

# **Non-occupational exposure to wildfire smoke and health**

Dave Stieb, Environmental Science and Research Bureau, Health Canada

# Wildfire activity this spring 'unprecedented,' federal officials say

BILL CURRY and MIKE HAGER  
Ottawa  
The Globe and Mail  
Published June 5, 2023  
Updated June 6, 2023



Department of Natural Resources and Renewables fire-fighter Kalen MacMullin of Sydney, N.S. works on a fire in Shelburne County, N.S. on Thursday, June 1. HO/The Canadian Press

# CANADA POLITICO 'Literally off the charts': Canada's fire season sets records — and is far from over

Officials say the risk will remain high through summer thanks to drought and above-normal temperatures.



Natural Resources Canada said it expects drought and above-normal temperatures to contribute to higher-than-

# The New York Times

## Canada Offers Lesson in the Economic Toll of Climate Change

Wildfires are hurting many industries and could strain households across Canada, one of many countries reckoning with the impact of extreme weather.

AP  
Gilgo Beach killings update Lisa Marie Presley's  
WORLD NEWS  
**Wildfires in Canada have broken records for area burned, evacuations and cost, official says**

Le Monde  
Subscribe

## ENVIRONMENT • CANADA Canada wildfires burn a record-breaking 10 million hectares

This unprecedented figure for 2023 will continue to rise in the coming weeks, government data showed.

## Unprecedented wildfire season "most definitely" linked to climate change: expert

JUNE 11, 2023

Canada is seeing an "unprecedented" wildfire season so far and summer hasn't even begun...  
Read more

Quebec / News / National

## Wildfire season is 10 times worse than normal, will burn for months: officials

"Fire activity could remain above normal through July and August across much of the country."

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Canada

## Exhausted crews battle Canadian wildfires as experts issue climate warning

CNN Live TV

## Canada's wildfire season is off to an 'unprecedented' start. Here's what it could mean for the US

By Rachel Ramirez, CNN  
Published 3:16 AM EDT, Sat June 10, 2023



Source: Montreal Gazette



Source: NPR



Source: NPR



Source: CNN



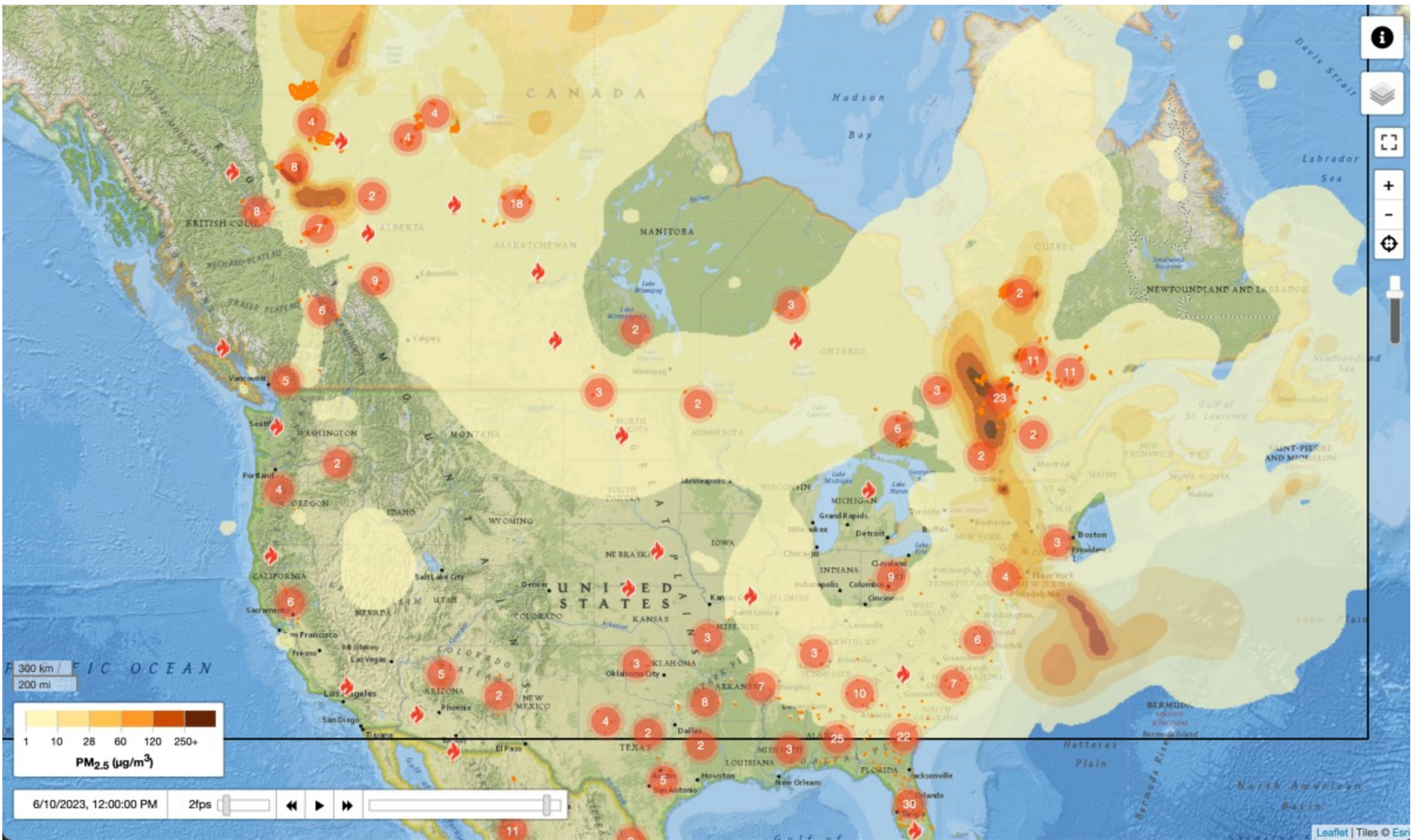
Source: NPR



Source: Pittsburgh Post Gazette











**5**

NATIONAL PREPAREDNESS LEVEL

**July 18 2023**

NATIONAL FIRE SITUATION REPORT

**565 Out of Control**

**118 Being Held**

**202 Under Control**

ACTIVE FIRES MAP

**3**

NEW FIRES TODAY

**885**

ACTIVE FIRES

**4246**

YTD FIRES

**11.0M**

AREA BURNED YTD (HA)

