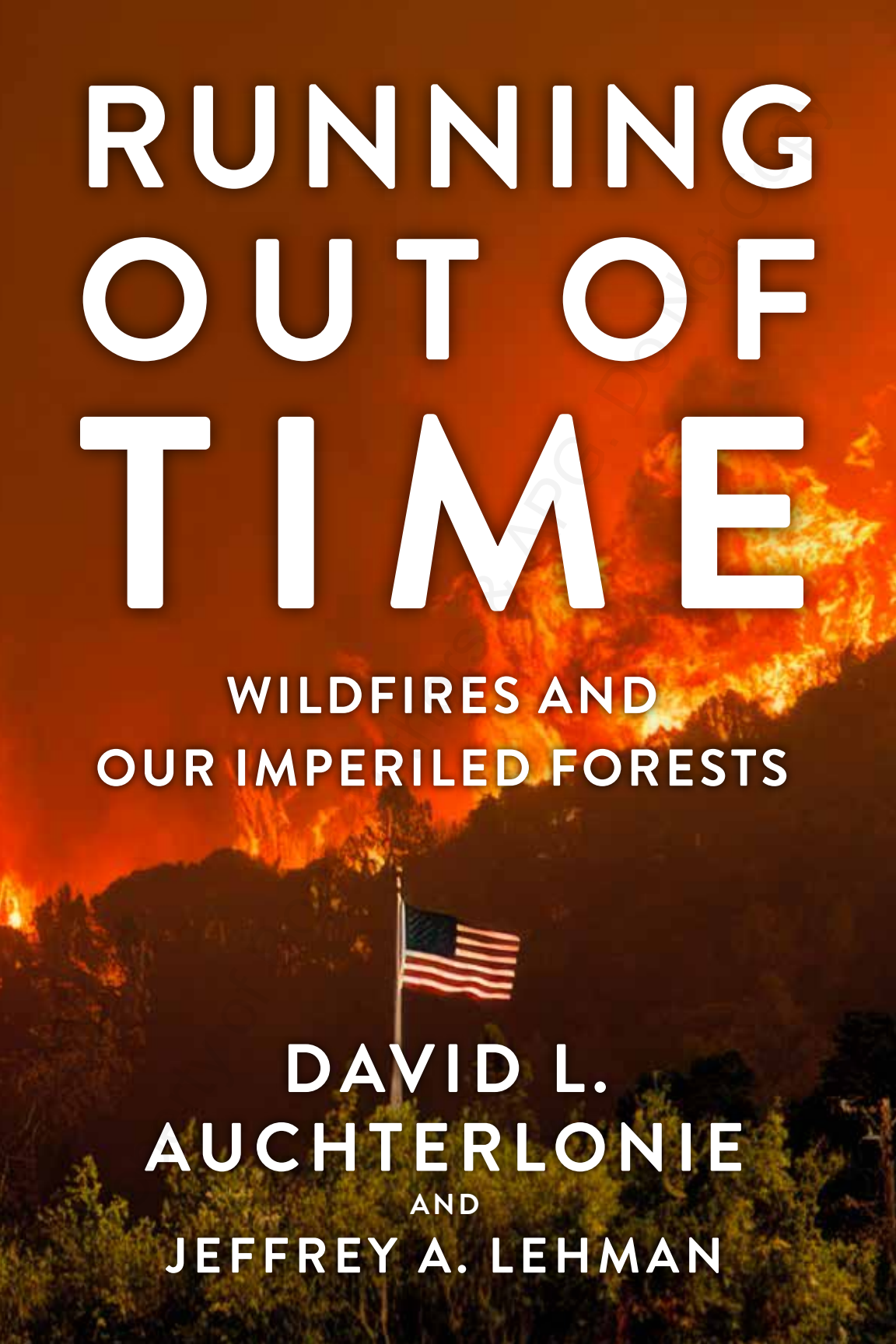
RUNNING OUT OF TIME

WILDFIRES AND OUR IMPERILED FORESTS



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Running Out of Time: Wildfires and Our Imperiled Forests

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FOREWORD

Neglected for decades, America's public forestlands are highly vulnerable to increased catastrophic wildfires, insects, and diseases that threaten the health of the nation's private forestlands as well. Communities, wildlife, water resources, and natural landscapes face increased jeopardy without additional human and capital resources. At least 100 million acres of national forests are at risk of severe wildfire without active forest management.

