Playing with Fire

How Climate Change and Development Patterns Are Contributing to the Soaring Costs of Western Wildfires

Union of Concerned Scientists

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Waldo Canyon fire, June 2012, Colorado Springs, CO.

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Wildfires have always been a natural and necessary part of the forest landscape in the American West. But recent human-induced changes are dangerously altering wildfire regimes and increasing costs to federal and state budgets and local communities.

Climate Change and Growing Wildfire Risks

Strong scientific evidence shows that climate change is producing hotter, drier conditions that contribute to more larger fires and longer fire seasons in the American West today. The annual number of large wildfires on federally managed lands in the 11 western states has increased by more than 75 percent: from approximately 140 during the period 1980–1989 to 250 in the 2000–2009 period. The western wildfire season has grown from five months on average in the 1970s to seven months today. Moreover, the threat of wildfires is projected to worsen over time as rising temperatures—rising more rapidly in the American West than the global average—continue to lead to more frequent, large, and severe wildfires and longer fire seasons.

Communities on the Frontlines of Risk

Simultaneously, with more homes and businesses being built in and near wildfire-prone forested areas, the danger to people plus the costs associated with fighting, enduring, and recovering from wildfires are also mounting. More than 1.2 million homes—with a combined estimated value of more than $189 billion—across 13 western states are at high or very high risk of wildfires. The majority of the highest-risk properties are in California, Colorado, and Texas, which together have nearly 80 percent of such properties in the western states.

In some areas, past fire suppression, timber harvesting, grazing practices, newly introduced plant species, and increasing geographic range of diseases and pests have altered vegetation and led to an overaccumulation of flammable biomass.

All these factors are converging to create greater wildfire risks and costs. The costs associated with putting out wildfires have soared, surpassing $1 billion (in 2012 dollars) every year since 2000. Since 1985 suppression costs have increased nearly fourfold from $440 million to more than $1.7 billion in 2013 (in 2012 dollars). Firefighting costs are only a minor fraction of the total costs of wildfires. A synthesis of six case studies of major recent wildfires in the western United States estimated that total wildfire costs can range anywhere from 2 to 30 times the direct suppression costs. Wildfires also have profound effects, both good and bad, on natural ecosystems.[1]

Managing and Mismanaging Risk

Some current federal, state, and local policies and commercial practices are worsening the impacts and costs of wildfires. Federal fire management is disproportionately skewed toward suppressing wildfire at the expense of efforts to proactively reduce wildfire risks and maintain healthy forests. The share of the Forest Service (FS) budget devoted to fire management rose from 13 percent in 1991 to more than 40 percent in 2012. From 2004 to 2008, 346 wildfires that each cost more than $1 million in suppression costs resulted in $2.25 billion in spending by the FS.

(Left:) Waldo Canyon fire, June 2012, Colorado Springs, CO.

State and local zoning policies continue to allow development near forests, creating a misalignment with actions that can help reduce risks from wildfires and keep costs down. Taxpayer funds, mostly directed at suppression, are not being used effectively to manage and prepare for the full range of wildfire risks and build resilience. And the full actual risks to homeowners living in fire-prone areas are not reflected in premiums for fire insurance.

The Costly Impacts of Wildfires

Damage to property, infrastructure, and local economies are often an expensive legacy of fires. For example, the 2003 San Diego wildfires caused more than $86 million in damages to roads, bridges, and electricity and gas infrastructure. Smoke from wildfires causes significant health problems, both when wildfires occur near major population centers and when smoke is carried long distances to populated areas. Aggravation of asthma and heart and lung diseases, breathing difficulties, and even death can result. The 2008 fire season led to almost $2.2 million in hospital costs in the Reno/Sparks area of Nevada caused by wildfires within a 350-mile radius.

Intense wildfires can leave burned areas and areas downstream at risk of soil erosion and serious flooding for years afterward. Burned landscapes and soil erosion can also harm water supplies. The 1997 Buffalo Creek fire and the 2002 Hayman fire in Colorado together cost Denver Water $26 million in watershed rehabilitation costs. The 2000 Cerro Grande fire in New Mexico forced direct expenditures of more than $9 million by the Los Alamos Water Utility and an additional $72.4 million in rehabilitation, restoration, and flood mitigation.

Wildfires can also have a significant impact on tourism revenue. The 1988 fires in Yellowstone National Park, the largest wildfires ever experienced in the national park, led to hotels and other accommodations closing four weeks ahead of the normal tourist season, a reduction in annual visits by 15 percent in 1988, and a $60 million loss in tourism benefits between 1988 and 1990.

Many western states have experienced some of their largest wildfires in recorded history in the last decade and a half. The 2002 Hayman fire in Colorado, the 2003 Cedar fire in California, the 2012 Ash Creek fire in Montana, and the 2012 Whitewater-Baldy Complex fire in New Mexico were all the largest recorded to date in those states. Billions of dollars have been spent on putting out fires in these states in the last decade and a half. Damage to the Cheeseman Reservoir in Colorado and the Rio Grande watershed in New Mexico, billions of dollars in insured losses in Colorado and California, significant health costs from smoke pollution, and devastating impacts on the Santa Clara Pueblo in New Mexico and the Northern Cheyenne Indian Reservation in Montana are some of the other major costs of recent wildfires.

Policies and Practices to Help Reduce Wildfire Risks and Costs

In light of these costly trends, we need to use our resources better to manage wildfires and help protect people. Incorporating the latest science to improve wildfire mapping and prediction, investing in fireproofing and fire safety measures, and ensuring that forest management practices reflect changes in climate are necessary starts for human safety and long-term forest health.

Coordinated action is needed among state and federal agencies and policy makers tasked with forest management and fire management, local agencies tasked with zoning regulations, communities located in high fire-risk areas, and insurance companies who insure homes in fire-prone areas. Mandatory building codes and zoning laws at the state and local level can help reduce future wildfire risks and costs. Moving more responsibility for mitigating wildfire risks and costs to homeowners and local communities to incentivize fireproofing measures—and charging insurance premiums that reflect the true danger to properties—can lead to less risky outcomes and decisions that help build local resilience.

Worsening wildfire seasons are forcing federal agencies to shift budgets from investments in long-term fire management and forest health to fire suppression. Funding fire suppression through separate emergency funds, as has been proposed in recent legislation, is an important step toward halting this harmful dynamic.

Public awareness campaigns and fire codes are also important for individual homeowners to understand the risks and the steps they can take to limit them. Homes are often much more flammable than forests. Investments in fireproofing homes and establishing vegetation-free defensible buffer zones around homes can slow or even stop fire from spreading and help keep firefighters safe. There is also a broader need for a national climate resilience fund to help communities cope with the impacts of climate change, including wildfires.

Adaptation measures, however, have their limits. Reducing the expansion of development in risky zones near fire-prone forested areas is the single best way to limit human exposure to wildfire risks (or human causes of wildfires) in the short term. Ultimately, cutting carbon emissions to slow climate change and temperature increases will be crucial to help curtail the impacts of wildfires on people and forests.

[INTRODUCTION]

The western United States has experienced record-breaking wildfire seasons in recent years. Since 2000, the average annual area burned in wildfires has more than doubled from the 1985 to 1999 annual average (NIFC n.d. a).[2] The costs associated with putting out wildfires have similarly soared, surpassing $1 billion every year since 2000 (in 2012 dollars).[3] The 2006, 2007, and 2012 fire seasons were, respectively, the first, second, and third worst since 1960 in terms of area burned, with 9.3 million to 9.8 million acres burned each year—an annual area twice the size of New Jersey (NIFC n.d. b). Many states have experienced some of their largest wildfires in recorded history in the last decade and a half. The 2002 Hayman fire in Colorado, the 2003 Cedar fire in California, the 2012 Ash Creek fire in Montana, and the 2012 Whitewater-Baldy Complex fire in New Mexico were all the largest recorded to date in those states.

Although wildfires have always been a natural and essential part of the forest ecosystems of the American West, new climatic conditions and increasing human development are fundamentally changing the nature of wildfires, the length of wildfire seasons, and the associated dangers. First, climate change, caused by our carbon emissions, is contributing to growing risks of wildfires in the western United States (Dennison et al. 2014; Climate Central 2012a; Westerling et al. 2006). Simultaneously, more people have built or are building homes in and near wildfire-prone areas, creating both a greater human exposure to wildfire risks as well as a greater chance of wildfires being ignited. Moreover, as a result of aggressive wildfire-suppression practices in the past, high fuel loads of underbrush have built up over years in some forests, creating the potential for larger, hotter fires when they happen.

This report explains why western wildfires are worsening; points out why some current policies and practices may be worsening wildfire risks and costs; highlights the many different impacts and costs of wildfires; and provides recommendations for what we can do to limit these costs. Case studies on California, Colorado, Montana, and New Mexico provide a more in-depth look at relevant issues in these states.

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Fighting wildfires can be expensive and dangerous, especially when fires break out near residential areas. In this picture, fire crews are attempting to contain the High Park fire in Cache La Poudre Canyon on June 27, 2012. The wildfire was located approximately 15 miles west of Fort Collins, CO, near several residential areas that had to be evacuated.

We have an opportunity to use our resources better to manage wildfires and help protect people. Coordinated action, with a fresh focus on resilient choices, is needed from federal and state agencies and policy makers tasked with forest management and fire management, local agencies tasked with zoning regulations, communities located in high fire-risk areas, and insurance companies. Incorporating the latest science to improve wildfire mapping and prediction, making investments in fire-safety measures, and better forest management practices can help address the need for human safety and long-term forest health.

Steps we take now—to build resilience to wildfires in communities that are on the frontlines of risk, reduce the expansion of development near fire-prone forested areas, and cut the emissions that are fueling climate change—will be crucial to help limit the impacts of wildfires on people and forests.

Climate Change and Growing Wildfire Risks

Drier, hotter conditions in the American West are significantly increasing the risk of wildfires today (Dennison et al. 2014; Climate Central 2012a; Westerling et al. 2006). Such conditions dry out forests, underbrush, and tinder, increasing their flammability. As global temperatures rise, such conditions will likely worsen, contributing to more frequent, large, and severe wildfires (Joyce et al. 2014; Ryan and Vose 2012).[4]

1.1 Drier, Hotter Conditions Contribute to More Severe Wildfires

Since 1970, average annual temperatures in the western United States have increased by 1.9°F, about twice the pace of the global average warming (Climate Central 2012b). In the Southwest, the multiyear cycle of El Niño (which brings wetter conditions to the region) and La Niña (which brings drier conditions) alternately dampen or amplify the risks, respectively. For example, La Niña years set in motion the severe 2011 fire season when most of the southern United States experienced elevated fire risk, and New Mexico, Texas, and Arizona all had record-breaking wildfires (NOAA 2012).[5,6,7] Overall, the warming and drying trend increases wildfire risks in the region (Kitzberger et al. 2007; Brown and Wu 2005; Westerling and Swetnam 2003; Swetnam and Betancourt 1990).[8,9]

Evidence abounds for a strong positive correlation between climate change and the number and severity of wildfires. A recent (2014) study of large wildfire trends on both public and private land in the western United States found that from 1984 through 2011, the number of large wildfires—ones greater than 1,000 acres—increased at a rate of nearly seven fires per year.[10] Over that same period, the total area burned by wildfires increased by more than 87,000 acres per year. Some ecoregions, including the Arizona–New Mexico Mountains, the Rocky Mountains, and the Sierra Mountains, saw an increase in both the number of fires and the size of area burned; these regions also showed a trend of rising drought severity.[11] Overall, the study points to climate change as "a dominant driver of changing fire activity in the western United States" (Dennison et al. 2014). Five years earlier, another study found that from 1977 through 2003, roughly 64 percent of the fire area burned by wildfires on public lands in the western United States can be related directly to such climate variables as temperature, precipitation, and drought (Littell et al. 2009).[12] The exact relationships varied by

[Climate change is significantly worsening the risk of large wildfires in the western United States today. The western wildfire season has also lengthened from five months on average in the 1970s to seven months today.]