**Average  
2.5 M**



# Wildfire Smoke 101

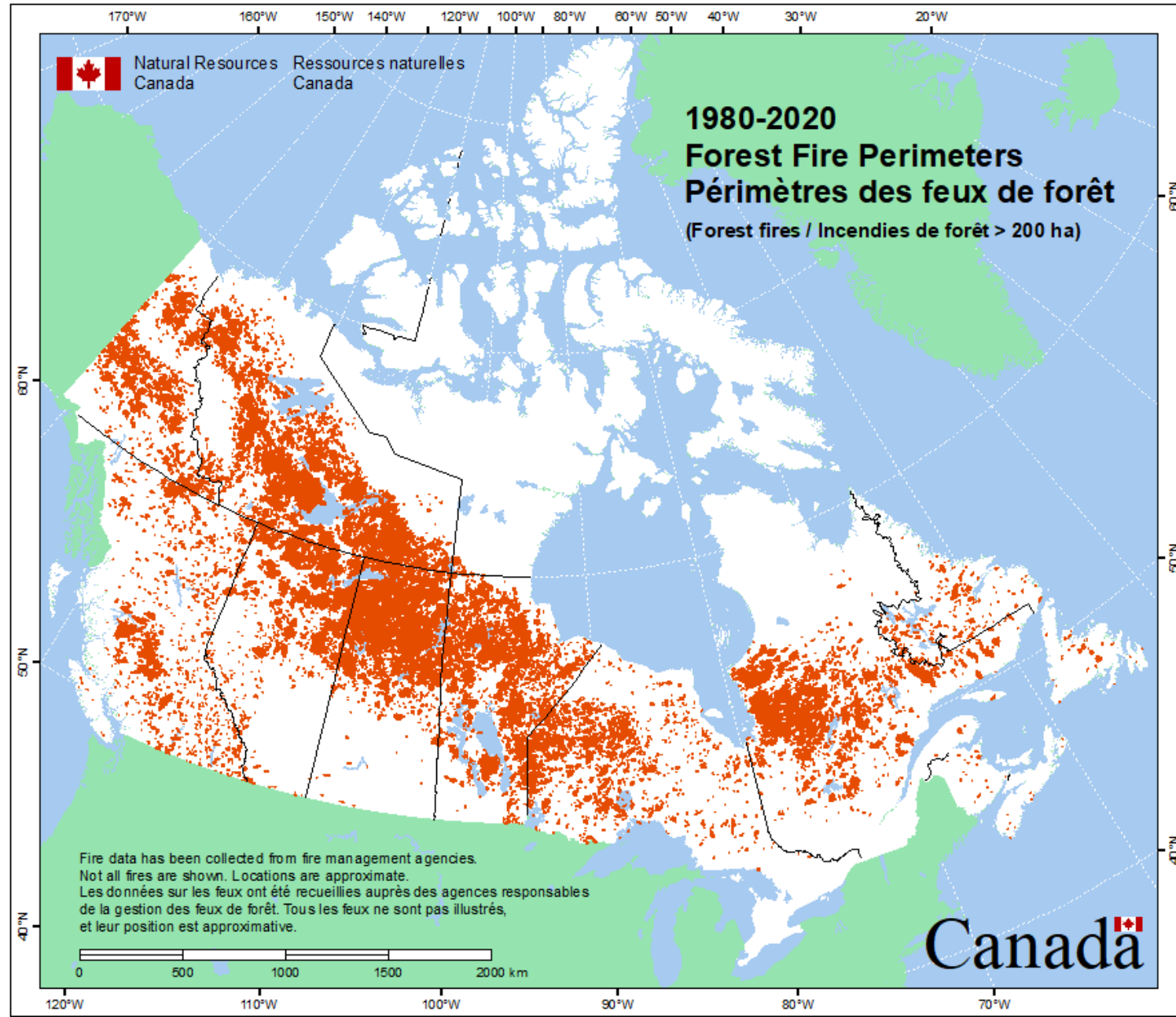


# Where there are trees (boreal forest)...



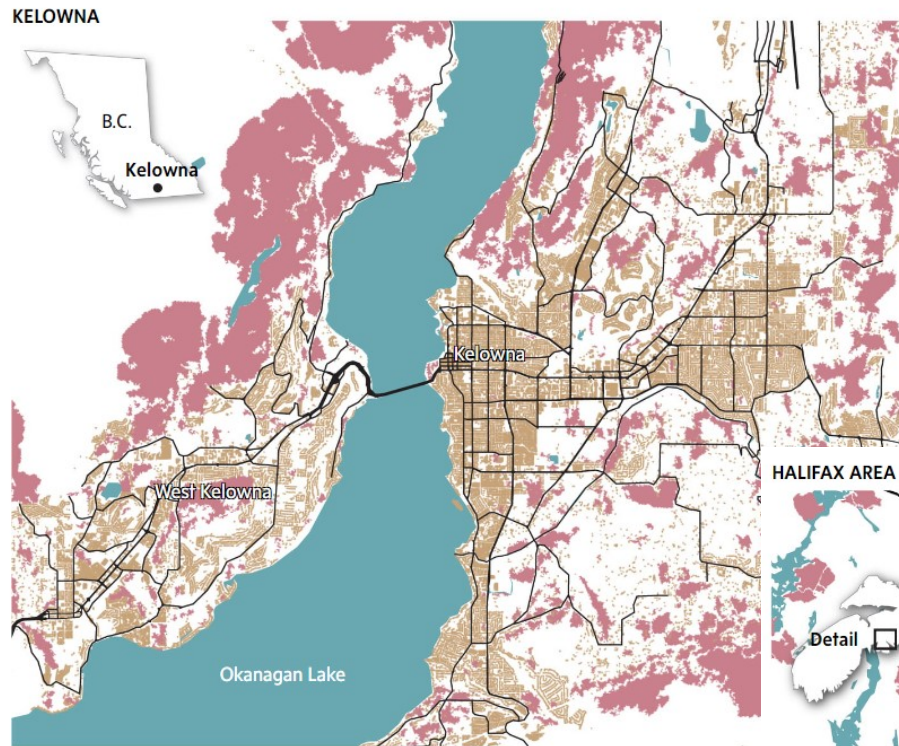


# ... there's fire

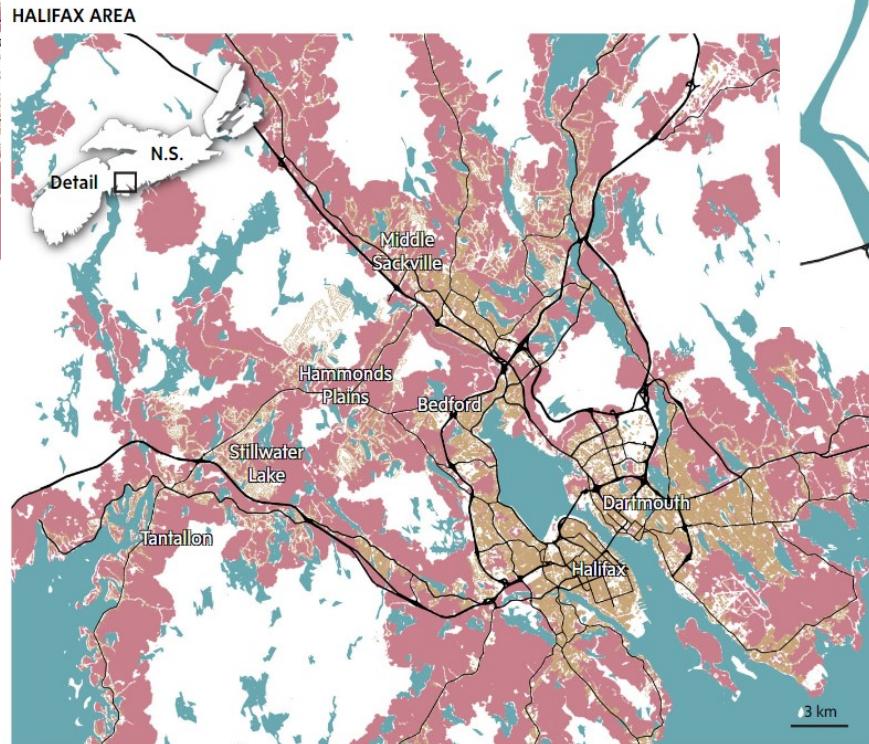
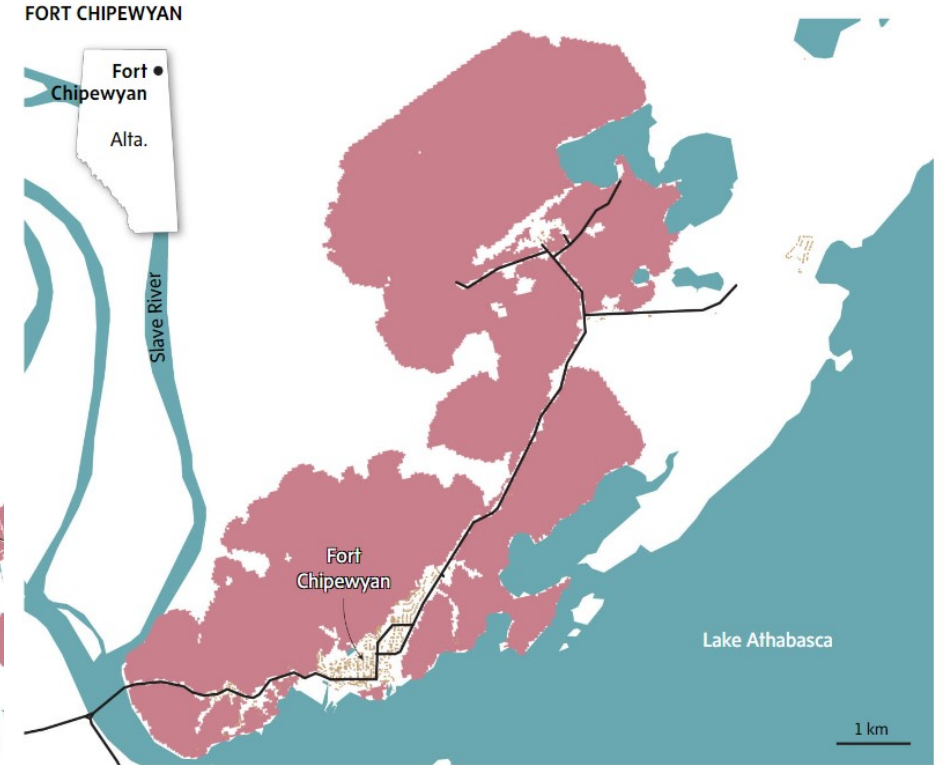


# Wildland Urban Interface (WUI)

Wildland-urban interface Building footprints

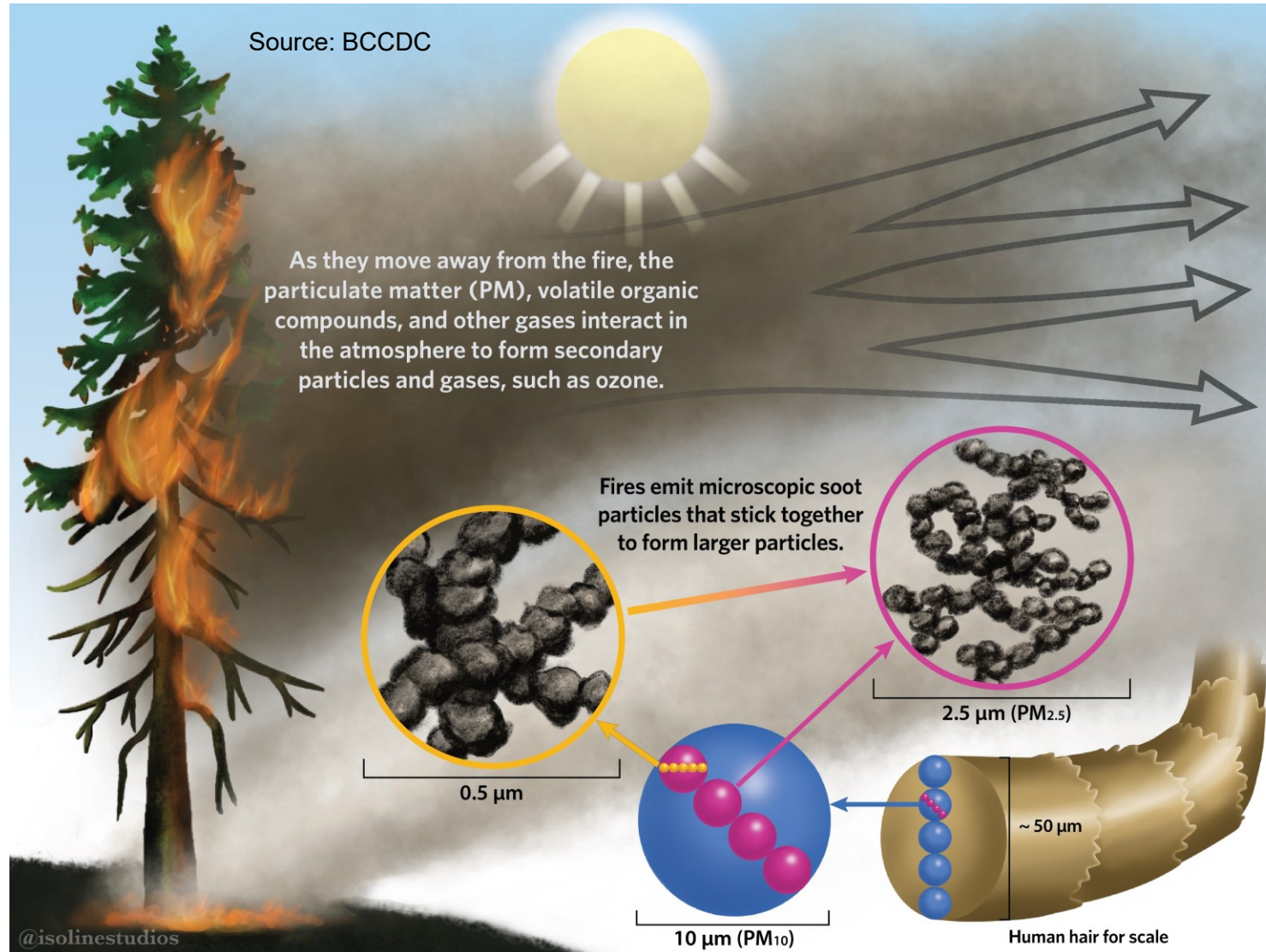


- Increasing encroachment in proximity to forests
- Urban planning decisions
- Lack of risk data/ mapping



