The scientific and social dimensions of the Canadian wildfires

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On July 1, 2023, the Canadian Interagency Forest Fire Centre (CIFFC) situation report noted there were 51 new fires and 552 active fires burning across approximately 34,000 square miles of the country, exceeding the record set in 1995 when more than 27,400 square miles were razed. Continuing the current pace, the season would end with 123,550 square miles burned out, an area 20 percent larger than California.

For the year to date, a total of 3,154 fires have been tallied. More than half of the current fires (281) are raging out of control across the country while the rest are either being held at bay or brought under control. An international cadre of wildfire fighters—from Australia, New Zealand, South Africa, the United States, France, Spain, Portugal, Chile, and Costa Rica—as well as fire experts, have been assembled to provide Canadian authorities assistance with the efforts to bring these fires to an end.

The Canadian wildfires began much earlier this year than the usual historic trends in which the fire season begins in July. The present fires started in March and have only gained in intensity throughout June. By official accounts, the 2023 wildfire season has been the worst in North American history and shows no signs of abating. A combined 11 of 13 Canadian provinces and territories have been impacted, with the largest blazes in Alberta, Nova Scotia, Ontario and Quebec.

The primary wildfires that started in central and western Canada in May were triggered by lightning. But once ablaze, they tore across the country at full tilt due to arid conditions created by an early heatwave which had approached record highs and that still continues.

Many of the fires are burning near the Arctic Circle in the Canadian boreal peatland forests—stretching from Labrador in the far northeast, to northeastern British Columbia and the Yukon Territory—which is a biome characterized by coniferous forests. These are one the world's largest biogeographical units, having formed some 12,000 years ago following the last glacial period.

Peatlands—a buffer against climate change

Peatlands act like natural sinks for carbon dioxide, promoting a cooling effect on the global climate. The lands are dominated by small "ancient land plants" known as bryophytes or "peat moss" that are difficult to decompose and produce substances that slow the microbial activities involved in generating methane and carbon dioxide gases. These regions are some of the most critical ecosystems that help limit the impact of greenhouse gases on climate.

The boreal forests are tens of thousands of years old and covered by deep layers of decayed plants and organic materials. It has been estimated that the global peatland may contain more than 550 gigatonnes (550 billion tons) of carbon. If all this carbon were to be released, the current CO2 levels in the atmosphere would double to over 800 parts per million.

Decades of industrial exploitation—logging, oil, and gas drilling—of these regions has already laid waste to 15 percent of global peatlands, which have been drained and repurposed for economic pursuits leading to 1.3 gigatonnes of carbon dioxide emissions entering the atmosphere, contributing to the global warming trends that are reaching critical levels. These have only made wildfire seasons longer and more intense, threatening these regions and their ability to store greenhouse gases.

A report published in 2019 by scientists Ellen Whitman and colleagues showed that short-interval wildfires and drought are overwhelming the boreal forest resilience and altering the ecosystems of the North American forests. Whitman told *CBC News*, "When you've had a severe disturbance or a repeated burning on top of burning or a real severe drought in the year after a fire, we might kind of start to see these patches changing to be more southern-like in their ecosystem structure. Almost like a savannah in some cases."

The United Nations Environment Programme (UNEP) published a report on February 23, 2022, which stated, "Climate change and land-use change are projected to make wildfires more frequent and intense, with a global increase of extreme fires of up to 14 percent by 2030, 30 percent by the end of 2050 and 50 percent by the end of the century."

The UNEP even warned that the Arctic regions, where warming is occurring nearly four times faster than the rest of the world in the last four decades, are no longer immune to wildfires. Annual mean temperatures across the Canadian forests were 1.6 degrees Celsius above norms in 2017.

Smoke plumes spread across the United States

The toxic smoke from the current wildfires has poured across the border into the midwestern and northeastern states in the US, leaving more than a third of the country's population under air quality alerts. The plumes containing soot, brown carbon and other pollutants have risen kilometers into the stratosphere and traversed the Atlantic Ocean, reaching the British Isles and even southwestern Europe.

