The mission of EPA is to protect human health and the environment.

Wildland fires are a national challenge impacting population health and ecological health through complex multi-media pathways.

While there are ecological benefits, uncontrolled wildfires and use of prescribed burning for fire control and agricultural cycling are increasingly raising questions related to potential impacts on:
  - Ambient air quality
  - Land management
  - Water quality
  - Effects of ecosystem services
  - Public health

The magnitude and frequency of these events is expected to worsen with our changing environment.
Increased acreage burned
• According to NIFC data, 9 of 10 years with the largest acreage burned have occurred since 2000, including the peak year in 2015

Increased impact on urban areas
• 10% of all land with housing are situated in the wildland-urban interface
• 38.5% of U.S. housing units (Radeloff et al. 2005)

>$1 billion every year to fight wildfires

Adapted from https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html
Higher Global Temperatures will Increase Burn Areas in the West

National Research Council
Various Facets of Wildland Fire

In Vivo Test
WILDFIRE PM (100 µg)
OROPHARYNGEAL ASPIRATION
MOUSE
BALF Analysis
- Lung injury
- Lung inflammation
- Cardiac function

Smoke Toxicology

Smoke Exposure (Monitors/Sensors)

EPA ACE Wildland Fire Research

Smoke Epidemiology
Public Health

Biomass Emissions Factors & Speciation

Smoke Emissions and AQ Impacts Modeling

Emergency Room Visits - Pocosin Fire
Air Quality Impacts: Near and Far

2014 National Emissions Inventory: ~32% of PM$_{2.5}$ emissions resulted from wildland fires

Annual average daily fire-PM$_{2.5}$ footprint for U.S. counties

How much does smoke contribute to air quality and how often does it lead to exceeding daily standard?

Primary NAAQS levels
- Annual: 12.0 μg/m$^3$ daily avg.
- Daily: 35 μg/m$^3$

# of days with fire-PM$_{2.5}$ above 35 μg/m$^3$ by counties of continental U.S.

Health effects known or suspected to be caused by wildland fire smoke
(Source: Studies reviewed in Liu et al 2015)

- All-cause mortality
- Asthma & chronic obstructive pulmonary disease (COPD) exacerbations
- Bronchitis & pneumonia
- Childhood respiratory disease
- Cardiovascular outcomes
- Adverse birth outcomes
- Symptoms such as eye irritation, sore throat, wheeze and cough
Who’s at Risk from Smoke?

At-risk populations include –
- Pregnant women and fetuses
- Children
- Older populations
- Populations with pre-existing respiratory disease
- Populations with pre-existing cardiovascular disease

Populations suspected to be at greater risk –
- Populations with chronic inflammatory diseases (e.g., diabetes, obesity)
- Women, African-Americans and populations with lower socio-economic status*

27% of U.S. population is at-risk

Changing U.S. Demographic Increases Wildfire Smoke-Related Risk

Changing U.S. Demographic
• U.S. population will continue to:
  o Grow
  o Median age will shift upward

Higher Prevalence of Chronic Diseases Conferring Risk to Wildland Fire Smoke
• Aging U.S. population with increasing prevalence of:
  o Heart-lung disease, obesity, diabetes

Source: Xu J, Murphy SL, Kochanek DK, Arias E. NCHS Data Brief No. 267, 2016
National map of community-health vulnerability index and air pollution awareness to adverse health effects

Factors of Vulnerability
- Peds & Adult Asthma
- COPD
- Obesity
- Diabetes
- Hypertension
- % population age 65+
- Income, education, poverty, unemployment

Community-Health Vulnerability Index Used in CDC-funded North Carolina Health Program

- Community-Health Vulnerability Index was translated for use in North Carolina
- Utilized CHVI to identify NC community most at risk to smoke health impacts
- Used CHVI to identify & add NC-specific layers (e.g., NC Forestry data)
- Engaged Hoke County stakeholders (e.g., local fire departments) with CHVI to discuss vulnerability to smoke health impacts
- CHVI discussion has given way to implementing prevention efforts, e.g. Smoke Sense

Courtesy of Lauren Thie NC Department of Public Health
Smoke Sense App

Aims of Smoke Sense:

