



THE  
FUTURE  
IS DUE  
NORTH

# FIRE AND ICE

Arctic Responses to Climate Change  
and Lessons for the Rest of Canada

JULY 2019

BY EDWARD STRUZIK





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Ottawa, ON, Canada, K1P 5G4  
613.238.7858

ISBN: 978-1-988886-64-0

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## INTRODUCTION

On June 17, 2014 a wildfire ignited along the northeast shore of Great Slave Lake in the Northwest Territories. Initially, no one saw this as a serious cause for concern. Wildfires are a fact of life in the boreal forest, which covers [270 million hectares](#) of land across Canada.

Wildfire is not necessarily a bad thing. Fire is a natural process that makes forests more resilient to drought, disease and to more intense fires that will inevitably ignite in the future. And it's often good for wildlife.

Intense fires, which are occurring more frequently than in the past, however, have the potential to threaten water supplies, forest and tundra structure, and infrastructure, as well as human health and safety. They can also accelerate permafrost thawing, sea ice melting and glacier retreat.

In the 20 years prior to summer of 2014, the Northwest Territories experienced, [on average, 245 fires annually](#). Typically, those fires [burned 570,000 hectares](#). The cost of suppressing those fires was about [\\$7.5 million annually](#).

The 2014 fire season, however, turned out to be more challenging than any other in recent Northwest Territories history thanks to drought, severe lightning storms and unusually hot weather—the kind of extreme weather events that are accelerating across Canada due to climate change. Mean annual temperatures in the Northwest Territories have risen by [two to three degrees Celsius](#) since the 1940s. That's more than twice the average global increase.

By the time cool, wet weather arrived in August, more than [385 fires](#) had burned a record [3.4 million hectares](#) of forest. The cost of suppressing those fires was more than [seven times higher than the average](#). Firefighting resources were so strained that [650 personnel from across Canada](#) had to be called in to help.

No one died and only a small number of buildings were destroyed or damaged. But, like the Horse River fire that burned in and around Fort McMurray in 2016 and the record fire seasons in British Columbia in 2017 and 2018, the 2014 Northwest Territories fire season was less an anomaly than it was a reflection of extreme weather events—wildfire, floods, drought, windstorms—that the entire country is facing with increasing regularity.

## OVERVIEW: IMPACTS ON THE ARCTIC AND SOUTHERN CANADA

Climate change is affecting Canada in many different ways. On average the area burned across Canada has more than [doubled](#) since the 1970s. Sea levels are rising, [imperiling many low-lying coastal communities](#) such as Vancouver and Burnaby. All three oceans are becoming [warmer and more acidic](#). There has been a [shift toward less snow falling and more rain falling](#). Drought and floods are occurring [more often](#). Environment Canada summed it up succinctly, stating: [“Weather changes in Canada are happening abruptly not subtly, rapidly not gradually.”](#)

The corresponding [decline of glaciers and mountain snowpack](#) are stressing water supplies in western Canada. The warming of oceans, rivers and lakes is threatening cold water fish species such as salmon, trout and Arctic grayling. Warming air temperatures are favouring insects and disease that [are killing tens of millions of trees](#). Droughts, which are expected to become more frequent and longer lasting, are adding to the stress on Canadian forests. One of several [exceptional droughts](#) since the turn of the century killed more than [a third of the aspen trees](#) in the southern half of the boreal forest in western Canada.

Canadians living in the south should look to the North if they want to see what the future holds. These climate change impacts are most pronounced in the Arctic and sub-Arctic regions of Canada because the climate is warming twice as fast.

Volumes of sea ice, glaciers, snow cover and permafrost, for example, are diminishing at a rapid rate. Shallow tundra lakes, which dominate the northern landscape, are [drying up](#).

