Wildland Fire:

Health Effects and Public Health Outreach

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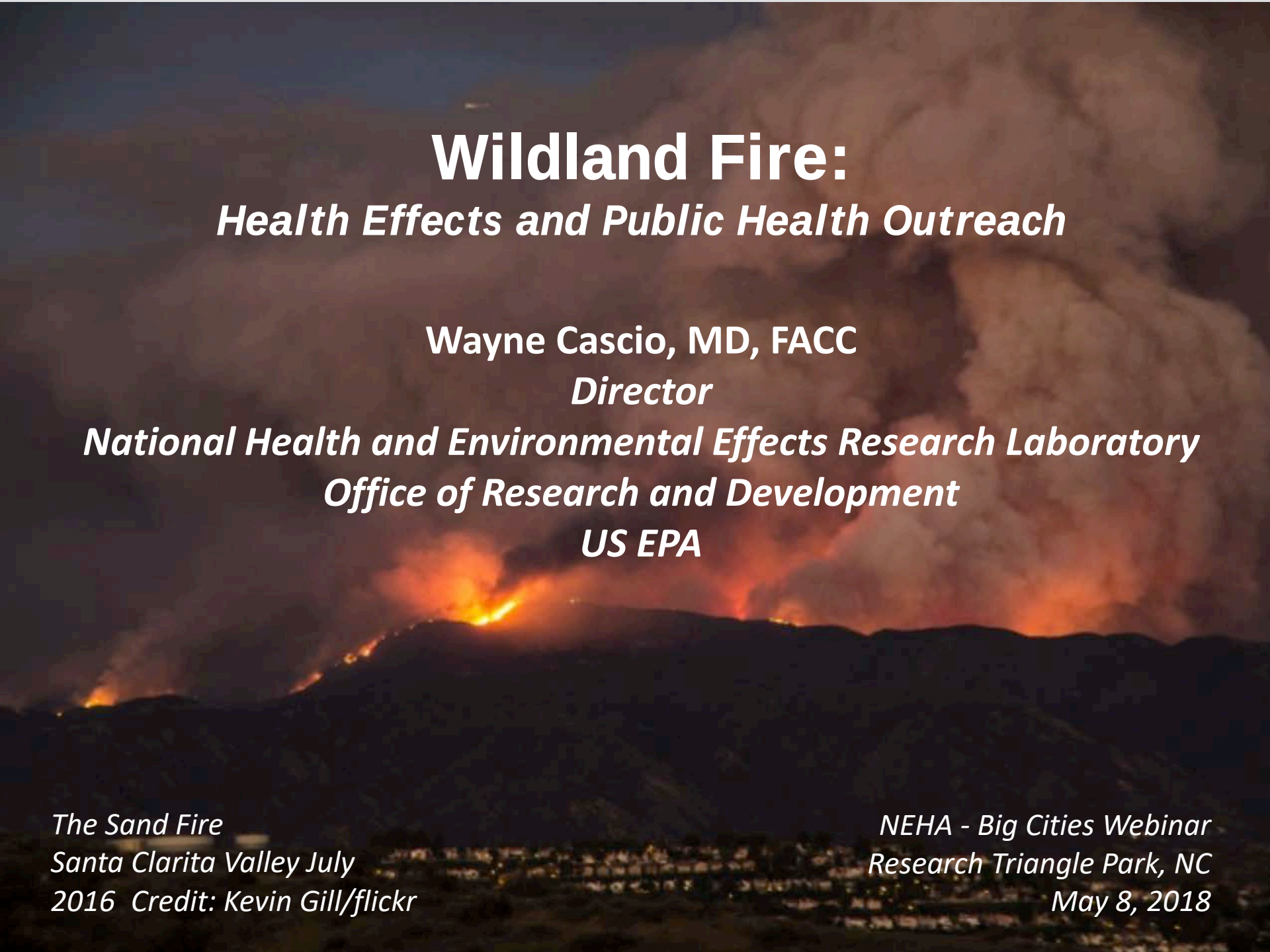
Office of Research and Development
US EPA



The Sand Fire
Santa Clarita Valley July
2016 Credit: Kevin Gill/flickr

NEHA - Big Cities Webinar
Research Triangle Park, NC
May 8, 2018

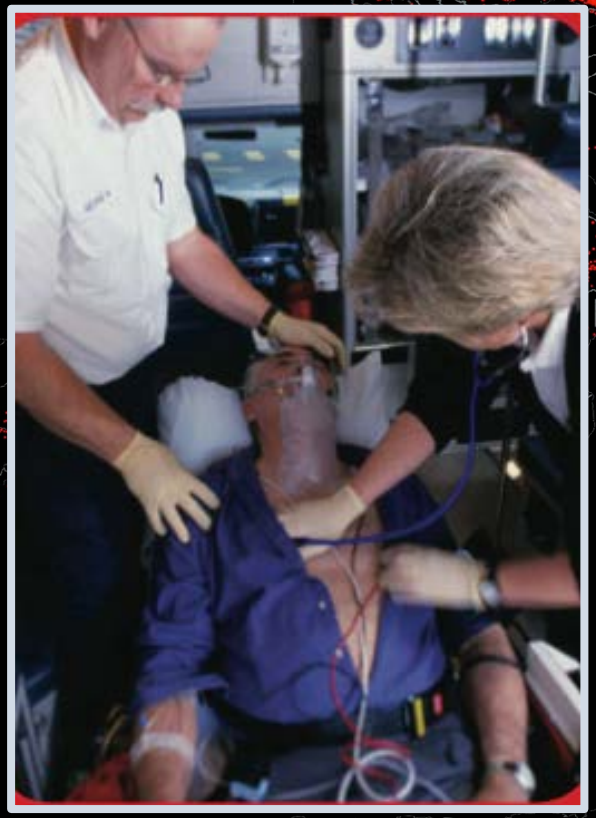
Wildland Fires & Their Emissions

A Large Urban Environmental Health Issue

San Francisco Bay Area experienced hazardous levels of smoke

Wildland Fires & Their Emissions

A Costly Individual and Public Health Issue



Estimated Economic Value of Wildfire-Attributed $PM_{2.5}$- Premature Deaths & Respiratory Admissions

Short-term **$63 billion**
(Range $6 -$170 billion)

Long-term **$450 billion**
(Range $42 – $1000 billion)

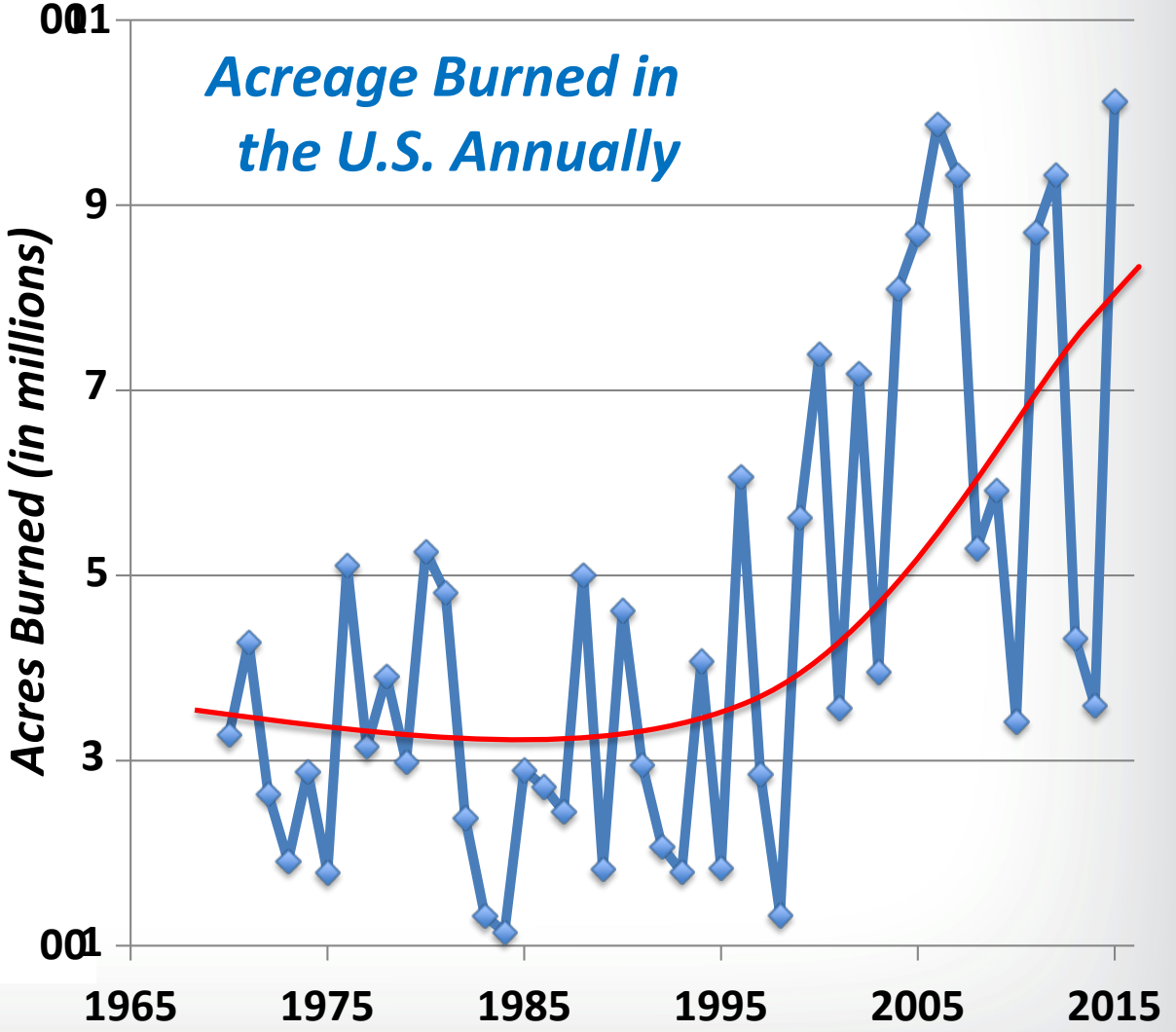
Fann N et al. *Science of the Total Environment* 610–611 (2018) 802–809