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From 2000 to 2013, bark beetles killed 47.6 million acres of forests in the western United States. Warmer winters have allowed the beetles to survive longer and reproduce more, resulting in record epidemics. They are also now able to infect higher-elevation species, such as whitebark pine.

ecoregion, with each ecoregion characterized by similar types of climate and vegetation.[13] A third study examined 40 years of FS data and showed that, on average, the annual number of large wildfires nearly quadrupled in Arizona and Idaho and doubled in California, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, and Wyoming (Climate Central 2012a). Overall, Arizona, California, Colorado, Idaho, and Montana have seen the most dramatic increases in wildfires since 1970.[14]

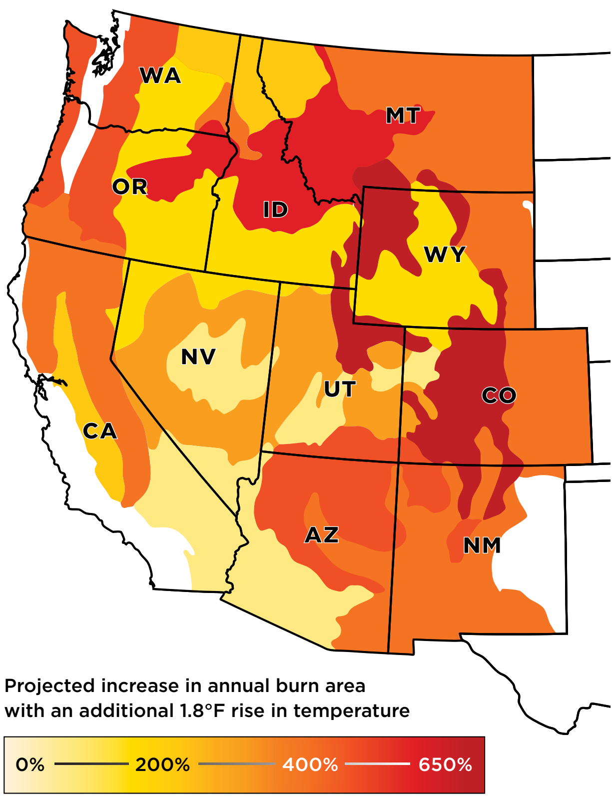
Moreover, evidence strongly indicates that the western wildfire season is lengthening, and has grown from five months on average in the 1970s to seven months today (Climate Central 2012a; Westerling et al. 2006; Brown, Hall, and Westerling 2004). The lengthening wildfire season has been accompanied by a trend toward a growing number of large wildfires greater than 1,000 acres. The annual number of large wildfires on federally managed lands in the 11 western states has increased by more than 75 percent: from approximately 140 during the period 1980–1989 to 250 in the 2000–2009 period (UCS 2013; USGS 2013).[15,16] The greatest increases have occurred in northern Rocky Mountain forests at mid-elevation—that is, at altitudes between 6,500 and 8,000 feet—where spring and summer temperatures are documented to be increasing and snow is melting earlier[17] (Westerling et al. 2006).

To be sure, the data on wildfire occurrence present significant challenges, including a lack of a geographically complete, consistent dataset across all land ownership categories and over long periods of time (Dennison et al 2014; Short 2014). Multiple agencies and jurisdictions play roles in forest and wildfire management and there is no centralized and standardized system of record keeping (Short 2014). U.S. policies on firefighting and land management, as well as patterns of land development, have also undergone major changes over the last 50 years—which, in turn, affect wildfire risks (Johnston and Klick 2012). Nevertheless, robust scientific evidence points to the specific role of climate change in elevating wildfire risks in the western United States, together with other important drivers of risk (Dennison et al. 2014; Climate Central 2012a; Littell et al. 2009; Westerling et al. 2006).

1.2 Warmer Temperatures Contribute to Beetle Infestations

Warmer temperatures contribute to diseases and to infestations by beetles and other pests that can cause trees to die and potentially make more fuel wood available for wildfires (Williams et al. 2013; NRC 2011; van Mantgem et al. 2009; van Mantgem and Stephenson 2007). For example, pathogens such as white pine blister rust have had a significant effect on tree mortality in the western United States, in conjunction with drought, increasing temperatures, and mountain pine beetle (a species of bark beetle) infestations (Sturrock et al. 2011).

FIGURE 1. Midcentury Increase in Area Burned by Wildfires in the Western United States



One study shows that for every additional 1.8°F (1°C) increase in temperature, much of the western United States will experience a significant increase in the area burned by wildfires. Colorado faces the highest overall increase in risk, with a potential increase in annual burned area of 400 to 650 percent. By mid-century, however, temperatures in the western United States are projected to far exceed this estimate, increasing another 2.5°F to 6.5°F over today's temperatures due to heat-trapping emissions from human activities. This would make the area even more vulnerable to wildfire damage.

SOURCE: UCS 2013; NRC 2011.

Even more severe, from 2000 to 2013, bark beetles killed 47.6 million acres of forests in the western United States—an area roughly the size of Nebraska (U.S. Forest Service 2014a). Warmer winter temperatures have allowed beetles to survive longer and reproduce more, resulting in record mountain pine beetle epidemics (U.S. Fish and Wildlife Service 2011). Because of warmer temperatures at higher altitudes, the beetles are also now able to infect higher-elevation tree species, such as whitebark pine, which have fewer defenses because of lack of prior exposure to the pests (Raffa, Powell, and Townsend 2013).

Impacts of pathogens and pests whose ranges have increased due to warmer temperatures have not yet been fully captured in model projections for future wildfire risks. The evidence on whether this widespread tree death makes forests more prone to wildfires is thus far inconclusive.

1.3 Future Trends: Hotter and Drier Yet

How climate change will affect future wildfire risks in a particular region will depend in part on changes to such local conditions as temperature, precipitation, humidity, and resultant changes in the forest ecosystem itself—that is, the types of vegetation present and their density.

By mid-century, temperatures in the western United States are expected to increase between 2.5°F and 6.5°F (1.4°C to 3.6°C) above current levels (NOAA 2013).[18] It is worth emphasizing that this predicted temperature rise is in addition to the 1.9°F increase since 1970 that the region has already experienced.

According to a 2011 study by the National Academies, the average area burned every year in the western United States will rise dramatically with even 1.8°F (1°C) of warming. Among the states, Colorado is projected to have the most area with the largest percentage increase compared with other states, with a potential increase of the annual burned area of 400 to 650 percent for much of the state (NRC 2011).[19]

A 2013 study using an ensemble of 15 climate models shows that, as a result of warmer, drier conditions, the western United States is likely to see an increase in area burned of 60 percent and a further lengthening of the fire season by more than three weeks (23 days) by midcentury (Yue et al. 2013).[20]

Precipitation changes are more variable both in intensity and geographically, so their impact is more uncertain (Kunkel et al. 2013; Peterson et al. 2013). Seasonal or multi-decadal factors such as the El Niño-Southern Oscillation (ENSO, which includes a cool phase of sea-surface temperatures in the equatorial Pacific called La Niña and a warm phase called El Niño) and the Pacific Decadal Oscillation (PDO) can significantly worsen hot and dry conditions associated with climate change, creating years with outsized fire risks (Brown and Wu 2005; Veblen, Kitzberger, and Donnegan 2000; Swetnam and Betancourt 1998; Swetnam and Betancourt 1990). Forecasts of such seasonal extremes can provide lead time in preparing for years with high wildfire risks (Williams et al. 2013; Hessl, McKenzie, and Schellhaas 2004).[21] For example, in the dry shrub and grassland areas of southern Arizona and New Mexico, the risk of a severe wildfire season is strongly related to the amount of fuel that accumulates due to climatic conditions in the 10- to 18-month period before the fire season (Westerling et al. 2003). Indeed, in arid areas, increased precipitation in prior seasons leads to a greater availability of flammable vegetation for fire seasons that follow (Littell et al. 2009).

1.4 Carbon Emissions from Forest Fires Increase

More and bigger wildfires will increase air pollution. Over the western United States, summertime surface organic carbon aerosol—fine particulate matter commonly referred to as soot—will increase by 46 to 70 percent; black carbon, the most strongly light-absorbing component of soot, will increase by 20 to 27 percent (Yue et al. 2013).[22] Soot pollution not only exacerbates climate change, as black carbon is potent at trapping heat, but also can cause respiratory and cardiovascular problems (see Section 4.4).

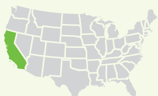
Moreover, the carbon dioxide (CO_2) gas released from forest fires—which can be especially pronounced for large wildfires—contributes to the rise in heat-trapping emissions. A 2010 study estimates that wildfires in the contiguous United States and Alaska release about 290 million metric tons of CO_2 a year, which is the equivalent of fully 4 to 6 percent of the nation's CO_2 emissions from burning fossil fuels (Wiedinmyer and Neff 2007).[23] The study also shows that the CO_2 emissions in several western and southeastern states[24] can be equivalent to 10 percent or more of the annual emissions from the state's entire transportation or power sector (Wiedinmyer and Neff 2007).

Annually, healthy vegetation and soil in forests and wildlands currently absorb more carbon from the atmosphere than they release. But as the climate warms and droughts and wildfires worsen over time, vegetation and soil become stressed and their storage capacity could diminish. Under some scenarios, Rocky Mountain forests could even turn into net sources of emissions by the end of this century, feeding the very CO_2 emissions buildup that is causing climate change (Boisvenue and Running 2010).

Smoke from wildfires can be carried many miles away from the original site of the wildfire. Here, a NASA satellite photo shows the smoke from the 2012 Little Bear fire in the Lincoln National Forest in New Mexico being carried across the border to Texas, shown by the vertical black line.

[STATE CASE STUDY 1]

California Extended Drought Elevates Wildfire Risks in Densely Populated Areas



California ranks first among western states in terms of average annual costs for fighting large wildfires on federal lands (Kenward and Raja 2013). Those costs, on average, exceed that of 10 other western states combined (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming). On average, almost half of all annual firefighting expenditures for western wildfires go toward fighting California fires even though the state's wildfires typically make up less than a quarter of all the acres burned in the western states (Kenward and Raja 2013). The overall budget of the California Department of Forestry and Fire Protection (CAL FIRE) for fire protection alone is currently more than $1 billion annually (State of California 2014).

