ONTARIO CLIMATE CHANGE AND HEALTH VULNERABILITY AND ADAPTATION ASSESSMENT GUIDELINES

Technical Document

Ontario

Authors: Kristie Ebi, Vidya Anderson, Peter Berry, Jaclyn Paterson, Anna Yusa

Acknowledgements: This publication was completed with financial support from Health Canada and weather and climate data analysis from the Climate Research Division at Environment Canada. The authors would also like to thank Nicholas Friedel for his contributions to the report.

Ministry of Health and Long-Term Care

Public Health Policy and Programs Branch

393 University Avenue, 21st Floor

Toronto, ON M7A 2S1

Copies of this report can be obtained from
INFOline: 1-866-532-3161
TTY 1-800-387-5559

ISBN 978-1-4606-6228-1 (PDF)

TABLE OF CONTENTS

PREFACE

The Environmental Health Climate Change Framework for Action has been developed by the Population and Public Health Division of the Ministry of Health and Long-Term Care to meet the public health challenges of a changing climate in Ontario. This framework is designed to support an adaptive and resilient public health system that anticipates, addresses and mitigates the emerging risks and impacts of climate change. This framework will improve the overall effectiveness and efficiency of the public health system and its ability to:

- Reduce incidence of adverse health outcomes from the impacts of climate change
- Reduce public exposure to health hazards related to a changing climate
- Identify interventions that reduce exposure to climate change impacts
- Enhance capacity to address the risk factors associated with climate change

As part of the Environmental Health Climate Change Framework for Action, a toolkit has been developed to assist public health units across Ontario.

This toolkit includes the:

- Ontario Climate Change and Health Vulnerability and Adaptation Assessment Guidelines: Technical Document;
- Ontario Climate Change and Health Vulnerability and Adaptation Assessment Guidelines: Workbook; and
- Ontario Climate Change and Health Modelling Study: Report.

These documents are designed to be used in concert to enable public health units to identify vulnerabilities within their communities; identify and implement local mitigation and adaptation strategies; raise awareness about the health hazards of climate change; and reduce public health vulnerability to climate change.

PURPOSE AND CONTEXT OF THE ASSESSMENT

Climate change and health vulnerability and adaptation (V&A) assessments are conducted at local to national scales to understand current impacts and projected future risks of climate variability and change, and to identify policies and programs to increase resilience to these risks. V&A assessments:

- Improve evidence and understanding of the current associations between weather/climate and health outcomes;
- Provide health and emergency management officials, stakeholders, and the public with information on the magnitude and pattern of current and future health risks associated with climate variability and change, including the populations most vulnerable to these risks;
- Identify opportunities to incorporate climate change concerns into existing policies and programs designed to manage health risks associated with weather and climate, and to develop new programs where necessary to prevent and reduce the severity of future risks;
- Serve as a baseline analysis against which future changes in risks and in associated policies and programs can be monitored; and
- Forge collaborations with sectors such as water and infrastructure to further promote activities to improve population health in a changing climate.

Photo Credit: CDC/James Gathany

This document provides practical guidance for conducting a vulnerability and adaptation assessment by public health units across Ontario. The assessment will provide information on the health risks of climate change and options to manage those risks that can be used by health units and communicated to the public and relevant stakeholders. An underlying theme is the importance of conducting a comprehensive assessment that includes other sectors and considers interdependencies. Doing so will help public health officials inform and improve existing operational processes with findings about climate change impacts on health. It will also facilitate cross-sectoral collaboration on new and existing adaptation programs. Achieving this type of integration is necessary to increase the resilience of Ontario communities to a changing climate. Box 1 provides an example. The guidelines presented here are flexible so that the assessment can be tailored to the circumstances, resources, and interests of health units and stakeholders.

Cumulative greenhouse gas emissions will determine the amount of climate change that communities will need to adapt to by mid-century, so reducing emissions is a high priority. Hospitals and health care facilities are often a significant source of such emissions. However, this document does not explicitly address conducting an assessment of actions that primary health care providers and public health units could undertake to reduce their greenhouse gas emissions.

Box 1: Heat-Health Vulnerability and the City of Windsor's Heat-Health Management Plan

In 2011, the City of Windsor carried out a vulnerability assessment to understand the community's exposure and sensitivity to extreme heat events as well as its capacity to adapt. A key finding of the assessment was that Windsor would face an increasing population of seniors and individuals with chronic illnesses, leading to a growth in the population vulnerable to the impacts of extreme heat events (Berry et al. 2011). The assessment recommended targeted education and outreach services for these groups to increase awareness about health risks from extreme heat events.

The *Stay Cool Windsor-Essex Heat Alert and Response Plan* includes communications and outreach activities that address the information needs of these key populations. Windsor targeted seniors with advertising in the publication *Retired Living* which is distributed monthly to neighborhoods with higher senior populations and to various other locations throughout Windsor-Essex (30,000 copies total). Seniors and individuals with chronic diseases were also targeted through pharmacy labels. Tips on the labels advised people to talk to their doctor or pharmacist about the impact of heat on health and possible interactions with medications (Richters, 2012).

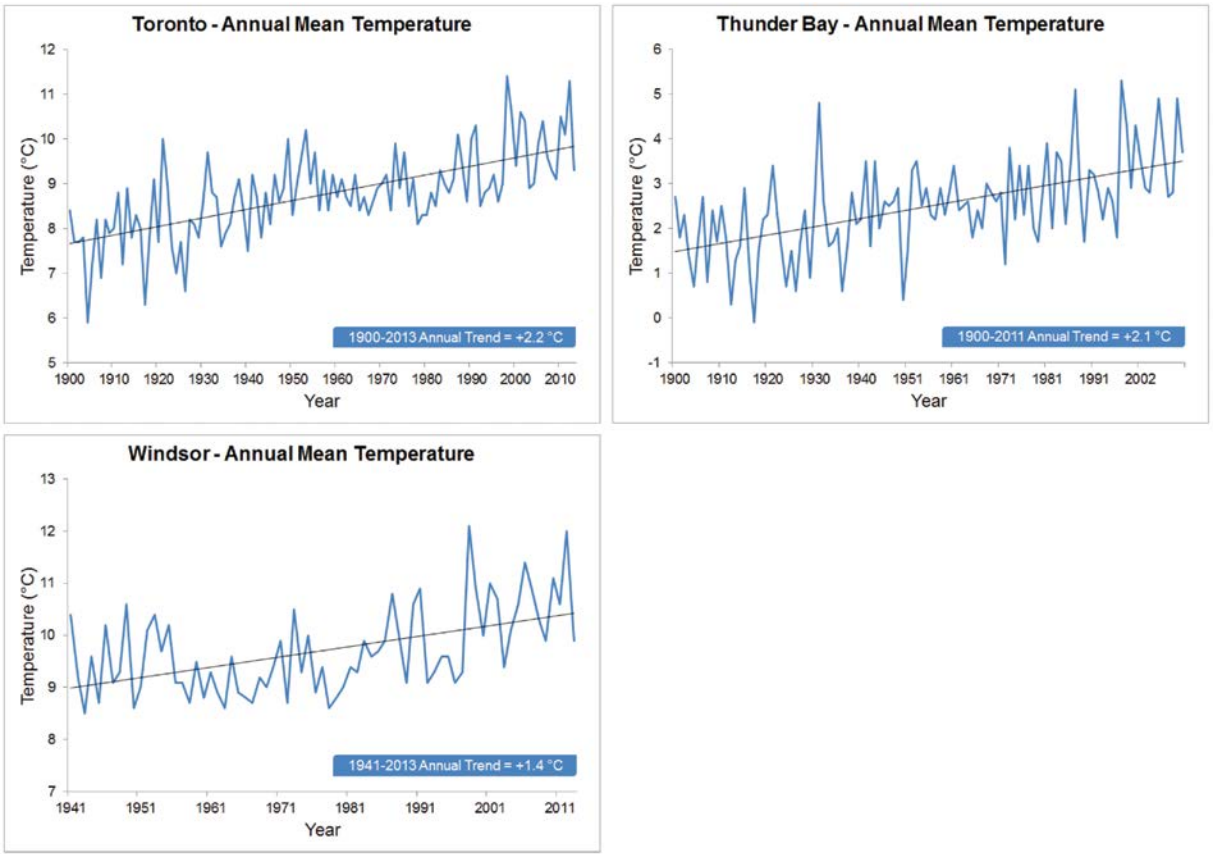
Climate Change in Ontario

Ontario covers a large geographical area and there are significant differences in climate in different parts of the province. Environment Canada provides historical climate data from stations across Ontario through its National Climate Archive (http://climate.weather.gc.ca/). Adjusted and homogenized Canadian climate data (including stations in Ontario) are also available from Environment Canada to assess long-term climate trends and variability (http://www.ec.gc.ca/dccha-ahccd/). To illustrate change in different regions of the province, Figure 1 shows the time evolution and long-term changes in annual, winter, and summer mean temperatures for three Ontario cities (Toronto, Thunder Bay and Windsor) over different periods of record (depending on the data available). For Toronto, the annual, winter, and summer mean temperatures increased 2.2, 2.6, and 1.9°C, respectively, over the period 1900–2013. For Thunder Bay, the annual, winter, and summer mean temperatures increased 2.1, 2.2, and 2.0°C, respectively, from 1900 to 2011. For Windsor, the annual, winter, and summer mean temperatures increased 1.4, 1.5, and 1.3°C, respectively, over the period 1941–2013.

Source: Ontario Ministry of Natural Resources and Forestry

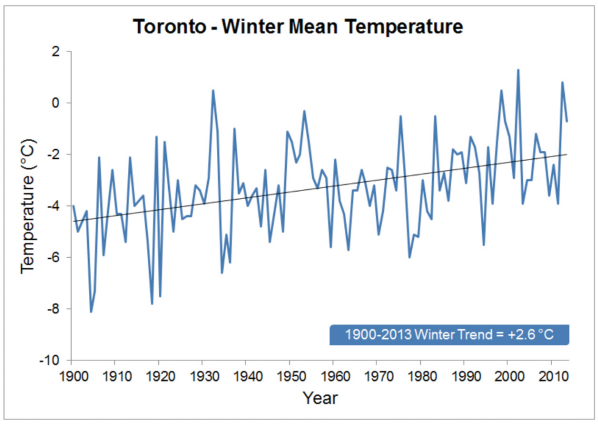
Figure 1: Time Series and Long-term Trends in a) Annual, b) Winter, and c) Summer Mean Temperatures for Toronto, Thunder Bay, and Windsor, Ontario[1]

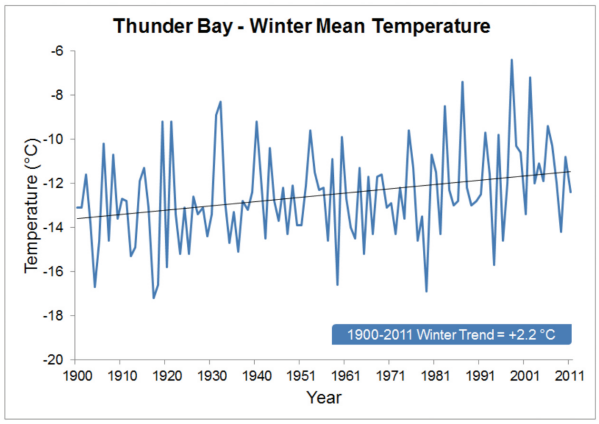
a)

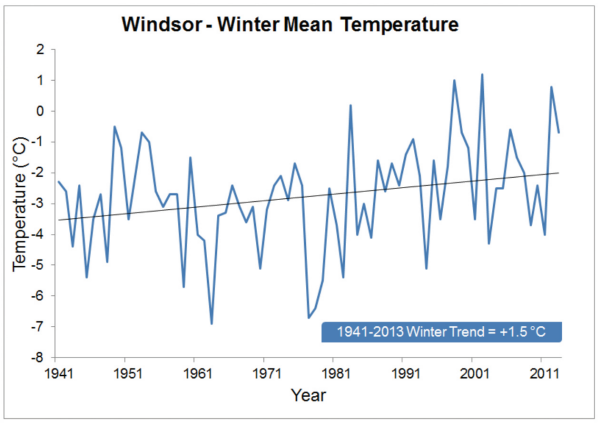


1 Trends were calculated using linear regression, based on data from Environment Canada.

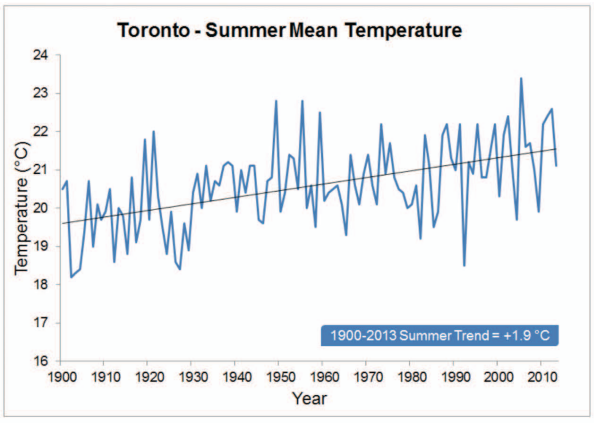
b)

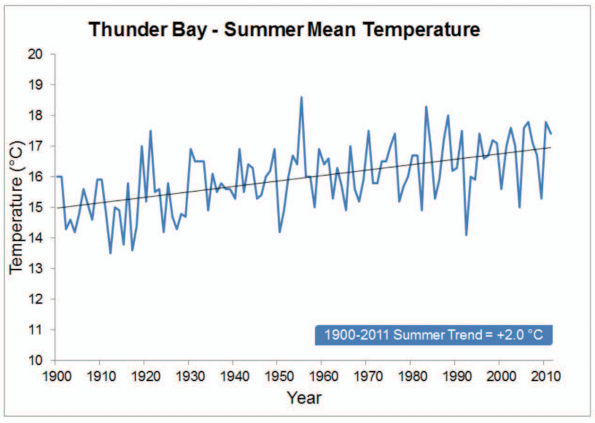

Toronto - Winter Mean Temperature
Temperature (°C)
Year
1900-2013 Winter Trend = +2.6 °C

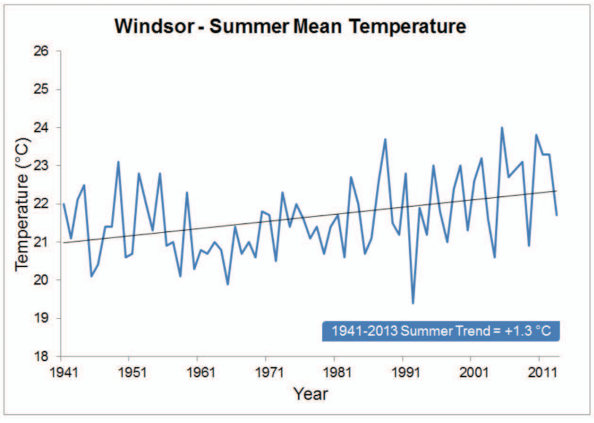

Thunder Bay - Winter Mean Temperature
Temperature (°C)
Year
1900-2011 Winter Trend = +2.2 °C


Windsor - Winter Mean Temperature
Temperature (°C)
Year
1941-2013 Winter Trend = +1.5 °C

c)


Toronto - Summer Mean Temperature
Temperature (°C)
Year
1900-2013 Summer Trend = +1.9 °C


Thunder Bay - Summer Mean Temperature
Temperature (°C)
Year
1900-2011 Summer Trend = +2.0 °C


Windsor - Summer Mean Temperature
Temperature (°C)
Year
1941-2013 Summer Trend = +1.3 °C

