

# Wildland Fire Research

## Overview and Highlights



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# EPA, Wildland Fire and Smoke

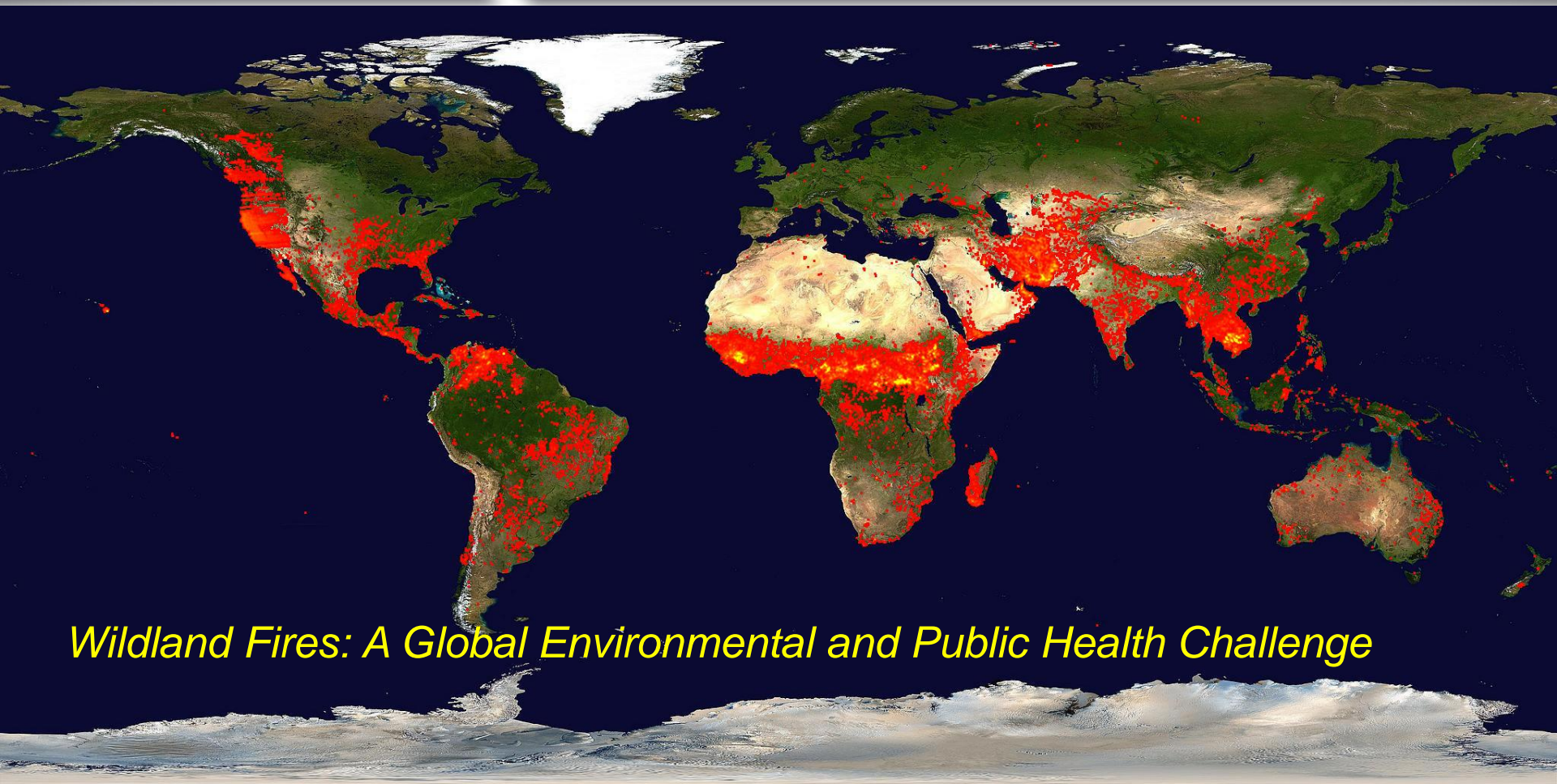
- The mission of EPA is to protect human health and the environment
- Wildland fires are a national challenge impacting population health and ecological health through complex multi-media pathways
- While there are ecological benefits, uncontrolled wildfires and use of prescribed burning for fire control 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







# *Wildland Fires & Emissions* Global Public Health Challenge



*Wildland Fires: A Global Environmental and Public Health Challenge*

URL: [lance-modis.eosdis.nasa.gov/cgi-bin/imagery/firemaps.cgi](http://lance-modis.eosdis.nasa.gov/cgi-bin/imagery/firemaps.cgi)

