Climate change, extreme heat and health

Protecting Canadians from the health impacts of extreme heat

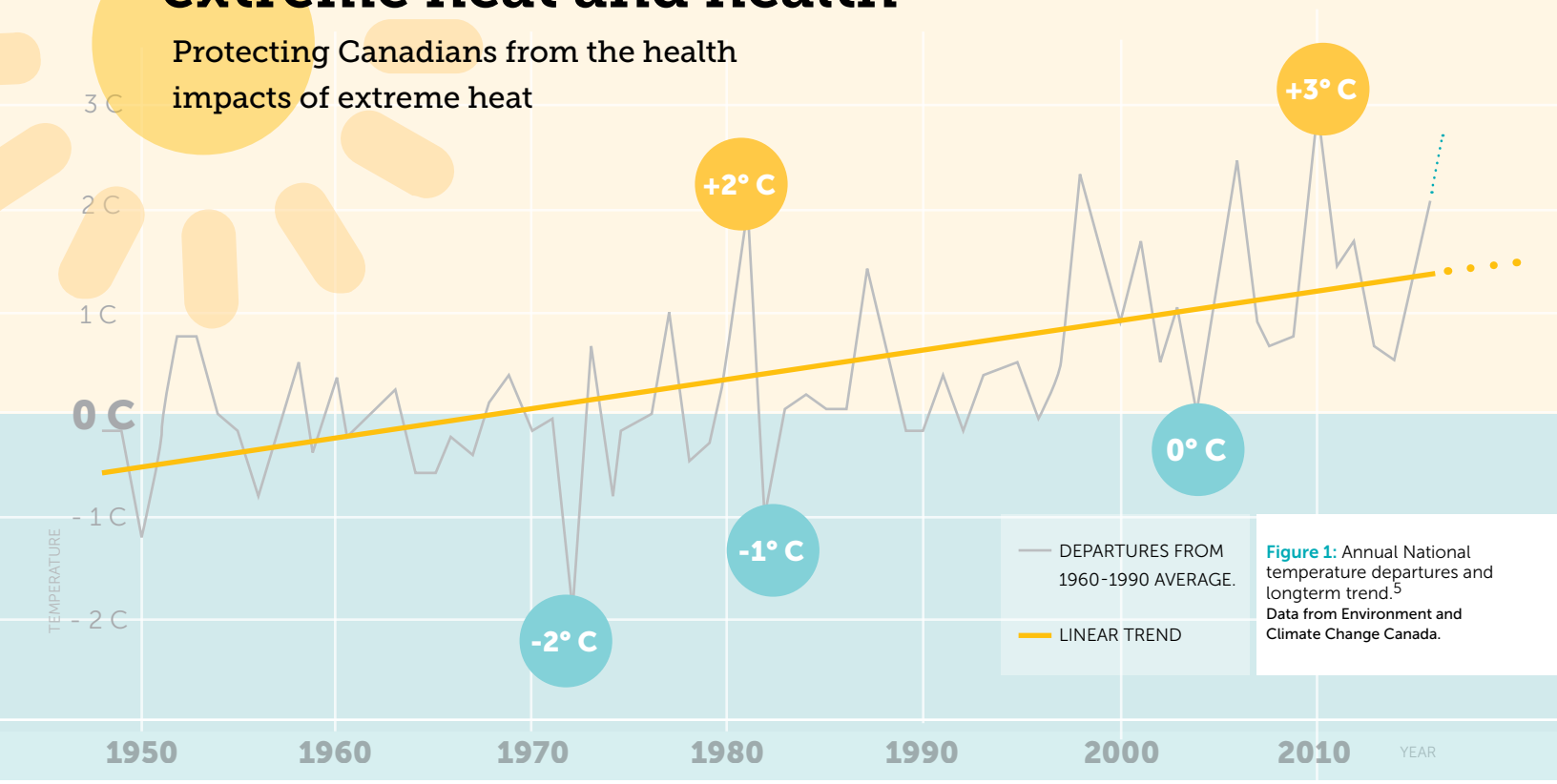


Figure 1: Annual National temperature departures and longterm trend.[5] Data from Environment and Climate Change Canada.