California's wildfire risks in 2014 are particularly high because of the extended drought and record low rainfall the state has been experiencing. From 2013 to 2014, southern California experienced an almost year-round fire season, with elevated wildfire risk even during the winter months (CAL FIRE 2014a), which may be a harbinger of a drought-prone future.[25] As of February 2014, snowpack in the Sierra Nevada Mountains reached a record low of 24 percent of normal levels (California Department of Water Resources 2014).[26]

The 2013 fire season saw the third-largest fire the state has seen to date, the Rim fire, which raged for more than two months (August 17 to October 24). The fire burned more than 257,000 acres in and around Yosemite National Park in Mariposa and Tuolumne counties in the Sierra Nevada region.[27] Suppression costs alone amounted to nearly $126 million (InciWeb 2013). A recent study estimated additional losses from the fire of $100 million to $736 million in lost environmental benefits (including food provisioning, raw materials, air quality, soil retention, water regulation, and recreation and tourism),[28] and an estimated $50 million to $265 million in the value of private property destroyed (Batker et al. 2013).[29] Salvage logging, the logging of trees for timber in a forest that is unhealthy or has been damaged in some way, has been proposed in the wake of the wildfire to recoup some of the suppression costs. The idea has proven to be controversial because of the potential for adverse ecosystem effects (Boxall 2014; Center for Biological Diversity and the John Muir Project 2014; Rott 2014).

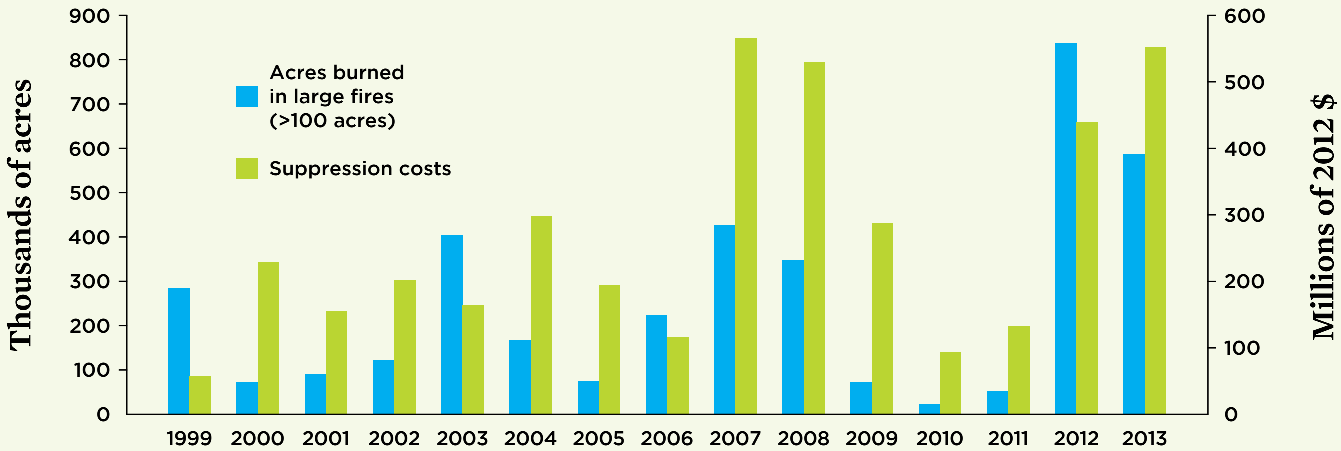
In January 2014, Governor Edmund G. Brown declared a state of emergency for California because of the record dry conditions, declaring that "the risk of wildfires across the state is greatly increased." He directed CAL FIRE to hire additional firefighters and take other actions to protect the public (Office of Governor Edmund G. Brown Jr. 2014).

Wildfire risks in southern California differ from those in the northern part of the state primarily because of their different vegetation types. Southern California's wildfire risks occur from a confluence of factors, including fuel buildup due to past watershed management and fire suppression, the local ecology and climate, and the Santa Ana weather events, which combine high and hot winds and low humidity (Keeley

© Flickr/U.S. Forest Service

Crews work hard to fight the Rim fire in Stanislaus National Forest that began in August 2013. The fire consumed 260,000 acres—a devastating loss to the natural landscape and neighboring communities.

FIGURE 2. Recent Large Wildfires in California, 1999–2013



20 Largest Fires in California

(Bold: More than 200,000 acres)

2013	**Rim**	**2008**	Klamath Theater Complex	**2003**	Simi	**1987**	Stanislaus Complex
2012	**Rush**	**2007**	Witch	**2002**	McNally	**1985**	Wheeler
2009	Station	**2007**	**Zaca**	**1999**	Big Bar Complex	**1977**	Marble Cone
2008	Basin Complex	**2006**	Day	**1996**	Highway 58	**1970**	Laguna
2008	Iron Alps Complex	**2003**	**Cedar**	**1990**	Campbell Complex	**1932**	**Matilija**

Between 1999 and 2013, there were more than 78,000 wildfires in California, which burned approximately 3.8 million acres and incurred more than $4 billion in suppression costs (in 2012 dollars). Of these, the Cedar, Rush, Rim, Zaca, and Matilija fires burned more than 200,000 acres apiece. The suppression costs of wildfires do not necessarily correlate with acres burned. Another major determinant of costs is where a fire occurs—costs tend to be higher if fires occur near developed areas.

DATA SOURCE: CAL FIRE 2014B; NFAM N.D.

et al. 2007; Westerling et al. 2004; Pyne 1997). The northern part of the state has risks similar to the high-elevation Rocky Mountain forested areas, which are experiencing a clear increase in the severity and length of the fire season due to climate change. It is possible that, with climate change, wildfires will increase in the northern part—especially the Sierras—but may decrease in the south, which is dominated by dry grass and shrublands (Westerling and Bryant 2008).[30,31] Throughout the state, but especially in the densely populated southern part, many people live near wildfire-prone areas, or downwind from them. This means that even small changes in wildfire risks due to climate change can have dangerous and costly consequences for millions of people.

California has suffered seven of the 10 most costly wildfires in the nation, including three that cost between $1.6 billion and $2 billion in insured losses.[32] A recent insurance industry estimate found more than 2 million California homes—nearly 15 percent of all California homes—at risk of extreme wildfire hazards. More than 77 percent of homes in the Northern California counties of Alpine, Mariposa, Nevada, and Tuolumne are already considered high risk even before taking climate change into consideration (IINC and Verisk Insurance Solutions 2012).[33,34,35] CAL FIRE also maintains a list of communities at high risk of wildfire to help determine where and how to direct its resources; currently, 874 communities are on the list (CAL FIRE 2014c).[36] Some of the cities on the list of "very high fire severity zones" include Berkeley, Oakland, and several cities in Los Angeles, Orange, Riverside, San Bernardino, and Ventura counties.

The human health effects of smoke from wildfires have been studied more in California than any other part of the country because wildfire smoke often affects large population centers. The 2003 wildfire season in particular produced heavy smoke that affected the Los Angeles metro area. A study of the impact on children's health showed that, with soot particles produced from the fire 10 to 20 times higher than usual levels, many children experienced acute eye and respiratory symptoms and the effects on those with asthma were particularly pronounced (Künzli et al. 2006). Another study focused on cardiorespiratory hospital admissions in the wake of the fires and found that elevated levels of PM2.5 (particulate matter less than 2.5 microns in diameter) had the strongest negative effects on older people (65 to 99 years, 10.1 percent increase in hospital admissions) and younger people (0 to 4 years, 8.3 percent increase in hospital admissions) (Delfino et al. 2009).[37] The 2008 wildfires led to some of the highest levels of PM concentrations in the Central Valley ever recorded at those air quality monitoring stations, and a study showed that this type of PM from wildfires is much more toxic to the lungs than PM that is usually found in the region's air (Wegesser, Pinkerton, and Last 2009).

California has taken key steps to prepare its residents for wildfire risks. It has developed a strategic fire plan for reducing risks before, during, and after fires (State Board of Forestry and CAL FIRE 2010). It has launched an active public awareness campaign to warn people of wildfire risks and how to protect themselves (CAL FIRE 2014d).[38] The state also uses its building code and other laws to require more fire-safe housing in the wildland-urban interface (WUI), where homes are located in or near vegetated areas prone to wildfires, and buffer zones free of flammable shrubs or debris (Burton 2013). In 2011, the state began charging rural dwellers an annual protection fee of $150 that has netted some $84 million for its strained firefighting budget, although it has also been criticized for being administratively expensive to collect and for not being significant enough to be a deterrent to living in wildfire-prone areas.

[*California's extended drought and record low rainfall are greatly increasing the risk of wildfires across the state.*]

California is one of five states that require insurers to fill out a survey asking if they consider climate change risks in their business model. The 2013 survey showed that close to 75 percent of them do, an encouraging sign that there is an awareness that the market must respond to changing conditions (California Department of Insurance 2013).

The state has been at the vanguard of overall climate mitigation and preparedness actions, enacting the Global Warming Solutions Act (commonly referred to as AB32 for Assembly Bill No. 32) and adopting a statewide climate adaptation strategy in 2009 that is being updated (California Natural Resources Agency 2013; California Natural Resources Agency 2009; Assembly Bill No. 32 2006).[39]

A Combustible Mix: Homes near Wildfire-Prone Forests Raise Risks

Forests are beautiful natural areas with many opportunities for outdoor recreation. People want to live near them or even within them. Growing housing development in and near wildfire-prone forested areas is a primary factor in raising exposure to the risks and costs of wildfires, and forcing more resources to be spent on fire suppression to defend these areas in the event of a fire. In some areas, past fire suppression, timber harvesting, grazing practices, newly introduced plant species,[40] and increasing range of diseases and pests have altered vegetation and led to an overaccumulation of flammable biomass—which, in turn, raises the risks of wildfires.

2.1 Development Is Growing in Wildfire-Prone Forested Areas

In the last 50 years there has been significant expansion of development near wildland areas in the United States, much of which comes from new homes (Theobald and Romme 2007; Radeloff et al. 2005). The junction of developed areas and wildlands is commonly referred to as the WUI.[41] Wildlands can include forests, shrublands, grasslands, and other types of natural ecosystems that can have elevated wildfire risks. For the purposes of this report we are primarily focused on forested areas in the western United States.

In 2000, the WUI in the United States occupied nearly 180,000 square miles (465,614 square kilometers) and contained more than 12.5 million housing units, a 52 percent expansion from 1970 (Theobald and Romme 2007). In 2008, approximately 40 percent of the 115 million single-family homes in the United States were located in such areas (Botts et al. 2013). If this trend continues, by 2030 the WUI is likely

TABLE 1. Development in the Wildland-Urban Interface

State	Percent Developed	Total Homes in WUI	Percent Second Homes
All Western States	16%	1,947,927	15%
Washington	29%	951,468	6%
California	17%	490,255	18%
Oregon	11%	179,451	15%
Colorado	20%	117,472	40%
Montana	9%	43,136	31%
Idaho	13%	43,454	34%
New Mexico	16%	27,387	40%
Arizona	16%	52,701	41%
Utah	7%	15,733	35%
Nevada	9%	20,970	23%
Wyoming	5%	5,900	43%

The proportion of the wildland-urban interface (WUI) that is developed is still relatively small in most western states, averaging 16 percent for all western states. Keeping the WUI contained provides a significant opportunity to help limit wildfire risks to people and their homes. The percent of second homes in the WUI is striking: In Arizona, Colorado, New Mexico, and Wyoming, more than 40 percent of the homes in the WUI are second homes. Although these homes may be occupied only seasonally, firefighters are compelled to defend them year-round from wildfires. Moreover, absentee homeowners may also be less likely to contribute to long-term management of fire risks.

SOURCE: HEADWATERS ECONOMICS 2014.

