Module 3

Climate Change Toolkit for Health Professionals

Climate Change Health Impacts Across Canada

April 2019

ACME CAPE

Recommended Citation: Canadian Association of Physicians for the Environment (CAPE). **Climate Change Toolkit for Health Professionals**: **Module 3 – Climate Change Health Impacts across Canada.** April 2019

Author: Helen Marie Doyle B.Sc. CPHI(C)

Project Manager and Editor: Kim Perrotta MHSc, CAPE Executive Director

Project Advisors: We would like to thank the following people who provided advice and/or comments on this module: Peter Berry PhD, Cathy Vakil MD CCFP FCFP, Andrea Hull MD CCFP DTMH

Design and Production: We would like to thank Kaeleigh Phillips B.A. PGC, CAPE Digital Communications Director, for formatting and designing this report.

Photos: Cover Photo: Wildfire. Photo by Luke Flynt on Unsplash. Background Title page Photo: Wind Turbine. Photo by Marten Bjork on Unsplash.

Acknowledgements: We would like to acknowledge the Government of Canada for providing the funding that made this project possible.

Funded by / Financé par

Environment and Climate Change Canada | Environnement et Changement climatique Canada

Additional copies of this publication may be downloaded in from the CAPE website at in English and in French.

ISBN: 978-1-9990531-0-9

ACME Association Canadienne des Médecins pour l'Environnement | CAPE Canadian Association of Physicians for the Environment

Preface

This toolkit consists of eight modules which have been prepared as stand-alone documents that can be read by themselves, but they have also been prepared to complement one another. It has been designed as a tool for health professionals and students in the health care and public health sectors who want to engage more directly on the issue of climate change as educators with their patients, peers and communities, and/or as advocates for the policies, programs and practices needed to mitigate climate change and/or prepare for climate change in their workplaces and communities.

Module 1 – Climate Change – Science, Drivers & Global Response provides an introduction to climate science and discusses the human activities that are contributing to climate change, the international commitments that have been made to address it, and where we are in terms of complying with those commitments.

Module 2 – Global Health Impacts of Climate Change summarizes the direct and indirect health impacts that are occurring, and are predicted to result from, climate change, on a global scale.

Module 3 – Climate Change Health Impacts across Canada summarizes the direct and indirect health impacts that are occurring, and that are predicted to occur, in the different regions of Canada.

Module 4 – Greenhouse Gas Emissions in Canada by Sector and Region discusses the volume of greenhouse gases emitted, and the trends in those emissions, from different sectors in Canada at a national, provincial and territorial scale.

Module 5 – Climate Change Solutions with Immediate Health Benefits discusses climate solutions that can produce fairly immediate health co-benefits for the jurisdictions that implement them.

Module 6 – Taking Action on Climate Change at Health Care Facilities discusses the climate mitigation and adaptation policies, programs and practices that can be adopted and implemented by health care institutions to reduce their greenhouse gas emissions and prepare for climate change.

Module 7 – Preparing for Climate Change in our Communities discusses the climate adaptation policies and programs that can be developed by public health units or municipalities to minimize the health impacts associated with climate change.

Module 8 – Engaging in Climate Change as Health Professionals discusses the different ways in which health professionals can educate and engage their patients, the public, their peers, and their communities on the health impacts of climate change, and the policies and programs needed to mitigate climate change and prepare for it.

Module 3 – Climate Change Health Impacts across Canada

Introduction

Climate variability and change is already impacting the health of Canadians across the country. Cardiovascular and respiratory diseases, cancer, infectious diseases, mental health, injuries and deaths can all be linked to our changing climate. While the burden of disease remains uncertain, there is strong evidence that the climatic conditions that contribute to these health outcomes are very likely to occur across Canada and are already occurring in many communities (Berry et al., 2014).

Overview of Health Impacts

Extreme heat contributes to heat-related illnesses and deaths. Air pollution, which has been attributed to approximately 14,400 annual deaths in Canada, is likely to increase with climate change (Health Canada, 2017). Forest fire smoke, smog, dust from droughts, and pollen, contributes to respiratory ailments and cardiovascular incidents. Damaging sunburns and skin cancer are on the rise. The incidence of vector-borne diseases is increasing. (PHAC 2018a). Food and water-borne illnesses have been linked to both extreme precipitation and droughts. Extreme weather events such as heavy rainfall, tornadoes, and ice storms put Canadians at risk from illness, injury, death and poor mental health as communities try to cope with power outages, food and water quality concerns, environmental exposures, evacuations and financial hardship in the aftermath of the event (Berry et al., 2014).

Flooded homes and buildings that are not properly remediated can lead to mould growth, aggravating allergy and asthma symptoms. Stress and mental health impacts are increased following extreme weather events that often leave people displaced for extended periods (Hayes et al, 2018). Disaster recovery costs may be unmanageable for some, increasing financial insecurity. Many of

Flooding. Photo by Chris Gallagher on Unsplash.

Table 1: Examples of climate-related health impacts and causal pathways of relevance in Canada.

HEALTH OUTCOME	HAZARD/ EXPOSURE	ENVIRONMENTAL EFFECT	CLIMATE CHANGE DRIVER
Cardiovascular Disease	Air pollutants	↑ formation of air pollutants ↑ forest fires ↑ droughts and dust storms	Rising temperatures Extreme weather events Changes in precipitation
	Extreme heat	↑ frequency and duration of heat waves	Rising temperatures Extreme weather events
Respiratory Conditions	Air pollutants	↑ formation of air pollutants ↑ forest fires ↑ droughts and dust storms	Rising temperatures Extreme weather events Changes in precipitation
	Extreme heat	Heat waves – hot days & warm nights	Rising temperatures Extreme weather events
Allergic Reactions	Pollen & spores	Longer growing season	Rising temperatures
	Mould	Heavy rainfall & flooding	Extreme weather events
Heat stroke/ exhaustion	Extreme heat	↑ frequency and duration of heat waves	Rising temperatures Extreme weather events
Cancer	Air pollutants	↑ formation of air pollutants	Rising temperatures
	UV radiation	Ozone layer depletion Longer summer season	Temp.-related changes Rising temperatures
Traumatic Injuries	Physical trauma, dangerous travel, drowning, violence	Floods, forest fires, tornadoes, hurricanes, storm surges, winter storms, melting permafrost	Extreme weather events Rising temperatures Sea level rise
Vector-borne Diseases	Infected mosquitoes, ticks and rodents	Expanding habitat conducive to disease vectors ↑ conditions for vector propagation	Rising temperatures Extreme weather events Changes in precipitation
Food-borne Illness	Food-borne pathogens/toxins	Contaminated food/flood waters ↑ conditions for bacterial growth	Extreme weather events Rising temperatures
Water-borne Illness	Water-borne pathogens/toxins	Contaminated water sources ↑ conditions for bacterial growth	Extreme weather events Changes in precipitation
Malnutrition	Food insecurity Water shortages	Drought, crop loss, biodiversity loss Floods	Rising temperatures Extreme weather events
Mental Health Stress & Anxiety	Population displacement Multiple stressors Climate-induced stress	Floods, forest fires, tornadoes, droughts, heat waves Prolonged and repeated climate-related events Catastrophic events	Rising temperatures Extreme weather events Sea level rise Changes in precipitation
Socio-economic impacts	Social disruptions Loss of incomes and culture ↓ quality of life	Floods, forest fires, tornadoes, droughts, heat waves Prolonged climate-related events Catastrophic events	Rising temperatures Extreme weather events

these health impacts and health inequities are predicted to increase with climate change (Rudolph et al., 2018).

Climate Adaptation

Adaptation by health authorities, communities and individual Canadians can be effective in reducing climate change risks to health (Martinez and Berry, 2018). Thus, the degree to which climate change contributes to adverse health outcomes in Canada is also highly dependent and reliant upon the public health interventions that are put in place, and the supporting adaptation efforts in other sectors. This will be discussed in more detail in Modules 6 and 7.

Health impacts may be partially offset by the benefits of a warming climate such as a longer growing season or fewer injuries and death associated with cold weather (Canada, 2018a; NRCan, 2017a). However, as the climate continues to warm, the threat of more severe and even catastrophic impacts on health to Canadians increases through cascading events and other climate surprises that may occur (Campbell et al., 2014).

Table 1 summarizes the adverse health outcomes that are associated with climate change and provides examples of the causal pathways from climate change driver to environmental effect to exposure to adverse health outcome.

A heat wave in Quebec in July 2018 resulted 93 heat-related deaths (ECCC, 2018b), while a 2010 heat wave in the same province saw a 33% increase in deaths (~ 280 deaths) and a 4% increase in hospital admissions (~ 3400 admissions) (Bustinza et al. 2013).

A 2009 heat wave in British Columbia saw a 40% increase in mortality within days of onset of the event and was associated with an increase in all-cause mortality compared to the previous 5-year average (Kostatsky et al., 2012; Kostatsky, 2010).

Extreme Heat

It is not just annual average temperature increases (general warming) that are of concern with a changing climate. Temperature extremes are of great concern for human health. Environment & Climate Change Canada (ECCC)'s climate scenarios indicate that the rate of warming in Canada has been more than double the global mean, with warming in the northern part of Canada approximately three times the global mean (ECCC, 2018a). While increasing average temperatures have multiple implications for human health, including drought, loss of biodiversity, food insecurity and changing habitat for vector-borne diseases, extremes of temperature have serious direct health consequences (Berry et al., 2014).

Canadians across the country are already experiencing heat-related health impacts and can expect to see more frequent, intense and prolonged heat waves because of climate change. The number of extremely hot days is expected to double or triple in some parts of Canada in the next 30 years. While all provinces and territories will see a significant increase the most populated urban centres in Saskatchewan, Manitoba, Ontario and Quebec are predicted to experience approximately 50 extremely hot days and over 30 warm nights (Climate Atlas, 2018). This has severe consequences for heat-related illness when people don't have the opportunity to cool down over extended periods of time.

Health Impacts

Prolonged, extreme heat events are associated with increased mortality, especially among older adults, persons with chronic illness, or people on certain medications, and those that are socially isolated. (Berry et al., 2014). Exposure to extreme heat can cause heat stroke, dehydration, cramps, skin rash and heat exhaustion. It can also exacerbate pre-existing conditions such as cardiovascular and respiratory diseases and neurological disorders. Extreme heat is also dangerous for young children and infants, outdoor workers, people who are active outdoors, and those who may not have the financial or social supports to protect themselves and their families from the heat (Health Canada, 2012).

While heat waves extending over multiple days highlight the most visible signs of health impacts, as seen in spikes in mortality, seasonal heat is also a risk. Canadian research has shown mortality rates increasing after daily average temperatures as low as 20°C (Doyon et al., 2008). In temperate climates like Canada, heat-related health impacts may occur earlier in the season,

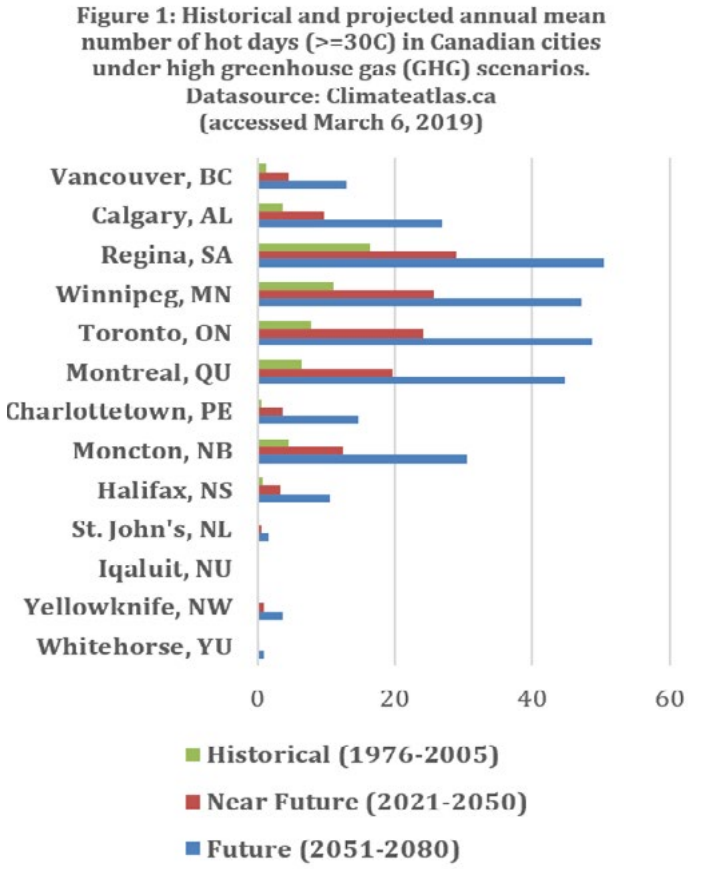


Figure 1: Historical and projected annual mean number of hot days (>=30C) in Canadian cities under high greenhouse gas (GHG) scenarios. Datasource: Climateatlas.ca (accessed March 6, 2019)

at less extreme temperatures, when the population is not yet acclimatized to the warmer weather (Ontario, 2016a).

