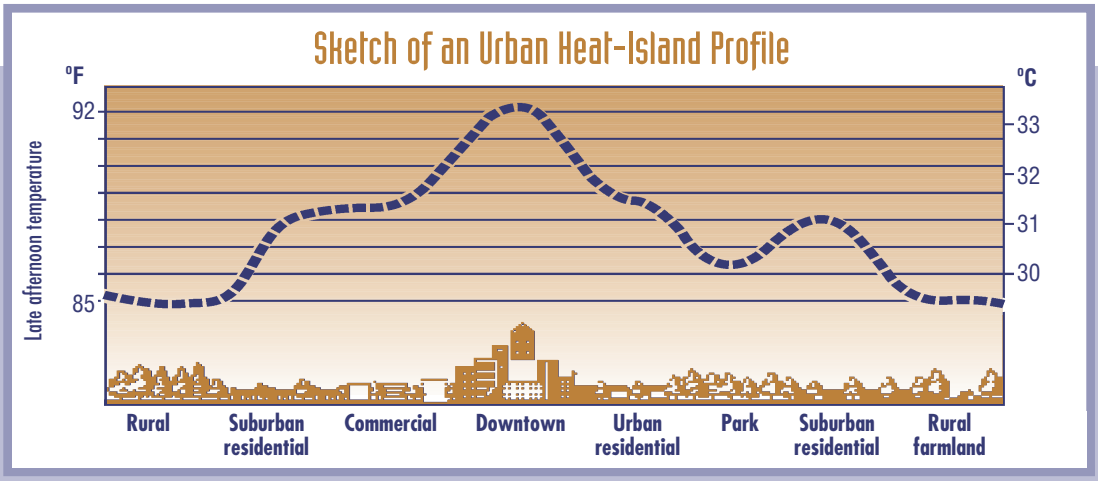


Source: D.S. Lemmen and F.J. Warren, 2004.[4]

Vulnerability: Who's Most at Risk?

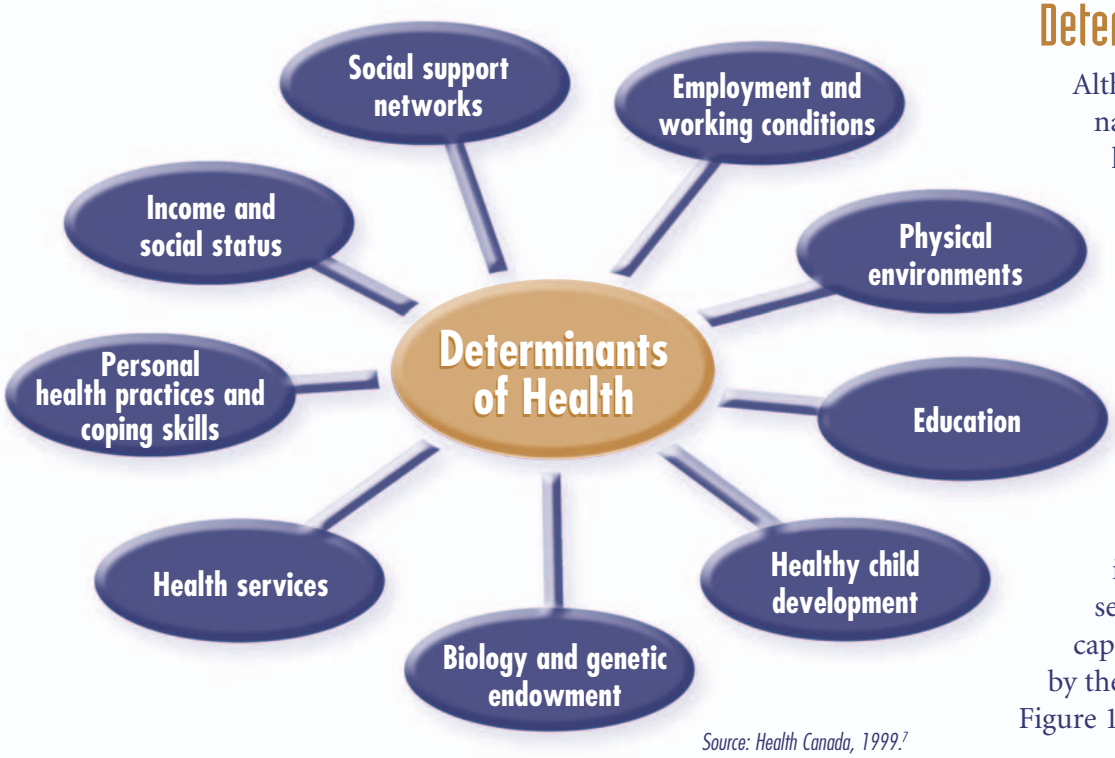
Anita Walker, *Indian and Northern Affairs Canada, formerly of Climate Change and Health Office, Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada*

Research shows that certain populations are more vulnerable than others to the health risks posed by climate change. This article explains the concepts of vulnerability and adaptive capacity, and explores how they are influenced by the determinants of health. It also identifies groups most at risk, and discusses our collective responsibility for protecting these populations from the impacts of climate change.

Differential Risks

The previous article identified the potential impacts of climate change on human health, as well as the projected magnitude of these risks in Canada and abroad. However, research shows that certain populations face a greater than average risk due to **increased exposures**, **existing sensitivities** or **low adaptive capacity**. For example, geographic location may increase exposure to extreme weather events or high temperatures. Some individuals may be more sensitive due to pre-existing health conditions or deficits in other "health determining" areas of their lives. As well, communities may have a limited capacity to cope with and adapt to climate-related events, due to poor infrastructure, limited knowledge about the risks, lack of human and social capital, or economic disparities.[1] Clearly, the populations most at risk are those coping with all three factors.

Figure 1: Determinants of Health



Source: Health Canada, 1999.[7]

Vulnerability and the Determinants of Health

Although the unpredictable nature of extreme weather and high temperature events can increase "feelings" of vulnerability, vulnerability is actually a function of exposure, sensitivity and adaptive capacity.[2-4] So, regardless of how vulnerable people feel, their vulnerability depends upon the degree to which these three variables are in play. These variables — increased exposure, existing sensitivities and low adaptive capacity — in turn, are influenced by the determinants of health (see Figure 1).[5,6]

Exposure

Although the degree of exposure to climatic variables depends on geographic location, it is also influenced by a range of occupational and behavioural factors. Socio-economic factors can play an important role as well — for example, a family with low relative income may have no other option but to live in substandard housing, thus increasing their exposure to hazards (e.g., the risk of injury during an extreme weather event).

Sensitivity

Sensitivity is the degree to which an individual is affected, either adversely or beneficially, by climate-related stimuli. It depends on many variables, such as the magnitude of the risk and the individual's pre-existing health status. A function of the interaction among all the determinants of health, health status is also a key factor in determining a person's susceptibility to the impacts of climatic events. For example, when an individual's health is compromised due to a pre-existing health condition (e.g., respiratory illness), he/she will be more sensitive to the health risks of air pollution. Sensitivity also depends on the magnitude of the threat posed by the environmental change. Some individuals may not be sensitive to mild changes in the environment, but are very sensitive to severe and repetitive climatic events. For instance, a child who is being treated appropriately for asthma may not be sensitive to one smog day, but may be exceptionally sensitive to a two-week long smog event compounded by higher than average temperatures.

The health risks of climate change are determined by the individual and society's collective ability to adapt, now and in the future. Adaptive capacity is influenced by many interrelated societal factors, such as economic resources, technology, information and skills, infrastructure, institutions, existing inequities in health status and pre-existing disease burdens.

Adaptive Capacity

Although sensitivities and exposure levels may both be high, the capacity to adapt to the impacts of climate change can reduce or eliminate vulnerability.[2] For instance, people who have an existing respiratory illness and are exposed to extreme heat will be more able to adapt to the negative impacts of heat and less vulnerable if they have direct access to health services and have been provided with treatment information.

The health risks of climate change are determined by the individual and society's collective ability to adapt, now and in the future.[8] Adaptive capacity is influenced by many interrelated societal factors, such as economic resources, technology, information and skills, infrastructure, institutions, existing inequities in health status and pre-existing disease burdens.[1] Countries will have greater adaptive capacity when they have higher levels of GDP or financial capital; substantial per capita investments in health care; access to technologies such as vaccines or water treatment facilities; high levels of human capital or knowledge (e.g., health research); well-developed public health infrastructures; well-established social institutions; equitable access to health care and social supports; and overall population well-being.[9,10]

The complex relationship between factors that influence the coping ability of societies and individuals makes it difficult to measure existing adaptive capacity. While Canada is generally considered able to cope with most climatic events, weaknesses in adaptive capacity are often not discovered until after an event or disaster has taken place. With a better understanding of which factors require further investment, adaptive capacity can be strengthened over time, thereby reducing vulnerabilities.[11]

Global Vulnerability

Globally, the most influential determinant of vulnerability is the level of development in the affected country or region. For example, over a billion people worldwide lack access to adequate supplies of safe water, sanitation, energy and nutrition.[12,13] High poverty levels contribute to environmental degradation because current needs take precedence over long-term stewardship of resources, and environmental degradation increases poverty as resource yields decline.[14] Many of

the same regions that commonly experience excessive environmental degradation, poverty and health problems also have low adaptive capacity because of political and economic instability, non-existent or deteriorating public health infrastructures and barriers to necessary resources.

It is expected that existing health and environmental problems will be exacerbated by climate change, and people living in regions without sufficient capacity to adapt will be exceptionally vulnerable to illnesses and death.[1] For example, two thirds of Africa is already affected by aridity and drought, and desertification is expanding. Climate change in Africa is expected to further decrease annual precipitation in some regions, aggravating food shortages and access to clean water, thus increasing rates of illness and death. At the same time, precipitation and floods are increasing in frequency and magnitude in some parts of northern India and Bangladesh, causing loss of life, economic decline, and widespread food and water quality problems. Small island developing states, particularly those in the Pacific Islands, are experiencing rising sea levels threatening food and water sources, housing and other key infrastructure. Some parts of these islands are already submerged, and if sea levels rise an additional one metre, the Marshall Islands and Tuvalu will likely disappear altogether.[15]

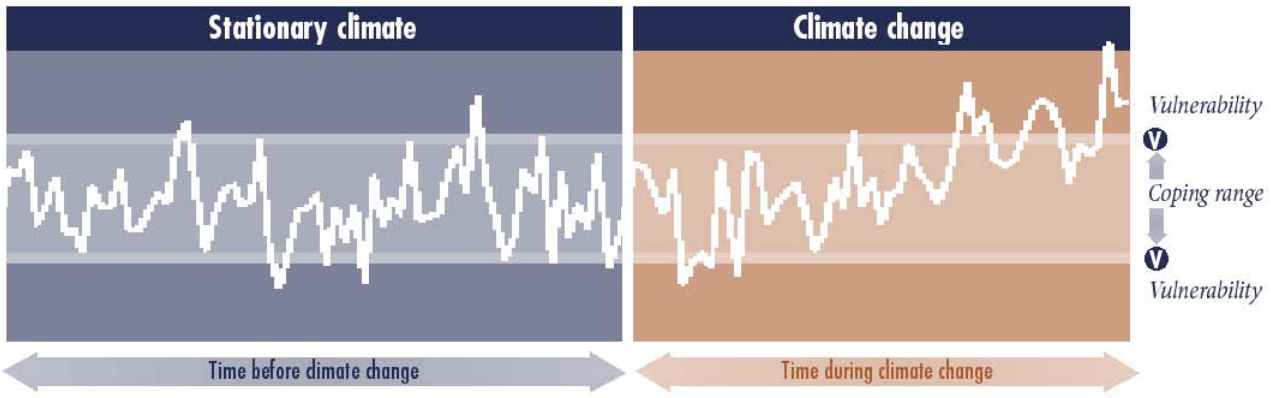
Although Canada has considerable capacity to adapt to the health impacts of climate change, some risks (e.g., extreme weather events, infectious diseases, air pollution) pose unique challenges because they may exceed our threshold to respond. In addition, certain subpopulations are more vulnerable to all climate-related impacts because of age, health status, gender or employment.

Through the Canadian International Development Agency (CIDA), Canada contributes to economic and social development in many of these regions. Countries around the world have learned to cope with most existing climate variability. However, as the climate becomes more extreme, climate-related events will increasingly occur outside the normal range of variability, creating new vulnerabilities as countries are not able to cope with such extremes. As Figure 2 shows, climate change impacts in some countries are expected to exceed the current coping threshold, resulting in even more deaths. Development and adaptation activities in developing regions will require approaches designed to anticipate future impacts of climate change in order to reduce vulnerability and improve the adaptation response. As Canada enjoys good overall health and access to financial and technological resources, it is well placed to help countries around the world take measures to protect their populations from the impacts of climate change.

Vulnerable Populations in Canada

Although Canada has considerable capacity to adapt to the health impacts of climate change, some risks (e.g., extreme weather events, infectious diseases, air pollution) pose unique challenges because they may exceed our threshold to respond. In addition, certain

Figure 2: Impact of Climate Change on Vulnerability



Source: Adapted with permission from Elsevier from G. Yohe and R.S.J. Tol, 2002.[10]

subpopulations are more vulnerable to all climate-related impacts because of age, health status, gender or employment. Our present public services and personal means may not be adequate to protect these populations against illness or death. Additional investments in institutional structures, public education, as well as new adaptive measures and strategies, may be needed to ensure healthy outcomes.