• Measure the effect of wildfire smoke exposure on health and productivity

• Develop health risk communication strategies to improve public health outcomes

As part of this, researchers have developed a Smoke Sense mobile phone application to:

• Collect user input on how smoke events impact their health and daily activities, and

• Provide information about the smoke exposure and recommended health risk messages

Pilot Season

• 5,000+ individuals from across the nation made personal contributions by using the app over 50,000 times
Launched Wildland Fire Sensors Challenge in April 2017

- Intended to stimulate development of low-cost, light-weight, accurate, and easily deployable sensor technology that could be used by first responders and public health agencies during wildland fires
- Collaborative project between EPA, NASA, USFS, NOAA, CDC, NPS) and NGOs
- 9-month development window, testing and judging in 2018

Designing complementary projects with EPA Regional offices and other interested groups to field test sensors in a wildland fire scenario
Wildfire Impacts on Water Resources

- Soil Erosion/Sedimentation/Turbidity
- Pollutant Mobilization
  - Low dissolved oxygen (DO)
  - Increased ammonia from fire retardants
  - Elevated phosphorus, metals, iron, manganese, and nitrate
- Hydrologic Impacts
  - Increased Flooding
  - Debris flow

Wildfire and Drinking Water Systems

- Fire Impacts on Facilities
- Post Fire/Stormwater Impacts
  - Treatment Plants (pollutants mobilized, debris management)
  - Source Water Management (watershed stabilization, relocating intakes, dredging reservoirs, new water sources)

Courtesy of Jeff Peterson (Retired-Office of Water, EPA)
Wildfire and Surface Water Pollution

Phosphorus

TSS

Sediment

Runoff

Source: Morrison KD Modeling the impacts of wildfire on runoff... J Env Man 2015
Tree roots hold soil and rocks. When fires come through and damages trees, what happens when it rains?

Mudslides

2014 NCA: Key Findings: Extreme Events

- Average precipitation has increased since 1900
- Heavy downpours are increasing nationally
- Recent trend towards increased heavy precipitation events will continue even in regions where total precipitation is projected to decrease, such as the Southwest

Source: Alaska NPR https://www.alaskapublic.org/2013/05/13/couple-escapes-as-landslide-destroys-cabin/
Examples of Wildfire-Water Research

- Characterizing watershed vulnerability to wildfire-caused degradation of water quality
- Understanding impacts of wildfire on cold water refugia
- Forest health and water quality: assessment of how effects of disease and pests impact forest susceptibility to wildfire, and how these dead trees as fuel lead to water quality issues

Courtesy of Jeff Peterson (Retired-Office of Water, EPA)
A Few Highlights of Recent Activities

Wildland fire emissions
- Field and chamber work estimating emission factors and emission speciation; includes open burn test facility
- Field study in Flint Hills, KS region to characterize grassland emission factors

Monitors and sensors measuring fire exposures
- ACE wildland fire sensors challenge
- Leveraging research from other Federal agencies

Improved AQ modeling of plume rise, transport, and chemical evolution

Ongoing toxicological studies
- Differentiate wildland fire smoke impacts human health from a typical urban air
- How different phases of combustion (flaming to smoldering) impact health

Water
- Grants to evaluate fuel reduction practices on drinking water quality and associated modeling of drinking water utility management

Communication and outreach
- Smoke Sense App
- Pilot Social Science projects
- Smoke Ready Toolbox
- Wildfire Smoke: A Guide for Public Health Officials
EPA’s multi-disciplined fire-related research aims to address needs identified by our Program, Regional Office and State partners as well as other stakeholder groups, like you.

Thank you

Baghdikian.Christina@epa.gov

EPA researchers lift a monitoring balloon to evaluate a prescribed fire in Camp Lejeune, NC
Resources for Protecting the Public from Smoke and Ash

Susan Lyon Stone
stone.susan@epa.gov

National Environmental Health Association
NEHA
Webinar
May 2, 2018
What Is the Air Quality Index?

