
HEAT WAVES AND HEALTH

A SPECIAL REPORT ON
CLIMATE CHANGE IN CANADA

Heat Waves of the Future

Longer, hotter, and more of them: a look at what climate models project for Canada

Heat and Your Health

Heat stress and social vulnerability: what you need to know to stay safe

Risk to Resilience

Take action to prevent global warming from getting worse

Heat Waves and Health

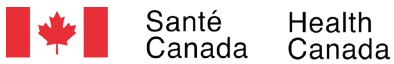
A Special Report on Climate Change in Canada

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Prairie Climate Centre
University of Winnipeg
Richardson College for the Environment and Science Complex
Winnipeg, Manitoba
info@climateatlas.ca



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Introduction

This report by the Prairie Climate Centre (PCC) takes a look at what extreme heat means for the health of Canadians. It draws on data and stories available through the Climate Atlas of Canada - an interactive tool produced by the PCC that combines science, mapping, and storytelling to make climate change meaningful to Canadians. Learn more at climateatlas.ca.

Many Canadians welcome the arrival of hot summer days as respite from our long, cold winters. Understandably, we tend to think of more summer heat as a good thing.

But too much heat can be dangerous.

Kim Perrotta, Senior Director of Health and Policy for the Canadian Association of Physicians for the Environment (CAPE), notes that high temperatures “can increase premature deaths, cause heat stroke, and can aggravate heart disease and respiratory diseases.” She warns that “this is actually a real concern for human health that’s affecting a large portion of the country.”

Extreme heat can also worsen mental health issues such as depression and anxiety. And it increases the risk of droughts and forest fires, which in turn have serious implications for our personal and community health.

Communities across Canada know the dangers of heat all too well. Heat waves and extreme heat warnings have happened frequently in recent summers, including in Winnipeg, Ottawa, Halifax, Toronto, and—most dramatically—Montreal. In the summer of 2018, temperatures in Montreal soared for eight days straight, reaching a searing high of over 40°C with the humidex. Sixty-six people died from the heat.¹

Other areas of southern Quebec were also hit by heat waves, bringing the total death toll across the region to eighty-six.²

Rising temperatures are a problem especially for people in larger cities. Gord Perks, a city councillor in Toronto, worries about rising temperatures becoming hazardous to the people in his city. “We’ve been lucky so far that we haven’t had a deadly heat wave,” he said in 2018. “We haven’t had that, but we’re likely to. All the models say we’re going to.”

“I don’t think any of us ever thought we’d use the words ‘heat wave’ and ‘Vancouver’ in the same sentence.”

- Andrea Reimer, former Vancouver city councillor

There’s no doubt that with climate change we’re going to see more heat waves. Even temperate coastal cities such as Vancouver are preparing for extreme heat impacts. “I don’t think any of us ever thought we’d use the words ‘heat wave’ and ‘Vancouver’ in the same sentence,” said former Vancouver city councillor Andrea Reimer, “but now it’s something we not only have to expect, but that we’re experiencing.”



Heat Waves of the **Future**

What is a heat wave?

In general, a heat wave is an extended period of unusually hot weather. There isn't a simple, commonly accepted scientific definition of a heat wave. For this map and report, we define it as a period of at least three days in a row that reach 30 °C or higher. We use this because 30 °C is experienced as a 'hot' day anywhere in Canada, and a string of these hot days will increase the likelihood of heat impacts that matter to Canadians.

What will heat waves be like in the future?

Heat waves are projected to become longer, hotter, and more frequent.