Infants and Children

Infants and children are especially vulnerable to climate change, as they are to environmental degradation, because of their inability to protect themselves, relatively high intake of water, air and certain foods, rapid growth and development, immature physiology and metabolism, and potential for high cumulative exposures over their lifetime.[16] For example, some researchers hypothesize that the significant increase in asthma rates since the early 1960s, particularly in young children, is due to climate change and resulting increases in pollen quantity and season length.[17]

Women

Recent research indicates that pregnant women and their developing fetuses may be at special risk during extreme weather events. A 2004 study of the 1998 ice storm in Ontario, Québec and New Brunswick concluded that anxiety and stress as a result of the extreme weather can give rise to obstetric and developmental complications.[18] Research has also shown that women may be more vulnerable to psychosocial health impacts during extreme weather events because they are more likely to bear the burden of recovering from the extreme event, and of continuing to meet multiple demands within and outside the household.[19,20]

Older Seniors

Older seniors are especially vulnerable because of their diminished ability to acclimatize to changing temperatures, pre-existing health conditions and social isolation. A study conducted by Toronto Public Health found that when air pollution combines with extreme heat, this group is the most vulnerable to premature mortality.[21] Research suggests that older men may be particularly vulnerable to climatic extremes because they tend not to be as well integrated into a defined social structure and therefore have less access to assistance through family members or community volunteer organizations.[22,23]

Gender in Climate Change

In many developing countries, women are especially vulnerable to the health impacts of climate change because they are more likely to be poor and dependent on natural resources, and have less access to property rights and information. For example, following the 1991 cyclone and flood in Bangladesh, the death rate was almost five times as high for women as for men. This was attributed to social roles that resulted in warning information being transmitted among men only, and prevented women from moving to safety if not accompanied by a male relative. In contrast, when Hurricane Mitch struck Central America in 1998, more men than women died because of gender norms encouraging men to engage in risky behaviour during the disaster.[24]

Other Populations at Increased Risk

People with low income and those with pre-existing health conditions, including mental health illnesses, are vulnerable because of their health status, and in some cases existing barriers to health care. Outdoor workers will be more vulnerable as they are directly exposed to extreme heat events and increased levels of ultraviolet (UV) radiation. Those who live on the land and whose livelihood is tied to natural resource-based employment will also be at greater risk.[25]

Geographic Variation

Regions across Canada will experience climate change differently. While urban populations may experience warmer temperatures and more smog episodes, rural populations may have greater problems with water quality and quantity as a result of flooding and drought. In regions that are closely tied to natural resources (e.g., farming, forestry, fishing), climate change may cause economic decline, social disruption and population displacement. Coastal areas will be hard hit by a rise in sea level, which may increase the degree of damage from natural disasters.[25]

Evidence in the North

Even now, Northerners are experiencing fundamental changes to their way of life and well-being because of a warming climate.[26] That said, it is difficult to entirely separate climate change impacts from other drivers of change in the North, such as the presence of environmental contaminants, resource development and loss of culture. The *Arctic Climate Impact Assessment* (ACIA) summarizes research that has been conducted around the world on northern climate change issues and concludes that, although there may be fewer injuries and less stress as a result of warmer winters, the risks of changing sea and ice patterns on food sources, water quality, mental and social stress, and disease outbreaks far outweigh the benefits.[27]

Recent studies of traditional knowledge demonstrate that Northerners are already observing these impacts in their communities. Hunters, elders and youth have documented changes in travel patterns, the ability to find and hunt certain country food species, and access to clean, natural sources of drinking water.[27-29] As the evidence suggests, shifts to more western diets are increasing the risks of cancer, obesity, diabetes and cardiovascular diseases among Northerners.

As well, changes in animal species may introduce infectious diseases previously unknown in the area.[27] Socioeconomic disruption occurs when there are reduced opportunities for employment and subsistence living, and communities are dislocated and disrupted because of erosion, permafrost thawing and impacts on infrastructure. People often experience mental health problems and increased stress when they face new risks such as heat stress and loss of species, and feel marginalized when their livelihoods are disrupted and their communities forced to relocate.[26] Northern communities are making great efforts to adapt to these changes, for example, by introducing community freezer programs to ensure food safety, and changing hunting routes to protect against injury. However, they will continue to require support from the rest of Canada to successfully manage these impacts and make the transition to a northern environment that will be vastly different in the centuries to come.[29]

One of the keys to managing the risks that all Canadians face from climate change is a better understanding of existing vulnerabilities so that adaptive capacity can be enhanced in communities and population groups most at risk. Although research has identified some important factors influencing capacity, the interrelationships among these factors is less well understood.

Meeting Future Needs

One of the keys to managing the risks that all Canadians face from climate change is a better understanding of existing vulnerabilities so that adaptive capacity can be enhanced in communities and population groups most at risk. Although research has identified some important factors influencing capacity, the interrelationships among these factors is less well understood. Canadians are fortunate they have well-established support systems to protect them against climate risks. But we should not take for granted that these infrastructures are fail-safe, or that Canadians will not be affected by the vulnerabilities of other countries or regions. Some populations, even in Canada, will be unable to cope with the effects of climate change. We need to develop adequate responses that increase our adaptive capacity even further and minimize the negative impact of climate change on health. At a global level, Canada needs to help protect the health of all populations and contribute to global efforts to manage the future impacts of climate change.

Click here for references.

Signs of Change, Signs of Trouble: Finding the Evidence

Dominique Charron, *D.V.M, Ph.D., and* **Paul Sockett**, *Centre for Infectious Disease Prevention and Control, Public Health Agency of Canada*

Given the diverse pathways by which climate change affects health, many sources of evidence are required to assess the potential or actual impacts of climate change on health. While public health professionals monitor Canadian population health trends through disease surveillance activities, researchers measure the links between health outcomes and changes in weather or climate, and model how climate change may alter patterns of health and disease. Surveillance is also helping public health authorities anticipate the climate-related spread of vector-borne diseases like Lyme disease by tracking geographic shifts in the distribution of ticks carrying the disease.

Surveillance Data: Covering All the Bases

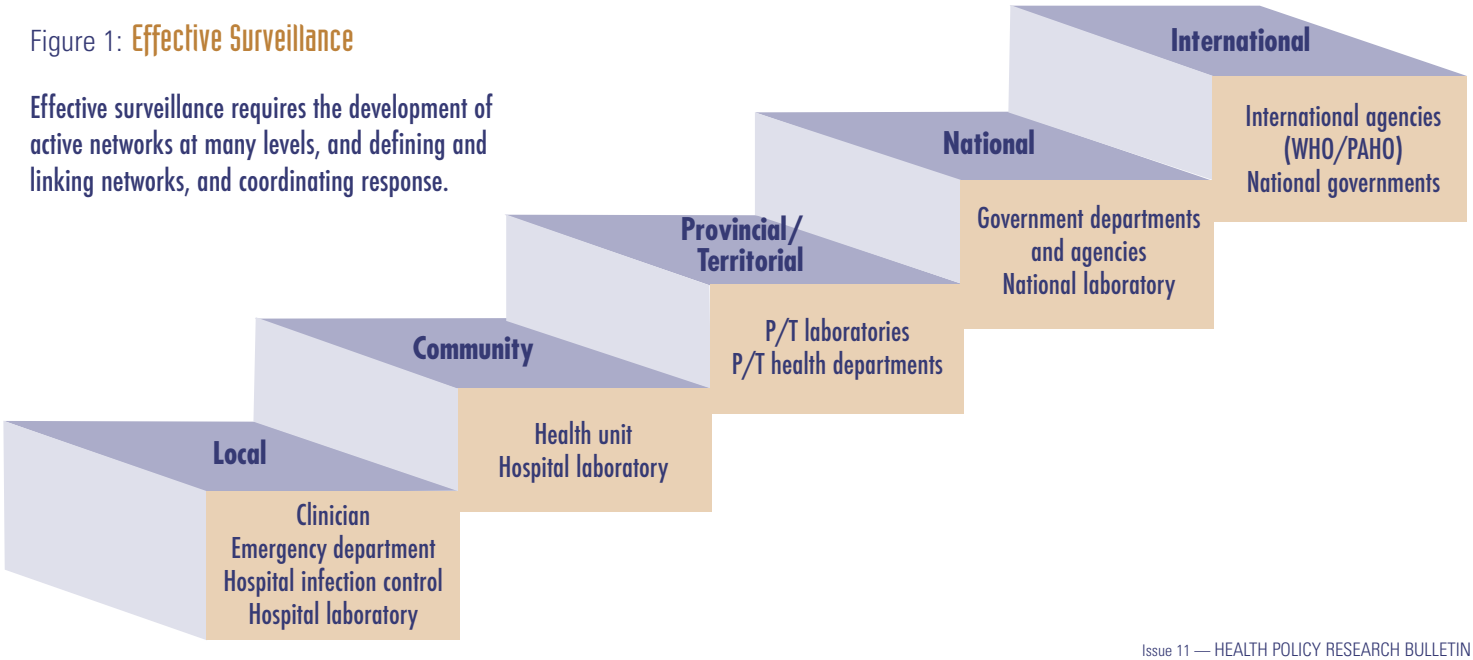
To detect and effectively assess the health impacts of climate change and climate variability, it is important to recognize the various ways by which climate can affect health (e.g., direct stress from temperature extremes, impacts of poor air quality episodes, more favourable conditions for waterborne and vector-borne diseases). Timely, accurate and reliable health surveillance data are key to detecting changes in disease patterns over time and between different populations, including changes that may result from the combined ecological and societal impacts of climate change. A key public health challenge is to understand the causes of these disease patterns and then to implement programs that reduce the burden of illness.

Comprehensive Disease Tracking Systems

Effective disease surveillance requires a variety of activities and the involvement of health authorities at all levels. As Figure 1 illustrates, local, provincial and federal health departments are all active participants in surveillance. Each maintains registries of health data on certain diseases, infections, hospitalizations and injuries, while the World Health Organization (WHO) monitors similar data at a global level.

Figure 1: Effective Surveillance

Effective surveillance requires the development of active networks at many levels, and defining and linking networks, and coordinating response.

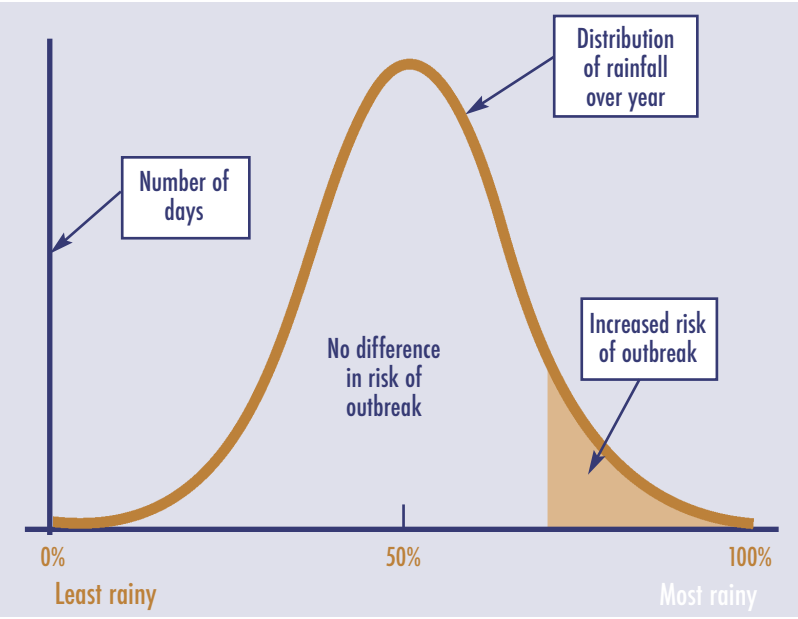


These data, collected by recording events as they occur, contribute to **passive surveillance** and may be enhanced by **active surveillance** programs that obtain data on particular health problems (e.g., emerging infections).[1] For example, during a recent Montréal heat wave, health outcomes of the older population were monitored as part of the city's *Heat Wave Mobilization Plan.*

Looking in Unexpected Places

A number of alternate surveillance activities augment the information obtained from tracking individual cases of disease. These include monitoring zoonotic diseases (diseases transmissible between animals and people) in reservoir animal populations. For example, Canadian public health authorities routinely monitor West Nile virus activity in birds and mosquitoes to measure the human health risk (http://www.phac-aspc.gc.ca/wn-no/surveillance_e.html). Research is also under way to understand how trends in over-the-counter medication (e.g., anti-diarrheal remedies) may help detect waterborne illness in communities where flooding has been a concern.[2] As discussed in the article on page 41, newspapers have also been useful in monitoring health problems related to extreme weather events.[3] The importance of alternative systems such as these is likely to increase as we face global environmental change in times of competing demands on limited resources.

Figure 2: Link between Rainfall and Waterborne Disease Outbreak



Source: D.F. Charron et al., 2004.[6]

Local Communities Play a Role

Local communities may also contribute helpful information often not captured by health surveillance activities alone. Sources such as these are especially important when studying the impacts of weather and climate on health. For example, First Nations elders may contribute pertinent observations on changes taking place in their communities and environments.[4] Farmers may understand the significance of weather patterns and can provide useful insights regarding health impacts. Similarly, hunters and fishers may observe changes in the health of wildlife that represent a human health risk.[5]

Linking Weather to Health

For specific information on health risks associated with climate and weather, public health professionals depend on research findings about the links between health outcomes and various health determinants, including climate and weather. Canadian researchers are increasingly active in this area and use meteorological records, climate models and data on many environmental and social health determinants to understand how some health problems may be vulnerable to changes in weather and, eventually, to the impacts of climate change. The following study, funded by Health Canada's Health Policy Research Program, found that heavy rainfall was linked to increased risk of waterborne disease.

Heavy Rain and Waterborne Disease

The Public Health Agency of Canada (PHAC) collaborated with the University of Guelph and Environment Canada on an analysis of historical outbreaks of disease linked to a source of drinking water. Preliminary findings indicate that warmer temperatures and very heavy rainfall tend to increase the risk of disease outbreaks within a six-week period.[6] As shown in Figure 2, only the heaviest rainfall periods contributed to increased risk of waterborne disease. Warmer temperatures also contributed to an increased outbreak risk.