Wildfire Smoke is an Increasing Health Hazard in the U.S.

Present Concerns

- ***Increasing acreage burned***
- ***Increasing impact on urban areas***
  - 10% of all land with housing are situated in the wildland-urban interface
  - 38.5% of U.S. housing units
- ***Increasing vulnerability of sensitive populations***

(Radeloff et al. 2005)



Adapted from https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html

Adverse Impacts on Air-Quality Extend for Long Distances

Health Impacts Can Extend Hundreds of Miles and Affect Heavily Populated Urban Areas

- **Forest fires in Quebec during July 2002 (red circles)**
- **Baltimore, Maryland, nearly a thousand miles downwind**
- **30-fold increase in airborne fine particle concentrations**

Source: Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on the Terra satellite, Land Rapid Response Team, NASA/GSFC

Health Effects of Wildfire Smoke

Systematic Reviews are Now Available

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

iew

ystematic review of the physical health impacts from
n-occupational exposure to wildfire smoke

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Environ Res. 2015 Jan;136:120-32. doi: 10.1016/j.envres.2014.10.015.

Environ Health Perspect. 2016; 124:1334–1343

Review

A Section 508–conformant HTML version of this article is available at http://dx.doi.org/10.1289/ehp.1409277.

Critical Review of Health Impacts of Wildfire Smoke Exposure

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Known and Suspected Health Effects of Wildfire Smoke

Known

- **Respiratory morbidity**
  - *Asthma & COPD*
  - *Bronchitis & pneumonia*
- **Susceptible populations**
  - *Children, elders and those with chronic disease*

Suspected

- **All-cause mortality**
- **Cardiovascular morbidity**
- **Adverse birth outcomes**

More data needed

- **Risk of mortality**
- **Cardiovascular morbidity**
- **Susceptible populations**

Who's at Risk from Wildfire Smoke

NHANES 2007-2010, N=10,898

Susceptible category	N	Percent (95% CI)
None	7135	73.0 (71.4, 74.6)
Respiratory only	642	6.4 (5.5, 7.2)
Cardiovascular only	319	2.6 (2.3, 2.9)
>65 years only	1713	10.9 (10.1, 11.8)
Respiratory and cardiovascular	136	1.0 (0.7, 1.3)
Respiratory and >65 years	220	1.6 (1.3, 1.8)
Cardiovascular and >65 years	608	3.8 (3.3, 4.3)
All three groups	125	0.7 (0.5, 0.9)

NHANES = National Health and Nutrition Education Survey

Wells EM, Dearborn DG, Jackson LW (2012). PLoS ONE 7(11): e50526

Who's at Risk from Wildfire Smoke

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Respiratory only		(5.5, 7.2)
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Respiratory and cardiovascu		(0.7, 1.3)
Respiratory and >65 years		(1.3, 1.8)
Cardiovascular and >65 years		3.8 (3.3, 4.3)
All three groups	125	0.7 (0.5, 0.9)

27% fall into at least one susceptible group category

NHANES = National Health and Nutrition Education Survey

Wells EM, Dearborn DG, Jackson LW (2012). PLoS ONE 7(11): e50526

Smoke Ready Toolbox for Wildfires

epa.gov/air-research/smoke-ready-toolbox-wildfi

Airnow.gov: Current Fire Conditions
Get current air quality conditions and learn what to do to protect your health from air pollution, including smoke from wildland fires. Airnow.gov provides local air quality forecasts using EPA's science-based air quality index. https://airnow.gov/index.cfm?action=topics.smoke_wildfires

How Smoke From Fires Can Affect Your Health
Learn who is more at risk from smoke, how to tell if it is affecting you, and steps you can take to protect your health. Learn what to do before, during and after a wildfire. https://airnow.gov/index.cfm?action=smoke.index

Wildfire Smoke: A Guide for Public Health Officials
The guide is an easy-to-use resource that outlines whose health is most affected by wildfire smoke, how to reduce exposure to smoke, what public health actions are recommended, and how to communicate air quality to the public. The recommendations are based on science conducted by EPA and others. https://www3.epa.gov/airnow/wildfire_may2016.pdf

Wildfire Smoke Exposure Infographics
Two infographics provide information on actions to take to reduce health risks from smoke exposure in areas with wildfire smoke and what respirator (mask) to wear if you have to go outside and how to wear it properly. https://www3.epa.gov/airnow/smoke_fires/reduce-health-risks-with-wildfire-smoke.pdf and https://airnow.gov/static/topics/images/epa-infographic-respirator.jpg

Smoke Sense App
The Smoke Sense mobile app, developed by EPA researchers, enables you to get information on air quality and learn how to protect your health from wildland fire smoke. The app is being used in a citizen science study to determine how smoke from fires impacts public health. The app is available for anyone to use and can be downloaded on Android or iOS. www.epa.gov/air-research/smoke-sense

Particle Pollution and Your Patients' Health Course
Particle pollution, also known as particulate matter or PM, is the main component of haze, smoke, and dust. This course provides health professionals with knowledge they can share with patients to help reduce overall risk of PM-related health effects, particularly in individuals with heart and lung disease. www.epa.gov/pmcourse

Online Healthy Heart Toolkit
Breathing in fine particulate matter ($PM_{2.5}$) can trigger heart attacks, ischemic stroke, abnormal heart rhythms and worsen heart failure in people with cardiovascular disease or older adults with medical conditions that put them at risk. Particle pollution is a main component of smoke. Use the toolkit to protect your heart. https://www.epa.gov/air-research/healthy-heart-toolkit-and-research

Smoke Ready Toolbox for Wildfires

- **Resources health officials can use to educate the public about the risks of smoke exposure and actions people can take to protect their health**

https://www.epa.gov/sites/production/files/2018-04/documents/smoke_ready_toolbox_for_wildfires_tagged.pdf