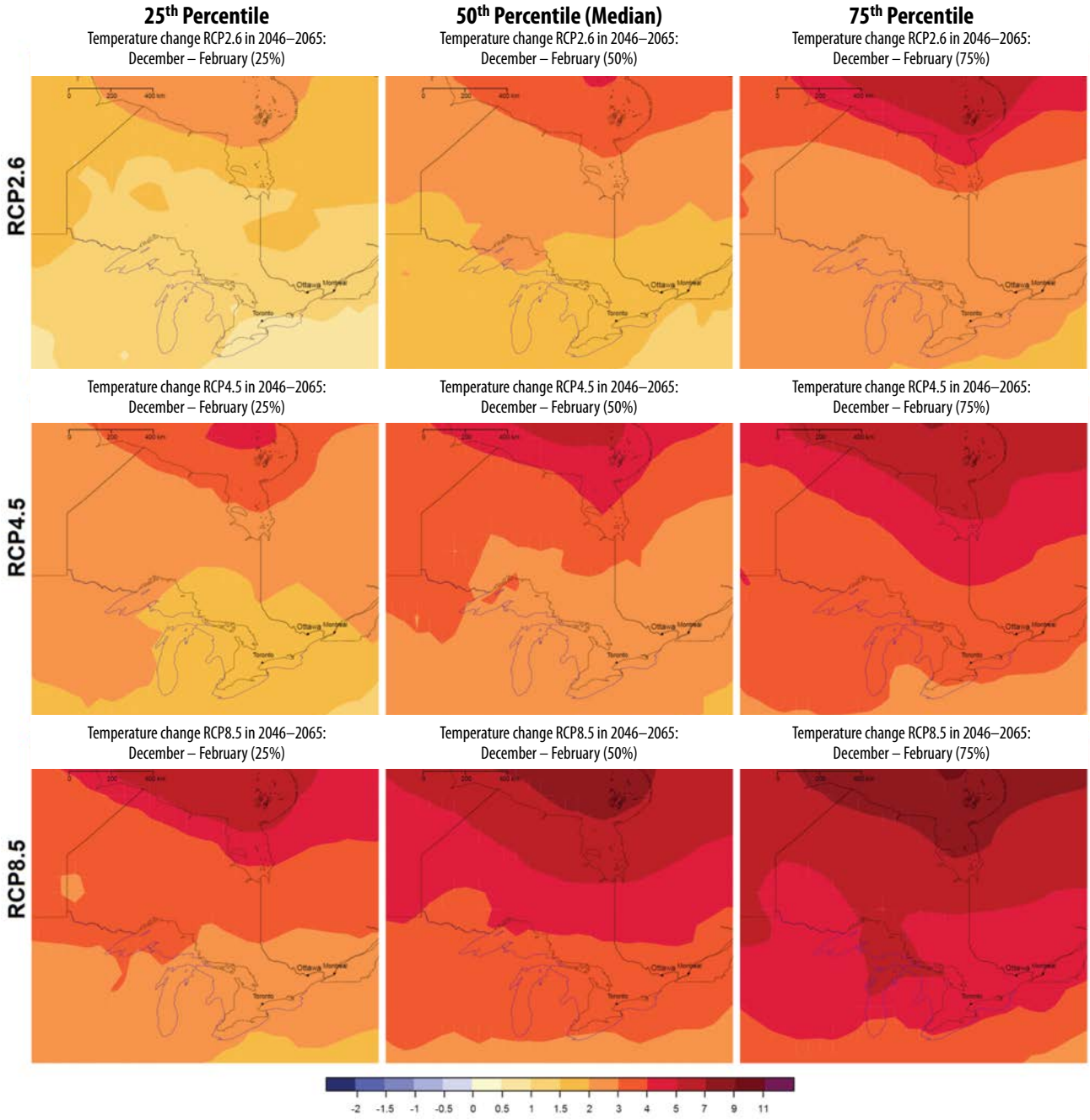
Annual mean temperature is projected to increase in the future, with the magnitude of projected increase largely dependent on future emissions of greenhouse gases. For example, by the middle of the 21st Century, winter (December–February) average temperature in Ontario is projected to increase by 3.2°C (with a range of 2.4–4.1°C, relative to the 1986–2005 baseline period; see Table 1 and Figure 2) under a mid-range atmospheric GHG concentration scenario characterized by RCP4.5 (one of the four Representative Concentration Pathways, or RCPs, used in the IPCC Fifth Assessment Report). The projected increase in winter average temperature in Ontario under the "business as usual" scenario (RCP8.5, which represents higher atmospheric GHG concentrations and little additional mitigation measures) is 4.6°C, with a range of 3.4–5.4°C. Under an aggressive mitigation scenario (RCP2.6, which represents lower atmospheric GHG concentrations), the projected winter average temperature increase in Ontario is 2.2°C (1.5–2.8°C). The analogous summer (June–August) average temperature projections for Ontario are: 2.1°C (range: 1.6–2.8 under RCP4.5; Table 1, Figure 3); 3.1°C (range: 2.6–3.9 under RCP8.5); and 1.4°C (range 1.0–2.2 under). Table 1 gives the projected winter and summer temperature increases for Ontario for the mid-21st Century, relative to the 1986–2005 baseline period (the median value as well as the range from the 25th to 75th percentiles) under three Representative Concentration Pathways. These projected increases are presented graphically in Figures 2 (winter) and 3 (summer). Additional Ontario-specific high resolution regional climate projections can be found at http://ontarioCCDP.ca and http://lamps.math.yorku.ca/drupal/ontariogmap.

Table 1: Projected Winter and Summer Average Temperature Increases for Ontario for the Mid-21st Century (2046–2065) Time Horizon (relative to 1986–2005 baseline period) as Calculated from Coupled Model Intercomparison Project Phase 5 (CMIP5) Multi-model Ensemble Projections (analysis from Environment Canada, 2015)

RCP 2.6	PROJECTED AVERAGE WINTER (DEC, JAN, FEB) TEMPERATURE INCREASE	PROJECTED AVERAGE SUMMER (JUNE, JULY, AUGUST) TEMPERATURE INCREASE
Median (50th Percentile)	2.2°C	1.4°C
Range (25th – 75th Percentile)	1.5–2.8°C	1.0–2.2°C
RCP 4.5	**PROJECTED AVERAGE WINTER (DEC, JAN, FEB) TEMPERATURE INCREASE**	**PROJECTED AVERAGE SUMMER (JUNE, JULY, AUGUST) TEMPERATURE INCREASE**
Median (50th Percentile)	3.2°C	2.1°C
Range (25th – 75th Percentile)	2.4–4.1°C	1.6–2.8°C
RCP 8.5	**PROJECTED AVERAGE WINTER (DEC, JAN, FEB) TEMPERATURE INCREASE**	**PROJECTED AVERAGE SUMMER (JUNE, JULY, AUGUST) TEMPERATURE INCREASE**
Median (50th Percentile)	4.6°C	3.1°C
Range (25th – 75th Percentile)	3.4–5.4°C	2.6–3.9°C

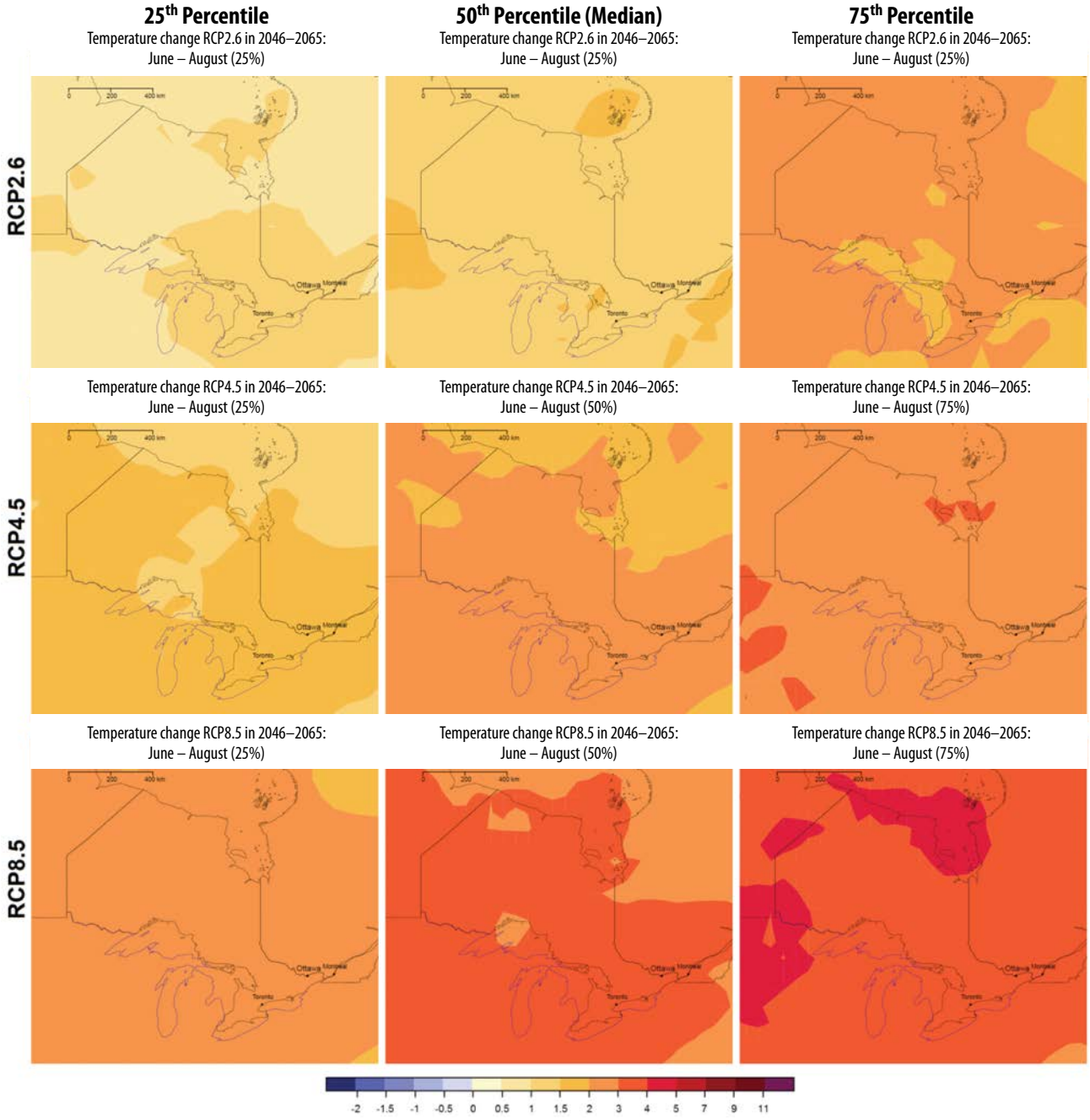
Source: Analysis from Environment Canada 2015

Figure 2: Projected Increase in Average Winter Temperature (°C) for the Mid-21st Century (relative to 1986–2005 baseline period) Under Three Representative Concentration Pathway (RCP) Scenarios



Source: Environment Canada 2015

Figure 3: Projected Increase in Average Summer Temperature (°C) for the Mid-21st Century (relative to 1986–2005 baseline period) Under Three Representative Concentration Pathway (RCP) Scenarios



Source: Environment Canada 2015

Climate change is bringing not just changes in temperature, but also changes in precipitation and in the frequency, intensity, and duration of extreme weather and climate events. Ontario has seen an increase in prolonged heat events, heavy rainstorms, and windstorms. Probabilistic projections of extreme events are available at http://lamps.math.yorku.ca/drupal/ontariogmap, with future precipitation intensity, duration and frequency (IDF) curves available at http://OntarioCCDP.ca.

Although there is uncertainty around attributing any one extreme event to climate change directly, there is scientific consensus that a broad range of health risks will increase as the climate continues to change. Box 2 provides an example of the significant impacts forest fires can have on communities and the health of individuals.

Box 2: Health Impacts of Forest Fires that Affected Northern Ontario in July, 2011

On July 6, 2011, a lightning storm sparked a series of forest fires that rapidly spread across northwestern Ontario, lasting for over two weeks (120 fires were reported on July 20). Many First Nations communities were directly threatened by the fires and those at increased risk of suffering from smoke inhalation were ordered to evacuate, as were communities impacted by power outages, food shortages, and a lack of food storage capacity. In total, 3292 people were evacuated from 8 First Nations communities including the entire communities of Keewaywin and Koocheching First Nations. Residents were relocated to 14 communities as far away as Southern Ontario and Manitoba. Evacuation and displacement from extreme weather events and related hazards can have negative psychosocial impacts on communities (Wilk et al. 2014).

Source: Public Safety Canada 2013

Definitions and Framing

Climate change presents many risks to health and well-being in Ontario. The V&A assessment is designed to increase understanding of how climate change may affect the health of people in Ontario's communities. Assessment results facilitate community-driven change that builds and maintains healthy communities and environments, while taking the economic implications of these changes into account, including the costs associated with reducing the burden of climate-sensitive health outcomes and reducing the strains on health care systems.

Conducting a climate change vulnerability and adaptation assessment has much in common with similar types of studies such as health impact assessments and risk assessments, and also points of departure. Therefore, many steps will be familiar, but others will require different approaches and interactions. In particular, understanding and effectively managing the health risks of climate change requires working with departments and stakeholders in other sectors.

This guidance is closely aligned with *Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011–2014* where a commitment was made to require consideration of climate change adaptation in the province's policies and programs. The Action Plan focused on five goals and has specific actions of immediate relevance to human health including:

- Raise public awareness of Lyme disease;
- Raise awareness about the health hazards of climate change;
- Support the development of risk management tools to manage heat-related illnesses;
- Consider climate change impacts in the Building Code;
- Integrate adaptive solutions into drinking water management; and
- Develop guidance for stormwater management.

In addition, this guidance supports the government's mandate to build on, and support, the most current science, and Ontario's new climate change strategy available at https://www.ontario.ca/page/climate-change-strategy, that sets out Ontario's vision for combating climate change and achieving a greenhouse gas emissions reduction target of 80 per cent below 1990 levels by 2050. This guidance also assumes familiarity with the Ontario Public Health Standards and Protocols (Box 3).

Source: Shutterstock

Box 3: Ontario Public Health Standards and Protocols

The *Ontario Public Health Standards and Protocols* establish the minimum requirements for fundamental public health programs and services; this includes assessment and surveillance, health promotion and policy development, disease and injury prevention, and health protection. Of particular relevance are the *Health Hazard Prevention and Management Standard* and related protocols. These focus on increasing public awareness of health hazards in the environment, including climate change; implementing control measures to prevent or reduce exposure to health hazards; managing health hazards in the environment; and developing policies related to reducing such hazards.

The document is available at: http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/

The results of the V&A assessment should be communicated broadly, so that identified risks to health and information on existing vulnerabilities can be included in future policies and action plans.

Key Definitions

The inherent multi-disciplinarity of climate change means that framing, concepts, and definitions central to the assessment process need to be agreed upon across sectors to facilitate common understanding of an approach to data acquisition and analysis. A few key terms are:

Adaptation – is the process societies go through in order to prepare for and cope with an uncertain future. Adapting to climate change entails taking measures to reduce the negative effects of climate change – or to take advantage of the positive effects.

Impact – an impact is a change in, for example, a health outcome. *Impact* is used instead of *effect* to better characterize the often complex interrelationships between changes in weather variables (including extreme weather and climate events) other factors that are important for determining the magnitude and pattern of a health outcome, and the health outcome. For example, changing weather patterns mean that the ticks that can carry Lyme disease are increasing their geographic range in southern Ontario. This change in range along with outdoor activities putting people into contact with ticks, increased forestation in some urban areas, and other factors can affect the distribution and incidence of the disease. Impacts can refer not just to effects on lives, but also on ecosystems, economic status, social and cultural assets, and infrastructure, as well as to effects on geophysical systems, including floods and droughts. The term impact is generally used to describe effects that have occurred.

Mitigation – in climate change science, mitigation means human interventions to reduce the sources of greenhouse gasses or enhance their sinks. This differs from standard usage in health, disaster risk management, and other fields, where it means actions to reduce the severity or seriousness of an outcome.

Resilience – describes the capacity of a system to respond or cope with a hazardous event or disturbance in ways that maintain its essential function.

Risk – describes the possible consequences of future changes in climate and the other factors relevant for a health outcome. Risk is generally described as the probability of occurrence of an adverse event multiplied by the consequences of that event if it occurs. For example, extreme heat events are increasing in frequency, intensity, and duration, increasing the risk of heat stress in vulnerable populations.

Sensitivity – is the degree to which a community or system is affected (positively or negatively) by climate variability or change.

Vulnerability – the core of the many definitions of *vulnerability* is that it is the propensity or predisposition to be adversely affected. Vulnerability can arise because of individual susceptibility, geographic location, socioeconomic factors, and a wide range of other factors that determine an individual or community's susceptibility to harm and ability to cope with an event. For example, certain individuals can be vulnerable to extreme heat events because of where they live (parts of cities may warm more than others), characteristics of their dwelling (such as whether there is cross ventilation) that influence inside temperature, socioeconomic status, age, fitness, and a range of other factors that determine their susceptibility to high ambient temperatures.