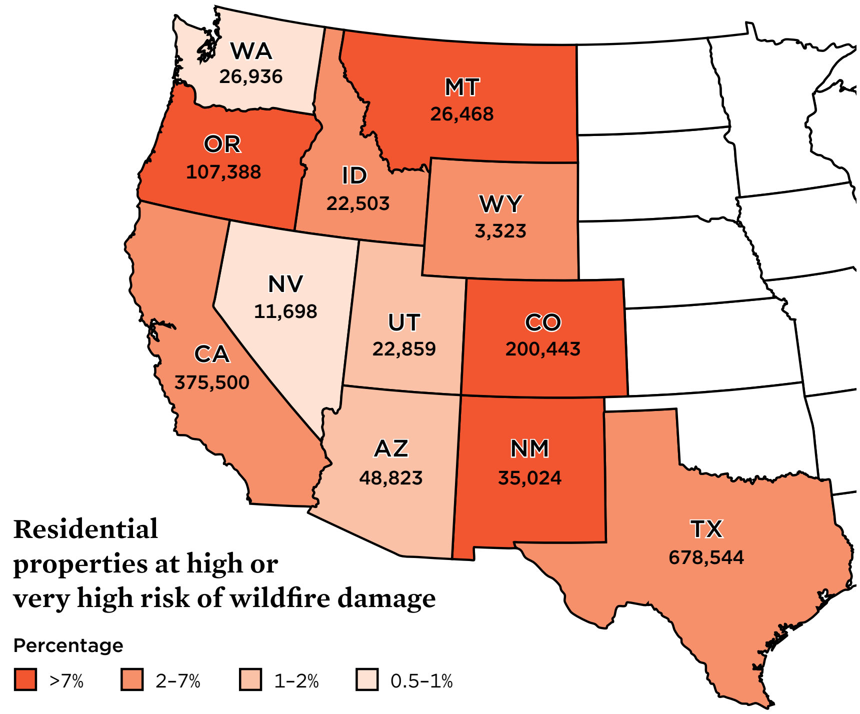
HOMES AND COMMUNITIES IN WILDFIRE-PRONE FORESTS FACE HIGH RISKS
Homes built in or near areas with forests face elevated risks of wildfires. These areas—often called the wildland-urban interface (WUI)—are also very challenging environments in which to fight fires. Colorado and California stand out as having the most homes in the high-risk WUI.

to expand to at least 200,000 square miles, with the greatest expansion occurring in the intermountain western states of Arizona, Colorado, Idaho, Montana, Nevada, and Utah (Theobald and Romme 2007).[42] More than 1.2 million homes across 13 western states are at high or very high risk of wildfires (Botts et al. 2013). These properties have a combined estimated value of more than $189 billion.[43] California, Colorado, and Texas have the largest number of properties exposed to the highest risk, together having nearly 80 percent of such properties in the western states. Population growth, housing preferences, and growing numbers of vacation homes are among the main factors contributing to these development trends (Hammer, Stewart, and Radeloff 2009).[44]

© Zach Dischner Photography

Homes and developed areas near wildfire-prone forests in the western United States are particularly exposed to the threat of wildfires. This picture shows the 2012 Flagstaff fire near the University of Colorado–Boulder campus.

FIGURE 3. Homes at Risk from Wildfires in the Western United States



Development in or near wildfire-prone areas in the western United States is significantly raising the risks and costs of wildfires. The colors on the map show the percentage of homes in each state that are either in the very high or high wildfire risk categories. Colorado, Montana, New Mexico, and Oregon are the states with the highest percentages of homes in very high and high risk categories, based on terrain, fuel, and vegetation characteristics of the property itself. The figures in each state show the number of properties that have the highest numeric risk score, factoring in a property's proximity to very high or high wildfire-risk areas. Texas, California, and Colorado have the greatest number of homes with the highest risk score.

SOURCE: BASED ON DATA BY CORELOGIC (BOTTS ET AL. 2013).

BOX 1.

Managing Wildfire Risks in the Wildland-Urban Interface

While wildfire risks present significant challenges where homes meet forests in the WUI, there are clear steps that can be taken to help address them (Calkin et al. 2014). Mapping the WUI and identifying high-risk communities is a critical first step to managing those risks and costs (Wildfire Insurance and Forest Health Task Force 2013). Public awareness campaigns are important for homeowners to understand the risks and the steps they can take to limit them. For example, investments in fireproofing homes and establishing vegetation-free buffer zones around homes have been shown to be very effective in protecting homes (CAL FIRE 2014d; Colorado State Forest Service 2012).[45] A cleared defensible-space zone around a home can slow or even stop fire from spreading and helps keep firefighters safe. The type of building material and the density of housing can have a big effect on how much a fire spreads and how much damage it causes (Spyratos, Bourgeron, and Ghil 2007).

For high-risk communities, establishing clear evacuation routes, creating warning mechanisms to inform residents of fires, making data on location and availability of firefighting resources easily accessible, and undertaking proactive fuels management are all helpful. Mandatory building codes and zoning laws at the state and local levels can help reduce future wildfire costs.[46] Finally, national policies to align firefighting budgets and disaster aid with more resilient development choices at the state and local levels will send an important signal to help protect homeowners in wildfire-prone areas and will benefit all taxpayers.

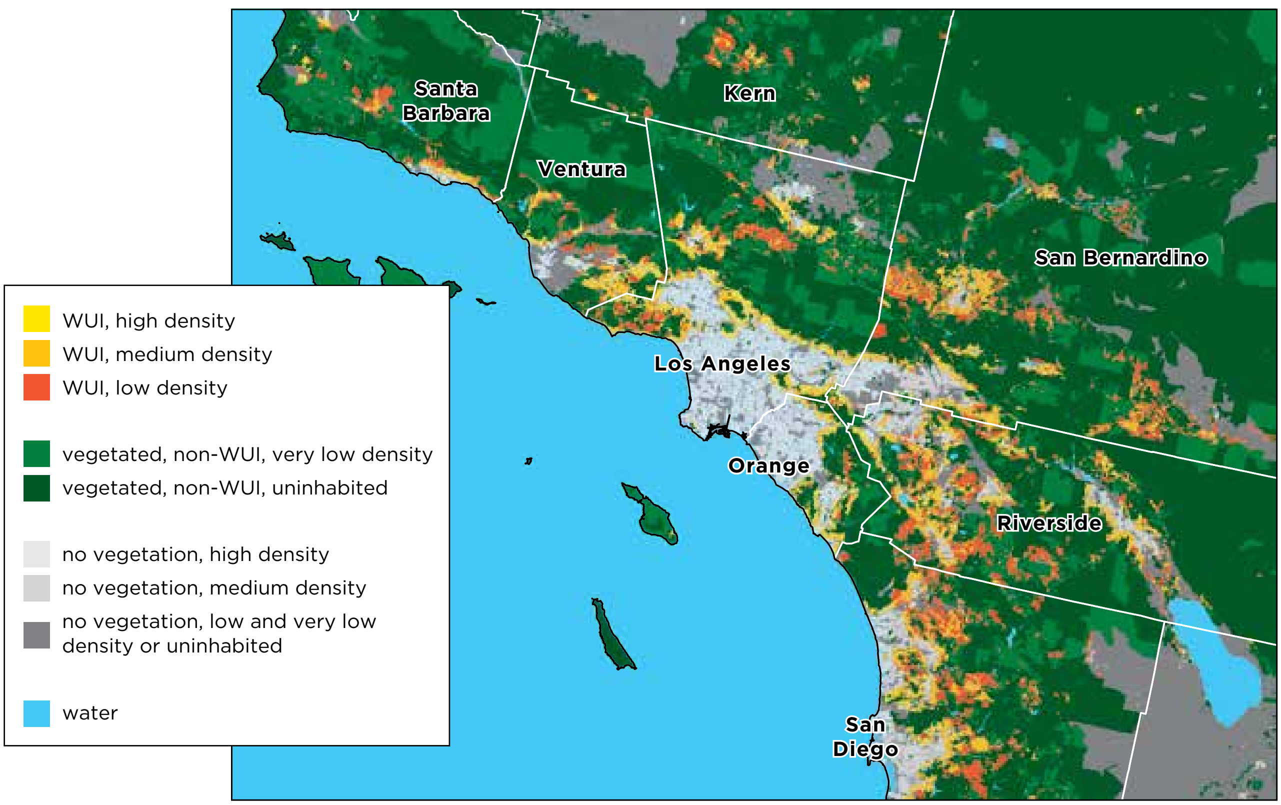
2.2 Mapping Wildfire Risks to People and Homes

To understand the risk of wildfire to homes, it is important to identify the WUI where fire-prone forested areas and developed areas intersect, allowing fires to jump from natural environments to human ones. One useful proxy is combining vegetation maps with U.S. Census data on housing or population (see Figure 4). More sophisticated methods are being developed that use more granular population data and also take into account fire characteristics and the probability of a fire spreading based on such factors as topography and historical behavior (Haas, Calkin, and Thompson 2013). Using such maps, southern California clearly stands out as having some of the largest, most densely populated areas exposed to wildfire risks (Haas, Calkin, and Thompson 2013).

© KGTV

Wildfires can have devastating impacts on personal property and lives. A San Diego couple watches as firefighters try to save their home.

FIGURE 4. Southern California's High Wildfire Risk

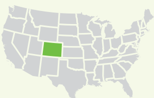


Southern California has some of the most densely populated areas in the United States exposed to high risks of wildfires at the wildland-urban interface (shown in yellow and orange colors on this map with 2010 data), where homes meet forested, grassland, or shrubland areas.

DATA SOURCE: SILVIS LAB 2012.

[STATE CASE STUDY 2]

Colorado Homes and People at Risk in the Front Range



Colorado's 2012 Waldo Canyon fire was one of the most destructive fires in the state's history. The fire burned more than 18,000 acres, destroyed 247 homes, took two lives, and forced the evacuation of nearly 30,000 residents (City of Colorado Springs 2013). Post-fire flooding and mudslides will remain a risk for the burned area for a number of years (Quarles et al. 2012). That single fire resulted in suppression costs amounting to $15.7 million and insured losses of $454 million (CDPS 2014; RMIIA n.d.). Following closely in 2013 was the catastrophic Black Forest fire with estimated insured losses of $288 million and suppression costs of $14.8 million (in 2012 dollars). Unfortunately, such costly "megafires" are likely to be a continuing part of Colorado's future as climate change and growing development in wildfire-prone areas combine to elevate risks.

Colorado's spectacular scenery and popularity with outdoor enthusiasts owes much to its location in the southern Rocky Mountains—right where hotter, drier conditions in this region are contributing to growing wildfire risks. Since the 1970s the average annual number of large wildfires (greater than 1,000 acres) on FS lands in Colorado have doubled (Climate Central 2012b).

Twenty percent of Colorado's population and a quarter of all homes are located in so-called red zones: areas at high risk of wildfires (9News.com 2012).[47] More than 117,000 homes—40 percent of them second homes—are in wildfire-prone areas near forests (Headwaters Economics 2014). Among the western

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A Wyoming National Guard plane drops fire retardant to try to slow the spread of the 2012 Waldo Canyon fire near Colorado Springs, CO. The plane belongs to a unit that is part of the nation's Modular Airborne Fire Fighting System, a joint effort between the U.S. Forest Service and the Department of Defense.