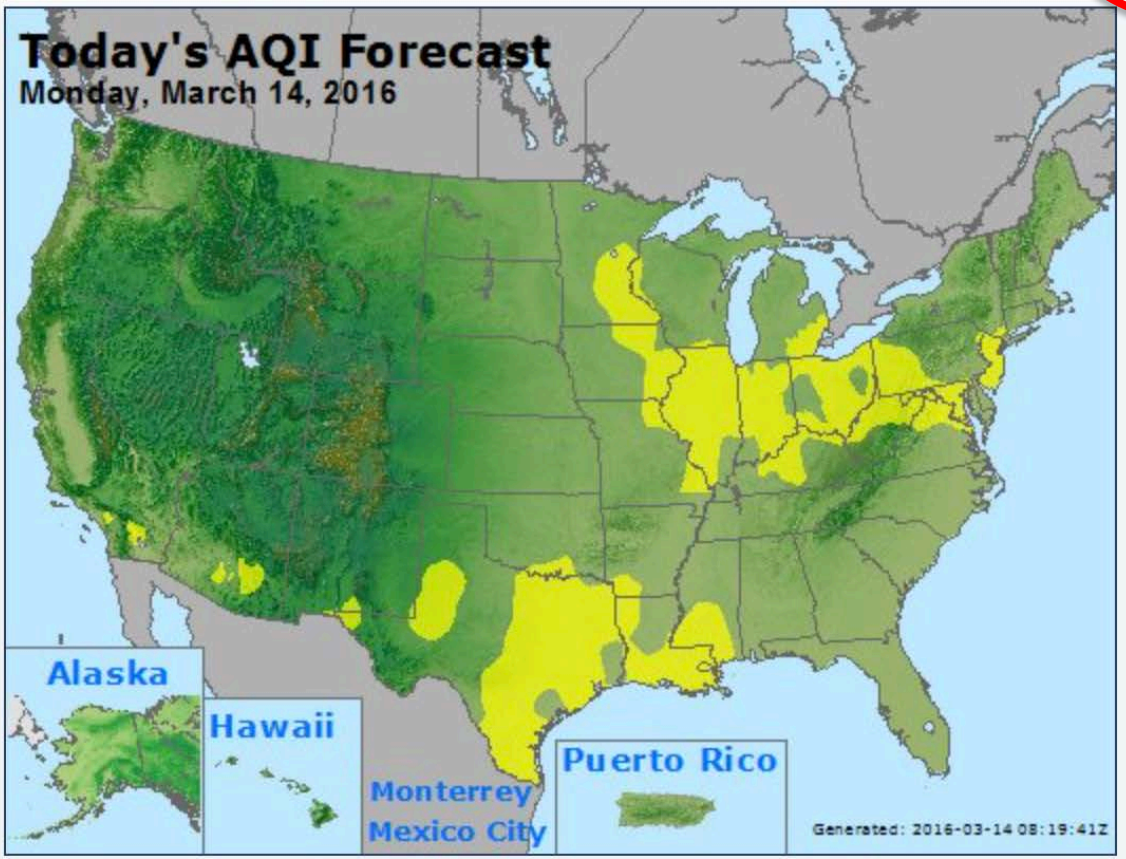
AirNow

Local Air Quality Conditions

Zip Code: Go State : Alabama Go National Summary

Go

Forecast | Current AQI | AQI Loop | More Maps



Good | Moderate | USG | Unhealthy | Very Unhealthy | Hazardous | ! Action Day

Fires: Current Conditions

Click to see map

U.S. Embassies and Consulates

Data from air quality monitors at select U.S. embassies and consulates around the world

Announcements

3/9/16: NEW: Spanish-language website for Air Quality Flag Program - NEUVO: En español—El sitio web de la programa de banderines sobre la calidad del aire

03/03/16: Now available! Heart Disease, Stroke, and Outdoor Air Pollution (en Español) - Enfermedades del corazón, ataques cerebrales y contaminación del aire

more announcements

Air Quality Basics

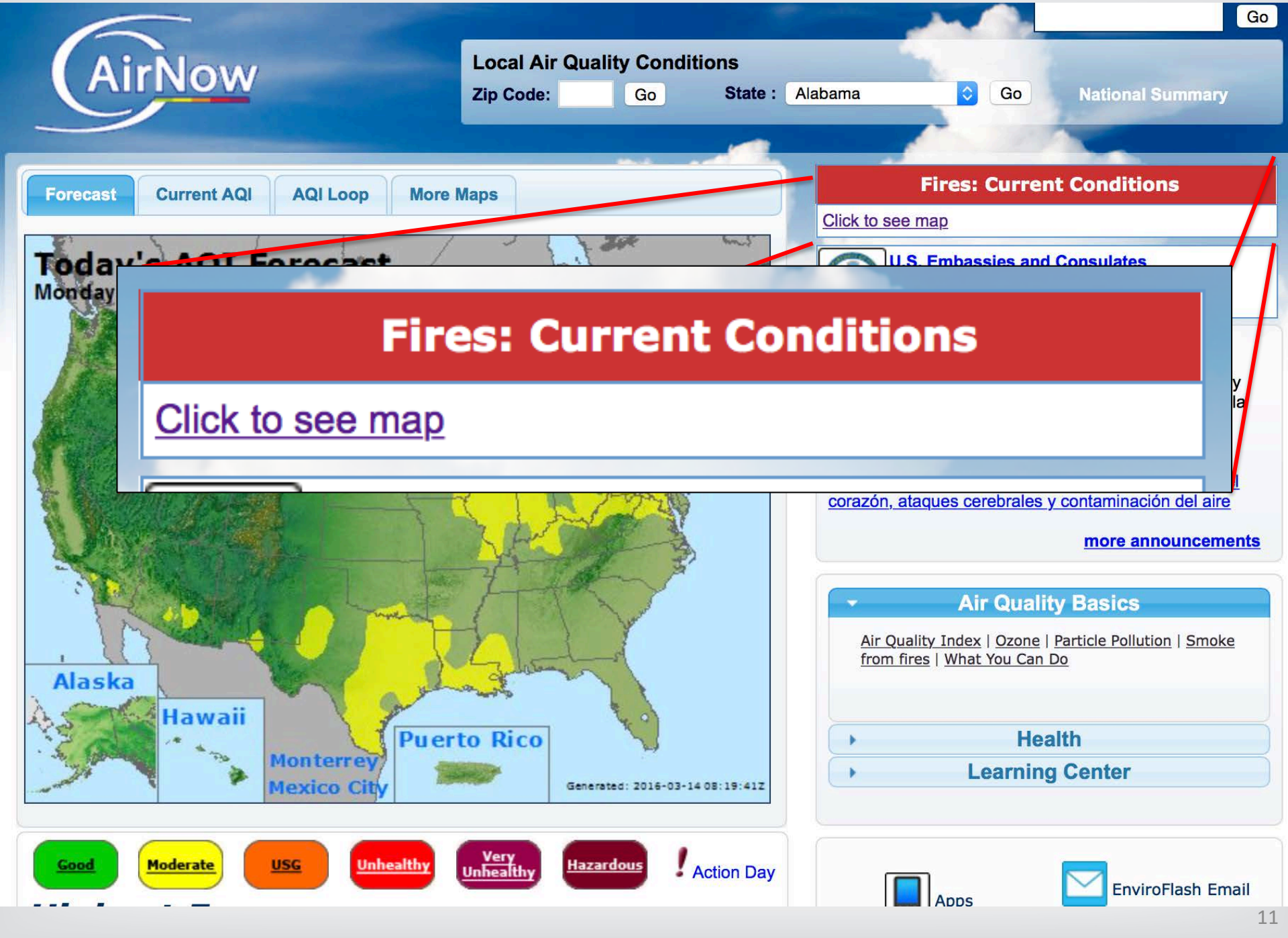
Air Quality Index | Ozone | Particle Pollution | Smoke from fires | What You Can Do