Useful Resources

World Health Organization – *Protecting Health from Climate Change: Vulnerability and Adaptation Assessment*
www.who.int/globalchange/publications/vulnerability-adaptation/en/

Health Canada – *Adapting to Extreme Heat Events: Guidelines for Assessing Health Vulnerability*
http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/adapt/index-eng.php

European Centre for Disease Prevention and Control – *Climate Change and Communicable Diseases in the EU Member States:* Handbook for National Vulnerability, *Impact and Adaptation Assessments*
http://www.ecdc.europa.eu/en/publications/Publications/1003_TED_handbook_climatechange.pdf

Ontario Ministry of Natural Resources and Forestry – *Climate Change and the Lake Simcoe Watershed: A Vulnerability Assessment of Natural Heritage Areas* and *Nature-based Tourism – CCRR28*
http://files.ontario.ca/environment-and-energy/aquatics-climate/stdprod_100941.pdf

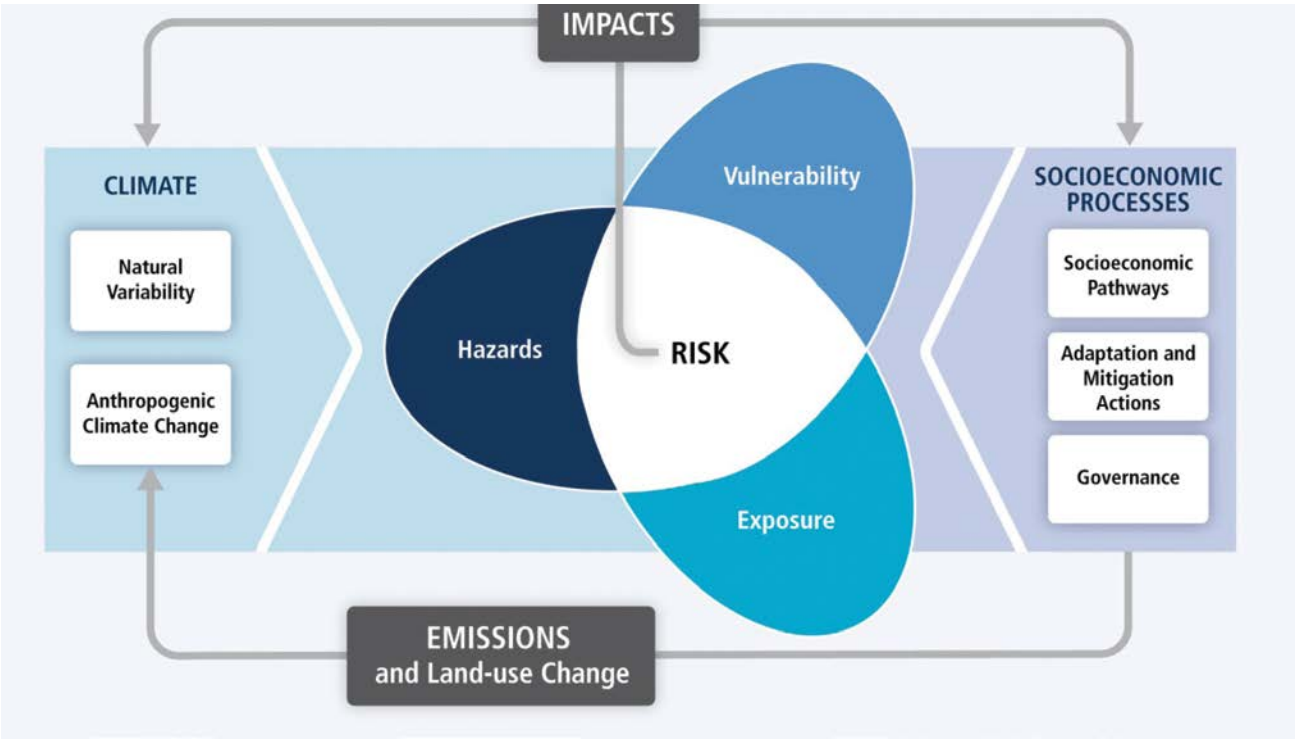
Canadian Council of Forest Ministers – *Adapting Sustainable Forest Management to Climate Change: Scenarios for Vulnerability Assessment*
http://www.ccfm.org/pdf/WilliamsonVulnerability_Eng_Final.pdf

Understanding and Managing the Risks of Climate Change

Figure 3 shows the framework for understanding the risks of climate variability and change, including those on human health. The magnitude and pattern of the health risks are a function of the:

- Hazards resulting from a changing climate, such as changing precipitation patterns, and increases in the frequency, intensity, and duration of heat events;
- The populations exposed to those hazards; and
- The vulnerability of exposed populations. Vulnerability is determined by population sensitivity to the exposure due to individual physiological factors, demographic structure, and other factors It is also determined by the ability of individuals and institutions to prepare for, cope with, respond to, and recover from the exposure (IPCC 2014; NRC 2012).

Figure 3: Framework of the Risks of Climate Variability and Change



Source: IPCC, 2014

The figure also shows that natural climate variability and anthropogenic climate change are drivers of weather and climate-related hazards, and that a range of socioeconomic processes are drivers of vulnerability and exposure.

This framing is useful as it highlights that a V&A assessment is not only about climate change, but is about all factors that can interact with climate to increase or decrease risk. An assessment needs to consider how climate change has or likely will alter the weather and climate hazards to which a population is exposed, whether exposures are likely to change with increasing climate change, and the characteristics of individuals and populations that can increase their risk when exposed to the hazard. This information is needed to be able to identify how modifying current programs could reduce the burden of climate-sensitive health outcomes. It is important to consider the full range of options for reducing health risks, including those that could be taken by other departments. For example, the health risks of high ambient temperatures can be exacerbated by urban heat islands; altering the built environment to reduce heat retention at night, changing land use planning to increase the amount of green space, modifying building codes to encourage the use of white roofs, and other factors could reduce these risks.

Source: Ontario Ministry of Natural Resources and Forestry. Photo Credit: Adam McAllister/ MNRF

Structure of the Guidelines

The steps of the assessment are described below, including the choices that need to be made and the approaches that can be used. The structure is flexible so the assessment can be tailored to the circumstances and resources of local public health units and communities. Only those steps most appropriate to address the focus of the assessment need to be followed in detail, although considering all steps will strengthen the relevance and usefulness of the assessment.

Sufficient time and effort should be devoted at the start of the assessment to deciding the health outcomes to be included. Increases in the frequency and intensity of extreme weather and climate events, particularly heat events and extreme precipitation, mean that including the health risks of climate variability may be particularly relevant. There may be pre-existing concerns about vector-borne diseases, air pollution, or other climate-sensitive health outcomes. Priorities will need to be set when there are more concerns than available time and resources. The choice of the health outcome(s) will determine the range of stakeholders and skill sets needed to conduct the assessment.

Because an important component of an assessment is informing the public and policymakers of the health risks of climate change, and of actions to reduce those risks, the assessment should deliver not just a report, but also communication materials to inform the public and media of the process and outcomes. Communication is generally more effective when it is started at the beginning of the assessment, providing information throughout the process to interested stakeholders and the public. Table 2 provides examples of climate change vulnerability assessments.

Source: Ontario Ministry of Natural Resources and Forestry

Table 2: Examples of Climate Change Vulnerability Assessments

ASSESSMENT EXAMPLE	DESCRIPTION
Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation (2014)	The report presents impacts, adaptations and recommendations to reduce climate change risks across sectors relevant to the Canadian context. It is an update to the 2008 science assessment report, *From Impacts to Adaptation: Canada in a Changing Climate*. A chapter on Human Health provides updated information on a wide range of health risks to Canadians that are increasing as the climate continues to change. For example, climate-sensitive diseases (e.g. Lyme disease) and vectors are moving northward into Canada and will likely continue to expand their range. The chapter also provides information on adaptation measures being taken in the health sector in Canada and provides recommendations for further actions. Source: http://www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2014/16309
Human Health in a Changing Climate: A Canadian Assessment of Vulnerabilities and Adaptive Capacity (2008)	The report synthesizes knowledge around the impacts of climate on the health of Canadians at the time of publication and what can be expected with climate change. The assessment examines issues including extreme weather events, air quality, water, food, vector and rodent borne diseases, and provides two regional assessments (the province of Quebec and Canada's North). It includes an assessment of health vulnerabilities, adaptation and adaptive capacity in Canada. Many adaptation measures can be taken to reduce climate change and health risks in Canada; an inventory of possible measures is provided in the report. Source: http://publications.gc.ca/collections/collection_2008/hc-sc/H128-1-08-528E.pdf
Climate Change Impacts in the United States (2014)	The assessment report was developed by a team of more than 300 experts guided by a 60-member Federal Advisory Panel. It examines how climate change affects key sectors such as health, water, and agriculture and impacts urban areas, rural communities, and Indigenous Peoples. Source: http://www.globalchange.gov/ncadac
Assessment Of Vulnerability To The Health Impacts Of Climate Change In Middlesex-London (2014)	The assessment examines possible health vulnerabilities resulting from climate change in Middlesex-London and provides recommendations about how to enhance adaptive capacity to address these vulnerabilities. The report focuses on key threats to health. Baseline measures of climate-related health vulnerability in the Middlesex-London region are established through analysis of historical weather variability and the occurrence of climate hazards and impacts, climate change projections, and priority health risks from climate change. Populations most vulnerable to current and future health impacts are identified. The report concludes with recommendations about how to enhance adaptive capacity within Middlesex-London to address the health vulnerabilities. Source: https://www.healthunit.com/climate-change
Assessing Health Vulnerability to Climate Change in the Region of Peel (2012)	The assessment was undertaken as part of implementing the Region's comprehensive climate change strategy. The assessment found that climate change may impact human health in Peel Region through increases in temperature, air pollution, extreme weather events, food and water contamination, vector survival, and health inequalities. Groups within the community that are more vulnerable to these impacts were identified and it was determined that existing programming may not be able to address these future impacts. The report recommended extensive consultations to further inform programming and policy, continued health information gathering and sharing, and using the assessment as a basis for broader discussions around public health vulnerability to climate change in the Region. Source: http://www.peelregion.ca/planning/climatechange/

STEPS IN CONDUCTING A VULNERABILITY AND ADAPTATION ASSESSMENT

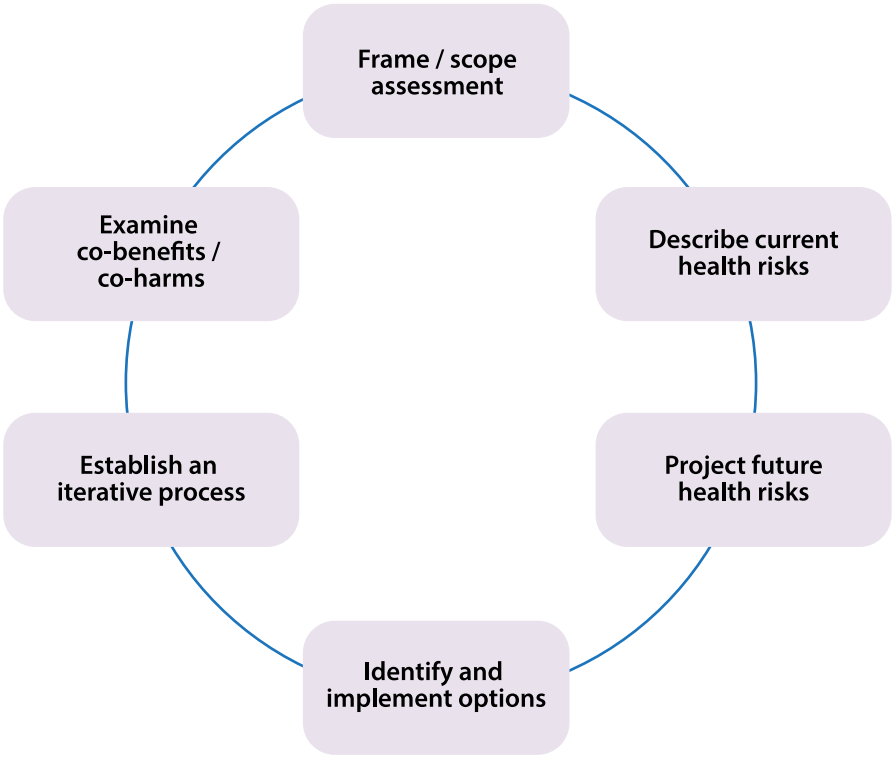
The six assessment steps are designed to produce a comprehensive vulnerability and adaptation assessment of the current and projected health risks of climate variability and change. They include:

1. Frame and scope the assessment;
2. Describe current risks, including vulnerabilities and capacities;
3. Project future health risks;
4. Identify and prioritize policies and programs to manage the additional health risks associated with a changing climate;
5. Establish an iterative process for managing and monitoring health risks;
6. Examine the potential health benefits and co-harms of adaptation and mitigation options implemented in other sectors.

Annex I provides a checklist of actions required to undertake a climate change and health vulnerability and adaptation assessment.

Figure 4 below illustrates the recommended steps for conducting a climate change and health vulnerability assessment in Ontario health unit jurisdictions.

Figure 4: Steps in a Health Vulnerability and Adaptation Assessment



Step 1: Frame and Scope the Assessment

Before an assessment is initiated, the assessment needs to be framed and scoped, which includes identifying:

- Timeframe and resources;
- Health risks of climate change of most interest;
- Future time period(s)for risks and adaptation that need to be considered;
- How the assessment will be managed; and
- Communication plan for informing decision-makers, stakeholders, and the public of the progress and results of the assessment.

It is important for the assessment to be framed and scoped so that it includes not only critical issues for the public health sector, but also linkages with the sectors relevant to the issues under consideration and their interdependencies. For example, the determinants of water and foodborne diseases include factors outside the heath sector, such as the extent to which stormwater infrastructure can manage extreme precipitation events. Creating these linkages where they do not exist could have consequences for the work plan and for the size and expertise of the project team.

1A DECIDE WHICH HEALTH OUTCOMES TO INCLUDE

Given time and resources constraints and the wide range of risks, the first decision to be made is which health outcomes are of greater importance for including in the assessment. In Ontario, climate variability and change can affect morbidity and mortality from:

- Extreme weather and climate events, including from heat events and cold spells;
- Changes in air quality arising from changing concentrations of ground level ozone, particulate matter, or aeroallergens;
- Water and foodborne diseases;
- Vectorborne diseases such as Lyme disease and West Nile virus; and
- Psychosocial impacts.

Table 3 lists key health concerns from climate change in Canada. In Ontario, altering weather patterns may facilitate changes in the geographic range, seasonality, and incidence of selected infectious diseases in some parts of the Province. The associations between weather and health outcomes, as well as how risks could change with additional climate change are comprehensively discussed in the Health Chapter of the 2014 Canadian assessment, *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation* (Warren and Lemmen, 2014). Health unit officials should refer to Ministry of Health and Long-Term Care's (MOHLTC) *Climate Change and Health Modelling Study* (Box 4) to identify future health risks of concern in their jurisdictions. The resource provides information on projected health risks of climate change based on climate models across each of the 36 Ontario health units for the periods 2020, 2050 and 2080.

Source: Ontario Ministry of Natural Resources and Forestry

Health unit officials are encouraged to consider the following questions when deciding which health outcomes to include:

- What are the priority climate-sensitive health outcomes of concern in the study area? For health units, the highest priority health outcomes are often those causing the greatest morbidity and mortality. For example, if air quality is a particular concern in the region, then focusing on how ground-level ozone and particulate matter might change with climate change could be a starting point.
- Which climate-sensitive health outcomes are of greatest concern for stakeholders and the public? For example, is there concern about Lyme disease or West Nile virus becoming more common or moving into the region?
- Did recent extreme weather and climate events raise concerns about health risks, such as heat events or floods?
- Were recent assessments conducted in the region in other sectors that highlighted issues that could affect health, such as changes in flooding risk? If so, then the work already conducted can be used to inform the assessment (eg.: assessments conducted in Peel, London, or Windsor.
- Are neighboring health units also conducting a health V&A assessment? If so, then public health units may choose to pool expertise and look at shared climate-sensitive health issues of common concern.

Supplemental resources, such as those listed throughout this document, should also be used to enhance understanding of priority risks and vulnerable populations.