Twenty percent of Colorado's population and a quarter of all homes are located in areas at high risk of wildfires.

states, Colorado ranks second, behind Washington, in the percentage (20 percent) of the state's WUI that is developed (Headwaters Economics 2014). Projections show that by 2030 developed wildfire-prone areas could be triple the area in 2000 (Theobald and Romme 2007).[48]

Along Colorado's Front Range—which encompasses such major population centers as Boulder, Colorado Springs, Denver, and Fort Collins—rapid development in high wildfire-risk areas has serious implications for people and their homes. Insured property losses related to wildfires are significant (see Table 2).

Colorado's water supplies, especially for the densely populated Front Range communities, have come under threat from past wildfires followed by flash floods, which have led to contamination from debris, ash, and sediment. For example, the 2002 Hayman fire affected the Cheeseman Reservoir, which stores 15 percent of the Denver metro area's water supply (Le Master, Shao, and Donnay n.d.). The fire also forced Denver Water, the local public utility company, to spend more than $26 million on dredging Strontia Springs Reservoir, treating water, and reseeding the forests in the watershed (DOI 2013). Those consequences have lasted for years, requiring costly ongoing maintenance and rehabilitation (Le Master, Shao, and Donnay n.d.).

Colorado's recent series of destructive wildfire seasons, and in particular the Waldo Canyon fire, led Governor John Hickenlooper to commission a wildfire taskforce[49] to study how better to manage risks in wildfire-prone developed areas. In its 2013 report, the taskforce recommended a number of steps including charging homeowners an annual fee to live in the WUI, undertaking wildfire mitigation audits for high-risk properties, and providing tax incentives or state funding for mitigation efforts (Wildfire Insurance and Forest Health Task Force 2013). Thus far, there has been opposition to specific legislation in response to the taskforce's recommendations; it is unclear whether legislation may be introduced in the future.

Currently, Colorado does not have any state laws requiring property owners in wildfire-prone areas to actively participate in risk-mitigation efforts, leaving such requirements to the discretion of local authorities. As a result, in some areas severely affected by wildfires, local and county governments have imposed stringent wildfire regulations, while other areas have few or no regulations. Colorado communities, as many others nationwide, do participate in adopting voluntary Community Wildfire Protection Plans.[50]

The Colorado State Forest Service has created an online tool to help individuals assess their risk from wildfires

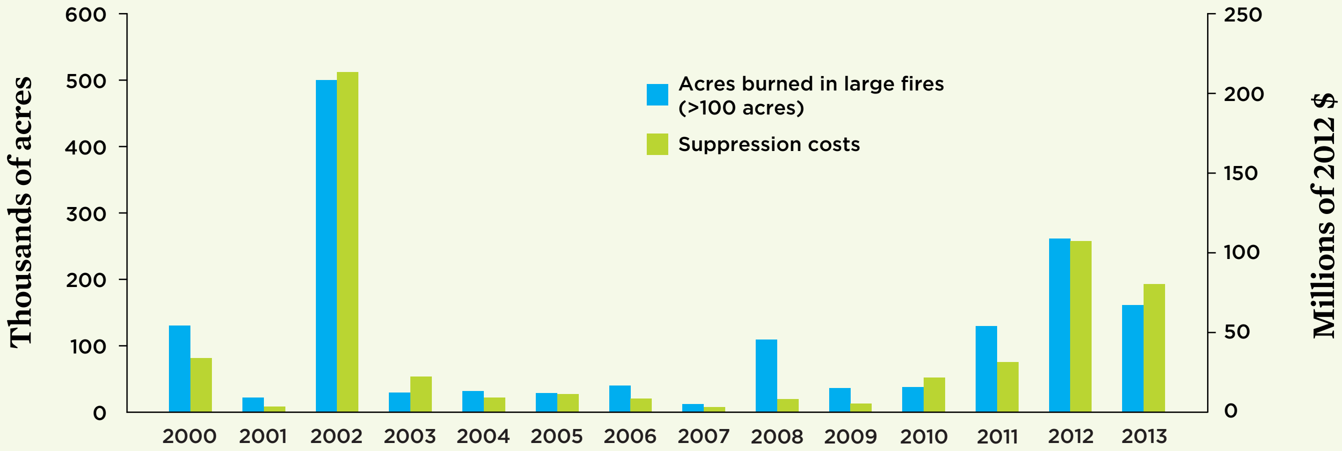
TABLE 2. Insured Losses from Recent Colorado Wildfires

Year	Fire	Insured Loss ($ Millions)	Insured Loss (Millions 2012 $)*
2012	Waldo Canyon, Colorado Springs	453.7	453.7
2013	Black Forest, near Colorado Springs	292.8	288.4
2012	High Park, near Fort Collins	113.7	113.7
2010	Fourmile Canyon, northwest of Boulder	217.0	225.1
2002	Hayman, southwest of Denver	38.7	47.8
2002	Missionary Ridge, near Durango	17.7	21.9
2002	Coal Seam, Glenwood Springs	6.4	7.9
2002	Iron Mountain, near Cañon City	7.5	9.3

*2012 estimated cost calculations based on the Consumer Price Index.

SOURCE: RMIIA N.D.

FIGURE 5. Recent Large Wildfires in Colorado, 2000–2013



Selected Large Fires

(**Bold: More than 10,000 acres;** *Italic: More than $5 million;* ***Bold Italic: Both***)

2000
Bircher
Bobcat
Buster Flats
High Meadow

2002
Big Fish
Burn Canyon
Cheyenne County
Coal Seam
Green Creek
Hayman
Lincoln County Complex
Million
Missionary Ridge
Mt. Zirkel Complex
Spring Creek Complex
Trinidad Complex

2005
Mason

2006
Mato Vega

2008
Bridger Fire
Mayberry

2011
Bear Springs Callie Marie
Duckett
Ft. Lyons
Karval
Shell Complex
Track

2012
Fern Lake
Heartstrong
High Park
Last Chance
Little Sand
Lower North Fork
Pine Ridge
Waldo Canyon
Weber

2013
Black Forest
East Peak
Fern Lake
West Fork Complex

From 2000 to 2013, there were 329 large wildfires in Colorado that were greater than 100 acres. Together, they burned approximately 1.5 million acres and incurred more than $557 million in suppression costs (in 2012 dollars).

SOURCE: CDPS 2014; NFAM N.D.

and provide information for local planners and emergency responders.[51] The state has also joined Colorado State University, local media, insurance companies, and wildfire agencies to launch a "Wildfire Ready" public awareness campaign ahead of wildfire season (CBS Denver 2014). Insurance companies in Colorado are increasingly asking homeowners to be more aware of their risk of wildfires and to take appropriate measures, such as fireproofing homes and creating vegetation-free buffer zones around homes, in order to maintain affordable insurance rates.[52] The Watershed Wildfire Protection Group, a partnership of state and federal agencies, research institutions, and water utilities, has been formed to help assess risks to water supplies and to take steps to help reduce them. The Upper Colorado headwaters and Big Thompson watershed are also the first pilot site for a new initiative on watershed protection from wildfire risks launched by the FS and the Department of the Interior (DOI) as part of President Obama's Climate Action Plan (DOI 2013).

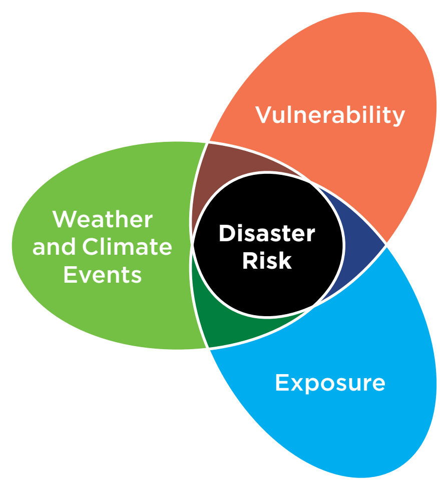
Managing and Mismanaging Wildfire Risks

Risk may be defined as the probability of an adverse event (or hazard) occurring that causes physical harm or monetary losses. The magnitude of the potential impact is a measure of the seriousness of the risk. In the context of wildfires, risks to people are increasing in part because of hotter, drier conditions caused by climate change. This is compounded by what economists call a "moral hazard" problem: homeowners and local decision makers may make choices that result in greater exposure to risks because they do not pay the full costs of those choices. For example, the choice to permit further development in wildfire-prone areas is primarily in the hands of local zoning authorities. However, this type of development can result in greater firefighting costs, a disproportionate share of which is paid for by taxpayers.

Mitigating economic risks from wildfires requires actions that reduce the risk itself (such as actions to limit the chances of wildfire damage through proactive fuels management or fireproofing measures in homes and communities), limit exposure to risk (for example, by limiting development in wildfire-prone areas or buying insurance), or line up resources to help people cope with the aftermath of fires (e.g., disaster assistance or insurance payouts). A combination of all these actions may be required. Some people may be more vulnerable to wildfire risks, such as children who suffer more from the health effects of smoke or communities that depend on healthy forests for their livelihoods.

Almost half the land in the western United States is publicly owned, in contrast with roughly 4 percent in the rest of the country.[53] Eleven western states, including California, Colorado, Montana, and New Mexico, have more than 10 million acres of federally owned land within their borders (Gorte et al. 2012). Thus, much of the funding for wildfire

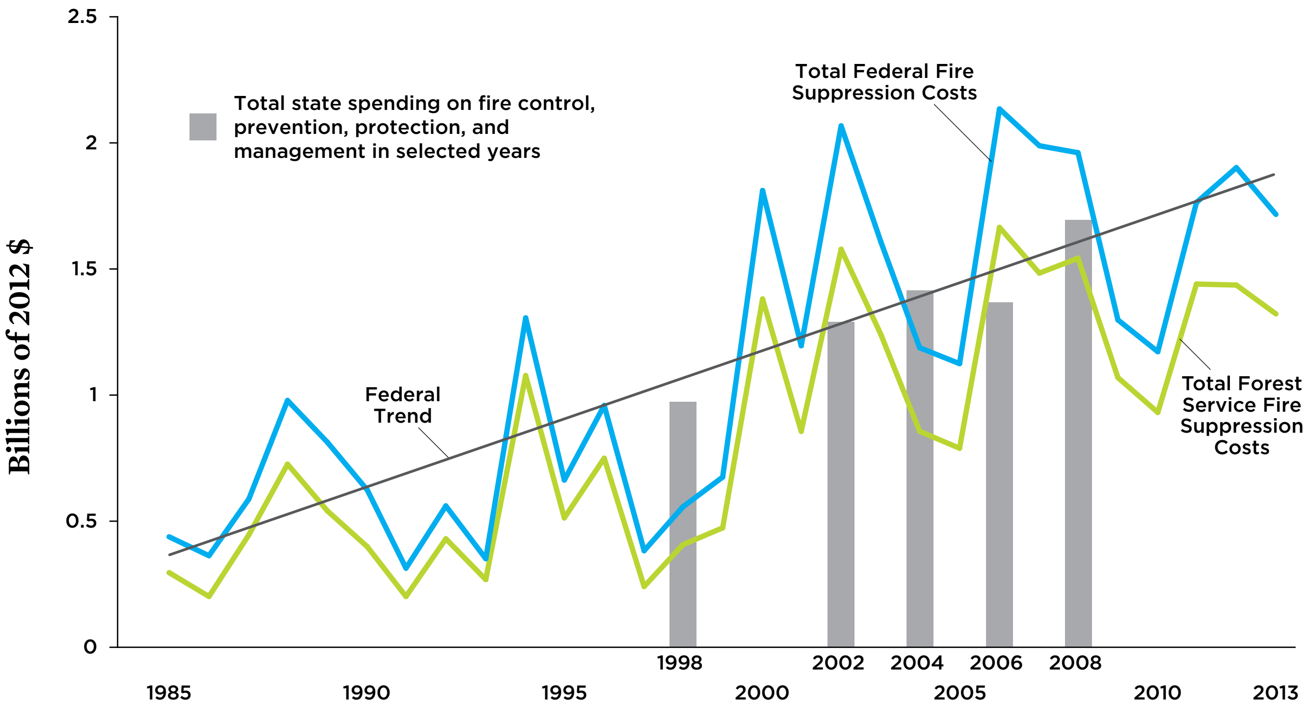
FIGURE 6. Factors That Influence Disaster Risk



ADAPTED FROM IPCC 2012.