THERE IS NO DENYING IT and no doubt about it: our planet is warming and climate change is well underway, around the world and right here in Canada. We see it in melting sea ice, changing precipitation patterns, thawing permafrost and the increased occurrence of extreme weather events, such as droughts, intense rainfall, flooding and record high temperatures.

Periods of extreme heat are uncomfortable, but they can also exacerbate existing health conditions, such as asthma, and put people at risk for heat-related illnesses, even death. Compared to other climate change hazards, the significance of the broad societal impacts of heatwaves has only recently been recognized.[1]

Last year, 2016, ranked as the planet's warmest year since temperature records began in 1880. Although Canada's average annual temperature seesaws from year to year, there is a clear upward trend. Canada is 1.7° C[2] warmer today than it was in 1948, when William Lyon Mackenzie King served his final year as Prime Minister. The greatest temperature increases have occurred during the winter months and are most pronounced in Yukon and the Northwest Territories.

Scientists predict that almost all of Canada will continue to get warmer during the next 80 years. Even with reduced greenhouse gas emissions, Canada's summers are projected to warm by 1.5° C to 2.5° C by mid-century.[3] Those temperatures will be higher if greenhouse gas emissions continue unabated.

Warming of a degree or two may seem small, but it's important to remember that these are average temperatures covering an entire year, and as average temperatures rise, so too does the occurrence of more extreme events[4].

Extreme heat

THERE IS NO UNIVERSAL DEFINITION of an extreme heat event, but it is associated with increased risks to human health. What constitutes an extreme heat event varies by region.

Extreme temperatures during summertime are increasing in Canada and scientists expect climate change will make heat waves hotter, last longer and occur more often[6], in the future.

Extreme heat events occur when a high-pressure system stalls over an area, causing a build-up of warm air close to the ground. Very severe extreme heat events, like those that struck Europe in 2003 and Russia in 2010, occur when the high-pressure system forms over areas of low soil moisture, creating a feedback loop that pumps more warmth into the air above to form a thick blanket of heat in the atmosphere[7]. Some studies show that such intense and possibly deadly heat waves will become 5-10 times more likely in the coming decades[8].

Hot days and warm nights are also expected to become more common in many Canadian

communities[10]. For example, Toronto, Winnipeg, Windsor, and other cities in the Windsor to Quebec City corridor are expected to see the number of days with temperatures above 30° C double between now and the end of the century. A record-breaking heat event that had previously occurred once every 20 years may well occur once every other year by 2100[11].

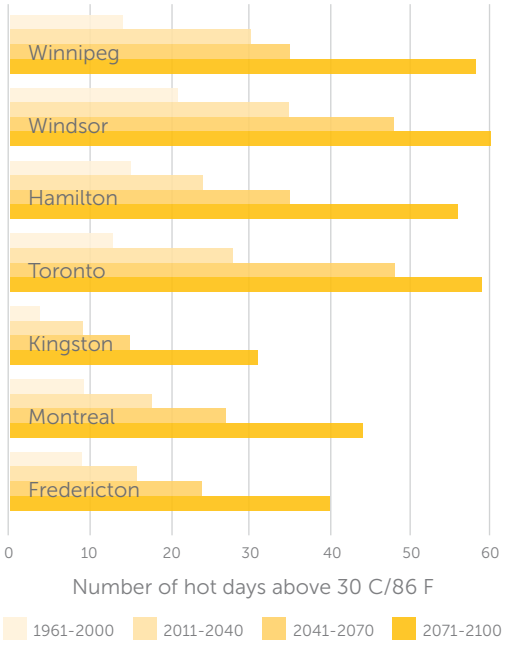


Figure 2: Historical and projected number of hot days and warm nights for select Canadian cities. Caseti et al, 2013[9]

Climate models show that the Great Lakes region and the plains of Saskatchewan and Alberta stand a greater chance of experiencing extreme heat, but for different reasons[12]. In the Great Lakes region, humidity is expected to help keep nighttime temperatures elevated, a hallmark of extreme heat events[13]. Whereas in the plains region, the lack of soil moisture helps dangerously hot temperatures persist over land.