Unfortunately, our communities have suffered from the lack of effective forest management, wildfire suppression, and timber harvests. Today anti-forestry obstruction and litigation prevent public land managers from implementing forest projects that reduce the risks of wildfires and the carcinogenic smoke they create. Regardless of the misguided good intentions behind these efforts, they are literally loving the forests they wish to protect to death.

This book thoroughly examines how our federal and state firefighting agencies lack the funding to meet today's wildland fire crisis. It provides insights into current firefighting and forest management practices and proposes solutions.

The authors suggest using novel private-public partnerships to muster the resources needed to act now to implement practical and necessary solutions as were accomplished in Texas. The book offers the opportunity to time-test scientifically proven alternatives and emerging technological advancements to determine the best forest management practices based on regional forest conditions. The incentives identified also allow ample investment to address our neglected forest management and wildfire suppression needs.

Tom Boggus

Chairman, National Association of State Foresters Foundation

Director Emeritus, Texas A&M Forest Service (2008—2021)

CHAPTER 1

THE IMPACT OF WILDFIRES

Fire seasons now average seven months each year, almost two and a half months longer than in 1970.[1]

The Earth is on fire. This is not hyperbole. Wildfires impacted every continent in 2020, with nearly 1 billion acres destroyed worldwide.[2, 3]

In the United States, 10.1 million acres were burned by over 59,000 wildfires in 2020, equivalent in size to the states of Maryland and Delaware combined, according to the Congressional Research Service.[4] Bushfires in Australia burned an astounding 47 million acres in 2019 through 2020, equivalent in size to the entire state of Washington.[5]

In recent years, countless more areas across the globe experienced historically dangerous wildfires (see fig. 1).

Wildfires typically occur during periods of increased temperature and drought. They are anything but a new phenomenon. Archaeologists discovered the first wildfires occurred more than 7,000 years ago.[6] Scientists determined that Greeks, Romans, and early Chinese civilizations faced wildfire threats.

Figure 1. Global image of wildfires on September 12, 2020. (Figure by NASA Fire Information for Resource Management System (FIRMS), September 12, 2020, https://firms.modaps.eosdis.nasa.gov/map/#t:adv;d:2020-09-11..2020-09-12,2020-09-13;l:country-outline;@-24.4,9.4,3z).

NORTH AMERICA

Similarly, North America's Indigenous people lived with wildfires impacting their daily way of life, but over time, they applied the knowledge gained to maintain their ecosystems. Charcoal evidence from geological and archaeological research suggests that Native Americans experienced a general decrease in America's wildfires until about 1750, when Western culture expanded geographically. Geological data between 1750 and 1870 implies a period of increased fire frequency in North America attributed to human population growth and influences such as land-clearing practices. This period was followed by an overall decrease in burning in the twentieth century, linked to the expansion of agriculture, increased livestock grazing, and fire prevention efforts.[7]

Nonetheless, as the population settled into wildland-urban interface (WUI) areas, wildfires again increased, particularly in the past fifty

years. Human activity in WUI areas brings not only exposure of life and property to wildfires but an additional source of ignition. Sparks from machinery, trains, escaping campfires, poorly planned agricultural and forestland management fires, arcing from electrical utility lines, and unwatched campfires are all human causes of wildfires; however, more than 60 percent of all wildfires in the United States in the past twenty-five years continue to be caused by Mother Nature as the result of lightning strikes igniting accumulated undergrowth in our forests (see fig. 2).