Health

Learning Center

Apps

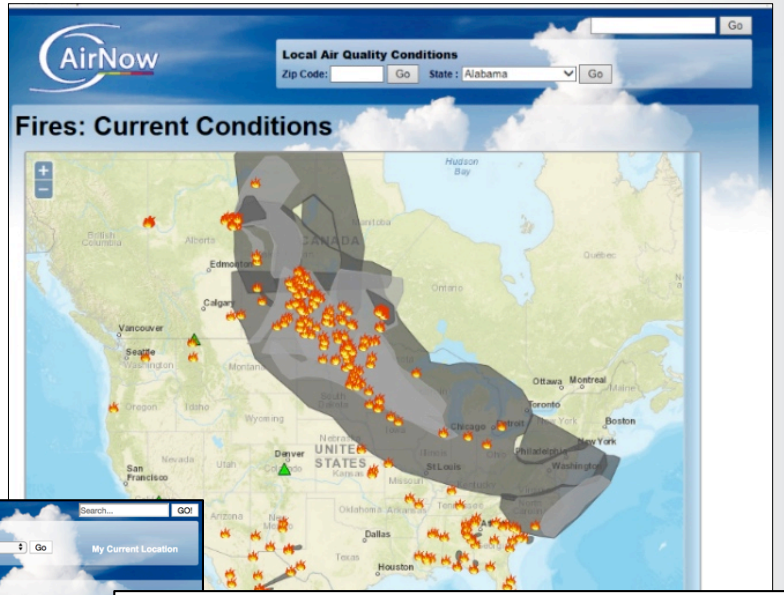
EnviroFlash Email

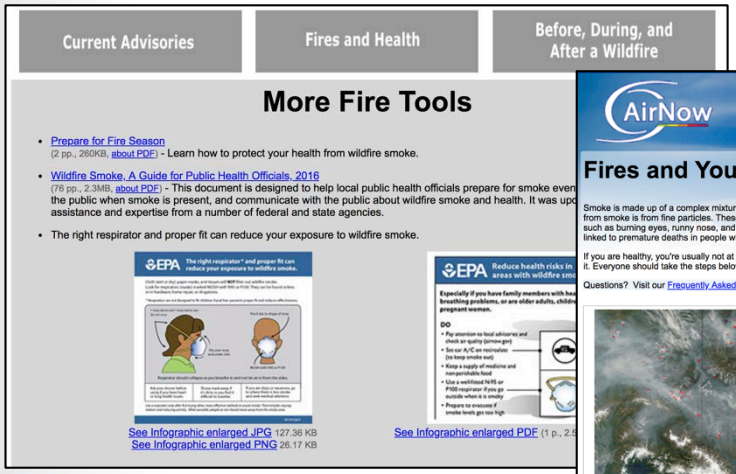


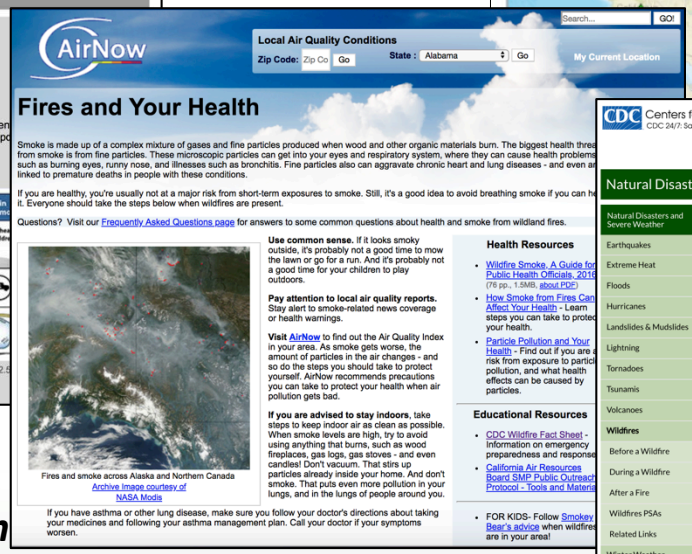
Fires: Current Conditions
Click to see map

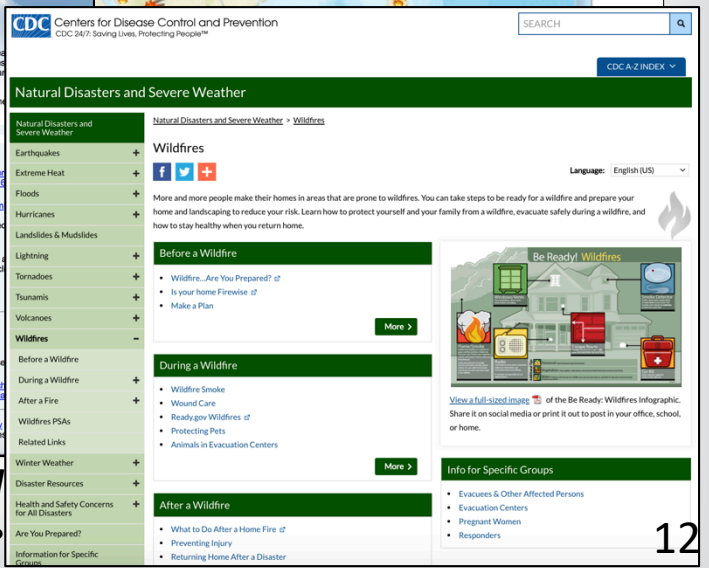
Fires: Current Conditions Page

- *Current Smoke Map generated by NOAA Hazard Mapping System*
- *Current Advisories – State/Local/Tribal agency blogs*
- *Wildland Fire Air Quality Response Program*









Fires and Your Health

CDC: Before, During and After a Wildfire

Wildland Fire Air Quality Response Program

Air Resource Advisors

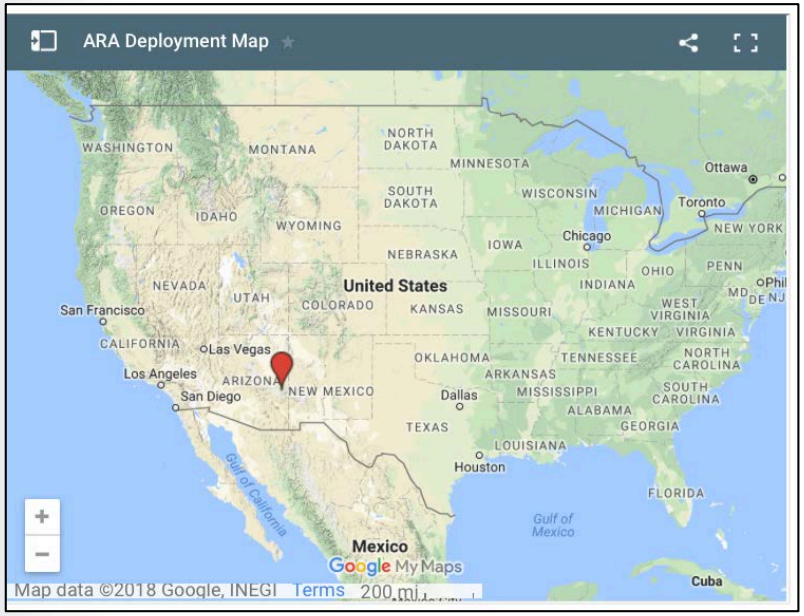
- Employed nationwide during large smoke events
- Assist on incidents to assist with understanding and predicting smoke impacts on the public and personnel.
- Analyze, summarize, and communicate these impacts to incident teams, air quality regulators, and the public

Monitoring

- Smoke monitors measuring $PM_{2.5}$ are tied into the GOES satellite system
- Near-real time data made available to the public via AirNow's website as well as smoke monitor data display systems developed by the Pacific Northwest Research Station's AirFire Team to support operational smoke forecasting.
- Orders for monitors are tied to the overall emergency response to a wildfire and the interagency systems which support incident management teams

Wildland Fire Air Quality Response Program

ARA Deployment Map



Coordination

- Success depends on contributions from numerous interagency partners

Modeling

- ARAs depend on daily smoke impact modeling of active wildfires
- Forecasts are produced by the USFS AirFire Team with their BlueSky smoke modeling system

How Smoke from Fires Can Affect Your Health

AirNow

Search... GO!

Local Air Quality Conditions

Zip Code: Zip Cc Go State : Alabama Go My Current Location

How Smoke from Fires Can Affect Your Health

Updated January 2017

Smoke may smell good, but it's not good for you

While not everyone has the same sensitivity to wildfire smoke, it's still a good idea to avoid breathing smoke if you can help it. And when smoke is heavy, such as can occur in close proximity to a wildfire, it's bad for everyone.

Smoke is made up of a complex mixture of gases and fine particles produced when wood and other organic materials burn. The biggest health threat from smoke is from fine particles. These microscopic particles can penetrate deep into your lungs. They can cause a range of health problems, from burning eyes and a runny nose to aggravated chronic heart and lung diseases. Exposure to particle pollution is even linked to premature death.

Some people are more at risk

It's especially important for you to pay attention to local air quality reports during a fire if you are

- **a person with heart or lung disease,** such as heart failure, angina, ischemic heart disease, chronic obstructive pulmonary disease, emphysema or asthma.
- **an older adult**, which makes you more likely to have heart or lung disease than younger people.
- **caring for children, including teenagers,** because their respiratory systems are still developing, they breathe more air (and air pollution) per pound of body weight than adults, they're more likely to be active outdoors, and they're more likely to have asthma.
- **a person with diabetes,** because you are more likely to have underlying cardiovascular disease.
- **a pregnant woman,** because there could be potential health effects for both you and the developing fetus.