Ultra-Violet Radiation

Health Impacts

Non-melanoma skin cancer is caused by ultra-violet (UV)-B radiation and scientists suspect that melanoma is also caused by exposure to UV light (Canada 2013a). The incidence of non-melanoma basal cell and squamous cell skin cancer is directly related to the amount of UV radiation exposure (Portier et al., 2010). Climate change is related to harmful UV radiation through two mechanisms. The first has to do with the depletion of the ozone layer or stratospheric ozone. While ground-level ozone is harmful to human health, stratospheric ozone provides protection from UV radiation that can cause skin cancer, sunburns, cataracts and eye damage. Some of the same greenhouse gases (GHG) that contribute to climate change e.g. chlorofluorocarbons (CFCs) are also responsible for depletion of the ozone layer. As stratospheric ozone levels decrease, UV radiation increases. While scientists are beginning to observe some stratospheric ozone layer recovery, there remains uncertainty which limits the ability to predict future changes (WMO 2018; Ball et. al., 2018).

The second way that climate change is related to UV radiation relates to the generally warmer climate that Canadians will experience. Warmer temperatures may lead to behaviour changes with people spending more time outdoors with greater exposure to UV radiation (Berry et. al., 2014). One study demonstrated this compounding impact by correlating non-melanoma skin cancer with both UV dose and average daily maximum summer temperature (van der Leun et al., 2008).

While the incidence of skin cancer associated with ozone layer depletion is expected to continue to rise over the coming decades, current observed reductions of ozone-depleting substances in the atmosphere and efforts to restrict their use could see significant improvement to the ozone layer by mid-century (WMO 2018; WHO, 2019a). At that point,

Smoke in a forest. Photo by Joanne Francis on Unsplash.

exposure to UV radiation and incidence of skin cancer may be more a consequence of behaviour change as a result of warmer weather (Bharath et al., 2009).

Air Pollution

Health Impacts

Air pollution is one of the most important risk factors for premature mortality in Canada and around the world. Climate change may increase this risk. Health Canada has estimated that 14,400 premature deaths annually in Canada result from air pollution emitted from human activities. This number represents air pollution deaths from all causes including heart disease, stroke, lung cancer and chronic obstructive pulmonary disease, from both chronic and acute exposure to three pollutants – fine particulate matter (PM2.5), nitrogen dioxide and ground-level ozone (Health Canada, 2017).

During the British Columbia forest fires in 2018, millions of people in Vancouver, Calgary and Edmonton were exposed to very poor air quality for days or weeks at a time because of smoke from regional wildfires.

In the month of August 2018 alone, the Air Quality Health Index (AQHI) was recorded as "high risk to health" (AQHI reading of 7-10) or "very high risk to health" (AQHI reading of 10+) for 128 hours in Vancouver, 138 hours in Edmonton, 92 hours in Calgary and 42 hours in Saskatoon (ECCC, 2019; Canada 2017a).

Air pollution also increases the risk of cardiovascular disease and exacerbates respiratory conditions, asthma and allergies (Berry et. al., 2014). Populations most vulnerable to the impacts of air pollution include: seniors, young children, people with pre-existing respiratory and cardiac conditions, people with diabetes, people who are on certain medications, people on low incomes, people living in close proximity to high volume traffic corridors, and people who are active outdoors (Canada, 2019a).

Climate Impacts on Air Quality

Climate change is expected to increase the weather conditions that can increase air pollution. Poor air quality is a factor of both emissions and weather conditions (Pfister et al., 2014). Warmer temperatures increase the formation of ground-level ozone which is linked to premature mortality, decreased lung function, shortness of breath, chest discomfort, and eye, nose and throat irritation (Canada, 2015a). Even healthy individuals can experience respiratory impairments when exposed to low levels of ozone (Canada, 2019a).

Warming weather and milder winters are already resulting in an increase in pollen and spore production in plants, causing health concerns for people with allergies and asthma. Climate change may also increase the allergenicity of pollen (Sierra-Heredia et. al., 2018). Ragweed is

highly allergenic and the leading cause of seasonal allergic rhinitis in north-eastern North America (Sierra-Heredia et. al., 2018; Berry et. al., 2014). The plant is highly prevalent in parts of Canada with the ragweed season having lengthened considerably in parts of the country (Sierra-Heredia et al., 2018; Ziska et al., 2011; Berry et.al., 2014). Climate change is expected to continue extending the allergy season in Canada as the growing season extends and frost-free days increase (Climate Atlas, 2018).

The combination of higher temperatures, droughts, wind and dust storms will increase exposure to PM2.5 and other air pollutants as will forest fire smoke. The small size of these particles poses serious health problems because they can get deep into the lungs, contributing to heart and lung conditions (PHAC, 2018a; INSPQ, 2014).

Vector-borne and Zoonotic Diseases

Climate change will alter conditions in the environment that may be more conducive to the emergence and spread of zoonotic and vector-borne diseases. Of particular concern in Canada is the spread of the Lyme disease tick vector, conditions that may increase exposure to the mosquito vectors of West Nile virus and other diseases, and zoonotic diseases such as hantavirus (Health Canada 2008). While

Mosquito. Photo by Егор Камелев on Unsplash.

research suggests that Canada's current climate does not support local mosquito transmission of more tropical diseases such as malaria, Zika, chikungunya or dengue, some studies suggest that climate change may increase conditions conducive to the emergence and transmission of these diseases in parts of Canada (Ogden, 2016; Lindsay, 2016; Kulkarni et al., 2015; Berrang-Ford et al., 2009).

Lyme Disease

Human cases of Lyme disease have increased significantly in Canada over the last decade, with the number of reported cases going from 144 in 2009 to 2025 in 2017. The total number of cases reported in this time period was 6029 (Canada, 2018b). Lyme disease can be very seri-

ous if left untreated, including symptoms such as severe headaches, facial paralysis, arthritis, heart disorders and neurological disorders. In rare cases, Lyme disease can lead to death (Canada, 2017b). Evidence indicates that the spread into eastern and central Canada of the black-legged tick (Lyme disease vector) is likely associated with climate change and the rapidly expanding geographical range of this tick (Gasmi, et al., 2017; Leighton et al, 2012). Lyme disease-endemic areas in Canada include southern Manitoba, southern and eastern Ontario, southern Quebec, southern New Brunswick and Nova Scotia (Ogden et al., 2014).

West Nile Virus

The number of human cases of West Nile virus (WNv) has peaked and waned over the last several years, but the disease remains a concern for Canadians. The first human case in Canada was reported in 2002. Since that time, over 6000 human cases of WNv have been reported in Canada (Canada, 2018c). Symptoms can range from mild to severe (Canada, 2015b). Older adults and persons with underlying chronic conditions are more at risk of severe symptoms which may include infections of the central nervous system, muscle weakness, paralysis, and loss of consciousness. Some severe cases of WNv can be fatal (Canada, 2015). The geographical range for WNv is predicted to expand in some regions of Canada such as the Prairie provinces (Zheng et al. 2014). In 2017, 193 human cases of WNv, including 8 deaths were reported to the Public Health Agency of Canada (PHAC), from the provinces of Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia; while in 2018 (up to Dec 15th), a total of 367 cases were reported from the provinces of Ontario, Quebec, Manitoba and Alberta (Canada, 2018c).

Rodent-borne Diseases

With climate change, there is also the potential for increases in rodent-borne diseases such as hantavirus, as warmer winters improve conditions for rodent survival, and heavy rainfall and flooding translate into higher likelihood of human contact with infected rodent urine or faeces (Health Canada, 2008). Hantavirus pulmonary syndrome is a severe respiratory infection spread through the inhalation of excreta of deer mice that have been infected with the hantavirus. Between 2000 and 2016 there were a total of 88 reported cases of hantavirus in Canada (PHAC, 2018b). The majority of cases were reported from the western provinces – British Columbia, Alberta, Saskatchewan and Manitoba. While cases of hantavirus are rare in Canada, they can cause serious health impacts. Hantavirus pulmonary syndrome has a 30% fatality rate in Canada (Drebot, et.al., 2015).

A field of lettuce. Photo provided by Pexels.

Food Safety

Health Impacts

Every year, approximately 4 million Canadians are affected by food-borne illness resulting in approximately 238 deaths and over 11,000 hospitalizations (PHAC, 2016). A warming climate and extreme weather events may increase food-borne illness rates in Canada. The food-borne pathogens responsible for the majority of these illnesses are norovirus, C. perfringens, Campylobacter, and Salmonella (PHAC, 2016). While anyone can contract a food-borne illness, seniors, pregnant women, and people with weakened immune systems are at greater risk of harm from them (Health Canada, 2015).

Fruits and Vegetables

The safety of food products may be compromised at any point in the food system. Climate change may create favourable conditions that support the growth and survival of foodborne diseases and create pathways that could increase the risk of contamination of food products through environmental media (i.e. contaminated flood waters inundating agricultural fields). Higher temperatures may stress livestock, increasing the likelihood of infection and the shedding of pathogenic micro-organisms in faeces (Health Canada, 2008).

Heavy rainfall events, followed by flooding, can contaminate water supplies that are used to irrigate produce. This is of particular concern for produce such as salad greens and fruit that are eaten raw. Increasing extremes of weather may result in the emergence or re-emergence of food-borne pathogens (Lake & Barker, 2018; Lake, 2017). Climate change has the potential to alter the spatial pattern and extent of food-borne pathogens allowing them to survive and thrive in geographical locations that were previously unsuitable (Short et al., 2017; Lake & Barker, 2018).

Every year, approximately 4 million Canadians are affected by food-borne illness resulting in approximately 238 deaths and over 11,000 hospitalizations.

Fish and Shellfish

Climate change may increase the severity and frequency of the occurrence of harmful algal blooms in marine waters increasing the risk of shellfish poisoning (NCCEH, 2017). In November 2018, Fisheries and Oceans Canada closed bivalve shellfish harvesting along much of the Sunshine Coast in British Columbia because of very high levels of paralytic shellfish poisoning toxin (Global News, 2018). In 2011, the first reported outbreak of shellfish poisoning in Canada was associated with consumption of cooked mussels causing 62 reported illnesses (Taylor et al., 2013). Warmer waters are conducive for growth of harmful algal blooms, thus increasing potential for shellfish poisoning to increase (Bouchouar et al., 2014)

Food Spoilage

The safety of food supplies, including traditional foods, in northern and Indigenous communities is a serious concern given the changing climate and warming temperatures already observed in some regions. Communities in northern Canada are reporting increases in food spoilage and inability to store food safety while hunting, because of warmer temperatures. This will become more difficult with climate change (Berry et al., 2014; Furgal and Sequin 2006).

Some studies have shown a higher risk of food-borne illness in warmer seasons, in part due to social behaviour and the potential for improper food handling and storage resulting in food spoilage and contamination (e.g. more BBQs, people preparing food outside). Other studies have shown a link between the occurrence of certain food-borne illness and warmer temperatures (Health Canada, 2008).

For the 5 days prior to the Walkerton outbreak in 2000, the community experienced very heavy rainfall which facilitated the transport of WBD pathogens into the community water supply (O'Connor, 2002).

Water Quality

Health Impacts

The most common water-borne disease (WBD) pathogens in Canada are Giardia, Cryptosporidium, Campylobacter, Shigella and verotoxigenic E. coli. These pathogens cause gastrointestinal illnesses, and some have led to chronic health conditions and death (Health Canada, 2008). While WBD outbreaks are rare in Canada, several outbreaks reveal the serious health impacts associated with these pathogens (Canada, 2013b). In 2000, contamination of the municipal drinking water supply in Walkerton, Ontario by pathogenic E. coli and Campylobacter killed seven people and was estimated to cause 2300 illnesses (O'Connor, 2002). In 2005, water supplies contaminated with E. coli caused the evacuation

Flooded Neighbourhood in Calgary. Photo provided by Thinkstock.

of residents of the Kashechewan reserve in northern Ontario (Canada, 2013b).

While there are multiple risk factors (including inadequate source-water protection and water treatment) for WBD outbreaks, several have been linked to extreme weather events, in particular intense, heavy rainfall and overland flooding (Wang et al., 2018; Auld et al., 2004; Moffat and Struck 2011). Private and small drinking water systems are more vulnerable to WBD outbreaks (Canada 2013).

