WILDFIRE SMOKE

Horizon Scanning for Hazard Readiness

By Scott Gunderson

Areas throughout the world continue to experience increasing effects of climate change, from record heat across Europe to devastating fires in Australia. The West Coast of the U.S. has experienced significant effects, with higher temperatures, larger wildfires and a longer wildfire season.

For example, catastrophic wildfires during the summer of 2020 led to several weeks of hazardous air quality in the Pacific Northwest, and a heat wave during the summer of 2021 led to a record high temperature of 116 °F in Portland, OR, where the author lives and works. Rather than dismissing these events as flukes, climate scientists warned such events were a sign of more to come (Samayoa, 2021).

Magnitude of the Problem

Climate and forestry scientists describe wildfires as increasing in both frequency and severity across the U.S., with the western U.S. at a particularly high level of risk (Borunda, 2020; Elbein, 2022). For example, Oregon is expected to experience "drier summers, higher temperatures and earlier melting of the snowpack" leading to higher risk of wildfires (NOAA National Centers for Environmental Information, 2022b). A wildfire season beginning earlier and ending later than previous years will lead to increasing frequency, with wildfires so frequent they can be described as seasonal events to be expected in many areas (Brown, 2022). Additionally, larger wildfires will lead to increasing severity and potential damage (Hill & Babin, 2020). Insurance studies modeling future losses warn of "projected several-fold increases in annual area burned" (Sousounis et al., 2021).

While the western U.S. has seen some of the most significant increases in wildfire activity, this is not a hazard limited to that region. The U.S. Environmental Protection Agency (U.S. EPA, 2022b) has identified this as a problem beyond the western states, with large areas of the U.S. threatened by a longer wildfire season. Wildfire activity is moving east across the U.S., creating a growing risk for many states (Sherfinski, 2022).

This increase in wildfire activity is leading to an increase in wildfire smoke and deteriorating air quality across the U.S. (Burke et al., 2021). Once considered a Western problem, spreading smoke reaches far and wide, "affecting communities hundreds to thousands of kilometers away from the fires" (Sever, 2022). This smoke is a health hazard for both residents of the affected communities and for employees in the workplaces of these communities.

Wildfire smoke is a serious source of pollution potentially exacerbating asthma in populations both nationally and globally (Hart, 2022; O'Dell et al., 2021; Reid & Maestas, 2019). In Oregon, environmental regulators warn of increasingly unhealthy air quality. In its report on wildfire smoke trends and air quality, the Oregon Department of Environmental Quality (2023) says that "large wildfires have been increasing across the western U.S. over the last decade and are expected to become more frequent," and that if these trends continue, Oregon will experience an increase in unhealthy air quality conditions during wildfire season, and more summers with widespread air quality impacts.

Regulatory Developments

While no national standards for occupational wildfire smoke exposure currently exist, some states are developing temporary or permanent standards (State of California DIR, 2021; Washington State Department of Labor and Industries, n.d.). Oregon OSHA (2022) has established some of the most protective rules for workplace exposure to wildfire smoke in the U.S. (Samayoa, 2022). These rules apply not only to outdoor work such as construction and agriculture, but also to work at indoor locations without mechanical ventilation, where smoke from outside can enter indoor work environments. The rules require protective measures such as the use of N95 filtering facepieces as levels of $PM_{2.5}$ increase in the workplace (Table 1).

The Oregon OSHA (2022) rules require wildfire smoke monitoring "when employees are, or are likely to be, exposed to an ambient air concentration for $PM_{2.5}$ at or above 35.5 $\mu g/m_3$." This level is equivalent to an air quality index of 101. In Oregon, this can be viewed on the Oregon Department of Environmental Quality's air quality index web page (Oregon DEQ, n.d.). Oregon OSHA has identified the use of this web page as an acceptable method for determining exposure to wildfire smoke, along with a review of local air quality advisories and the use of direct read instruments in the workplace. However, most of these methods, especially reliance on local and workplace-specific information, do not allow time for advance communication and preparation.

TABLE 1
WILDFIRE SMOKE RESPIRATORY PROTECTION REQUIREMENTS

AQI threshold	$PM_{2.5}$	Respiratory protection
101	35.5 $\mu g/m_3$	Voluntary use of filtering facepiece respirator
251	200.9 $\mu g/m_3$	Required use of filtering facepiece respirator; implement Wildfire Smoke Respiratory Protection Program per Appendix A of the Oregon OSHA wildfire smoke rules
501	500.4 $\mu g/m_3$	Required use of filtering facepiece respirator per Oregon OSHA respiratory protection rules 1910.134

Note. Adapted from "Oregon OSHA's Adoption of Rules to Address Employee Exposure to Wildfire Smoke," by OSHA Oregon, 2022.