How to tell if smoke is affecting you

https://airnow.gov/index.cfm?action=smoke.index

Public Health Recommendations

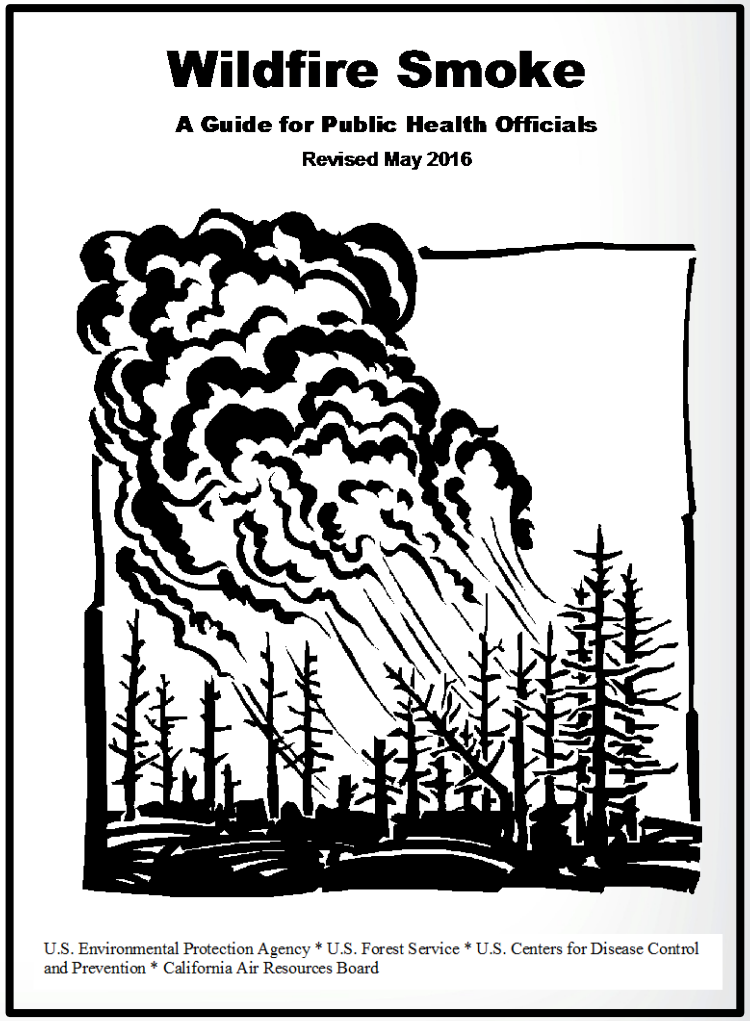
Exposure Reduction Measures

An individual can be advised to:

- Stay indoors
- Reduce outdoor physical activity
- Respirators (e.g., N-95) can help in the short-term
- Activate asthma/COPD action plans
- Use a home clean air shelter

A community can be advised to:

- Cancel outdoor events
- Provide community clean air shelters
- Increase air filtration in institutions
- Evacuate



https://www3.epa.gov/airnow/wildfire_may2016.pdf

High Particle Pollution Events
Wildfire Smoke

Patient Exposure and High Particle Pollution Events

On this page:

Introduction

Ozone and the other common pollutants rarely reach very high levels in the U.S. But almost every year, in many parts of the country, particle pollution levels reach the very unhealthy or hazardous ranges of the AQI. These events are usually associated with fires or dust storms. The fires are often wildfires, but on a smaller spatial and temporal scale high particle pollution levels may be found near other types of fires or combustion. Ex
wood burning in valleys during winte
for reducing exposure to particle pol
particles are wildfires, other fires, tra
needed with some fires depending o

Portions of the text in the following s
for Public Health Officials (May 2016)
for smoke events, to take measures t
with the public about wildfire smoke
assistance and expertise of a numbe
Control and Prevention, National Ins

Consistent with Wildfire Smoke: Guide for Public Health Officials

Wildfire Smoke Guide 2018

Anticipate Availability Late Summer/Fall

- ***Updated look***
- ***Smoke vs urban particles***
- ***Addition of ozone***
- ***Add sections***
  - *PM web course*
  - *Sensors*
  - *Ash clean-up*
- ***Stand-alone fact sheets***
  - *Children*
  - *Older adults*
  - *Older adults*
  - *Respirator use*
  - *Pets/livestock*
  - *Ash clean-up*
  - *Preseason preparedness*
  - *Exposure reduction*
  - *Know when to evacuate*

Wildfire Smoke Guide 2018

Fact Sheets Being Release as Approved

EPA United States Environmental Protection Agency

WILDFIRE SMOKE FACTSHEET

Children and Families

Background

- **Wildfires** expose children and women of reproductive age to a number of environmental hazards, e.g., fire, smoke, psychological stress, and the byproducts of combustion of wood, plastics, and other chemicals released from burnings structures and furnishings.
- **During the acute phase** of wildfire activity, the major hazards are fire and smoke.
- **Children, Pregnant Women**, individuals with pre-existing lung or cardiovascular diseases (e.g. asthma), impoverished populations are especially vulnerable to hazards due to wildfires.

Environmental Hazards

- Wildfire Smoke: Consists of very small organic particles, liquid droplets, and gases such as carbon monoxide (CO), carbon dioxide (CO2) and other volatile organic compounds (VOCs), such as formaldehyde and acrolein. The actual content of the smoke depends on the fuel source.

Health Effects from Smoke

- Symptoms from smoke inhalation can include chest tightness, shortness of breath, wheezing, coughing, respiratory tract and eye irritation and burning, chest pain, dizziness, or lightheadedness and other symptoms.
- Underlying conditions such as allergies and asthma symptoms may be exacerbated.
- The risk of developing cancer from short-term exposures to smoke is vanishingly small.

Recommendations

Prepare Before Wildfire Season

- **Stock up** so you don't have to g
  it's smoky. Have several days o
  medications on hand. Buy groce
  not need to be refrigerated or co
  because cooking can add to ind
  levels.
- **Create a "clean room"** in your
  Choose a room with as few win
  doors as possible, such as a b
  a portable air cleaner and avoid
  sources of pollution.
- **Buy a portable air cleaner** bef
  smoke event. High-efficiency pa
  (HEPA) filter air cleaners, and e
  precipitators that do not produce
  help reduce indoor particle level
- **Organize** your important items
  time and know where to go in ca
  have to evacuate.

EPA United States Environmental Protection Agency

WILDFIRE SMOKE FACTSHEET:
Indoor Air Filtration

Exposure to Particle Pollutants

Indoor sources of particulate matter (PM) come from combustion events such as smoking, candle burning, cooking and wood–burning. During a wildfire event, outdoor PM can increase indoor PM levels well above the levels normally found. As outlined in the Guide, reducing indoor sources of pollution is a major step to lower the concentrations of PM indoors. Further reductions in indoor PM can be achieved using one of the filtration options discussed below.

Filtration Options

There are two effective options for improving air filtration in the home: upgrading the central system filter, or using high efficiency portable air cleaning appliances. Before discussing filtration options, it is important to understand the basics of filter efficiency.

Filter Efficiency

The most common industry standard for filter efficiency is known as the Minimum Efficiency Reporting Value, or MERV rating. The MERV scale for residential filters ranges from 1-20. The higher the MERV rating the greater the percentage of particles captured as the air passes through the filter media. Higher MERV (higher efficiency) filters are especially effective at capturing very small particles that can most affect health.

Central Air System Filter

The filter used in the central heating/cooling system of the home can effectively reduce indoor PM. A home typically will have a low MERV (1-4) fiberglass filter that is 1" thick. filter with a medium efficiency significantly improve the air Higher efficiency filters (MER even better, and a true high e 16) in the central system can re as a 95%. However, these fil more resistance to air flow, wh energy used by the blower m You may wish to consult technician or the manufactur system to confirm that the syst efficiency filter. If you are not more efficient filter, simply continuously by switching t "Auto" to "On" has been sh concentrations by as much as

Portable Air Cleaners

Portable air cleaners are self- appliances that can be used al enhanced central filtration t particles. Their effectiveness depends on several factors su air cleaner, the filter efficienc unit is turned on and at what fa cleaners fitted with high efficie indoor PM concentrations by more.

Portable Air Clean Choose

There is a wide variety of air cl ranging in price from about $5 air cleaners under about $200 the air well and would not be situation.

Types of Air Cleaners

Most air cleaners fall under t mechanical and electronic. Me

WILDFIRE SMOKE FACTSHEET

Prepare for Fire Season

If you live in an area that is regularly affected by smoke or where the wildfire risk is high, take steps to prepare for fire season. Know how to get ready before a wildfire. Know how to protect yourself from smoke exposure during a wildfire.

Being prepared for fire season is especially important for the health of children, older adults, and people with heart or lung disease.

Prepare Before a Wildfire

- **Stock up** so you don't have to go out when it's smoky. Have several days of medications on hand. Buy groceries that do not need to be refrigerated or cooked, because cooking can add to indoor particle levels.
- **Create a "clean room"** in your home. Choose a room with as few windows and doors as possible, such as a bedroom. Use a portable air cleaner and avoid indoor sources of pollution.
- **Buy a portable air cleaner** before there is a smoke event. High-efficiency particulate air (HEPA) filter air cleaners, and electrostatic precipitators that do not produce ozone, can help reduce indoor particle levels.
- **Understand** how you will receive alerts and health warnings, including air quality reports and public service announcements, from local officials.
- **If you have heart or lung disease,** check with your doctor about what you should do during smoke events.
- **If you have asthma or another lung disease,** update your respiratory management plan.
- **Have a supply of N95 masks** and learn how to use them. They are sold at many home improvement stores and online.
- **Organize** your important items ahead of time and know where to go in case you have to evacuate.