Heavy Rain and Floods

With climate change, the intensity and frequency of heavy rainfall events is expected to increase across Canada. The combination of possible drought conditions, warmer temperatures, and intense heavy rainfall events can increase the risk of WBD outbreaks and illness from contaminated drinking water supplies. There is also the concern for chemical contamination of water supplies following heavy rainfall events as a result of fertilizers, pesticides, nitrates and other substances carried by run-off and floodwaters, including through large scale events like tornadoes or hurricanes that damage large industrial facilities or disturb contaminated sites (Berry et al., 2014).

Climatic conditions, warmer weather, and heavy precipitation may impact water quality at recreational beaches increasing the potential for beach postings or closures due to high bacterial counts or the presence of toxic cyanobacteria blooms. Some cyanotoxins can impact health if the water is ingested or inhaled if aerosolized. Cyanobacteria blooms have been reported across Canada (Health Canada, 2008).

Melting Permafrost

While climate change has the potential to increase the likelihood of contamination of drinking water supplies, several indigenous communities continue to experience water quality problems. As of February 4th, 2019, sixty-two (62) long-term drinking water advisories remained in place on public drinking water systems on reserves in Canada (Canada, 2019b). Drinking water quality in northern communities may also be compromised due to melting permafrost and the transport of contaminants to drinking water supplies. These communities may also be at higher risk as they are

more dependent on untreated water and snow melt for their drinking water source (Auditor General of Canada, 2005).

Droughts and Rising Sea Levels

Increasing drought brought on by climate change can also impact water quality in parts of Canada. Chemicals and pathogens may be concentrated in a diminishing water source. In addition, drought conditions followed by heavy rainfall increases the potential for overland flow of rainwater, and with it, both chemical and microbiological contaminants (Yusa et al. 2015; Semenza et al. 2011). Sea level rise could impact drinking water supplies in coastal regions due to saltwater intrusion (Health Canada, 2008).

Food and Water Insecurity

Food and Water Insecurity

Numerous factors come in to play when considering the impact of climate change on both food and water security. Many families and communities across Canada currently live with food insecurity. According to a 2009 - 2012 survey, 7.2% of Canadians aged 18 and over reported living in households with food insecurity (PHAC, 2018c). These percentages were much higher for people identifying as Inuit (24.8%), First Nations living off reserve

Cooking goose-Severn River Watershed. Photo by Dan Tobias.

(18.3%), and Metis (14.8%). Information on food insecurity for First Nations people living on reserve and in northern communities is collected through the First Nations Regional Health Survey. The 2008-2010 survey revealed that 38.3% of First Nations adults living on reserve and in northern communities lived in a food insecure household (PHAC, 2018c).

Climate change could affect the availability and cost of some foods, which is of particular concern for persons on low incomes or those in isolated communities (Berry et. al., 2014). Droughts and heavy rainfall may lead to crop loss or diminished crop yields which could result in disruptions to the food supply. Bacterial or chemical contamination of water supplies because of heavy rainfall, warmer weather, droughts or a combination of these factors, may render a water source no longer useable. Droughts

may diminish or deplete a community's drinking water supply (Yusa et al., 2015).

Northern communities that rely on traditional food sources are more vulnerable to food insecurity as climate conditions, melting permafrost, unstable hunting and harvesting routes, and changes in the geographical distribution and diminished quality decrease availability and nutritional value of these food sources (Berry et al., 2014).

Extreme Weather Events

More Frequent and Severe

Extreme weather events are increasing in frequency and severity across Canada. The Canadian Disaster Database reported over 195 disaster-level extreme weather events between 2008 and 2018. These included wildfires, floods, winter storms, droughts, extreme heat, and tornadoes. These pose serious health and safety risks to Canadians. Between 2003 and 2019, there were 203 deaths due to extreme weather recorded in Ontario (PHO, 2015). In 2016 alone, wildfires, floods, tornadoes and severe winter storms resulted in the evacuation of approximately 94,485 residents in communities across the country (PSC, 2019a).

According to a report of the Canadian Forest Services between 1980 and 2017 almost half a million people across Canada were evacuated because of wild fires (NRCan, 2017b).

Toronto Ice Storm 2013 - Forest Hill Road. Photo by Andrea Williams.

Climate change is expected to make weather more variable, increasing the likelihood of more intense and frequent extreme weather events and natural hazards such as heavy rainfall, flooding, winter storms, freezing rain, droughts, wildfires, extreme temperatures, sea level rise, storm surges, hurricanes, landslides and avalanches (Warren et al., 2014). Some of these events will build slowly and others will have a rapid onset, but all of them can have direct and/or indirect impacts on human health.

Examples of direct impacts include injury or death from physical trauma suffered during severe storms, flooding, temperature extremes or wildfires. Indirect

health impacts include illness or death resulting from prolonged events or the aftermath of events. These can include food-, water- or vector-borne diseases, food or water shortages, exposure to mould and other contaminants, exacerbation of cardiovascular and respiratory conditions, disruptions of health and emergency services, stress from community evacuations and population displacement, mental illness, and compounding of existing health inequities (Moudrak et al., 2018; Berry et al, 2014).

Floods

Floods are the most commonly occurring and costliest natural disaster in Canada. Floods can occur in coastal areas and along rivers and lakes. They can result from extreme rainfall events and rapid snow melt (NRCan 2018a). Flood risk is exacerbated by urbanization and development on floodplains (Peter et al., 2014). Heavy rainfall and flooding can impact health in the short term and longer term by damaging crops, increasing risk of water-borne disease outbreaks, increasing risk of respiratory ailments from mould and poor indoor air quality in flooded homes that have not been adequately remediated, and causing anxiety and mental health issues if people have to be evacuated, lose their home and suffer financial losses (Berry et al., 2014; Hayes et al., 2018).

A winter storm in February 2016 resulted in over 750,000 people in Quebec being without power for an extended period (PSC, 2019).

Droughts

Climate change projections for Canada suggest that the south and interior parts of the country will experience more drought (Yusa et al., 2015). Drought can impact health by aggravating existing respiratory conditions (e.g. inhalation of particulate matter from dust storms and smoke from wildfires), increasing risk of water-borne diseases, increasing risk of vector-borne diseases and increase stress and mental illness for people whose livelihood is tied to the agricultural sector (Yusa et al., 2015).

Droughts and heavy rainfall events can have devasting impacts on farm families and communities that rely primarily on agriculture for their economic and social sustainability. Climate models project drier summers and increased precipitation in both winter and spring, making it more difficult for farmers to plant and harvest crops (Climate Atlas, 2018). A study of heat stress on dairy cow herds during heat waves between 2010-2012 in Ontario showed an increase in animal deaths from heat stress, a loss in milk production, and a projected economic loss with the increasing number of extreme heat events expected from climate change (Bishop-William, 2015).

Case Study: Interior Health Authority, B.C.

Interior Health Authority reported that a wildfire resulted in:
• 48,000 registered wildfire evacuees;
• 15 First Nations communities under alert or order;
• 800 patients/clients evacuated;
• 700 staff displaced;
• 19 Interior Health sites/facilities closed;
• 2000+ air filters replaced every two to three weeks at Interior Health facilities due to smoky conditions.
Estimated cost to the Interior Health Authority for wildfire response was $2.7 million (Toews, 2018).

Power Outages

Extreme weather events often disrupt power supplies which can increase various health and safety risks e.g. food or water-borne illness from spoiled food or untreated water supplies, carbon monoxide poisoning from indoor use of gas-powered generators, medical emergencies for persons needing electric-assistive devices, and exposure to extreme heat or extreme cold. While winters are expected to be warmer across Canada, extreme cold events will continue to happen, but less frequently, thus continuing to contribute to cold-related morbidity and mortality in the coming decades (Romero-Lankao et al., 2014; Martinez-Solanas et al., 2018).

Wildfires

As noted earlier, wildfires have a very significant impact on communities across Canada. A critical review of the health impacts of wildfire smoke exposure found consistent evidence for the association between wildfire smoke exposure and respiratory morbidity with growing evidence supporting an association with all-cause mortality (Reid et al., 2016). With climate change expected to increase the number of warmer, drier and longer wildfire seasons, the health risks associated with exposure to wildfire smoke is likely to increase.

Impact on Healthcare Services

Extreme weather events can also disrupt health and community services, impacting the health of Canadians. Damage to critical infrastructure such as hospitals and healthcare facilities may disrupt the ability of health services to respond to the health care needs of the community, further compromising the health of disaster victims (Curtis et al., 2017; Balbus et al., 2016; HCWH, 2018). More information on how health care facilities is provided in Module 6.

Mental Health

Climate change can have both direct and indirect impacts on mental health. Extreme weather events, such as wildfires, heat waves and floods can lead to post-traumatic stress disorder (PTSD), anxiety, depression, and substance abuse.

Extreme Events

Studies out of Australia following communities directly impacted by bush fires report that a significant minority of the population reported persistent PTSD, depression and psychological distress, and that mental health consequences can persist for many years (Bryant et al., 2014). Researchers studying Fort McMurray residents six months after the fire found that certain risk factors increased the risk of anxiety symptoms, including pre-existing anxiety disorder, witnessing homes burning, exposure to media coverage on the fire, being relocated, and perceived lack of support from family, friends and/or government agencies (Agyapong et al., 2018).

A Heiltsuk girl holding one of the paddles of the "Glwa", the Heiltsuk canoe, during the official opening of the Qatuwas Festival, an international gathering of maritime indigenous nations of the Pacific Rim. 27/ Jun/1993. UN Photo/John Isaac.

Some studies suggest that healthcare providers may be higher risk of mental health and psychosocial effects following disasters as they could be working in heightened stressful situations or high-risk conditions (e.g. physical damage to facilities), working longer shifts or experiencing personal anxiety concerning the disaster (Nukui et al., 2018; Nickell et al., 2004). Emergency responders may be at increased risk of climate-related mental health outcomes as they are often the first to be exposed to the effects of extreme weather events, affected for longer durations and dealing with personal stressors such as separation from families (Tak et al., 2007).

Changing Climate

Climate variability and incremental changes such as sea level rise, rising temperatures and drought can also lead to poor mental health outcomes including anxiety, depression and suicidal thoughts. The threat of future climate-related disasters, current climate change risks and

Table 2: Examples of how climate change may amplify existing health inequities and increase climate-related health risks for vulnerable populations.

Health Inequity	Examples of Climate-Related Inequity Multipliers
Income and social status	↑ risk from extreme heat, air pollution, UV exposure and extreme weather events Limited financial resources/ability to take adequate protective action e.g. seek shade, access cool spaces, afford air conditioning, make needed repairs to housing, and avoid sources of air pollution such as high traffic corridors
Food security	↑ risk of food insecurity due to extreme weather events such as droughts, heavy rainfall and flooding that damage or destroy food crops, leading to ↑ cost of healthy foods
Employment and working conditions	↑ exposure to extreme heat, air pollution, UV radiation and extreme weather events for outdoor workers (agriculture, construction)
Housing and homelessness	↑ risk from extreme heat and extreme cold for people who are homeless or living in housing with inadequate heating or cooling ↑ risk of damage from flooding and storms if living in home in need of major repair or living in flood-prone areas ↑ risk of poor indoor and outdoor air quality if living close to sources of air pollution
Children and older persons	↑ sensitivity to extreme heat, air pollution ↑ risk from extreme weather events due to ↓ mobility and ↑ reliance on care-givers ↑ risk from mental health following disasters and extreme weather events
Indigenous people	↑ existing inequities (e.g. access to traditional cultural practices, access to safe water, access to health care) ↑ risk food insecurity due to general warming and ↓ availability/access to traditional food sources
Health status	↑ risk from extreme heat, air pollution, infectious diseases and extreme weather events for persons who are immunocompromised or living with chronic diseases or disabilities
Access to health services	↑ risk for northern, remote and low-income communities that currently experienced inequities in terms of access to health care ↑ risk from extreme weather events as health, community and social supports may be disrupted by evacuations, population displacement and damage to critical infrastructure (e.g. hospitals, water, wastewater and transportation systems)
Social support networks	Persons who are marginalized or socially isolated are more vulnerable to extreme heat and extreme weather events
Personal behaviours & coping skills	↑ risk from extreme weather events, extreme heat and climate variability and change While the general population is vulnerable to climate-related stress and distress, risks are amplified for persons with existing mental health conditions

perceived threats can cause emotional distress, heightened anxiety and feelings of hopelessness (Hayes et al., 2018). People may experience "solastalgia" – a term coined by researchers to refer to feelings of distress or mental health effects as a result of loss of home or identity, often as a result of environmental damage (Sandifer et al., 2017).

High Risk Populations

Marginalized populations including those already experiencing poor mental health, are at greater risk of increased mental health impacts. While it is difficult to link mental health outcomes to specific risks, a growing body of evidence suggests that climate-related mental health outcomes will increase with climate change, and that certain populations will be disproportionately impacted (Hayes et al., 2018).