The Copernicus Atmosphere Monitoring Service (CAMS) reported that the fire radiative power for Canada in the first three weeks of June was significantly higher than ever seen in the last two decades. Carbon emissions for the month have been estimated at over 100 billion kilograms. A persistent smell of ash and even plastic is everywhere. Horizons and city skylines are, at times, barely discernible through the thick orange-gray haze. In many of these regions, the air quality index has far exceeded the WHO thresholds for a hospitable climate.

UNEP Executive Director Inger Andersen warned, "Current government responses to wildfires are often putting money in the wrong place. Those emergency service workers and firefighters on the frontlines who are

risking their lives to fight forest wildfires need to be supported. We have to minimize the risk of extreme wildfires by being better prepared: invest more in fire risk reduction, work with local communities, and strengthen global commitment to fight climate change."

The UNEP report continued: "Wildfires disproportionately affect the world's poorest nations. With an impact that extends for days, weeks and even years after the flames subside, they impede progress towards the UN Sustainable Developmental Goals and deepen social inequalities." The destruction of these forests not only leaves behind highly contaminated regions that are uninhabitable, but also triggers a vicious cycle, or positive feedback loop, exacerbating the factors that have created these devastating conditions in the first place.

The trend in global wildfires over the last two decades has worsened considerably. Fire seasons are beginning sooner and lasting longer than ever before. They are burning twice as much tree cover, amounting to three million more hectares of tree cover loss per year compared to 2001, according to a University of Maryland study published in 2021. That year approximately 9.3 million hectares of tree cover were lost globally.

The effects of air pollution, especially small particles

The health impact of air on billions of people who lack access to technologies that could protect them can not be overstated. Wildfires release enormous quantities of carbon dioxide, black and brown carbon, ozone precursors, and volatile and semi-volatile organic materials and nitrogen oxides that form ozone. Even more dangerous is the organic particulate matter known as PM2.5, fine particles that are equal to or less than 2.5 microns, smaller than the size of SARS-CoV-2 aerosols, which can bypass all the respiratory mechanisms that would prevent their entry deep into the lungs and circulatory system. The primary mechanism of injury is thought to be from the free radicals, metal and organic compounds in these fine particulates, that lead to formation of hydroxyl radicals which cause damage to the lung cells' DNA, contributing to various pathologies including lung cancers.

Economist Arden Pope, a researcher at Brigham Young University on health effects of air pollution, told *Chemical and Engineering News*, that regardless of the source of the air pollution, "what we can say for sure is that breathing combustion-related particles leads to respiratory and cardiovascular diseases, adverse birth outcomes, and diabetes." And the smaller the particulates, the more harmful they are. "Particles that are larger than 2.5 μm [microns] in diameter don't seem to have as big a health impact because they're larger and so they don't penetrate as far into the lungs." Wildfire smoke is predominately composed of these smaller particles, PM2.5.

According to the World Health Organization (WHO), outdoor air pollution in urban and rural areas led to the premature death of 4.2 million people in 2019 and is one of the leading causes of deaths annually. In the US, that premature death figure has been estimated at around 200,000 per year. The WHO wrote, "Some 37 percent of outdoor air pollution-related premature deaths were due to ischemic heart disease and stroke, 18 and 23 percent of deaths were due to chronic obstructive pulmonary disease and acute lower respiratory infections respectively, and 11 percent of deaths were due to cancer within the respiratory tract." Those living in low- and middle-income nations faced the lion's share of these deaths, accounting for 89 percent.

The long-term health risks of wildfire smoke were exemplified by the 1997 Indonesian forest fires. Ten years after, people exposed to the smoke suffered worse lung capacity, general health and physical capacity than those not exposed. The elderly with chronic health disease, pregnant women and young children with less mature respiratory and immune systems are particularly affected. Also, workers who must labor outdoors fall into the high-risk category.

