Reducing Risk from Wildfire Smoke

A look at the risks from wildfire smoke and the tools and resources available to monitor and combat major smoke events.
Wildfires are increasing in size and frequency and are making headlines across the globe. Between November 2019 and February 2020, unprecedented bush fires consumed over 25.5 million acres in Australia. In the United States, data from NASA’s RECOVER program indicate wildfires in the West—including megafires burning more than 100,000 acres—have increased in number, size, and intensity between 1950 to 2017. Wildfires can start suddenly and spread rapidly; furthermore, smoke from these fires can impact public health far away from the fire. The consequences of smoke can be damaging to both health and property; in 2018, for example, smoke impacts from the Ferguson Fire that burned in three National Forests in California threatened the health of both the public and outdoor park personnel, leading to the closure of Yosemite National Park and affecting surrounding communities for several weeks.

Wildfire smoke contains a complex mixture of combustion emissions that contribute to elevated levels of air pollution downwind. This includes pollutants such as particulate matter, ozone, and carbon monoxide, as well as an array of hazardous air pollutants. In cases where wildfires move into the wildland–urban interface (WUI), they can consume manmade materials such as plastics and structures that may release other chemicals into the air. However, the largest threat from wildfire smoke is particle pollution, which can get deep into your lungs and may even enter the bloodstream. Fine particulate matter (PM$_{2.5}$) poses the greatest risk to health. The most obvious effects are symptoms such as coughing and burning eyes, but in fact, particle pollution can cause serious damage to the heart and lungs. Since U.S. National Air Quality Standards were first issued for PM$_{2.5}$ in 1997, extensive federally funded research efforts have uncovered a wide array of health effects associated with fine particle exposure, including premature death.

**At-Risk Populations**

Recent studies support a direct link between wildfire smoke exposures and an array of adverse health outcomes, including respiratory and cardiovascular impacts. Furthermore, some people have underlying conditions that may increase their risk of adverse health effects following exposure to wildfire smoke, including: people with heart or lung disease, people with asthma, people with diabetes, children or teenagers with asthma who enjoy spending time outside, pregnant women, outdoor workers, and the elderly.

The U.S. Environmental Protection Agency (EPA) and other federal, state, and tribal partners have long recognized that people with these underlying conditions are more at risk from breathing wildfire smoke. Recent developments with the COVID-19 pandemic have raised the question of how air pollution and wildfire smoke may affect susceptibility to respiratory infection. Some preliminary studies have emerged; however, it is too early to draw conclusions linking COVID-19 infection rates and health outcomes with particle pollution exposure. Peer reviewed toxicological, controlled human exposure, and epidemiological studies have demonstrated that inhaled particles do reduce immune response against influenza and respiratory viruses and can worsen the outcomes among the already infected individuals. Additionally, studies have shown that viruses can be transported on particles and the ambient concentrations of PM can increase the risk of exposure to viruses.

Together, federal partners have worked to develop specialized materials that help ensure at-risk populations have ready access to the resources they need to address risks from smoke exposures. For example, EPA and the U.S. Centers for Disease Control and Prevention (CDC) jointly developed a special online course for physicians, registered nurses, asthma educators, and others involved in clinical or health education, entitled Wildfire Smoke and Your Patients’ Health (https://www.epa.gov/wildfire-smoke-course). The course is designed to provide information about the health effects associated with wildfire smoke and actions for patients to take before and during a wildfire to reduce exposure.

In addition, EPAs Office of Children’s Health Protection has developed a fact sheet on Protecting Children from Wildfire Smoke and Ash (https://www.epa.gov/sites/production/files/2018-11/documents/protecting-children-from-wildfire-smoke-and-ash.pdf) endorsed by the American Academy of Pediatrics. Children are a population of concern because their lungs are still developing, which puts them at higher risk for health effects from exposure to wildfire smoke. Furthermore, respirators designed for adults, including the popular N95 masks, may not fit children properly. Further research is needed to determine the most effective devices for protecting children from smoke exposures. Identifying the needs of at-risk populations and addressing them effectively is a high priority for reducing adverse health outcomes from smoke exposure.