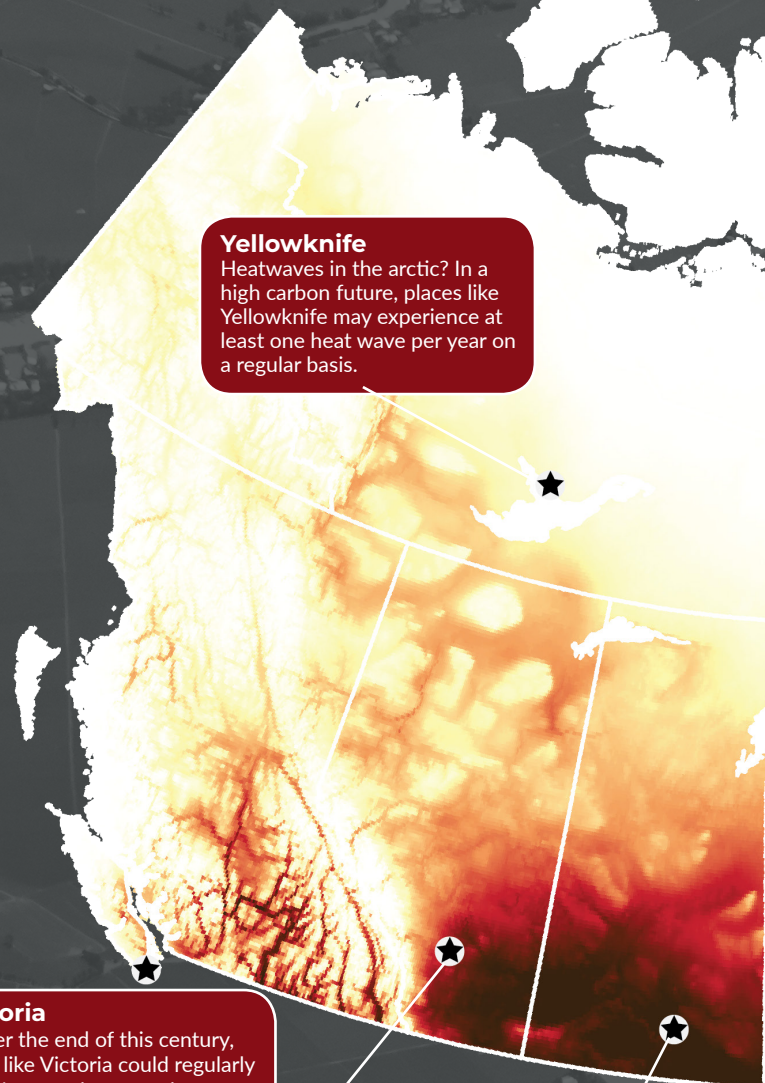
This map shows that heat waves are likely to happen frequently in the coming decades—if the current pace of greenhouse gas emissions is allowed to continue.

The daytime and night-time average temperatures during heat waves are both projected to rise almost everywhere across the country, meaning that heat waves are expected to get hotter as well as more common.

And worryingly, these future heat waves are projected to last much longer than the ones we've experienced in the recent past. Many of these heat waves linger for more than just three days, and some are projected to last for weeks in the hotter parts of the country.

Urban heat islands

The effects of heat waves will be especially severe in our cities and towns, because they tend to be much warmer than the surrounding countryside. This is called the "urban heat island effect." It happens because the closely packed buildings and paved surfaces that make up our cities amplify and trap heat.



Yellowknife

Heatwaves in the arctic? In a high carbon future, places like Yellowknife may experience at least one heat wave per year on a regular basis.

Victoria

Nearer the end of this century, cities like Victoria could regularly experience at least one heat wave per year.

Calgary

Historically, heatwaves are rare in Calgary. By 2051-2080, however, climate models project an average of 4 heatwaves per year.