Particulate Matter Web Course

For Healthcare Professionals and Educators

CME credit from CDC to physicians, nurses and health educators

EPA's Healthy Heart Program

Increasing Environmental Health Literacy

EPA's Healthy Heart program aims to prevent heart attacks and strokes by:

- Raising public awareness about the role outdoor air pollution plays in cardiovascular health, and
- Steps individuals can take to reduce their pollution exposure

http://www.epa.gov/healthyheart/

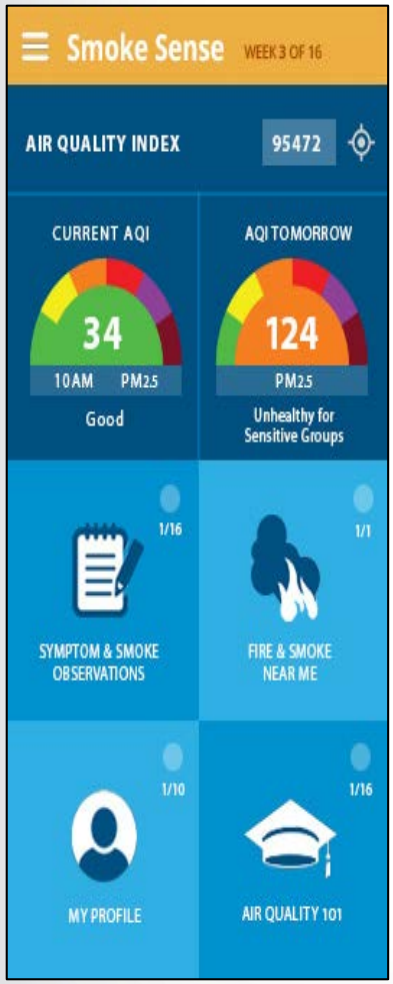
Healthy Heart Toolkit

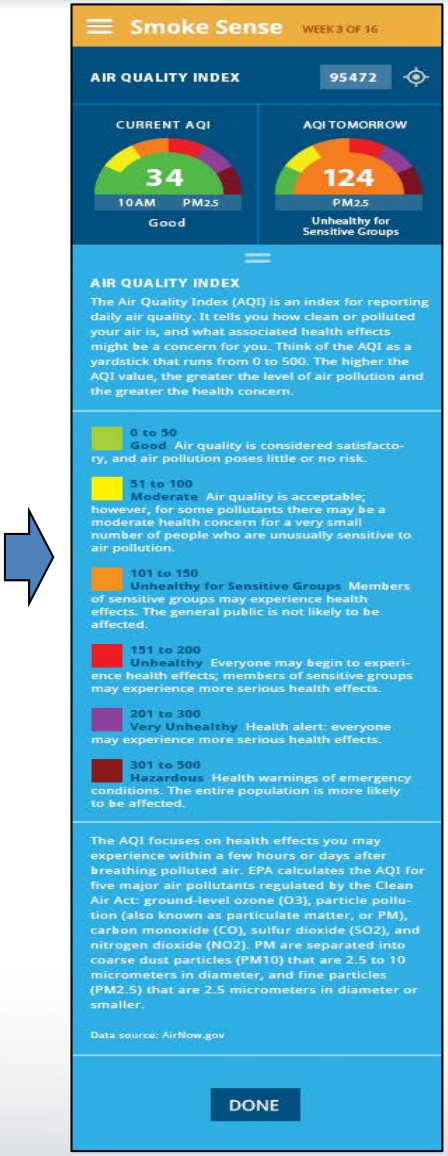
www.epa.gov/air-research/healthy-heart-toolkit-and-research

- *When are air pollution levels high?*
- *Are you at risk?*
- *Steps to Protect Your Heart*
- *How to Reduce your Risk?*
- *Warning Signs of a Heart Attack*
- *Warning Signs of a Stroke*

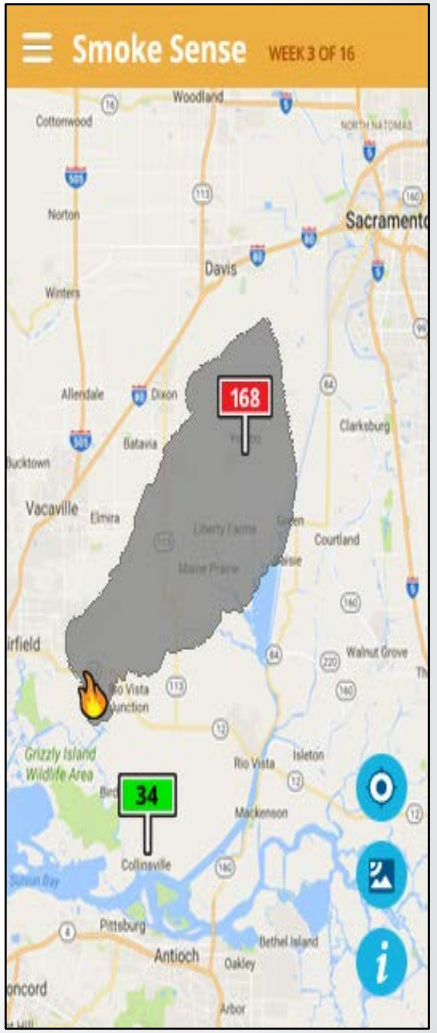
https://www.epa.gov/air-research/healthy-heart-toolkit-and-research-steps-you-can-take

Air Quality & Smoke Plume Info





- ***Smoke Sense provides information about current and future air quality***
- ***Forecasted smoke plumes can be visualized***
- ***Less time outside during smoke episodes to decrease exposure, & protect health***
- ***Smoke Sense helps collect information about who, when, and how frequently people are impacted by smoke***
- ***Information about smoke in the air and symptoms experienced in the past week will be logged***



Coming This Fall

AirNow Redesign

- **Look will be different: focus on local conditions**
- **Mobile-friendly web site**
- **Same great information**
  - Health Care Provider page
  - Fires: Current Conditions page
- **Better display of temporal changes in air quality**

Health Impacts of Wildfire Smoke Merit Our Attention & Action

- *Population & clinical health impacts are real and costly*
- *Intensity of wildland fires is increasing*
- *Size of vulnerable & sensitive populations is Increasing*
  - *Increasing area of the Wildland-Urban Interface*
    - *contains 60% of new homes built in the U.S. after 1990*
    - *contains 46 million single family homes, thousands of businesses, & a population greater than 120 million*
  - *Increasing size of the sensitive population*
    - *aging U.S. population with high prevalence of heart & lung disease*
    - *increasing prevalence of obesity and diabetes*
- *Drought and poor forest health are increasing risks of wildland fire and risks of co-morbidity*

Develop, Harmonize, Implement and Evaluate Impact Public Health Communication on Health Effects

- **Link wildfire smoke forecasts to public health messaging to decrease exposure**
- **Evaluate the effectiveness of:**
  - interventions to decrease wildfire smoke exposures and associated adverse health outcomes
  - PSAs (public service announcements) and other communication methods

Lui JC et al. *Environ Res* 136: 120–132, 2015

Thank you

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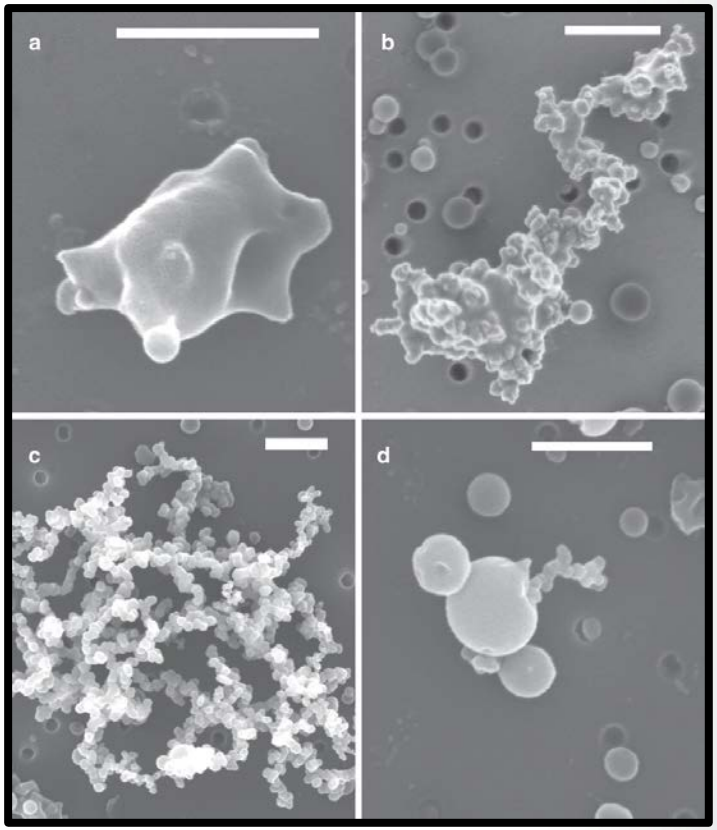
- No conflicts of interest
- The presentation represents the opinions of the speaker and does not necessarily represent the policies of the US EPA

