Fifth National Climate Assessment

Focus on Western Wildfires

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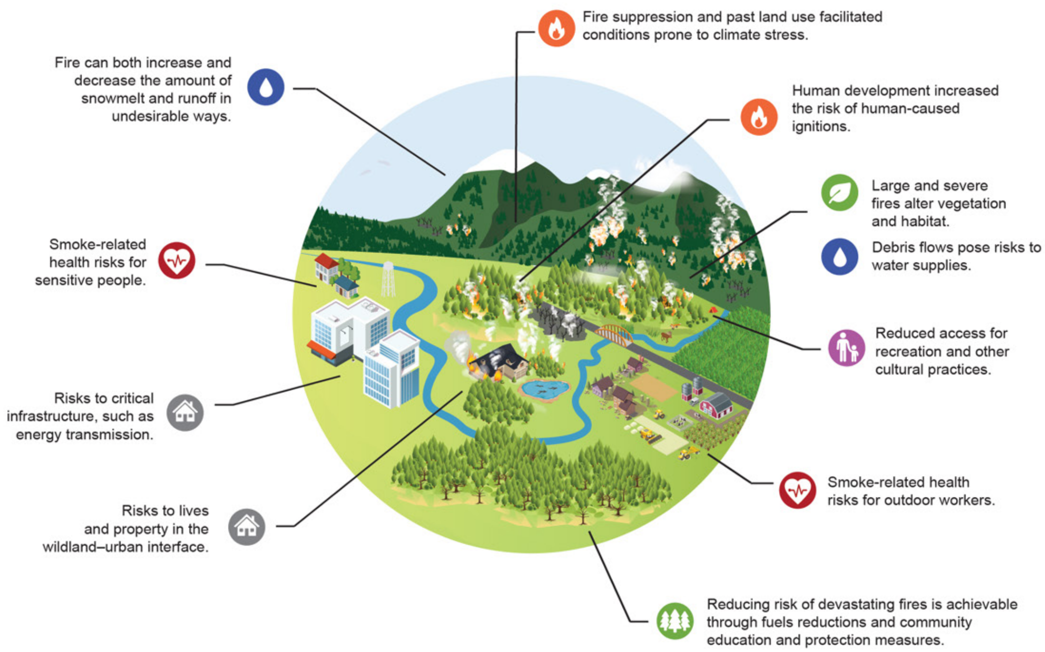
Focus on Western Wildfires

Climate change is leading to larger and more severe wildfires in the western United States, bringing acute and chronic impacts both near and far from the flames. These wildfires have significant public health, socioeconomic, and ecological implications for the Nation.

Fire is a critical ecosystem process across the western US. In recent decades, wildfires in the western United States have become larger, hotter, and more destructive and deadly due to a suite of factors, including climate change. Prior to federal policy to suppress wildfires, natural wildfire and Indigenous burning ensured that landscapes benefited from regular fires for millennia (KM 28.5).[1] Nineteenth- and early-20th-century land-use practices, followed by a policy of fire elimination, led to vegetation fuel buildup in low-elevation fire-adapted western forests, and livestock grazing promoted highly flammable annual grass dominance in rangelands (KMs 2.2, 7.1, 28.5).[2,3,4] Development in the last 50 years has greatly expanded the wildland–urban interface (KMs 12.2, 28.5)[5] and increased human-caused ignitions, jeopardizing people, property, and infrastructure.[6,7] In recent years, climate change has contributed to very large and severe fires. While low- and moderate-severity fire with small patches of high severity can have important ecological benefits (Chs. 7, 28), large, high-severity fires often have profoundly negative long-term ecological, social, and economic consequences (Figure F2.1; KM 28.4).[8,9]

Wildfire Impacts



Wildfire: Causes and drivers

Warming, shifts in precipitation, and a drier near-surface atmosphere are increasing the frequency of large fires and the area burned (KMs 2.2, 7.1).

Fire exclusion and past management in dry forests have increased climatic stress and fire risk (KM 28.5).

Risks: Water

Particulates from wildfires reduce the albedo of snow and can accelerate snowmelt, influencing water retention and runoff (KM 28.5).

Burned areas are a debris-flow risk and threaten water supplies through erosion and particulates from smoke (KM 3.4).

Risks: Society and culture

Burned areas reduce access for recreation and other cultural uses (KMs 16.1, 28.5).

Wildfire generates substantial economic impacts, from whole sectors to individuals (KM 19.1).

Risks: Ecosystems

Large burned areas, especially with high fire severity, can promote vegetation and habitat changes (KMs 6.1, 7.2, 8.1, 8.2).