A warmer and shorter ice season is resulting in [less time](#) for polar bears to hunt seals in the southern regions of their range and [more time](#) for mosquitoes and flies to take their toll on caribou, whose populations are at an [historic low](#). As sea levels continue to rise, powerful storm surges are resulting in [massive seawater intrusions](#) that are imperiling freshwater lakes, wetlands and deltas that support tens of millions of nesting birds. Sooner than later, low-lying coastal Inuit communities such as Tuktoyaktuk that are sitting on rapidly thawing permafrost that are vulnerable to sea level rise, will have to be shored up at great expense or relocated, just as the [Alaskan community of Shismaref](#) is about to be. Critical roadways like the Mackenzie and Alaska highways, which also sit on rapidly thawing permafrost, are [becoming less stable](#). Some highways, such as the Dempster, are particularly vulnerable to massive slumps that can cover [40 hectares with headwalls that are 25 metres high](#). These mega-slumps are on the rise.



Figure 1 - Examination of thaw slumps on Banks Island. Credit: NTGS

We are already seeing the rippling effects of some of these changes throughout the Arctic ecosystem. Mega-slumping in permafrost areas is affecting water quality and [dramatically altering the aquatic food chain](#).

Capelin, not Arctic cod, is now the dominant prey fish in Hudson Bay. Killer whales, which were once largely absent from the Arctic, are beginning to [prey on narwhal and beluga](#), important food sources for the Inuit. [Trees and shrubs](#) are overtaking tundra vegetation that serve as food for many Arctic animals. Sub-Arctic forests are burning bigger, hotter and more often.

There is no longer a guarantee that the Arctic Ocean in Canada will completely freeze every winter, as it has traditionally done in all but a few places. Thick ice, which occurs in areas where ice doesn't completely melt from one summer to the next, is diminishing. The extent of sea ice cover is also fading rapidly. The 12 lowest extents of sea ice cover have occurred in the last 12 years.

The warming of the ocean is resulting in toxic algal blooms in places where they have never occurred before. It is also threatening marine mammals such as beluga, narwhal and seals that prey on ice-edge animals such as krill and Arctic cod. And it is making it increasingly dangerous for the Inuit to use sea ice as a transportation and hunting platform.

Without sea ice to act as a buffer, powerful storm surges are swamping low level shorelines. Heat from this relatively warm ocean water is thawing permafrost, which keeps the ground glued together.

Increasingly, infrastructure, food security and human health and safety are in peril.

## INFRASTRUCTURE

The infrastructure increasingly being threatened by climate change includes the roads, buildings, power lines and water treatment plants required for the operation of both businesses and societies.

The 2014 fires in the Northwest Territories, for example, [damaged and forced the closure](#) of highways. They [destroyed fibre optics cables](#) and temporarily [disrupted](#) the city of Yellowknife's main power supply.

The increasing number of forest fires in Canada are also threatening both the quality and quantity of water supplies that are already being degraded by warmer weather and the drought that often comes with it. As just one example, in 2014 the shipping season on the Mackenzie River was [shut down](#) about a month early because of low water levels.

The effect of major wildfires on drinking water supplies can be severe, as evidenced by fires that burned upstream of places such as Fort McMurray, Alberta in 2016; Denver and Fort Collins, Colorado in 2002 and 2012; and Canberra, Australia in 2003. Water treatment plants in those places were [overwhelmed](#) by sedimentation, dissolved organic carbon, and by chemicals that were released by fire.

### How does this happen?

Intense fires often remove trees and vegetation that would otherwise absorb rain and melting snow along a watershed. Burned trees and vegetation can also leave a waxy layer on the ground that prevents water from being absorbed into the soil. When winter snow melts or spring and summer rains fall, floods sometimes follow, carrying tonnes of ash, debris, heavy metals and nutrients from the burned forest floor directly into rivers and lakes.

## TAKING A TOLL

Highways, fibre optic networks and shipping corridors [shut down or were damaged](#) during NWT wildfires in 2014

[10 million people](#) breathed noxious smoke from B.C. wildfires in 2018

An estimated [121 million litres of mercury](#) is trapped in the Arctic's permafrost

Nearly [13,000 people](#) had to be evacuated from First Nations communities in response to [49](#) wildfire emergencies in 2017.



When mixed with chlorine used to treat water, organic carbon [can produce carcinogens](#) that most treatment plant technicians don't have the expertise to manage. Fort McMurray, for example, is now spending more than twice as much on water treatment chemicals as it did before the fire burned along the Athabasca River. Other municipalities that purify water supplies with chlorine [could face a similar threat](#) in the wake of severe forest fires.