The findings suggest that warmer temperatures and extreme rainfall are contributing factors to waterborne disease outbreaks in Canada. Given that warmer temperatures and more extreme precipitation are projected under many climate change scenarios, decision makers

and planners should consider watershed protection measures and increasing safety barriers to protect drinking water from extreme rainfall.

Modelling the Health Impacts of Climate Change

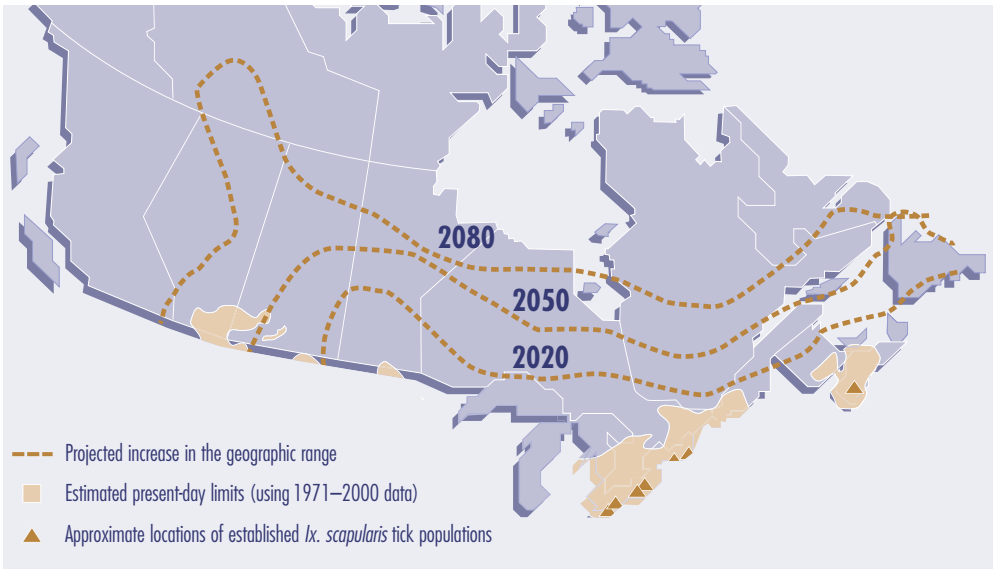
Knowing how certain health problems are influenced by weather is vital. However, it is also important to use this knowledge to anticipate and predict future health risks posed by a changing climate. As the following study demonstrates, new disease modelling techniques that project the impacts of climate change on Canadian health issues are becoming valued public health tools.

Mapping the Spread of Vector-Borne Diseases

The geographic range of many vector-borne diseases is limited by climate conditions.[7-10] A case in point is Lyme disease, which is caused by a bacterial infection transmitted by black-legged ticks in certain regions of Canada. Research funded by the Climate Change Action Fund of the Government of Canada has shown that vector tick distribution east of the Rockies is confined by climate and habitat. However, a changing climate could extend the tick's range, thereby exposing more Canadians to Lyme disease.

Lyme disease infects about 20,000 people a year in the United States.[11] Fewer than 50 cases are diagnosed annually by laboratory in Canada,* but many more are treated for Lyme disease based on symptoms and history alone. Lyme disease ecology differs from region to region across Canada. The current northern limit of the vector tick *Ix. scapularis* is southern Ontario, with a few isolated tick populations on the shores of Lakes Erie and Ontario, and one population on the south coast of Nova Scotia.[12] The western black-legged tick, *Ix. Pacificus*, is found throughout British Columbia,[13] but because this tick prefers reptilian hosts that do not harbour the Lyme disease bacteria, the disease is not as easily spread to humans.

Figure 3: *Ixodes Scapularis* — Current and Projected Ranges in Canada



Note: future limits are model-derived temperature limits mapped as limits in mean annual degree-days >0°C. Climate change projections were obtained from output from the CGCM2 global climate model using IPCC emissions scenario "A2."

Source: Adapted with permission from Elsevier from N.H. Ogden et al., Climate change and the potential for range expansion of the Lyme disease vector Ixodes scapularis in Canada, International Journal of Parasitology, 2005 (in press).

Due to projected climate change, a northward shift in range is expected for many arthropods such as ticks.[14,15] Figure 3 illustrates the northward shift in range expected for *Ix. scapularis*. Established populations and present-day limits of the tick's geographic range (using 1971–2000 data) are shown, along with projected future geographic ranges of temperature conditions suitable for the tick to become established.

If the range of *Ix. scapularis* expands northward, it will extend into parts of southeastern Canada that are densely populated, with consequent risks for public health. Such an expansion is considered likely in the face of climate change for the following reasons:

- Some areas of the United States most severely affected by Lyme disease border on Québec, Ontario and the Maritimes. Migrating birds carry infected ticks into Canada from these areas.
- These same areas in southeastern Canada already provide a habitat for mice and white-tailed deer,

*Approximately half of the cases diagnosed by laboratory are linked to travel to areas outside of Canada where Lyme disease is very common.

which are animal hosts to *Ixodes* ticks. The ticks are also able to survive in these areas when off their animal hosts.

- At the northern edge of its range, *Ix. scapularis* survival is closely controlled by temperature.[10,12]

Short- and Long-Term Health Challenges

Climate variability and change have impacts on a broad spectrum of health determinants and, consequently, far-reaching impacts on society. For this reason, public health professionals and health care providers will need to be alert to the indirect as well as the direct impacts of climate change. For example, while warmer and drier summer conditions in the Canadian Prairies might not result in an increased number of heat-related deaths, attention must be paid to the more subtle and long-term health effects of drought. Drinking water supplies may be threatened. Crop failure and loss of farmland from soil salinity may have enormous economic implications for farm families and rural communities, with repercussions on overall nutrition, child health and mental health. This, in turn, may result in an increasing incidence of suicide and family violence, injuries and chronic diseases.

Moving Forward

Climate change poses complex short- and long-term public health challenges. It requires that health professionals from all disciplines take a broader, more systemic view of the possible linkages and trends between health determinants and health outcomes, as well as the linkages between human health and the health of our natural and built environments. The diverse pathways through which climate change affects health underscores how human health and well-being are intricately linked to the health of the ecosystems in which we live.

Evidence shows that human activity has contributed to climate change and that changes in weather patterns and reduced predictability of weather are having health impacts. Public health professionals and health care providers play an important role in providing evidence about these impacts and in helping reduce the health impacts of climate change.

In Canada, disease surveillance has moved from the traditional work of recording past events to a more active, anticipatory activity designed to identify health threats as early as possible. To be effective, such an approach requires a collaborative effort among health professionals and their allies at all levels of government, as well as internationally. Currently, the Public Health Agency of Canada (PHAC) is working with provincial and territorial ministries and agencies to conduct health surveillance. PHAC is also leading important research on how climate change may affect Canadians' risk of infectious diseases. Together with Health Canada, the Agency is fostering partnerships with other federal departments to determine the impacts of climate change on the broader determinants of health and to better identify the risks posed by climate change.

@ *Click here for references.*

Myth?

Climate change may cause malaria to re-emerge in Canada.

True

There is considerable uncertainty about how climate change will affect the vector life cycle and disease incidence of malaria in North America. Climate change is only one of a number of factors that can affect the spread of malaria; increased travel and immigration, and increased drug resistance are some of the other causes. People infected with malaria who are exposed to North American mosquitoes capable of transmitting the *Plasmodium* parasite can cause local outbreaks.[5] As well, new insect vectors introduced to North America from other countries and capable of spreading the parasite may extend their range to Canada if climatic conditions become more favourable. However, Canada's public health infrastructure minimizes the threat of disease spreading beyond a local outbreak.

EXTREME Weather Events:

Facing the Challenges in Health Emergency Management

David Hutton, *Ph.D., Centre of Emergency Preparedness and Response, Public Health Agency of Canada;* **John Lindsay**, *Brandon University; and* **Joan Simpson** *and* **Gylda Fry**, *Office of the Voluntary Sector, Public Health Agency of Canada*

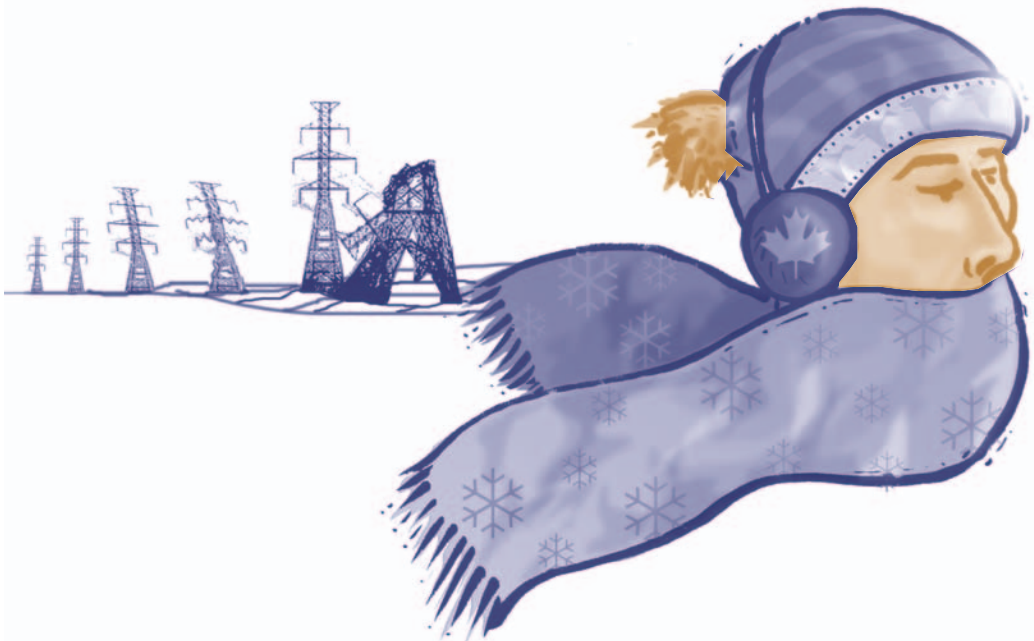
In the past, health emergency management focused predominantly on responding to health casualties. Recently, however, increased attention has been directed to helping individuals and communities increase their resiliency and adapt to the impacts of disasters. This article discusses recent developments in health emergency management and highlights the important role played by voluntary sector organizations.

More Frequent and More Severe

Of the 253 hazardous events listed in the *Canadian Disaster Database* for the period between 1990 and 2004, 151 are weather-related.[1] While not all weather-related events are due to climate change, in Canada climate change is expected to bring more weather-related natural hazards such as heat waves and cold snaps, heavy rain or snowfalls, prolonged drought, hurricanes, tornadoes and ice storms. As a result, Canadians will potentially be faced with health-related concerns that are more frequent and more severe, occurring in communities where they have not been experienced before.[2]

Strengthening Mitigation and Preparedness

The mitigation and reduction of threats and vulnerabilities related to environmental health is now recognized as a multifaceted process. Although health emergency management has traditionally focused on responding to health casualties and impacts, there is now increased attention on helping individuals and communities become more resistant to the impacts of disasters. Increasingly, health emergency management is attempting to shift the threshold at which such threats affect a community by decreasing the damage caused by disasters and increasing the capacity of communities to cope with such damage. This type of multidisciplinary approach involves strengthening a community's mitigation, preparedness, response and recovery capacities.



National Framework for Health Emergency Management

One of the challenges facing health emergency management in Canada is preparing for and responding to traditional, as well as emerging and re-emerging threats. The past decade has seen a growing number of natural disasters, the emergence of SARS, a higher probability of pandemic influenza and the continuing threat of terrorism. In 2001, the Federal, Provincial and Territorial Ministers of Health acknowledged the necessity of a comprehensive, integrated and coordinated strategic plan for managing health emergencies in Canada.[3] In response, the *National Framework for Health Emergency Management* was developed to provide a consistent, interoperational approach to health emergencies at a pan-Canadian level.[4] This approach aims to enhance the capacity of local, provincial and federal authorities to prepare for and respond to emergencies by fostering operational bridges based on shared principles, guidelines and operating procedures.

Key principles of the National Framework include an all-hazards/consequences approach, resiliency and sustainability of programs and planning, and comprehensive management practices that balance mitigation, preparedness, response and recovery. This all-hazards approach examines the full range of threats and their implications for Canadians, not only in terms of their individual and public health impacts, but the community and societal effects as well. Although controlling infectious diseases and other health emergencies continues to be a priority, this new approach begins to bridge the gap between climate change and health emergency management policy and decision making.

Working from a population health perspective, the Framework recognizes that vulnerability to health risks, as well as the capacity to cope and adapt at all levels, is intricately linked to the basic determinants of health. With an increased emphasis on health promotion, health protection, and social and community development, this approach defines health not only as the capacity to cope with daily life, but to respond to challenges such as environmental threats and changes. The goal of maintaining and enhancing quality of life, and the capacity to respond to extreme environmental events, underlies the concept of sustainable mitigation. As shown in the text box, Miletti has identified six key principles of sustainable development.[5]

In implementing the Framework, Health Canada and the Public Health Agency of Canada are working closely with partners across government. At the same time, the voluntary sector is being recognized as an important player in health emergency management and in addressing the challenges posed by climate change and extreme weather events. Voluntary organizations have a long history of delivering services during and after disasters, and enhancing communities' capacity to prepare for and respond to health threats. The overall impacts of climate change will have an expanding effect on the type of and need for services in Canadian society. Governments have been increasingly relying on the voluntary sector in order to keep pace with needs, and to provide a strengthened capacity to support diverse communities and populations affected by disaster events.

Principles of Sustainable Development

- Maintain and, if possible, enhance people's environmental quality.
- Maintain and, if possible, enhance people's quality of life.
- Foster local resiliency and responsibility for disasters.
- Recognize that sustainable, vital local economies are essential.
- Identify and ensure intra- and intergenerational equity.
- Adopt a consensus-building approach, starting at the local level.