Regina

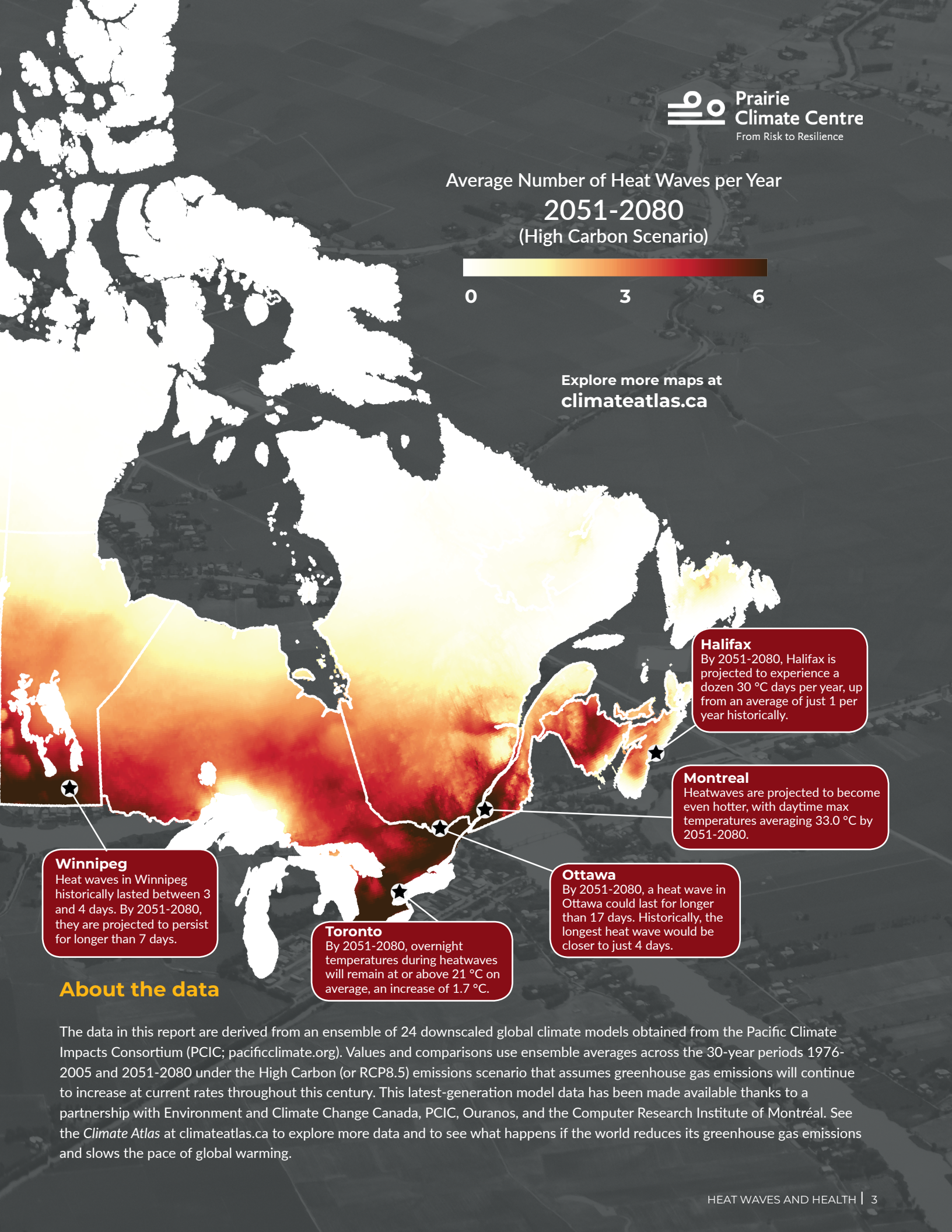
The average number of days per year that reaches or exceeds 34 °C is expected to increase from 3 to over 23 by 2051-2080.

The temperatures reported in the *Climate Atlas of Canada* do not take the urban island effect into account. The frequency, length, and intensity of heat waves in these locations are likely to be somewhat higher than shown on the map.

Average Number of Heat Waves per Year
2051-2080
(High Carbon Scenario)



Explore more maps at
climateatlas.ca



Halifax

By 2051-2080, Halifax is projected to experience a dozen 30 °C days per year, up from an average of just 1 per year historically.

Montreal

Heatwaves are projected to become even hotter, with daytime max temperatures averaging 33.0 °C by 2051-2080.

Ottawa

By 2051-2080, a heat wave in Ottawa could last for longer than 17 days. Historically, the longest heat wave would be closer to just 4 days.

Toronto

By 2051-2080, overnight temperatures during heatwaves will remain at or above 21 °C on average, an increase of 1.7 °C.

Winnipeg

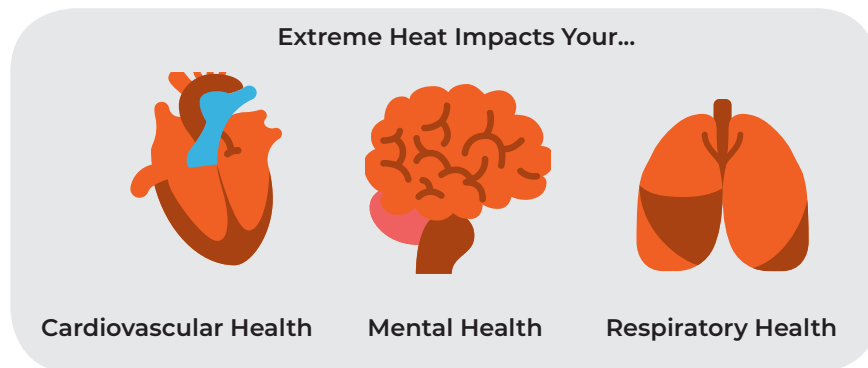
Heat waves in Winnipeg historically lasted between 3 and 4 days. By 2051-2080, they are projected to persist for longer than 7 days.