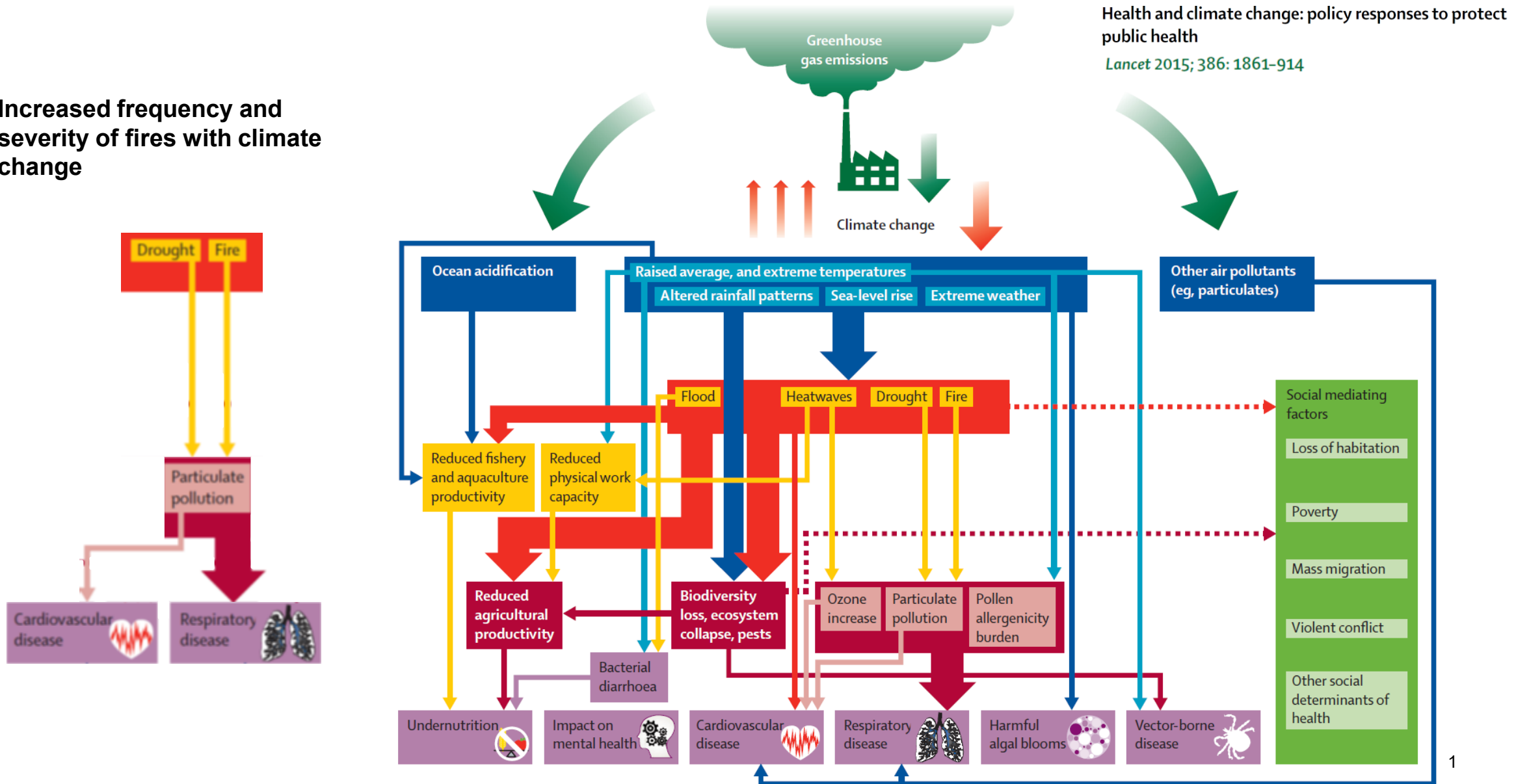


# Emissions from wildfires



# “Unprecedented”...but not unexpected

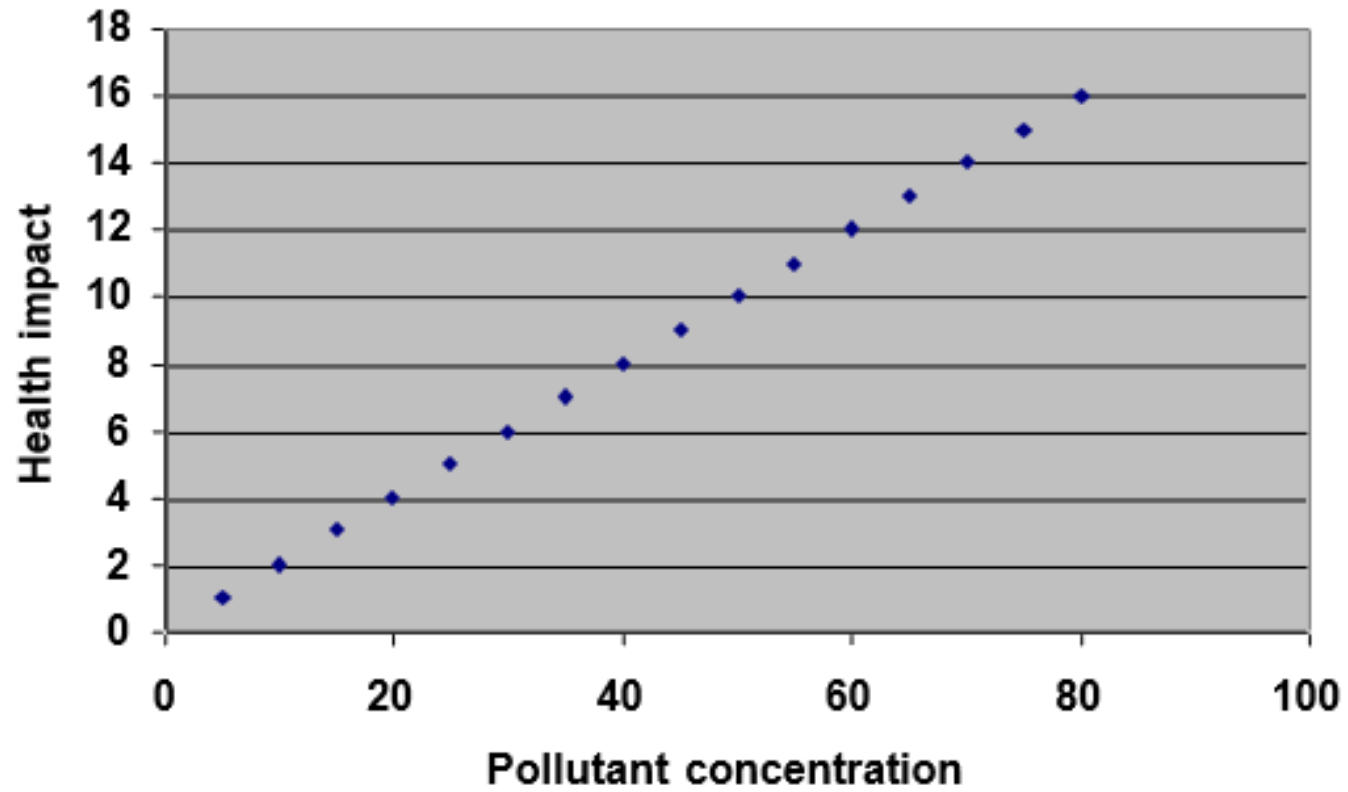
Increased frequency and severity of fires with climate change





# Health Effects

# No threshold for adverse effects...





# No threshold for adverse effects...

## Canadian Ambient Air Quality Standards (CAAQS)



Pollutant	Averaging Time	Numerical Value			Statistical Form
		2015	2020	2025	
Fine Particulate Matter (PM <sub>2.5</sub> )	24-hour	28 µg/m <sup>3</sup>	27 µg/m <sup>3</sup>		The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations
	Annual	10.0 µg/m <sup>3</sup>	8.8 µg/m <sup>3</sup>		The 3-year average of the annual average of the daily 24-hour average concentrations
Ozone (O <sub>3</sub> )	8-hour	63 ppb	62 ppb	60 ppb	The 3-year average of the annual 4th highest of the daily maximum 8-hour average ozone concentrations
Nitrogen dioxide (NO <sub>2</sub> )	1-hour	-	60 ppb	42 ppb	The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations
	Annual	-	17.0 ppb	12.0 ppb	The average over a single calendar year of all 1-hour average concentrations
Sulphur dioxide (SO <sub>2</sub> )	1-hour	-	70 ppb	65 ppb	The 3-year average of the annual 99th percentile of the SO <sub>2</sub> daily maximum 1-hour average concentrations
	Annual	-	5.0 ppb	4.0 ppb	The average over a single calendar year of all 1-hour average SO <sub>2</sub> concentrations



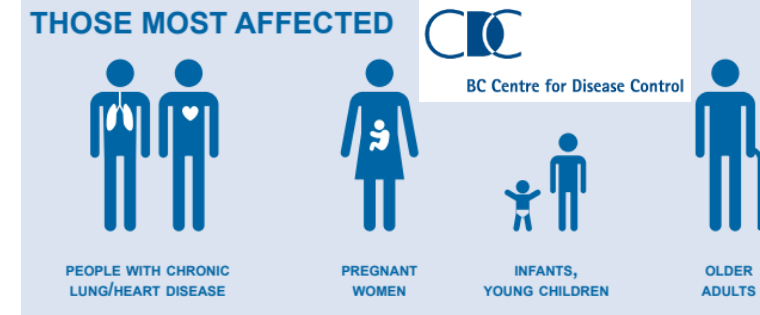
**Table 0.1. Recommended AQG levels and interim targets**

Pollutant	Averaging time	Interim target				AQG level
		1	2	3	4	
PM <sub>2.5</sub> , µg/m <sup>3</sup>	Annual	35	25	15	10	5
	24-hour <sup>a</sup>	75	50	37.5	25	15
PM <sub>10</sub> , µg/m <sup>3</sup>	Annual	70	50	30	20	15
	24-hour <sup>a</sup>	150	100	75	50	45
O <sub>3</sub> , µg/m <sup>3</sup>	Peak season <sup>b</sup>	100	70	-	-	60
	8-hour <sup>a</sup>	160	120	-	-	100
NO <sub>2</sub> , µg/m <sup>3</sup>	Annual	40	30	20	-	10
	24-hour <sup>a</sup>	120	50	-	-	25
SO <sub>2</sub> , µg/m <sup>3</sup>	24-hour <sup>a</sup>	125	50	-	-	40
CO, mg/m <sup>3</sup>	24-hour <sup>a</sup>	7	-	-	-	4

<sup>a</sup> 99th percentile (i.e. 3-4 exceedance days per year).

<sup>b</sup> Average of daily maximum 8-hour mean O<sub>3</sub> concentration in the six consecutive months with the highest six-month running-average O<sub>3</sub> concentration.