Risks: Built environment

Risks to critical infrastructure, energy, and water storage (KM 6.1).

Risks to personal safety and property and higher insurance costs for people living in the wildland–urban interface (KM 5.1).

Risks: Health

Smoke can be transported thousands of miles; airborne particulate matter creates health risks, especially for those with existing health conditions, older adults, and children (KMs 14.2, 15.1, 28.4).

Smoke and long periods of degraded air quality create health risks for outdoor workers and firefighters (KM 28.4) and disproportionately affect vulnerable populations (KM 27.5).

Opportunities: Management and adaptation

Adaptation of management strategies that create, maintain, and restore resilient forest ecosystems are critical to maintaining equitable provisioning of ecosystem services (KMs 7.3, 28.5, 31.1).

Climate change has increased the area burned and severity of wildfires and impacts on the environment, human health, and society.

Figure F2.1. Indicators and risks illustrate the drivers of, impacts from, and solutions to wildfire across a range of socioecological contexts within and beyond the western states. Considering these helps improve understanding of how impacts are experienced and how to adapt. Figure credit: USDA ARS, USDA Forest Service, University of Washington, and Montana Health Professionals for a Healthy Climate.

Climate change has produced warmer and drier conditions with prolonged droughts that stress forest vegetation, facilitating pest outbreaks and tree death, leading to the accumulation of surface fuel.[10,11] Wildfires are moving up in elevation, due to warming temperatures, reduced snowpacks and summer precipitation, and overall drier conditions (KMs 2.2, 3.5, 7.1, 28.5). Climate change has also increased vapor pressure deficit that dries fuels, altering fire behavior that results in large, hotter, and more severe fires (KMs 7.1, 28.5).[12,13,14,15] Consequently, the annual area burned and area burned by high-severity wildfires have increased in the West about eightfold since 1985 (Ch. 7).[14,16] And while the annual area burned is on par with pre-European settlement, the very large, high-severity, and deadly and destructive wildfires result in significant socioecological and economic impacts. These trends are expected to continue at least to midcentury, when fuel availability is expected to become more limited in some western forests (KMs 3.5, 28.5).[17]

In some non-forested regions, primarily arid shrublands and steppes, changes in the frequency and extent of wildfires are being driven primarily by invasive annual grasses that have benefited from climate change.[2,18] Intermountain West steppe rangelands are among the most threatened ecosystems in the US due to land use and wildfires, which have become larger and more frequent.[19] In oak savanna and chaparral shrublands, historical increases in fire are linked to changes in human ignitions and land use.[7,20]

Further increases in area burned and wildfire severity are expected to alter the distribution and abundance of plants and animals and lead to biodiversity loss (KM 7.1). In some cases, forested areas that experienced repeated severe reburns have transitioned to shrublands or other vegetation types.[21,22,23] Already, approximately 75% of vegetation type conversion in the Southwest is due to high-severity fire.[24] Continued warming, reductions in precipitation in some areas, and more frequent fire in forest and non-forest ecosystems can facilitate the establishment of invasive species, increase fuel flammability, reduce tree regeneration after wildfires,[18,25,26] and alter vegetation types (KMs 7.5, 28.5).[27] Potential reductions in forest and shrub cover due to climate-driven changes and wildfire reduce the potential for some western forestlands and steppe rangelands to function as carbon sinks (KM 7.2).

Although restored fire regimes can benefit forest hydrology in some cases,[28] wildfires can put critical infrastructure at risk by altering soil conditions and water runoff (KM 6.1). Following fire, intense rain on water-repellent soils can cause debris flows, which cause human deaths, property damage, and costly road closures (KM 6.1).[29] Chemical runoff can contaminate water supplies, and excess sediment runoff can reduce reservoir storage capacity.[30,31,32] Soot from fire emissions also darkens the surface of snow and ice, altering snow retention and melt in potentially undesirable ways.[33,34]

Human infrastructure can also affect wildfire risk. Although uncommon, fires caused by electrical transmission lines have been large and deadly. The 2018 Camp Fire nearly destroyed the entire town of Paradise, California, displacing tens of thousands of residents,[35] many of whom have not returned. To reduce such ignitions, electrical grid power shutoffs are used during windy weather.[36] However, this approach can disrupt local economies (e.g., agriculture and healthcare) and livelihoods, with disproportionately high impacts on rural and overburdened communities.[37]