Table 3: Key Health Concerns from Climate Change

HEALTH IMPACT CATEGORY	POTENTIAL CHANGES	PROJECTED/POSSIBLE HEALTH EFFECTS
Temperature extremes	• More frequent, severe, and longer heatwaves • Overall warmer weather, with possible colder conditions in some locations	• Heat related illnesses and deaths • Respiratory and cardiovascular disorders • Possible changed patterns of illness and death due to cold
Extreme weather events and natural hazards	• More frequent and violent thunderstorms, more severe hurricanes, and other types of severe weather • Heavy rains causing mudslides and floods • Rising sea levels and coastal instability • Increased drought in some areas, affecting water supplies and agricultural production, and contributing to wildfires • Social and economic changes	• Injuries, illness, and death from violent storms, floods, etc. • Psychological health effects, including mental health and stress-related illnesses • Health impacts due to food or water shortages • Illnesses related to drinking water contamination • Effects of the displacement of populations and crowding in emergency shelters • Indirect health impacts from ecological changes, infrastructure damages, and interruptions in health services
Air quality	• Increased air pollution from higher levels of ground-level ozone and airborne particulate matter, including smoke and particulates from wildfires • Increased production of pollens and spores by plants	• Eye, nose, and throat irritation, and shortness of breath • Exacerbation of respiratory conditions • Chronic obstructive pulmonary disease and asthma • Exacerbation of allergies • Increased risk of cardiovascular diseases (e.g. heart attacks and ischemic heart disease) • Premature death

continued on next page

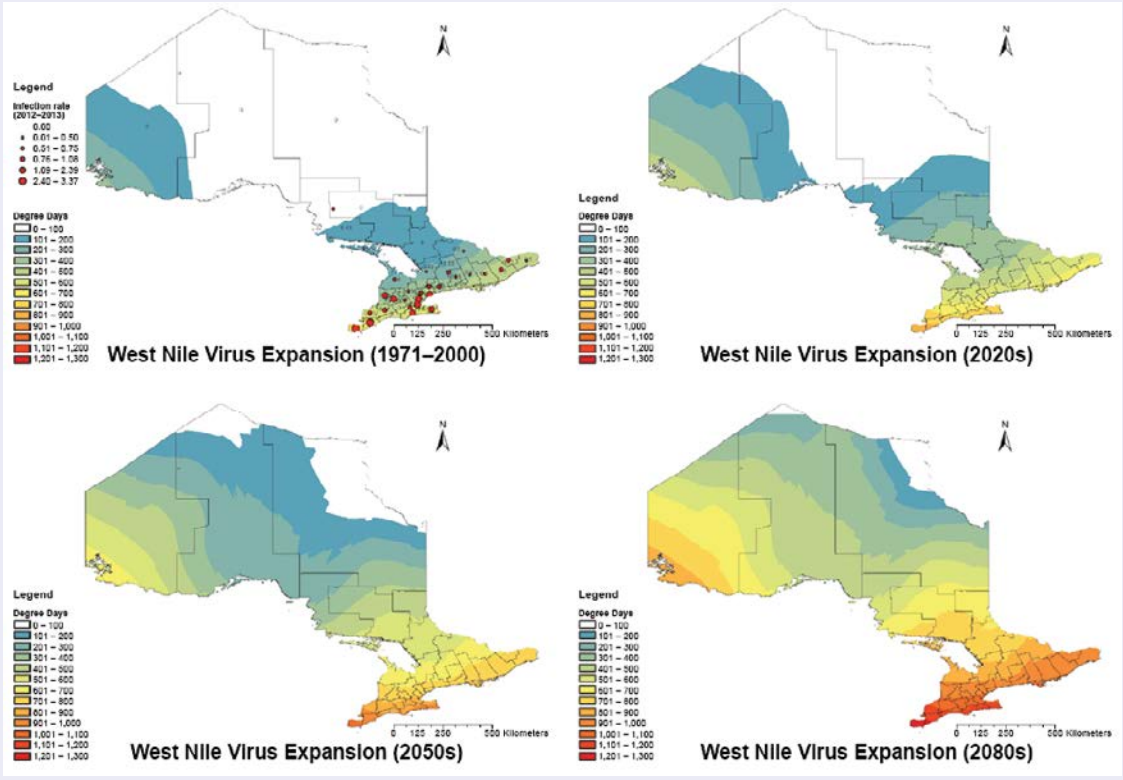
HEALTH IMPACT CATEGORY	POTENTIAL CHANGES	PROJECTED/POSSIBLE HEALTH EFFECTS
Water and foodborne diseases	• Increase contamination of drinking and recreational water by run-off from heavy rainfall • Changes in marine environments that result in algal blooms and higher levels of toxins from fish and shellfish • Behavioural changes with warmer temperatures resulting in an increased risk of water and foodborne infections (e.g. through longer BBQ and swimming seasons) • Increase economic pressures on low income and subsistence food users	• Sporadic cases and outbreaks of disease from strains of waterborne pathogenic micro-organisms • Foodborne illnesses • Other diarrheal and intestinal disorders • Impacts on nutrition due to changing availability of local and traditional foods
Infectious diseases transmitted by insects, ticks, and rodents	• Changes in the biology and ecology various disease-carrying insects, ticks, and rodents (including geographical distribution) • Faster maturation for pathogens within insect and tick vectors • Longer disease transmission season	• Increased incidence of vectorborne infectious diseases native to Canada (e.g. Eastern and Western Equine encephalitis, Rocky Mountain spotted fever) • Introduction of infectious diseases new to Canada • Possible emergence of new diseases, and re-emergence of those previously eradicated in Canada
Stratospheric ozone depletion	• Depletion of stratospheric ozone by some of the same gases responsible for climate change (e.g. chloro- and fluorocarbons) • Temperature-related changes to stratospheric ozone chemistry, delaying recovery of the ozone hole • Increased human exposure to UV radiation owing to behavioural changes resulting from a warmer climate	• More cases of sunburns, skin cancers, cataracts, and eye damage • Various immune disorders

Source: Berry et al. 2014

Source: Ontario Ministry of Natural Resources and Forestry

Box 4: Ontario Climate Change and Health Modelling Study

The Ontario Ministry of Health and Long-Term Care in partnership with the Ontario Ministry of the Environment and Climate Change and the University of Toronto conducted a study that projects climate change and health risks across the 36 health units in Ontario. Health risks are based on temperature and precipitation changes and weather extremes projected with climate change for the years 2050 and 2080. In each public health unit area, information is provided on the projected risks to health. This information can help public health officials identify priority climate change and health risks to focus on when conducting vulnerability assessments and when developing adaptation plans. The report also provides graphical representation of health risks over the aforementioned time periods to illustrate the spatial distribution them for use by decision-makers.



1B IDENTIFY THE PROJECT TEAM

Once the health outcomes to be considered are identified then a project team with relevant expertise can be identified and a work plan developed. In deciding whom to include on the project team, it can be helpful to consider a person's:

- Area of responsibility (such as departments managing the health outcomes included, or other sectors whose activities can affect the health outcomes);
- Expertise; or
- Whom they represent (individuals or organizations).

It also would be helpful to identify additional resource persons with targeted expertise on specific topics.

The assessment needs to include on the project team (or conduct interviews with) stakeholders from local authorities whose activities can affect the burden and pattern of climate-sensitive health outcomes, such as:

- Conservation authorities to determine if key health or health dependent infrastructure is located in a floodplain;
- Public works departments to determine age and vulnerability of sewage and water treatment infrastructure, and to determine the vulnerability of roads and bridges that are needed for access to health care facilities during flooding events;
- Utility providers to identify sensitive infrastructure that can impact public health during a heatwave, cold spell, or flooding event;
- Conservation authorities and local planning departments for local natural heritage plans;
- Local health unit representatives responsible for the surveillance, monitoring, and control of health risks of concern, including surveillance of vector-borne diseases;
- Health service providers that may operate facilities (e.g. hospitals) that are vulnerable to climate change impacts;
- Regional offices for the Ministry of the Environment and Climate Change with respect to source water protection and air quality;
- District offices for the Ministry of Natural Resources and Forestry with respect to invasive species (emerging pathogens), flooding, natural heritage, biodiversity, and forest management; and
- First Nations, NGOs, and other community groups that work with or represent particularly vulnerable groups.

It is important to include representatives of the groups who could be potentially affected either by the risk or by the actions to manage the risk. In all cases, it would be important to include a representative of health care providers who would diagnose and treat any identified impacts. Having core members of the project team who stay throughout the project is highly beneficial. There is always a tension between a high degree of inclusivity, which has the benefits of increasing access to relevant information and buy-in for the assessment, vs. having smaller assessment teams that may be able to direct the study more effectively.

Determining the membership of the project team may require identifying within other departments and organizations individuals that are working on issues relevant to the mandate of the assessment. Illustrative examples include:

- If there is interest in assessing vulnerability to Lyme disease or West Nile virus changing its geographic range with climate change, then it would be helpful to include on the project team experts in disease transmission, representatives from the department involved in monitoring and surveillance of the tick/mosquito that can carry Lyme/West Nile; and individuals working on land use and land use change to identify any changes in ecosystems that can facilitate mosquito breeding grounds.
- If there is interest in assessing vulnerability to changes in air quality, then it would be helpful to include on the project team experts on the sources of ground-level ozone and particulate matter from industry and transport, individuals knowledgeable in agricultural practices, and representatives from local and provincial departments responsible for policies and programs that regulate and monitor air pollutants.

National agencies such as Health Canada (http://www.hc-sc.gc.ca/ewh-semt/climat/index-eng.php) and the Public Health Agency of Canada (http://www.phac-aspc.gc.ca/hp-ps/eph-esp/index-eng.php) can often provide technical information to assist in assessing vulnerability on a wide range of issues. Environment Canada provides historical climate data and future climate projections and scenarios to support vulnerability assessments (http://www.ccds-dscc.ec.gc.ca/).

During this step, it may be helpful to include communication experts to discuss how to present the results to the public in ways that empower appropriate behavioral actions, such as checking for ticks after spending time in a forested area.

1C DEVELOP AN ASSESSMENT WORK PLAN

The work plan needs to consider the extent to which steps in a vulnerability and adaptation assessment are needed to achieve the desired results. For example, because of time and financial resources, it may be decided to delay until the next assessment examination of the potential health benefits and co-harms of adaptation and mitigation options implemented in other sectors. If certain assessment steps are not taken, it would be helpful to document why in the final report so that users of the report can understand the rationale for the approach taken and inform the framing and scoping of subsequent assessments. The work plan should specify the management plan, key responsibilities and activities, the time line, and resources needed for the assessment.

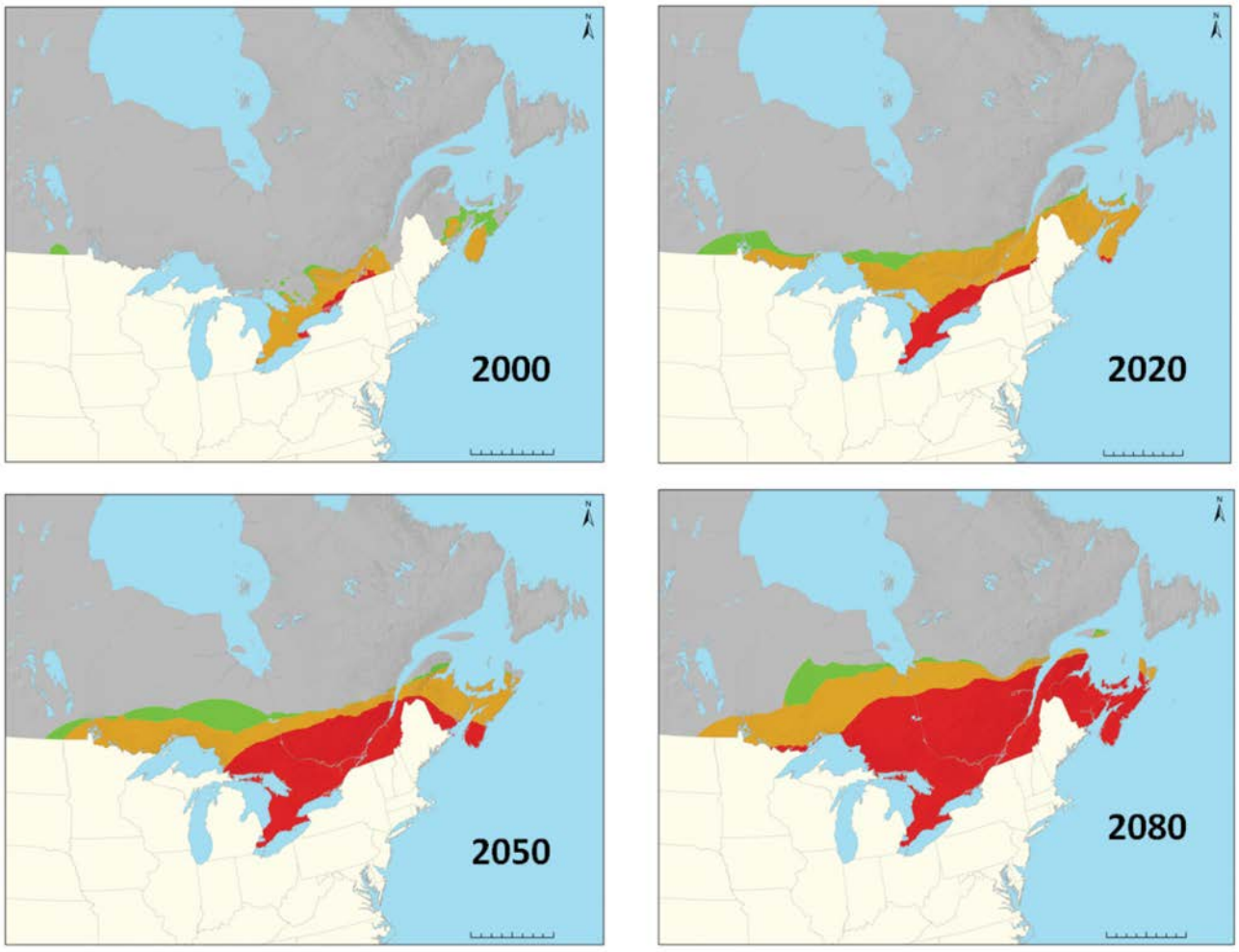
1D IDENTIFY QUALITATIVE AND QUANTITATIVE INFORMATION TO INFORM THE ASSESSMENT

Another activity to undertake during the scoping phase is to identify available and relevant information to inform the assessment. This includes:

- Peer-reviewed literature. For example, for the impacts of extreme heat on health, there are quite a few publications on potential changes in risks to vulnerable populations in Canada and the US that can be accessed through PubMed or from the authors of the publications. Some of these include projections of future hot days and warm nights in Canada in the coming decades (e.g. Casati et al. 2014) and maps on the current and projected ranges of the vector that causes Lyme disease in eastern Canada (Ogden et al. 2014 and Figure 5);
- Grey literature describing the current burden of climate-sensitive diseases and plans and management approaches for the health outcomes of concern. Also, national and provincial level assessment reports in Canada include potential changes in air quality and the frequency of extreme heat events in various cities;
- Online resources, such as watershed maps from the local conservation authority; and
- Provincial and community health reports and associated datasets of relevance.

Gathering this information before starting the assessment will facilitate development of the work plan and the conduct of relevant steps of the assessment.

Figure 5: Risk Maps for the Establishment and Spread of the Lyme Disease Vector *Ixodes scapularis* Under Current Climate (2000) and Projected Future Climate



The green zone indicates the main extent of locations where *I. scapularis* may become established. The orange and red zones indicate areas with increasingly high risk for *I. scapularis* population emergence. The grey zone indicates areas where the risk of *I. scapularis* population emergence is very low. The scale bar indicates 720km.