The Meteorological Service of Canada (MSC), part of Environment and Climate Change Canada (ECCC), issues heat warnings when air temperatures and humidity surpass established thresholds in a particular region[14]. Many of these thresholds have been developed in conjunction with Health Canada based on health evidence. Those values vary from place to place and are being updated currently to all be based on health evidence. In Vancouver, for example, the maximum daily temperature must hit 29° C or more on consecutive days; but in nearby Abbotsford, the threshold is 34° C for at least two days in a row. Elsewhere, such as in southern Ontario, nighttime temperatures are also considered and humidity can be a factor in reaching the threshold.

The risks of extreme heat

WHEN THE BODY'S ABILITY TO DISPEL HEAT is compromised, the body's core temperature rises above its normal range, which can lead to a variety of health impacts[16]. Heat-related impacts can include skin rashes, cramps, dehydration, fainting, exhaustion and heat stroke. Excessive heat can aggravate pre-existing conditions, including those affecting the lungs, heart and kidneys, and for people with mental health issues. And it can cause death.

Very severe extreme heat events with prolonged periods of higher than usual daytime and nighttime temperatures in Europe in 2003 contributed to 70,000 additional deaths recorded across 12 countries. Closer to home, an extreme heat event in Quebec in 2010 resulted in an estimated 280 additional deaths[17]. A recent report by the World Meteorological Organization, a United Nations agency, found that heat waves have also become deadlier over time[18].

However, there is also evidence that mortality rates from extreme heat events are declining in many countries due to increased use of air conditioning, better health systems and other factors. But health risks from such events are still a significant concern, given that some key vulnerability factors - such as an ageing population, the urban heat island and a growing number of heat events - are projected to increase.

Identifying the rates of heat illness and their impact on health and community resources can be more

WHAT IS THE URBAN HEAT ISLAND EFFECT?

Cities tend to have much hotter daytime and nighttime temperatures than the surrounding countryside. The annual average air temperature of cities of a million or more people can be 1-3° C warmer than the surrounding area, and as much as 12° C warmer, in some areas.[15]

The concrete, brick and asphalt that make up the built environment absorb heat from the sun during the day and emit some of that heat at night. The geometry of urban structures can increase the absorption and reflection of solar radiation, and reduce air flow. Buildings, vehicles and the machinery within cities can exacerbate urban heat islands by releasing waste heat into urban areas.

Climate change is projected to significantly increase temperatures in cities. Cities are also growing in size, adding to the heat island effect. Adding reflective roofs, green roofs, urban trees and parks can reduce the urban heat island effect locally. Cool or reflective roofs help lower air temperature by reflecting the sun's energy. Trees and green spaces help cool cities by providing shade and through evapotranspiration.

challenging. Researchers who have tried to understand the prevalence of heat-related illnesses have generally found increases in hospital admissions and calls to emergency services. The 2010 heat wave in Quebec, for example, led to an extra 3,400 admissions to emergency departments in the province[19]. During a 2005 Toronto heat wave, researchers found a 29 percent increase in ambulance calls for heat-related illness for each one-degree Celsius increase in maximum temperature[20].

Heat-related illness and death are often greater when extreme heat events occur in the spring or early summer, partly because people are less acclimatized to the heat.

Who's at risk?

EVERYONE CAN BE AT RISK from extreme heat. However, a person's physiology, their exposure to extreme heat, and their ability to take protective action determine just how large the risk really is. For example, factors that can influence whether an extreme heat event poses a health risk to people include urban heat islands (see explanation in box above), a city's proximity to water, access to air conditioning, the population's vulnerability to extreme heat and its experience with high temperatures.

Children and the elderly are among sectors of the population that are at greater risk from extreme heat events. For example, they sweat less and may rely on caregivers to take actions to prevent illness during extreme heat events or to notice they're suffering in the heat.

Recent studies have found that socio-economic factors may play an important role in modifying heat health risk. Seniors who are confined to bed, live alone or who do not have air conditioning show greater risk of illness and death during extreme heat events than seniors who have access to air conditioning, live with others and are mobile. Many of the people who died during the 1995 Chicago heat wave and the 2003 heat wave in France were elderly and living alone.