Exposure Monitoring & Assessment

NIOSH (2021) advises that employers "prepare for and plan to implement procedures to reduce exposures to smoke when necessary." As Keith (2022) notes:

> Time-sensitive emergency management is integral to ensuring the safety of a company's employees. . . . If a facility is affected by seasonal wildfires, atmospheric data can help the facility prepare for a break in production should the air quality deteriorate to an unsafe level.

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FIGURE 1

ACTIVE LARGE FIRES, JULY 21, 2022

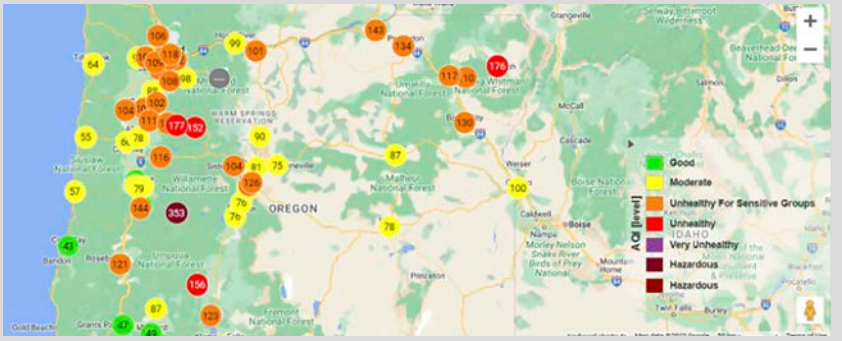
Map of active large fires in the western U.S., captured at 6:50 a.m. on July 21, 2022 (regional view).

Note. From "Information and statistics: Active large fires map," by Oregon Department of Forestry, n.d. www.oregon.gov/odf/fire/pages/firestats.aspx.

FIGURE 2

AIR QUALITY MAP, SEPT. 11, 2022

Map of air quality in Oregon captured at 4:17 a.m. on Sept. 11, 2022. This shows a state-level view with deteriorating air quality following the onset of high winds.

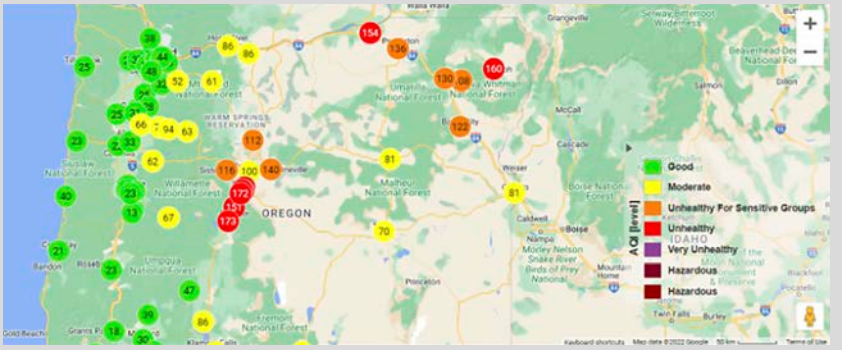


Note. From "Air quality monitoring data," by State of Oregon DEQ, n.d. https://oraqi.deq.state.or.us/home/map.

FIGURE 3

AIR QUALITY MAP, SEPT. 13, 2022

Map of air quality in Oregon captured at 7:36 a.m. on Sept. 13, 2022. This shows a state-level view with smoke migration from eastern Oregon through mountain passes into western Oregon.



Note. From "Air quality monitoring data," by State of Oregon DEQ, n.d. https://oraqi.deq.state.or.us/home/map.

However, reliance on local and workplace-specific information that prevents timely communication and preparation is not enough to maintain good safety management practices. Safety professionals must look further, essentially extending their local perspective beyond the horizon. The term "horizon scanning" refers to monitoring emerging and future developments that may represent either a risk or an opportunity to an organization (Bell, 2020; Crask, 2021). While the term is typically used to refer to distant future events, in this case, wildfire smoke being literally beyond the horizon makes this a useful concept to illustrate the need to review information about wildfire smoke as a potential approaching threat.