An exploratory study in Nunatsiavut, Labrador ranked mental health and well-being as climate-sensitive health priorities for the region (Harper et al., 2015). Researchers noted that mental health of northern Indigenous people may be affected by a variety of climate-related impacts including food insecurity, damage to infrastructure, changes in land, ice and snow, changes in weather, and a loss of a sense of place, and that these impacts may be compounding existing stress and distress (Cunsolo et al., 2015).

Other populations at increased risk of climate-related mental health outcomes include children, seniors, women, resource-based workers, people with low incomes and people with pre-existing medical conditions (Hayes and Poland, 2018).

Health Equity & Vulnerable Populations

Vulnerable Populations

Climate change will affect everyone, but certain Canadian populations, especially those already experiencing health inequities, will be disproportionately impacted. Canada ranks as one of the top countries to live in terms of quality of life, yet health inequities do exist. Unequal distribution of income, education, and social and environmental conditions contribute to these inequities (Mikkonen and Raphael, 2010).

In Canada, Indigenous people, sexual and racial minorities, immigrants, people living with disabilities, and populations living on low incomes are

at greater risk of adverse health impacts (PHAC, 2018c). In 2011, one-third of Canadians lived in households with core housing needs due to cost, over-crowding, or housing in need of repair; and 8.3% of Canadian households experienced moderate to severe food insecurity (PHAC, 2018c).

Poverty Multiplier

Climate change has been described as a "poverty multiplier" (Ebi et al., 2018). The World Health Organization describes determinants of health as the physical environment, socio-economic environment and individual characteristics and behaviours which all play a part in determining the health of individuals or populations (WHO, 2019b). Table 2 provides examples of how climate change may amplify health inequities by acting on the determinants of health.

Persons on low incomes are at increasing risk of food insecurity if the cost of healthy foods increases or availability decreases because of droughts or other extreme weather events. Persons on low income are less likely to be able to afford home insurance or necessary upgrades to increase climate resiliency e.g. flood-proofing, roof repairs, and air conditioning (Moudrak et al., 2018,

Girl with ashtma inhaler.
Photo provided by Thinkstock.

Berry et al, 2014). Low income neighbourhoods are more likely to be situated in areas with greater exposure to natural and human-made hazards that may be amplified by climate change (e.g. high traffic corridors, flood-prone areas, lack of greenspace). Lower socioeconomic status populations are more likely to have reduced access to health care and social supports than the general population, putting them at increased risk of extreme heat, or from injury and disease following extreme weather events (Rudolph et al., 2018).

Indigenous Populations

Indigenous people are already seeing impacts on their way of life because of a changing climate (Climate Telling 2017; ERG 2017). Those in northern and remote communities that rely on traditional food sources will experience greater challenges. Melting permafrost, unstable transportation routes and the changing migration patterns and availability of food sources such as the caribou are all consequences of climate change. Indigenous people may be at greater risk because of existing health inequities and compounding socio-economic factors (e.g. history of colonization, social exclusion, income, housing and water quality, food insecurity and chronic diseases) (Mikkonen and Raphael, 2010).

Medical Conditions

Persons with pre-existing medical conditions face additional health risks from climate change. Exposure to extreme heat increases risk for those with cardiovascular disease. People with respiratory or cardiovascular disease are more vulnerable to air pollution. Asthmatics and persons with allergies face increased exposure to pollen. Immuno-compromised persons have a greater likelihood of illness and serious complications from food-, water- and vector-borne diseases. Extreme weather events may knock out power, disrupt transportation systems and require evacuation of homes, creating additional risks for persons on medications, using electrically-powered medical equipment, or with limited mobility (Rudolph et al., 2018; Molinari et al., 2017; Berry et al., 2014).

Age, Gender and Occupation

Both elderly persons and children are more vulnerable than the general population to climate-related risks. They are more susceptible to heat stress as they are less able to regulate their body temperature, more sensitive to the adverse impacts of air pollution, and more vulnerable to extreme weather events because of mobility issues. Young children and infants are more vulnerable to food-borne and water-borne diseas-

Children running. Photo by Jordan Whitt.

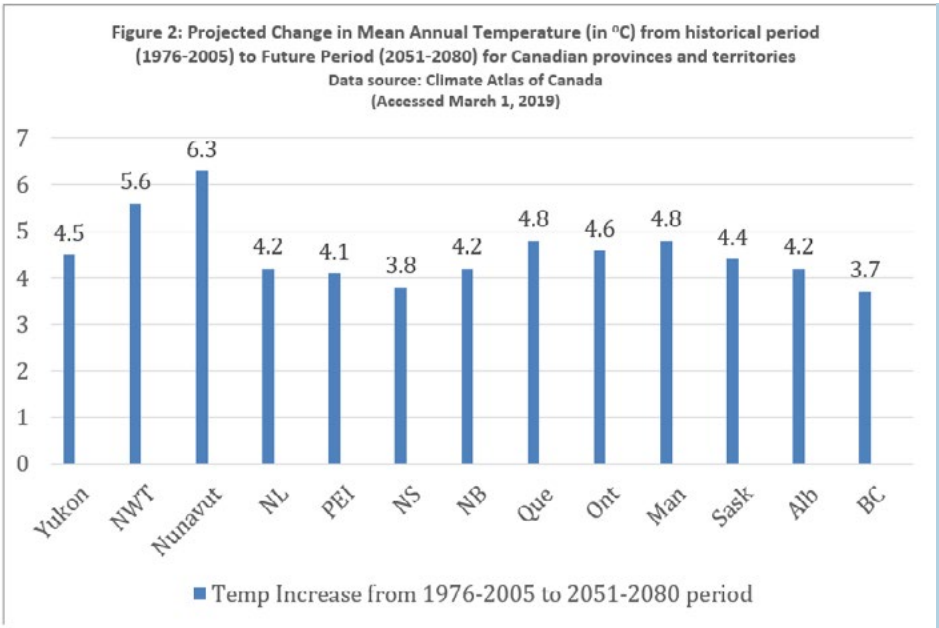


Figure 2 presents the projected change in mean annual temperature for provinces and territories across Canada from the historical period (1976-2005) to the future period (2051-2080) (Climate Atlas, 2018). All regions are projected to experience significant increases in mean annual temperature with the greatest increase in Canada's northern regions.

es because their immune systems are not fully developed (Health Canada, 2008).

Urban and Rural Vulnerabilities

Climate change health risks vary for urban populations and rural populations. Canadians living in urban communities may be at greater risk from heat-related morbidity and mortality because of the urban heat island effect – as limited green space, greater asphalt and dark surfacing on buildings, roads and pavement trap heat and result in hotter microclimates. Urban communities may also be more prone to flooding and sewer system overflows during heavy rainfall events as water flows more rapidly over impervious surfaces, and sewer and storm-water systems may not be designed to handle heavy and prolonged rainfall (Berry et al., 2014).

Many rural areas rely on private wells or communal systems that may be at greater risk from flooding and contamination from heavy rainfall events, snowmelt or permafrost melt. Rural communities that are more heavily reliant on the land for their food and their livelihood face greater risk from extreme weather events like droughts and heavy rainfall that can damage crops, and from a changing climate that diminishes their traditional food sources. Many rural communities are already facing economic difficulties because of dependence on natural resources. Rural residents can also be at greater risk for injury, illness or death from natural hazards

such as rising sea levels, storm surges, forest fires and avalanches. Rural and remote communities may also have limited access to healthcare and other vital services in the aftermath of an extreme weather event (Berry et al., 2014).

Key Regional Climate Risks to Canadians

Climate variability and change is being felt in communities throughout Canada, but the picture looks different across and within regions (Canada, 2018e). Regional impacts and climate change risks are influenced by geography, demographics, and existing economic and societal conditions.

This section highlights some climatic trends and future predictions in the six regions across Canada. It also includes regional information on some health impacts and potential climate change health risks, but is not inclusive, noting that the same degree of information is not consistently available across the country. For more information on local climate change health risks and impacts, consult the provincial/ territorial and local public health, environment and climate change agencies for the region.

Northern Canada

Northern Canada is experiencing the most rapid changes in climate which is presenting multiple health challenges for communities and populations. The north is warming faster than the global average (ECCC, 2018a) and some of the strongest seasonal warming trends (both summer and winter) that Canada is seeing are in the north. While nationally, winter temperature averages have warmed by 3.4°C over the past 71

Extreme Weather Event – 2008 Flooding in Pangnirtung, Nunavut

Flash flooding in the community of Pangnirtung, Nunavut in June of 2018 caused 2 bridges to collapse and cut off access to the water reservoir, sewage treatment facility and garbage dump for some residents in the community. Water taxis were used to connect residents to food and community services. Poor weather conditions prevented the Nunavut government from flying in emergency crews to the community which is not accessible by road. Community officials declared a state of emergency for the hamlet of Pangnirtung. Officials said that this type of extreme weather event was new to their community, but they had heard of similar anecdotes from other Nunavut communities (CBC News, 2008). The community didn't have the economic capacity to repair the damage and requested financial support from the Federal government for the $5 million cost to repair the damages (Spinney and Pennesi, 2012).

years, areas of the Yukon and North B.C. Mountains region have seen a 5.7°C increase (ECCC, 2018a). The strongest summertime trend has been observed in the Mackenzie District region which has seen a 1.9°C increase compared to the national average of 1.5°C (ECCC, 2018a).

The warming trend in the north across all seasons is having significant impacts on the environment. Examples of changes include melting permafrost, shorter ice season, thinning of sea ice, reduced snow cover, coastal shoreline erosion and change in plant species and wildlife (Lemmen et al., 2014; Bush et al., 2014, Fungal and Sequin, 2006). These climatic changes in turn are impacting communities. Melting permafrost is threatening the stability of homes, buildings and critical public health infrastructure (water and power supplies). Shoreline erosion and storm surges have the potential to damage infrastructure and supply routes. Warmer temperatures are shortening the ice season and the ability to safely use ice roads. Forests are becoming more vulnerable to pests and forest fires (Warren et al., 2014).

Hurricane Igor's devestation, Newfoundland. Photo by Zippo S.

Indigenous communities have a strong relationship to the land. The climatic changes that are happening in the north are impacting their way of life and increasing health and safety risks. Many indigenous people harvest natural resources for their sustenance and livelihood (Ford, 2012; Fungal and Sequin, 2006). Hunting and fishing are becoming more difficult as travel becomes more dangerous. Warmer temperatures increase the potential for food spoilage. Traditional food sources are harder to find as wildlife migration patterns change and availability of sensitive plant species diminishes. Extreme weather events such as storm surges, coastal erosion, flooding and forest fires may result in population displacement (Warren et al., 2014). These changes threaten food safety and security, water quality, physical and mental health, and traditional cultural practices in northern communities in Canada.

Atlantic Canada

Climate change will bring more frequent and intense storms, rising sea levels, storm surges, coastal erosion and flooding to parts of Atlantic Canada. Hurricanes and floods in Atlantic Canada in

the past have resulted in injury and death, property and infrastructure damage, power outages and loss of access to emergency services (Kovacs and Thistlewaite, 2014; Lemmen et al., 2008). While average temperatures are not expected to increase by as much in the Atlantic provinces as in other parts of Canada, 2018 saw the highest ever average temperature records set in cities in all four Atlantic provinces in the month of July (ECCC, 2018b).

Coastal communities may be faced with infrastructure damage, loss of livelihood, displacement or loss of their community. Heavier rainfall could increase risk of contamination of water supplies and overwhelm water treatment facilities. Newfoundland is seeing an increasing number of tropical storms and hurricanes now than in the past (Newfoundland and Labrador 2013).

Certain populations within Atlantic Canada are more vulnerable to climate changes. Many communities have an aging population and lower income compared to the national average. Indigenous communities in the Atlantic region have lower per capita income and higher proportion of younger citizens compared to the rest of Canada. They also rely more on traditional foods, have close ties to the land and have food security concerns (Harper et al., 2015). Climatic changes may result in communities being displaced because of storm events or rising sea levels. Loss of livelihood and income because of climate disruptions to sectors such as fisheries, agriculture and tourism could have health and social impacts, leading to stress-related illness and mental health issues (Lemmen et al., 2008).

Extreme Weather Event – Hurricane Igor, Newfoundland, 2010

One of the strongest hurricanes in Atlantic Canada's history struck the eastern coast of Newfoundland in September 2010 with winds reaching 140 km/hour and a storm surge a meter high. Over 200 mm of rain was reported, flooding and washing out roads and bridges. One person died when his driveway was washed away. Thirty communities declared a state of emergency and some residents were forced to evacuate their homes because of flooding. Power outages and road washouts cut off tens of thousands of residents. Health officials closed down community-based facilities, issued advisories for persons on home oxygen and ventilators, and made provisions to ensure residents had access to emergency and acute care services (ECCC, 2013; Weather Network, 2014; CBC, 2015).