People in socially disadvantaged situations - living in shelters or currently experiencing homelessness - often have increased exposure to dangerously hot temperatures. They frequently reside in urban centres where the heat island effect is strongest, or they lack air conditioning or the means to access cooling options, such as cooling centres or pools.

People with chronic physical conditions or illnesses, including those that affect the heart, lungs, kidneys and nervous systems, are among those more likely to experience health impacts during an extreme heat event. They may also be dependent on a caregiver, be socially isolated, or be taking certain medications that can impact their ability to cope with the heat. In addition, air pollution tends to be higher during extreme heat due to ground-level ozone production (smog), wildfires and the effects of drought, which can put many of these individuals at further risk by making it harder to breathe and worsening existing lung or heart-related symptoms.

Some medications can interfere with the body's ability to cool itself or change the way the body uses water and salt, making people who take them more vulnerable to heat. Drugs that are used to treat depression, epilepsy, high blood pressure and anxiety are among those that can increase a person's sensitivity to heat.

Newcomers and tourists face additional risks in extreme heat events. They may not be familiar with the climate or have language barriers that keep them from getting the information they need to protect themselves and their families during hot weather.

Athletes and other physically active people may also find themselves suffering during an extreme heat event. Cyclists, runners and recreational athletes who participate in their sports outdoors may not realize they are putting themselves at risk of heat illness. The increased physical strain during a hot and humid day caused by increased heat production, blood pooling, and fluid loss, or in certain sports due to the reduced ability to dissipate heat when wearing protective gear can lead to heat cramps, heat stroke, dehydration and even sudden death.

Similarly, people who work outdoors, such as landscapers, agricultural workers or construction workers may also be exposed to extreme heat conditions, and be subject to many of the same physical strains as athletes, thereby putting them at a greater risk of developing a heat-related illness.

RURAL COMMUNITIES

RURAL AREAS ARE GENERALLY COOLER THAN URBAN AREAS, BUT THE PEOPLE WHO LIVE THERE CAN ALSO BE VULNERABLE TO HEAT STRESS.

Some reports have found increases in hospital admissions and deaths in rural areas during heat waves. One study found that hospitals serving rural areas in southern Ontario saw an 11 percent rise in emergency room visits during a heatwave[21]. This may be due to increased exposure to extreme heat (agricultural workers) or social isolation, being less exposed to media warnings about the heat, and having fewer transportation options to access cooling centres.

Protecting people from extreme heat events

HEALTH CANADA HAS IDENTIFIED extreme heat as an important risk to Canadians now—and in the future. However, it is possible to prevent heat-related illness and death.

Health Canada has been working to protect Canadians from extreme heat since 2008. Activities include supporting the development and implementation of Heat Alert and Response Systems (HARS) in communities and provinces across the country in addition to maximizing the sharing and development of information and its integration into local emergency alert and response systems, and developing and disseminating heat health training, information and tools to the health care sector and the public.

ONTARIO HEAT WARNINGS

MONITORING
Environment and climate Change Canada (ECCC) monitors weather forecast.

EARLY NOTIFICATION
ECCC advises Public Health Unit (PHU) that conditions/criteria are forecast to be met in advance of issuing a Heat Warning. Warning is issued publicly 18-24 hours in advance of the criteria being reached.

HEAT WARNING
ECCC advises PHU that conditions/criteria have been forecast to be met. PHU gives a heads up to municipalities and partners that conditions are expected to be met and to prepare. PHU notifies media of Heat Warning as appropriate (e.g. share health protective messaging with public.)

EXTENDED HEAT WARNING
Continued if forecast conditions persist. PHU notifies and works with municipalities and community partners within the context of local plans to ensure implementation of response activities.

NOTIFICATION OF DE-ESCALATION
ECCC issues public notification that heat warning is ended as conditions are no longer in effect. PHU notifies municipalities and community partners. PHUs may decide on additional notifications to media, on website, etc.

Figure 3:
Notification and Warning Process from ECCC to PHUs and Community Partners.
Data from Ontario Ministry of Health and Long-term Care[22]

HARS are one important way that communities can warn the public of dangerously hot conditions and take action to protect vulnerable people. HARS include warnings to the public and government or community partners when weather conditions are forecast to reach pre-determined levels that are understood to increase heat-related illnesses or deaths. Communities may have plans to communicate to the public and partners, activate actions to protect health such as cooling stations and a plan for evaluating the system.