The Voluntary Sector — Partners in Response

Health Canada recognizes the voluntary sector[6] as a key partner in strengthening the health of Canadians and their communities by developing and delivering emergency preparedness programs designed to build community resiliency and adaptive capacity. In the event of a disaster, humanitarian relief organizations provide emergency social services such as clothing, shelter, tracing and reunification services, and emotional support for affected communities. However, the voluntary sector's contribution to disaster relief and mitigation also encompasses information exchange and public awareness, education and training, access to health care delivery and personal support, research and policy development, and data collection for operational and policy planning. Voluntary sector training programs and public education initiatives reach individuals of all ages, helping to build the community resiliency and adaptative capacity necessary to meet the ongoing challenges of climate change.

In 2001, the *Accord between the Government of Canada and the Voluntary Sector* set out a blueprint for a strong and vibrant government/voluntary sector relationship, formally recognizing the significance of the sector.

The profound reach and importance of the voluntary sector has clearly emerged in recent surveys by Statistics Canada[7,8] and the Canadian Centre for Philanthropy.[9,10] In 2001, the *Accord between the Government of Canada and the Voluntary Sector*[11-13] set out a blueprint for a strong and vibrant government/voluntary sector relationship, formally recognizing the significance of the sector. The importance of this relationship is illustrated in situations such as climate change and extreme weather events, where government relies on the voluntary sector for programs and services it cannot provide on its own. In crisis situations, the strength of the relationship between voluntary organizations and government is a critical success factor. Recognizing and committing energy to this effort is an important consideration in policy development.

Response and Planning Roles

Canadian voluntary organizations are essential partners, assisting all levels of governments by providing expertise and networks for emergency and disaster relief. As discussed in the article on page 22, the health challenges associated with climate change are expected to be more severe for vulnerable populations.

Myth?

The tsunami that devastated areas of southeast Asia on December 26, 2004, was caused by a changing climate.

False

A tsunami is actually a series of very long waves generated by any rapid, large-scale disturbance of the sea. Most are generated by large undersea earthquakes or other events, such as a landslide or sub-marine volcanic eruption. While not caused by a changing climate, tsunamis can result in great destruction and loss of life within minutes on the shores near their source; some also cause destruction within hours across an entire ocean basin. Although they do not occur frequently, tsunamis are a significant natural hazard that can only be dealt with effectively through programs of warning, adaptation and education. These same mechanisms are used to address the health impacts caused by extreme weather events, which are predicted to increase with climate change.

Children, seniors, people with disabilities, those living below the poverty line and people with special health needs often depend on voluntary sector capacity to help meet their needs. Voluntary organizations collaborate on health issues, and help plan and deliver emergency preparedness and response activities, such as feeding and hydration stations when there are interruptions in the food supply. They enhance access to health services for people with special health needs, for example, dialysis, chemotherapy and respiratory aids. They promote the delivery of health and social services in non-traditional settings by responding to individual and community needs, such as community outreach services during air quality alerts and culturally-appropriate program settings.[14]

From Policy to Practice

Voluntary organizations are instrumental in informing, persuading and changing public behaviour, and helping communities respond effectively to emergency situations. The school-based *Expect the Unexpected* program,[15] developed by the Canadian Red Cross in response to the Saguenay floods, is one example of education and outreach. Since 1997, this program has delivered learning activities on natural disasters and extreme weather events to over 180,000 students in 11 provinces and territories. In 2005, the Public Health Agency of Canada funded two national planning and capacity-building projects[16] — the first to develop an enhanced "episodic" volunteer base to meet the surge demand for qualified people necessary for timely responses during disasters, and the second to broaden the capacity of national voluntary organizations to effectively engage with all levels of government in implementing the *National Framework for Emergency Health Management.*

Framing climate change within a multidisciplinary perspective is important, both to capture its complexity and to ensure a more integrated and comprehensive approach to policy making and decision making. Effective mitigation and preparedness ultimately lie in the ability of communities to respond not only to emerging health threats and crises, but also to groups who are at increased risk.

Voluntary organizations play an important role in health promotion and developing social capital by empowering people and communities to take action, and providing extensive networks of service at the community level. Key partners in the development of public policy, these organizations are uniquely positioned to address public health issues. In addressing the growing need for voluntary sector outreach posed by climate change, two broad policy areas merit attention: engaging citizens and communities, and making effective use of human resources. Related areas of health emergency management requiring further research include sustainable program delivery, volunteer recruitment and retention, organizational effectiveness and enhanced policy capacity.

A Multifaceted Approach

Framing climate change within a multidisciplinary perspective is important, both to capture its complexity and to ensure a more integrated and comprehensive approach to policy making and decision making. Effective mitigation and preparedness ultimately lie in the ability of communities to respond not only to emerging health threats and crises, but also to groups who are at increased risk. Successful interventions therefore require an integrated, comprehensive framework from which policy makers, researchers and practitioners across both government and voluntary sectors can respond effectively to the impacts of climate change.

Click here for references.

Planning Our Future:

Reducing the Health Impacts of Climate Change

Peter Berry, *Ph.D., Climate Change and Health Office, Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada*

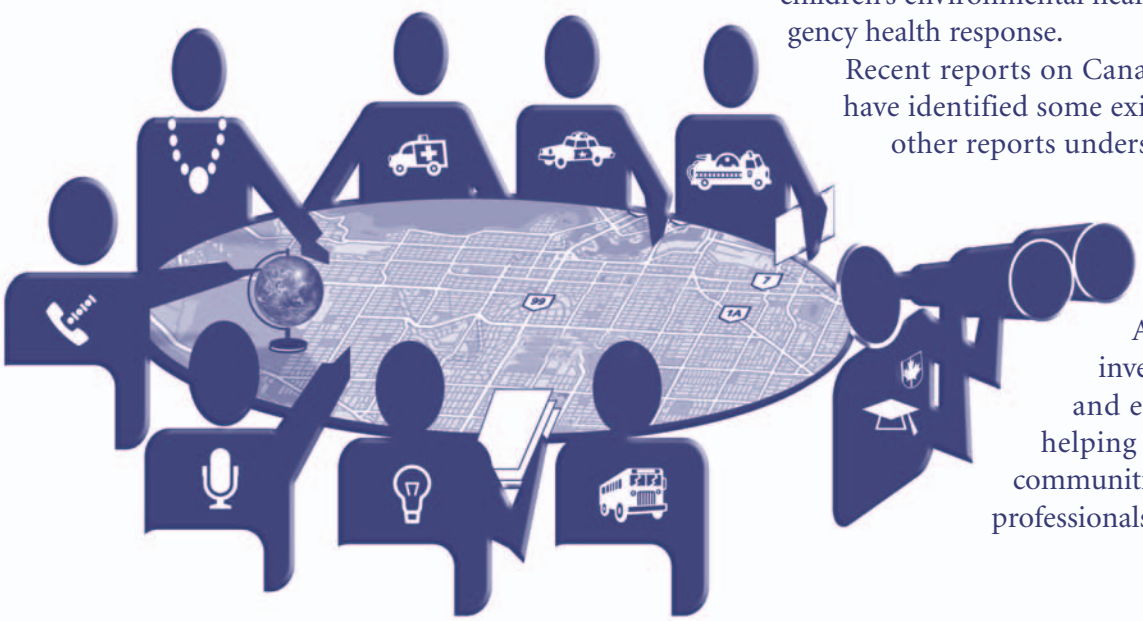
To effectively address the potential impacts of climate change on the health of Canadians, adaptive actions must be taken at a number of levels. Efforts are under way in Canada to expand the knowledge base on climate change and health, and to identify policy options for adapting to anticipated impacts, for the population as a whole, as well as for vulnerable groups. This article explores the strategic directions Health Canada and its partners are taking to address the impacts of climate change on health.

The Challenge

The extent to which climate change will disrupt society, affect the economy or erode Canadians' quality of life and health will largely depend on our willingness to plan for short- and long-term changes and our capacity to adapt. Adapting means changing individual behaviour and government policies and programs to help avoid the most severe impacts of climate change, position us to exploit its opportunities and prepare us to cope more effectively with its unavoidable consequences.

> ***"Everybody complains about the weather, but nobody does anything about it."***
>
> — Mark Twain

Compared to other countries, particularly those in the developing world, Canada has a greater capacity to adapt to the health impacts of climate change because of its greater financial resources, knowledge base and strong health care system.[1] Given the breadth of these impacts, however, individual communities will face increased challenges in delivering important public health functions such as primary health care, mental health services, disease monitoring and surveillance, housing and shelter, children's environmental health, healthy living and emergency health response.



Recent reports on Canada's public health systems have identified some existing capacity challenges;[2,3] other reports underscore the need to address these capacity issues in response to climate change.[1] The newly created Public Health Agency of Canada and related investments in public health and emergency preparedness are helping to strengthen the ability of communities, Canadians and health professionals to respond.

Building Canada's Capacity to Adapt to Health Impacts

- Creation of Public Health Agency of Canada
- New Atlantic Storm Prediction Centre in Dartmouth, Nova Scotia
- Climate Change Adaptation Strategy for Canada's North
- Québec's *Civil Protection Act* (Bill 173)
- Ontario's *Emergency Readiness Act* (Bill 148)
- Canadian Climate Impacts and Adaptation Research Network (C-CIARN)

Reducing Health Risks

Health authorities at the federal, provincial, territorial and municipal levels are responsible for a range of functions and services that may be affected by climate.

On their own, few climate-related risks are likely to warrant new systems and infrastructures. Rather, efforts to protect Canadians from the impacts of climate change will likely entail revising, reorienting or strengthening public health policies and practices currently aimed at protecting Canadians from air pollution (e.g., smog alerts), poor water quality (e.g., boil water advisories), vector-borne and zoonotic diseases (e.g., monitoring and surveillance), extreme weather events (e.g., emergency health services) and heat waves (e.g., "cooling off" locations).

As an initial step, decision makers in the health sector and related sectors need to identify and assess their "climate-sensitive" policies and programs.[1] Where significant concerns about health risks exist, assessments using future scenarios, climate models and expert knowledge can be used to determine the need for adaptive actions.[4] As climate change scientists provide more information on expected impacts (e.g., community flood risk, heat wave risk, air pollution episodes), this information can be used in public health and community planning processes to guide future policy development and ensure that future risks are managed adequately. The City of Ottawa's *Air Quality and Climate Change Management Plan*, which calls for more heat-island controlling measures, heat alerts, smog alerts and West Nile disease control measures, is an example of how communities are integrating information on impacts into public health planning.[5]

The Costs of Not Adapting

The potential costs to the health and well-being of Canadians and to communities' quality of life of not planning adaptive responses to climate change can be substantial. Recent events, such as the 2003 heat wave in Europe or Hurricane Katrina in 2005, which devastated parts of the U.S. Gulf Coast, demonstrate that even wealthy countries with strong health and social systems may be unprepared and unable to cope with extreme climatic events. Studies suggest that Canadian communities are also vulnerable to such events; moreover, these events are likely to become more frequent and severe with climate change.[6]

> ***"Our society was not prepared."***
>
> — Hubert Falco, Secretary of State for the Elderly, France, in the aftermath of the August 2003 heat wave

Without effective planning, the costs of climate change will extend beyond the direct health impacts (e.g., increased incidence of illness, injury, disease and

Moving Forward on Kyoto

On April 13, 2005, the Government of Canada released ***Moving Forward on Climate Change: A Plan for Honouring Our Kyoto Commitment.*** The Plan includes a set of policies and programs to help Canada reach its goal of reducing greenhouse gas emissions by 6% below 1990 levels by 2008–2012. In addition to acknowledging the current impacts of climate change and the need to invest in helping vulnerable populations, the Plan calls for investments in scientific research to inform decision making and help Canada meet the challenges of climate change.

death) to include economic costs to health care and social systems.[7] The impacts of climate change could further threaten the sustainability of a health care system already facing significant resource pressures. For example, air pollution, which is expected to worsen as a result of climate change, is estimated to cost Ontario's health care system $1 billion per year.[8] These costs will likely increase without appropriate adaptation strategies such as greenhouse gas and air contaminant reduction measures and effective outreach programs to enable people to protect themselves. However, adaptation can pay high dividends, as many European countries have witnessed in the dramatic decline in flood fatalities over the past three decades, due to better emergency preparedness, mitigation and response efforts.[9]

Canada Responds

As noted in the interview on page 9, Canadians are moving forward with actions to reduce their greenhouse gas emissions — a key cause of climate change — and to further understand and prepare for the health impacts. In many regions of the country, scientists are starting to work with policy makers, and governments are reaching out to people in communities to plan for a changing climate. For example, a Federal/Provincial/Territorial Climate Change Impacts and Adaptation Working Group has developed a *National Climate Change Adaptation Framework*, which will be released later this year. The Framework is the product of almost three years of intergovernmental collaboration, with input from leading experts in the field of climate change impacts and adaptation. It provides a basis from which governments can work together to guide adaptation efforts.

In Québec, the consortium Ouranos — a joint initiative of the Government of Québec, Hydro-Québec and the Meteorological Service of Canada — builds an understanding of regional climate change and its environmental, social and economic impacts. (Visit: <http://www.ouranos.ca>.) Ouranos is developing the research tools necessary to provide decision makers with detailed climate change scenarios on a regional scale. Tools such as these will help health sector and social service professionals tailor their planning processes to incorporate climate change as an important risk that needs to be managed. Non-governmental and volunteer organizations are also playing an important role in climate change and health issues as illustrated by Pollution Probe's *Primer on Climate Change and Human Health*, which is designed to enhance awareness about these issues among Canadians.[10] (Visit: <http://www.pollutionprobe.org>.)