# Who's at greater risk?



Population	Factor(s) mediating elevated risk
Children	<ul style="list-style-type: none"> <li>• Developing immune and respiratory systems</li> <li>• More time outdoors</li> <li>• Greater intensity of outdoor activity</li> <li>• Larger air intake per kg</li> </ul>
Seniors	<ul style="list-style-type: none"> <li>• Increased frailty</li> </ul>
Individuals with chronic disease (asthma, COPD, heart disease, diabetes)	<ul style="list-style-type: none"> <li>• Compromised respiratory, circulatory physiology</li> </ul>
Pregnant people	<ul style="list-style-type: none"> <li>• Developing fetus</li> </ul>
Outdoor workers	<ul style="list-style-type: none"> <li>• More time outdoors</li> <li>• Greater intensity of outdoor activity</li> </ul>
Lower socioeconomic status	<ul style="list-style-type: none"> <li>• Reduced access to healthy diet, medical care</li> </ul>
Inadequate dietary antioxidant intake (vitamins C and E)	<ul style="list-style-type: none"> <li>• Reduced ability to manage oxidative stress</li> </ul>




# What percentage of the population is at greater risk?

Canadian Journal of Public Health (2019) 110:149–158  
<https://doi.org/10.17269/s41997-018-0169-8>

## QUANTITATIVE RESEARCH

### Variability in ambient ozone and fine particle concentrations and population susceptibility among Canadian health regions

David M. Stieb<sup>1,2</sup>  • Jiayun Yao<sup>3,4</sup> • Sarah B. Henderson<sup>3,4</sup> • Lauren Pinault<sup>5</sup> • Marc H. Smith-Doiron<sup>1</sup> • Alain Robichaud<sup>6</sup> • Aaron van Donkelaar<sup>7</sup> • Randall V. Martin<sup>7</sup> • Richard Ménard<sup>6</sup> • Jeffrey R. Brook<sup>8,9</sup>

**Table 2** Variability of prevalence (%) of susceptibility factors by health region ( $n = 110$ )


Characteristic	Number or percent of health region population					
	Minimum	25th percentile	Median	Mean	75th percentile	Maximum
Population ( $n$ )	14,153	82,400	164,616	322,662	417,167	2,804,607
Urban (%)	10.4	56.3	67.3	67.5	82.6	100.0
Rural (%)	0.0	17.4	32.8	32.6	43.8	89.6
1. Age < 10 (%)	7.3	9.6	10.6	11.0	11.6	22.3
2. Age 75+ (%)	0.9	6.1	7.4	7.2	8.6	10.9
3. Asthma, COPD, heart disease, diabetes (age 10–74) (%)	8.8	12.8	14.8	14.7	16.6	22.4
4. Pregnant (%)	0.5	0.6	0.7	0.7	0.8	1.8
5. Outdoor work (%)	13.0	14.3	14.9	15.1	15.9	18.4
6. Less than high-school education (%)	1.4	4.0	4.8	5.3	6.3	18.2
7. Inadequate vitamin C intake (%)	2.9	5.6	5.9	6.0	6.4	7.7
8. Remainder of 10–19 and 65–74 (%)	9.8	11.2	12.1	12.1	13.1	15.1
Restrictive (sum of factors 1–4) (%)	24.4	31.8	33.5	33.6	35.6	41.2
Inclusive (sum of factors 1–8) (%)	61.2	69.8	72.3	72.1	74.4	87.0

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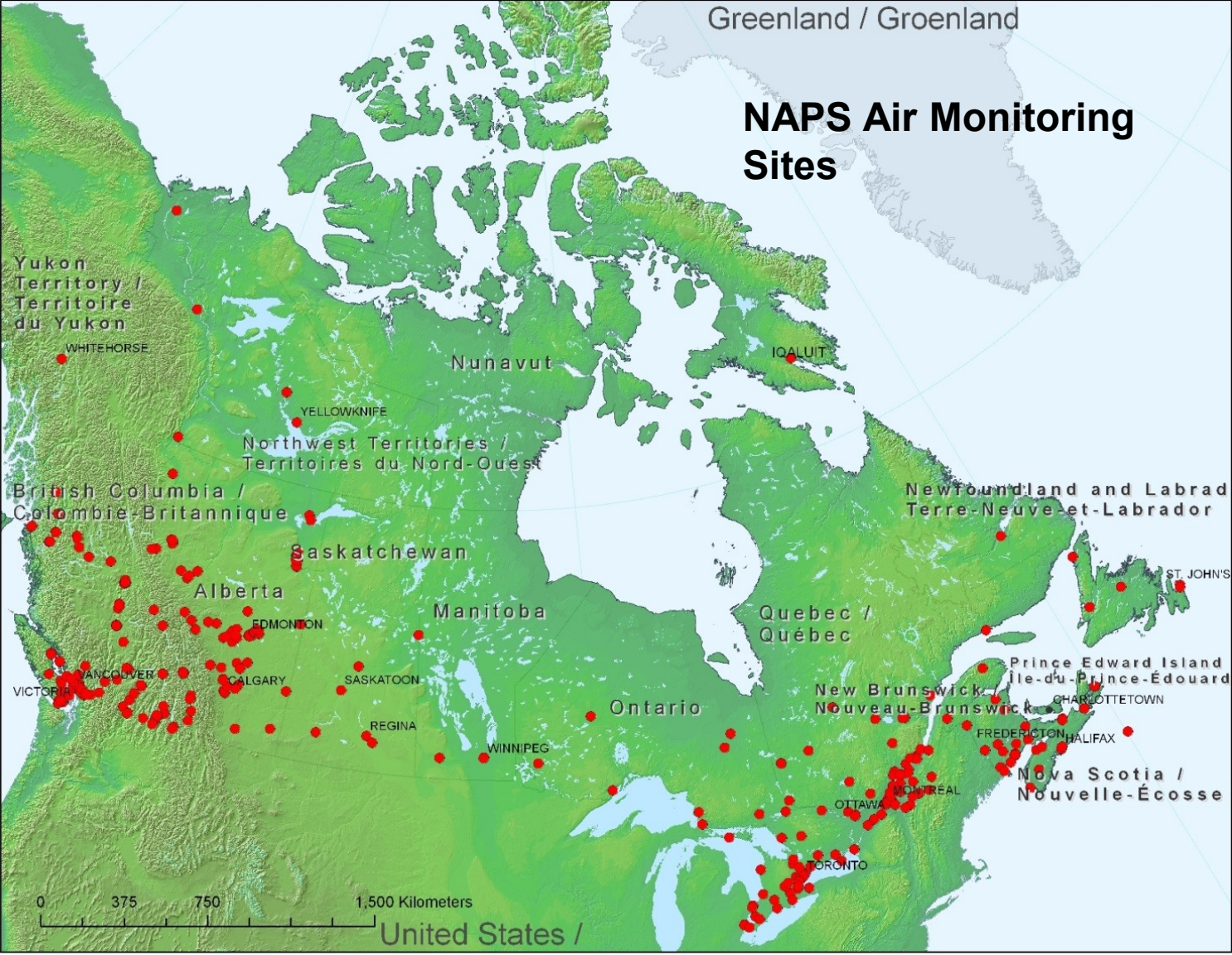
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# Indigenous populations

- Indigenous, rural and remote communities are often located closer to fires
- Residents likely to be more susceptible to adverse health effects (e.g. greater outdoor activity)
- Data on PM2.5 exposures are often unavailable, owing to the lack of routine monitoring.







# RESPIRATORY EFFECTS



## Symptoms:

- Cough
- Phlegm
- Chest tightness
- Wheezing
- Shortness of breath

## Increased sickness and premature death from:

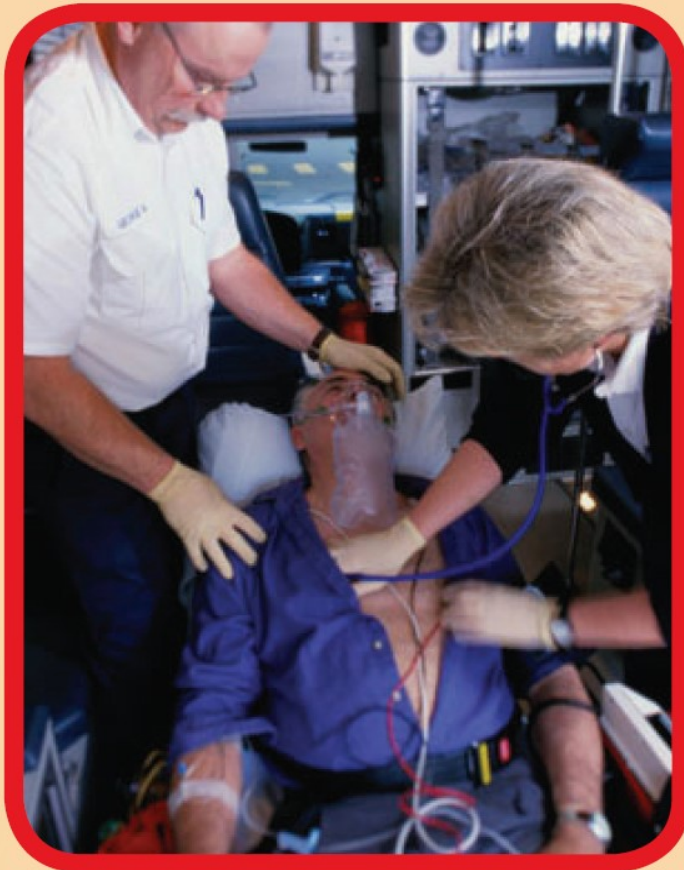
- Asthma
- Bronchitis (acute or chronic)
- Emphysema
- Pneumonia

## Development of new disease

- Chronic bronchitis
- Premature aging of the lungs



# CARDIOVASCULAR EFFECTS



## Symptoms:

- Chest tightness
- Chest pain (angina)
- Palpitations
- Shortness of breath
- Unusual fatigue

## Increased sickness and premature death from:

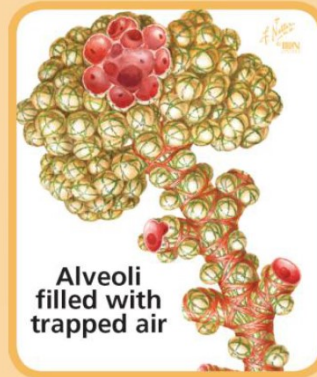
- Coronary artery disease
- Abnormal heart rhythms
- Congestive heart failure



# Mechanisms of respiratory effects

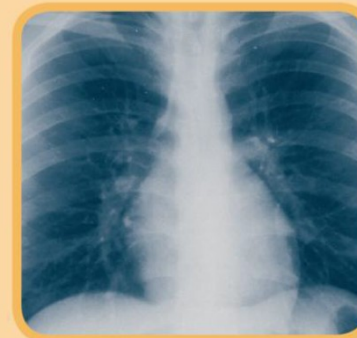
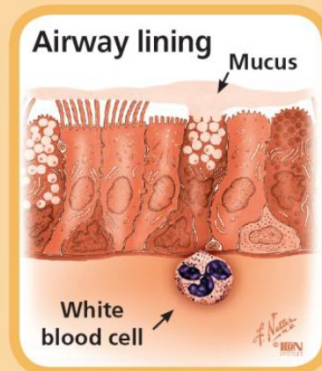
## Effects on Lung Function

- Narrowing of airways (bronchoconstriction)
- Decreased air flow



## Airway Inflammation

- Influx of white blood cells
- Abnormal mucus production
- Fluid accumulation and swelling (edema)
- Death and shedding of cells that line airways