Wildfire smoke can be transported thousands of miles, causing significant environmental, public health, and socioeconomic impacts across the country (KMs 14.1, 19.1, 25.1).[38,39] Smoke from burning vegetation and built structures contains fine particulate matter ($PM_{2.5}$), ozone precursors, and other toxic components (KM 14.2).[40] Although the annual average level of $PM_{2.5}$ has declined over recent decades due to air quality policies, the frequency and severity of smoke events in the western US make wildfire the largest contributor to $PM_{2.5}$ in this region, offsetting some of those improvements (KM 14.1). Exposure to wildfire smoke is associated with adverse cardiovascular and respiratory outcomes (KM 15.1), as well as increased risks of

COVID-19 mortality (Focus on COVID-19 and Climate Change).[41,42] Wildfire smoke may also affect neonatal human health, such as lower birthweights or pregnancy loss.[43,44]

Projected changes in wildfire are expected to result in a significant health burden, especially for at-risk populations.[45] Susceptibility to wildfire smoke exposure can be exacerbated by age, preexisting health conditions, socioeconomic status, occupation, and housing status (e.g., people who are unhoused experience constant exposure). Wildland firefighters are at increased risk of lung cancer mortality and cardiovascular diseases.[46] Where wildfires overlap with harvest seasons, farmworkers and other outdoor workers (frequently low-income workers from immigrant and Indigenous communities) are at risk (KMs 14.2, 15.2, 16.1, 27.1, 28.4).

Enhancing ecosystem resilience and protecting communities from wildfires is achievable through investments in both ecosystems and social systems (KM 28.5). Proactive actions include strategically placing forest fuel treatments in high-fire-risk locations and accelerating vegetation management, including the use of fire at ecologically meaningful spatial scales. These actions often require surface and ladder fuel reductions through prescribed burning or mechanical removal[47] and allowing low-intensity wildfires to burn in strategic locations (KMs 7.3, 28.5). In fire-adapted ecosystems, low- and moderate-severity wildfires reduce smaller trees, shrubs, and dead fuels, maintaining forests with fewer, more widely spaced trees (KMs 7.3, 28.5), thus increasing resilience to future climate impacts. Burned area rehabilitation efforts can reduce sediment runoff and protect water supply and hydroelectrical infrastructure (KMs 5.1, 7.1).

Efforts to strategically reduce the number of human-caused ignitions and investments in home hardening are important adaptation measures in some areas.[7,20] Fireproofing structures and other design and construction efforts can reduce the likelihood of structure ignition, lessening wildfire risk to communities.[48] Land and community planning practices—including zoning, ordinances, and building codes—influence wildfire risks to homes in wildfire-prone regions.[49] Additional measures for protecting communities involve improvements in data access and usability, emergency response planning, healthcare system preparedness, and early-warning systems for evacuation and timely communication of health impacts to the public, especially for at-risk populations and outdoor workers (KMs 14.1, 19.3).

Traceable Accounts

Description of Evidence Base and Research Gaps

This focus box examines observed and projected wildfire trends for western North America and the impacts of wildfire nationally.[3,38,50] This includes research that has used remotely sensed and modeled data, alongside field-based experimental and observational data, to demonstrate that the influence of climate change on current and future wildfire is through warming temperatures, which have reduced fuel moisture content and made the fuels more flammable.[11,12,14,22] Research demonstrates that roughly half of the increase in area burned is due to increases in fuel flammability as a result of anthropogenic climate change (KMs 3.5, 7.1).[12] Warming, lowered humidity, and atmospheric drying (i.e., higher vapor pressure deficit) have facilitated increases in the frequency of fire-conducive weather as well as of annual area burned and the proportion burned at high severity by wildfire (KM 2.2).[14,16] Similar methods have also been used to elucidate factors influencing wildfire smoke pollutant mixture and the effects on human health.[38,39,42]

There is strong and building evidence that reducing forest fuels and lowering the density of trees in forests lessens the impact of climate-mediated stress and disturbance.[4] Greater resistance and resilience to wildfire can be achieved through mechanical vegetation treatments with the use of prescribed fire and managed wildfire (KMs 7.3, 28.5). An increased and refined understanding of appropriate adaptation strategies to safeguard ecosystems, communities, and people could enhance outcomes of future investments.[4] There is evidence that planning, zoning, updating building codes, and fireproofing structures can mitigate risk and losses to infrastructure and property.[48,49] Key areas of future investigation include, but are not limited to, the appropriate suite of land-based practices (i.e., thinning, prescribed fire) as well as the ecosystem specificity (e.g., forest or vegetation type) and the appropriate spatial scale needed to meaningfully reduce risk.[15] Lastly, an increased understanding of the composition of rural populations in the western US, how different subsets of the population access information, and behavioral responses to wildfire-related alerts would allow for more targeted messaging and more informed allocation of resources during wildfire and smoke events.[45]

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