Source: Ogden et al. 2008

Useful Resources

Statistics Canada – *2011 Census Profiles*
Community level information on population, age, sex, dwellings, families, marital status and language presented for various levels of geography.
http://www12.statcan.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E

Statistics Canada – *Maps and Geography*
Thematic maps by subject for census subject areas including agriculture, environment, and health; map series at national, provincial/territorial, and regional levels, as well as for census of metropolitan areas and census subdivisions (e.g. percentage of population aged 65 years and older, aged 80 years and older, with low income, adult obesity, circulatory and respiratory diseases and deaths, asthma by health region).
http://www.statcan.gc.ca/eng/mgeo/thematic

Natural Resources Canada – *The Atlas of Canada*
On-line maps of health topics including health behaviours, non-medical determinants of health, health resources, rural health, and health status; people and society section topics including age, education, language, and literacy (e.g. age structure, old-age dependency ratios, performance on adult literacy skills, educational attainment, foreign-born population).
http://atlas.nrcan.gc.ca/site/english/index.html

Statistics Canada – *Canadian Vital Statistics Program Death Database*
Demographic and medical (cause of death) information annually from all provincial and territorial vital statistics registries on all deaths in Canada for calculation of basic indicators (e.g. counts and rates) on deaths of residents of Canada and statistical analyses (e.g. cause-specific death rates, life expectancy).
http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3233&lang=en&db=imdb&adm=8&dis=2

Ontario Ministry of Natural Resources and Forestry – *Comparing Various Approaches for Estimating Fire Frequency – The Case of Quetico Provincial Park – CCRR18*
This report compares approaches used to estimate the fire frequency for Quetico Provincial Park, Ontario, to highlight their advantages and associated challenges. Information is intended to augment resource managers' understanding of natural fire regimes to support forest and protected area planning and management.
http://www.climateontario.ca/MNR_Publications/stdprod_088018.pdf

Public Health Agency of Canada – *Notifiable Disease Surveillance System*
This portal provides information including the number and rates of reported cases for diseases identified as priorities for monitoring and control in Canada.
http://dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/index-eng.php

Public Health Ontario – *Vector-Borne Disease Surveillance Reports*
These reports encompass vector-borne diseases of public health importance in Ontario (including West Nile virus, Lyme disease, and Eastern Equine Encephalitis virus).
http://www.publichealthontario.ca/en/ServicesAndTools/SurveillanceServices/Pages/Vector-Borne-Disease-Surveillance-Reports.aspx

continued on next page

Public Health Ontario – *Monthly Infectious Diseases Surveillance Report*
These reports feature information including counts and rates of reportable disease incidents.
http://www.publichealthontario.ca/en/ServicesAndTools/SurveillanceServices/Pages/Monthly-Infectious-Diseases-Surveillance-Report.aspx

Ontario Ministry of the Environment and Climate Change – *Air Quality in Ontario Report & Appendix*
These annual reports provide a summary of the state of ambient (outdoor) air quality in Ontario.
http://www.airqualityontario.com/press/publications.php

Ontario Ministry of Natural Resources and Forestry – *A Summary of the Effects of Climate Change on Ontario's Aquatic Ecosystems – CCRR11*
This report provides information about the known and potential effects of climate change on aquatic ecosystems and selected fish species and outlines research priorities and management strategies available to natural asset managers.
http://www.climateontario.ca/MNR_Publications/stdprod_088243.pdf

Environment Canada – *National Climate Data and Information Archive*
Official climate and weather observations (e.g. temperature, humidity) for Canada.
http://climate.weather.gc.ca/index_e.html

Environment Canada – *Adjusted and Homogenized Canadian Climate Data*
Adjusted and homogenized climate data for many climatological stations in Canada for use in assessing long-term climate change and variability. Updated regularly.
http://www.ec.gc.ca/dccha-ahccd/

Environment Canada – *Canadian Climate Data and Scenarios website*
Provides access to Canadian climate data and climate change scenarios from various multi-model ensembles.
http://www.ccds-dscc.ec.gc.ca/

1E DEVELOP A COMMUNICATION PLAN

Finally, developing a communication plan early in the process is important for ensuring the assessment is structured from the beginning to communicate identified risks effectively to those who will manage the risks and those who could be affected. The communication plan should specify the primary output of the assessment (generally a report), to whom it will be communicated, mechanisms for sharing the results (e.g. webinars, workshops), and whether outreach materials will be developed to communicate results to, for example, key stakeholders or particularly vulnerable groups.

Step 2: Describe Current Risks Including Vulnerabilities and Capacities

This step is undertaken to describe current climate change and health relevant exposures, vulnerabilities, and capacities, to provide the context for understanding where modifications to current programs could decrease vulnerability to current and projected climate change. The information is also helpful for consideration of where new programs are needed to better manage the health risks expected within the next couple of decades.

The key components of this step are:

- Review qualitative and quantitative information;
- Estimate current relationships between weather patterns and climate-sensitive health outcomes;
- Describe trends for environmental hazards of interest;
- Characterize current vulnerability of exposed individuals and communities;
- Describe and assess effectiveness of policies and programs; and
- Develop an explicit baseline for use in monitoring future vulnerability and for evaluation of adaptation options.

An example of a comprehensive vulnerability and adaptation assessment is presented in Box 5.

Box 5: Assessing Health Vulnerability to Climate Change in the Region of Peel

As part of the Region of Peel's Climate Change Strategy, Peel Public Health (PPH) undertook a climate change and health vulnerability assessment. The assessment followed World Health Organization/Pan American Health Organization methodology (WHO 2012) to identify current and future climate-related exposures, sensitivities, and adaptive capacities in the Region of Peel. Staff from PPH and Health Canada advised on the scope of the assessment and provided relevant reports and resources in the grey literature. A consultant conducted a search of the peer-reviewed and grey literature. The assessment concluded that climate change has the potential to affect human health in the region of Peel by: (1) increasing temperature-related morbidity and mortality; (2) exacerbating air quality; (3) increasing the risks of injuries and death from extreme weather; (3) increasing water and foodborne contamination; and (5) increasing the incidence of vectorborne diseases. Populations most vulnerable to impacts include seniors, children, those experiencing social isolation, individuals with chronic conditions and/or disabilities, and socially or economically marginalized individuals. Further, climate change may worsen existing health inequalities in the community by increasing the health burden in already vulnerable groups.

The assessment recommended conducting further community and stakeholder consultations to capture Peel's unique social and cultural characteristics, continued gathering of relevant health information to improve understanding of local health impacts of climate change, sharing the report with municipal, provincial, and federal partners; using the report as a foundation from which to begin a broader discussion of health vulnerability; and development of an implementation plan to address identified vulnerabilities.

Source: Pajot and Aubin 2012

2A REVIEW QUALITATIVE AND QUANTITATIVE INFORMATION

The datasets, department documents, peer-reviewed publications, and internet sources identified during the scoping phase should be reviewed for relevant information. Gaps in knowledge can be filled to some extent by interviewing subject matter experts to describe current exposures, vulnerabilities and capabilities (see Box 6 for an example from Europe). Generally, health unit experts have a wealth of knowledge on vulnerable locations and populations, and on what modifications would help improve the effectiveness of current control programs. Further, experts from other sectors, such as those working in authorities that monitor water treatment plants, can provide insights into the strengths and limitations of current equipment and practice.

Box 6: Using Expert Judgment to Identify the Risks Climate Change Might Pose to the Burden of Infectious Diseases in Europe

The European Centre for Disease Prevention and Control combined information from a literature review with expert solicitation to better understand what adjustments will likely be needed to existing surveillance practices in the European Union in a changing climate (Lindgren et al. 2012). A weighted risk analysis looked at the strength of the association of infectious diseases with climate change and the potential severity of consequences of an increase in incidence or geographic range to society, both categorized as low, medium, and high. Because a strong association between a disease and climate change does not necessarily imply the need for surveillance, the risk analysis combined the prevalence, severity, and secondary complications (including human and financial costs) into one ranking. The results were plotted on a matrix (Figure 6) to reflect the joint importance of climate change and the severity of a specific infectious disease in Europe. The results can be used to prioritize improvements in surveillance and monitoring programs.

Figure 6: Weighted Risk Analysis of Climate Change Impacts on Infectious Disease Risks in Europe

Strength of link with climate change in Europe	Low	Medium	High
High		Vibrio spp. (except *V. cholerae* 01 and 0139) Visceral leishmaniasis	Lyme borreliosis
Medium	CCHF* Hepatitis A Leptospirosis	Tularaemia Yellow fever Yersiniosis	Campylobacteriosis Chikungunya fever Cryptospiridiosis Giardiasis Hantavirus Rift Valley fever Salmonellosis Shigellosis VTEC** West Nile fever	Dengue fever TBE
Low	Anthrax Botulism Listeriosis Malaria	Q fever Tetanus Toxoplasmosis	Cholera (01 and 0139) Legionellosis Meningococcal infection	

Potential severity of consequence to society

Weighted low risk Weighted medium risk Weighted high risk

Note: CCHF* = Crimean-Congo haemorrhagic fever
VTEC** = Entero-haemorrhagic E. coli infection
Changes to disease-specfic surveillance are highlighted in bold

Source: Adapted from Lindgren et al. 2012

2B ESTIMATE CURRENT RELATIONSHIPS BETWEEN WEATHER PATTERNS AND CLIMATE-SENSITIVE HEALTH OUTCOMES

Where there are sufficient local or regional health, meteorological, and environmental data, determine the associations (if any) between the exposures and the incidence, seasonality, and geographic range of the climate-sensitive health outcomes under consideration. Graphing the data may prove useful for identifying patterns, particularly with limited time series. Because a range of environmental factors may be associated with a health outcome, it is important to consider more than mean temperature and precipitation. For example, minimum temperatures may be a determinant of the geographic range of vectors. It is important to consider factors that could influence any observed trends, such as changes in disease control programs and changes in land use. There will be more confidence in analyses conducted using longer and larger health data series.

When sufficient data are not available, estimates of the strength of association can be gathered from the published literature or from interviews with subject matter experts (Box 6). For example, experts may be able to provide estimates of the impacts of extreme heat events on excess mortality, or of heavy precipitation events on episodes of gastrointestinal diseases. This information can be used to describe exposure-response relationships.

2C DESCRIBE HISTORICAL TRENDS IN THE ENVIRONMENTAL HAZARDS OF INTEREST

Once the current weather patterns (e.g. heat, heavy precipitation, drought. air pollution) associated with climate-sensitive health outcomes are determined, then data and maps can be collected on recent trends in these weather variables. Data can be obtained from the Ontario Ministry of the Environment and Climate Change, the Ontario Ministry of Natural Resources and Forestry, Natural Resources Canada (the atlas of Canada http://atlas.nrcan.gc.ca/site/english/index.html), or Environment Canada (national climate data and information archive http://climate.weather.gc.ca). If the assessment will consider extreme weather and climate events, then it would be helpful to understand how the geographic range, intensity, and duration of particular events have changed over recent decades. Including a meteorologist or climatologist on the project team can be helpful to ensure data are interpreted appropriately.

2D CHARACTERIZE THE CURRENT VULNERABILITY OF EXPOSED INDIVIDUALS AND COMMUNITIES, INCLUDING SENSITIVITY AND ABILITY TO COPE

Effectively designing adaptation policies and programs requires understanding which subpopulations are vulnerable to particular climate-sensitive health outcomes. There are multiple lenses through which to identify vulnerability, including socioeconomic, geographic, and biologic. The extent to which a particular group is vulnerable to a specific health outcome reflects the balance between factors that increase sensitivity and factors that increase the ability to cope with exposures. Sensitivity is an expression of the increased responsiveness of an individual or community to an exposure, generally for biological reasons (e.g. age or the presence of pre-existing medical conditions). Experience with the health outcomes of interest and the medical and epidemiology literature can provide information on factors increasing or decreasing biological sensitivity. The ability to cope measures the ability of individuals and communities to plan for, respond to, and recover from exposure to climate change-related hazards.

While general information on vulnerability is available for each health outcome, this step is focused on which individuals and communities in the area served by the health unit are more vulnerable to recent and projected climate change. The more detailed the information, the easier it will be to design effective adaptation options. For example, particularly vulnerable populations to extreme heat events include older adults, infants and young children, people with chronic illnesses or who have mobility/cognitive constraints, poorer populations, newcomers to Canada, outdoor workers, the physically active, and pregnant women (Table 4). Questions to consider for heat-vulnerable groups include if there are neighborhoods within the health unit that have higher proportions of such populations. Or, are there places within an urban area that are likely to experience a greater urban heat island effect?

Source: Shutterstock image

Table 4: Heat-Vulnerable Groups and Examples of Challenges They May Face in Adapting to Extreme Heat Events

HEAT-VULNERABLE GROUPS	EXAMPLES OF CHALLENGES
Older adults	Physiological characteristics that may contribute to increased vulnerability to heat include: • Reduced thirst sensation • Reduced fitness level • Reduced sweating ability • Increased susceptibility to chronic dehydration • Visual, cognitive, and hearing impairments Agility and mobility challenges Differing perceptions of risks and vulnerabilities based on life experiences Reduced literacy Social isolation
Infants and young children	Physiological and behavioural characteristics that may contribute to increased vulnerability to heat include: • Increased body heat production during physical activity • Faster heat gain from the environment if air temperature is greater than skin temperature owing to greater surface-area-to-body-weight ratio • Inability to increase cardiac output • Reduced sweating Dependence on caregiver to recognize heat impacts and take recommended actions

continued on next page

HEAT-VULNERABLE GROUPS	EXAMPLES OF CHALLENGES
People with chronic illness or who are physically impaired	Physiological characteristics that may amplify health risks, such as failing cardiovascular or respiratory systems, psychiatric illnesses, or renal illnesses Taking certain medications that affect heat sensitivity by interfering with the body's cooling functions or water/salt retention (e.g. antihypertensives, antidepressants, antipsychotics, anti-Parkinson's agents) Confined to bed or dependence on caregiver, family or friends for assistance with daily living (e.g. water access) Communication, sensory or cognitive impairment Characteristics related to health status or behaviour (e.g. chronic dehydration, shut-in, or does not leave home) Social isolation
Socially disadvantaged individuals and communities: • **Low income** • **Homeless** • **Living alone**	Limited financial resources to adequately take protective actions Reduced access to clean water and cool places Limited access to health care and social services More environmental exposures (e.g. homeless, living on higher floors with no air conditioning) Higher rates of alcohol and drug dependency Social isolation
Newcomers to Canada and transient populations, such as tourists	Language and literacy barriers for non-English or non-French speakers Cultural differences, such as food consumption habits, clothing choices, and pre-existing social or cultural beliefs Unique media use patterns Limited knowledge of local alert systems, health and social service programs
Occupational groups	Environmental and workplace exposures (e.g. farmers, construction workers, miners, tree planters) Increased physical strain Variation in health and safety regulations, codes, and standards Irregular exposure to heat (i.e. lack of acclimatization) for new workers with job-related heat exposures and those faced with early season extreme heat events
The physically active	Greater environmental exposures (e.g. marathon runners, recreational athletes, people who walk or bike) Increased physical strain Reduced perception of risks and heat vulnerabilities Expectation of usual performance in the heat

Source: Reprinted from Health Canada, *Communicating the Health Risks of Extreme Heat Events: Toolkit for Public Health and Emergency Management Officials*, 2011.

Urban and rural communities have different histories and characteristics that affect climate change and human health vulnerability. Table 5 provides information on urban and rural characteristics that increase vulnerability to climate change and related impacts.

Table 5: Urban and Rural Characteristics that Increase Vulnerability to Climate Change and Climate-Related Impacts

KEY VULNERABILITY FACTORS	EXAMPLES OF URBAN CHARACTERISTICS	EXAMPLES OF RURAL CHARACTERISTICS
Exposure • **Geography** • **Land use** • **Climate**	Complex infrastructure, high density buildings, and landscape dominated by impervious surfaces Higher population density Higher air pollution levels	Increase health risks from water contamination due to a high reliance on small drinking water systems More people employed in outdoor occupations Higher risk of exposure to land shifts, wildfires, vector-borne diseases, and floods
Individual sensitivity • **Age and gender** • **Health status**	Ageing population Cardiovascular and respiratory conditions in large urban centers from air pollution and extreme heat	High elderly population and high incidence of chronic illnesses, smoking, and obesity
Key adaptive capacity factors • **Socioeconomic status** • **Public services and risk communication programs** • **Employment**	Greater prevalence of high risk population groups, with limited adaptive capacity (e.g. low socioeconomic status) Higher prevalence of social isolation and limited access to services (e.g. immigrants, First Nations, homeless, or persons of low income or with mental illnesses) High reliance on critical infrastructure for health care and emergency service provision that are vulnerable to extreme weather	Limited access to services during extreme events (e.g. power, water, food, medical) Limited availability and accessibility of public services and programs and communication venues to deliver health and emergency messages High dependency on natural resources that are vulnerable to disruption from extreme weather Lower proportion of population highly educated Limited livelihood opportunities and economic diversification Limited resources and services to respond to extreme weather events and associated health burdens Limited service access to remote communities

Information to determine and describe vulnerability and the ability to cope can be obtained from datasets and records or from interviews with city planners and other departments. Those who work with vulnerable groups, or researchers engaged in the issue may also provide useful information. GIS mapping of particularly vulnerable regions can be a helpful output from the assessment (e.g. locations of vulnerable subpopulations, geographic regions at higher risk of, for example, flooding).

2E DESCRIBE AND ASSESS THE EFFECTIVENESS OF POLICIES AND PROGRAMS TO MANAGE CURRENT VULNERABILITIES AND HEALTH BURDENS

It can be helpful to generate a list of all existing policies and programs that affect the climate-sensitive health outcomes considered in the assessment, and to identify which of these have undergone formal evaluations, such as early warning systems, and monitoring and surveillance programs.

For each policy and program, effectiveness can be estimated from any formal evaluation(s) that have been conducted, or through expert judgment. The basic question is how well policies and programs are protecting individuals and communities against climate-related hazards. If there are early warning systems, have these systems reduced morbidity and mortality associated with the extreme event? For infectious diseases, how well have the disease burdens been managed over the past few decades, and what additional activities could further reduce morbidity and mortality irrespective of climate change? Are there programs designed to address particular vulnerabilities, such as urban heat islands? If so, how effective have they been?

Effectiveness can be measured qualitatively or quantitatively. It is important that the criteria used be explicitly described in an annex to the report so that others can duplicate the process. For example, a monitoring and surveillance program could be considered effective if it: (1) collected timely and high quality data that covered the areas of concern; (2) analyzed the data quickly enough to identify worrying trends; and (3) triggered responses to address any increases in health burdens. Box 7 provides an example.