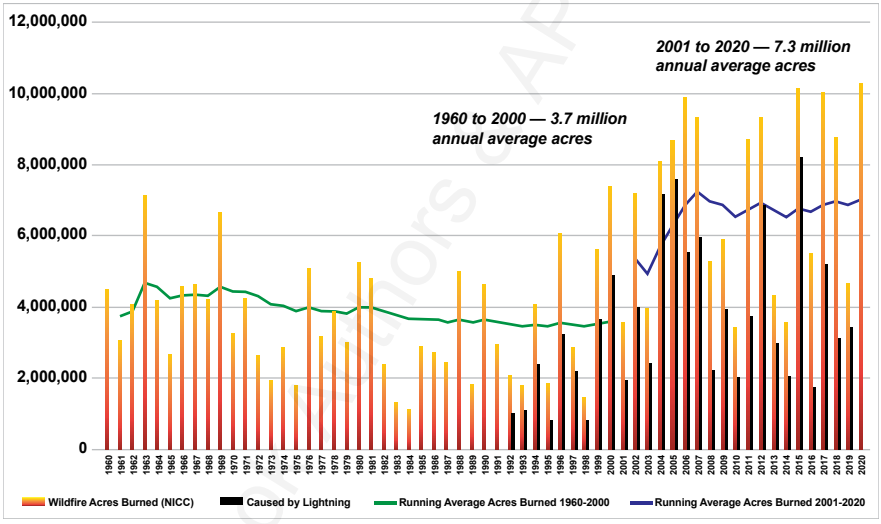

Figure 2. United States acres consumed by wildfires—1960–2020. Annual wildfire acres burned 1960–2020 and lightning-caused acres burned 1992–2020, with running annual average 1960–2020 and 1992–2020. (Lightning-caused fire reporting began in 2001). (Figure created by Crowbar Research Insights LLC™ with data from the National Interagency Coordination Center, https://www.nifc.gov/. © Crowbar Research Insights LLC™. All rights reserved).

Acreage burned in the United States increased from an average of 3.3 million acres in the 1990s, roughly the size of Connecticut, to an annual average of 7 million acres since 2000, about the size of

Massachusetts. On average, 3.3 million acres burned in the 1990s. This number rose to 10.1 million acres in 2020, a 206 percent increase.[8] But there were more wildfire incidents in 1991 (75,754) as compared to 2020 (58,258), indicating the size and severity of wildfires is increasing.[9]

The largest amount of acreage burned (2.4 million) in 2019 was in Alaska, but California had the most wildfires.[10] Three of Colorado's largest wildfires in its history occurred in 2020.[11] Colorado's catastrophes consumed 625,000 acres, about six times the size of Denver, and cost more than $200 million in fire-suppression costs.[12]

Of the top six largest wildfires in California, five occurred in 2020—most notably, the largest to date, the August Complex fire, which consumed 1.03 million acres.[13] California's numbers mirror national statistics. In 2019 the state reported 260,000 acres burned by 7,860 wildfires. In 2020 9,639 wildfires burned 4.2 million acres, roughly 4 percent of California (see fig. 3).[14]

Figure 3. A home is engulfed in flames during the Creek Fire in the Tollhouse area of unincorporated Fresno County, California, early on September 8, 2020. (Photograph by Josh Edelson/AFP via Getty Images, September 8, 2020, https://www.gettyimages.com/detail/news-photo/home-is-engulfed-in-flames-during-the-creek-fire-in-the-news-photo/1228399068.)

In early October 2020, sixty-five large fires consumed more than 2 million acres in California, Idaho, Montana, Oregon, Washington, and five other states. In Oregon, an estimated 4,000 homes were damaged or destroyed by wildfires, forcing the evacuation of thousands to escape the flames that scorched more than 230,000 acres—an area fourteen times the size of Portland, Oregon. In California, fires stretching across approximately 800 miles of landscape burned from the north all the way to the Mexican border (see fig. 4). In Washington, more acres were burned in 2020 than in the past twelve fire seasons combined.[15] The evidence is clear: wildfires are increasing in number and intensity.

Figure 4. A law enforcement officer watches flames launch into the air as fire continues to spread at the Bear Fire in Oroville, California, on September 9, 2020. (Photograph by Josh Edelson/AFP via Getty Images, September 9, 2020, https://www.gettyimages.com/detail/news-photo/law-enforcement-officer-watches-flames-launch-into-the-air-news-photo/1228424195.)