Wildfire Smoke: A Complex Mixture
Depends on Fuel & Combustion Conditions

Cascade Complex, Idaho, 2007

Varies Spatially & Temporally

- **Particulate matter**
- **CO**
- **VOCs**
- **Trace gases**
- **Air toxics**
- **Metals**
- **Ozone**



China S, *et al. Nat Commun* 4, No.: 2122
doi:10.1038/ncomms3122

https://picasaweb.google.com/lh/photo/-ZF6POTn-Q0Dubaw7GCsktMTjNZETYmyPJy0liipFm0?full-exif=true

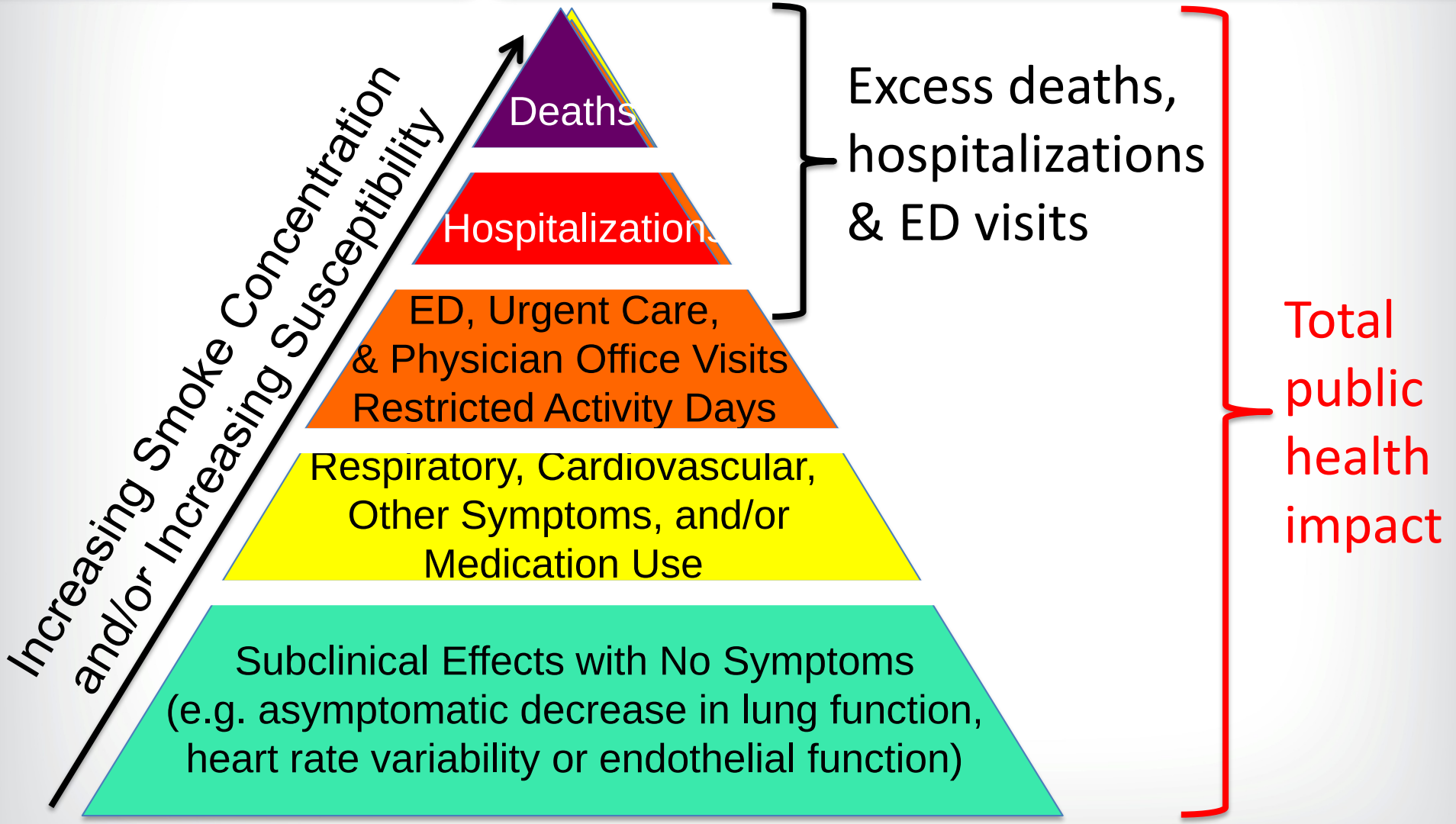
Estimating Health-Related Costs
2008 Pocosin Lakes National Wildlife Refuge

Satellite image showing the location of Evans Road Fire in the Pocosin Lakes National Wildlife Refuge, NC

- ***Burned 40K acres of peat bogs***
- ***$20M in suppression efforts, 2 billion gallons of water, 202 days***
- ***Cost of excess ED visits for asthma and heart failure ~ $1 million***
- ***Additional estimates of health costs***
  - 4.4 premature deaths
  - 31 non-fatal heart attacks
  - 41 bronchitis, & 810 asthma attacks
  - 530 lower respiratory symptoms
  - 769 upper respiratory symptoms
  - 3,700 work days lost
- ***Health & death-related costs $48.4 million***

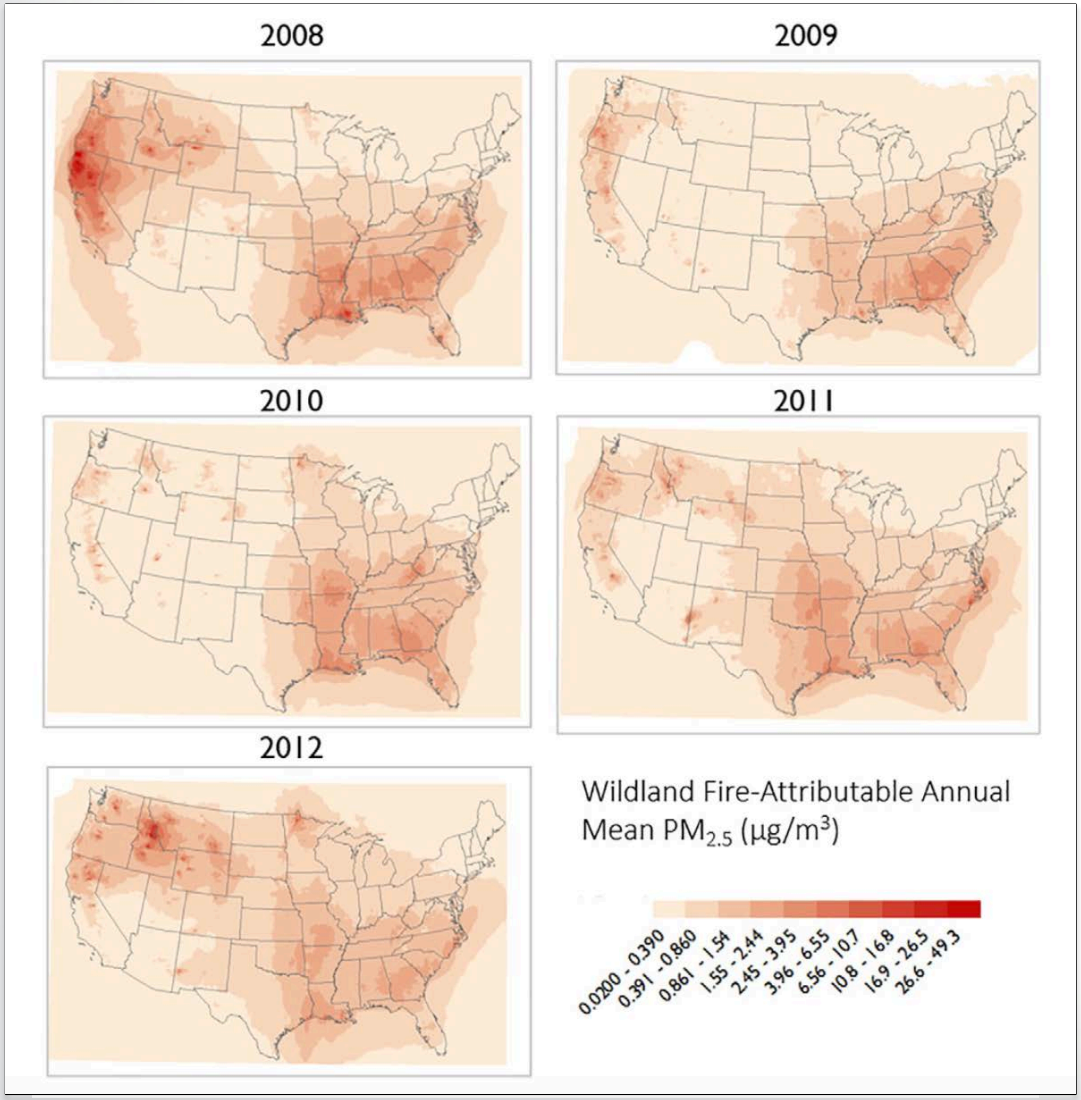
Rappold A et al. Environ Sci & Tech 2014