It is useful to assess the capacity of community and regional health services to manage climate change hazards to health. Health care facilities need to be prepared to manage increasing risks from climate change to patients, visitors, and staff. The Canadian Coalition for Green Health Care, in collaboration with Health Canada, developed a toolkit to assess the climate change resiliency of health care facilities so that hospital administrators could take actions to improve preparedness for expected impacts. The toolkit, including the assessment checklist, is available at http://www.greenhealthcare.ca/component/content/article/251-ccr.

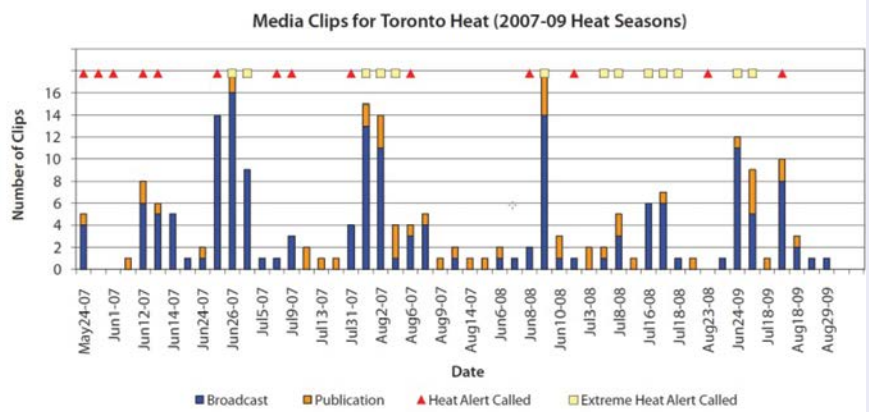
Box 7: Evaluation of the City of Toronto's Heat Alert and Response System

As part of a multi-pronged evaluation of Toronto's Heat Alert Response System (HARS), a media content analysis for the period 2007–2009 was conducted to assess the media attention received by Toronto's heat alerts. It also examined the heat-related messages that are communicated through the Toronto media as part of an evaluation of the city's HARS. Both print and broadcast media clips related to heat and alerts/warnings were examined in this study. The analysis showed that:

- Toronto's heat alerts generate significant media interest. Media coverage was concentrated during the heat season when Toronto's system is active (May 15 – Sept 30)
- The health messages communicated through the media are consistent with those provided by Toronto Public Health.

A telephone survey of 1,100 Toronto adults conducted in August 2010 found that 70% or more of respondents undertook eight of Toronto Public Health's recommended actions after receiving the heat-health messaging.

Source: Gower et al. 2011
More information about Toronto's HARS is available from www.toronto.ca/health



2F DEVELOP A BASELINE OF INFORMATION FOR USE IN MONITORING FUTURE VULNERABILITY AND FOR EVALUATING ADAPTATION OPTIONS

An important output from a vulnerability and adaptation assessment is the description of an explicit baseline of information that can be used as the basis for determining the success (or failure) of adaptation policies and programs. The baseline should describe current morbidity and mortality of the climate-sensitive health outcomes of concern, including recent trends and information on the key factors associated with the outcome. It should also examine the policies and programs in place to manage those outcomes, including measures of their effectiveness. The baseline information comes directly from the results of the assessment.

For the health outcomes of concern, the assessment should gather and report information on the current burden of climate-sensitive health outcomes and on recent trends in the incidence of disease or deaths, both as the numbers of cases and as rates per 1000, so that future assessments can compare health burdens over time. It also would be helpful to include any information on key factors associated with an outcome, such as a recent extreme event associated with excess morbidity or mortality (to put trends into perspective), changes in regulations that affected concentrations of air pollutants, changes in disease surveillance systems, and other factors that influence the burden of health outcomes.

The assessment also should describe current policies and programs to reduce and manage the burden of climate-sensitive health outcomes, such surveillance programs for water- and foodborne diseases of concern, assessments of the effectiveness of these programs, and recommendations for improvements. Having this information gathered in one place will make future comparisons easier to determine the extent to which any changes implemented were effective in reducing future health risks of climate variability and change.

Step 3: Project Future Health Risks

This step builds on the information gathered in the previous step (2b) on the relationships between weather patterns and health outcomes to consider how the current magnitude and pattern of climate-sensitive health burdens could be affected by climate change.

3A REVIEW QUALITATIVE AND QUANTITATIVE INFORMATION

Datasets, department documents, peer-reviewed publications, and internet sources should be explored to identify relevant information. In some cases, there may be sufficient information to address some of the questions the assessment was designed to answer, such as how climate change could affect air pollution or the frequency, intensity, and duration of future heat events. In others, the assessment will need to identify additional information, including that generated by expert judgment.

3B DESCRIBE HOW CURRENT RISKS COULD CHANGE UNDER DIFFERENT WEATHER AND DEVELOPMENT PATTERNS

In this step, the first question to be addressed is the time frame for projecting future risks. There is greater certainty in climate projections over the next few decades (to about the 2040s), thereby reducing the need to include consideration of the potential consequences of a range of different emission scenarios past mid-century. The MOHLTC's *Climate Change and Health Modelling Study* provides information on projected climate-related health impacts in 2050 and 2080 (Box 4). Public health officials can use this information to identify future health risks and plan accordingly.

The typical approach to projecting future health risks is to multiply current exposure-response relationships by the projected change in the relevant weather variable(s) over the time periods of interest. However, doing so assumes that current vulnerability will remain the same over coming decades. As this in not likely, it is important to consider how both weather and development patterns could affect how climate-sensitive health risks evolve. Given the complexity of projecting future risks, health officials can work with individuals or groups with modelling expertise, or take a more qualitative approach that focuses on the next few decades. For example, expert interviews or facilitated discussions can be used to estimate how morbidity and mortality of the health outcome of interest could be altered by (1) development patterns alone (2) climate change alone and (3) climate and development.

If time and resources permit, it would be helpful to host an expert meeting with the goal of describing several possible development pathways over the next few decades, taking into consideration planned changes in policies and programs. These pathways should include the major drivers of the health outcome of interest, including assumptions about levels of research and technology development. There may be quantification of some factors, such as population growth and urbanization, from regional or national authorities.

In addition to the MOHLTC's *Climate Change and Health Modelling Study*, if more information is required, local and regional climate projections are available from provincial and national sources. Scenarios can be created that combine the development pathways (e.g. Representative Concentration Pathway scenarios) and climate change projections, to facilitate projections that cover a wider range of possible futures.

No matter the approach, the projected risks will have several sources of uncertainty. However, the inherent uncertainty about the future should not obstruct decision-making for priority health risks. It is important that the assessment report clearly describes the uncertainties and the extent to which they could influence the projected health risks.

Useful Resources

Ontario Ministry of the Environment and Climate Change – https://www.ontario.ca/ministry-environment

Ontario Ministry of Natural Resources and Forestry – *Climate Change Projections for Ontario: Practical Information for Policymakers and Planners* http://www.climateontario.ca/MNR_Publications/276923.pdf

Natural Resources Canada – *Climate Change and the Future Fire Environment in Ontario: Fire Occurrence and Fire Management Impacts CCRR-01* https://cfs.nrcan.gc.ca/publications?id=34351

Environment Canada – *Canadian Climate Data and Scenarios website* http://www.ccds-dscc.ec.gc.ca/

Ontario Centre for Climate Impacts and Adaptation Resources http://www.climateontario.ca/

Consortium on Regional Climatology and Adaptation to Climate Change http://www.ouranos.ca/en/

Pacific Climate Impacts Consortium http://www.pacificclimate.org/

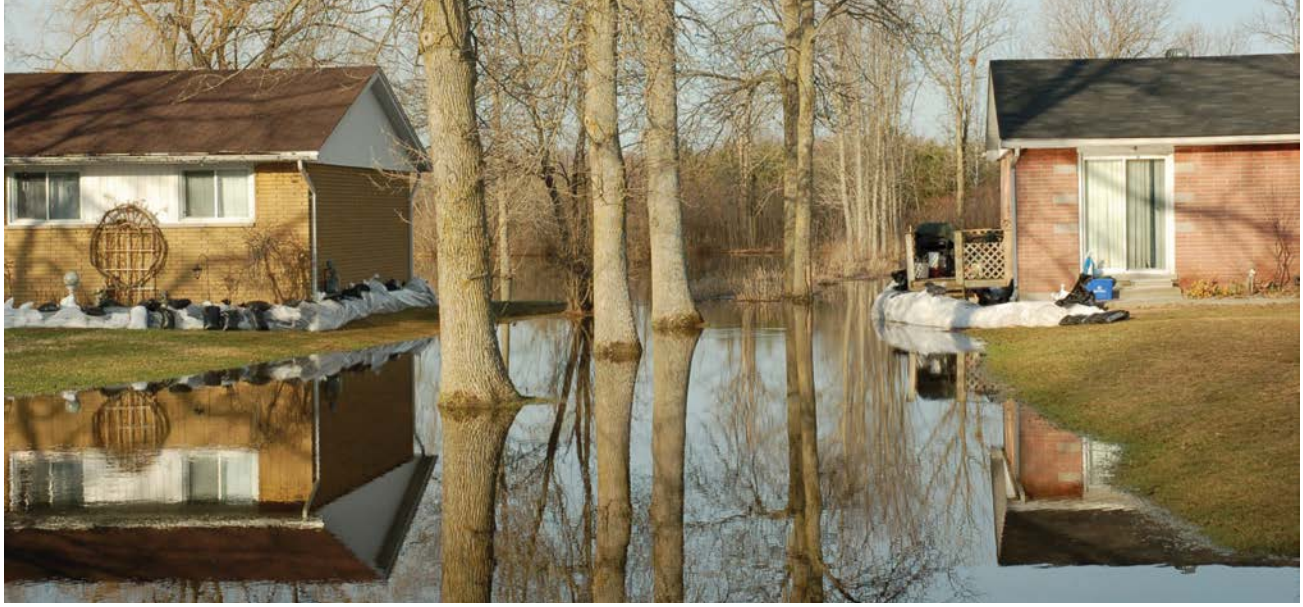
See also Box 4

Step 4: Identify and Prioritize Policies and Programs to Manage the Additional Health Risks Associated with a Changing Climate

There are a wide range of policies and programs that can reduce the burden of climate-sensitive health outcomes that could increase in the future. This step will recommend options to modify current policies and programs to protect health. Opportunities for increasing resilience to climate change include:

- Strengthening integrated disease surveillance programs;
- Strengthening environmental health services;
- Strengthening early warning systems and disaster risk management;
- Mainstreaming climate change into public health policy;
- Strengthening primary health care services; and
- Improving infrastructure and built environment initiatives by including climate change considerations and informants.

Prioritizing the identified options will indicate the most appropriate time scale for implementation. Examples of climate change adaptation as it pertains to health emergency management are presented in Box 9.



Source: Ontario Ministry of Natural Resources and Forestry. Photo Credit: Gary Wice/MNRF

Box 9: Adaptation Actions to Reduce Health Risks From Climate Change

The chart below illustrates the application of emergency management activities with and without possible adaptation measures to reduce climate change risks. The left panel highlights routine emergency management activities that do not include climate change adaptation. The right panel provides options for mainstreaming climate change into these emergency management activities. For example, Hazard, Risk, and Vulnerability Assessments could integrate climate change projections and/or findings from climate change impacts and adaptation assessments. Drivers of climate change could inform disaster mitigation efforts, for example, by taking actions to address the urban heat island effect. Disaster planning could be informed by climate change, for example, by planning for events that could occur simultaneously or in close succession. It will be important to monitor new health risks. Health care facilities can play a role by adopting a syndromic surveillance system to link climate-related exposures to health outcomes, including emerging infectious diseases. Finally, it will be important to broaden partnerships to include those with expertise on climate change or persons knowledgeable of what climate variability and climate change means for your health unit.

EMERGENCY MANAGEMENT ACTIVITY	EMERGENCY MANAGEMENT ACTIVITY WITH ADAPTATION
Hazard Risk Vulnerability Assessment (HRVA)	HRVA integrating climate change and climate change assessment findings
Disaster mitigation	Disaster mitigation informed by climate change drivers (e.g. mitigating urban heat islands)
Disaster planning	Disaster plans informed by climate change (e.g. simultaneous events)
Table-top exercises	Table-top exercises include climate change scenarios
Surveillance and monitoring of known health risks	Surveillance and monitoring of new climate change risks
Response and recovery efforts	Training staff on response and recovery activities to address new climate change risks
Increasing planning capacity	Partners involved in planning who have knowledge about climate change risks and staff are aware of these risks

Source: Berry and Paterson, 2014

4A REVIEW QUALITATIVE AND QUANTITATIVE INFORMATION

Step 2e assessed the policies and programs designed to manage current morbidity and mortality associated with climate-sensitive health outcomes. Step 4a builds on that one by identifying information on possible modifications of current policies and programs, and possible additional new efforts, to manage the increased health risks associated with climate variability and change. This information can come from discussions with health authorities in other jurisdictions, including the Ontario Ministry of Health and Long-Term Care, Public Health Ontario, Health Canada and the Public Health Agency of Canada, to determine what they are doing to manage climate-sensitive health outcomes, or from peer-reviewed publications or internet sources. The increasing interest in sharing adaptation lessons learned and best practices means that NGOs and others are publishing more information on effective approaches to manage particular health risks.

An important source for adapting to extreme heat events is the HARS best practices guide developed by Health Canada (Health Canada, 2012). The best practices were identified through an examination of the peer reviewed literature and HARS plans and guidance documents from the World Health Organization, the United States Environmental Protection Agency, Europe, Australia, and Canada. The report also drew upon lessons learned through the pilot development of new HARS in four communities – Winnipeg, Manitoba; the Town of Melita in the Assiniboine Regional Health Authority[2], Manitoba; Windsor, Ontario; and Fredericton, New Brunswick.

4B INVENTORY OPTIONS TO IMPROVE THE EFFECTIVENESS OF CURRENT POLICIES AND PROGRAMS OR TO IMPLEMENT NEW ONES TO MANAGE THE HEALTH RISKS OF CLIMATE VARIABILITY AND CHANGE

This step requires building on the inventory developed to identify possible modifications to current policies and programs, or the implementation of new ones, to manage changing health risks with climate change. Examples of possible adaptation options include:

- Implementing an early warning system;
- Increasing targeted monitoring and surveillance for a particular infectious disease;
- Increasing public awareness of the risk and possible preventive measures; and
- Improving diagnosis and treatment.

It is important to include policies, measures, and operational processes within and outside the health sector because some of the key drivers of health outcomes are managed by other sectors (Box 10). For example, water quality can be affected by agricultural runoff, urban or industrial development, and the capacity of the water treatment systems to manage historically large amounts of precipitation. Air quality can be affected by the location of housing with respect to industrial development, major highways, and other sources of air pollutants.

It can be informative to identify all possible measures that could be implemented, without regard to technical feasibility, cost, or other limiting criteria. This list can be based on information gathered during the review of quantitative and qualitative information, through a survey of current practices and experience in other health authorities and other sectors, and from discussions with scientists, practitioners, and stakeholders within and outside the health sector. For example, gastrointestinal disease outbreaks can be associated with heavy precipitation events washing pathogens into drinking water sources. When considering changes in policies and programs to address more frequent heavy precipitation events, key stakeholders should include representatives from the Ministry of the Environment and Climate Change, the local Conservation Authority and individuals who might be affected by such events.

The main output of this step is a list of possible adaptation options. Such a list can prove useful to inform policymakers of the range of options, and can be the basis for identifying additional adaptations when the next V&A is conducted.

2 In 2012, the province of Manitoba reduced the number of health regions from 11 to 5. At this time, the ARHA and two other regional health authorities merged to form the Prairie Mountain Health Authority.

Box 10: Collaboration Across Sectors to Reduce Climate Change Impacts on Health

Managing the health risks of climate change often involves working across sectors. A simple example is heatwave early warning and response systems. Establishing an effective system involves at minimum representatives from health, meteorology, and other stakeholder groups engaged in outreach activities. Possible adaptation options to reduce the urban heat island, such as increasing tree cover, often need to be implemented by other sectors or agencies, in this case local urban planning departments and conservation authorities.

Source: Adobe Stock

White-Newsome et al. (2014) interviewed government and non-governmental organization leaders representing public health, general social services, emergency management, meteorology, and the environmental planning sectors in four U.S. cities chosen for their diverse demographics, climates, and climate adaptation strategies (Detroit, MI; New York City, NY; Philadelphia, PA and Phoenix, AZ). The interviews identified activities to reduce the harmful effects of high ambient temperatures and the obstacles faced. Cooling centers, heatwave early warning systems, programs to distribute fans and/or air conditioning, and outreach programs were common across the cities. The local context, including political will, resources, and the maturity of community organizations were important for identifying and reaching the most vulnerable populations and for using health statistics effectively. The primary obstacles faced were financial constraints, strategies for promoting the effective use of cooling centres, and other communication issues. Addressing these issues requires multi-sectoral approaches.