Astonishingly, more than 90 percent of the global population live in areas where ambient PM2.5 concentrations rise above the 10 micrograms/m3 threshold set by the WHO in 2005. The worst affected regions were Southeast Asia and the Eastern Mediterranean.

Currently, the level of these fine particulates being emitted by the wildfires in and around Ottawa, Ontario, is equivalent to smoking more than a half a pack of cigarettes a day. In Ottawa, for the last week in June, weekly average exposure to PM2.5 had reached 80 micrograms/m3 with a one-hour spike to an average of 240 micrograms/m3 on June 25, 2023. This compares to the WHO guidelines, recently lowered to 5 micrograms/m3.

According to the WHO Global Air Quality Guidelines:

> To date, strong evidence shows causal relationships between PM2.5 air pollution exposure and all-cause mortality, as well as acute lower respiratory infections, chronic obstructive pulmonary disease, ischemic heart disease, lung cancer and stroke. A growing body of evidence also suggests causal relationships for type II diabetes and impacts on neonatal mortality from low birth weight and short gestation. Air pollution exposure may increase the incidence of and mortality from a larger number of diseases than those currently considered, such as Alzheimer's and other neurological diseases. The burden of disease attributable to air pollution is now estimated to be competing with other major global health risks such as unhealthy diet and tobacco smoking, and was in the top five out of 87 risk factors in the global assessment.

In a report published in *Lancet: Planetary Health* in 2021, the authors found that for every increase in 10 micrograms/m3 in a three-day moving average of wildfire-related PM2.5 there was a relative 1.7 to 1.9 percent increase in all-cause mortality, cardiovascular deaths and respiratory deaths. In concrete terms, 0.62 percent of all-cause deaths annually are attributable to these fine particulates associated with wildfires.

The authors explained, "Wildfire-related PM2.5 undergoes long-range transport and continues to contribute to poor air quality even after fire seasons. Therefore, evaluating health effects of wildfires should not be restricted to areas and time periods where and when wildfires occur."

Worse, these particles released from the burning of the vegetation in forest fires become more toxic over time, according to atmospheric chemist Professor Athanasios Nenes of the Institute of Chemical Engineering Sciences in Patras, Greece. He is the principal investigator of the PyroTRACH project, which aims to study the impact of emissions from wildfires and biomass burning on the Earth's atmosphere and, by extension, on human health and climate.

The project found in 2017 that smoke lingering in the atmosphere for several weeks undergoes a chemical reaction known as oxidation as it spreads, being converted into highly reactive compounds known as free radicals that are highly injurious to cells and tissue. Nenes noted, "We know that breathing in smoke when you are close to a fire is not good, but we have seen that over time it gets worse—up to four times more toxic a day down the road. This means that even if you are far away from a fire, if the smoke is being blown towards you, it can have significant impact on health. People might not even be aware they are breathing in the fumes from a faraway forest fire, but it will be affecting their health."

In the callous terms of capitalist immediate short-term reasoning, the World Bank estimated in 2013 that exposure to these fine particulates cost

$143 billion in lost labor income and $3.55 trillion in welfare costs. The economic consequences have been estimated to cost 1 percent of global GDP annually as a result of sick days and medical bills incurred, and declining agricultural outputs it causes.

As this scientific review demonstrates, the issues of wildfires, climate change and air pollution are among the most serious for humanity. The COVID-19 pandemic has already brought to the fore the international character of any serious response to a global threat to public health. Whether it be a pathogen that jumps into the human population through a zoonotic transfer from animals, or fires that rage hotter and longer, producing toxic chemicals affecting everyone, bringing such catastrophes to an end and preventing future eruptions requires the collaboration of every scientific and public health discipline across national borders.

The quality of the air we breathe takes on a definitive social character, for which the current regime of capitalist production cannot offer a viable solution. Capitalism elevates profit and the interests of rival nation-states above any concern for processes that could have historically transformative implications for life on this planet. In this regard, the demand for clean air has revolutionary implications.