Adapting to New Vector-Borne or Zoonotic Disease Outbreaks

As a physician or public health practitioner, here is what you can do:

- Stay informed about the evolution of infectious diseases around the world.
- Ask about the travel history of patients who present clinical symptoms compatible with diseases that are exotic to Canada.
- Educate the public, especially members of vulnerable groups, about these diseases and strategies for minimizing the risk of exposure.
- Take note of extreme weather events and climate trends that can presage disease outbreaks.
- Work with the public health community to develop local and regional health plans for adapting to climate change.

Health Canada: Doing Its Part

Health Canada is working with the Public Health Agency of Canada, other federal departments and internationally to bring the health and well-being "voice" to greenhouse gas mitigation discussions and to support researchers and decision makers in addressing the health impacts of climate change. For example, the jointly produced report, *Methods of Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change*, which was developed by Health Canada in collaboration with the World Health Organization and other international partners, outlines methods and tools that health decision makers and planners can use to conduct vulnerability assessments. This document, along with the results of research funded by the Health Policy Research Program at

Health Canada, will contribute to the *Canadian Climate Change and Health Vulnerability Assessment 2007*, which the Department is leading. This initiative will contribute to a better understanding of the vulnerability of Canadians to climate change, assess Canada's capacity to minimize the risks of climate change on health and provide policy direction for the years to come. Health Canada is also developing a document entitled *Your Health and a Changing Climate: Information for Health Professionals*, which will help public health practitioners and policy makers better understand the health-related implications of climate change and identify potential adaptation actions.

Now is the time to move forward with research and policy initiatives that address the projected health impacts of climate change. Putting in place adaptation processes and plans will require collaborative and sustained efforts on the part of governments, health agencies and individuals.

A Global Concern

Outside of Canada, some developed countries and regions that are at risk from climate change have recognized the threats to health and have conducted impact assessments that also evaluate possible adaptation measures. For example, the European Union recently completed the Climate Change and Adaptation Strategies for Human Health (cCASHh) project, a comprehensive review of the health effects of climate change and a policy review of adaptation measures. Additionally, at the Fourth Ministerial Conference on Environment and Health, held in Budapest, Hungary, in June 2004, participants from around the world adopted a declaration to "take action to reduce the current burden of disease from extreme weather and climate events and report on progress in 2007."

Moving Forward

As this article has argued, now is the time to move forward with research and policy initiatives that address the projected health impacts of climate change. Putting in place adaptation processes and plans will require collaborative and sustained efforts on the part of governments, health agencies and individuals. For its part, Health Canada will continue working with its partners to improve the health and quality of life of Canadians in the face of a changing climate.

@ *Click here for references.*

Myth?

Climate change will not cause increases in air pollution and the number of smog alerts in Canada.

False

Without measures to reduce emissions of smog-causing pollutants, we can expect climate change to increase the number of days in which weather conditions are conducive to smog formation. Scientists expect that the higher temperatures accompanying climate change will stimulate the production of smog in urban centres.[6] Photochemical smog is a mixture of vapours, gases and particles that usually appears as a yellowish-brown haze in the air over many cities. Two of the principal components of smog are ground level ozone (O_3) and particulate matter (PM). Smog forms most readily on hot, dry sunny days with little wind, and can remain in an area for days or weeks until a new weather system clears it away, or rain washes it out of the air.

A smog alert is issued when the Air Quality Index (AQI) reaches or exceeds 50, indicating that smog conditions are reaching dangerous levels. The AQI is based on hourly pollutant measurements of some or all of the six most common air pollutants: sulphur dioxide, O_3, nitrogen dioxide, total reduced sulphur compounds, carbon monoxide and fine PM. Whenever smog conditions rise to dangerous levels in Ontario, for example, the Ministry of the Environment issues a provincial smog alert to notify local public health offices and the general public, and to urge them to take appropriate action.[7]

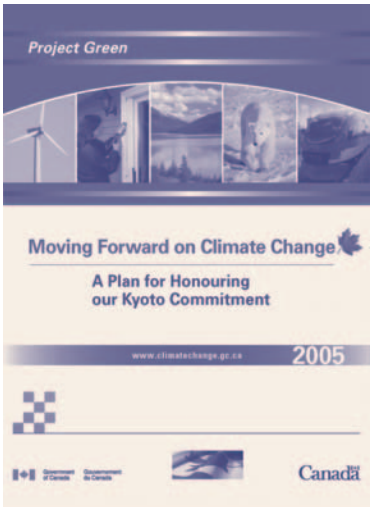
Who's Doing What?

Who's Doing What? is a regular column of the Health Policy Research Bulletin that looks at key players involved in policy research related to the theme area. This column highlights some of the governmental committees, research groups and non-governmental organizations working in support of climate change and health policy development in Canada.

Wendelin Galatianos, *University of Guelph, and* **Marcia Armstrong**, *Climate Change and Health Office, Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada*

Government of Canada

Project Green: Moving Forward on Climate Change



This report outlines Canada's plan for meeting its *Kyoto Protocol* commitments to reduce greenhouse gas emissions. One key objective is "to contribute significantly to cleaner air for Canada's cities and communities, enhance biodiversity and generally improve quality of life for Canadians." Visit: <http://www.climatechange.gc.ca>.

Canadian Climate Impacts and Adaptation Research Network (C-CIARN)

C-CIARN (http://www.c-ciarn.ca) generates new climate change knowledge by bringing researchers together with decision makers from industry, government and non-governmental organizations. Funding is provided through the Canadian Climate Impacts and Adaptation Program (http://www.adaptation.nrcan.gc.ca). Health Canada's Climate Change and Health Office (visit: <http://www.hc-sc.gc.ca/ewh-semt/climat/index_e.html>) coordinates five distinct health research networks for the C-CIARN Health Sector:

- **Natural Disaster Health Research Network**
  <http://iclr.org/programs/health.htm>
- **Climate Change, Air Pollution and Health Network**
  <http://www.climateairhealth.ca/>
- **The Climate Change, Vectorborne/Zoonotic Diseases Research Network**
  <http://www.eccho.ca/hirn-vbz.asp>
- **The Climate Change, Food- and Waterborne Contaminants Research Network**
  <http://www.eccho.ca/hirn-fwc.asp>
- **Population Vulnerabilities in Rural and Urban Communities**
  <http://www.chuq.qc.ca/oms/cc/>

Canadian International Development Agency (CIDA)

CIDA administers the Canada Climate Change Development Fund, which helps developing countries meet their commitments to the *United Nations Framework Convention on Climate Change*. Visit: <http://www.acdi-cida.gc.ca/climatechange>.

Networks of Centres of Excellence (NCEs)

NCEs are unique partnerships among universities, industry, government and not-for-profit organizations aimed at turning research and entrepreneurial talent into economic and social benefits for all Canadians. The Centres are supported through Industry Canada and three federal granting agencies — the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada, and the Social Sciences and Humanities Research Council of Canada.

- **Canadian Water Network**
  One hundred collaborators address critical issues related to clean water and the use of water resources, and protecting human and aquatic ecosystem health. Visit: <http://www.cwn-rce.ca>.
- **ArcticNet**
  ArcticNet connects well-established Centres of Excellence in the natural, human health and social sciences field with Inuit organizations, northern communities, federal and provincial agencies, and the private sector to study the impacts of climate change in the coastal Canadian Arctic. Visit: <http://www.arcticnet-ulaval.ca/>.

Non-Governmental Sector

The Climate and Health Research Program (CHRP)

This University of Alberta initiative investigates the dynamic relationship between climate and human health, including weather-related mortality, air pollution, tropical vector-borne diseases and traffic-related particulate levels. Related projects focus on the relationship between the physical and social environment, and population health inequities. Visit: <http://www.ualberta.ca/~ksmoyer/chrp/home.htm>.

The Ecosystems, Climate Change and Health Omnibus Project (ECCHO)

The University of Guelph hosts several Canadian and international collaborations, and two climate change and health research networks. Research topics include climate impacts relating to ecosystem health, community resiliency, vector-borne/zoonotic diseases, water- and foodborne illness and climate downscaling. Visit: <http://www.eccho.ca>.

Canadian Risk and Hazards (Knowledge and Practice) Network (CRHNet)

CRHNet was developed to promote and strengthen disaster risk reduction and emergency management. One of its resources, entitled *Assessment of Natural Hazards and Disasters in Canada*, provides decision makers and practitioners with information on why and how disasters and emergencies happen, various coping mechanisms and how to create a safer society. Visit: <http://www.crhnet.ca/>.

ClimAdapt

In 2001, the Nova Scotia Environmental Industry Association pioneered this partnership to incorporate climate change adaptation management frameworks into government environmental impact assessments, municipal risk management processes and industry infrastructure development practices, in Canada and internationally. Visit: <http://www.climadapt.com/>.

National Voluntary Health Organizations (NVHOs) Initiative for Emergency Preparedness: The Canadian Red Cross Society

In 2005–2006, with support from NVHOs, the Canadian Red Cross will develop a national volunteer health emergency management system in partnership with St. John Ambulance and the Salvation Army, among others. Visit: <http://www.redcross.ca>. The International Federation of Red Cross/Red Crescent Societies has also established a climate centre that works to reduce loss of life and damage to livelihoods from climate change and extreme weather events. Visit: <http://www.climatecentre.org>.

International

World Health Organization (WHO)

Since 1998, WHO has provided input to the Inter-Agency Committee on the Climate Agenda, in support of the *United Nations Framework Convention on Climate Change*. Joint activities by WHO, the World Meteorological Organization and the United Nations Environment Program focus on three major areas: capacity building, information exchange and promoting research. Health Canada collaborated with this group to produce *Methods of Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change* (2003).

WHO Regional Office for Europe

The Climate Change and Adaptation Strategies for Human Health (cCASHh) project examines the health impacts of floods and heat waves (direct effects of weather on health), and foodborne diseases and tick/mosquito-borne diseases (indirect effects of weather through changes in seasonal patterns of infectious diseases). Visit: <http://www.euro.who.int/ccashh>.

Professional Associations

Canadian Public Health Association (CPHA)

CPHA hosts the Roundtable on Health and Climate Change to review health issues associated with climate change and identify actions that will have immediate beneficial effects. One project is Supporting Public Awareness Initiatives on the Health Effects of Climate Change and Air Pollution. Visit: <http://www.ccah.cpha.ca/Start.htm>.

Ontario College of Family Physicians (OCFP)

The *Report on Public Health and Urban Sprawl in Ontario* explores the health impacts associated with climate change. Visit: <http://www.ocfp.on.ca/local/files/Communications/Current%20Issues/Urban%20Sprawl-Jan-05.pdf>.

Using Canada's Health DATA

Using Canada's Health Data is a regular column of the Health Policy Research Bulletin highlighting some of the methods used in analyzing health data. This issue focuses on newspapers as a source of useful data on climate change and health.

Colin L. Soskolne, *Ph.D., and* **Justine D.A. Klaver-Kibria**, *University of Alberta; and* **Kaila-Lea Clarke** *and* **Peter Berry**, *Climate Change and Health Office, Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada*

Climate Change and Health

As previous articles have demonstrated, the progressive warming of global temperatures is having both direct and indirect effects on the health and well-being of people and their communities. Because the negative health impacts of climate change are often mediated by factors outside the traditional health field, adaptation strategies must take these other factors into account.

For this reason, health assessments of climate change require the use of a broad range of health data, and analytical methods and tools, as well as interdisciplinary collaboration among researchers from many fields of expertise. Among the methods available are literature reviews, ecological studies, time-series methods and scenario-based approaches. Both qualitative and quantitative approaches may be useful, depending on the level and type of knowledge required by policy makers.[1] Whatever methods are chosen, however, they should support the goal of identifying the health impacts of climate change on vulnerable populations by evaluating:

- possible threshold effects
- the effects of multiple stressors
- the implications of policy actions (including their uncertainties)
- the coping capacity of individuals and their communities

The Challenges of Extreme Weather

One category of health concerns relates to extreme weather events. As temperatures warm, extreme events are expected to occur with increasing frequency, severity[2] and unpredictability.[3] The health effects of extreme weather can include death, injury and illness, as well as indirect health impacts resulting from damage to local health services and civic infrastructure, disruption of community life, displacement of people and ecological changes. Extreme weather can also cause considerable mental harm when people lose their loved ones, personal property and/or their livelihoods.[4] All of these factors underscore the urgent need for adaptation strategies and efficient ways of scientifically informing policy.

Using Newspapers: A Novel Epidemiological Method

How have extreme weather-related disasters affected human health and where can researchers access the information they need to evaluate future risks?

Newspapers are an innovative and underutilized source of epidemiological information useful for both qualitative and quantitative analyses. They provide accessible long-term records of weather events, as well as valuable information about pre- and post-event circumstances (i.e., the context). This type of descriptive information is important in assessing health impacts and is not systematically recorded in the administrative databases used in quantitative health research (e.g., hospital records, mortality data).

A Case Study in Alberta

One study, entitled *Climate Change, Extreme Weather and Health Effects in Alberta*, took a unique approach to obtaining and analyzing climate-related health data.[3] Conducted at the University of Alberta, the study was made possible through funding provided by the Health Policy Research Program at Health Canada.

Drawing on four decades of reporting (1960 to 2001), the study used information from newspapers to assess the human health impacts that disasters and extreme weather events have had on Albertans. The purpose of the research was to better understand how extreme weather had affected population health, and how communities could best adapt to these changing conditions as climate change continues to exert an influence on extreme weather events. Among the events investigated were droughts, periods of extreme cold and heat, snowstorms, forest fires, flash floods and river flooding.

Six-Step Approach for Collecting and Analyzing Health Data in Newspapers

Step 1

Researchers defined the extreme weather events to be investigated and identified their associated dates and locations. This was accomplished using daily meteorological records and the online *Canadian Disaster Database*.

Step 2

Based on information from Step 1, researchers selected numerous Alberta newspapers and searched their archives for reports relating to selected extreme weather events. Relevant reports were photocopied and scanned into a database for coding and analysis.