• The Air Quality Index (AQI) is EPA’s color-coded tool for telling the public how clean or polluted the air is

• It recommends steps people can take to reduce their daily exposure to pollution

• The AQI converts pollutant concentrations to a number on a scale from 0 to 500; generally a value of 100 is equal to the level of the short-term standard

• Cities and states use the AQI for reporting and forecasting air quality

• Metropolitan statistical areas with a population over 350,000 are required to report the daily AQI value (40 CFR Part 58 Appendix G)

• Reporting requirements:
  • Daily to the news media and a publicly available location such as the internet
  • When AQI is greater than 100, it is critical that reporting to the news media be as extensive as possible.
  • Real-time data reporting and voluntary action programs that provide timely air quality information may also be used to meet reporting requirements
# AQI Categories and Health Messages

<table>
<thead>
<tr>
<th>Category Descriptor</th>
<th>Index Value</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>0 to 50</td>
<td>Air quality is considered satisfactory, and air pollution poses little or no risk.</td>
</tr>
<tr>
<td>Moderate</td>
<td>51 to 100</td>
<td>Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.</td>
</tr>
<tr>
<td>Unhealthy for Sensitive Groups</td>
<td>101 to 150</td>
<td>Members of sensitive groups may experience health effects. The general public is not likely to be affected.</td>
</tr>
<tr>
<td>Unhealthy</td>
<td>151 to 200</td>
<td>Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.</td>
</tr>
<tr>
<td>Very Unhealthy</td>
<td>201 to 300</td>
<td>Health alert: everyone may experience more serious health effects.</td>
</tr>
<tr>
<td>Hazardous</td>
<td>301 to 500</td>
<td>Health warnings of emergency conditions. The entire population is more likely to be affected.</td>
</tr>
</tbody>
</table>
Air Quality Index

• Pollutant-specific health effects and cautionary statements address question “who will be affected”

• Based on health information supporting the NAAQS
  • Controlled human exposure, epidemiological studies exposure/risk assessments used to set breakpoints
  • Epidemiological studies useful for identifying risk factors and more serious effects
  • Controlled human exposure studies useful for identifying proportion of healthy population affected, symptoms, mechanisms of effects, genetic variability

How to use the AQI to lower the dose of inhaled pollution:

Dose = Concentration x Ventilation rate x Time
  C - be active outdoors when air quality is better
  V - take it easier when active outdoors
  T - spend less time being active outdoors

Since people respond differently - PAY ATTENTION TO SYMPTOMS!
Fires: Current Conditions

AirNow (airnow.gov)
Fires: Current Conditions

AirNow redesign coming later this summer!!!!
Information will be available in
• Current Air Quality (circled)
• Map (below)

AirNow (airnow.gov)
Fires: Current Conditions
Fires Current Conditions Map

- Current Conditions map for August 18, 2017
- Smoke map generated by NOAA Hazard Mapping System (HMS)
- Updated about 5 times a day
- Uses satellite data, enhanced now that GOES-16 is operational
Fires: Current Conditions – Current Advisories

Smoke Forecast Outlook, Chetco Bar Fire, 8/18/17, 10:45 am
How Smoke from Fires Can Affect Your Health

- New document - currently in html only
- May develop pdf version

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

- Revised by EPA/CDC and NIOSH/USFS/California Agencies
- Updated air quality and health information
- Exposure reduction measures incorporate stronger evidence base
- Entirely new section on communicating air quality
  - Uses “Current PM” levels from AirNow
  - Uses satellite information on Fires: Current Conditions page
  - Visual range information updated
- New fact sheets about children’s health

https://www3.epa.gov/airnow/wildfire_may2016-revised.pdf
✓ Prepare for Fire Season
  • Protect Your Lungs
  • Indoor Air Filtration
  • Reduce Your Smoke Exposure
  • Children’s Health and Wildfire Smoke
  • Protect Yourself from Ash

https://www3.epa.gov/airnow/smoke_fires/prepare-for-fire-season.pdf
Wildfire Guide – Next Revision

- Updated look
- Health effects section
  - Addition of ozone
  - Multi-day exposure
  - Heat and smoke
  - Smoke vs urban particles
- Add sections
  - PM web course for health professionals
  - Sensor use
  - Ash clean-up
- Additional fact sheets
  - Older adults
  - Pets
  - Livestock
  - After the Fire
Infographics

**EPA**

The right respirator* and proper fit can reduce your exposure to wildfire smoke.