In the lead-up to the 2015 Pan Am and Para-Pan Am Games, public health units (PHU) in the Games' footprint in southern Ontario collaborated on a pilot project that aimed to make heat warnings consistent across the region. (See Figure 3.)

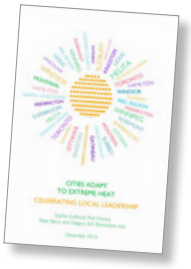
Under this protocol, ECCC provides advance notice to public health units when the meteorologists predict the weather will exceed set criteria within a region for temperatures (day and night) or humidex. The criteria used to establish these triggers are based on an Ontario-specific analysis of heat-related illness and death[23]. Heat warnings are usually issued 18-24 hours before a heat event[24], but the meteorologists look 3 to 5 days into the future to identify multiday events, and contact the affected public health units[25]. ECCC issues a heat warning for that two-day event only when its meteorologists are confident the criteria will be met. The public health unit may choose to issue a collaborating message.

If ECCC forecasts that the heat warning will last longer than two days, it will continue that warning, at which point the public health unit may declare an extended heat warning. In Toronto, city pools may extend their operating hours and public health inspectors visit boarding homes, rooming homes and other residences to see if the landlords have put their hot weather plans into action, such as providing an accessible air-conditioned room for tenants.

This new harmonized heat warning system was rolled out across Ontario in 2016, and is under development in other parts of the country.

Communities adapting to Extreme Heat

In addition to the work being carried out by the federal and provincial governments, many communities across the country have been taking action to address the increasing risk to Canadians from extreme heat events. A 2016 publication authored by the Institute for Catastrophic Loss Reduction and Health Canada highlights twenty community case studies.



Mitigating the urban heat island effect

HEALTH CANADA HAS ALSO BEEN working with communities to reduce the urban heat island effect. Windsor, Ontario, for example, is Canada's southern-most city and has built-up downtown and industrial areas.

It is also one of the hottest, most humid places in Canada[26]. The maximum temperature exceeds 30° C an average 23 days per year, and climate models project the average will double within 60 years.

After mapping the urban heat islands, Windsor installed green roofs and cool roofs on municipal buildings, planted trees, installed gazebos, and constructed splash pads in city parks.[27]

WHAT YOU CAN DO TO BEAT THE HEAT

TIPS TO KEEP COOL

- Tune into local weather forecasts and alerts
- Drink plenty of water
- Wear a hat and lightweight loose clothing
- Take a cool bath or shower, or visit your local public swimming pool
- Limit outdoor activities
- Seek out air-conditioned places or cooling stations
- Check on neighbours, family and friends
- Never leave pets or children alone in vehicles

SYMPTOMS OF HEAT ILLNESS

- Dizziness or fainting
- Nausea or vomiting
- Headache
- Rapid breathing and heartbeat
- Extreme thirst
- Dark urine and decreased urination

If you have any of these symptoms, move to a cool place and drink plenty of fluids, preferably water.

Someone who has a high body temperature and is unconscious, confused or stopped sweating may have heat stroke. **Call 911 immediately** and begin cooling the person with fans, cool compresses, or by moving them to an air-conditioned room.

Resources

- **Heat Alert and Response Systems to Protect Health: Best Practices Guidebook**
  https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/climate-change-health/heat-alert-response-systems-protect-health-best-practices-guidebook.html
- **Heat Health Brochures:**
  http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/index-eng.php#HeatHealthBrochures
- **Cities Adapt to Extreme Heat**
  https://www.iclr.org/images/Cities_Adapt_to_Extreme_Heat_online.compressed.pdf
- **Environment and Climate Change Canada Weather Warnings:**
  http://weather.gc.ca/warnings/index_e.html
- **City of Toronto Harmonized Heat Warning and Information System:**
  http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=923b5ce6dfb31410VgnVCM10000071d60f89RCRD

This backgrounder was commissioned by Health Canada, and written and prepared by the Science Media Centre of Canada

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