[We have to do a better job aligning limited federal and state firefighting budgets with local zoning decisions and homeowners' choices to build in wildfire-prone areas.]

FIGURE 7. Federal Fire Suppression Costs and State Fire Management Costs



Federal wildfire suppression costs show fluctuations over time reflecting the severity of fire seasons. However, the overall trend in federal spending is upward, in real terms. Data for state expenditures on firefighting are limited. For the five years available, the data show that states are also spending large amounts on fire management, almost matching or exceeding federal suppression costs in some years. Some of the state expenditures may be reimbursed by the federal government under cost-share agreements or through disaster declarations.

SOURCES: NIFC N.D. B (FEDERAL DATA); NASF 2008 (STATE DATA).

suppression comes from federal sources—ultimately, the American taxpayer (see Figure 7).

In contrast, nearly 90 percent of the developed areas located in or near forests are privately owned lands—and nearly two-thirds of them are at high risk of wildfires (Theobald and Romme 2007).[54] Moreover, the proximate cause of as many as 90 percent of wildland fires in the United States is human activities: campfires left unattended, burning of debris, negligently discarded cigarettes, and intentional acts of arson. The remaining 10 percent are started by lightning or lava (NPS n.d.). With the federal government being responsible for paying for suppressing fires that originate on federal land regardless of cause, locally driven pressures to develop private lands complicate decisions about how to manage forests and fires.

Simply put: we have to do a better job of aligning limited federal and state firefighting budgets with state and local zoning decisions and private incentives to build in risky areas (see Section 5). And this is more urgent in light of hotter, drier conditions that are worsening wildfire risks in the western United States.

3.1 Federal and State Responsibility for Fire Management

Wildfire management policy in the United States has evolved significantly over the last century. The FS, formed in 1905, once focused primarily on total fire suppression at all costs in response to the prevailing public sentiment.[55] Through the 1960s and 1970s, it became increasingly obvious that suppression costs were rising; moreover, this narrow anti-fire focus was adversely affecting forest health and wildlife habitat, and potentially creating forests even more prone to large wildfires because of fuel buildup (Stephens et al. 2012; Allen et al. 2002).

Wildfires can have benefits, particularly for fire-dependent ecosystems and species (Center for Biological Diversity and the John Muir Project 2014; Butry et al. 2001). Maintaining a regular cycle of fires and regeneration is also important to help reduce the buildup of flammable material in a forest. Without that, there becomes a danger of a growing tinderbox that could be ignited at any time. Thus, a series of revisions in policy that attempt to recognize the beneficial role of wildfires have shifted the goals of the FS more toward wildfire management, rather than simply wildfire suppression.[56]

Federal fire management policy today extends to hazardous fuel reduction, ecosystem restoration, and community assistance (DOI 2012). Yet, efforts still are weighted toward fire suppression, which takes up a major share of fire management budgets (Donovan and Brown 2007). The primary reason is the legitimate concern that if wildfires are allowed to burn, even if they start in remote areas, there is a danger of their growing in size and spreading to areas near where people live. The legacy of past fire-suppression practices lingers in many places in the form of excessive fuel buildup and changed vegetation.

The main federal agencies responsible for wildfire protection are the U.S. Department of Agriculture (USDA) (specifically, the FS) and the DOI (specifically, the Bureau of Land Management, National Park Service, Fish and Wildlife Service, and Bureau of Indian Affairs). The FS takes the lead in terms of budget and the area of federal lands under their control.[57] Together, these agencies not only fight fires as they occur (fire suppression), but also invest in preparedness ahead of fires (by hiring and training personnel, ensuring adequate equipment, and making fire predictions), reduction of flammable vegetation (through prescribed burns and thinning to reduce fuel loads), and post-fire restoration activities (such as rehabilitation of sites and clearing of dangerously located debris) (see Figure 10, p. 28).

On non-federal lands, states also play an essential role in managing forests and fighting fires. State foresters protect two-thirds of the nation's forests and are responsible for managing 75 percent of all wildfires (NASF n.d.), although they do not pay for the suppression costs of all those fires. A diverse group of state agencies provide resources and expertise to help prepare for, respond to, and recover from wildfires.[58] Federal and state agencies work together under the umbrella of the National Cohesive Wildland Fire Management Strategy, which prioritizes resilient landscapes and fire-adapted communities (see Section 5).

A complex system of cost-share agreements—which differ by state and sometimes even for different fires within a state—governs how suppression costs are divided between state and federal agencies (GAO 2006). There is no standardized source for state fire suppression cost data, so determining the relative proportion of state and federal responsibility for overall costs is difficult. In general, federal agencies (in most cases the FS) pay for the costs of wildfires that originate on federal lands (U.S. Fire Administration 2012). With growing private development adjacent to federal lands, greater federal resources are being expended to fight fires.

3.2 Homeowners' Responsibility for Fire Management

Urban or suburban residences near or intermingled with forested areas—the WUI—present one of the most challenging and costly environments in which to fight wildfires (Montana DNRC 2007; Cohen 2000; Winter and Fried 2000). Difficulties in accessing these properties and the need to protect structures and lives create greater challenges and risks for firefighters than they face fighting fire on continuous wildlands. The presence of homes also raises the costs of putting out wildland fires. For example, data from Montana show that, not only were there 50 percent more fires—and more human-caused fires—in WUI areas than in non-WUI areas, but the cost of suppressing any individual WUI wildfire was also 46 percent higher than for non-WUI fires (Montana DNRC 2007).[59] The development of homes in and near the WUI has increased costs for federal agencies that provide financial and technical assistance to states and local agencies for wildfire protection.

The overarching priority in wildfire management is human safety, with the protection of natural resources and property as a secondary priority. However, an audit of FS expenditures found that a majority of the costs of putting out large fires are "directly linked to protecting private property in the WUI" (Office of the Inspector General 2007). Indeed,

Federal fire management includes fire suppression, hazardous fuels reduction, ecosystem restoration and community assistance. With worsening wildfire risks and growing development in wildfire prone areas, a major share of the fire management budget is being spent on fire suppression.

© Sarah Foster/Washington State Department of Natural Resources

Homeowners who live near wildfire-prone forested areas can take steps to reduce their risks by investing in fireproofing measures. This homeowner has created a defensible space around their home, with no large trees in a wide perimeter around the home. This helps reduce the risk of fire spreading from forests to homes and also gives firefighters space to fight the fire.

based on data on large fires from 2003 and 2004, a survey of FS managers and staff concluded that 50 to 95 percent of the large wildfire costs were directly related to protecting private property in the WUI. Scaled up nationally, the costs of protecting these types of properties from large fires were estimated to be $547 million to $1 billion in 2003 and 2004 (Office of the Inspector General 2006). Other studies confirm that finding. A study of 100 large (greater than 300 acres) wildfires in the Northern Rocky Mountains from 1996 to 2005 that were suppressed by the FS also showed that the location of private property near public lands greatly increased FS suppression expenditures (Liang et al. 2008).[60] Studies in Montana and the Sierra Nevada Mountains of California show a high correlation between wildfire suppression costs and the number and density of homes in the WUI (Headwaters Economics 2011; Headwaters Economics 2008).

Homeowners share responsibility for protecting themselves and their property; taking such precautions as using fire-resistant construction materials, especially for roofs, and clearing the area around their homes of flammable vegetation can help prevent wildfires from spreading easily. In many western states, however, the homeowners' responsibility is voluntary and not enforced by statewide law or insurance companies. California is among very few states with strict statewide building codes and fire codes for communities in wildfire-prone areas (see California case study, p. 8).

Fireproofing homes can have a major effect on limiting the damage that a fire causes to both an individual home and entire communities (Calkin et al. 2013; Spyratos, Bourgeron, and Ghil, 2007). A modeling study found that even small changes in the flammability of homes in the WUI could significantly affect the probability of a large fire and its ability to spread (Spyratos, Bourgeron, and Ghil, 2007). Also, the greater the density of non-fireproofed homes in a community, the greater the risk of entire neighborhoods burning in the event of a fire. Fireproofing is important for protecting not only homes, but also forests, since houses contain more flammable material per square yard than forests.

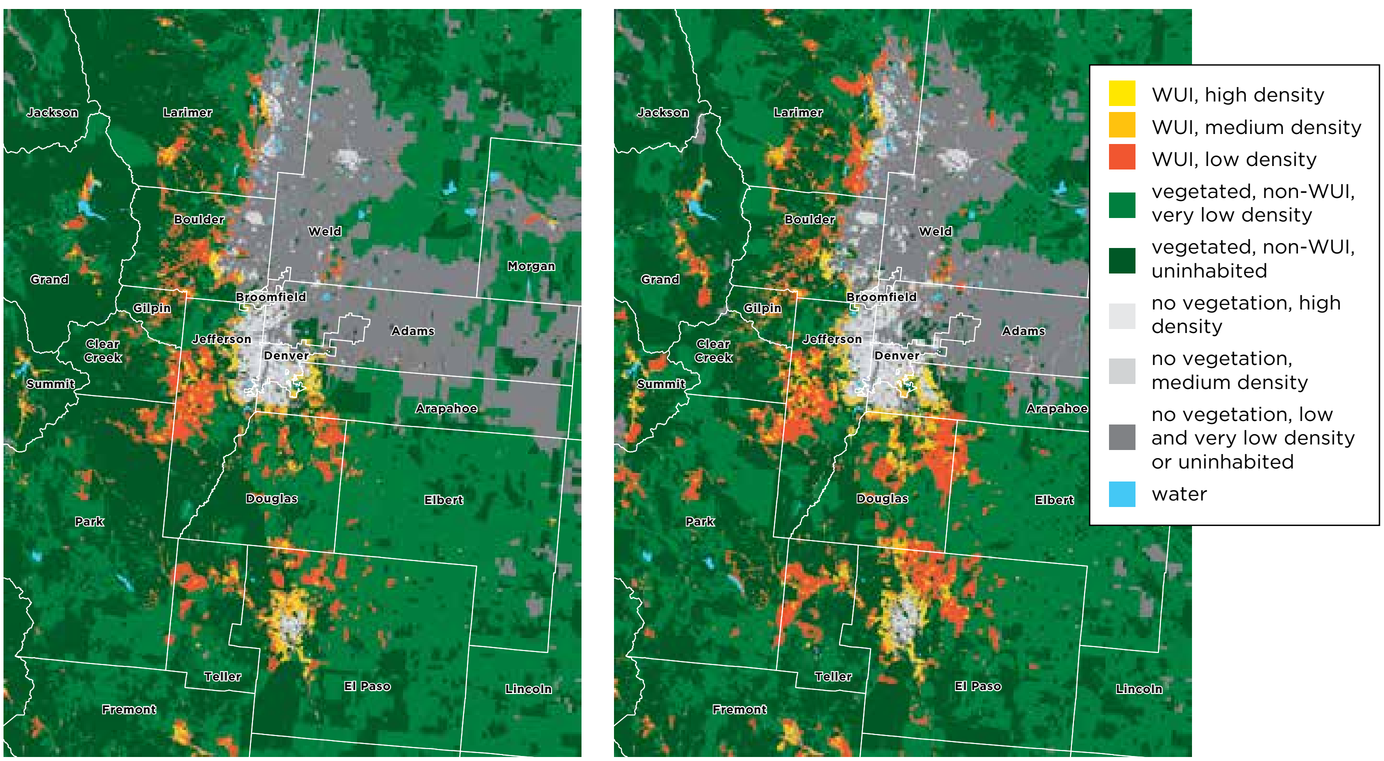
Finally, it is important to recognize that fire catastrophes in wildfire-prone developed areas can also originate in homes, rather than in forests (Calkin et. al. 2013). That fact creates opportunities for fires caused by homeowners that spread to the forest (Cardille, Ventura, and Turner 2001). Human-caused fires are a greater risk in WUI areas (Montana DNRC 2007).