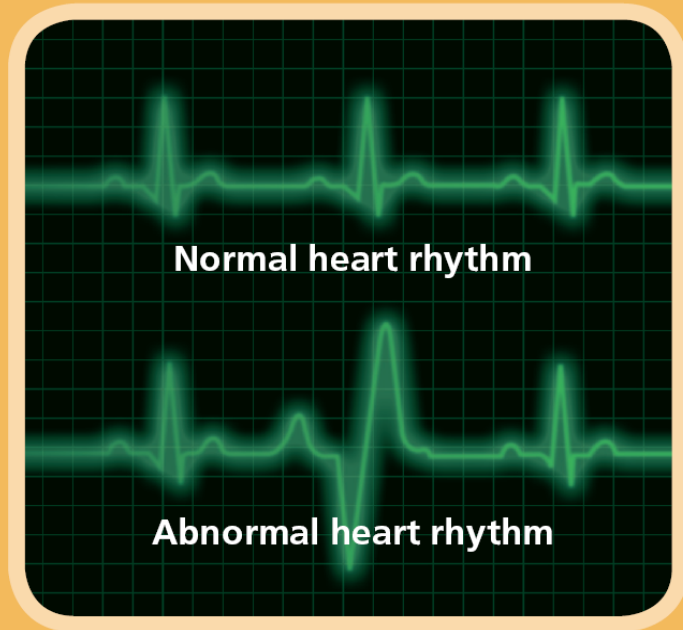
Normal



Lung with respiratory infection

Increased Susceptibility to Respiratory Infection

# Mechanisms of cardiovascular effects



## Vascular Inflammation

- Increased risk of blood clot formation
- Narrowing of vessels (vasoconstriction)
- Increased risk of atherosclerotic plaque rupture

## Effects on Cardiovascular Function

- Low oxygenation of red blood cells
- Abnormal heart rhythms
- Altered autonomic nervous system control of the heart

## Wildfire exposure during pregnancy and the risk of adverse birth outcomes: A systematic review

Sana Amjad <sup>a</sup>, Dagmara Chojecki <sup>b</sup>, Alvaro Osornio-Vargas <sup>c</sup>, Maria B. Ospina <sup>a,\*</sup>

*Conclusion:* Current evidence suggests that maternal exposure to wildfire during late pregnancy is linked to reduced birth weight and preterm birth. Well-designed comprehensive studies are needed to better understand the perinatal effects of wildfires.

Environmental Pollution 244 (2019) 915–925

## Maternal exposure to short-to medium-term outdoor air pollution and obstetric and neonatal outcomes: A systematic review<sup>☆</sup>

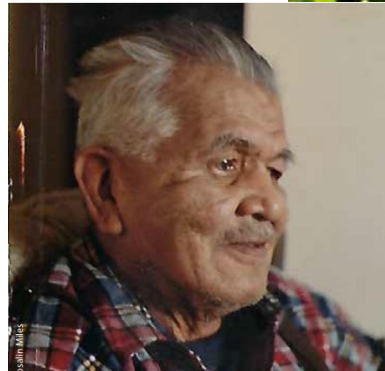
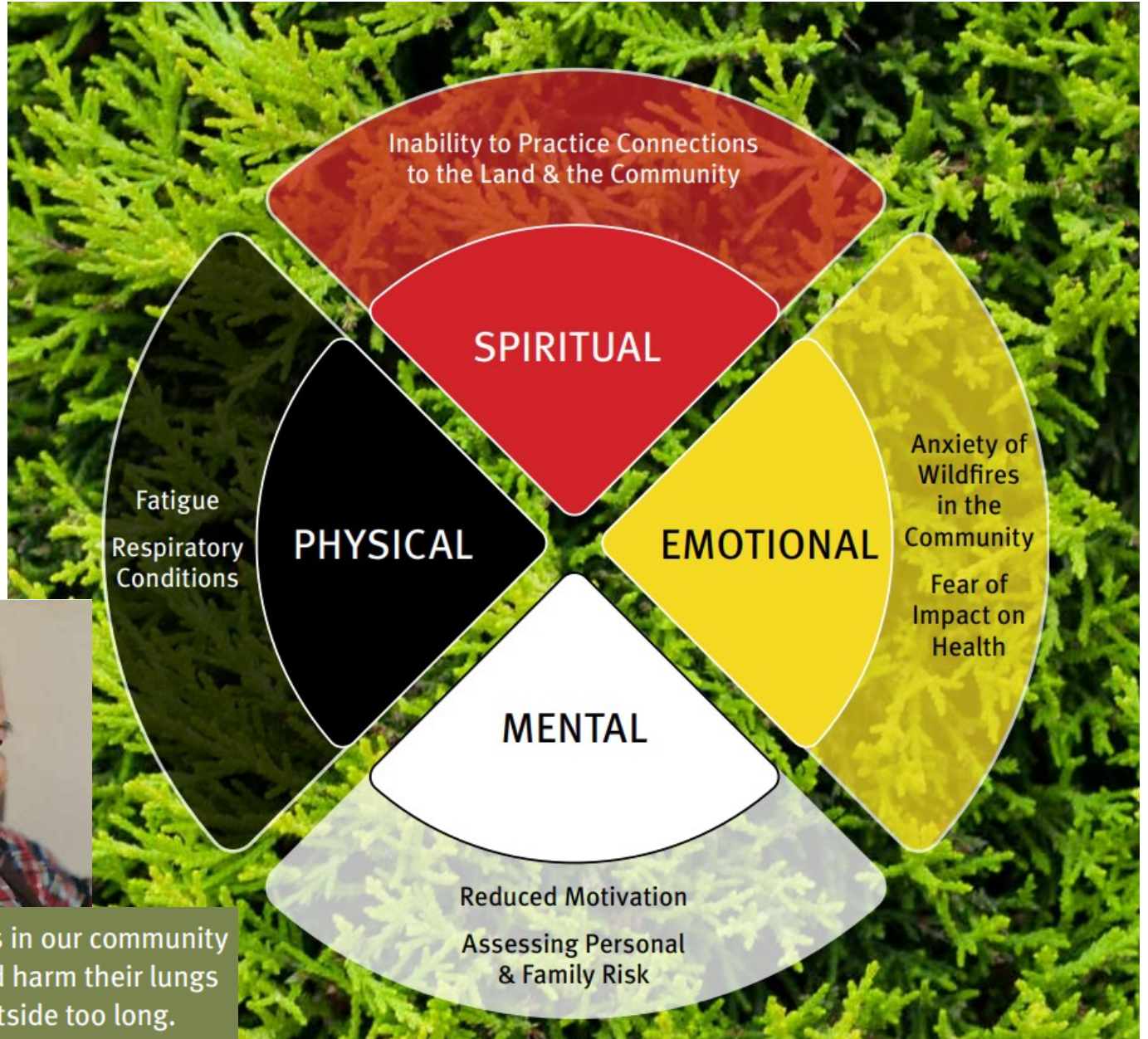
Shannon M. Melody <sup>a</sup>, Jane Ford <sup>b, c</sup>, Karen Wills <sup>a</sup>, Alison Venn <sup>a</sup>, Fay H. Johnston <sup>a,\*</sup>

*Conclusion:* Overall, there is some evidence that maternal exposure to acute changes in air quality of short-to medium-term duration increases the risk of fetal growth restriction and preterm birth. The relationship for other adverse obstetric or neonatal outcomes is less clear.





**INDIGENOUS**  
EDUCATIONAL TOOLKIT  
for Understanding Air Quality  
& the Impacts on Health and Well-Being



I worry about the Elders in our community and I know that it would harm their lungs and heart if they are outside too long.

# BC Coroner issues safety alert over wildfire smoke after child's death

VICTORIA  
THE CANADIAN PRESS  
PUBLISHED YESTERDAY

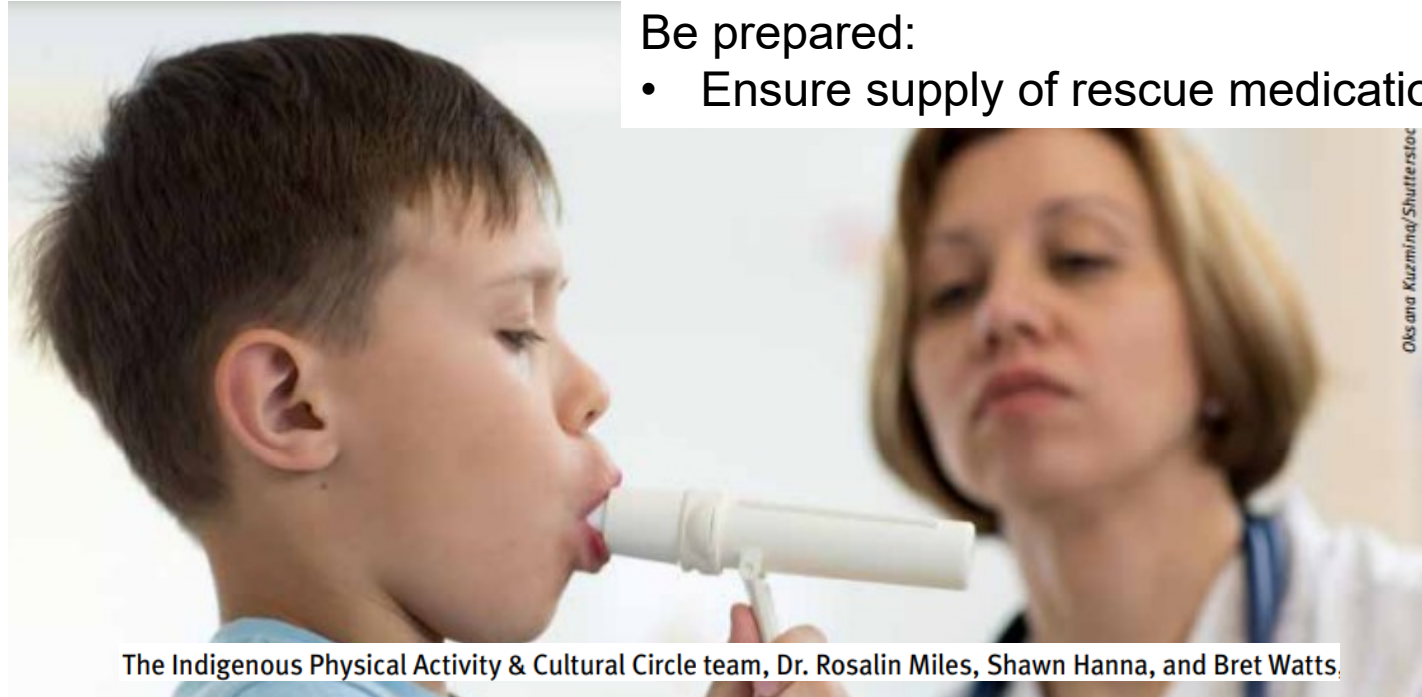


# Effective Interventions



Be prepared:

- Ensure supply of rescue medication



The Indigenous Physical Activity & Cultural Circle team, Dr. Rosalin Miles, Shawn Hanna, and Bret Watts.