WHY WILDFIRES ARE INCREASING

Many factors, including accumulation of forest undergrowth, insect infestation, and WUI, contribute to hotter, drier, and longer wildfire seasons. Just as telling, research data indicates that from 1970 the annual average temperatures in the western United States increased 1.9 degrees Fahrenheit.[16] Winter snow is melting earlier than in previous decades, leading to drier forests, while large areas of dead trees increase the likelihood of wildfires, possibly due to uninhibited infestation by insects, including the bark beetle.[17]

Halofsky, Peterson, and Harvey, in *Fire Ecology*, dramatically warned of the ramifications. "Changing climate and fire frequency, extent, and severity are likely to influence forest regeneration processes, thus affecting the structural and compositional trajectories of forest ecosystems," they wrote. "[W]armer weather is expected to affect regeneration through increased fire frequency. As fire-free intervals shorten, the time available for plants to mature and produce seed before the next fire will be limited. Such changes in fire-free intervals can have significant effects on postfire regeneration because different plants have varied adaptations to fire. Species that resprout following fire may decline in density, but species that are fire-killed and thus require reproduction from seed may be locally eliminated."[18]

Research by the University of Oregon concludes reforestation following a large wildfire event may take between fifteen and twenty years.[19] Tree planting helps restore these areas to become forested once again.[20]

Forests cover 31 percent of the Earth's surface.[21] Lightning is the cause of most naturally occurring wildfires, which tend to burn more acreage than those started by humans; however, it is humans who cause most wildfire incidents (approximately 89 percent).[22] While the larger wildfires occur primarily in the West, more wildfires occur east of the Mississippi.[23] Population growth continues to encroach on forests due

to WUI, increasing the likelihood of more damaging human-caused wildfires through burning debris such as dead vegetation, unattended campfires, equipment sparks, arcing power lines, and discarded cigarettes.[24] When forests are purposefully intruded upon for new homes and communities—a prime example of WUI—fire risk increases dramatically. It obviously is more difficult to let natural wildfires burn in WUI areas, which are the fastest-growing land-use type in the contiguous United States.[25] Most new WUIs are the result of new housing (97 percent). According to the U.S. Department of Agriculture, there are more than 70,000 communities and 46 million homes at risk from wildfires (see fig. 5).[26]

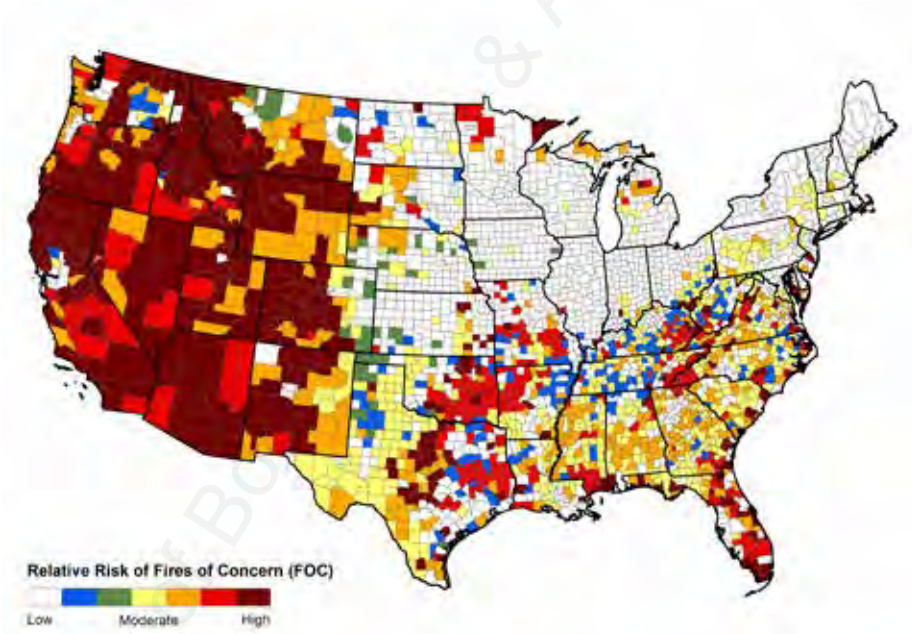

Figure 5. Areas in the United States at risk for large, long-duration wildfires. (Figure by the Science Analysis of the National Cohesive Wildland Fire Management Strategy, 2022, https://cohesivefire.nemac.org/option/10.) [Figure credit: NEMAC and the Eastern Forest Environmental Threat Assessment Center (EFETAC)]

AIR QUALITY AND WILDFIRES

In addition to the direct impacts, there are other substantial effects on society due to fires. Smoke from wildfires impacts large population centers, some of them thousands of miles from the original wildfire site. Recreation centers and national parks frequently are closed in many states during August and September, as was the case in 2020, because of toxic air quality conditions.[27] The expansive nature of large fires and the smoke they create impacts inhabitants living on half the land mass of the United States, or an estimated 212 million people.[28] Figures 6 and 7 demonstrate examples recorded by National Aeronautics and Space Administration (NASA) satellites of the extensive residual smoke impact from fires in California and Colorado in 2020 (see figs. 6 and 7).