## FOOD SECURITY

Climate change threatens food security for people in the North and for many First Nation and rural people living in the boreal forested regions across the country. This is happening in several ways.

Wildfire and warming temperatures are [harmful to](#) the lichen, sedges and grasses that Arctic animals such as caribou favour in winter.

Permafrost thawing and wildfire can also liberate harmful chemicals such as mercury, which is emitted by coal-fired plants and other industrial sources from around the world. Much of the 2,000 tonnes of mercury that is emitted into the atmosphere each year [ends up in](#) the boreal forest and Arctic regions of Canada. Once there, the mercury is absorbed by vegetation. When the plants die, the mercury is [deposited](#) into the frozen soil. Scientists estimate that there are [121 million litres](#) of mercury trapped in the Arctic's permafrost. This is [twice as much](#) mercury as is contained in the rest of the world's soils, atmosphere and oceans.

Once liberated from this frozen state by either wildfire or permafrost thawing, the mercury gets washed into rivers and streams that drain into the Arctic Ocean. In the ocean, the mercury can be [converted](#) into organic methylmercury, which is highly toxic and poised to enter the food chain. Runoff from tundra soil to the Arctic Ocean accounts for [half to two-thirds](#) of total Arctic Ocean mercury deposits.

Levels of mercury over the last 40 years have increased in [31%](#) of Canadian wildlife populations studied. Of all the populations that report increases, [83%](#) are from the Arctic. The greatest increases have been seen in seabirds.

This is obviously not just a northern problem. In 2006, Canadian scientist David Schindler and his colleagues linked a [five-fold increase](#) in mercury in fish that dwelled in Moab Lake in Jasper National Park to a fire that burned three-quarters of the trees along the shoreline. Since then, the link has been affirmed by other scientists.

Pathogens—both old and new—that thrive in warmer conditions also threaten food security. Anthrax continues to kill bison in Wood Buffalo National Park. The bacterium *Erysipelothrix rhusiopathiae* killed an estimated [24,000 muskoxen](#) on Banks Island between 2010 and 2014. An unprecedented [13 outbreaks](#) of avian cholera killed thousands of eider ducks in 1,300 colonies that nest on islands at the north end of

Hudson Bay. And there is mounting evidence of [phocine-distemper-like viruses](#) in the western Arctic where beluga whales have no immunity to the disease.

Many pathways exist for disease and pathogens to enter the Arctic. Climate and ecosystem changes are causing some bacteria, such as those that are linked to avian cholera, to mutate into more harmful forms. There is evidence to suggest that [anthrax](#) is being liberated from rapidly thawing permafrost. Invasive species such as harbour seals and white-tailed deer may be carrying diseases that Arctic animals have no immunity to.

## HUMAN SAFETY

Human health and safety are increasingly in peril as a result of rapidly warming temperatures and increasingly unpredictable weather. The thinning of sea and lake ice has made fishing and wildlife harvesting [more dangerous](#). Unpredictable weather has resulted in [a rise in](#) hypothermia among youth and heat-related stresses among the elderly. Warming temperatures are [increasing the risk](#) of water- and food-borne parasites in humans.

The increasing number of intense wildfires is adding a new dimension to the risks. There is evidence to suggest that the dark-coloured soot emitted by wildfire is falling on sea ice, snow and glaciers and hastening their meltdown.

The increase in size and frequency of wildfire are also threatening human health and safety.

In 2014, for example, [12 communities](#) in the Northwest Territories were at risk of being in harm's way from the fires that burned. Unlike most of southern Canada, the North is very thinly populated. This accounted for the fact that very few people were forced to evacuate. Those who stayed, however, were advised to remain indoors and refrain from vigorous outdoor exercise. Even then, the city of Yellowknife's hospital saw a [50%](#) spike in people seeking medical aid for respiratory problems.

Exceptional as this was for the Northwest Territories, it is becoming the norm across Canada. And this is not a northern challenge, but a national one. There are only two regions in Canada—southern Ontario and Prince Edward Island—that are not vulnerable to major wildfire events. The west is [more vulnerable](#) than the east. But provinces such as [Quebec, in 2010](#) and [Ontario, in 2018](#), have had years in which fire management resources have been strained. And New Brunswick experienced one of the [biggest wildfires in North American history](#).