4C PRIORITIZE OPTIONS AND IDENTIFY RESOURCE NEEDS

The next step is to screen this wide range of options to identify which policies and programs are possible to implement over a particular time period, within existing technological, human, and financial resource constraints. The focus should be on options that not only reduce the burden of adverse health outcomes, but that also enhance or improve the natural and built environments. This step will generate a short list of options from which policymakers can choose. Criteria to decide which choices are practical include:

- Whether the option is technically feasible. For example, a possible option to reduce future burdens of Lyme disease is vaccination. However, because no vaccine is available, this is not a feasible option at this time;
- The degree of effectiveness of the proposed measure in reducing morbidity and mortality. Long experience with managing the risks of climate-sensitive health outcomes means that public health programs are typically effective but further improvements would enhance effectiveness in a changing climate;
- The consequences that might be associated with the option. For example, draining wetlands may decrease vector breeding sites, but often with dire and unacceptable ecological consequences on wetlands, which also act as carbon sinks. This calls for thinking about what (and how) implementation could go wrong, and for monitoring outcomes and taking appropriate corrective actions as needed;
- Whether there is the financial capacity to implement and maintain the option. Upgrading water purification to reduce the presence of pathogens such as cryptosporidiosis may be possible, but at a very high cost that a community might find difficult to afford; and
- Whether the proposed option is socially acceptable. For example, people may object to spraying mosquito breeding sites with insecticides.

Once the list of practical options is finalized, the project team will then need to prioritize which options to recommend implementing over the short and medium term. It can be helpful to create two sets of priorities- critical policies and programs that should be implemented now and those that are important but can wait a few years before implementation.

There are multiple approaches to prioritization, each with advantages and challenges, including multi-criteria analysis, cost-benefit analysis, and stakeholder-driven identification of prioritization criteria. Any approach can be taken, provided the criteria used to identify the priorities are explicitly described. Considerations should include the current morbidity and mortality from the health outcome of concern, and how well it is managed with current policies and programs. Low priority may be assigned to health outcomes with relatively low numbers of annual cases and with relatively effective control programs, under the assumption that a small increase in risk with climate change could be managed. Conversely, higher priority may be assigned to emerging health risks causing high morbidity and mortality, or where there is significant public concern.

Useful Resources

Ontario Ministry of Natural Resources and Forestry – *A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems*
https://www.ontario.ca/environment-and-energy/practitioners-guide-climate-change-adaptation-ontarios-ecosystems-ver-1-2011

Canadian Council of Forest Ministers – *Adapting Sustainable Forest Management to Climate Change: Preparing for the Future*
http://www.ccfm.org/pdf/Edwards_PreparingForFuture_FinalEng.pdf

Ontario Ministry of the Environment and Climate Change – *Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011–2014*
https://www.ontario.ca/environment-and-energy/climate-ready-adaptation-strategy-and-action-plan-2011-2014

Ontario Ministry of the Environment and Climate Change – *Adapting to Climate Change in Ontario: Towards the Design and Implementation of a Strategy and Action Plan* http://www.climateontario.ca/doc/publications/ExpertPanel-AdaptingInOntario.pdf

4D ASSESS POSSIBLE CONSTRAINTS TO IMPLEMENTING OPTIONS AND HOW TO OVERCOME THEM

For each priority policy and program, it is helpful to write a brief description of:

- The technological, human, and financial resources required for implementation;
- The expected time frame for implementation;
- Any other requirements; and
- The possible constraints that will need to be overcome to implementing the options.

It is helpful to differentiate constraints (or barriers), which can be overcome, from limits where there is no adaptation option or the available options are too difficult or expensive to implement. An example of a limit is maintaining engineering design standards (such as the flood return period for a bridge) in the face of increases in the frequency and intensity of heavy precipitation events.

Constraints make it more difficult to plan and implement adaptation options. Constraints can arise from lack of awareness or political will, limited human and financial resources, limited information, and lack of authority or jurisdiction to act. Constraints also can arise from the attitudes and beliefs of decision-makers. Options for overcoming constraints are important to identify, evaluate, and incorporate into the implementation processes. For example, broadening an existing monitoring and surveillance program will generally require additional human and financial resources. This could require convincing decision-makers of the need for prioritizing resources for this use over other needs. A well-documented assessment can be used to generate the support needed to secure these resources.

Discussions of constraints to adaptation should include other sectors to identify opportunities for these sectors to implement policies and programs that advance adaptations that promote population health. Such discussions will also allow the health sector to advance adaptations that help other sectors achieve their goals, such as mutual planning on disaster risk management. In many cases, working with other sectors to implement adaptation measures that achieve mutual goals can help overcome adaptation barriers. Box 11 provides an example of how multiple partners across sectors combined efforts to implement a shade policy in the City of Toronto that achieves multiple goals including climate change adaptation and mitigation.

Box 11: Shade Policy and Guidelines in the City of Toronto

The Shade Guidelines were created by the Shade Policy Committee of the Toronto Cancer Prevention Coalition in collaboration with the Department of Parks, Forestry and Recreation and with the support of Toronto Public Health. The Shade Guidelines are intended to complement the Shade Policy for the City of Toronto and to assist all city agencies, boards, commissions, and divisions (ABCDs) to provide ultraviolet radiation (UVR) protection and sun safety measures for their outdoor environments. As stated in the Shade Policy, the provision of shade can be an effective means of reducing exposure to UVR and its associated health risks such as skin cancer. In addition, the Shade Policy provides numerous co-benefits in many areas that are important to human health. Most notably, they help reduce the urban heat island effect, air pollution, climate change, and provide energy savings. Planting trees can also help reduce flood risks by increasing filtration of floodwaters.

The development and implementation of the Shade Policy and Guidelines were successful in large part due to collaboration amongst several partners across sectors to identify and work towards achieving common goals. Partners included: Toronto Public Health; Parks, Forestry and Recreation (Community Recreation, Parks Development and Capital Projects, and Urban Forestry Branches); City Planning including Urban Design; Children's Services; Facilities and Real Estate; Ryerson University Department of Architectural Science and School of Occupational and Public Health; Local Enhancement and Appreciation of Forests; the Toronto District School Board; Evergreen; Tree Canada; dermatologists from Women's College Hospital and University Health Network Senior Architect from Parsons (former Delcan Corporation), Play by Nature, environmentalists and urban foresters.

The 2014 US Surgeon General's Call to Action to prevent skin cancer cites Toronto's Shade Policy as one of the success stories in skin cancer prevention. A short film entitled *"Partners In Action" captures* reflections of members of the Shade Policy Committee about the importance of Toronto's Shade Policy and is available at https://www.youtube.com/watch?v=Jq1jD6E43Z4.

The Shade Guidelines are available at: http://www1.toronto.ca/health/shadeguidelines

4E DEVELOP A CLIMATE CHANGE AND HEALTH ADAPTATION PLAN

The information generated in previous steps can be synthesized to develop a climate change and health adaptation plan that considers shorter and longer time scales, and that facilitates coordination and collaboration with other sectors to promote resilience. The action plan does not have to be extensive, but should provide enough information so that those not involved in its development can understand it and use it to implement the recommended actions.

The plan should link with initiatives to address the risks of climate change in other sectors, and include specific goals and the time frame over which they will be accomplished. For example, a goal might be to establish an integrated approach for managing the health effects of heatwaves, with one possible activity to establish an early warning system. The plan would articulate how establishing an early warning system would be achieved, which stakeholders should be involved, within what time frame it would be implemented, and how (and with what frequency) its effectiveness would be monitored.

Depending on the context, the plan may include expected results, milestones, the sequencing of activities, clear responsibilities for implementation, the required human and financial resources, the costs and benefits of interventions, and financing options. The plan should promote coordination and synergies with city and provincial goals. Including on the project team someone involved with the city and provincial climate change plans would be an effective approach to making these linkages. Box 12 provides an example of an air quality and climate change management plan.

Box 12: Air Quality and Climate Change Management Plan, City of Ottawa

The City of Ottawa's *Air Quality and Climate Change Management Plan* (2014) outlines goals, objectives, and recommendations to address climate change over the next 5 years. Included in the Plan are specific goals and activities underway or planned to reduce climate-related health risks. One goal is to adapt to climate change and protect people and property by reducing the risks to public health (e.g. through West Nile and Lyme disease monitoring and prevention programs).

Source: Shutterstock image

This will be achieved through the identification and communication of health risks to Ottawa residents and businesses, continued disease surveillance, education and prevention programs for vectorborne diseases such as West Nile virus and Lyme disease, and increasing the ratio of vegetated to impermeable surfaces to reduce the urban heat island effect. Ottawa Public Health identified a need to continue to invest resources to combat illnesses associated with extreme weather in Ottawa and conduct research and evaluation studies to keep improving the Heat and Smog Action Plan to protect health.

Source: City of Ottawa 2014

Step 5: Establish an Alterative Process for Managing and Monitoring Health Risks

Ensuring the adaptation plan is effective in the face of ongoing climate change means it is important to develop an iterative process for managing and monitoring health risks (Ebi 2011; Hess et al. 2012). This includes recommending when the V&A assessment should be repeated to identify whether new risks have arisen, including any changes in the geographic range of health outcomes. It also involves determining the effectiveness of the implemented adaptation options and what modifications are needed to continue to be effective with additional climate change.

5A DEVELOP A MONITORING PLAN

Effectively managing the health risks of climate variability and change requires interventions to explicitly address risks over spatial and temporal scales, with high degrees of uncertainty as to the magnitude, rate, and pattern of changes in a particular location at a particular time. These include risks from a changing climate as well as from changes in other factors that determine the distribution and incidence of climate-sensitive health outcomes (see Step 3).

Therefore, a plan is needed for monitoring the burden of health outcomes and the effectiveness of adaptation options implemented, including milestones for evaluation. This step is closely aligned with Step 2f that developed a baseline for comparing how morbidity and mortality of climate-sensitive health outcomes change over time. As noted in the discussion of that step, it is expected that morbidity and mortality will decrease with effective adaptation. However, the health burden could increase if, for example, infectious diseases change their geographic range, seasonality, or intensity of transmission because of climate change-related changes in the ecosystems on which the vectors rely.

Similarly, heat-related mortality could increase with increases in the frequency, intensity, and duration of extreme heat events. It is therefore important to specify in the climate change and health adaptation plan what will be monitored, how frequently, and how the data will be collected and analyzed and how it will be communicated to ensure appropriate and timely adjustments to the adaptation options.

5B DEVELOP INDICATORS FOR MONITORING

Defining indicators for the health risks of climate change is an emerging field (English et al. 2009; Cheng and Berry 2013). An agreed set of minimum indicators, similar to those defined for measuring meteorological and climatological variables, along with means of verification, are needed for measuring the degree of success of health adaptation activities. Working with stakeholders, indicators should be chosen that include quantification of health burdens and qualitative metrics of the process of adaptation. For example, Appendix 1 of the Region of Peel assessment lists vulnerability tables, organized by health outcomes and indicators for exposure, sensitivity, and adaptive capacity. Indicators for exposure to heat could include excess heat-related morbidity and mortality, tree cover, percent impervious surface, occupational groups working outdoors, households without air conditioning, and metrics of social and economic disadvantage. Refer to the text box below for information on how to evaluate programs and policies that may be helpful in completing step 5.

Information on conducting evaluations on programs and policies for reducing health risks from climate change hazards.

Box 13: Information Sources for Evaluations of Programs or Policies

Formal evaluations are most credible and useful when information is gathered using a mix of qualitative (e.g. focus groups, in-depth interviews, open-ended survey questions) and quantitative methods (e.g. surveys, process tracking forms and records, large data sets). Informal feedback from stakeholders and target audiences, as well as observations about the performance of the policy or program from lead agencies, may be used for the evaluation; however, this type of data is often incomplete and may be biased. The most appropriate indicators and methodologies for data collection can be identified when the evaluation design addresses the following: evaluation goals, data availability, types of tools and measures needed for data collection, frequency of data collection and optimal time frame to collect the data, and organizations responsible for data collection and analysis. A collaborative approach to the evaluation process, including identifying the core objectives, is essential. Using this approach, partners and stakeholders contribute to the evaluation through their knowledge of individual and community-level vulnerabilities, target audiences for outreach activities, and existing information gaps. It is important to identify core elements of the program or policy and its ultimate goal. A schematic can guide the evaluation process by highlighting how the program or policy operates and by identifying leads with their roles and responsibilities.

Process and Outcome Evaluations

- **Process evaluation** determines if the policy or program has been carried out as planned and whether each component of the policy or program has been operating effectively. It involves gathering data during implementation to assess program-specific issues of relevance and performance as well as design and delivery. The evaluation should address pre-identified questions using a set of indicators. Data sources could include: financial reporting information, interviews, meeting summaries, website usage statistics and other inquiries received and table-top exercises.
- **Outcome evaluation** focusses on the impact of the policy or program based upon the policy or program goals and objectives. An evaluation should be focussed on issues of greatest concern to partners and stakeholders, while being as simple and cost-effective as possible. It is most appropriate for well-developed programs or policies that have made progress towards achieving intermediate objectives and ultimate goals. This type of evaluation should focus on policy or program effectiveness by measuring changes in morbidity and mortality and the impact of the public health interventions on awareness, knowledge, understanding and behavioural change. Outcome evaluations may need more resources because they require several years of observation, the establishment of baseline data, access to hospitalization and annual mortality data, and the expertise of an epidemiologist to conduct the analysis. A detailed analysis of health outcomes based on only a few years of implementation of the program or policy will likely convey a limited understanding of program impact and effectiveness.

Adapted from Health Canada, 2012, Heat Alert Response Systems to Protect Health: Best Practices Guidebook –
http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/pubs/climat/response-intervention/response-intervention-eng.pdf

5C IDENTIFY AND SHARE LESSONS LEARNED AND BEST PRACTICES

During the process of implementing and monitoring adaptation options, it would be helpful to other health authorities for the project team to document lessons learned and to share this information with partners and stakeholders. As experience grows with health adaptation, there will be a growing body of information to help other health authorities as they conduct vulnerability and adaptation assessments.

Step 6: Examine the Potential Health Benefits and Co-Harms of Adaptation and Mitigation Options Implemented in Other Sectors

6A REVIEW ADAPTATION AND MITIGATION OPTIONS IMPLEMENTED/PROPOSED IN OTHER SECTORS

Because climate change adaptation and mitigation options implemented in other sectors can affect public health, an important part of a vulnerability and adaptation assessment is to engage with these sectors to identify possible health consequences from these options, and to identify and recommend actions for minimizing health risks and maximizing any potential health gains. This review can be accomplished by an expert evaluation of the policies and programs to determine the nature and magnitude of possible health impacts. These health effects are generally unintended, and can range from none to highly significant. For example, green roofing has multiple environmental benefits, such as cooling and storm water management, that are unlikely to have other than beneficial or neutral health impacts. Changes to industrial processes to reduce carbon dioxide emissions have the potential for human exposures to potentially hazardous materials, depending on the technology, the chemicals or other agents involved, and how they are implemented.

There may be local or regional climate change programs that coordinate climate change activities; engaging with these programs can facilitate identification of adjustments to adaptation and mitigation choices that would promote health. Box 13 gives an example if initiatives led by the government of Quebec to reduce urban heat islands. The Department of Health and partners in other sectors are involved in these efforts, illustrating the effectiveness of collaborative initiatives to address vulnerabilities to a changing climate, thereby promoting resilience in health and other sectors simultaneously.

Box 14: Urban Heat Island Reduction Initiatives Led by the Government of Quebec

Quebec is at the forefront of efforts within Canada to reduce the urban heat island (UHI) effect. A number of projects have been undertaken as part of the Quebec Government's 2006–12[3] and 2013–20[4] Climate Change Action Plans. Under both Plans, the Institut National de Santé Publique du Québec (INSPQ) has been mandated with developing initiatives to prevent and reduce the risk from climate change to human health. This has led to heat-related initiatives such as developing heat alert and response plans and advancing preventative actions such as pilot greening projects that help reduce the UHI effect. Innovative UHI-related projects include:

Quebec Online Heat-Health Portal[5] – The INSPQ developed an online heat-health mapping portal for Quebec that displays land surface temperatures for the southern portion of the province and sends automated alerts. The portal features an interactive map of the province and includes heat-health data layers (i.e. cooling centres, vegetation maps, socio-economic deprivation, access to air conditioning, etc.) that can easily be turned on or off to accommodate viewer preferences[6]. A vulnerability tool at the census dissemination area level is also available and can be parameterized by the user.