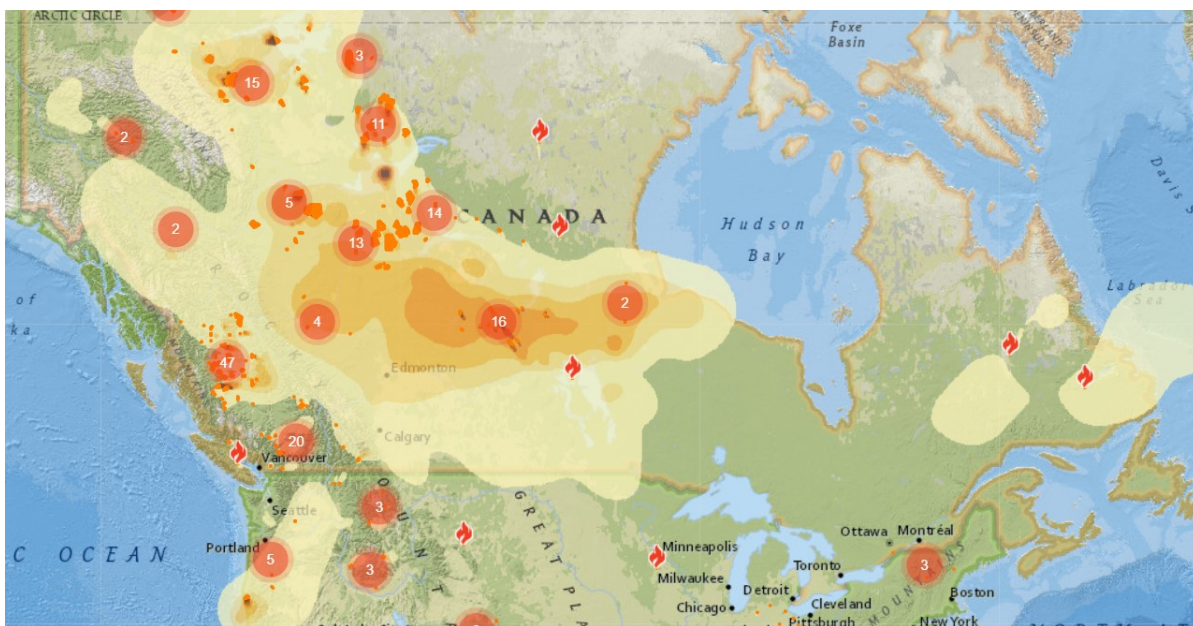
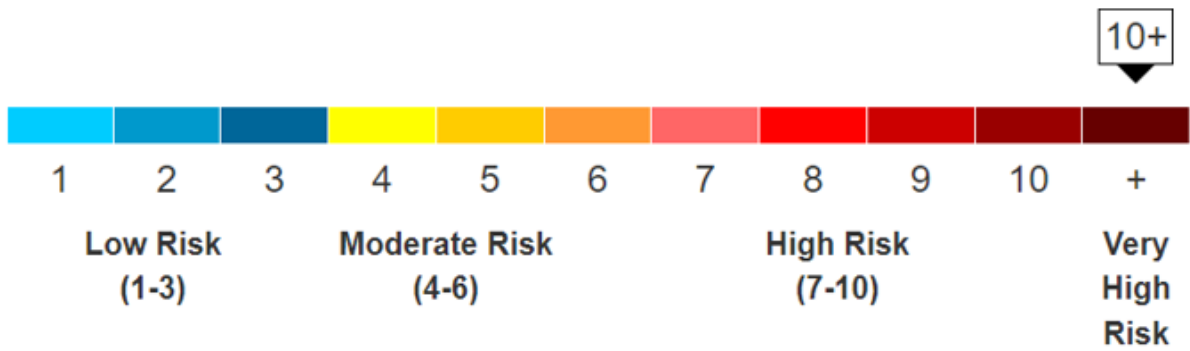
## Be prepared...

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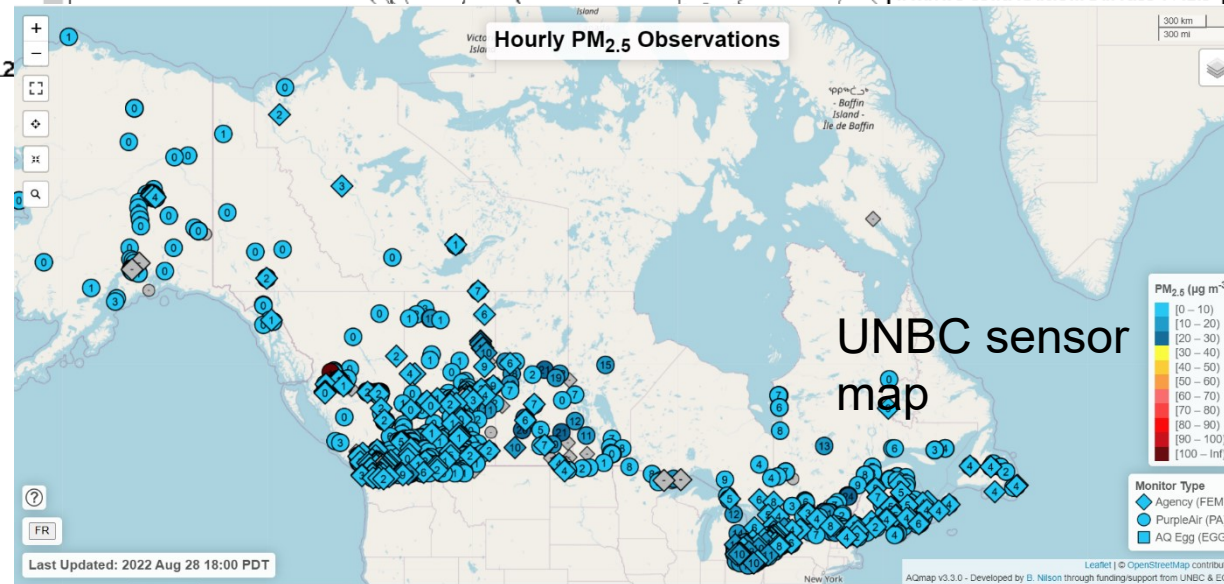
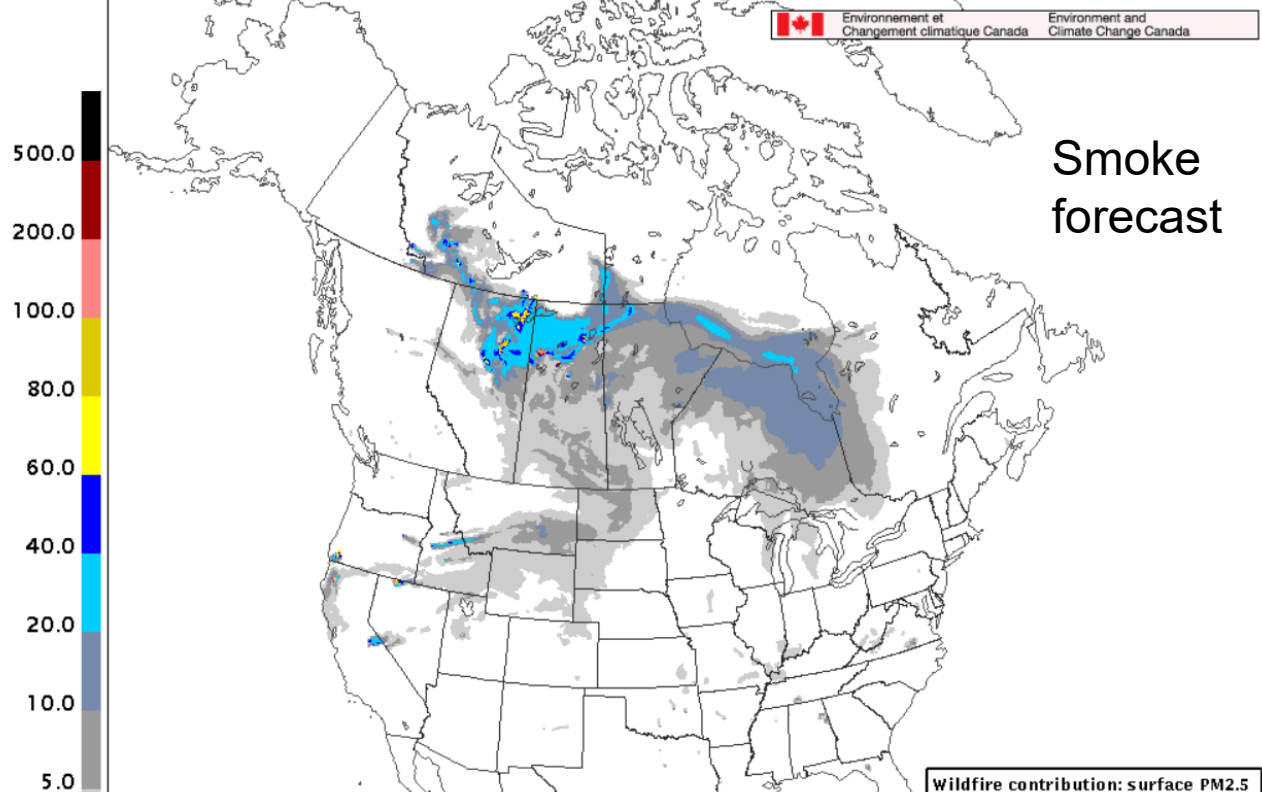
- Know your HVAC system
- Install highest possible efficiency filter for system
- Know how to close fresh air intake or set to recirculate
- Ensure windows, doors tightly sealed when closed
- Clean air shelter if can't reduce exposure at home
- Dangerous heat and wildfire smoke often occur together