**Smoke Ready Communities Framework**

One of the most effective things that vulnerable individuals and communities can do is to plan for smoke events. Such planning—particularly appropriate for communities downwind of wildlands that are ecologically fire dependent, are in areas with high wildfire risk or have had wildfires previously—can improve communities’ ability to respond quickly and effectively and take the actions necessary to reduce public health impacts from wildland fire smoke. EPA and the U.S. Forest Service (USFS) have joined forces with other federal agencies, including the CDC, to provide communities and individuals accurate information to help them plan for smoke events. This is being done under a broad Smoke Ready Communities Framework, which will build on work already being done by states, tribes, and local areas to prepare communities for smoke events and reduce potential
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health impacts. EPA also plans to include a robust research component to measure how available tools and resources are used and whether these strategies result in improved health outcomes during smoke events.

The ideal “smoke ready” community is prepared and empowered to provide its residents with evidence-based, locally relevant information during fire-related smoke events and to recommend actions to reduce public health impacts from smoke. A range of preparedness activities may be appropriate, depending on the forecasted risk for wildfires, the frequency and severity of smoke impacts, the nature of the fire event (e.g., size, duration, fuel type), underlying vulnerabilities of local populations, and other attributes of the community.

For example, communities economically dependent on tourism, outdoor recreation, agriculture, viticulture, or forestry may have a particularly strong incentive to engage in advanced planning, as may those which experience smoke impacts frequently. A smoke ready community will assess these vulnerabilities in advance, plan for appropriate responses, and act during a fire, with the goal of reducing the health impacts of breathing smoke.

Key preparedness activities may include local action to:

- Identify populations vulnerable to smoke and how to reach them during a smoke event;
- Set up information delivery methods in advance so community members know where to go for critical information;
- Distribute ready-made communications/education materials, including resources about how to plan for wildfire smoke impacts and ways to reduce exposure and risk;
- Establish decision points for a tiered set of response actions that meet the needs of that community (e.g., when to limit outdoor activity; how to safely operate schools; and when to encourage people to prepare and utilize “clean rooms” within the home or seek out “clean air spaces” [i.e., publicly accessible locations that provide filtered air, if public gathering is appropriate]);
- Create and prepare to effectively utilize clean air spaces and other mitigation measures, including clearly assigning roles and responsibilities for implementing these measures;
- Purchase and store adequate protective equipment, such as N95 masks (when available) and air filtration systems, and provide instructions on proper use of this equipment (NOTE: other types of face coverings, including many used for COVID-19 protection, are not designed to protect against smoke exposures); and Identify suitable locations for deployment of additional air quality monitors and sensors during a fire.

**Community Resources**

Federal, state, and tribal partners have already developed a suite of tools and resources to help communities develop preparedness plans, and more are being created. In 2019, EPA led a collaborative effort with CDC, USFS, and California state agencies (California Air Resources Board, California Environmental Protection Agency, and California Department of Health) to update the Wildfire Smoke: A Guide for Public Health Officials (https://www3.epa.gov/airnow/wildfire-smoke/wildfire-smoke-guide-revised-2019.pdf), a comprehensive online resource to help health officials prepare for smoke events and communicate health risks and take measures to protect the public when wildfire smoke is present.

Along with the guide, there are many wildfire-related fact sheets available online in both English and Spanish (https://www.epa.gov/smoke-ready-toolbox-wildfires/wildland-fire-publications-fact-sheets-and-other-resources#h_fact_sheets). These fact sheets offer actionable advice on important topics of interest to affected communities, for example, how to reduce smoke exposure indoors and outdoors. Currently, USFS, EPA, CDC, and other federal agencies have come together to identify additional resources communities will need to further their preparedness activities. In addition, the agencies have recently embarked on new cooperative research efforts to better understand the health implications of managed prescribed fire versus uncontrolled wildfire, recognizing that the size, timing, and fire dynamics can vary.
significantly, having potentially significant effects on the public health impacts of the fire event and communities’ ability to prepare.

During smoke events, federal agencies offer several resources that provide information in real time. One source of real-time information is AirNow. The “Fire and Smoke Map” link at airnow.gov takes users to an interactive map (see Figure 1) with Air Quality Index (AQI) information layered with current wildfire locations. EPA is working to continually improve the information available on AirNow, refining and applying the latest analytical tools [Editor’s Note: For more information about EPA’s tools. See companion article elsewhere in this issue by Baker et al.]