Global Fire Map 2/20/2016 – 2/29/2016



# A National Concern

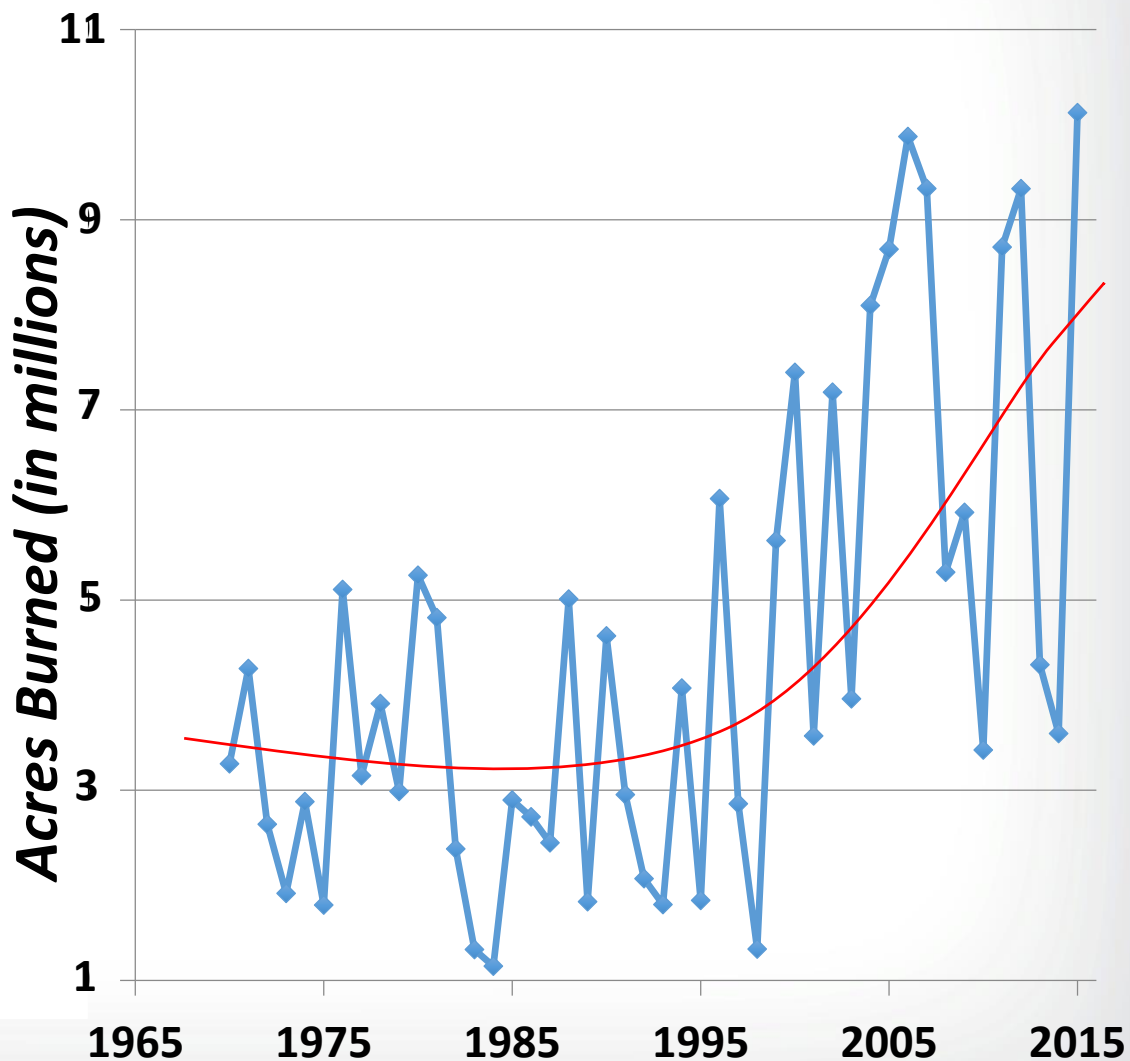
## Increased acreage burned

- 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

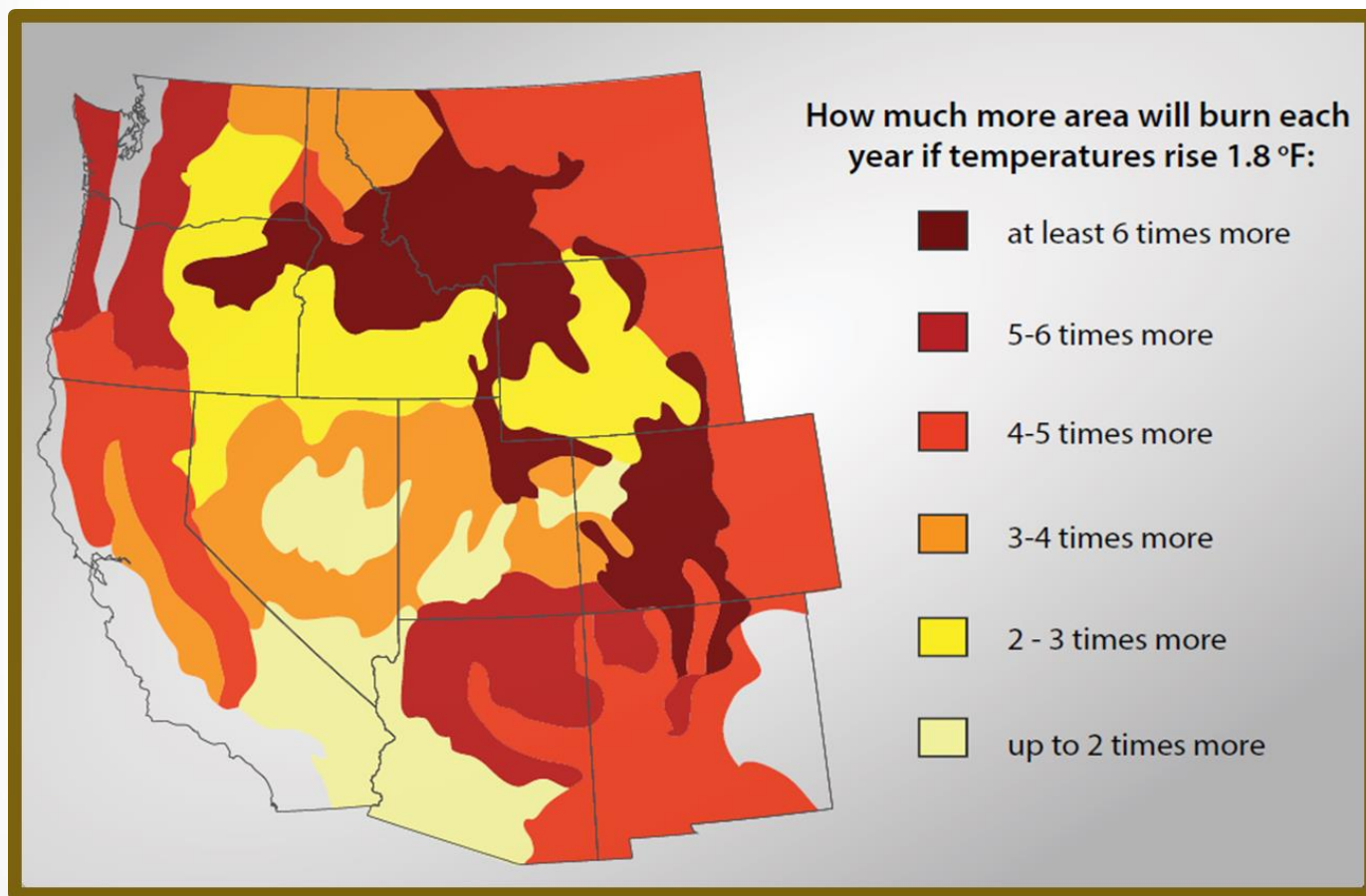
- 10% of all land with housing are situated in the wildland-urban interface
- 38.5% of U.S. housing units (Radeloff et al. 2005)

**>\$1 billion every year to fight wildfires**



Adapted from [https://www.nifc.gov/fireInfo/fireInfo\\_stats\\_totalFires.html](https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html)

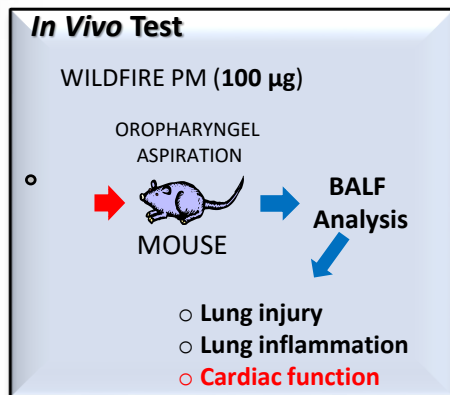
# Higher Global Temperatures will Increase Burn Areas in the West