Safety professionals do not need to rely on local and workplace-specific information because there are resources available that allow the review of activity farther from the workplace that may identify wildfire smoke as an oncoming hazard. Some of these resources such as the National Oceanic and Atmospheric Administration's (NOAA, 2022a) satellite smoke map may not provide adequate ground-level detail for safety professionals. Other resources such as fire danger maps and climate prediction models may require more knowledge and training in climate, weather and forestry, or may be more useful for long-term planning than short-term hazard preparation (NICC, n.d.; NWS, n.d., 2022). But other resources can help OSH professionals evaluate distant wildfire smoke hazards. Nationally, the U.S. Department of Agriculture Forest Service (n.d.) active fire map includes a map of wildfires across the U.S. Resources from the U.S. EPA (n.d.b, 2023) include national air quality, and fire and smoke maps, both allowing review down to local levels.

Regionally, most state agencies have made active large fire maps and air quality maps available online. These maps provide real-time information on fires and air quality in the region, potentially giving safety professionals advance warning to initiate protective measures such as rescheduling outdoor work, enclosing indoor work as much as possible or providing respiratory protection as a last resort (Oregon Department of Forestry, n.d.; Oregon DEQ, n.d.). The author used these resources during the 2022 wildfire season for a workplace in Portland, OR.

Significant wildfire activity took place throughout much of the Western U.S. during July 2022 (Figure 1). However, by July 21, 2022, Oregon had not yet experienced similar wildfire activity. This low level of wildfire activity in the state meant that air quality levels remained generally good both regionally and locally. This changed 10 days later when increasing wildfire activity in northern California and southern Oregon led to deteriorating air quality in southern and central Oregon.

Further wildfire activity led to wildfire smoke migrating north up the Willamette Valley toward Portland, OR, on Aug. 17, 2022. While some local monitoring stations showed levels moderately unhealthy or unhealthy for sensitive groups, the general air quality in Portland did not deteriorate to unhealthy levels, requiring no significant response at the workplace by the author.

High winds swept Oregon on the weekend of Sept. 9, 2022. These winds spread smoke from wildfires across the state, degrading the air quality in Portland by Sept. 11, to levels from moderately unhealthy to unhealthy for sensitive groups (Figure 2). However, changing weather conditions cleared the air by the start of the workweek

on Sept. 12, again requiring no significant response at the workplace by the author.

Knowledge of local and regional geography can be essential for early understanding of developments in smoke migration. In the scenario described, the Cascade Mountains, which separate western and central Oregon, appeared to keep smoke from rapidly growing wildfires on the eastern side of the state until monitoring stations showed deteriorating air quality along several lower-elevation highway passes between the mountains (Figure 3, p. 21). The author monitored this closely for potential movement into the Willamette Valley toward Portland until the smoke cleared and there was no further reason for concern.

Conclusion

The 2022 wildfire season in Oregon ended with no significant wildfire smoke events or hazardous air quality in the author's region. That said, the author learned much navigating the first summer under new Oregon OSHA rules for wildfire smoke exposure in the workplace:

1. Assess location vulnerability to wildfire smoke, including outdoor work, indoor work in porous facilities (e.g., open bay doors), historic smoke events and projected wildfire trends.
2. Identify rules and standards for wildfire smoke exposure applicable to the organization.
3. Establish response procedures for wildfire smoke exposure such as rescheduling work, limiting outdoor work, enclosing indoor operations as much as feasible and providing respiratory protection when necessary.
4. Identify resources for monitoring regional and local wildfire activity and air quality.
5. Regularly monitor regional conditions including wildfires and air quality to anticipate negative effects on local conditions. The author reviewed regional conditions at least daily and recorded this review on a spreadsheet.
6. Communicate potential effects on local conditions with organizational leaders in advance as often as feasible. During the onset of high winds and increased smoke on Sept. 9, 2022, the author sent updates by email with screenshots of regional air quality maps several times through the weekend until conditions improved.
7. Implement response procedures based on local conditions.

Climate change will continue to bring significant hazards to communities and workplaces, and OSH professionals will have to include these hazards in their scope of practice (Gunderson, 2021). This duty of care will not be limited to safety professionals; it will become a standard risk management element for the organizations they support (ISO, 2021). As wildfire activity will increase, smoke from wildfires will represent a foreseeable hazard that safety professionals must anticipate, using resources available for early warning, preparation and response. **PSJ**

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