One example is the development of the NowCast AQI, which is designed to be responsive to rapidly changing air quality conditions, such as during a wildfire. The NowCast calculation (https://airnow.zendesk.com/hc/en-us/articles/212303417-How-is-the-NowCast-algorithm-used-to-report-current-air-quality-) uses longer averages during periods of stable air quality and shorter averages when air quality is changing rapidly. NowCast allows AirNow’s current conditions to align more closely with what people are seeing or experiencing in real time. This gives people information they can use to protect their health when air quality is poor; and help them get outdoors and get exercise when air quality is good.

Areas without continuous PM$_{2.5}$ monitors may be able to get temporary, portable monitors through their federal, state, tribal, or local air quality agencies or the USFS. As part of the USFS-led Interagency Wildland Fire Air Quality Response Program (IWFAQRP) (https://wildlandfiresmoke.net), a cache of monitors is available for deployment for areas being impacted severely by smoke from wildfires which have an Air Resource Advisor (ARA) assigned to the incident. [Editor’s Note: For more information about the (IWFAQRP), see companion article elsewhere in this issue by Lahm and Larkin].

ARAs are technical experts who work with federal, state, tribal, and local agencies during smoke events to assist with understanding and predicting smoke impacts on the public and fire personnel. Smoke exposures had traditionally taken a back seat to other health and safety risks in wildfire situations, but in fact smoke exposures can affect large numbers of people and may be one of the most significant risks that need to be considered by public officials. Having ARAs on the incident command teams during wildfires provides the public with access to important on-the-ground information and advice on a daily basis to reduce exposures. A community that has identified in advance where smoke monitoring is needed as part of being smoke ready will be one step ahead when an ARA arrives on scene with monitoring equipment.

With wide-ranging expertise in air quality monitoring and modeling, ARAs bring unique skills to wildfires. These trained technical specialists work as integral members of an Incident Management Team to assist state, tribal, or local air regulators, state forestry and health departments, and the public. Their main task is to provide timely smoke impact and forecast information and messaging based on the best available science and current monitored conditions. A community that is smoke ready will be prepared to utilize the messages created by ARAs.

The demand for the ARA program has increased over the years. In 2012, 13 ARAs were dispatched, but 2017 and...
2018 saw the need for over 100 deployments (see Figure 2). That year, ARA’s produced over 1200 daily smoke forecasts. With expected increase in the number and magnitude of fire events in the future, this demand is likely to grow.

Some states and local agencies are taking advantage of improvements in low-cost sensor technologies to track and report localized, and often rapidly changing, conditions associated with wildfires. In addition, the public is taking a more active role in measuring and understanding air quality, and they become particularly engaged when impacted by smoke. Federal and state agencies are doing a tremendous amount of work related to sensors, from understanding the performance of these devices to helping the public make sense of what sensor data means. A host of resources are available on the Air Sensor Toolbox website (https://www.epa.gov/airsensor-toolbox/videos-air-sensor-measurements-data-quality-and-interpretation). EPA recently released a series of informational videos (https://www.epa.gov/airsensor-toolbox) describing how the agency collects and uses air quality data, how air quality health risks are communicated, and how to interpret data collected using air sensors.

Summary

Wildfire smoke can be dangerous for those who are vulnerable to its effects and can adversely impact those who are healthy. Although most healthy adults and children will recover quickly from wildfire smoke, reducing or avoiding exposure is the best approach. This requires advance planning to educate the public, prepare communities to be smoke ready, and ensure that measures are in place to protect people during wildfire events. Federal agencies remain committed to providing the tools and resources necessary to help communities prepare.

Erika N. Sasser, Ph.D., is Director of the Health and Environmental Impacts Division of the Office of Air Quality Planning and Standards for the U.S. Environmental Protection Agency, Research Triangle Park, NC; and Peter Lahm is with the U.S. Department of Agriculture (USDA) Forest Service, Fire and Aviation Management Program in Washington, DC. E-mail: sasser.eriKa@epa.gov

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