Step 3

A content analysis framework (CAF) was developed to organize and code the health-related data, using Microsoft Access® to capture qualitative and quantitative information.

Step 4

Researchers reviewed each newspaper report and used the CAF to organize, code and store the data.

Step 5

The accuracy of the newspaper data was checked using both qualitative and quantitative methods (i.e., cross-referencing with known, reliable sources). This process did not reveal any evidence questioning the accuracy of the newspaper reports.

Step 6

Researchers analyzed the health data, generating many useful insights into the various dimensions of extreme weather and health.

In order to collect and analyze the data, researchers extracted the necessary data from meteorological records (1900 to 2001), a disaster database and newspaper reports. The key steps in this multifaceted approach are summarized in the text box.

Some Relevant Findings

A number of important findings, largely unavailable using information from traditional sources, demonstrate the effectiveness of using newspapers as a data source:

- Significant health problems, including morbidity, mental disorders and injury, were associated with extreme weather.
- Mental health impacts corresponded closely with disasters that damaged property and resulted in economic loss.
- Snow, cold and fires were the most costly events in terms of property and economic losses, and resulted in the most service interruptions and greatest institutional overload.
- Early warning systems, when they were available, allowed those affected to take action and reduce damage, loss and negative health consequences.
- Newspapers often gave advance warnings for floods and fires, fewer warnings for cold weather conditions and no warnings at all for snow.

Among its many recommendations, the study called for initiatives designed to:

- implement health-related advance warning systems for extreme weather events
- stop residential and commercial construction in flood plains
- identify and rank severely drought-prone areas

More information about this study is available at: <http://www.hc-sc.gc.ca/sr-sr/finance/hprp-prpms/final/2004-scleros_e.html>.

In Summary

The varied information reported in newspapers provides a basis for understanding the extent of the direct and indirect impacts of climate change on health. Newspaper-based enquiries can help to inform decisions about measures to ensure that communities have adequate resources available, and appropriate plans and policies in place to deal with extreme weather events.

Click here for references.

NEW and Noteworthy

New and Noteworthy *is a regular column of the* **Health Policy Research Bulletin** *highlighting "up and coming" policy research in the health field.*

Health Care in Canada 2005

Health Care in Canada 2005, the sixth annual report on Canada's health care system from the Canadian Institute for Health Information (CIHI), examines the relationship between hospital volumes and patient outcomes from various perspectives. Also included are the results of a recent national survey on what Canadians consider most important about health care. Look for the report on CIHI's website at: <http://www.cihi.ca>.

Incidence Study of Child Abuse and Neglect

The Public Health Agency of Canada's Injury and Child Maltreatment Section is releasing a report on the latest findings from the Canadian Incidence Study surveillance initiative. The second nationwide study on child abuse and neglect in Canada, the report examines the incidence of investigated child maltreatment cases in 2003, as well as changes since 1998. It also provides detailed characteristics about maltreated children, the alleged perpetrators, children's family environment, and the maltreatment itself (including type, duration, number of perpetrators, physical and emotional harm, and responses by child welfare services, police and the justice system). The report is available at: <http://www.phac-aspc.gc.ca/ncfv-cnivf/familyviolence/index.html>.

Climate Change and Health Research Report

This publication highlights the work of the Health Sector of the Canadian Climate Impacts and Adaptation Research Network (C-CIARN) in identifying areas where new knowledge is needed to better understand the relationship between climate change and human health. The report also profiles the accomplishments of selected Canadian researchers. To access an electronic copy, visit: <http://www.c-ciarn.ca/health>; to order a print copy, contact Marcia Armstrong at: Marcia_Armstrong@hc-sc.gc.ca.

RésEau

This online demonstration is an important step forward in the complex task of providing timely access to credible water information, data and tools to water stakeholders in all levels of government, non-governmental organizations and community groups, across jurisdictions and partners. Led by Environment Canada, with the cooperation of Natural Resources Canada and Health Canada, the demonstration will be online in March 2006. For more information, visit: <http://map.ns.ec.gc.ca/reseau/en/>.

National Population Health Survey

Now eight years old, the *National Population Health Survey* (NPHS) is a longitudinal survey of 17,276 individuals across Canada that provides information on participants' changing health over the years. Four articles based on the NPHS findings can be found in the new Internet publication, *Healthy today, healthy tomorrow? Findings from the National Population Health Survey*. The articles address smoking cessation and relapse, immigrant health, obesity, and healthy aging. Employees of Health Canada and the Public Health Agency of Canada can access the microdata or the articles through DAIS. All other interested persons should contact France Bilocq at: (613) 954-6956 or France_Bilocq@hc-sc.gc.ca.

Arctic Climate Impact Assessment (ACIA)

Commissioned by the Arctic Council and the International Arctic Science Committee and released in November 2004, the ACIA is a comprehensively researched, fully referenced and independently reviewed evaluation of arctic climate change and its potential impact on the region and on the world. Based on a variety of technical reports, ACIA includes a chapter on the health impacts of climate warming. For more information, visit: <http://www.acia.uaf.edu>.

Mark Your Calendar

What	When	Theme
United Nations Climate Change Conference	November 28–December 9, 2005 Montréal, QC <http://unfccc.int/meetings/cop_11/items/3394.php>	First Meeting of the Parties to the *Kyoto Protocol* and 11th Session of the Conference of the Parties to the Climate Change Convention
International Conference on Men, Women and Youth	February 12–16, 2006 Dhaka, Bangladesh <http://www.mcgill.ca/international/events/>	Identify internal and external influences that reduce the quality of life of targeted risk populations
6th International Conference on Occupational Stress and Health	March 2–4, 2006 Miami, Florida <http://www.apa.org/pi/work/wsh2006.html>	Address the changing nature of work and its implications on the health, safety and well-being of workers
Women and Depression Conference	April 6–9, 2006 Sydney, Australia <http://www.womenanddepression.herwill.net/>	Exploration of the challenges related to depression in women
17th International Conference on the Reduction of Drug Related Harm	April 30–May 4, 2006 Vancouver, BC <http://www.harmreduction2006.ca>	Focus on developing realistic, responsive and effective harm reduction strategies
Canadian Breast Cancer Research Alliance 4th Scientific Conference	May 6–8, 2006 Montréal, QC <http://www.breast.cancer.ca/reasons_for_hope_conferences>	Update on the status of breast cancer research, including prevention, treatment and early detection
6th European Conference on Health Economics	July 6–9, 2006 Budapest, Hungary <http://www.eche2006.com>	Strengthen links and collaborative approaches in health economics
10th International Conference on Obesity	September 3–8, 2006 Sydney, Australia <http://www.ico2006.com>	Exploration of basic science through physiology, public health and clinical medicine
7th Canadian Immunization Conference	December 3–6, 2006 Winnipeg, MB <http://www.phac-aspc.gc.ca/cnic-ccni/>	Theme TBA

References

References for *Climate Change 101* (p. 5)

1. Meteorological Service of Canada & Environment Canada. (2002). *Frequently Asked Questions about the Science of Climate Change.* Ottawa, ON: Minister of Supply and Services.
2. Environment Canada. (2001). *Climate Change Overview: What is Climate Change?* Retrieved August 8, 2005, from <http://www.ec.gc.ca/climate/overview_factors-e.html>.
3. Environment Canada. (2005). *Climate Change Overview: The Science of Climate Change.* Retrieved August 8, 2005, from <http://www.ec.gc.ca/climate/overview_science-e.html>.
4. Environment Canada. (2004). *The Earth is a Greenhouse.* Retrieved August 15, 2005, from <http://www.climatechange.gc.ca/english/climate_change/earth.asp>.
5. Lemmen, D.S., & Warren, F.J. (Eds.). (2004). *Climate Change Impacts and Adaptation: A Canadian Perspective.* Ottawa, ON: Natural Resources Canada.
6. Watson, R.T., et al. (2001). *Climate Change 2001: Synthesis Report. Contributions of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University Press.
7. Intergovernmental Panel on Climate Change. (2001). *Climate Change 2001: Impacts, Adaptation and Vulnerability. Summary for Policy Makers and Technical Summary of the Working Group II Report.* Cambridge, UK: Cambridge University Press.
8. Government of Canada. (2005). *One-Tonne Challenge: Climate Change Impacts.* Retrieved August 8, 2005, from <http://www.climatechange.gc.ca/onetonne/english/impacts.asp>.

References for *Canada's Evidence Base: Where Are We Now, Where Are We Going?* (p. 12)

1. McMichael, A.J., Campbell-Lendrum, D.H., Corvalan, C.F., Ebi, K.L., Githeko, A., Scheraga, J.D., et al. (Eds.). (2003). *Climate Change and Human Health: Risks and Responses* (pp. 1–17). Geneva, Switzerland: World Health Organization.
2. Riedel, D. (2004). Human Health. In D.S. Lemmen & F.J. Warren (Eds.), *Climate Change Impacts and Adaptation: A Canadian Perspective* (pp. 151–170). Ottawa, ON: Natural Resources Canada.
3. Lemmen, D.S., & Warren, F.J. (Eds.). (2004). *Climate Change Impacts and Adaptation: A Canadian Perspective.* Ottawa, ON: Natural Resources Canada.
4. Hassol, S.J. (2004). *Impacts of a Warming Arctic: Arctic Climate Impact Assessment.* Cambridge, UK: Cambridge University Press.
5. Koppe, C., Kovats, S., Jendritzki, G., & Menne, B. (Eds.). (2004). *Heat-waves: risks and responses.* Geneva, Switzerland: World Health Organization.
6. Mao, Y., et al. (2005). *A Multi-centre Approach to Investigate the Health Impacts of Extreme Heat and Cold Events due to Climate Change and Climate Variation.* Research in progress. Public Health Agency of Canada.
7. Campbell, M., & Cheng, C.S. (2005). *Differential and combined impacts of winter and summer weather and air pollution due to global warming on human mortality in south-central Canada.* HPRP File No. 6795-15-2001/4400011. Ottawa, ON: Health Canada.
8. Drouin, L., King, N., Jacques, L., Fortier, I., Roy, L-A., Litvak, E., et al. (2005, May 4–7). *The Response of the Montréal Public Health Board to Climate Change: Preventing Excess Morbidity and Mortality due to Extreme Summer Temperatures in Vulnerable Human Populations.* Paper presented at the Adapting to Climate Change in Canada 2005 Conference, Montréal, QC.
9. Charron, D.F., & Waltner-Toews, D. (2005). *Links between climate, water and waterborne illness, and projected impacts of climate change.* HPRP File No. 6798-15-2001-4400016c. Ottawa, ON: Health Canada.
10. Ogden, N.H., Bigras-Poulin, M., Barker, I.K., Lindsay, L.R., Maarouf, A., O'Callaghan, C.J., et al. (2005). A dynamic population model to investigate effects of climate on geographic range and seasonality of the tick *Ixodes scapularis. International Journal of Parasitology, 35*, 375–389.
11. Laplante, D.P., Barr, R.G., Brunet, A., Galbaud du Fort, G., Meaney, M.J., Saucier, J-F., et al. (2004). Stress During Pregnancy Affects General Intellectual and Language Functioning in Human Toddlers. *Pediatric Research, 56*, 400–410.
12. Garneau, M., Guay, F., & Breton, M-C. (2005). *Modélisation des concentrations polliniques à partir de scénarios climatiques (Partie I).* Montréal, QC: Consortium Ouranos, Université du Québec à Montréal, département de géographie et Centre de Modélisation Régionale du Climat.
13. Fleury, M., Charron, D., Holt, J., & Maarouf, A. (2005, May 4–7). *Modeling the Relationship Between Temperature and Foodborne Disease.* Poster session presented at the Adapting to Climate Change in Canada 2005 Conference, Montréal, QC.
14. Health Canada. (2004). *Climate Change and Health: Research Report.* Ottawa, ON: Author.
15. Maltais, D., Lachance, L., Fortin, M., Robichaud, S., Fortin, C., & Simard, A. (2000). L'état de santé psychologique et physique des sinistrés des inondations de juillet 1996 : étude comparative entre sinistrés et non-sinistrés. *Santé mentale au Québec, XXV(1)*, 116–138.

16. Hutton, D. (2004). Psychosocial Effects of a Natural Disaster: A Post-Flood Assessment in the Red River Valley. *Environments Journal, 3(2)*, 27–43.

17. Gosselin, P., & Grondin, J. (2002, August 27–28). *Changing behaviours in a time of climate change: Social science perspectives on the health impact assessment of climate change and adaptive behaviours*. Report on a workshop held in Québec City, QC. Office of Climate Change and Health, Health Canada, and Institut national de santé publique du Québec (INSPQ), Québec.

18. The Heinz Center and the Health Effects Institute. (2000, November 29–30). *Health Implications of Technological Responses to Climate Change*. Report of a workshop held in Washington, DC.

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

1. McMichael, A.J., & Githeko, A. (2001). Human Health. In J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken & K.S. White (Eds.), *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 451–486). Cambridge, UK: Cambridge University Press.

2. Riedel, D. (2004). Human Health. In D.S. Lemmen & F.J. Warren (Eds.), *Climate Change Impacts and Adaptation: A Canadian Perspective* (pp. 151–170). Ottawa, ON: Natural Resources Canada.

3. McMichael, A.J. (2003). Introduction. In A.J. McMichael, D.H. Campbell-Lendrum, C.F. Corvalan, K.L. Ebi, A. Githeko, J.D. Scheraga et al. (Eds.), *Climate Change and Human Health: Risks and Responses* (pp. 1–17). Geneva, Switzerland: World Health Organization.

4. McMichael, A.J., Haines, A., Sloof, R., & Kovats, S. (Eds.). (1996). *Climate Change and Human Health: An assessment prepared by a Task Group on behalf of the World Health Organization, the World Meteorological Organization and the United Nations Environment Programme*. Redhill, UK: Horley Studios.