Cloth (wet or dry), paper masks, and tissues will **NOT** filter out wildfire smoke. Look for respirators marked NIOSH with N95 or P100. They can be found online, or in hardware, home repair, or drugstores.

* Respirators are not designed to fit children. Facial hair prevents proper fit and reduces effectiveness.

- I strap above and I strap below ears.
- Do not cross
- Pinch nose to shape of nose
- Fits over nose and under chin
- NIOSH with N95 or P100
- Respirator should collapse as you breathe in and not let air in from the sides.

**DO**

- Pay attention to local advisories and check air quality (airnow.gov)
- Set car A/C on recirculate (to keep smoke out)
- Keep a supply of medicine and non-perishable food
- Use a well-fitted N-95 or P100 respirator if you go outside when it is smoky
- Prepare to evacuate if smoke levels get too high

**KEEP AIR CLEAN**

- Close windows and doors.
- Close fresh intake on A/C units.
- If your home is too warm, try to stay with friends or relatives.

Use a portable air cleaner with HEPA filters properly sized for a specific room.

**DON’T**

- ✗ Fry or broil foods, which can add particles to indoor air
- ✗ Use a fireplace, gas logs or gas stove
- ✗ Play or exercise outdoors
- ✗ Smoke indoors
- ✗ Vacuum, it can stir up dust

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https://airnow.gov/static/topics/images/epa-infographic-respirator.jpg

PM Web Course for Healthcare Professionals

This web course and the following tools can be found at: https://airnow.gov/index.cfm?action=health_providers.index
What Is It? Who Is It For?

*Particle Pollution and Your Patients’ Health* is an evidence-based training course that:

- Describes the biological mechanisms responsible for the cardiovascular and respiratory health effects associated with particle pollution exposure
- Helps health-care providers advise their patients about particle pollution exposure
- Provides practical education tools to help patients understand how particle pollution exposure can affect their health and how they can use the Air Quality Index to protect their health

*Particle Pollution and Your Patients' Health* is designed for family medicine physicians, internists, pediatricians, occupational and rehabilitation physicians, nurse practitioners, nurses, asthma educators, pulmonary specialists, cardiologists, and other medical professionals who counsel patients about lung, heart or vascular disease

Offers Continuing Education Credits to physicians, nurses, health educators
- Continuing education for clinicians is required for continued licensure in many states
Patient Exposure and the AQI

Patient Exposure and the Air Quality Index

On this page:

- Should I recommend that my patients reduce their exposure to particle pollution?
- What is the Air Quality Index (AQI)?
- Where can I find daily air quality reports?
- What can I advise my patients to do when air quality is unhealthy?
- How can my patients reduce particle pollution exposure near roads?
- How effective are air quality notifications in reducing potentially adverse health effects?
- What education materials are available?

Should I recommend that my patients reduce their exposure to particle pollution?

Yes. All people should be educated about the health effects from unhealth levels of pollution and how to reduce exposure.

Patients more likely to be affected by particle pollution exposure that should consider exposure-reduction measures are:
High Particle Pollution Events

Consistent with Wildfire Smoke
A Guide for Public Health Officials
Why a Course for Clinicians?

- Part of CDC’s Behavioral Risk Factor and Surveillance System of health related telephone surveys
  - In 2005 six states included questions about how environmental factors and the AQI affect people’s activity levels
  - The states: Colorado, Florida, Indiana, Kansas, Massachusetts, and Wisconsin
- Results highlights:
  - **People with lifetime asthma** were almost twice as likely to report a change in activity based on an air quality alert if they had been advised by a healthcare professional to do so (Wen et al., 2009)
  - **People without asthma** were than three times as likely to report such a change, if they had been advised by a healthcare professional to do so. (Wen et al., 2009)
  - **In Kansas**, people were almost four times as likely to change outdoor activity levels if they were advised by a healthcare professional.
  - BUT: only a small percentage of people in groups considered to be at increased risk from particle pollution reported that healthcare professionals had advised them to pay attention to the AQI. (Kansas Department of Health and Environment, 2006).
PM Web Course Outreach Materials