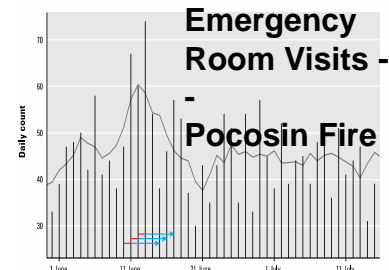
National Research Council



# Various Facets of Wildland Fire



**Smoke Toxicology**



**Smoke Exposure (Monitors/Sensors)**

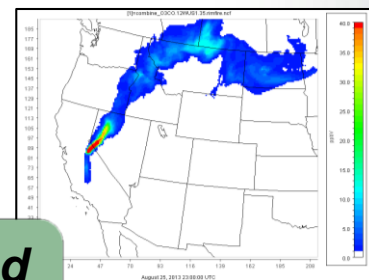
**Smoke Epidemiology Public Health**

**EPA ACE Wildland Fire Research**



**Biomass Emissions Factors & Speciation**

**Smoke Emissions and AQ Impacts Modeling**



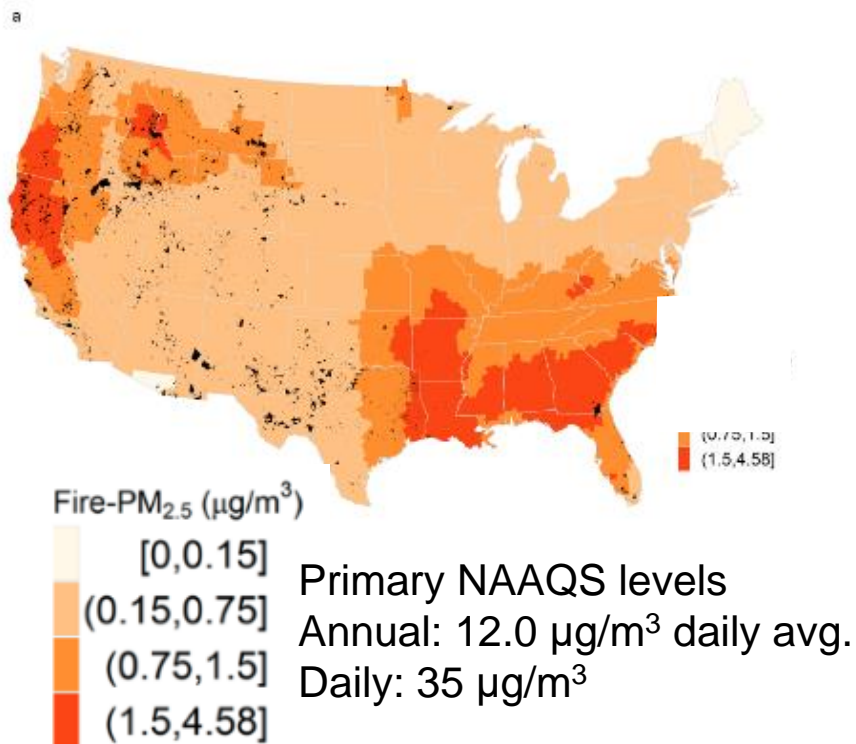




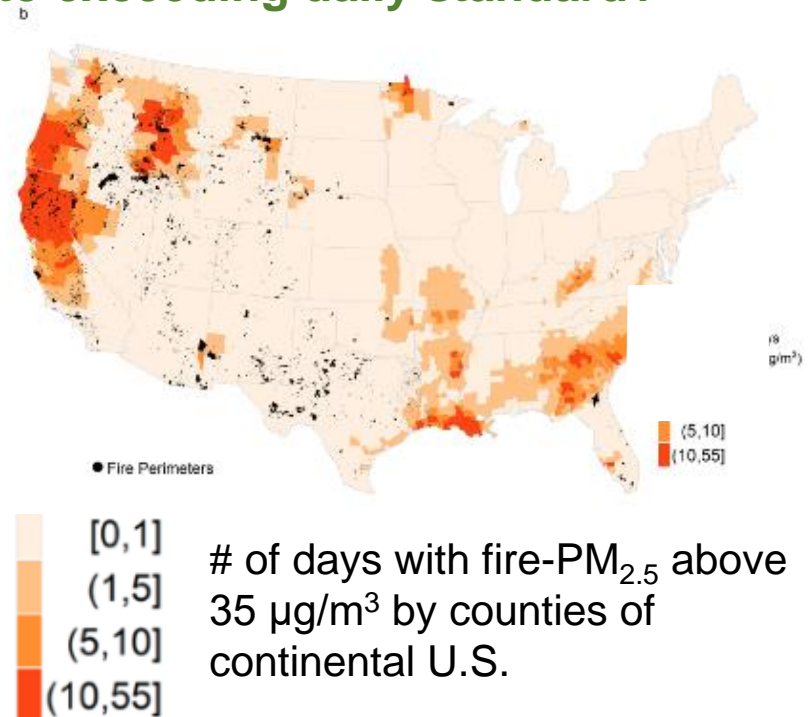
# Air Quality Impacts: Near and Far

**2014 National Emissions Inventory: ~32% of PM<sub>2.5</sub> emissions resulted from wildland fires**

## Annual average daily fire-PM<sub>2.5</sub> footprint for U.S. counties



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