Chronic health conditions may be exacerbated or increase vulnerability to climate related risks such as extreme heat and poor air quality. Air pollution is estimated to cause 286 premature deaths annually across the Atlantic provinces (Health Canada, 2017). The prevalence of diabetes and obesity is higher in the Atlantic provinces than the national average (PHAC, 2010) which can put people at greater risk from air pollution. Warmer temperatures and wetter weather may increase burden of water-, food-, and vector-borne diseases. The health care system may need to respond to an increasing number of illnesses and injuries due to extreme weather events, respiratory ailments or disease (Nova Scotia, 2014).

Quebec

Climate change has already had significant health impacts for the Quebec population and will continue to do so as the climate warms and extreme weather events become more frequent (Ouranos 2015). Climate predictions indicate increased health risks for Quebec from: heat-related morbidity and mortality; cardiovascular and respiratory risks resulting from air pollution (forest fires, ozone and particulate matter); allergic reactions from pollen; skin cancer from UV radiation; and water-borne, vector-borne (Lyme disease) and zoonotic diseases (Gosselin et al. 2011).

Mean average temperatures in Quebec have increased from 1 to 3°C between 1950 and 2011. Annual average temperatures are expected to rise by 2 to 4°C for the 2014-2070 period and 4 to 7°C for the period 2071-2100. Maximum temperatures are expected to increase in Quebec resulting in a greater number of hot summer days and warmer nights (Ouranos, 2015). The southern part of Quebec has been increasingly experiencing very hot summers. Heat risk maps show high risk areas in the most populated areas of Quebec, with a higher proportion of socially vulnerable populations (INSPQ, 2012).

The number of very hot days (>30°C)

Extreme Weather Event - Quebec Heat Wave, 2018

A prolonged heat wave in July 2018 in Quebec resulted in 93 deaths from heat-related complications (ECCC, 2018b). The majority of the deceased were males living alone. Montreal's public health officials said that many of the people who died did not have air conditioning in their homes and many suffered from chronic illnesses. Most of the deaths occurred in Montreal. The heat wave lasted over 5 days with temperatures exceeding 40°C with the humidex. Emergency health services in Montreal experienced a 30% increase in calls during the heat wave (ECCC, 2018b; Toronto Star, 2018).

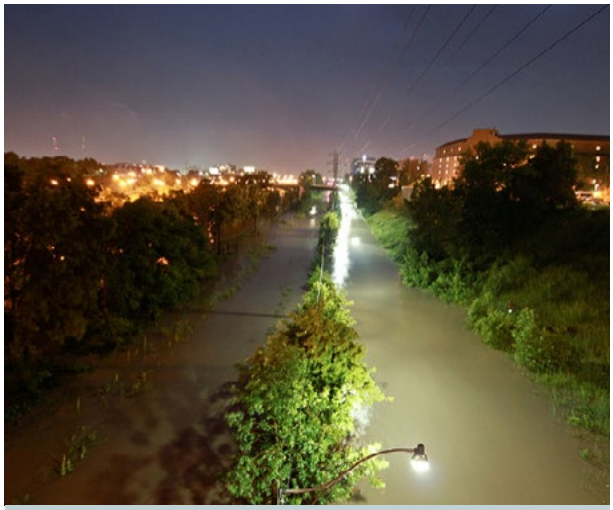
in Montreal is expected to increase from historical levels (1976-2005) of 8 per year, to over 20 for the 2021-2050 period and over 50 per year for the 2051-2080 period. The number of warm nights (>20°C) is expected to increase from 5, to 12 to over 30 for the same time periods (Malik et al., 2018). Significant increases in the length of heat waves is expected (Ouranos, 2015).

Flooding is the main natural climate-related risk in Quebec. Quebec has seen an upward trend in spring and summer rainfall in the period 1950-2010 as well as an increase in the quantity of rainfall within a short time frame and subsequent flooding. More intense rainfall events are predicted which is a particular risk for urban areas where intense rainfall increases the likelihood of localized flooding (Ouranos 2015).

Coastal erosion will create risks for homes, infrastructure and roads. Acidification of the oceans because of increasing CO_2 levels will impact fisheries. While it is harder to predict the frequency and intensity of post-tropical cyclones, it is expected that the quantities of precipitation from these events will increase. Similar to challenges in northern Canada, melting permafrost will further impact communities in northern Quebec, damaging homes and infrastructure, and limiting ability to secure traditional foods and access to the land (Ouranos, 2015).

Ontario

Ontario's annual mean temperature has increased by 1.5°C between 1948 and 2008 and is expected to increase by 3 to 8°C over the next century. Winter average temperatures are projected to increase by 4.6°C by mid-century with summer averages projected to increase by 3°C (Ontario, 2016b). Ontario has already seen an increase in prolonged heat waves and this trend is expected to continue, with the southern and most populated urban areas of the province expected to see an average of three heat waves per year by the 2050s and six per year by the 2080s (Ontario, 2016b).



Bayview Ave under water after record breaking rainfall in Toronto, ON in 2013. Photo by Roozbeh Rokni.

Climate-Related Event – Forest fires in northern Ontario in 2011

Forest fires in July 2011 resulted in the evacuation of over 3000 people in northwestern Ontario. Sandy Lake First Nation residents were evacuated to Sioux-Lookout, Thunder Bay and 11 other communities throughout Ontario and into Manitoba (Sandy Lake First Nation, 2011). In 2014-2015, the First Nations Wildfire Evacuation Partnership met with Sandy Lake First Nations residents to investigate how they were affected by the 2011 wildfires and evacuations.

Residents reported that it was very stressful because they were separated from family members, received little information on the location of family members and experienced financial problems. Elders missed traditional food and culture; some forgot medicines and other essentials; and some medically vulnerable people were sent to evacuation locations without care givers. Statements from community members tell a very impactful story: "I was concerned about my granddaughters; two of them had asthma, along with my wife"; "When people were put on the plane, they didn't know where they were going. For you, if you want to go somewhere, and you're going on the plane, you know where you're going, right? You know your destination. But these people, they were just put on the plane without knowing where they were going" (Asfaw 2017; FNWEP, 2019).

Climate change is expected to increase air pollution in Ontario by increasing levels of ground-level ozone, pollen concentrations and forest fire smoke. Currently, approximately 7,020 premature deaths per year in Ontario have been attributed to air pollution. (Health Canada, 2017). Due to increasing temperatures and higher UV exposure, levels of basal cell carcinoma across Ontario are predicted to increase by 7.8 to 8.7% by the 2050s and 12.8 to 14.8% by the 2080s (Ontario, 2016b).

Ontario is already seeing a change in the geographic range of disease vectors such as the black-legged tick that is responsible for the increase in Lyme disease cases. Lyme disease is established in southern Ontario and could expand into northern Ontario. West Nile virus is in southern, western and central Ontario and is expected to cover all of Ontario by 2050-2080 (Ontario, 2016b).

The frequency and intensity of extreme precipitation events across Ontario is increasing. Ontario communities are already seeing damage to critical infrastructure such as water, wastewater and transportation systems, overflowing sewers and road washouts because of intense rainfall and flooding. Extreme precipitation in the summer months may result in increased beach closures (Ontario, 2016b).

The Prairies

Climate change across the Prairies can be expected to produce more warmer and drier weather, droughts, changing vector-borne disease habitats, more weather variability and more frequent and intense extreme weather events.

Extreme Weather Event – 2013 Alberta Flood and Public Health Surveillance Post-Flood

In June of 2013, heavy rainfall and a massive flood impacted 30 communities and over 100,000 residents in southern Alberta. Water and wastewater infrastructure and transportation infrastructure were damaged as well as several schools and health care facilities. A provincial state of emergency was declared and some areas were evacuated, with 12,000 residents of High River north of Calgary having to leave their homes.

Alberta Public health officials implemented enhanced surveillance following the flood. Various data sources were used including Emergency Department data, pharmaceutical information data, communicable disease reporting and laboratory reporting. Surveillance revealed increases in injuries, tetanus administration, carbon monoxide poisoning, use of anti-anxiety medication and sleep aid, and an increase in sexual assaults. No increases in gastrointestinal illnesses were identified but small clusters of norovirus at evacuation centres were noted and mitigated. The enhanced surveillance allowed public health officials to send media alerts (e.g. warning about carbon monoxide poisoning when using generators indoors) and to implement rapid response to communicable disease reports if needed (Sahni et al., 2015).

The Canadian Prairies are particularly susceptible to drought (Warren et al., 2014). With climate change, reduced summer rainfall will affect both the quality and quantity of water and increase droughts. Increased spring floods could increase run-off, soil nutrient loss and the production of algal blooms in surface water (Warren et al., 2014).

Summers will be especially drier on the Prairies, with more severe storms, climate extremes, and flood events expected (PARC 2007; Teufal et al., 2017). It is difficult to attribute any one extreme weather event, such as the 2013 flood or the 2016 wildfire in northern Alberta, to climate change; however, scientists assessing these disasters are noting the contributing climate-related factors. The 2016 Wood Buffalo Wildfire Post-Incident Assessment Report noted that the largest contributing factor was the hazard conditions in northern Alberta – extremely dry the previous summer, low moisture over winter and a dry warm spring (KPMG, 2016).

Changing ecosystems on the Prairies could increase vector-borne and zoonotic diseases that are sensitive to climate. Higher rodent populations are linked to warmer mild and wet winters. Mild winters allow certain mosquito vectors to over-winter. In 2007, 98% of the 2,215 reported cases of WNv in Canada were in

the Prairies. Climate models suggest an expanding range of WNv in the Prairies (Zheng et al., 2014; Chen et al., 2013). While some studies suggest that the Prairies are too dry for the spread of Lyme disease other vectors could become a health threat either because they have an animal reservoir population, there have been human cases, or they have a history in the Prairies (Charron et al., 2003).

British Columbia

Average annual temperature in British Columbia has increased by 1.4°C since the turn of the century. Lakes and rivers are becoming ice free earlier in the spring, annual precipitation has increased, sea level has risen along most of the coast and sea surface temperature has increased (BC, 2016). It is predicted that the average annual temperature in B.C. may increase by 1.7 to 4.5°C from 1961-1990 averages, and average annual precipitation may increase by 4 to 17% from the 1961-1990 averages (BC, 2016).

Heat-related illnesses are expected to increase in British Columbia. While Victoria experienced, on average, 3 hot days per year between 1951 and 1980, this number is estimated to increase to 13 days in the 21st century. The Lower Mainland and interior will likely see more frequent hot days (BC, 2016).

Air pollution is a concern for B.C. residents (BC, 2016). Approximately 1310 premature deaths per year in B.C. have been attributed to air pollution (Health

Extreme Weather Event – British Columbia Forest Fires 2017/2018

The number of forest fires in British Columbia during the 2018 season far surpassed the 2017 records and resulted in air quality advisories in B.C. and across Alberta. As noted in these on-line media headlines from August 2018, smoke from the B.C. forest fires created poor air quality and visibility concerns in several cities in Alberta:

- *CBC News. August 8, 2018: "Smoke from B.C. wildfires prompts air quality advisories across Alberta"*
- *Global News. August 18, 2018: "Safe bet Alberta will be impacted by B.C. wildfire smoke in future" – 10+ Air Quality Health Index reading in Edmonton and other Alberta communities forecast air quality to be very high risk to health*
- *Global News. August 19, 2018 "Air quality in nearly a dozen B.C. communities 'very high risk' on Sunday" – BC's Air AQHI forecast 10+, or very high risk to health*
- *Global News. August 20, 2018: "Smokiest summer on record in Calgary: Environment – Canadian records set in Calgary, Edmonton, Red Deer and Grande Prairie*
- *Global News. August 23, 2018: "Smoke from B.C. wildfires impacted parts of Saskatchewan" – Environment Canada models show smoke from B.C. fires have spread to west central parts of Saskatchewan causing poor air quality*

Resources for Health Professionals

- *Acute Care during Extreme Heat: Recommendations and Information for Health Care Workers. Government of Canada*
- *Air Quality Health Index Publications. Government of Canada*

Climate Atlas of Canada

- *Climate Change and Public Health Fact Sheets. Government of Canada*
- *Climate Change, Health, and Equity: A Guide for Local Health Departments*
- *Factsheets and Infographics on Climate Change. American Public Health Association*
- *For Health Professionals. Lyme disease. Government of Canada*
- *Health of Canadians in a Changing Climate. Government of Canada*
- *Notifiable Diseases Online. Government of Canada*

Canada, 2017). Forest fires continue to devastate local communities and increase health risks as smoke from fires can travel large distances and impact air quality. In 2017 forest fires in B.C. caused the evacuation of over 65,000 residents (NRCan, 2018b).