Particle Pollution and Your Patients’ Health Web Course

An extensive body of scientific evidence shows exposure to fine particle pollution may lead to a range of adverse health effects, including heart and lung effects, and even premature death. This course will provide health professionals with knowledge they can share with patients to help reduce overall risk of particle pollution-related health effects, particularly in individuals with heart and lung disease.

https://www.airnow.gov/index.cfm?action=health_providers.index
Downloadable Factsheets for Heart and Lung Disease
In English and Spanish

Asthma

https://www3.epa.gov/airnow/asthma-flyer.pdf

Cardiovascular Disease – February 2016

https://www3.epa.gov/airnow/heartflyer.pdf
Important Planning Tool

National Interagency Fire Center (NIFC) – updated monthly; current predictions through July 2018

https://www.predictiveservices.nifc.gov/outlooks/outlooks.htm
Sensor Concentration ≠ Air Quality Index

<table>
<thead>
<tr>
<th>Sensor Reading</th>
<th>Air Quality Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration</td>
<td>Index Value &amp; Color</td>
</tr>
<tr>
<td>Short term</td>
<td>Averaged (e.g. 8-hour, 24-hour)</td>
</tr>
<tr>
<td>(e.g. 1-minute)</td>
<td>Data Quality Assured</td>
</tr>
<tr>
<td>Data Quality</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
</tr>
</tbody>
</table>
Air Resource Advisors: Forecasting Wildfire Smoke

Ali Kamal, PhD | Health Scientist
Health & Environmental Impacts Division
Office of Air Quality Planning & Standards
U.S. Environmental Protection Agency
May 2, 2018
Introduction to the ARA Program

- What is the Air Resource Advisor (ARA) Program?

- What does an ARA do?
Introduction to the ARA Program

-Between 2005 and 2014, 6.4 Million Acres Burned on average in the US, in 2015, +10 Million Acres Burned, 2017 costs highest on record
Introduction to the ARA Program

- Between 2005 and 2014, 6.4 Million Acres Burned on average in the US, in 2015, +10 Million Acres Burned, 2017 costs highest on record

- The fire season is getting longer, drier and hotter summers, less snow pack, El Niño effects, communities closer to fire-prone areas, and many years of unburned fuels.

- The only real control strategy is Prescribed Burns to reduce the risk, but once a wildfire is burning, Avoidance through Messaging is the only option.
The Need for ARAs

-Air quality early-warnings are effective at protecting at-risk populations (AirNow, AQI, Wildfire Smoke Guide)

-ARAs are dispatched to predict smoke impacts on the public & fire crews

-ARAs relay smoke information to the public to mitigate smoke exposure
ARA Deployments

• Number of ARAs Dispatched
  2017: 101    2014: 39
  2016: 55    2013: 25
  2015: 40    2012: 13

• More than 1200 Daily Smoke Forecasts were produced in 2017
What does an ARA do?

Modeling
- Smoke Impacts (BlueSky)
- Hysplit/Playground 2.0

Monitoring
- Real-Time PM Monitoring
- Observing Fire Behavior

Messaging
- Smoke Forecasts
- Meeting/Briefings
Modeling: Projecting the Path of Smoke

- Meteorological Data
- Infrared Satellite Data
- 72 Hour Projections
- Help ARAs forecast the smoke for the next 1 to 2 days
Monitoring: Smoke Observations

- Determine the siting of PM$_{2.5}$ monitors to track the smoke near at-risk communities
- Hourly PM$_{2.5}$ data is uplinked by satellite and accessible in an online database
- Observe day/night trends and how smoke behaves in downwind communities
Messaging

• Daily Smoke Forecasts provide communities with expected smoke impacts

• Public can then make informed decisions on when to go outside and when to take shelter
ARAs and the Public

- Social Media (Facebook/Twitter)
- Air Quality Blogs/Inciweb
- Reach Out to Local Groups
- *Inform* Incident Commanders
- Attend Public Meetings
- Available to Answer Questions
- Go out and talk to people!
Thank you
wildlandfiresmoke.net

Ali Kamal
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