Source: Rappold AG, et al. Environ Sci Technol 2017



# Health Effects Linked to Smoke from Wildland Fires

## *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

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

## 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\*



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

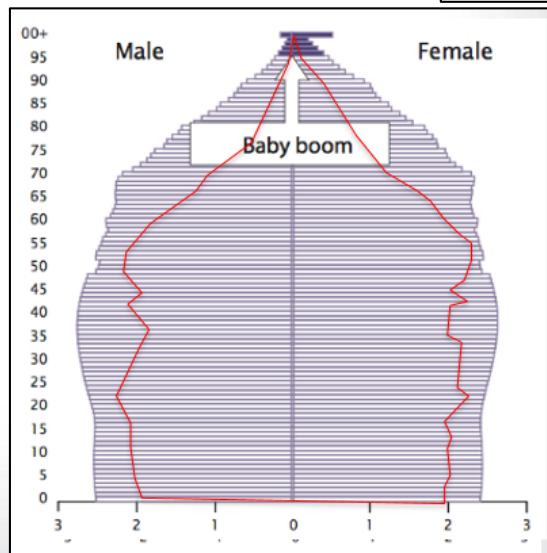
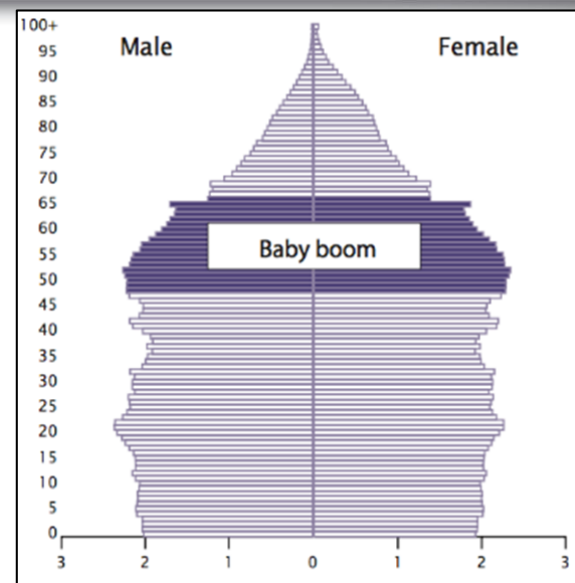
## Changing U.S. Demographic

- U.S. population will continue to:
  - Grow
  - Median age will shift upward

## Higher Prevalence of Chronic Diseases Conferring Risk to Wildland Fire Smoke

- Aging U.S. population with increasing prevalence of:
  - Heart-lung disease, obesity, diabetes