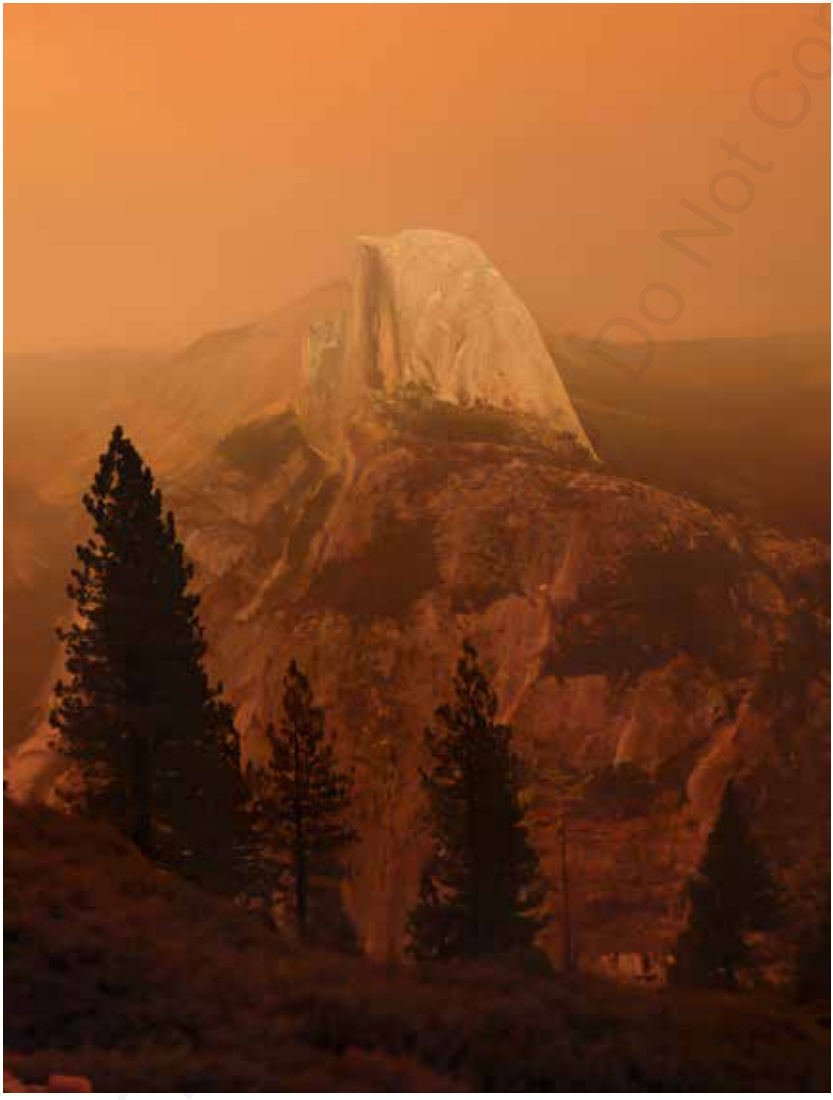

Figure 6. Yosemite National Park, Half Dome September 6, 2020. Smoke and ash from the Creek Fire, which began on September 4, 2020, in the Sierra National Forest. On September 7, 2020, the USDA Forest Service closed all Southern California National Forests due to unprecedented fire conditions. (Photograph by the *Fresno Bee*, September 8, 2020, https://www.fresnobee.com/news/nation-world/national/article245559400.html). [Photo credit: From the *New York Times* © 2020 the New York Times Company. All rights reserved. Used under license.]