About the data

The data in this report are derived from an ensemble of 24 downscaled global climate models obtained from the Pacific Climate Impacts Consortium (PCIC; pacificclimate.org). Values and comparisons use ensemble averages across the 30-year periods 1976-2005 and 2051-2080 under the High Carbon (or RCP8.5) emissions scenario that assumes greenhouse gas emissions will continue to increase at current rates throughout this century. This latest-generation model data has been made available thanks to a partnership with Environment and Climate Change Canada, PCIC, Ouranos, and the Computer Research Institute of Montréal. See the *Climate Atlas* at climateatlas.ca to explore more data and to see what happens if the world reduces its greenhouse gas emissions and slows the pace of global warming.

Heat & Your Health

Extreme heat can do a lot of harm to your body if you're unable to cool down. Health practitioners warn against a number of heat-related health problems. Heat impacts can range from cramps and rashes to more severe illnesses that are caused by prolonged exposure, such as fainting, heat exhaustion, and heat stroke. In the most extreme circumstances, being unable to lower your body temperature could result in death.³



Less directly, rising temperatures can impact our health by producing more air pollution. High temperatures “bake” vehicle exhaust, turning it into harmful surface-level ozone and smog. Smog is often concentrated in big cities, but air-quality problems can be just as bad in rural and suburban areas, especially as Canada experiences more wildfires. Air pollution can irritate your eyes, nose, and throat, worsen pre-existing heart and lung problems, or in some cases, cause long-term health issues.⁴

Importantly, heat can affect mental health and community well-being too. Occurrences of mood disorders, anxiety disorders, dementia, and psychological distress have all been shown to increase when the mercury goes up.⁵ Heat can have an impact on interpersonal interactions, with increases in irritability and aggression.^{6,7} Domestic violence and violent crimes have also been shown to spike during heat events.⁸

Who is vulnerable to extreme heat?

Toronto City Councillor Gord Perks notes that when extended heat waves happen, “a large part of the population suddenly becomes vulnerable.” We saw the tragic reality of these risks in the summer of 2018, as serious heat waves struck many Canadian cities. In Montreal, temperatures remained high for eight days straight and 66 people died from the heat. Most of the victims were older men living alone.⁹

All of us experience increased health risks from hot weather, but as the 2018 Montreal heat wave shows, some people are more vulnerable than others. Managing the effects of heat is largely dictated by a person’s ability to access resources.¹⁰ For example, people without adequate housing, air-conditioning, or sufficient supplies of drinking water will have difficulty dealing with the heat.

When extended heat waves happen,
“a large part of the population
suddenly becomes vulnerable.”

- Gord Perks, Toronto city councillor

People who are socially isolated or those with mobility issues may have challenges getting help and moving to cooler locations. Individuals who have difficulty accessing or understanding public health information such as heat warnings may be at greater risk as well. Dr. Jean Zigby, a palliative care physician in Montreal, says that people experiencing social isolation, and especially people with mental health issues, are at higher risk: “they seem to be a disproportionate percentage of the population that are found, unfortunately, dead due to heat exhaustion.”

Other factors such as pre-existing medical conditions and being particularly sensitive to heat (especially seniors and

children) affect vulnerability. Dr. Zigby says that “we see a lot of patients deteriorate after smog episodes and after heat waves,” and notes that when the heat rises it’s a “huge risk” for his patients “every time they take a trip outside.”

It’s also important to remember that anyone who is active outside, by participating in outdoor activities or working outdoors, is at increased risk.

Taking action to prevent health impacts

Communities across Canada are making an effort to manage the reality of increased heat under climate change. Both Montreal and Toronto have extreme heat response and adaptation plans, and are putting in measures to reduce risk.

Dr. Zigby says “we’re seeing an increased sensitivity on the part of our public health officials and our city officials in order to make sure that infrastructure has been adapted for heat waves.” He reports that over the past 15 years, Montreal has implemented “plans to actually contact people who are socially isolated in order to make sure that they get access to cool areas”. He also notes that there has been “a massive investment in parks where there is a component of water included” that allows children and other vulnerable people to cool themselves off.