U.S. Population  
2012

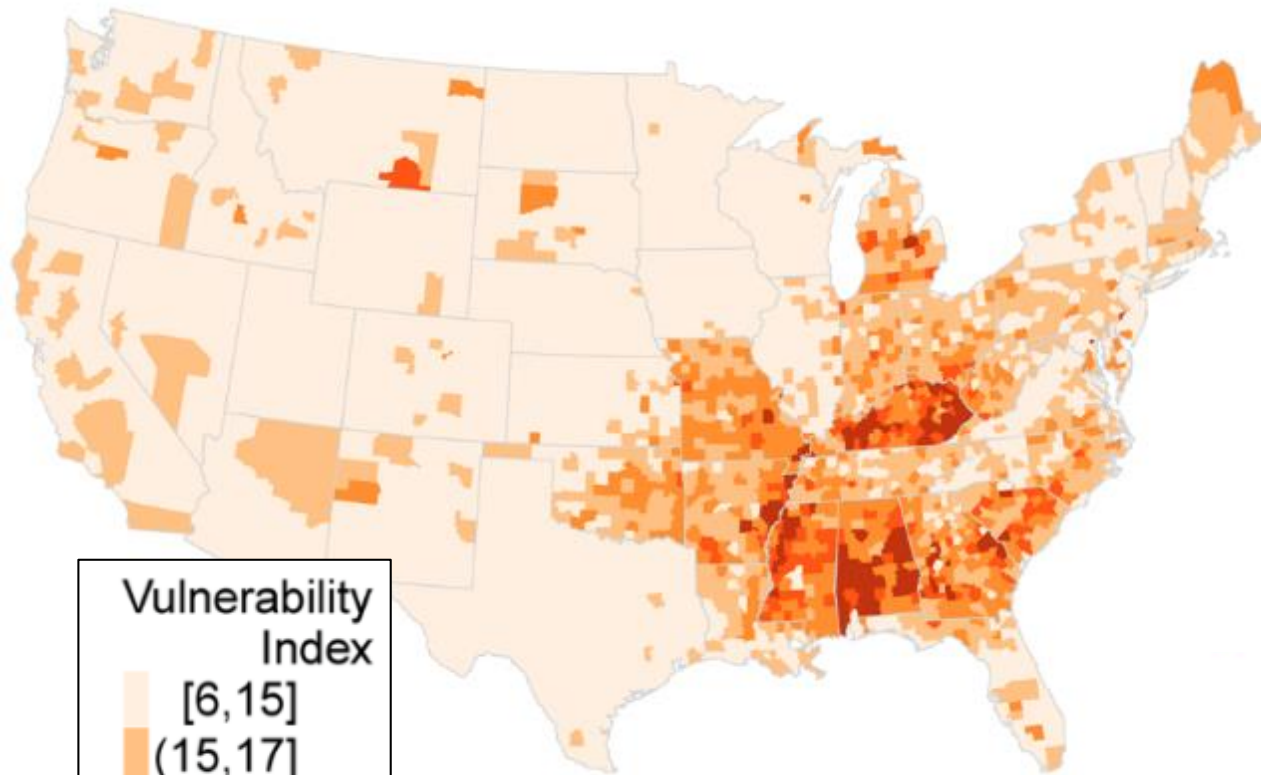


Projected U.S.  
Population 2060

(2012 U.S. Population –  
Red outline)

Source: Xu J, Murphy SL, Kochanek DK, Arias E. NCHS Data Brief No. 267, 2016

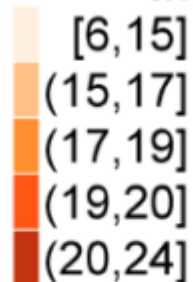
## National map of community-health vulnerability index and air pollution awareness to adverse health effects



### Factors of Vulnerability

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

#### Vulnerability Index



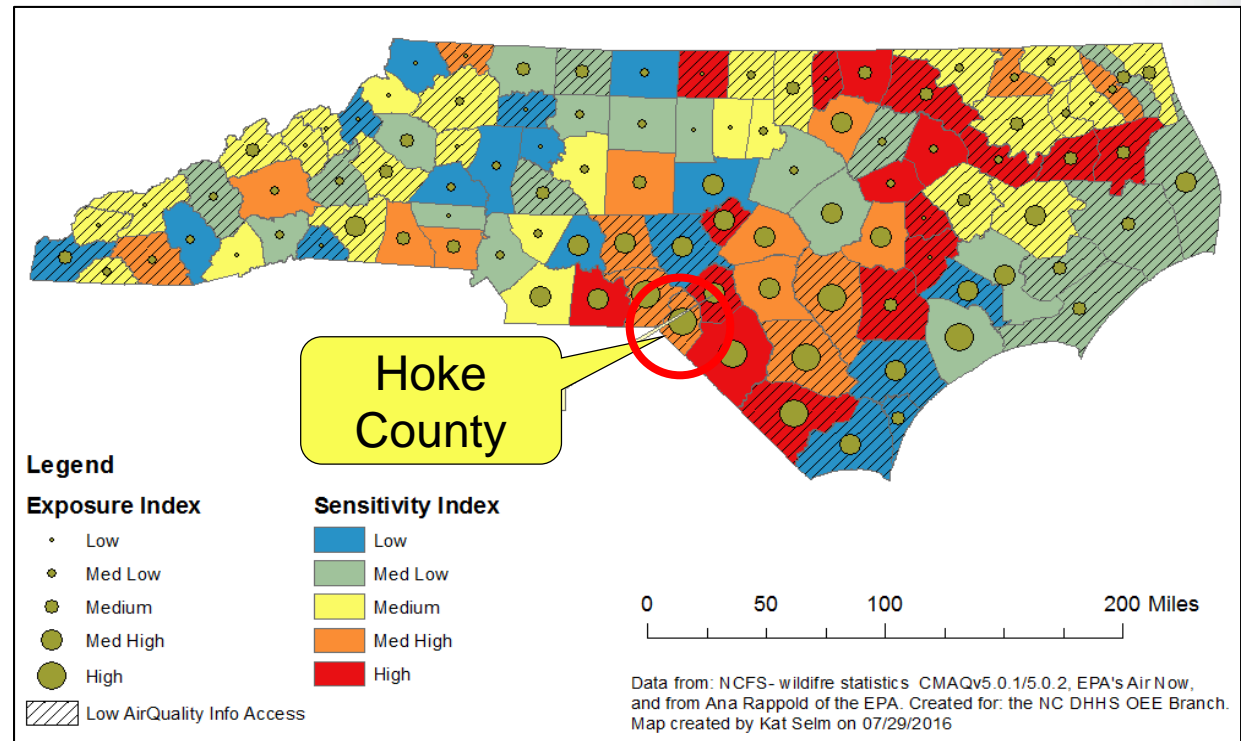
Source: Rappold AG, et al Environ Sci Technol 2017