Wildland Fire Smoke and Population Health Effects

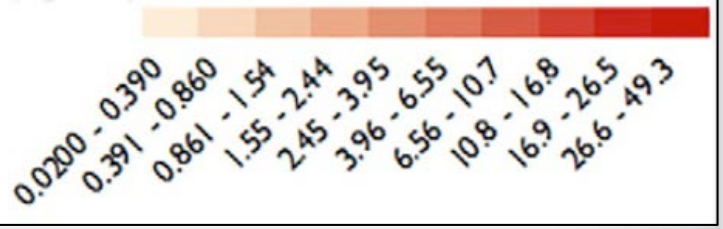


Size of Population Affected by Exposure to Wildfire Smoke

Annual U.S. Wildland Fire-Attributable $PM_{2.5}$ & Costs (2008-2012)



Wildland Fire-Attributable Annual Mean $PM_{2.5}$ ($\mu g/m^3$)



Estimated Economic Value of Wildfire-Attributed $PM_{2.5}$- Premature Deaths & Respiratory Admissions

Short-term **$63 billion**
(Range $6 -$170 billion)

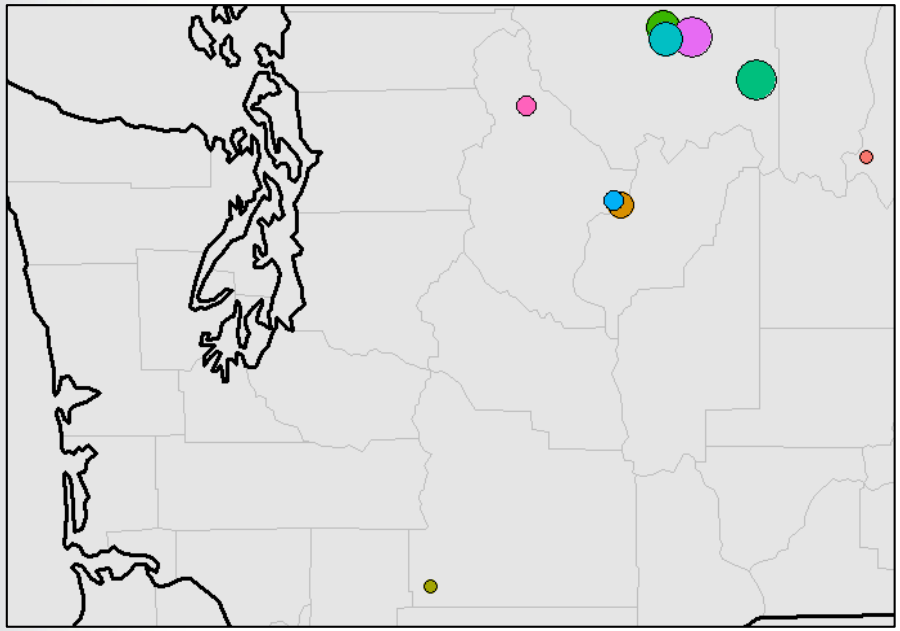
Long-term **$450 billion**
(Range $42 – $1000 billion)

Fann N et al. Science of the Total Environment 610–611 (2018) 802–809

Wildfire Smoke Information

Public Interest in AirNow

Locations for Fires > 50,000 Acres
Washington State for 2015



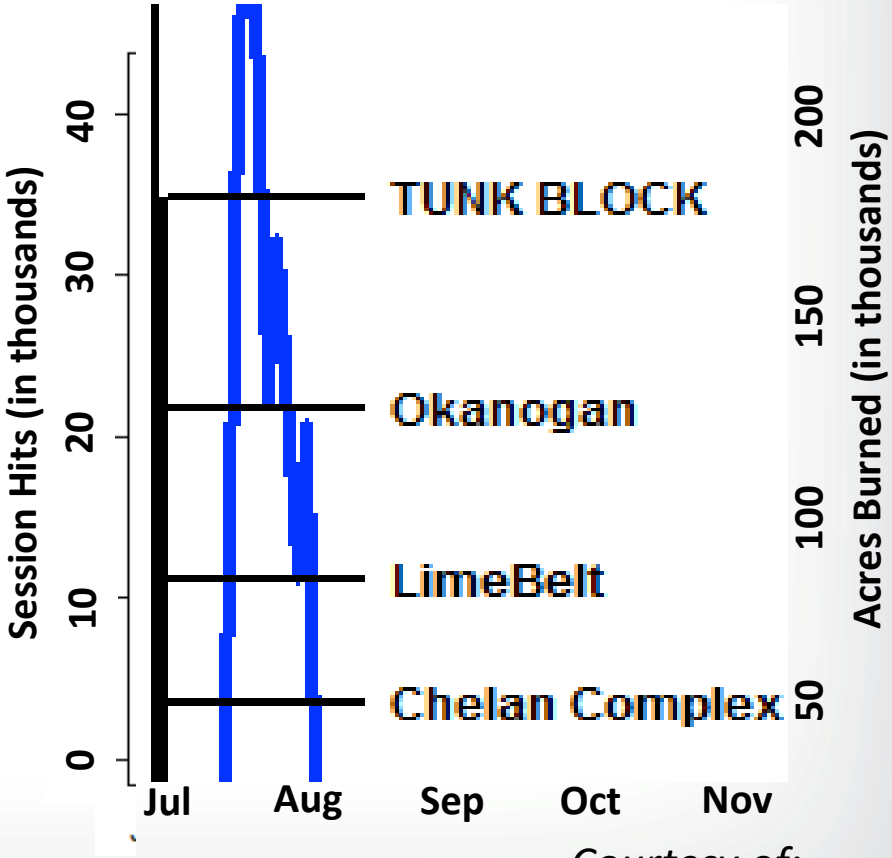
Acres Burned (thousands)

- (50, 70]
- (70, 76]
- (76, 100]
- (100, 150]
- (150, 220]

Fires

- CARPENTER RD.
- Chelan Complex
- COUGAR CREEK
- LimeBelt
- NORTH STAR
- Okanogan
- Reach
- STICKPIN
- TUNK BLOCK
- WOLVERINE

AirNow Sessions Hits
in Washington State 2015
With Fires Burning >50,000 Acres



Courtesy of:
Ana Rappold NHEERL/ORD/US EPA

Odds Ratio for Changing Activity due to Poor Air Quality

Susceptible category	Unadjusted	Adjusted
None (referent)		
Respiratory only	2.64 (2.06, 3.37)	2.61 (2.03, 3.35)
Cardiovascular only	1.16 (0.76, 1.77)	1.33 (0.86, 2.04)
>65 years only		
Respiratory & CV	4.06 (2.31, 7.15)	4.36 (2.47, 7.69)
Respiratory and >65 years	3.64 (2.35, 5.64)	3.83 (2.47, 5.96)
Cardiovascular and >65 yrs	1.23 (0.78, 1.91)	1.38 (0.89, 2.13)
All three groups	2.80 (1.94, 4.04)	3.52 (2.33, 5.32)

- 12% of the study population changed activities due to bad air quality
- 25% of those with a respiratory condition changed activities
- People with CV disease did not change their activity

NHANES 2007–2010, N = 10,898.

Wells EM, Dearborn DG, Jackson LW (2012). PLoS ONE 7(11): e50526