A warming climate, heavy rainfall and expanding disease vector habitats could result in increases of food-, water-, and vector-borne diseases. In 1995, in Victoria, an outbreak of toxoplasmosis was linked to extreme precipitation that contaminated a drinking water supply (BC, 2016). Shellfish poisoning has been associated with ingestion of mussels contaminated with the toxin from algal blooms. Climate change may increase the occurrence of toxic algal blooms (BC, 2016). Warmer weather increases risk of exposure zoonotic diseases. Six cases of hantavirus, spread by the deer mouse have been reported in BC in the past, with 2 cases resulting in death. The vector of Lyme disease has been found in black-legged ticks in the Fraser Valley. The black-legged tick is very common in B.C. (BC, 2016).

References

- Agyapong VIO, Hrabok M, Juhas M, Omeje J, Denga E, Nwaka B, Akinjise I, Corbett SE, Moosavi S, Brown M, Chue P, Greenshaw AJ and Li X-M (2018) Prevalence Rates and Predictors of Generalized Anxiety Disorder Symptoms in Residents of Fort McMurray Six Months After a Wildfire. Front. Psychiatry 9:345. doi: 10.3389/fpsyt.2018.0034https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6079280/
- Asfaw, Henok W., PhD student, University of Alberta, Department of Earth and Atmospheric Sciences. Presentation given at First Nations Emergency Management Forum, March 28-30, 2017, Calgary, Alberta. The First Nations Wildfire Evacuation Partnership https://www.eas.ualberta.ca/awe/files/Henok_Asfaw_s_presentation-_Sandy_Lake_First_Nation.pdf
- Auditor General of Canada, 2005 September Report of the Commissioner of the Environment and Sustainable Development. Chapter 5. Drinking Water in First Nations Communities
- Heather Auld, D. MacIver & J. Klaassen (2004) HEAVY RAINFALL AND WATERBORNE DISEASE OUTBREAKS: THE WALKERTON EXAMPLE, Journal of Toxicology and Environmental Health, Part A, 67:20-22, 1879-

1887, DOI: 10.1080/15287390490493475
- Balbus J, Berry P, Brettle M, Jagnarine S, Soares A, Ugarte C, Varangu L. Villalobos Prats, E. Enhancing the sustainability and climate resiliency of healthcare facilities: an international perspective. Rev Panam Salud Publica. 2016; 40(3):174–80. https://scielosp.org/scielo.php?script=sci_arttext&pid=S1020-49892016000900174&lng=en&nrm=iso&tlng=en
- Bernard Doyon, Diane Bélanger, Pierre Gosselin. The potential impact of climate change on annual and seasonal mortality for three cities in Québec, Canada. International Journal of Health Geographics, 2008, Volume 7, Number 1, Page 1. https://ij-healthgeographics.biomedcentral.com/articles/10.1186/1476-072X-7-23
- L. Berrang-Ford, J. D. MacLean, Theresa W. Gyorkos, J. D. Ford, and N. H. Ogden, "Climate Change and Malaria in Canada: A Systems Approach," Interdisciplinary Perspectives on Infectious Diseases, vol. 2009, Article ID 385487, 13 pages, 2009. https://doi.org/10.1155/2009/385487
- Berry, P., Clarke, K., Fleury, M.D. and Parker, S. (2014): Human Health; in Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, ON, p. 191-232. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/assess/2014/pdf/Chapter7-Human-Health_Eng.pdf
- Bharath, A. K., & Turner, R. J. (2009). Impact of climate change on skin cancer. Journal of the Royal Society of Medicine, 102(6), 215-8.
- Bishop-Williams, K. E., Berke, O., Pearl, D. L., Hand, K., & Kelton, D. F. (2015). Heat stress related dairy cow mortality during heat waves and control periods in rural Southern Ontario from 2010-2012. BMC veterinary research, 11, 291. doi:10.1186/s12917-015-0607-2 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4662015/
- Etran Bouchouar, Samantha Bruzzese, Chelsea Pyles, and Kate Stechyshyn. Evidence Review. Environmental Health Review. Shellfish toxins a public health concern for Canadians 2014
- British Columbia (BC) 2016. Indicators of Climate Change for British Columbia: 2016 Update, British Columbia Ministry of Environment, Revised June 2016. https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/reporting/envreportbc/archived-reports/climate-change/climatechangeindicators-13sept2016_final.pdf
- British Columbia (BC) 2019. Forest Fires and Air Quality (accessed Feb 8 2019) https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-pollution/smoke-burning/forest-fires-air-quality
- Richard A Bryant, Elizabeth Waters, Lisa Gibbs,H Colin Gallagher, Philippa Pattison, Dean Lusher, Colin MacDougall, Louise Harms, Karen Block, Elyse Snowdon, Vikki Sinnott, Greg Ireton, John Richardson and David Forbes Psychological outcomes following the Victorian Black Saturday bushfires Australian & New Zealand Journal of Psychiatry 2014, Vol. 48(7) 634–643 DOI: 10.1177/0004867414534476 https://journals.sagepub.com/doi/pdf/10.1177/0004867414534476
- Bush, E.J., Loder, J.W., James, T.S., Mortsch, L.D. and Cohen, S.J. (2014): An Overview of Canada's Changing Climate; in Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, ON, p. 23-64.
- Bustinza, R., Lebel, G., Gosselin, P., Bélanger, D., & Chebana, F. (2013). Health impacts of the July 2010 heat wave in Québec, Canada. BMC public health, 13, 56. doi:10.1186/1471-2458-13-56
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3554487/
- Campbell, I.D., Durant D.G., Hunter, K.L. and Hyatt, K.D. (2014): Food Production; in Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, ON, p. 99-134. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/assess/2014/pdf/Chapter4-Food-Production_Eng.pdf
- Canada 2012. Extreme Heat. Heat Waves. https://www.canada.ca/en/health-canada/services/sun-safety/extreme-heat-heat-waves.html (accessed Jan 30, 2019)
- Canada 2013a. Ozone layer depletion. Health and environmental effects. https://www.canada.ca/en/environment-climate-change/services/air-pollution/issues/ozone-layer/depletion-impacts/health-environmental-effects.html accessed March 1 2019)
- Canada 2013b. The Chief Public Health Officer's Report on the State of Public Health in Canada 2013 – Food-borne and water-borne infections.
- https://www.canada.ca/en/public-health/corporate/publications/chief-public-health-officer-reports-state-public-health-canada/chief-public-health-officer-report-on-state-public-health-canada-2013-infectious-disease-never-ending-threat/food-borne-and-water-borne-infections-invisible-threats.html
- Canada, 2015a. Addressing Climate Change and Air Quality https://www.canada.ca/en/environment-climate-change/services/archive/sustainable-development/2015-progress-report/climate-change-air-quality.html (accessed Feb 3, 2019)
- Canada, 2015b. Symptoms of West Nile virus. https://www.canada.ca/en/public-health/services/diseases/west-nile-virus/symptoms-west-

nile-virus.html (accessed Feb 17, 2019) Canada 2017a. Air Quality Health Index https://www.canada.ca/en/environment-climate-change/services/air-quality-health-index.html (accessed Feb 3, 2019) Canada 2017b. Symptoms of Lyme disease. https://www.canada.ca/en/public-health/services/diseases/lyme-disease/symptoms-lyme-disease.html (accessed Feb 17, 2019)
- Canada 2018a. Climate change and health: Health Effects. https://www.canada.ca/en/health-canada/services/climate-change-health.html#a5 (accessed Feb 27, 2019)
- Canada 2018b. Surveillance of Lyme disease. https://www.canada.ca/en/public-health/services/diseases/lyme-disease/surveillance-lyme-disease.html (accessed Feb 17, 2019)
- Canada 2018c. Surveillance of West Nile virus. https://www.canada.ca/en/public-health/services/diseases/west-nile-virus/surveillance-west-nile-virus.html#s1 (accessed Feb 17, 2019)
- Canada 2018d. Climate Change/Canada's action on climate change/Women and climate change [accessed March 1 2019]. https://www.canada.ca/en/environment-climate-change/services/climate-change/women.html Canada 2018e. Climate Change and Public Health Fact Sheets https://www.canada.ca/en/public-health/services/health-promotion/environmental-public-health-climate-change/climate-change-public-health-factsheets.html
- Canada 2019a. Health Effects of Air Pollution. https://www.canada.ca/en/health-canada/services/air-quality/health-effects-indoor-air-pollution.html (accessed Feb 7 and Mar 2, 2019)
- Canada 2019b. Indigenous Services Canada. Ending long term drinking water advisories. Water in First Nations Communities. https://www.sac-isc.gc.ca/eng/1506514143353/1533317130660
- CBC News 2006. Kashechewan: Water Crisis in Northern Ontario. Posted Nov 9 2006 https://www.cbc.ca/news2/background/aboriginals/kashechewan.html
- CBC News Posted August 8, 2018. Smoke from B.C. wildfires prompts air quality advisories across Alberta. https://www.cbc.ca/news/canada/edmonton/smoke-from-b-c-wildfires-prompts-air-quality-advisories-across-alberta-1.4777625
- CBC News Posted Jun 11, 2008. Pangnirtung in State of Emergency During Heavy Floods. https://www.cbc.ca/news/canada/north/pangnirtung-in-state-of-emergency-during-heavy-floods-1.725661 (accessed Feb 5 2019)
- CBC News Posted July 23 2011. More than 100 Wildfires Burn in Northern Ontario. https://www.cbc.ca/news/canada/toronto/more-than-100-wildfires-burn-in-northern-ontario-1.976223 (accessed Feb 8 2019)
- CBC News Posted Sept. 20 2015. Five years later looking back at Hurricance Igor. https://www.cbc.ca/news/canada/newfoundland-labrador/5-years-later-looking-back-at-hurricane-igor-1.3234312
- Chen, C. C., Jenkins, E., Epp, T., Waldner, C., Curry, P. S., & Soos, C. (2013). Climate change and West Nile virus in a highly endemic region of North America. International journal of environmental research and public health, 10(7), 3052-71. doi:10.3390/ijerph10073052 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3734476/
- Climate Atlas of Canada, version 1 (4 April 2018) https://climateatlas.ca (accessed February -March 2019)
- Climate Telling 2017, "An Indigenous community portal for climate change and health" http://www.climatetelling.info (accessed Feb 27 2019)
- Cunsolo Willox, A., Stephenson, E., Allen, J. et al. Reg Environ Change (2015) 15: 169. https://doi.org/10.1007/s10113-014-0630-z https://link.springer.com/article/10.1007%2Fs10113-014-0630-z#citeas
- Curtis, S., Fair, A., Wistow, J., Val, D. V., & Oven, K. (2017). Impact of extreme weather events and climate change for health and social care systems. Environmental health: a global access science source, 16(Suppl 1), 128. doi:10.1186/s12940-017-0324-3
- Dale Dominey-Howes, Andrew Gorman-Murray & Scott McKinnon (2014) Queering disasters: on the need to account for LGBTI experiences in natural disaster contexts, Gender, Place & Culture, 21:7, 905-918, DOI: 10.1080/0966369X.2013.802673 https://doi.org/10.1080/0966369X.2013.802673
- Dominique F. Charron, M. Kathleen Thomas, David Waltner-Toews, Jeffery J. Aramini, Tom Edge, Robert A. Kent, Abdel R. Maarouf & Jeff Wilson (2004) VULNERABILITY OF WATERBORNE DISEASES TO CLIMATE CHANGE IN CANADA: A REVIEW, Journal of Toxicology and Environmental Health, Part A, 67:20-22, 1667-1677,DOI: 10.1080/15287390490492313 Pages 1667-1677 | Published online: 12 Aug 2010
- Drebot MA, Jones S, Grolla A, Safronetz D, Strong JE, Kobinger G, Lindsay RL.National Microbiology Laboratory, Public Health Agency of Canada, Winnipeg, MB. Hantavirus pulmonary syndrome in Canada: An overview of clinical features, diagnostics, epidemiology and prevention. https://doi.org/10.14745/ccdr.v41i06a02
- Doyon, B., Belanger, D. and Gosselin, P. (2008). The Potential Impact of Climate Change on Annual and Seasonal Mortality for Three Cities in Quebec, Canada. Int. J. Health. Geogr., 7, 23-35. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2410102/
- Ebi, K., Campbell-Lendrum, D., Wyns, A., The 1.5 Health Report – Synthesis on Health and Climate Science in the IPCC SR1.5 https://www.who.int/globalchange/181008_the_1_5_healthreport.pdf?ua=1
- Environment and Climate