Urban centres are not immune to the health effects associated with wildfires burning in remote northern areas. In 2002, smoke from wildfires in northern Quebec caused a [50% increase](#) in hospitalizations of elderly people in New England. In 2014, smoke from the Northwest Territories triggered [serious air](#)

[pollution problems](#) throughout Manitoba. In 2018 an estimated [10 million people](#), from Vancouver Island to the shores of Lake Superior, were breathing in noxious smoke from B.C.'s wildfires.

First Nations communities, [80% of which are located in forested regions](#), continue to be the most vulnerable. According to Public Safety Canada's [estimates](#), there are "around 200 Indigenous communities that are really exposed and have a high risk of wildfires." These communities have a [33% greater chance](#) of being evacuated than non-reserve communities.

In 2017 alone, First Nations communities faced 49 wildfire emergencies. Nearly [13,000 people](#) had to be evacuated. Exacerbating the challenges these communities face is the [apparent disconnect](#) between fire officials in the provinces and the territories who are responsible for fighting fire, the federal government, which is responsible for the well-being of First Nations communities, and band councils that are responsible for evacuation orders.

Unacceptable as this is, alternatives are limited. Many communities across Canada have little access to [Fire Smart programs](#), to firefighting equipment and to other tools and strategies that would make them more resilient to the impacts and dangers of fire. In most cases, there is only one road in and one road out. Fort McMurray was fortunate in 2016 because the twinning of the highway south was completed just a week before the evacuation. That allowed vehicles to flee using all four lanes instead of just two.

## MOVING FORWARD

The Arctic and boreal forest regions of northern Canada are warming faster than scientists predicted 10 years ago. Some regions will be [3 to 5 C warmer](#) by 2050 and [5 to 9 C warmer](#) by 2080, relative to 1986–2005 levels. By 2050, the Arctic will be seasonally ice-free in the summer. Rising sea levels will result in more frequent coastal flooding, erosion, seawater contamination, and damage to infrastructure.

The drying of shallow tundra lakes that dominate the northern landscape will be [widespread](#). Fire will burn bigger and more often.

There is a need now to mitigate and adapt to the changes that are coming and Canada is unique in its ability to deal with the challenges. These measures apply as much to the rest of Canada as they do to the North and need to be debated by both northerners and southerners alike.

Changes may include:

- Forward-thinking conservation strategies that will ensure a future for the wildlife many communities rely on for food.

- An [Arctic Wildlife Health Observing Network](#), which would establish partnerships with Inuit, Métis and First Nations people, to coordinate existing wildlife health monitoring programs and develop new ones, and provide mechanisms for storing and accessing specimens.
- A more comprehensive assessment of groundwater, rivers and lakes that may be degraded by climate warming.
- Investing more in traditional firefighting resources. Some of it should go to small forested communities that rely almost entirely on outside help.
- New and improved tools for firefighters such as unmanned aircraft, better fire-risk maps, real-time warning systems, smoke projections for active wildfires and computer models that predict where the next fire might strike.
- The federal government should restore funding of the Canadian Forest Service (CFS) to at least 1990s levels, when it employed 2,200 people. CFS employs about 700 people now, and only about a dozen of those are wildfire scientists. That's not nearly enough to deal with the new wildfire paradigm that has no analog in recent history. Federal, provincial and territorial governments also need to invest more in climate science in ways that allow knowledge to be readily turned into action and meaningful adaptation.
- More communities need to sign up for the very sensible Fire Smart Program, which promotes a variety of prevention measures such as forest thinning and the use of fire-resistant building materials to reduce the impact of fire.
- Vulnerable towns should follow Nelson, B.C. and Whitehorse, Yukon in developing evacuation plans and encouraging people to keep enough food and water on hand to sustain them for 72 hours. Such measures could also be used to prepare for other extreme weather events such as flooding.

There is no denying that the North is warming faster than any other place in Canada. But climate change, and the extreme weather events that come with warmer weather, is happening across Canada. The lessons learned in the North can help all of Canada adapt to a rapidly warming world.