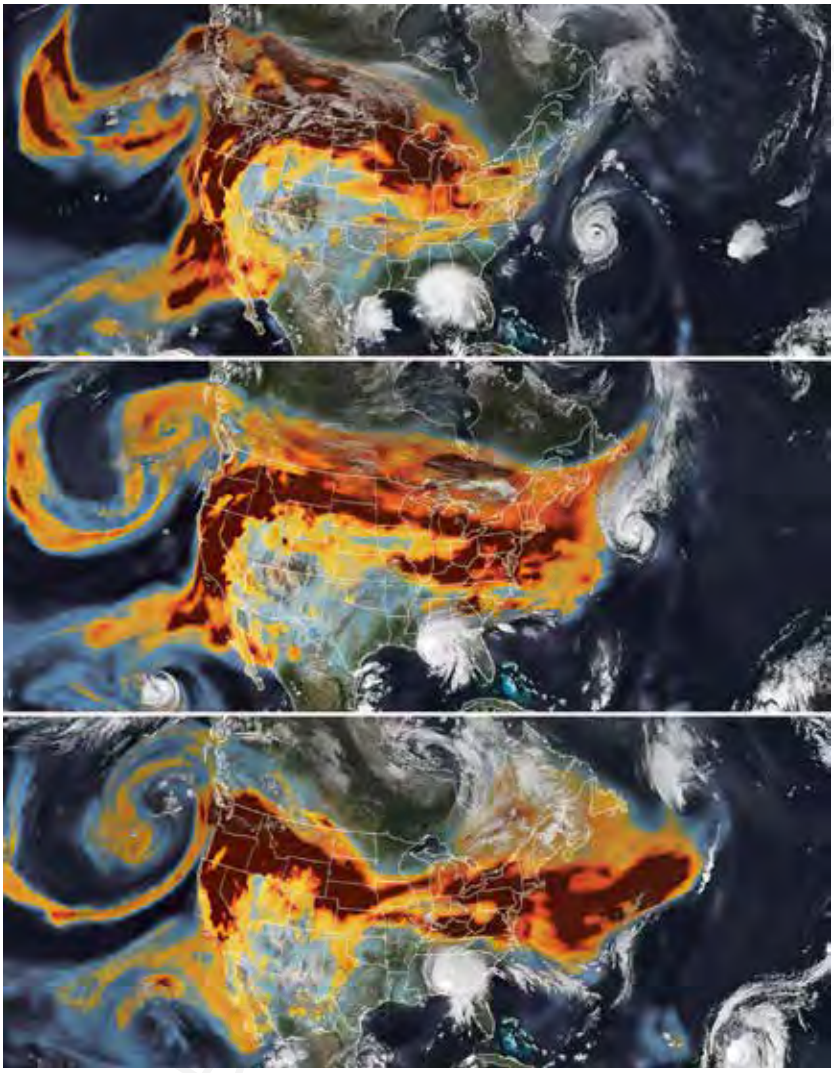

Figure 7. In September 2020, historic wildfires on the United States West Coast lofted plumes of smoke high into the atmosphere. Pushed by prevailing winds that sweep air from west to east, satellites tracked the smoke as it spread widely across much of the continental United States. A second hazard—tropical cyclones—also helped steer the high-flying smoke plumes as they streamed over the Midwest and Northeast between September 14 and 16, 2020.

The series of images above shows the abundance and distribution of black carbon, a type of aerosol found in wildfire smoke, as it rode jet stream winds across the United

States. The black carbon data comes from the GEOS forward processing (GEOS-FP) model, which assimilates information from satellite, aircraft, and ground-based observing systems. The Visible Infrared Imaging Radiometer Suite (VIIRS) on the NOAA-NASA Suomi NPP satellite acquired the images of the storms. (Photography by the Earth Observatory, September 14–16, 2020, https://earthobservatory.nasa.gov/images/147293/a-meeting-of-smoke-and-storms).