3.3 The Role of Private Insurers

Insurance against loss and damage to homes from wildfires is mostly covered through private insurance policies, usually as part of a standard homeowner's insurance policy. However, many states do not require the purchase of homeowner's insurance; rather, that is usually a requirement imposed by mortgage lenders. Homeowners not financing their homes through mortgages make their own choices about whether or not to purchase insurance.

Insurance premiums for homes in wildfire-prone areas do not yet fully reflect the growing risks such areas face. In part, that is because neither homeowners nor insurance companies pay the full costs of the risk to homes in wildfire-prone areas since they do not pay for firefighting costs or disaster assistance. In some high-risk places such as the Front Range in Colorado (see Figure 8) and in southern California, insurance companies are starting to notice the growing liability they face and are requiring homeowners to take protective measures as a precondition to getting a policy. Hotter, drier conditions are also raising future wildfire risks, an eventuality that many insurance companies are not yet fully factoring into their business models.

FIGURE 8. Denver/Central Colorado Wildland-Urban Interface



The Front Range area of Colorado, which includes Boulder, Colorado Springs, Denver, and Fort Collins, is a region at particularly high risk of wildfires. The left and right maps show the wildland-urban interface (WUI) in 1990 and 2010, respectively. Areas shown in yellow and orange represent the WUI where homes are built close to forests and hence face elevated fire risk. These areas have grown considerably between 1990 and 2010.

DATA SOURCE: SILVIS LAB 2012.

BOX 2.

Firefighters on the Front Lines

Wildland firefighters have a grueling and dangerous job. During peak fire seasons, they often work long hours in rapidly changing fire and smoke conditions and difficult terrain, carrying heavy equipment. The tragic loss of 19 firefighters from the Granite Mountain Hotshots in the 2013 Yarnell fire in Arizona epitomizes the sacrifices these dedicated professionals make in order to protect others. Fighting forest fires near communities is particularly challenging, because the stakes are higher and there is often less space in which to maneuver.

In 2012, there were approximately 14,000 federal firefighters employed by the FS and DOI (Bracmort 2013). Many states also employ full-time and seasonal firefighters. According to NIFC data, from 1990 to 2013 an average of 18 firefighters were killed annually in the line of duty.

Budget cuts at the federal and state levels have taken a toll both on full-time firefighter positions and the resources required to train and equip them. In 2011, a $34 million cut in the CAL FIRE budget resulted in a 25 percent reduction in its firefighting force. This has sometimes meant that during a severe fire season, federal and state agencies have had to work quickly to ensure adequate personnel are available. The extended drought in California, for example, has greatly increased fire activity even in normally quiet months and required CAL FIRE to hire additional firefighters much earlier in the season than usual (CAL FIRE 2014a).

Wildland fires create dangerous and unpredictable conditions for firefighters who work to protect people, homes, and forests.

Some insurance companies are starting to place restrictions on homes they are willing to insure and are encouraging homeowners to take protective steps. For example, State Farm will not insure homes with unrated wood "shake" shingled roofs. Starting in 2003 the company instituted a wildfire loss prevention program in California, Colorado, Montana, and New Mexico. Under the program, the company inspects homes in high-risk areas and mandates that homeowners comply with requirements, such as maintaining defensible space around their homes, or risk losing their insurance (Vogrin 2013; Sheridan 2012).

In setting fire insurance premiums, many private insurers use information from a rating system developed by the Insurance Services Office (ISO) that measures a community's ability to suppress fires as a way to assess risk. The ISO rating is based on information on municipal fire protection efforts and offers one way for communities to reduce their premiums by investing in fire protection. In high-risk states such as Colorado, many insurers are also now requiring their policyholders to invest in fireproofing measures as a precondition for getting insurance coverage (Wildfire Insurance and Forest Health Task Force 2013).

3.4 Drawbacks in Current Fire Management Practices

Fire management budgets are still heavily weighted toward fire suppression, in part a result of public expectations for protection from wildfires (Office of the Inspector General 2006). The FS has also been criticized for not taking all possible steps to contain its costs, including renegotiating cost-sharing agreements with states and strengthening financial accountability for those in charge of firefighting efforts (Office of the Inspector General 2006). In a survey of fire managers conducted by the National Association of State Foresters, almost a quarter of the respondents indicated that the lack of accountability to reduce costs is one of the two most significant factors, alongside protection of homes in the WUI, leading to rising suppression costs. With private contractors playing an increasingly large role in firefighting, their costs are also a significant driver for overall costs.[61]

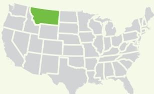
Insurance premiums for homes in wildfire-prone areas do not yet fully reflect the worsening risks of wildfires.

The fact that the federal government bears most of the firefighting costs, while local authorities and developers make decisions about where and how much to build in wildfire-prone areas, has come under heavy criticism by many experts (Gorte 2013; GAO 2006; Office of the Inspector General 2006). Indeed, that misalignment of incentives may actually encourage development in high-risk areas, reduce the incentive for homeowners to fireproof their homes and properties, and increase firefighting costs and risks to firefighters (NASF 2000). It also complicates efforts to establish coherent forest and fire management policies.

The increased cost of wildfire management on federal lands and to protect nearby homes also has a negative effect on other federal land programs. With the costs of firefighting often exceeding actual budget allocations in many recent severe wildfire seasons, the FS has been forced to borrow from non-suppression or even non-fire management budget lines (Tidwell 2013). In some cases, this borrowing—or "fire transfer"—has been done at the expense of more long-term preparedness activities to lower future wildfire risks. In addition, it has delayed conservation land acquisitions, and reduced expenditures on building maintenance and recreation and wildlife habitat programs.[62] An FS analysis of state-by-state impacts of fire transfers in 2012 and 2013 includes the cancellation of hazardous fuels management projects on the Santa Fe National Forest in New Mexico and the deferment of more than $400,000 in watershed projects in Colorado (U.S. Forest Service 2014b). Protecting areas near private property has also affected fuel reduction activities on other federal lands (Gorte 2013).

[STATE CASE STUDY 3]

Montana The Big Sky State Faces Growing Wildfire Risks



Montana has experienced several severe wildfire seasons in the recent past, with 2000, 2003, and 2007 standing out as particularly bad years in terms of number of large fires and their costs (see Figure 9, p. 26). The 2012 fire season in Montana was the worst since 1910 in terms of acres burned (although much of this was large grass fires, which are typically of shorter duration and relatively less costly to suppress). More than 1.2 million acres burned,[63] and suppression costs amounted to more than $113 million (NRCC n.d. a). The single largest conflagration was the Ash Creek fire in southeastern Montana, which consumed almost 250,000 acres and cost $7.5 million to suppress. It burned for more than two weeks, from June 25 to July 10, destroying property and infrastructure and forcing evacuations in the Northern Cheyenne Indian Reservation and Rosebud and Powder River counties. Just a month later, the Rosebud Complex fire affected some of the same area, causing the evacuation of the entire Northern Cheyenne Indian reservation, damaging homes, burning another 200,000 acres, and costing $9 million to fight (NRCC n.d. a).

In a news article at the time, Derek Yeager, fire management officer for the Southern Montana Land Office in Billings, expressed concern about risks posed from Montana's growing development in wildfire-prone areas, especially in the eastern part of the state: "We're starting to wonder if this is the theme for the future. A lot of land in Montana is just not resilient, and it's not getting any more resistant to fire" (Thackeray 2012).

[*The Northern Cheyenne Indian Reservation faced two devastating wildfires in 2012, which damaged homes, watersheds, cultural assets, and livelihoods.*]

© Dan Borsum, NOAA/NWS/WR/WFO/Billings Montana

A hotshot firefighter crew at work during the 2006 Derby fire. The fire burned almost 225,000 acres near the foothills of the Absaroka Range Mountains and the Yellowstone River, forced the evacuation of hundreds of people, and cost over $19 million to put out. Severe drought conditions contributed to the extreme fire.

Risk Factors for Wildfires in Montana

As is the case for other states in the Rocky Mountain West, Montana has seen an increase in large wildfires, and a lengthening of the fire season in the past few decades, as temperatures have risen due to climate change (Dennison et al. 2014; Climate Central 2012a; Westerling 2006). Over the last decade and a half, Montana has experienced years of below-normal precipitation and drought-like conditions. Many areas, especially in the western part of the state, have also experienced mountain pine beetle infestations, which are driven in part by the changing climate.[64] While currently there is not as much development in wildfire-prone areas in Montana as some other western states, Montana has one of the highest percentages of homes in the very high and high wildfire-risk areas (Botts et al. 2013; Theobald and Romme 2007). The state's WUI is also projected to grow nearly 20 percent by 2030 (Theobald and Romme 2007), and with that will come growing risks to people and their homes from wildfires.

The Costs of Wildfires in Montana

Suppression costs for wildfires in Montana have been high in several recent years because of active fire seasons, reaching a record-topping $340 million (in 2012 dollars) in 2003 (see Figure 9).[65] With nearly 30 percent of the state being publicly owned federal lands,[66] much of the fire-suppression costs are borne by federal agencies including the FS, Bureau of Land Management, and Federal Emergency Management Agency (FEMA).