“We’re seeing an increased sensitivity on the part of our public health officials and our city officials in order to make sure that infrastructure has been adapted for heat waves.”

- Dr. Jean Zigby, physician

Acting on their heat response plan, the City of Montreal took steps to reduce risk during the 2018 heat wave. Firefighters and police officers went door-to-door in vulnerable neighbourhoods to check on residents and offer advice on how to stay safe. The city also increased available paramedics and ambulances, sent out alert bulletins, extended public pool hours, and opened emergency cooling centres.¹¹ The mortality rate during the 2018 heat wave was much reduced compared to another serious heat wave in 2010, very likely thanks to better forecasting and public health interventions.²

In Toronto, some community groups are taking the response to heat waves into their own hands. A group of

faith organizations have banded together to open their doors during extreme heat events, creating a network of community-organized cooling centres and strengthening social resilience to the threat of extreme heat.¹²

Developing a support network within your community can be an effective way to look out for people who may be more vulnerable. Regular check-ins when weather warnings are issued can be an easy way to make sure everyone is safe, informed, and receiving help if needed.

Individuals and communities can rise to the challenges of heat waves with these sorts of actions, but social and political change is needed as well to reduce the risks more generally.

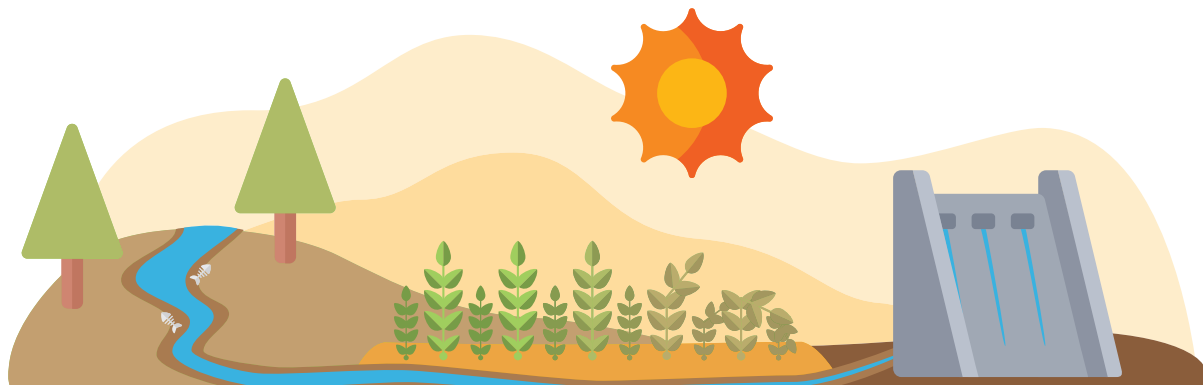
For example, Montreal city planner Chakib Benramdane notes that the built environment of cities makes warming worse, but “where there is lots of greenery, lots of nature, this nature absorbs these effects. Nature is well-made, it balances itself.” He argues that cultivating more extensive vegetation, trees, water, and natural spaces is the best solution to the urban intensification of heat risks.

Developing, improving, or expanding green space within city centres can greatly decrease temperatures on the ground and reduce the impacts of extreme heat events.¹³ And in addition to reducing temperatures, the presence of green spaces such as parks, trees, and natural vegetation has been linked to a number of additional health benefits. These include better mental and physical health, and overall well-being.^{14,15} Studies also show green spaces can provide a boost to social connections and build community.¹⁶



Drought & Your Health

Droughts are periods of long-lasting and widespread water shortages that can have dramatic environmental and socio-economic impacts. Climate projections showing summers with multiple heat waves, or heat waves that last for weeks on end, imply that drought will become much more likely and widespread. Although droughts happen for many different reasons, heat is usually a key component. All else being equal, more heat means more drought.



Lower water levels
and flow

Dry, dusty
conditions

Economic
losses

Interrupted
hydroelectricity

Drought poses many risks to Canada's people and environment. During a drought, farmers' crops wilt, forests become much more prone to fire, hydroelectric production can be interrupted, and water sources can run low.

Perhaps less obvious, however, are the various ways in which drought can negatively impact human health.