Exceptionally fine particulate matter ($PM_{2.5}$) is carried within the smoke and ash. It is small enough to penetrate deep into the lungs and cross into the bloodstream. The World Health Organization (WHO) has determined that $PM_{2.5}$ causes acute respiratory issues, such as asthma, and is increasingly linked to death from heart and lung disease (see fig. 8).[29]

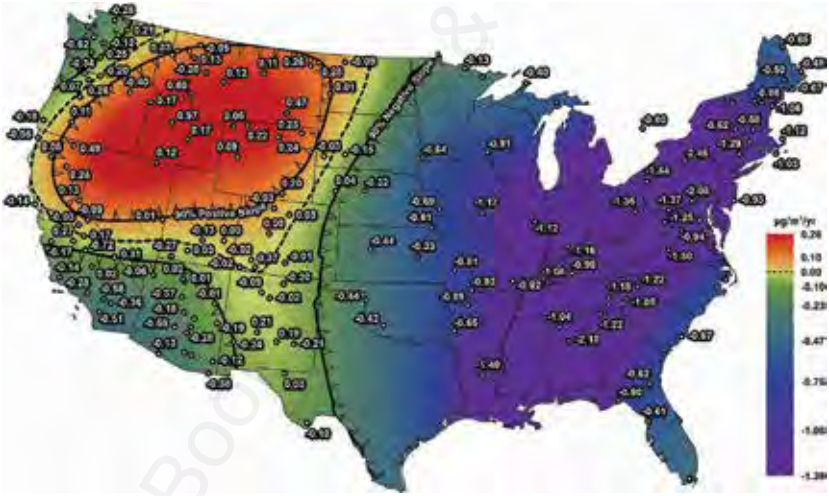

Figure 8. Fine particulate matter trends from 1988–2016. Wildfires are a major source of fine particulate matter (diameter <2.5 μm; $PM_{2.5}$), which is a health hazard. Since the mid-1980s, the total U.S. area burned by wildfires has been increasing, with fires in the Northwest United States accounting for ~50–60 percent of that increase. In the Northwest United States, a positive trend in the 98th quantile of $PM_{2.5}$ in contrast to other areas of the country. (Figure by the Proceedings for the National Academy of Sciences [PNAS], July 31, 2018, U.S. particulate matter air quality improves except in wildfire-prone areas | PNAS).

The Copernicus Atmosphere Monitoring Service (CAMS) monitors emissions from global fires and predicts how these pollutants will affect global air quality. In 2019 CAMS tracked emissions and activity of more than 100 wildfires in the Artic Circle and Alaska. This tracking revealed that in the first half of July, more than 31 megatons of CO_2 were released from these wildfires.[30] In the same year, CAMS monitored nearly 400 wildfires in Alaska. The smoke they emit poses a health risk to those in the state and much farther as these pollutants are blown thousands of miles, contributing to poor air quality globally.[31] In fact, using ozone observations, satellite data, and specific models, researchers attributed poor air quality in Houston, Texas, in July 2004 to forest fires that started a week prior in Alaska and Canada.[32]

A recent study estimated the long-term, present-day, and future exposure to wildfire-related $PM_{2.5}$ across Alaska. Researchers determined that by the mid-twenty-first century, nearly all of Alaska's population could be exposed to increases of 100 percent or more in wildfire-specific $PM_{2.5}$ levels.[33]

According to one study, deaths from wildfire smoke and $PM_{2.5}$ could double this century in the United States.[34] The outlook for Europe is also grim. Worldwide, the study estimates 340,000 premature deaths per year are caused by wildfire particulate matter.[35]

Other direct effects of wildfires include accelerated flooding, massive soil erosion, delay in crop and timber harvests, landmass movement, and pollution of water bodies. Not to be overlooked are additional social impacts, such as disruptions to road and air traffic, business closures, and loss of employment during and immediately after a wildfire. Further, long-term reductions of tourism, aesthetic values of the landscape, and home values are all adverse economic consequences of wildfires (see fig. 9). As a society, are we prepared for further disruptions and lockdowns as unhealthy air quality forces us to stay indoors during wildfire seasons each year?

Figure 9. Lefthand Canyon in Boulder County, after the floods of September 2013. (Photograph by *Boulder Daily Camera*, September 2013, https://www.weather.gov/bou/Number1September2013Floods). [Photo credit: MediaNews Group/Boulder Daily Camera via Getty Images.]

ENVIRONMENTAL IMPACT

Beyond the enormous quality of life issues and economic impacts, wildfires produce approximately 10 percent of the greenhouse gas emissions each year.[36, 37] As wildfires grow in intensity and fire seasons extend, this annual percentage is expected to increase. In 2021 wildfires emitted an estimated 1.76 billion metric tons of carbon, according to CAMS.[38] Wildfire emissions are more than 50 percent of the global CO_2 emissions created by automobiles. Some environmentalists warn that large wildfires will become the norm because of global warming, thereby almost guaranteeing an increase in greenhouse gases for current levels (see fig. 10).