# Monitor air quality conditions

## AQHI



Firesmoke.ca



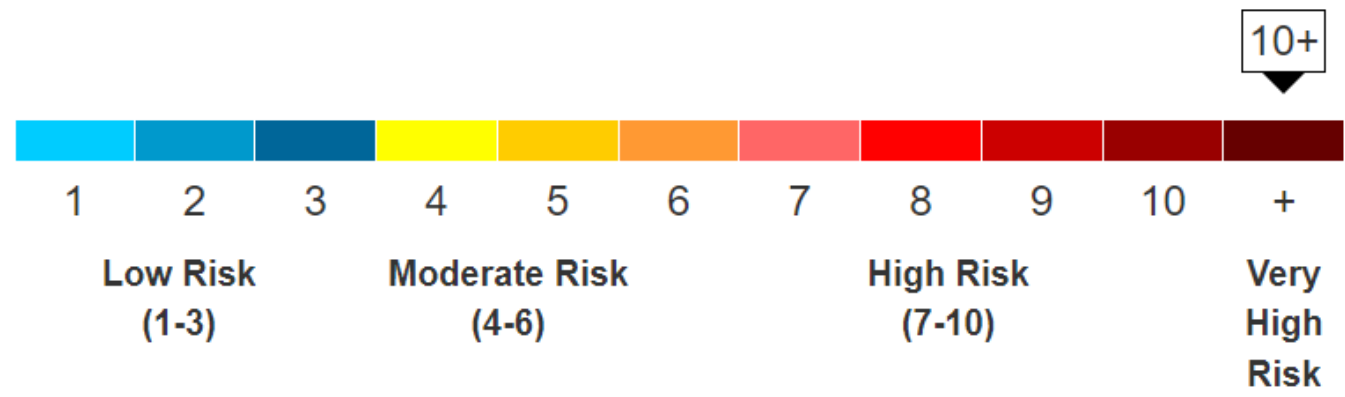


# Edmonton - Air Quality Health Index

 **SPECIAL AIR QUALITY STATEMENT** 

Observed Conditions  [Past 24 hr](#) | [AQHI by Station](#)

**Calculated at:** 5:00 PM MDT Saturday 15 July 2023



### At-Risk Population:

- Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.
- [Find out if you are at risk](#)

### General Population:

- Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

## Forecast Maximums

[Next 24 hr](#) | [Health Message](#)

**Issued at:** 5:00 PM MDT Saturday 15 July 2023

Saturday night

**10+** - Very High Risk



Sunday

**10** - High Risk



Sunday night

**9** - High Risk



Monday

**6** - Moderate Risk



Health Risk	Air Quality Health Index	Health Messages	
		At Risk Population*	General Population
Low Risk	1 - 3	<b>Enjoy</b> your usual outdoor activities.	<b>Ideal</b> air quality for outdoor activities.
Moderate Risk	4 - 6	<b>Consider</b> reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.	<b>No need to modify</b> your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High Risk	7 - 10	<b>Reduce or reschedule</b> strenuous activities outdoors. Children and the elderly should also take it easy.	<b>Consider</b> reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High Risk	Above 10	<b>Avoid</b> strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	<b>Reduce or reschedule</b> strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

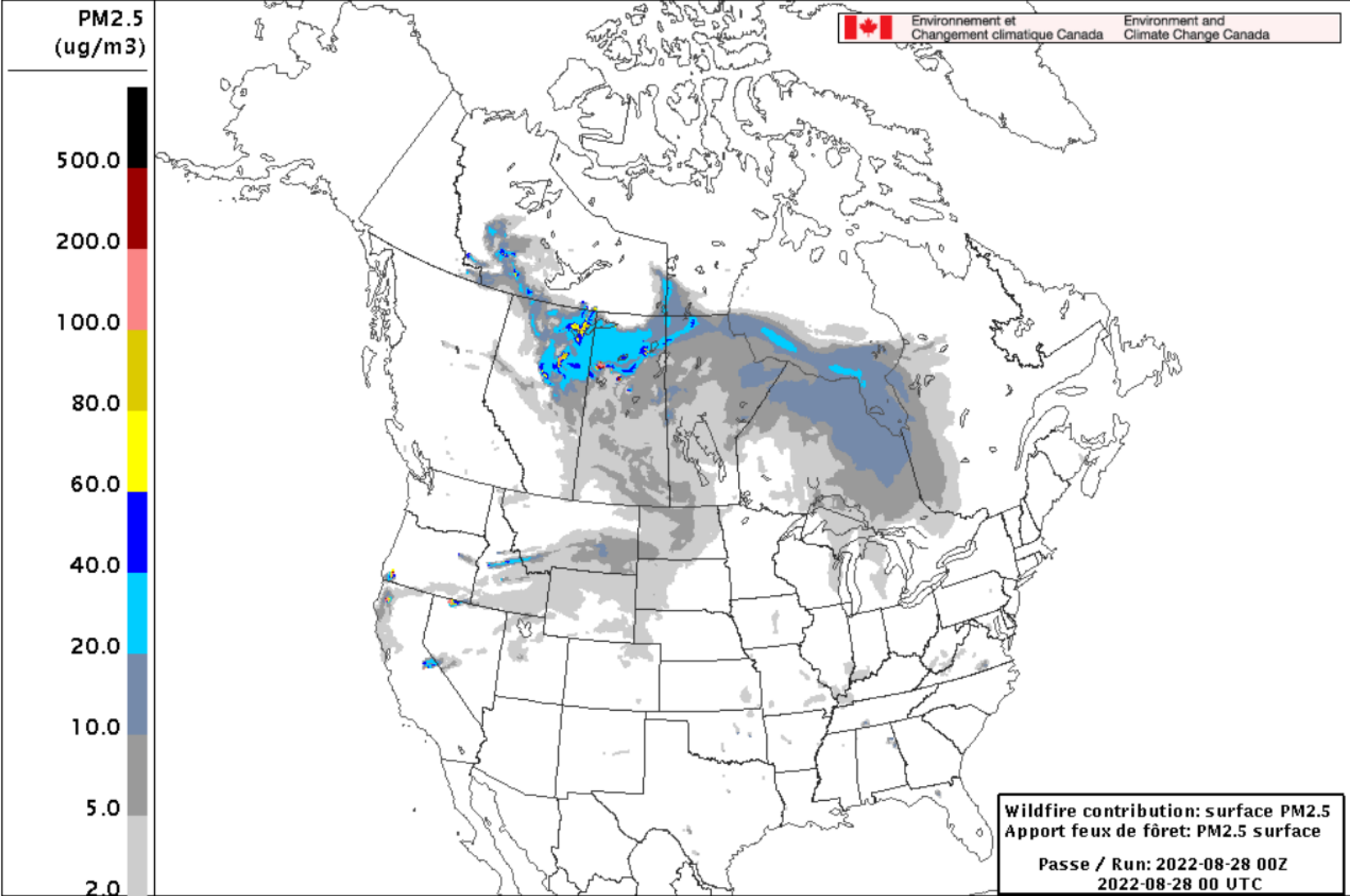
**\*People with heart or breathing problems are at greater risk.  
Follow your doctor's usual advice about exercising and managing your condition.**

[https://weather.gc.ca/airquality/pages/index\\_e.html](https://weather.gc.ca/airquality/pages/index_e.html)



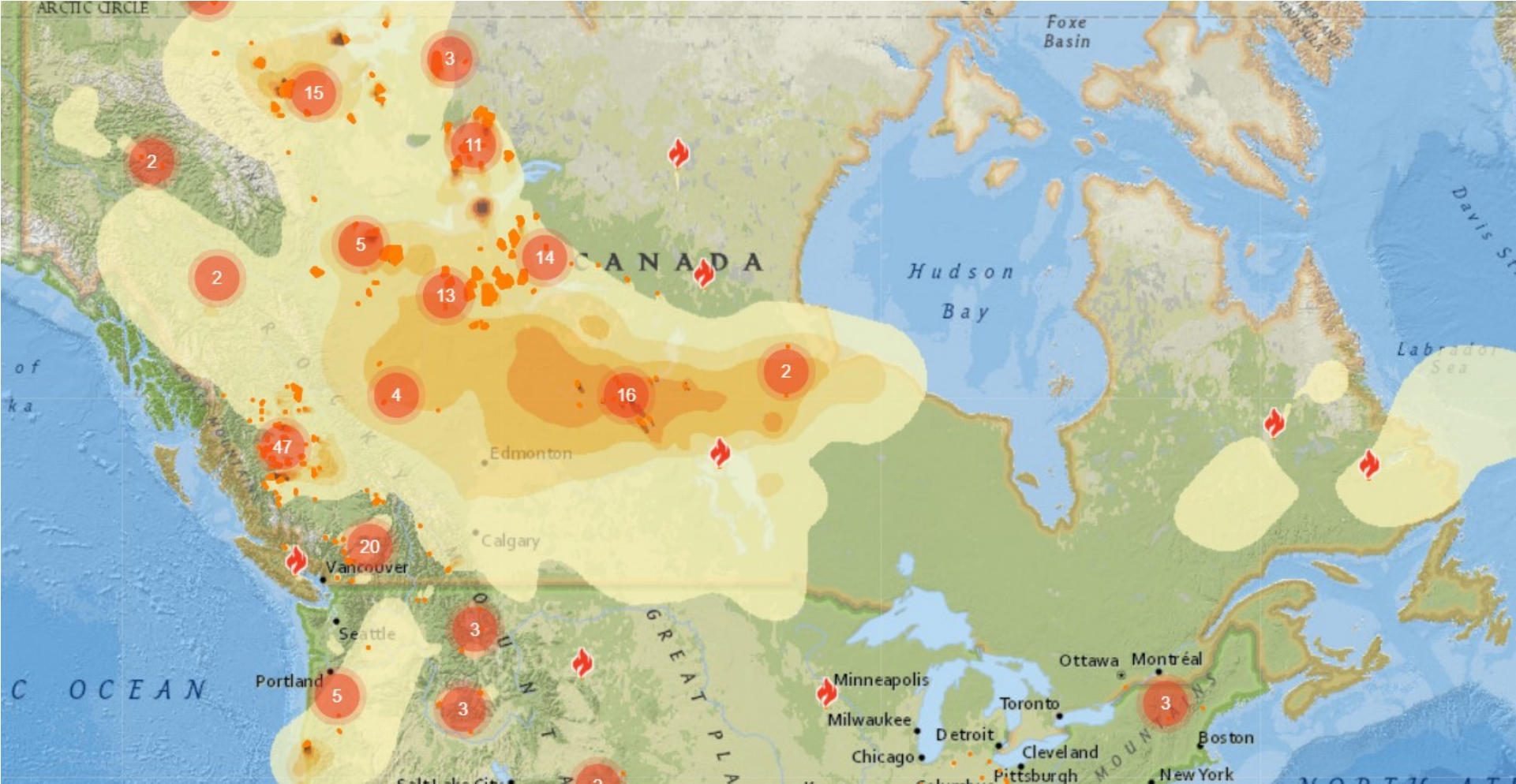
ECCC FireWork Model

[https://weather.gc.ca/firework/firework\\_anim\\_e.html?type=em&utc=12](https://weather.gc.ca/firework/firework_anim_e.html?type=em&utc=12)