## 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





# Smoke Sense App



## Aims of Smoke Sense:

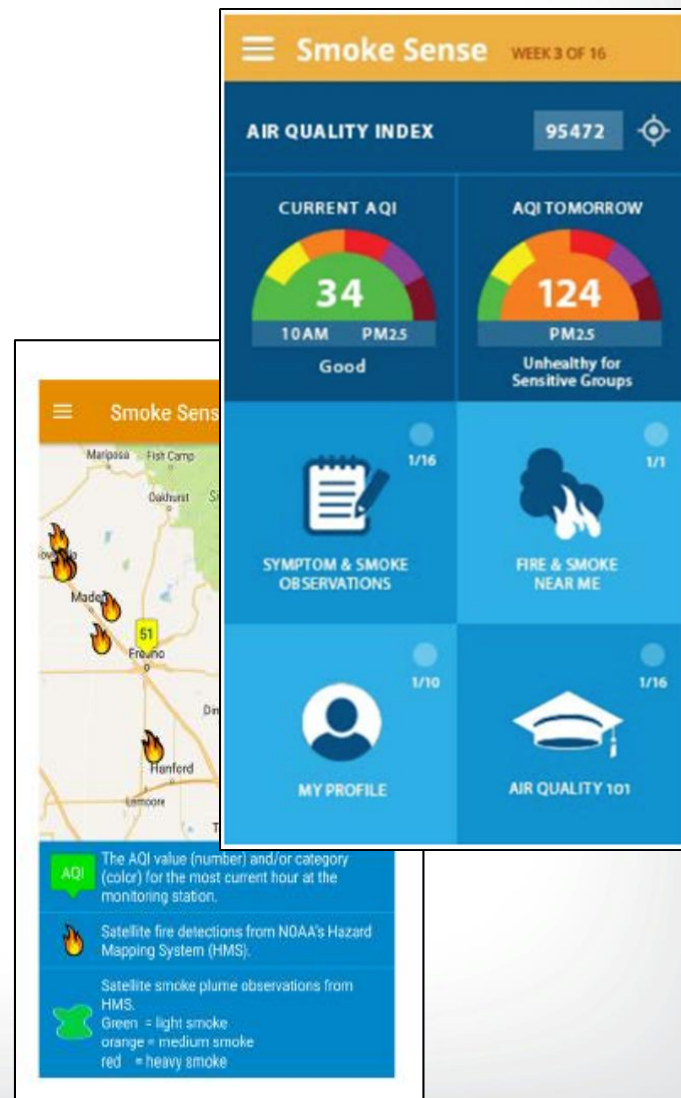
- Measure the effect of wildfire smoke exposure on health and productivity
- Develop health risk communication strategies to improve public health outcomes

## 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





# Wildland Fire Sensors Challenge

## 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

### Wildland Fire Sensors Challenge



**"Air pollutant measurement system to protect public health during wildland fires"**

Do you have ideas on new air pollution measurement strategies for wildfire events?

Wildland fires can produce significant air pollution, which may pose health risks to those in close proximity (first responders, residents in nearby areas) as well as downwind populations. Quickly deploying air pollution measurement stations has, to date, been limited by the cost of technology, portability issues, and maintenance problems. However, emerging technologies including miniaturized direct-reading sensors, compact micro-processors, and wireless data communications provide new opportunities to detect air pollution.

Collaborating partners have prepared a challenge opportunity to develop a prototype multi-node measurement system capable of rapid deployment and continuous real-time monitoring of highly dynamic air pollution levels during a fire event, including PM<sub>2.5</sub>, CO, O<sub>3</sub>, and CO<sub>2</sub>.

For more information, visit:  
<https://www.challenge.gov/challenge/wildland-fire-sensors-challenge>



Collaborating partners include EPA, NASA, USFS, NOAA, NPS, CDC, and Tall Timbers Research Station