Change Canada (ECCC). 2013. https://ec.gc.ca/ouragans-hurricanes/default.asp?lang=En&n=2A6E3A33-1
- ECCC. Climate Trends and Variations Bulletin https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/trends-variations.html (accessed Feb 7, 2019)
- ECCC. Climate Trends and Variations Bulletin – Annual 2017 https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/trends-variations/updated-autumn-2017---summer-2018/5999-090-Annual%20EN2%20edited%203Dec2018.pdf
- Environment and Climate Change Canada (ECCC). 2018a. Changes in Temperature https://www.canada.ca/en/environment-climate-change/services/climate-change/canadian-centre-climate-services/basics/trends-projections/changes-temperature.html
- Environment and Climate Change Canada (ECCC). 2018b. Canada's top 10 weather stories of 2018. https://www.canada.ca/en/environment-climate-change/services/top-ten-weather-stories/2018.html
- Environment and Climate Change Canada (ECCC). 2019. Personal Correspondence. March 5, 2019. Melissa MacDonald, Environment and Climate Change Canada.
- Environics Research Group (ERG) 2017. Public Perceptions of Climate Change and Health. Final Report. Prepared by Environics Research Group. Prepared for Health Canada. For more information on this report: info@hc-sc.gc.ca
- Eyzaguirre, Jimena. Climate Change and Canada: An untapped opportunity to advance gender equality? Canadian Women's Health Network. Fall/Winter 2008/09 Volume 11, number 1. http://www.cwhn.ca/en/print/node/39364
- First Nations Wildfire Evacuation Partnership. 2019. Wildfire evacuation experiences of Sandy Lake First Nation. [Accessed on line Feb 11 2019] https://www.eas.ualberta.ca/awe/files/TwoPager_Sandy_Lake_First_Nation.pdf
- Ford J. D. (2012). Indigenous health and climate change. American journal of public health, 102(7), 1260-6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3477984/
- Furgal, C., & Seguin, J. (2006). Climate change, health, and vulnerability in Canadian northern Aboriginal communities. Environmental health perspectives, 114(12), 1964-70.
- Gasmi S, Ogden NH, Lindsay LR, Burns S, Fleming S, Badcock J, Hanan S, Gaulin C, Leblanc MA, Russell C, Nelder M, Hobbs L, Graham-Derham S, Lachance L, Scott AN, Galanis E, Koffi JK. BC Surveillance for Lyme disease in Canada: 2009–2015. Can Commun Dis Rep. 2017;43(10):194-9. https://doi.org/10.14745/ccdr.v43i10a01
- Global News posted August 18, 2018. Safe bet Alberta will be impacted by B.C. wildfire smoke in future. https://globalnews.ca/news/4395785/alberta-air-quality-bc-wildfire-smoke/
- GlobalNewspostedAugust19,2018.Airqualityinnearly a dozen B.C. communities 'very high risk' on Sunday.
- https://globalnews.ca/news/4396436/bc-air-quality-risk/
- Global News posted on August 20, 2018. Smokiest summer on record in Calgary: Environment Canada. https://globalnews.ca/news/4398690/2018-the-smokiest-summer-on-record-in-calgary-environment-canada/
- Global News posted August 23, 2018. Smoke from B.C. wildfires impacted parts of Saskatchewan. https://globalnews.ca/news/4401825/smoke-bc-wildfires-saskatchewan-air-quality
- Gosselin, P., Bélanger, D., Lapaige, V., & Labbé, Y. (2011). The burgeoning field of transdisciplinary adaptation research in Quebec (1998-): a climate change-related public health narrative. Journal of multidisciplinary healthcare, 4, 337-48.
- Hansen, A., Bi, P., Nitschke, M., Ryan, P., Pisaniello, D., & Tucker, G. (2008). The effect of heat waves on mental health in a temperate Australian city. Environmental health perspectives, 116(10), 1369-75.
- Harper, S. L., Edge, V. L., Ford, J., Willox, A. C., Wood, M., IHACC Research Team, RICG, … McEwen, S. A. (2015). Climate-sensitive health priorities in Nunatsiavut, Canada. BMC public health, 15, 605. doi:10.1186/s12889-015-1874-3 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4489362/
- Hayes, K., Blashki, G., Wiseman, J., Burke, S., & Reifels, L. (2018). Climate change and mental health: risks, impacts and priority actions. International journal of mental health systems, 12, 28. doi:10.1186/s13033-018-0210-6
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5984805/
- Hayes, K., & Poland, B. (2018). Addressing Mental Health in a Changing Climate: Incorporating Mental Health Indicators into Climate Change and Health Vulnerability and Adaptation Assessments. International journal of environmental research and public health, 15(9), 1806. doi:10.3390/ijerph15091806 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6164893/#B20-ijerph-15-01806
- Health Canada, 2008. Human Health in a Changing Climate: A Canadian Assessment of Vulnerabilities and Adaptive Capacity http://publications.gc.ca/collections/collection_2008/hc-sc/H128-1-08-528E.pdf
- Health Canada 2015 Food Safety for Vulnerable Populations. https://www.canada.ca/en/health-canada/services/food-safety-vulnerable-populations.html
- Health Canada, 2017. Health Impacts of Air Pollution in Canada. An estimate of premature mortalities http://publications.gc.ca/collections/col-

lection_2018/sc-hc/H144-51-2017-eng.pdf
- Health Care Without Harm. 2018. Safe Haven in the Storm. Protecting lives and margins with climate-smart health care https://noharm-uscanada.org/sites/default/files/documents-files/5146/Safe%20Haven.pdf
- Hiroshi Nukui, Sanae Midorikawa, Michio Murakami, Masaharu Maeda, Akira Ohtsuru; Mental health of nurses after the Fukushima complex disaster: a narrative review, Journal of Radiation Research, Volume 59, Issue suppl_2, 1 April 2018, Pages ii108–ii113, https://doi.org/10.1093/jrr/rry020 Institut national de sante publique Quebec (INSPQ) 2012. Literature Review of Urban Heat Island Mitigation Strategies 2009. Government of Quebec 2012.
- Institut national de sante publique Quebec (INSPQ) 2014. Health Impacts of Particles from Forest Fires. Government of Quebec 2014. https://www.inspq.qc.ca/pdf/publications/1793_Health_Impacts_Forest_Fires.pdf
- Intergovernmental Panel on Climate Change (IPCC) 2014. Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects: Working Group II Contribution to the IPCC Fifth Assessment Report. Cambridge: Cambridge University Press. Doi:10.1017/CBO9781107415379
- Kosatsky, T. (2010): Hot day deaths, summer 2009: what happened and how to prevent a recurrence; British Columbia Medical Journal, v. 52, no. 5, p. 261.
- Kosatsky, T., Henderson, S. B., & Pollock, S. L. (2012). Shifts in mortality during a hot weather event in Vancouver, British Columbia: rapid assessment with case-only analysis. American journal of public health, 102(12), 2367-71.
- Kovacs, P. and Thistlethwaite, J. (2014): Industry; in Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, ON, p. 135-158.
- KPMG 2016. Wood Buffalo Wildfire. Post Incident Assessment Report. Prepared by KPMG for the Alberta Emergency Management Agency. https://www.alberta.ca/assets/documents/Wildfire-KPMG-Report.pdf
- Kulkarni, M. A., Berrang-Ford, L., Buck, P. A., Drebot, M. A., Lindsay, L. R., & Ogden, N. H. (2015). Major emerging vector-borne zoonotic diseases of public health importance in Canada. Emerging microbes & infections, 4(6), e33. doi:10.1038/emi.2015.33
- Lake, I. R., & Barker, G. C. (2018). Climate Change, Foodborne Pathogens and Illness in Higher-Income Countries. Current environmental health reports, 5(1), 187-196. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5876342/
- Lake, I.R. (2017). Food-borne disease and climate change in the United Kingdom.Environmental Health201716 (Suppl 1) :117. https://doi.org/10.1186/s12940-017-0327-0
- Lancet 2018. The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. Nick Watts, et al., Lancet 2018; 392: 2479–514 Published Online November 28, 2018 http://dx.doi.org/10.1016/ S0140-6736(18)32594-7
- Patrick A. Leighton, Jules K. Koffi, Yann Pelcat, L. Robbin Lindsay and Nicholas H. Ogden, Journal of Applied Ecology, 2012, 49, 457-464Predicting the speed of tick invasion: an empirical model of range expansion for the Lyme disease vector Ixodes scapularis in Canada. 2012. https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2664.2012.02112.x
- Lemmen, D.S., Johnston, M., Ste-Marie, C. and Pearce, T. (2014): Natural Resources; in Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, ON, p. 65-98.
- Lemmen, D.S.,Warren, F.J., Lacroix, J., and Bush, E., editors (2008): From Impacts to Adaptation: Canada in a Changing Climate 2007; Government of Canada, Ottawa, ON, 448 p.
- Lindsay LR. Present state of common vector-borne diseases in Canada. Can Comm Dis Rep 2016;42:200-1. https://doi.org/10.14745/ccdr.v42i10a03
- Malik, M., Stranberg, R., Meunier, M., Donaldson, S. (2018). Poster: Heat Health - Addressing Adaptation. Climate Change and Innovation Bureau. Health Canada. Ottawa.
- Martinez, G.S., Berry, P., Balbus, J., Hodgson, T., Salazar, M. Chapter 5: (2018) The Global Adaptation Gap, In United Nations Environment Programme. The Adaptation Gap. United Nations Environment Programme.
- Martínez-Solanas, È., López-Ruiz, M., Wellenius, G. A., Gasparrini, A., Sunyer, J., Benavides, F. G., & Basagaña, X. (2018). Evaluation of the Impact of Ambient Temperatures on Occupational Injuries in Spain. Environmental health perspectives, 126(6), 067002. doi:10.1289/EHP2590
- Mikkonen, J., & Raphael, D. (2010). Social Determinants of Health: The Canadian Facts.Toronto: York University School of Health Policy and Management. http://www.thecanadianfacts.org/
- Moffat, H., and Struck, S., Water-borne Disease Outbreaks in Canadian Small Drinking Water Systems. (2011). National Collaborating Centre for Environmental Health. http://www.ncceh.ca/sites/default/files/SDWS_Water-borne_EN.pdf
- Molinari, N. A., Chen, B., Krishna, N., & Morris, T. (2017). Who's at Risk When the Power Goes Out? The At-home Electricity-Dependent Population in the United States, 2012. Journal of public health management and practice : JPHMP, 23(2), 152-159.
- Moudrak, N., Feltmate, B., Venema, H., Osman, H. 2018. Combating Canada's Rising Flood Costs: Natural infrastructure is an underutilized option. Prepared