For example, as water levels in lakes, rivers, and wetlands decrease and flows stagnate, concentrations of toxins and water-borne diseases increase. Many food-borne illnesses, vector-borne diseases, and fungal diseases also spread more quickly during periods of hot and dry weather.¹⁷ These effects can lead to decreased availability of drinking water, higher risk of food shortages, and increased rates of human illness.

Drought conditions can decrease air quality, which impacts respiratory health. As soil dries up, it can be picked up by the wind as dust. Dusty conditions lead to coughing, wheezing, and irritation of the eyes, nose, and throat.

Drought-like weather also leads to more wildfires. Wildfire smoke particles are much smaller than dust particles, and can become embedded in our lungs, causing severe respiratory and cardiovascular illnesses.¹⁸

The economic impacts of drought can be massive. Canada's last major drought (during the summers of 2001 and 2002) resulted in a \$5.8 billion drop in Canada's Gross Domestic Product.¹⁹ Large economic losses such as this profoundly affect communities, families, employers, and workers, causing many to experience stress and other mental health issues.²⁰

Our health systems and collective resilience to heat waves rely on electricity generation, which can also be impacted by drought. Two-thirds of Canada's electricity is generated by hydro.²¹ When water resources are put under strain, communities that rely on hydroelectricity may face power disruptions. Nuclear power plants also require significant volumes of water to operate safely, and may have to be shut down under drought conditions. The use of fossil fuel power to offset the loss of hydro and nuclear impacts our health by decreasing air quality, and power failures mean that vital air-conditioning systems stop working, often during heat waves when they are needed most.

Taking action on drought

Protecting our health from the impacts of drought and heat waves will require creative thinking. There are also many ways we could reduce our water usage, including upgrading to high-efficiency appliances and xeriscaping (landscaping that requires little to no irrigation).

Currently, much of our urban infrastructure and developed land is designed to remove water during heavy rainfall events and the spring melt. More water could be made available during heat waves and droughts if our urban and rural landscapes retained water, for example by increasing the amount of green space in a city or allowing natural wetlands to thrive on the landscape.²²

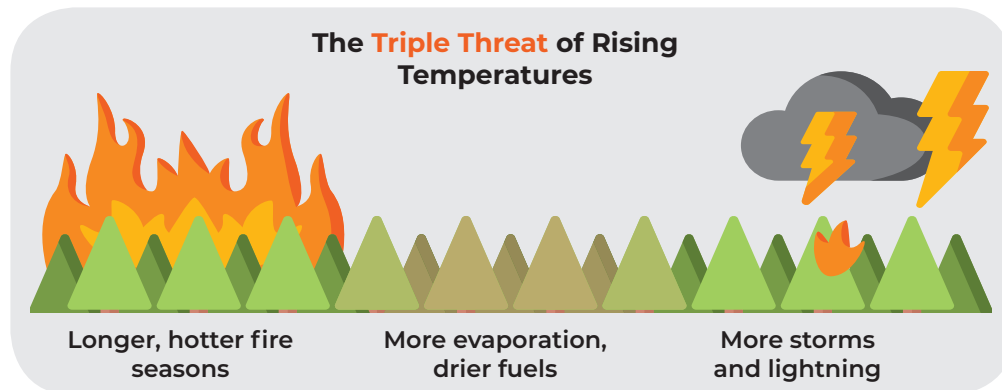
What should you do during a heat wave?

1. **Be aware when extreme heat warnings are issued in your area.** Prepare yourself and those around you for the increased temperatures.
2. **When it is hot out, limit the amount of time you spend outdoors, especially when participating in strenuous activities.** Staying indoors in air-conditioned and well-circulated spaces is the best way to keep cool. If you don't have access to air conditioning or a cool basement at home, public buildings such as libraries or cooling shelters offer spaces that can be used to cool down.
3. **When outdoor activities are unavoidable, try to schedule them for earlier or later in the day when the temperature has cooled off.** While outside, take frequent breaks in order to not overexert yourself.
4. **Drink plenty of water to keep hydrated.** Limit alcohol intake, and swap alcoholic drinks for non-alcoholic alternatives to reduce the risk of dehydration.
5. **Wearing lightweight and lightly coloured clothing along with a hat (and sunscreen to prevent sunburns) can make all the difference by reducing your exposure to the sun's rays and making sure your body can breathe.** Stick to shaded areas away from the direct heat of the sun.
6. **Reducing the risk from heat waves is a team effort.** Look out for neighbours and people in your community who may need help protecting themselves. Checking in and making sure everyone is safe and doing well is an effective way to reduce risk.