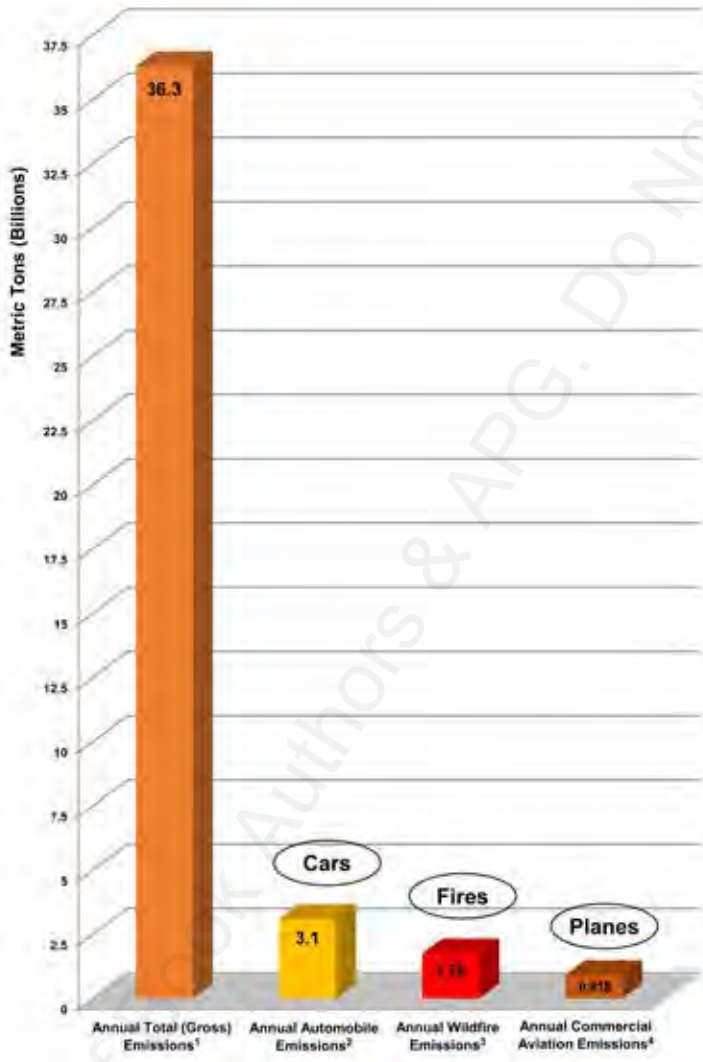

Figure 10. Selected drivers of global GHG emissions. (Figure by Crowbar Research Insights LLC™. Sources: (1) https://www.iea.org/reports/global-energy-review-co2-emissions-in-2021-2; (2) https://www.iea.org/topics/transport; (3) https://atmosphere.copernicus.eu/copernicus-2021-saw-widespread-wildfire-devastation-and-new-regional-emission-records-broken; (4) https://theicct.org/publication/co2-emissions-from-commercial-aviation-2013-2018-and-2019/, © Crowbar Research Insights LLC™. All rights reserved.)

Despite their severity, wildfires and their toxic transmissions are the most controllable of all greenhouse gas emissions. We can and must extinguish wildfires faster to *immediately* reduce greenhouse gas emissions and toxic $PM_{2.5}$ pollutants.

CAUSE FOR OPTIMISM

Despite the alarming trends described above, wildfire damages can be reduced and improved quality of life achieved through enhanced wildfire and forest management practices. This book provides a blueprint; however, major structural changes will be required, particularly to the governmental agencies responsible for our treasured forests and wildfire management.

THE KEY TAKEAWAYS FROM THIS CHAPTER ARE:

- Wildfires produce more than half the CO_2 emissions produced globally by automobiles.
- Globally, wildfires are increasing in number and intensity.
- The rapid expansion of wildland-urban interface contributes to the risk of wildfires.
- Wildfires pose a danger to public health because of their toxic air quality and greenhouse gas emissions.