"Cool Island" Grant Program[7] – The INSPQ developed a $14 million grant program to support pilot projects that reduce urban heat islands. The grants were open to municipalities publicly funded services such as schools, daycares, and affordable housing and, non-profit groups such as environment groups and housing cooperatives. There were 37 projects selected that obtained funds and contributed twice as much in total. The program supported projects in communities that are characterised by a UHI and have vulnerable populations. Projects included the greening of schoolyards, the creation of "green alleyways", and the planting of trees and climbing plants at affordable housing sites, as well as improved local management of rainwater and high albedo roofs.

Green Parking Lot Design Standards[8,9] – The Government of Quebec's Fonds Vert and Natural Resources Canada jointly supported the development of parking lot design guidelines that provide recommendations to mitigate urban heat island and reduce storm water run-off volumes. The Guidelines were produced by the Bureau de Normalisation de Quebec, a recognized standards granting agency. In 2014, the City of Montreal formally endorsed the guidelines for the design and construction of parking lots throughout the city.

3 Quebec Government's Climate Change Action Plan (2006–12): http://www.mddelcc.gouv.qc.ca/changements/plan_action/2006-2012_en.pdf
4 Quebec Government's Climate Change Action Plan (2013–2020): http://www.mddelcc.gouv.qc.ca/changements/plan_action/pacc2020-en.pdf
5 Ilots de chaleur/fraicheur urbains et température de surface http://www.donnees.gouv.qc.ca/?node=/donnees-details&id=2f4294b5-8489-4630-96a1-84da590f02ee#meta_point0fContact
6 Kestens, Y., Brand, A., Fournier, M., Goudrequ, S., Kosatsky, T., Maloley, M. and Smargiassi, A. (2011). Modelling the variation of land surface temperature as determinant of risk of heat-related health events. International Journal of Health Geographics. 10 (7). doi:10.1186/1476-072X-10-7
7 INSPQ: Plan d'action 2006–2012 sur les changements climatique (PACC) – Volet sante http://www.inspq.qc.ca/plan-daction-2006-2012-sur-les-changements-climatiques
8 BNQ: Lutte aux ilots de chaleur urbain http://www.bnq.qc.ca/fr/normalisation/environnement/lutte-aux-ilots-de-chaleur-urbains.html
9 http://ville.montreal.qc.ca/documents/Adi_Public/CM/CM_PV_ORDI_2014-03-24_14h00_FR.pdf

6B IDENTIFY SYNERGIES FOR ADAPTATION AND MITIGATION OPTIONS

Greenhouse gas mitigation is a primary prevention health measure that is required and advocated by public health officials to reduce climate change and health risks. There are many examples of actions that aim to mitigate GHG emissions and increase resilience to future climate-related health risks, such as, planting trees, buying local food, and installing green roofs.

Box 14 and 15 provides examples of mitigation and adaptation actions and initiatives underway in the City of Toronto that will help reduce health risks from climate change as well as contribute to GHG mitigation.

Box 15: Examples of Adaptation and Mitigation Actions in the City of Toronto

The City of Toronto has a strong commitment to addressing climate change and is actively working to reduce greenhouse gas emissions and increase the resilience of the city to a changing climate and extreme weather events. The success of Toronto's efforts is reflected in the fact that it is estimated that greenhouse gas emissions in 2012 were about 25% below 1990 levels. Toronto far exceeded its initial target of a 6% reduction by 2012. A few examples of efforts occurring in Toronto are:

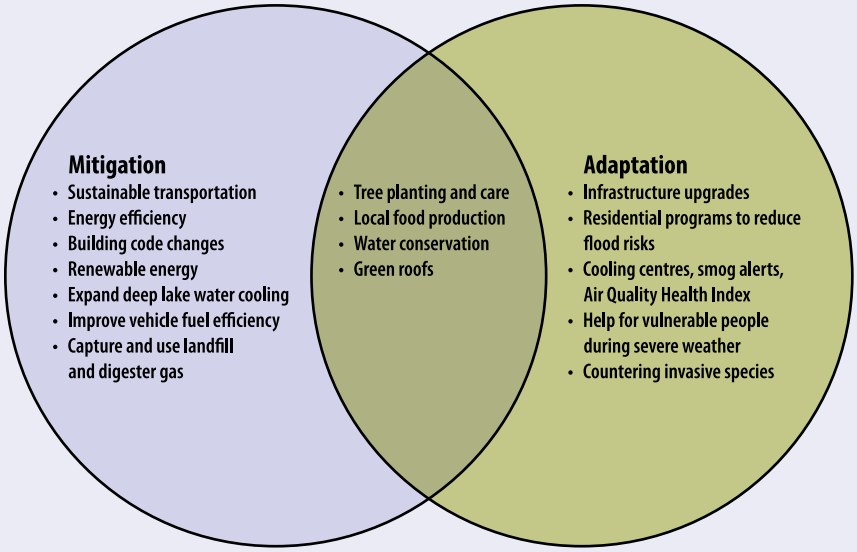
1. **A Commitment to Double the Tree Canopy** – Expanding the tree canopy in Toronto will provide shade, lessen the urban heat island effect, and reduce runoff and other effects of climate change. Toronto's Strategic Forest Management Plan for 2012–2022 can be found at: http://www1.toronto.ca/City%20Of%20Toronto/Parks%20Forestry%20&%20Recreation/Urban%20Forestry/Files/pdf/B/backgroundfile-55258.pdf

2. **Building Green Roofs** – Toronto is working to reduce the negative effects on the UHI of large flat roofs through its Green Roof Bylaw which requires the construction of a green roof on effectively all new development. The EcoRoof Financial Incentive program provides financial assistance towards the installation of a green or cool roof on existing buildings. http://www.toronto.ca/greenroofs/overview.htm

3. **Creating Energy Efficiency Buildings** – Innovative regulations, programs and financing options have and are being established to encourage deep energy efficiency retrofits. For example, Toronto has utilized changes to the Local Improvement Charge regulations to create the Home Energy Loan Program that provides low interest, long term loans for residents wanting to make substantive energy efficiency upgrades to their home. Other programs include the Toronto Green Standard and the Better Buildings Partnership. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=fd95ba2ae8b1e310VgnVCM10000071d60f89RCRD

Box 16: Examples of Adaptation and Mitigation Actions in the City of Toronto

The figure shows the intersection of adaptation and mitigation actions in the City of Toronto. It was adapted from Sandink and MacLeod 2009: http://www.iclr.org/images/Muni_world_Sandink_McLeod.pdf



CONCLUSION

Climate change is among the major challenges for health this century. Projected health impacts include greater morbidity and mortality related to an increase in the frequency and severity of extreme weather events (e.g. extreme heat, floods, hurricanes, ice storms and droughts), increases in illnesses and deaths due to poor air quality, food and waterborne illnesses and the expansion of vectorborne and zoonotic diseases. Recent scientific assessments indicate that Ontarians are at risk from the impacts of climate change and these risks will continue to increase in coming decades. Ontario is taking aggressive actions to comprehensively address climate change including the development of the *Environmental Health Climate Change Framework for Action* to reduce public health vulnerability to climate change and support an adaptive and resilient public health system.

As part of a suite of tools to help public health officials address environmental and climate change risks to health, the guidance in this document provides step-by-step direction to help decision-makers understand current impacts and projected future risks of climate variability and change, and identify policies and programs to increase resilience to these risks. Health officials are encouraged to use this information to plan an assessment, obtain and analyse relevant data, and communicate the results to governmental partners, stakeholders and the public. Case studies of application of assessment steps are included to provide practical guidance to the user, as is a checklist for use by assessment teams. Information resources that can be drawn upon for completion of each step are also highlighted. In this regard, a key source of information is the *Ontario Climate Change and Health Modelling Study* which projects climate change and health risks across the 36 health units in Ontario. Understanding how future risks to health might change is critical for enhancing resilience to future climate change impacts and not just to current climate stresses on health.

Efforts to prepare for the health impacts of climate change will bring significant benefits to Ontarians now and reduce risks into the future. Collaborative efforts among researchers and public health officials supported by community engagement in the assessment process can provide the evidence based information needed to adapt successfully helping to make communities safer and more resilient to climate change.

REFERENCES

Berry P, Clarke K, Fleury MD, Parker S. Human health in Canada in a changing climate: Sector perspectives on impacts and adaptation. Eds: Warren EJ, Lemmen DS. Government of Canada, Ottawa, ON. P 191-232. 2014. http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/assess/2014/pdf/Chapter7-Human-Health_Eng.pdf

Berry P, Paterson J, Buse C. Assessment of vulnerability to the health impacts of climate change in Middlesex-London County. Report Prepared for the Middlesex-London Health Unit, Ottawa. 2014.

Berry P, Richters K, Clarke K-L, Brisbois M-C. Assessment of vulnerability to the health impacts of extreme heat in the City of Windsor. Report prepared for the City of Windsor, 2011.

Buse C, Lana D. Assessing health vulnerability to climate change in the Region of Peel. Region of Peel, 2012

Casati B, Yagouti A, Chaumont D. Analysis of extreme temperature indices in 9 Canadian communities using the Canadian Regional Climate Model projections for public health planning; Journal of Applied Meteorology and Climatology, 52: 2669-2698 (2013). DOI:10.1175/JAMC-D-12-0341.1

Cheng JJ, Berry P. Development of key indicators to quantify the health impacts of climate change on Canadians. Int J Public Health 2013, DOI 10.1007/s00038-013-0499-5

City of Ottawa, Air quality and climate change management plan. 2014.

Ebi KL. Climate change and health risks: assessing and responding to them through 'adaptive management'. Health Affairs (Millwood) 2011 May;30(5):924-30.

English PB, Sinclair AH, Ross Z, Anderson H, Boothe V, Davis C, et al. Environmental health indicators of climate change for the United States: findings from the State Environmental Health Indicator Collaborative. Environ Health Perspect 2009;117:1673–1681.DOI:10.1289/ehp.0900708

Gower S. Yusa, A. Rogaeva, A. Mee, C. Pacheco, E. Best practices to reduce health risks from extreme heat: Collaborative evaluation of the Toronto Heat Alert and Response System (HARS). Poster presented at the Canadian Public Health Association Conference 2011.

Health Canada. Heat alert and response systems to protect health: Best practices guidebook. Ottawa, Minister of Health. 2012.

Health Canada. Adapting to extreme heat events: guidelines for assessing health vulnerability. Health Canada, Ottawa, Canada. 2011.

Hess JJ, McDowell JZ, Luber G. Integrating climate change adaptation into public health practice: using adaptive management to increase adaptive capacity and build resilience. Environ Health Perspect 2012;120:171-179.

IPCC 2012.Managing the risks of extreme events and disasters to advance climate change adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA.

Lindgren E, Suk J, Sudre B, Semenza JC. Monitoring EU emerging infectious disease risk due to climate change. Science 2012;336:418-419.

National Research Council (NRC).Climate and social stress: Implications for security analysis. Committee on Assessing the Impacts of Climate Change on Social and Political Stresses.[J.D. Steinbruner, P.C. Stern, and J.L. Husbands, Eds.] Board on Environmental Change and Society, Division of Behavioral and Social Sciences and Education. 2012. Washington, DC: The National Academies Press.

Ogden NH, St-Onge L, Barker IK, Brazeau S, Bigras-Poulin M, Charron DF, Francis CM, et al. Risk maps for range expansion of the Lyme disease vector, Ixodesscapularis, in Canada now and with climate change. Int J Health Geogr2008;7:24. doi: 10.1186/1476-072X-7-24

Ogden NH, Radojevic M, Wu X, Duvvuri VR, Leighton PA, Wu J. Estimated effects of projected climate change on the basic reproductive number of the Lyme disease vector *Ixodesscapularis*. Environ Health Perspect 2014;122:631-638. DOI: 10.1289/ehp.1307799.

Public Safety Canada. Canadian disaster database.2013.
http://www.publicsafety.gc.ca/cnt/rsrcs/cndn-dsstr-dtbs/index-eng.aspx

Richters, K. 2012. Stay cool Windsor-Essex *2011*. End of Season Report. City of Windsor.

Warren FJ, and Lemmen, DS. Eds: Canada in a changing climate: Sector perspectives on impacts and adaptation. Government of Canada, Ottawa, ON.2014.
http://www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2014/16309

White-Newsome JL, McCormick A, Sampson N, Buxton MA, O'Neill MS, Gronlund CJ, et al. Strategies to reduce the harmful effects of extreme heat events: a four-city study. Int J Environ Res Public Health 2014;11:1960-1988. DOI:10.3390/ijerph110201960.

Wilk A, Berry P, Paterson J, Morris-Oswald T. The psychosocial impacts of climate change in Canada: Understanding current and future risks to inform adaptation. Report Prepared for Health Canada, Ottawa. 2014.

ANNEX 1: VULNERABILITY ASSESSMENT ACTIVITIES CHECKLIST

Step 1: Frame and Scope the Assessment

- Specify timeframe and resources
- Identify health risks and outcomes from climate change of most interest
- Specify future time period for associated risks and adaptation needs to be considered
- Define and describe how the assessment will be managed
- Develop a communication plan for informing stakeholders of results and progress
- Include critical public health sector issues, linkages with the sectors and interdependencies
- Create a project team with relevant expertise
- Identify available information to inform the assessment
- Identify additional resource persons with targeted expertise on specific topics
- Conduct interviews with stakeholders to obtain information as needed on specific topics
- Consult with communication experts to discuss how to present the results to the public
- Develop a work plan

Step 2: Describe Current Risks Including Vulnerabilities and Capacities

- Compile avalable qualitative & quantitative information
- Estimate current relationships between weather patterns and climate-sensitive health outcomes
- Describe trends for environmental hazards of interest
- Characterize current vulnerability of exposed individuals and communities
- Describe and assess effectiveness of policies & programs
- Develop an explicit baseline for use in monitoring future vulnerability and for evaluation adaptation options

Step 3: Project Future Health Risks

- Define time frame for projecting future risks (2020's, 2050's, 2080's)
- Refer to the MOHLTC's Climate Change and Health Modelling Study as a key resource for identifying future climate change and health risks
- Consider how weather and development patterns could affect future climate-sensitive health risks
- Refer to other available resources as needed
- Identify uncertainties and the extent to which they could influence projected health risks

Step 4: Identify and Implement Adaptation Options

- Identify information on possible modification of current policies and programs
- Recommend options to be implemented to modify current policies and programs, examples are:
  - Strengthening integrated disease surveillance programs
  - Strengthening environmental health services
  - Strengthening early warning and disaster risk management
  - Mainstreaming climate change into public health policy
  - Strengthening primary health care service
  - Improving infrastructure
  - Improving built environment (e.g. plant trees, improve urban landscape)
- Prioritize options to identify time scale for implementation
- Identify information on possible modifications of current policies and programs
- Identify possible additional new efforts to manage additional health risks from climate variability and change
- Consult with health authorities in other jurisdictions, sectors, scientists, practitioners and other stakeholders within and outside the health sector
- Identify all possible measures that could be implemented regardless of technical feasibility, cost, or other limiting criteria
- Identify possible policies and programs to implement over a particular time period, within existing technological, human and financial resource constraints. Screening criteria could include:
  - Whether the option is technically feasible
  - The degree of effectiveness of the proposed measure in reducing morbidity and mortality
  - What consequences might be associated with the option
  - Where there is the financial capacity to implement and maintain option
  - Whether the proposed option is socially acceptable
- Prioritize which options to implement over the short and medium term
- Create two sets of priorities: critical policies and programs that should be implemented now; and those that are important but can wait a few years before implementation
- Assess possible constraints to implementing options and how to overcome them
- Develop a climate change and health adaptation plan that:
  - Defines action that will be taken in shorter and longer time scales
  - Facilitates coordination and collaboration with other sectors to promote resilience
  - Specifies overarching strategies (e.g. climate change strategies in other sectors)
  - Specifies goals and the timeframe of accomplishments
  - Outlines expected results, milestones, sequencing of activities
  - Outlines roles and responsibilities for implementation
  - Outlines required human and financial resources required to implement plan
  - Provides analysis of costs and benefits of interventions and financing options
  - Promotes coordination and synergies between the implementation plan and city and provincial goals

Step 5: Establish an Iterative Process for Managing and Monitoring Health Risks

- Develop a plan for monitoring the burden of health outcomes and effectiveness of adaptations
- Indicate when the V&A assessment should be repeated to identify new risks
- Specify milestones for evaluation
- Identify what will be monitored, how frequently and how data will be analyzed and communicated
- Identify an agreed set of minimum indicators to track health outcomes and adaptation progress
- Document lessons learned
- Share lessons learned with partners and stakeholders and more broadly

Step 6: Examine the Potential Health Benefits and Co-Harms of Adaptation and Mitigation Options Implemented in Other Sectors

- Review Adaptation and Mitigation Options Implemented/Proposed in Other Sectors
- Identify Synergies for Adaptation and Mitigation Options

NOTES

NOTES

NOTES

ISBN 978-1-4606-6228-1 (PDF)

Ontario