Read more at Health Canada: "Extreme Heat: Heat Waves"³

Wildfires & Smoke

When forest fire researcher Mike Flannigan looks ahead at what climate change means for wildfires in Canada, he doesn't beat around the bush: "in a word, the future is smoky." Research shows that climate change will worsen the three major factors that influence wildfires: having longer fire seasons, more dry fuel to burn, and frequent lightning strikes that start fires.²³



Record-breaking wildfire seasons have made headlines across Canada every summer in recent years. In August 2018, British Columbia declared a provincial state of emergency due to forest fires. At its peak, there were over 560 wildfires burning in the province. The smoke from the fires travelled thousands of kilometres, causing air quality warnings to be issued across BC, Alberta, and as far away as southern Manitoba.²⁴

Wildfire risks will intensify as climate change makes summers longer and drier, leading to more health impacts for Canadians. When he considers what's in store for Canada, Flannigan says simply that "There is a lot more fire in the future, and we better get used to it."

"With wildfires, you have the injuries and deaths that can happen immediately. But you also have the stress that happens from evacuations."

- Kim Perrotta, Senior Director, CAPE

More wildfires mean more wildfire smoke, and more smoke means more smoke-related health problems. Kim Perrotta of CAPE says that "with wildfires, you have the injuries and deaths that can happen immediately. But you also have the stress that happens from evacuations."

In addition, Perrotta notes, wildfire smoke exposes Canadians to "extremely high levels of air pollution that we would never see otherwise." And since smoke travels easily, these health problems don't only affect people who live in fire-prone areas.

How does wildfire smoke affect our health?

Think of a smog-filled industrial city like Beijing. The air in these cities is often filled with very tiny particles that are an especially dangerous type of air pollution. The extremely small size of these particles means that they are easily carried by wind across large distances, and can also penetrate deeply into your lungs, causing irritation and inflammation.

When we talk about wildfire smoke as a health issue, we're essentially talking about a type of very intense air pollution. Dense smoke from wildfires can have fifty times the amount of these tiny particles than the World Health Organization's guidelines for safe exposure.

By far, the biggest health impact from wildfire smoke is difficulty breathing. Emergency room visits spike during wildfires. Perrotta says that increased exposure to wildfire smoke "could put people in the hospital, it could aggravate

Who is vulnerable to wildfires?

We all breathe, which means that all of us are vulnerable to the impacts of wildfire smoke. And a majority of us are especially vulnerable, including:

- » People who work, play, or spend significant time outdoors
- » People with asthma, allergies, or certain other health issues
- » People with limited economic means
- » Children
- » Older adults
- » Pregnant women

asthma, it's going to aggravate heart conditions. It could lead to premature deaths, but probably there are long-term health impacts from it too."

Wildfire smoke impacts aren't limited to breathing issues. According to Jeff Eyamie, an Air Quality Officer with Health Canada, "there's now evidence to connect wildfire smoke with low birth weight, stroke, cardiovascular disease, and all kinds of other health impacts."

The good news is that when the smoke goes away, these short-term risks usually go away too. Scientists are also conducting research to determine what long-term impacts are caused by short-term smoke exposure.²⁵ But since the short-term impacts can be serious, it's important to protect yourself and others during a smoke event.

Community health and wildfires

There are well-known links between wildfire smoke and anxiety, depression, and other mental health challenges.²⁶ When much of BC was ablaze in 2018, the Canadian Mental Health Association ramped up its communications efforts to address these risks, and various provincial governments in Canada have developed mental health strategies for responding to wildfires.²⁷

Wildfire smoke is particularly challenging for remote and rural communities. "If you are in an isolated community, like a northern First Nation community that's only accessible by air, it can be very isolating to be in a prolonged smoke event, where you can't really move. You can't do your traditional activities outdoors," says Eyamie. Smoke events make everyday life harder in places where services are already limited, and if evacuation is needed the process can be extremely difficult and stressful for people and communities.