# Shifting Gears: Water Impacts

## 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

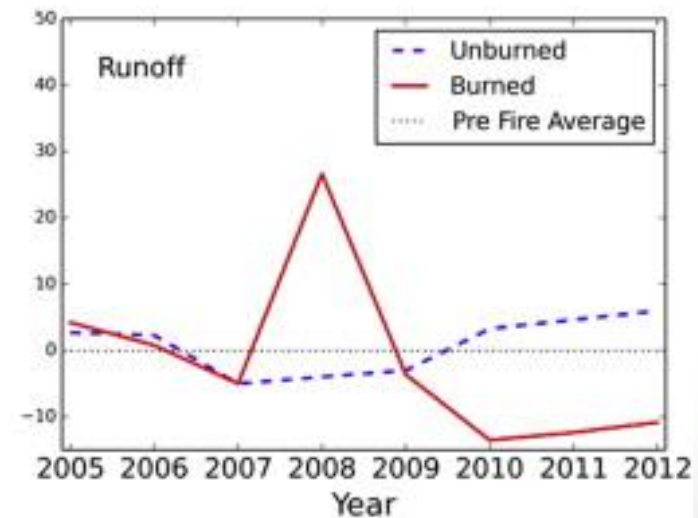
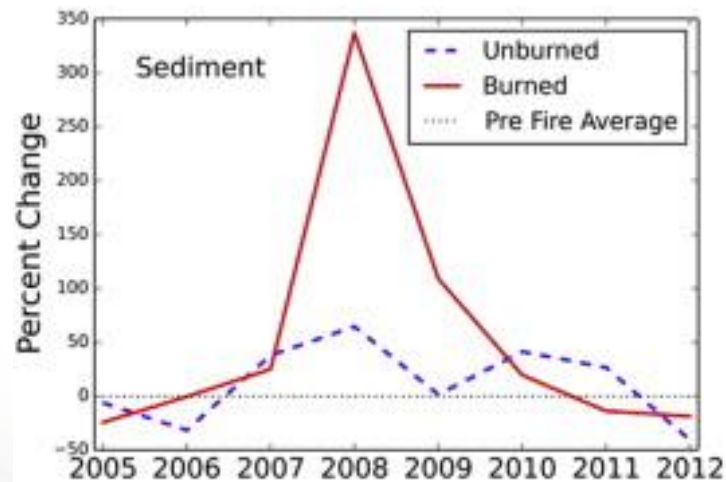
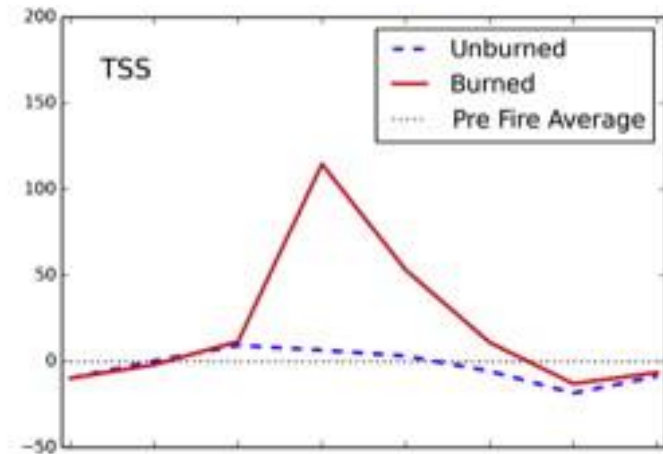
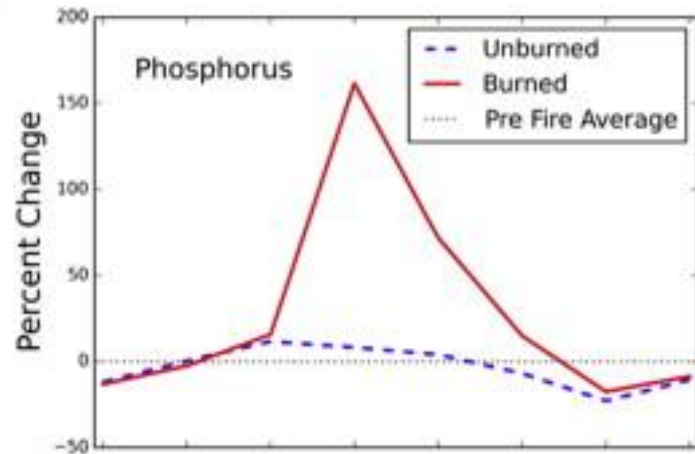


## Wildfire and Drinking Water Systems

- 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)



# Wildfire and Surface Water Pollution



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





## 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



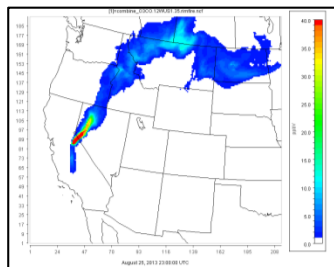
Courtesy of Jeff Peterson (Retired-Office of Water, EPA)



# 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



## 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

## Monitors and sensors measuring fire exposures

- ACE wildland fire sensors challenge
- Leveraging research from other Federal agencies



## 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



Smoke Sense



# Summary

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

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EPA researchers lift a monitoring balloon to evaluate a prescribed fire in Camp Lejeune, NC