5. Health Canada, Climate Change and Health Office. (2003). *Canada's Health Concerns from Climate Change and Variability*. Retrieved August 1, 2005, from <http://www.hc-sc.gc.ca/ewh-semt/climat/health_table-tableau_sante_e.html>.

6. World Health Organization. (2004). Heat-waves: Risks and Responses. *Health and Global Environmental Change*. Series No. 2. Geneva, Switzerland: Author.

7. Anderson, C.A., Anderson, K.B., Dorr, N., DeNeve, K.M., & Flanagan, M. (2000). Temperature and aggression. *Advances in Experimental Social Psychology, 32*, 63–133.

8. Anderson, C.A. (2001). Heat and violence. *Current Directions in Psychological Science, 10(1)*, 33–38.

9. Thompson, W., Burns, D., Mao, Y., et al. (2001). *Feasibility of Identifying Heat-Related Illness and Deaths as a Basis for Effective Climate Change Risk Management and Adaptation*. Report No. A124. Ottawa, ON: Government of Canada, Climate Change Action Fund.

10. Pengelly, D., Cheng, D., & Campbell, M. (2005). *Differential and Combined Impacts of Winter and Summer Weather and Air Pollution due to Global Warming on Human Mortality in South-Central Canada*. Toronto, ON: Toronto Public Health.

11. Rainham, D.G., & Smoyer-Tomic, K. (2002). *Human Health Impacts from Urban Heat*. Toronto, ON.

12. Stott, P., Stone, D.A., & Allen, M.R. (2004). Human contribution to the European heatwave of 2003. *Nature, 432*, 610–614.

13. World Health Organization Europe. (2004). *Public health response to extreme weather and climate events*. Working Paper EUR/04/5046267/13. Geneva, Switzerland: Author.

14. McBean, G., & Henstra, D. (2003). *Climate Change, Natural Hazards and Cities*. ISBN 0-9732213-9-9. Ottawa, ON: Natural Resources Canada.

15. International Federation of Red Cross and Red Crescent Societies. (2004). *World Disasters Report 2004*. Retrieved April 8, 2005, from <http://www.ifrc.org/publicat/wdr2004/>.

16. Soskolne, C.L., Smoyer-Tomic, K.E., Spady, D.W., McDonald, K., Roth, J.P., & Klaver, J.D.A. (2004). *Climate Change, Extreme Weather Events and Health Effects in Alberta*. HPRP File No. 6795-15-2001/4400013. Ottawa, ON: Health Canada.

17. Public Safety and Emergency Preparedness Canada, Office of Critical Infrastructure Protection and Emergency Preparedness. (2005). *Canadian Disaster Database*. Retrieved August 5, 2005, from <http://www.ocipep.gc.ca/disaster/bg_info.asp?lang=eng>.

18. Etkin, D., Haque, E., Bellisario, L., & Burton, I. (2004). *An assessment of natural hazards and disasters in Canada: A report for decision-makers and practitioners*. Ottawa, ON: Public Safety and Emergency Preparedness Canada, and Environment Canada.

19. DesJarlais, C., Bourque, A., Décoste, R., Demers, C., Deschamps, P., & Lam, K. (Eds.). (2004). *Adapting to Climate Change*. Montréal, QC: Consortium Ouranos.

20. United Nations, Intergovernmental Panel on Climate Change. (2002). *Climate Change and Biodiversity — IPCC Technical Paper V*. Retrieved from <http://www.ipcc.ch/pub/tpbiodiv.pdf>.

21. Reponen, T., Nevalainen, A., Jatunen, M., et al. (1992). Normal Range criteria for indoor air bacteria and fungal spores in a subarctic climate. *Indoor Air, 2*, 26–31.

22. United States Environmental Protection Agency. (1995). *The Inside Story — A Guide to Indoor Air Quality*. EPA Document No. 402-K-93-007. Retrieved from <http://www.epa.gov/iaq/pubs/insidest.html>.

23. Stieb, D.M., Pengelly, L.D., Arron, N., et al. (1995). Health Effects of Air Pollution in Canada: Expert Panel Findings for the Canadian Smog Advisory Program. *Canadian Respiratory Journal, 2*, 155–160.

24. Health Canada, Environmental and Workplace Health. (2004, June 25). *Health Effects of Air Pollution*. Retrieved August 5, 2005, from <http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/effe/health_effects-effets_sante_e.html>.

25. Ontario Medical Association. (2005). *The Illness Costs of Air Pollution: 2005–2026 Health and Economic Damage Estimates*. Retrieved August 5, 2005, from <http://www.oma.org/Health/smog/report/ICAP2005_Report.pdf> and <http://www.oma.org/phealth/icap05a.htm>.

26. Judek, S., Jessiman, B., & Stieb, D. (2004, August 30). *Estimated Number of Excess Deaths in Canada due to Air Pollution*. Retrieved June 2005, from <http://www.hc-sc.gc.ca/ahc-asc/media/nr-cp/2005/2005_32bk2_e.html>.

27. Duncan, K., Guidotti, T., Cheng, W., Naidoo, K., Gibson, G., Kalkstein, L., et al. (1997). Canada Country Study: impacts and adaptation — health sector. In G. Koshida & W. Avis (Eds.), *Responding to Global Climate Change: National Sectoral Issue, Volume VII* (pp. 501–620). Ottawa, ON: Environment Canada.

28. Ogden, N.H., Bigras-Poulin, M., Barker, I.K., Lindsay, L.R., Maarouf, A., O'Callaghan, C.J., et al. (2005). A dynamic population model to investigate effects of climate on geographic range and seasonality of the tick *Ixodes scapularis*. *International Journal for Parasitology* (in press).

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

1. Grambsch, A., & Menne, B. (2003). Adaptation and adaptive capacity in the public health context. In A.J. McMichael, D.H. Campbell-Lendrum, C.F. Corvalan, K.L. Ebi, A. Githeko, J.D. Scheraga et al. (Eds.), *Climate Change and Human Health: Risks and Responses* (pp. 1–17). Geneva, Switzerland: World Health Organization.

2. McMichael, A.J., & Githeko, A. (2001). Human Health. In J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken & K.S. White (Eds.), *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 451–486). Cambridge, UK: Cambridge University Press.

3. Lemmen, D.S., & Warren, F.J. (Eds.). (2004). *Climate Change Impacts and Adaptation: A Canadian Perspective*. Ottawa, ON: Natural Resources Canada.

4. Ebi, K.L., Burton, I., & Smith, J. (2003). Public Health Adaptation to Climate Change. *IHDP Update, 03/2003*, 8–9.

5. Lalonde, M. (1981). *A New Perspective on the Health of Canadians: A Working Document*. Catalogue No. H31-1374. Ottawa, ON: Government of Canada.

6. Federal, Provincial and Territorial Advisory Committee on Population Health. (1999). *Toward a Healthy Future: Second Report on the Health of Canadians*. Ottawa, ON: Author.

7. Health Canada. (1999, June). *Canadian Handbook on Health Impact Assessment — Volume 1: The Basics* (Chapter 1, p. 1-2). Ottawa, ON: Author. Retrieved August 21, 2005, from <http://www.phel.gov.uk/hiadocs/15_canadian_handbook_partone.pdf#search>.

8. Adger, W.N. (2003). Social aspects of adaptive capacity. In J.B. Smith, R.J.T Klein & S. Huq (Eds.), *Climate Change, Adaptive Capacity and Development*. London, UK: Imperial College Press.

9. Adger, W.N., Brooks, N., Kelly, M., Bentham, G., Agnew, M., & Eriksen, S. (2003). *New Indicators of Vulnerability and Adaptive Capacity: Final Project Report*. Tyndall IT1.11: July 2001–June 2003. Project ongoing.

10. Yohe, G., & Tol, R.S.J. (2002). Indicators for social and economic coping capacity — moving towards a working definition of adaptive capacity. *Global Environmental Change — Human and Policy Dimensions, 12*, 25–40.

11. Kovat, S.R., & Haines, A. (2005). Global climate change and health: recent findings and future steps. *Canadian Medical Association Journal, 172(4)*, 501–502.

12. World Health Organization. (2000, June). *Health in Emergencies, Issue 6*. Geneva, Switzerland: Author.

13. World Health Organization. (2003). *Looking Back: Looking Ahead*. Geneva, Switzerland: Author.

14. Ollis, W. (Ed.). (2001). Population, Development, and Human Security. *Aviso, 7*, 2–8.

15. Federal Ministry for Economic Cooperation and Development. *Adaptation to Climate Change: Causes, Impacts, Responses*. Bonn, Germany: Author.

16. Wigle, D.T. (2003). *Child Health and the Environment*. New York: Oxford University Press.

17. Beggs, P.J., & Bambrick, H.J. (2005). Is the Global Rise of Asthma an Early Impact of Anthropogenic Climate Change? *Environmental Health Perspectives, 113(8)*, 915–919.

18. Laplante, D.P., Barr, R.G., Brunet, A., Galbaud du Fort, G., Meaney, M.J., Saucier, J-F., et al. (2004). Stress During Pregnancy Affects General Intellectual and Language Functioning in Human Toddlers. *Pediatric Research, 56*, 400–410.

19. Elliot, M. (2001). Gender differences in causes of depression. *Women and Health, 33(3–4)*, 163–177.

20. Enarson, E. (2001). What women do: Gendered labour in the Red River Valley Flood. *Environmental Hazards, 3*, 1–18.

21. McKeown, D. (2005, May 27). Combined Impact of Extreme Heat and Air Pollution on Mortality. *Toronto Staff Report.* Retrieved August 16, 2005, from <http://www.toronto.ca/health/hphe/pdf/boh_combined_impact_smog_and_heat.pdf>.

22. Klinenberg, E. (2002). *Heat Wave: A Social Autopsy of Disaster in Chicago.* Chicago: University of Chicago Press.

23. Soskolne, C.L., Smoyer-Tomic, K.E., Spady, D.W., McDonald, K., Roth, J.P., & Klaver, J.D.A. (2004). *Climate Change, Extreme Weather Events and Health Effects in Alberta.* HPRP File No. 6795-15-2001/4400013. Ottawa, ON: Health Canada.

24. Rohr, U. (2005, July 11). Gender and Climate Change — A Forgotten Issue? *Tiempo Climate Newswatch.* Comment 050711. Retrieved July 22, 2005, from <http://www.tiempoclimate.org/newswatch/comment050711.htm>.

25. Riedel, D. (2004). Human Health. In D.S. Lemmen & F.J. Warren (Eds.), *Climate Change Impacts and Adaptation: A Canadian Perspective* (pp. 151–170). Ottawa, ON: Natural Resources Canada.

26. Krupnik, I., & Jolly, D. (Eds.). (2002). *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change.* Fairbanks, AK: Arctic Research Consortium of the United States & Arctic Studies Centre, Smithsonian Institute.

27. Berner, J., & Furgal, C. (2005). Human Health. *Arctic Climate Impact Assessment.* Retrieved June 30, 2005, from <http://www.acia.uaf.edu/PDFs/Ch15_Pre-Release.pdf>.

28. Ashford, G., & Castleden, J. (2001). *Inuit Observations on Climate Change: Final Report.* Prepared for the Government of Canada's Climate Change Action Fund.

29. Furgal, C.M., Martin, D., Gosselin, P., Viau, A., Nunavik Regional Board of Health and Social Services/Nunavik Nutrition and Health Committee, Labrador Inuit Association & Labrador Inuit Health Commission. (2002). *Climate Change and Health in Nunavik and Labrador: What We Know from Science and Inuit Knowledge.* Prepared for the Government of Canada's Climate Change Action Fund.

References for *Signs of Change, Signs of Trouble: Finding the Evidence* (p. 27)

1. Pinner, R.W., Rebmann, C.A., Schuchat, A., & Hughes, J.M. (2003). Disease surveillance and the academic, clinical, and public health communities. *Emerging Infectious Disease Journal, 9(7)*, 781–787.

2. Edge, V.L., Pollari, F., Lim, G., Aramini, J., Sockett, P., Martin, S.W., et al. (2004). Syndromic surveillance of gastrointestinal illness using pharmacy over-the-counter sales. A retrospective study of waterborne outbreaks in Saskatchewan and Ontario. *Canadian Journal of Public Health, 95(6)*, 446–450.

3. Soskolne, C.L., Smoyer-Tomic, K.E., Spady, D.W., McDonald, K., Rothe, J.P., & Klaver, J.D.A. (2004, April 30). *Final Report: Climate Change, Extreme Weather Events and Health Effects in Alberta.* HPRP File No. 6795-15-2001/4400013. Ottawa, ON: Health Canada.

4. MacKinnon, M. (2005). A First Nations voice in the present creates healing in the future. *Canadian Journal of Public Health, 96 Suppl. 1*, S13–S16.

5. Sang, S., Booth, C., & Balch, G. (2004). *Documentation of Inuit Qaujimajatuqangit (local knowledge) in Pangnirtung, Coral Harbour and Arviat, Nunavut: Nunavut Wildlife Health Assessment Project.* ©World Wildlife Fund Canada and Trent University, Canada. Retrieved from <http://wwf.ca/Documents/Arctic/nwha_eng_sp.pdf>.

6. Charron, D.F., et al. (2004). The Role of High Impact Weather in Waterborne Disease Outbreaks in Canada, 1975–2001. Submitted to *International Journal of Environmental and Occupational Health.*

7. Alto, B.W., & Juliano, S.A. (2001). Precipitation and temperature effects on populations of Aedes albopictus (Diptera: Culicidae): implications for range expansion. *Journal of Medical Entomology, 38(5)*, 646–656.

8. Reiter, P. (2001). Climate change and mosquito-borne disease. *Environmental Health Perspectives, 109 Suppl. 1*, 141–161.

9. Brownstein, J.S., Holford, T.R., & Fish, D. (2003). A climate-based model predicts the spatial distribution of the Lyme disease vector *Ixodes scapularis* in the United States. *Environmental Health Perspectives, 111(9)*, 1152–1157.