Wildfire evacuations have real, and often devastating, psychological and social health impacts from the disruptions they cause to normal life. From the 2016 Fort McMurray fires, there is evidence showing higher levels of stress, anxiety, depression, PTSD, and substance abuse following the disaster.²⁸ This is why it's vital that emergency responses include mental health and social supports during and after a fire.²⁹ For Indigenous communities in particular, service delivery needs to be flexible and culturally relevant.³⁰

Reducing wildfires

In the big picture, the real challenge is how to reduce forest fire smoke in the first place. That means reducing wildfires, especially through better forest management. Eyamie explains, "we have to manage our forests intelligently, with fire as part of forest management. We have to welcome fire as a creative force within the ecosystem."

At the same time, it's vital that we reduce the number of human-caused wildfires—by respecting fire bans, for example. Almost half of wildfires are caused by humans, which means there's a lot we can do to stop them.

But regardless of how well we manage wildfires, there's no denying we'll be seeing more of them in the years to come. That's why it's more important than ever to cut our fossil fuel emissions. The more effort we put into reducing climate change, the less our communities will be impacted in the long run.

How to stay safe during wildfire season³¹

1. Be aware: information and tools are available to track wildfire smoke and air quality in your region (FireWork, Air Quality Health Index).
2. Drink plenty of water: keep hydrated to help your body deal with the smoke.
3. Reduce exposure to the smoke: reduce time spent outdoors and limit strenuous activity. Keep house and car windows closed and recirculate the air inside.
4. Breathe filtered air: use HEPA filtration in your home, or seek out public buildings like shopping malls, community centres or libraries that may have cooler, smoke-free environments.
5. Seek medical assistance: when feeling discomfort or exhibiting symptoms, consult your physician or local health authority.
6. Monitor and help others who may be vulnerable, such as children or the elderly.

Take Action

One of the best strategies to reduce the risks posed by very high temperatures is to prevent global warming from getting worse. The more we allow our climate to change, the more extreme heat we will all face.

There are two aspects of climate action: mitigation (making sure climate change doesn't get worse) and adaptation (getting ready to handle the impacts of ongoing climate change). We have to both reduce the severity of climate change and take steps to live with the change that's already happening.

Mitigating and adapting to climate change require a combination of:

Technical know-how

To find solutions that allow us to effectively transition to low-carbon sources of energy, to provide data and analysis to understand global warming and its consequences, to create innovative adaptation tools and methods.

Political will

To create market incentives such as carbon pricing that reduce our collective reliance on high-carbon fuels, and to create climate-smart laws and regulations in the face of resistance and denial.

Personal responsibility

To recognize the importance and urgency of the global warming threat, to make changes in our own lives, and to empower community, government, and business leaders to take a key role in our communal effort, so we can creatively rise to the collective economic, social, and health challenges.

Fortunately, many of the things we can do to reduce and adapt to climate change are also good for our health and well-being. They also make great economic sense. Kim Perrotta of CAPE says "Many climate solutions actually provide immediate health co-benefits for the jurisdiction that takes action. By investing in public transit and active modes of transportation, we can increase levels of physical activity and decrease air pollution, which will in turn reduce chronic diseases and acute health impacts; health issues that produce billions of dollars in health-related costs for Canadians every year."

If we rethink how we build and live in our cities, develop active and public transportation, and shift towards the use of renewables for our energy needs, we can make lasting improvements to the health and prosperity of our communities at the same time as we do our part to take care of Earth's climate.



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"Many climate solutions actually provide immediate health co-benefits for the jurisdiction that takes action. By investing in public transit and active modes of transportation, we can increase levels of physical activity and decrease air pollution, which will in turn reduce chronic diseases and acute health impacts; health issues that produce billions of dollars in health-related costs for Canadians every year."

- Kim Perrotta
Senior Director, Health and Policy
Canadian Association of Physicians for the Environment



The Prairie Climate Centre is committed to making climate change meaningful and relevant to Canadians of all walks of life. We bring an evidence-based perspective to communicating the science, impacts, and risks of climate change through maps, documentary video, research reports, and plain-language training, writing, and outreach.

The Climate Atlas Of Canada

The Climate Atlas of Canada is an interactive tool for citizens, researchers, businesses, and community and political leaders to learn about climate change in Canada. It combines climate science, mapping and storytelling to bring the global issue of climate change closer to home, and is designed to inspire local, regional, and national action and solutions.

The Atlas is one of the only tools in the world that integrates interactive web design with climatology, cinema, and cartography to geovisualize and connect scientific data with personal experience in compelling and easy-to-use ways.

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