for Insurance Bureau of Canada. Intact Centre on Climate Adaptation, University of Waterloo. http://assets.ibc.ca/Documents/Resources/IBC-Natural-Infrastructure-Report-2018.pdf
- National Collaborating Centre for Environmental Health (NCCEH). Marine Shellfish Poisoning 2017.
- http://www.ncceh.ca/environmental-health-in-canada/health-agency-projects/marine-shellfish-poisoning
- The National Institute of Environmental Health Sciences (NIEHS). A Human Health Perspective on Climate Change: A Report Outlining the Research Needs on the Human Health Effects of Climate Change. Interagency Working Group on Climate Change and Health. Environmental Health Perspectives. www.niehs.nih.gov/climatereport https://www.cdc.gov/climateandhealth/pubs/hhcc_final_508.pdf [accessed March 1 2019]
- Natural Resources Canada (NRCan) 2018a. Case Studies in Floodplain Mapping. Volume 1. 2018
- http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/306/306436/gip_118_en.pdf
- Natural Resources Canada (NRCan) 2017a. Growing Season https://www.nrcan.gc.ca/forests/climate-change/forest-change/18470
- Natural Resources Canada (NRCan) 2017b. Wildland Fire Evacuation in Canada. Christianson, A., 2017 https://www.cif-ifc.org/wp-content/uploads/2017/10/20171101-E-Lecture.pdf
- Natural Resources Canada (NRCan). 2018b. Indicator. Forest Fires. https://www.nrcan.gc.ca/forests/report/disturbance/16392
- Newfoundland and Labrador 2013. Climate Change Projections for Newfoundland and Labrador Late 20Century to Mid 21Century - Summary Presentation June 2013 , Office of Climate Change, Energy Efficiency and Emissions Trading
- Nickell, L. A., Crighton, E. J., Tracy, C. S., Al-Enazy, H., Bolaji, Y., Hanjrah, S., Hussain, A., Makhlouf, S., … Upshur, R. E. (2004). Psychosocial effects of SARS on hospital staff: survey of a large tertiary care institution. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne, 170(5), 793-8.
- Nova Scotia 2014, Climate Change Nova Scotia. Health Impacts. https://climatechange.novascotia.ca/adapting-to-climate-change/impacts/health
- The Honourable Dennis R. O'Connor. Report of the Walkerton Inquiry. Part 1. The Events of May2000 and Related Issues. Government of Ontario. 2002
- Nicholas H. Ogden; Climate change and vector-borne diseases of public health significance, FEMS Microbiology Letters, Volume 364, Issue 19, 16 October 2017, fnx186, https://doi.org/10.1093/femsle/fnx186
- Ogden NH. Vector-borne disease, climate change and urban design. Can Comm Dis Rep 2016;42:202. https://doi.org/10.14745/ccdr.v42i10a04
- Ogden NH, Koffi JK, Pelcat Y, Lindsay LR. Environmental risk from Lyme disease in central and eastern Canada: a summary of recent surveillance information. (2014) https://www.ncbi.nlm.nih.gov/pubmed/29769885
- Ontario Power Authority, "Ontario Electricity Demand 2012 Annual Long Term Outlook" (presentation, 2012) slides 14-15, 21, 22, online: <cms. powerauthority.on.ca/sites/default/files/news/Q2-2012LoadForecast. pdf>.
- Ontario 2016a. Ontario Ministry of Health and Long-Term Care: A Harmonized Heat Warning and Information System for Ontario, 2016
- Ontario 2016b. Ontario Ministry of Health and Long-Term Care: Ontario Climate Change and Health Modelling Study. 2016. © Queen's Printer for Ontario, 2016. Printed in Ontario, Canada
- Ouranos 2015. Summary of the Synthesis on Climate Change Knowledge in Quebec. 2015 Edition. Montreal, Québec : Ouranos, 13 p. https://www.ouranos.ca/publication-scientifique/Synthesis_Summary.pdf
- Pfister, G. G., S. Walters, J.-F. Lamarque, J. Fast, M. C. Barth, J. Wong, J. Done, G. Holland, and C. L. Bruyère (2014), Projections of future summertime ozone over the U.S., J. Geophys. Res. Atmos., 119, 5559 – 5582, doi:10.1002/2013JD020932. https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2013JD020932
- Portier CJ, et al., 2010. A Human Health Perspective On Climate Change: A Report Outlining the Research Needs on the Human Health Effects of Climate Change. Research Triangle Park, NC:Environmental Health Perspectives/National Institute of Environmental Health Sciences. doi:10.1289/ehp.1002272 Available: www.niehs.nih.gov/climatereport
- Prairies Adaptation Research Collaborative (PARC). Summary Document No.08-01. Climate Change Impacts on Canada's Prairie Provinces 2007. http://www.parc.ca/saskadapt/cc-research-highlights/ccia-research-prairies.html (accessed Feb 10 2019)
- Public Health Agency of Canada (PHAC) 2010. The Burden of Diabetes in Atlantic Canada, 2010. Produced by Audrey Layes for the Public Health Agency of Canada, Atlantic Regional Office
- Public Health Agency of Canada (PHAC) 2016. https://www.canada.ca/en/public-health/services/food-borne-illness-canada/yearly-food-borne-illness-estimates-canada.html
- Public Health Agency of Canada (PHAC)

2018a. Climate Change, Forest Fires and Your Health https://www.canada.ca/en/public-health/services/health-promotion/environmental-public-health-climate-change/climate-change-public-health-factsheets-forest.html (accessed Feb 6, 2019)
- Public Health Agency of Canada (PHAC) 2018b. Notifiable Disease Online http://diseases.canada.ca/notifiable/charts-list (accessed Feb 4, 2019)
- Public Health Agency of Canada (PHAC) 2018c Key Health Inequalities in Canada: A National Portrait https://www.canada.ca/en/public-health/services/publications/science-research-data/key-health-inequalities-canada-national-portrait-executive-summary.html
- Public Health Ontario (PHO) 2015. Extreme Weather – The Fallout After the Storm. 2015. https://www.publichealthontario.ca/-/media/documents/ohp-extreme-weather.pdf?la=en
- Public Safety Canada (PSC) 2019a. Canadian Disaster Database [internet – accessed Feb 27 2019]. Ottawa, ON.,
- Public Safety Canada (PSC) 2019b. Emergency Management Strategy for Canada – Towards a Resilient 2030. Her Majesty the Queen in Right of Canada. 2019
- Ravesteijn, B., van Kippersluis, H., & van Doorslaer, E. (2013). The contribution of occupation to health inequality. Research on economic inequality, 21, 311-332.
- Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliott CT. 2016. Critical review of health impacts of wildfire smoke exposure. Environ Health Perspect 124:1334–1343; http://dx.doi.org/10.1289/ehp.1409277
- Romero-Lankao, P., J.B. Smith, D.J. Davidson, N.S. Diffenbaugh, P.L. Kinney, P. Kirshen, P. Kovacs, and L. Villers Ruiz, 2014: North America. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1439-1498.
- Rudolph, L., Harrison, C., Buckley, L. & North, S. (2018). Climate Change, Health, and Equity: A Guide for Local Health Departments. Oakland, CA and Washington D.C., Public Health Institute and American Public Health Association. https://www.apha.org/-/media/files/pdf/topics/climate/climate_health_equity.ashx?la=en&hash=14D2F64530F1505EAE7AB16A9F9827250EAD6C79
- Sahni et al., 2015. Vanita Sahni, MHSc, Allison N. Scott, MSc, Marie Beliveau, MSc, Marie Varughese, MSc, Douglas C. Dover, MSc, James Talbot, MD, PhD. Public health surveillance response following the southern Alberta floods, 2013. Can J Public Health 2016;107(2):e142–e148 doi: 10.17269/CJPH.107.5188. https://journal.cpha.ca/index.php/cjph/article/viewFile/5188/3394
- Sandifer, P. A., Knapp, L. C., Collier, T. K., Jones, A. L., Juster, R. P., Kelble, C. R., Kwok, R. K., Miglarese, J. V., Palinkas, L. A., Porter, D. E., Scott, G. I., Smith, L. M., Sullivan, W. C., … Sutton-Grier, A. E. (2017). A Conceptual Model to Assess Stress-Associated Health Effects of Multiple Ecosystem Services Degraded by Disaster Events in the Gulf of Mexico and Elsewhere. GeoHealth, 1(1), 17-36.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6309401/
- Sandy Lake First Nation. 2011. http://sandylake.firstnation.ca/?q=public-statement-1-fire-and-evacuation-july-25-2011
- Sarkar A, Hanrahan M, and Hudson A. (2015). Water quality in Aboriginal communities in Labrador: a study of the Southern Inuit community of Black Tickle. Memorial University of Newfoundland, St John's, NL, Canada. https://www.mun.ca/harriscentre/reports/Sarkar_Water_12_13_Final.pdf
- Semenza, J. C., Herbst, S., Rechenburg, A., Suk, J. E., Höser, C., Schreiber, C., & Kistemann, T. (2011). Climate Change Impact Assessment of Food- and Waterborne Diseases. Critical reviews in environmental science and technology, 42(8), 857-890.
- Sellers, Sam. University of Washington. Climate change and gender in Canada: a review. 2018. Women's Environment and Development Organization. https://wedo.org/wp-content/uploads/2018/04/GGCA-CA-RP-07.pdf
- Short, E. E., Caminade, C., & Thomas, B. N. (2017). Climate Change Contribution to the Emergence or Re-Emergence of Parasitic Diseases. Infectious diseases, 10, 1178633617732296. doi:10.1177/1178633617732296
- Spinney, Jennifer & Pennesi, Karen. (2013). When the river started underneath the land: Social constructions of a 'severe' weather event in Pangnirtung, Nunavut, Canada. Polar Record. 49. 10.1017/S0032247412000320.
- https://www.researchgate.net/publication/259435712_When_the_river_started_underneath_the_land_Social_constructions_of_a_'severe'_weather_event_in_Pangnirtung_Nunavut_Canada/download
- Sierra-Heredia, C., North, M., Brook, J., Daly, C., Ellis, A. K., Henderson, D., Henderson, S. B., Lavigne, É., … Takaro, T. K. (2018). Aeroallergens in Canada: Distribution, Public Health Impacts, and Opportunities for Prevention. International journal of environmental research and public health, 15(8), 1577. doi:10.3390/ijerph15081577
- Smith, K.R., A. Woodward, D. Campbell-Len-

drum, D.D. Chadee, Y. Honda, Q. Liu, J.M. Olwoch, B. Revich, and R. Sauerborn, 2014: Human health: impacts, adaptation, and co-benefits. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 709-754.

- Stieb DM, Judek S, van Donkelaar A, Martin RV, Brand K, Shin HH, Burnett RT, Smith-Doiron M. 2015. Estimated public health impact of changes in fine particle air pollution in Canada, 2000-2011. Can J Public Health 106(6): 362–368.
- Tak, S., Driscoll, R., Bernard, B., & West, C. (2007). Depressive symptoms among firefighters and related factors after the response to Hurricane Katrina. Journal of urban health : bulletin of the New York Academy of Medicine, 84(2), 153-61.
- Taylor et al., 2013. Marsha Taylor, Lorraine McIntyre, Mark Ritson, Jason Stone , Roni Bronson , Olga Bitzikos , Wade Rourke , Eleni Galanis Outbreak of Diarrhetic Shellfish Poisoning Associated with Mussels, British Columbia, Canada. Mar. Drugs 2013, 11(5), 1669-1676; doi:10.3390/md11051669
- Teufel, B., Diro, G.T., Whan, K. et al. Clim Dyn (2017) 48: 2881. https://doi.org/10.1007/s00382-016-3239-8. Investigation of the 2013 Alberta flood from weather and climate perspectives
- Toews, Erin 2018. Canadian Healthcare Facilities – Journal of Canadian Healthcare Engineering Society. Volume 38, Issue1. Winter/Spring 2017/2018, pg 28-3 https://issuu.com/riccardo11/docs/chf_winter_2017-2018
- Toronto Star, July 18, 2018. Quebec Bureau. Montreal. Allan Woods. More than 90 deaths now linked to heat wave in Quebec
- van der Leun, J.C., Piacentini, R.D., de Gruijl, F.R.,.Climate change and human skin cancer. Photochem. Photobiol. Sci., 2008,7, 730-733 https://pubs.rsc.org/en/content/articlelanding/2008/pp/b719302e#!divAbstract
- Vescovi, L., Rebetez, M.,Rong, F. 2005.Assessing public health risk due to extremely high temperature events: Climate and social parameters.
- Warren, F.J. and Lemmen, D.S., editors (2014): Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation; Government of Canada, Ottawa, ON, 286p. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/assess/2014/pdf/Full-Report_Eng.pdf
- Weather Network 2014. https://www.theweathernetwork.com/news/articles/a-look-back-at-devastating-hurricane-igor/13153
- Wen Qi Gan; Lillian Tamburic; Hugh Davies; Paul Demers; Mieke Koehoorn; Michael Brauer; Changes in Residential Proximity to Road Traffic and the Risk of Death From Coronary Heart Disease. Epidemiology. 21(5):642-649, SEP 2010. DOI: 10.1097/EDE.0b013e3181e89f19
- World Health Organization (WHO). 2019a. Stratospheric ozone depletion, ultraviolet radiation and health https://www.who.int/globalchange/ozone_uv/en/ (Accessed Feb 7 2019)
- World Health Organization (WHO) 2019b. Determinants of Health https://www.who.int/hia/evidence/doh/en/ (accessed March 3, 2019)
- World Meteorological Organization (WMO), Scientific Assessment of Ozone Depletion: 2018, Global Ozone Research and Monitoring Project–Report No. 58, 588 pp., Geneva, Switzerland, 2018.
- Yi Wang, Edward McBean and Bahram Gharabaghi (2018). Increased Risks of Waterborne Disease Outbreaks in Northern Ontario due to Climate Change. GHD Limited; University of Guelph. DOI: 10.14796/JWMM.C436
- Yusa, A., Berry, P., Cheng, J. J., Ogden, N., Bonsal, B., Stewart, R., and Waldick R., (2015) Climate Change, Drought and Human Health in Canada. Int J Environ Res Public Health, 12(7), 8359-412. DOI: 10.3390/ijerph120708359. http://www.ncbi.nlm.nih.gov/pubmed/26193300
- Zheng, H., Drebot, M. A., & Coulthart, M. B. (2014). West Nile virus in Canada: ever-changing, but here to stay. Canada communicable disease report = Releve des maladies transmissibles au Canada, 40(10), 173-177.https://www.

ncbi.nlm.nih.gopmc/articles/PMC5864456/

308- 192 Spadina Avenue
Toronto, ON M5T 2C2
www.cape.ca
Twitter: @CAPE_Doctors Facebook:@capedoctors