10. Ogden, N.H., Lindsay, L.R., Charron, D., Beauchamp, G., Maarouf, A., O'Callaghan, C.J., et al. (2004). Investigation of the relationships between temperature and development rates of the tick *Ixodes scapularis* (Acari: Ixodidae) in the laboratory and field. *Journal of Medical Entomology, 41*, 622–633.

11. Centers for Disease Control. (2003). Notice to Readers: Final 2002 Reports of Notifiable Diseases. *Morbidity and Mortality Weekly Report, 5(31)*, 741–750.

12. Ogden, N.H., Bigras-Poulin, M., Barker, I.K., Lindsay, L.R., Maarouf, A., O'Callaghan, C.J., et al. (2005). A dynamic population model to investigate effects of climate on geographic range and seasonality of the tick *Ixodes scapularis. International Journal of Parasitology, 35*, 375–389.

13. Morshed, M. (2005). Personal communication. British Columbia Centre for Disease Control.

14. Parmesan, C., & Yohe, G. (2003). A globally coherent fingerprint of climate change impacts across natural systems. *Nature, 421*, 37–42.

15. Ogden, N.H., Barker, I.K., Lindsay, L.R., Maarouf, A., O'Callaghan, C.J., Waltner-Toews, D., et al. (2005). *Survival of Ixodes scapularis ticks in habitats of South Eastern Canada: field study and modelling analysis.* In prep.

References for *Extreme Weather Events: Facing the Challenges in Health Emergency Management* (p. 31)

1. Etkin, D., Haque, E., Bellisario, L., & Burton, I. (2004). *An Assessment of Natural Hazards and Disasters in Canada: A Report for Decision-Makers and Practitioners.* Prepared for The Canadian Natural Hazards Assessment Project. ISBN 0-9735436-0-4. Retrieved April 1, 2005, from <http://www.crhnet.ca/docs/Hazards_Assessment_Summary_eng.pdf>.
2. Health Canada. (2004). *Climate Change and Health: Research Report.* Ottawa, ON: Minister of Health.
3. Health Canada. (2003). *Centre for Emergency Preparedness and Response: Report of Activities 2001–2002.* Ottawa, ON: Minister of Health.
4. Federal/Provincial/Territorial Framework on Emergency Preparedness and Response. (2005). *National Framework for Health Emergency Management: Guideline for Program Development.* Ottawa, ON: Author.
5. Miletti, D. (1999). *Disasters by Design: A Reassessment of Natural Disasters in the United States.* Washington, DC: Joseph Henry Press.
6. Public Health Agency of Canada, Office of the Voluntary Sector, voluntary sector definition. Retrieved May 2, 2005, from: <http://www.phac-aspc.gc.ca/vs-sb/voluntarysector/index.html>. The voluntary sector consists of private, non-profit organizations, devoted to the public good, whose activities are carried out by volunteers and paid staff, and whose existence depends on the engagement of citizens to donate their time, knowledge, skills, energy and resources to assist fellow citizens. Voluntary sector organizations are involved in activities designed to provide help to individuals, families, groups and communities.
7. Statistics Canada. (1997, 2000). *Canada Survey of Giving, Volunteering and Participating.* Ottawa, ON: Author. Retrieved from <http://www.vsi-isbc.ca/eng/knowledge>.
8. Statistics Canada. (2004). *Canada Satellite Account of Non-Profit Institutions and Volunteering.* Ottawa, ON: Author. Retrieved from <http://www.vsi-isbc.ca/eng/knowledge>.
9. Canadian Centre for Philanthropy. (2004). *National Survey of Non-profit and Voluntary Organizations.* Toronto, ON: Author. Retrieved from <http://www.imaginecanada.ca>. (Note: In 2005, the Canadian Centre for Philanthropy was renamed Imagine Canada.)
10. Canadian Centre for Philanthropy. (2005). *Johns Hopkins Comparative Nonprofit Survey.* Toronto, ON: Author. Retrieved from <http://www.imaginecanada.ca>. (Note: In 2005, the Canadian Centre for Philanthropy was renamed Imagine Canada.)
11. Health Canada, Voluntary Sector Task Force. (2001, December). *An Accord Between the Government of Canada and the Voluntary Sector.* Catalogue No.CP32-75/2001. Ottawa, ON: Author.
12. Health Canada, Voluntary Sector Initiative. (2002, October). *A Code of Good Practice on Funding: Building on an Accord Between the Government of Canada and the Voluntary Sector.* Catalogue No. CP22-67/2002. Ottawa, ON: Author.
13. Health Canada, Voluntary Sector Initiative. (2002, December). *A Code of Good Practice on Funding: Building on an Accord Between the Government of Canada and the Voluntary Sector.* Catalogue No. CP22-67/2002. Ottawa, ON: Author.
14. Riedel, D. (2004). Human Health. In D.S. Lemmen & F.J. Warren (Eds.), *Climate Change Impacts and Adaptation: A Canadian Perspective* (pp. 151–170). Ottawa, ON: Natural Resources Canada.
15. Canadian Red Cross. (2005). *Expect the Unexpected Program.* Retrieved April 1, 2005, from <http://www.redcross.ca/article.asp?id=009874&tid=028>.
16. Canadian Red Cross. (2005). *Developing the National Network of National Voluntary Health Organizations (NVHOs) Working in Emergency Preparedness, and Maintaining the Passion: The Emergency Response "Episodic" Volunteer.* Report soon to be available from <http://www.redcross.ca>.

References for *Planning Our Future: Reducing the Health Impacts of Climate Change* (p. 35)

1. Burton, I. (1997). Vulnerability and Adaptive Response in the Context of Climate and Climate Change. *Climatic Change, 36,* 185–196.
2. Health Canada. (2003, October). *Learning from SARS: Renewal of Public Health in Canada. Health Canada. A Report of the National Advisory Committee on SARS and Public Health.* Ottawa, ON: Author.
3. Kirby, M. (2003, November). *Reforming Health Protection and Promotion in Canada: Time to Act.* Report to the Standing Senate Committee on Social Affairs, Science and Technology (SSCSAST). Ottawa, ON: Government of Canada.
4. World Health Organization, Health Canada, United Nations Environment Programme, World Meteorological Association. (2003). *Methods of assessing human health vulnerability and public health adaptation to climate change.* Retrieved July 10, 2005, from <http://www.euro.who.int/eprise/main/WHO/Progs/GCH/Publications/20031125_1>.
5. City of Ottawa. (2004, November). *Ottawa 20/20: Air Quality and Climate Change Management Plan.* Retrieved from <http://www.ottawa.ca/city_services/planningzoning/2020/air/index_en.shtml>.

6. Etkin, D., Haque, E., Bellisario, L., & Burton, I. (2004). *An Assessment of Natural Hazards and Disasters in Canada: A Report for Decision-Makers and Practitioners.* Prepared for The Canadian Natural Hazards Assessment Project. ISBN 0-9735436-0-4. Retrieved April 1, 2005, from <http://www.crhnet.ca/docs/Hazards_Assessment_Summary_eng.pdf>.
7. Institute for Population Health. (2002). *Expert Panel Workshop on Climate Change and Health & Well-being in Canada: Key Findings and Recommendations.* Report prepared for Health Canada. Ottawa, ON: University of Ottawa.
8. Ontario Medical Association. (2001, June). *Ontario Air: Years of Stagnation. Report by the Ontario Medical Association.* Toronto, ON: Author.
9. European Environment Agency. (2004). *Impacts of Europe's Changing Climate: An Indicator-based Assessment.* No. 2. Copenhagen, Denmark: Author.
10. Nugent, O., & Holmes, R. (2004, April). *Primer on Climate Change and Human Health.* Pollution Probe. Retrieved from <http://www.pollutionprobe.org>.

Additional References

— Ahmad, Q.K., et al. (2001). Summary for Policymakers. In J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken & K.S. White (Eds.), *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* New York: Cambridge University Press.

— Arctic Council and International Arctic Science Committee. (2004). *Impacts of a Warming Arctic: Arctic Climate Impact Assessment.* Retrieved July 10, 2005, from <http://amap.no/acia/>.

— Chiotti, Q., Morton, I., & Maarouf, A. (2002). *Toward an Adaptation Action Plan: Climate Change and Health in the Toronto-Niagara Region.* Prepared for Natural Resources Canada, Climate Change Action Fund.

— Commission on the Future of Health Care in Canada. (2002, November). *Building on Values: The Future of Health Care in Canada — Final Report.* ISBN 0-662-33043-9. Saskatoon, SK: National Library of Canada.

— Frank, J., Di Ruggiero, E., & Moloughney, B. (2003). *The Future of Public Health in Canada: Developing a Public Health System for the 21st Century.* Toronto, ON: Canadian Institutes of Health Research.

— Government of Canada. (2005). *Project Green — Moving Forward on Climate Change: A Plan for Honouring Our Kyoto Commitment.* Retrieved from <http://www.climatechange.gc.ca>.

— Health Canada. (2000). *Health Canada Decision-Making Framework for Identifying, Assessing, and Managing Health Risks.* Ottawa, ON: Author.

— Health Canada, Environmental and Workplace Health. (2001). *Climate Change and Health and Well-Being: A Policy Primer.* Catalogue No. H46-2/02-260. Ottawa, ON: Minister of Public Works and Government Services Canada. Retrieved July 10, 2005, from <http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/policy_primer-abecedaire_en_matiere/index_e.html>.

— Intergovernmental Panel on Climate Change. (2001). *Climate Change 2001: Working Group II: Impacts, Adaptation and Vulnerability.* Chapter 9: Human Health. Retrieved from <http://www.grida.no/climate/ipcc_tar/wg2/347.htm>.

— Kovats, S., & Haines, A. (2005, February 15). Global Climate Change and Health: Recent Findings and Future Steps. *Canadian Medical Association Journal, 172(4)*, 501.

— Ontario Medical Association. (1998). *The Illness Costs of Air Pollution in Ontario: A Summary of Findings.* Retrieved from <http://www.oma.org/phealth/icap.htm>.

— Riedel, D. (2004). Human Health. In D.S. Lemmen & F.J. Warren (Eds.), *Climate Change Impacts and Adaptation: A Canadian Perspective.* Ottawa, ON: Natural Resources Canada. Retrieved from <http://adaptation.nrcan.gc.ca/perspective_e.asp>.

— Sheltair Group. (2003). *Climate Change Impacts and Adaptation Strategies for Urban Systems in Greater Vancouver: Volume 1 — Preliminary Assessment.* Vancouver, BC: Natural Resources Canada.

— World Health Organization, World Meteorological Organization & United Nations Environment Program. (2003). *Climate Change and Human Health: Risks and Responses.* Geneva, Switzerland: WHO. Retrieved from <http://www.who.int/globalchange/climate/summary/en/>.

References for *Using Canada's Health Data* (p. 41)

1. World Health Organization, World Meteorological Organization & United Nations Environment Program. (2003). *Climate Change and Human Health: Risks and Responses.* Geneva, Switzerland: WHO. Retrieved January 13, 2005, from <http://www.who.int/globalchange/climate/summary/en/>.
2. Etkin, D. (1998). Climate Change and Extreme Events: Canada. In N. Mayer & W. Avis (Eds.), *The Canada Country Study: Climate Impacts and Adaptation. National Cross-Cutting Issues Volume* (Chapter 2, pp. 31–80). Environment Canada. Retrieved June 15, 2005, from <http://dsp-psd.pwgsc.gc.ca/Collection/En56-119-7-1998E.pdf#search='Canada%20Country%20Study%3A%20Impacts%20and%20Adaptation'>.

3. Soskolne, C.L., Smoyer-Tomic, K.E., Spady, D.W., McDonald, K., Rothe, J.P., & Klaver, J.D.A. (2004, April 30). *Final Report: Climate Change, Extreme Weather Events and Health Effects in Alberta*. HPRP File No. 6795-15-2001/4400013. Ottawa, ON: Health Canada.

4. Health Canada, Climate Change and Health Office. *Canada's Health Concerns from Climate Change and Variability*. Retrieved August 1, 2005, from <http://www.hc-sc.gc.ca/ewh-semt/climat/health_table-tableau_sante_e.html>.

References for *Did You Know* (various pages)*

1. Arctic Council and International Arctic Science Committee. (2004). *Impacts of a Warming Arctic: Arctic Climate Impact Assessment*. Retrieved July 10, 2005, from <http://amap.no/acia/>.

2. International Council for Local Environmental Initiatives. Retrieved April 15, 2005, from <http://www.hotcities.org/#anchor706126>.

3. Dhakhwa, G.B., & Campbell, C.L. (1998). Potential effects of differential day-night warming in global climate change on crop production. *Climatic Change, 40(3–4)*, 647–667.

4. Lemmen, D.S., & Warren, F.J. (Eds.). (2004). *Climate Change Impacts and Adaptation: A Canadian Perspective*. Ottawa, ON: Natural Resources Canada.

5. Bradley, C.B., et al. (2000). Probable locally acquired mosquito-transmitted Plasmodium vivax infection, Suffolk County, New York, 1999. *Morbidity and Mortality Weekly Report, 49(22)*, 495–498.

6. Chiotti, Q., Morton, I., & Maarouf, A. (2002). *Toward an Adaptation Action Plan: Climate Change and Health in the Toronto-Niagara region*. Prepared for Natural Resources Canada, Climate Change Action Fund.

7. Air Quality Ontario. (2005). *Smog Alerts*. Ontario Ministry of the Environment. Retrieved April 19, 2005, from <http://www.airqualityontario.com/alerts/alert.cfm>.

*Note: *Did You Know?* is a regular column of the *Health Policy Research Bulletin* examining aspects of health information, data and research that may be subject to misconception. In this issue, we examined a number of misconceptions about climate change and health which appeared on various pages throughout Issue 11 as *Myths?* with an explanatory true/false statement.