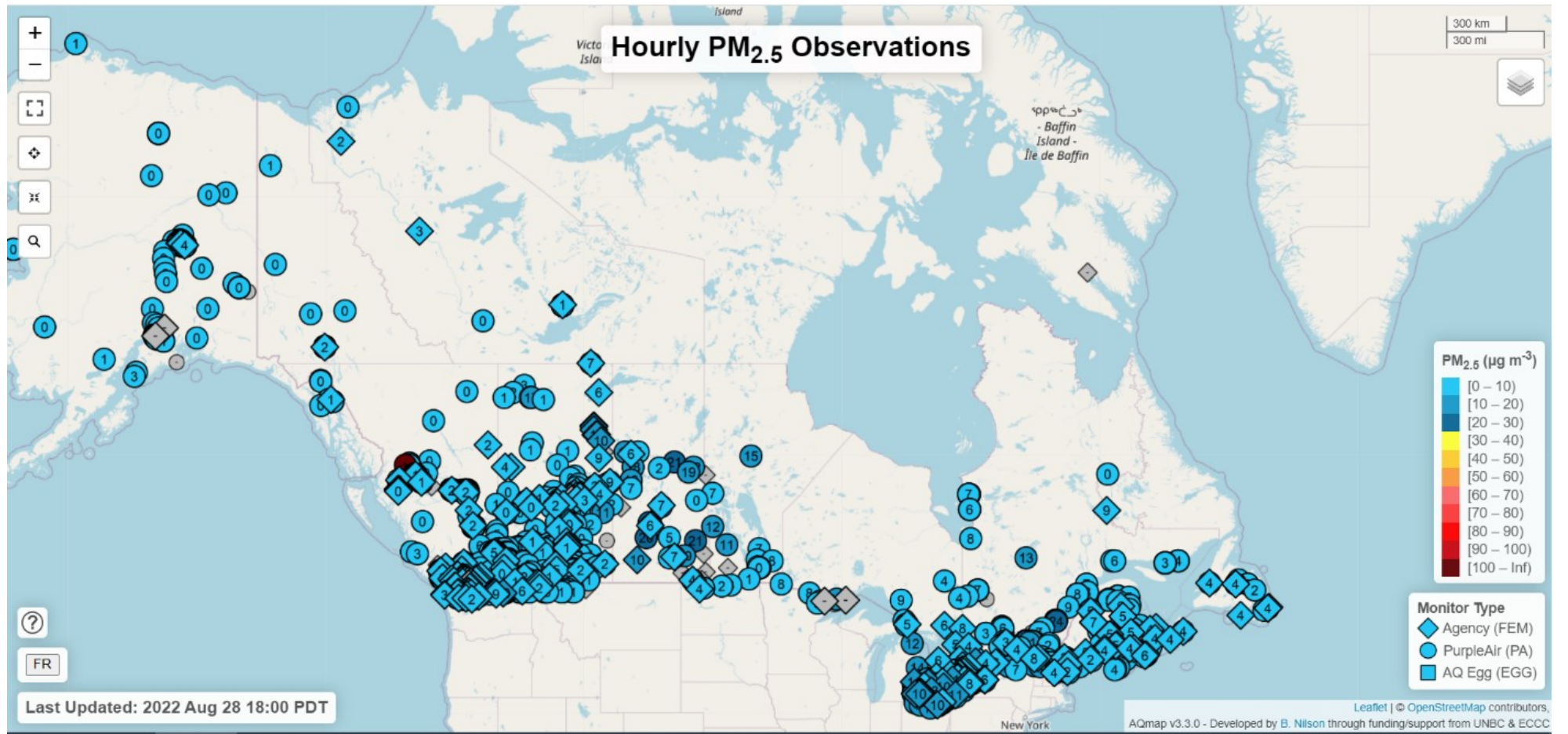
UBC Bluesky model

<https://firesmoke.ca/forecasts/current/>



[UNBC low cost sensor map](#)

Crowd-sourced data from low cost monitors







BC Centre for Disease Control

## Portable Air Cleaners for Wildfire Smoke

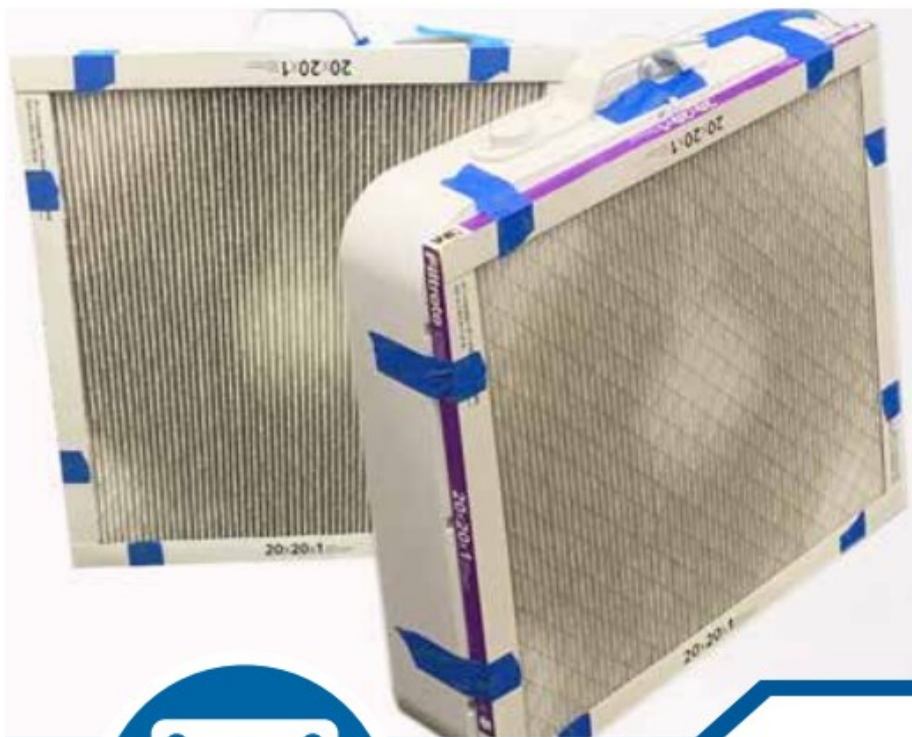
Wildfire smoke is a complex mixture of air pollutants, including small particles that can cause irritation and inflammation when inhaled. Smoke can come into buildings through windows, doors, vents, air intakes, and other openings.



Most people spend up to 90% of their time indoors, where portable air cleaners can be used to reduce the impacts of wildfire smoke.



Most portable air cleaners use high efficiency HEPA filters to trap the very small particles in wildfire smoke.



## Home-Made Box Fan Air Filters

One of the best ways to protect your health from wildfire smoke is to create and stay in a cleaner air space at home. Commercially available portable air cleaners with HEPA filters are ideal for removing small particles from the air, but they may not be easily accessible. A home-made box fan air filter can also help to reduce indoor concentrations of wildfire smoke in a small room.



**If you choose to make and use a home-made box fan air filter, there are limitations and potential risks that should be acknowledged.**



BC Centre for Disease Control



BC Centre for Disease Control

## Face Masks for Wildfire Smoke

The best way to protect your health from wildfire smoke is to seek cleaner air. Use a portable air cleaner at home, find an indoor environment with filtered air, or relocate to an area with less smoke. If you cannot access cleaner air, some face masks can provide protection from wildfire smoke. However, it is important to be aware of the limitations and potential risks.



# **A few words on occupational context**

# IARC MONOGRAPHS VOL. 132: OCCUPATIONAL EXPOSURE AS A FIREFIGHTER

Occupational exposure as a firefighter is **carcinogenic to humans (Group 1)** on the basis of **sufficient evidence for cancer in humans**



The *IARC Monographs* classification indicates the level of certainty that an agent can cause cancer (*hazard identification*)

Higher level of certainty      Lower level of certainty



Cancer types with **sufficient evidence** for cancer in humans:



Cancer types with **limited evidence** for cancer in humans:



**Strong mechanistic evidence in exposed firefighters**



Exposures of firefighters include combustion products, diesel exhaust, building materials, asbestos, chemicals, shift work, ultraviolet radiation




**Firefighters respond to various types of fire**





**C-224** 44th Parliament, 1st session  
November 22, 2021, to present

## An Act to establish a national framework for the prevention and treatment of cancers linked to firefighting

**Short title:** National Framework on Cancers Linked to Firefighting Act

 **Bill type**  
Private Member's Bill

 **Sponsor**  
[Sherry Romanado \(Longueuil—Charles-LeMoynes\)](#)

 [Text of the bill](#)



**This bill received royal assent on June 22, 2023**

*Statutes of Canada 2023, c. 20*

[Debates of the Senate](#)

The national framework may include measures to

- (a)** explain and support research on the link between firefighting and certain types of cancer;
- (b)** identify the training, education and guidance needs of health care and other professionals related to the prevention and treatment of cancers linked to firefighting and compile information relating to those needs;
- (c)** make recommendations respecting regular screenings for cancers linked to firefighting;
- (d)** promote research and improve data collection on the prevention and treatment of cancers linked to firefighting;
- (e)** promote information and knowledge sharing in relation to the prevention and treatment of cancers linked to firefighting; and
- (f)** prepare a summary of existing standards that recognize cancers linked to firefighting as occupational diseases.



# Firefighter Cancer Research Priorities Workshop

## December 2022

- Jointly funded by (Ontario) Occupational Cancer Research Centre (OCRC) and Health Canada
- 66 participants:
  - provincial health and safety authorities (e.g., WorkSafe BC, ON Ministry of Labour, Alberta OHS Prevention Initiative)
  - universities where firefighter research is being carried out
  - federal departments involved in firefighting (e.g., Canadian Forces, Parks Canada) and research on firefighting and/or cancer epidemiology (e.g., Health Canada, Statistics Canada)
  - stakeholder organizations: CAFC (Canadian Association of Fire Chiefs), the IAFF (International Association of Firefighters), the CCFMFC (Canadian Council of Fire Marshalls and Fire Commissioners), the NIFSC (National Indigenous Fire Safety Council), the CIFFC (Canadian Interagency Forest Fire Centre), and the CVFSA (Canadian Volunteer Fire Services Association).
- Identified priorities:
  - Surveillance and screening
    - » disease incidence, biomarkers of exposure/effect
    - » paucity of information for women, indigenous groups, military, aviation, volunteer and wildland firefighters
  - Intervention and exposure mitigation
    - » intervention research to evaluate the efficacy of PPE and standardised operating procedures
    - » research examining post-event interventions to reduce exposure
  - Communication and knowledge transfer
    - » effective communication regarding screening (e.g., biomarker results)
    - » knowledge translation - need to work with labour groups and firefighter organizations

# B.C. firefighter killed as wildfires continue to burn

XIAO XU > AND MIKE HAGER >  
PUBLISHED JULY 14, 2023  
UPDATED JULY 15, 2023



## Pilot dead after helicopter fighting wildfire crashes in northwestern Alberta



41-year-old victim was from Whitecourt, Alta., RCMP say

# Northwest Territories firefighter killed as wildfires continue burning in record-breaking season

JANE SKRYPNEK  
PUBLISHED JULY 16, 2023  
UPDATED JULY 17, 2023



Photo: CBC

Questions or  
comments?