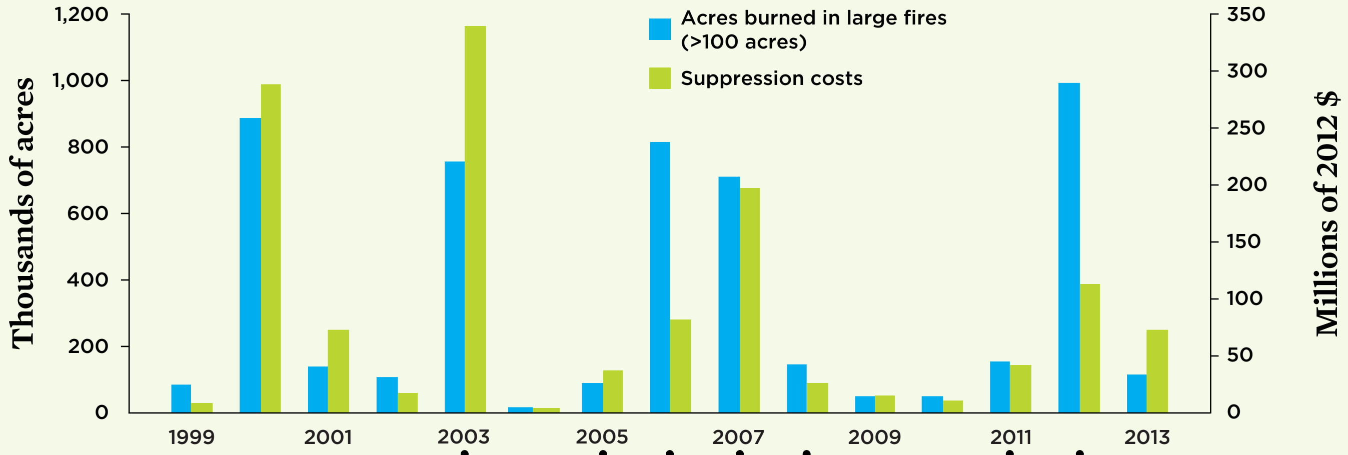
Montana has experienced severe flood damage in the wake of wildfires (Montana DNRC 2013). For example, after extensive fires in the summer of 2000, the Ashland, Bitterroot, and Canyon Ferry areas saw flooding and debris flows due to storms in 2000 and 2001 (Parrett, Cannon, and Pierce 2004). Other costs included ecosystem damages, water quality issues (including impacts on livestock operations), air pollution, loss of tourism revenues, and disruption to power supply and/or transmission lines.

Opportunities for Change

Because development in the WUI has not yet skyrocketed in Montana, there is still an opportunity to limit future development—or at least to keep future development more resilient to wildfire risks—and thereby limit the costs of suppressing wildfires. These choices lie in the hands of state and local zoning authorities and homeowners. A 2013 resolution from the Lewis and Clark County Board of Commissioners clearly stated support for prioritizing firefighter safety ahead of protecting homes in the WUI during wildfire suppression efforts (Lewis and Clark County Board of Commissioners 2013).

Legislation passed in 2013 (Montana Legislature 2013), with bipartisan support, has changed how Montana funds fire suppression costs by setting aside dedicated funds ahead of the fire season. The fund is capped at $100 million; in 2012 the state spent $56 million on fire suppression (Johnson 2013).

FIGURE 9. Recent Large Wildfires in Montana, 1999–2013



Selected Large Fires

(Bold: More than 75,000 acres;
Italic: More than $5 million; ***Bold Italic: Both***)

2003
Blackfoot Lake Complex
Cooney Ridge
Fish Creek Complex
Hobble
Lincoln Complex
Little Salmon Creek Wildland Fire Complex
Little Salmon Creek Wildland Fire Use Complex
Mineral-Primm
Missouri Breaks Complex
Robert
Trapper Creek
Wedge Canyon
Windmill Complex

2005
Selway-Salmon

2006
Black Pulaski
Bundy Railroad
Derby
Pine Ridge Complex
Red Eagle

2007
Ahorn
Brush Creek
Chippy Creek
Conger Creek
Fool Creek
Jocko Lakes
Meriwether
Powder River Complex
Rat Creek
Rombo Mountain
Sawmill Complex
Skyland
Wicked Hicks Complex

2008
Dunn Mtn. Assist

2011
Diamond Complex

2012
Ash Creek
Delphia
Elbow Pass Complex
Rosebud Complex
Sarpy Hills Complex
Southeast MT Complex
Welder

Montana has experienced several large wildfires in recent years. There were more than 8,000 wildfires in Montana from 1999 to 2013, which burned more than 1.8 million acres and incurred more than $1.3 billion in suppression costs. Of these, 756 were larger than 75,000 acres each.

SOURCES: NRCC N.D. A; NRCC N.D. B.

[SECTION 4]

Growing Costs of Wildfires: How Much and Who Pays?

Wildfires are costly. Those costs are driven in large part by two factors: the size of a wildfire and how much private property lies in the path of a fire (Liang et al. 2008).

Studies show that the single biggest factor affecting wildfire suppression costs is the acres burned, and that burn area is highly correlated with hotter, drier conditions as are now being experienced in the western United States (Dennison et al. 2014; Liang et al. 2008). Most fires are put out while they are still small. Fires larger than 300 acres were only 1.4 percent of all fires from 1980 to 2002, but were responsible for nearly 94 percent of suppression expenditures (FS, DOI, and NASF 2003). As the size of a fire increases, the resources and personnel required to fight it increase considerably—which is one of the major reasons suppression efforts are geared toward an early, strong response to limit the spread of a fire (Montana DNRC 2007).[67] Fires that occur near more densely populated and developed areas will almost invariably call for more intensive and costly suppression efforts to protect people and their property. Large fires are also more likely to cause expensive property damage.

Moreover, a focus on readily quantifiable, immediate costs—such as the costs of suppression—significantly underestimates the true costs of a wildfire. Other categories of costs, such as pre-suppression costs, disaster relief expenditures, timber losses, property damage, tourism-related losses, human health effects, and ecosystem damages can greatly exceed the direct suppression costs, and in some cases may not be fully evident until years after a fire (Butry et al. 2001).

4.1 Who Bears the Risks and Costs?

The risks and costs of wildfires are borne by a larger, more diverse group of people than may be immediately obvious. Risks and costs are borne by not just the people living in wildfire-prone areas, but also those living tens or even hundreds of miles downwind from wildfire smoke, plus the firefighters, federal and state taxpayers, forest managers, and a host of people who depend on healthy forests for their livelihoods or for ecosystem services such as clean water. Within a state, as well as nationwide, the taxpayer costs of fighting fires are not borne equitably, with all taxpayers funding costs related to homes in high fire-risk areas.[68]

4.2 Federal Fire Management Costs

The share of the FS budget devoted to fire management rose from 13 percent in 1991 to more than 40 percent in 2012 (Tidwell 2013). Wildfire suppression costs have risen nearly every year, in real terms, since 2000 (see Figure 7). Since 2002, of the $3.3 billion average annual federal wildfire funding, 91 percent has been used for protecting federal land, 7 percent for wildfire protection assistance to local and state governments, and the remaining 2 percent for other activities such as fire research (Gorte 2013). Together, emergency appropriations to fight wildfires and budgeted fire suppression dominate the other categories of expenditure for wildfire protection on federal lands (see Figure 10, p. 28).

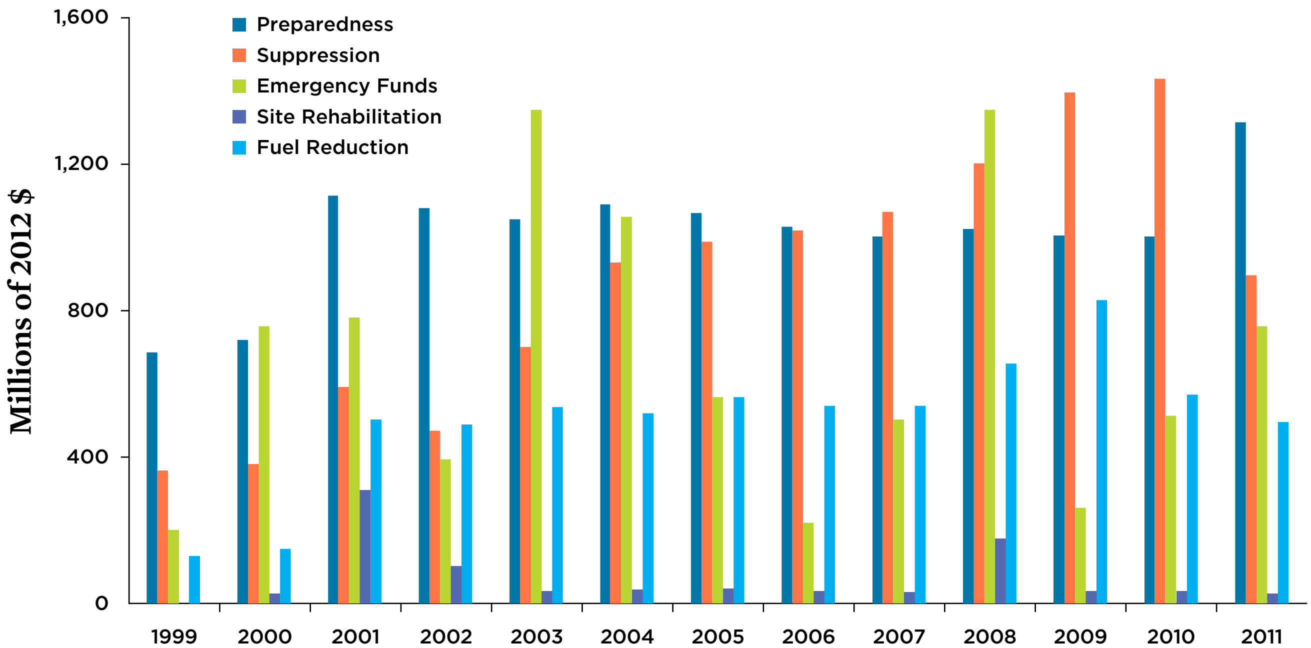
Fire management costs include costs of preparedness ahead of the fire season, suppression or firefighting costs, measures to reduce available fuel (either through removal or prescribed

Since 1985, federal fire suppression costs have increased fourfold, from approximately $440 million to more than $1.7 billion in 2013, all in 2012 dollars.

burns), and post-fire rehabilitation (Bracmort 2013). Severe wildfires frequently trigger emergency appropriations (Bracmort 2013). Since 1985, suppression costs have increased nearly four fold, from approximately $440 million to more than $1.7 billion in 2013 (all figures in 2012 dollars); of the total federal costs in 2013, almost 77 percent were borne by the Forest Service while 23 percent were borne by the DOI (NIFC n.d. b).[69]

From 2004 to 2008, 346 wildfires that each cost more than $1 million in suppression costs resulted in $2.25 billion in spending by the FS. That amount represented nearly 40 percent of the total FS fire suppression spending during this period (Ellison et al. 2012). As already noted, growing fire suppression costs are straining federal firefighting budgets, requiring the FS to move funds from other parts of its budget to firefighting, and also requiring an increased reliance on supplemental emergency appropriations from Congress. According to the Obama administration, in 2012 and 2013 the FS and DOI transferred more than $1 billion from accounts covering other programs to fight wildfires (Wilson 2014). Recent policy proposals—such as legislation proposed by

FIGURE 10. Funding for Wildfire Protection on Federal Lands, 1999–2011



The amount spent on suppression and preparedness represents the largest category of costs in recent years, followed by emergency funds. Fire-suppression costs vary from year to year depending on the intensity of the fire season and the particular locations where the fires occur, but they are on an upward trend overall. From 1999 to 2011, suppression costs more than doubled while preparedness costs almost doubled (in 2012 dollars). In recent years, emergency funds have been appropriated primarily to help pay for fire-suppression costs in excess of what was allocated under the regular budget process. Emergency funds have been required in every year from 1999 to 2011 and are especially high in years with, or immediately after, severe fire seasons, including 2003 and 2008.

SOURCE: GORTE 2010.

TABLE 3. The Ten Costliest Wildfires in the United States

Year	Fire	Insured Loss at the time of fire ($ Millions)	Insured Loss (Millions 2012 $)*
1991	Oakland Fire, CA	1,700	2,584
2007	Witch Fire, CA	1,300	1,402
2003	Cedar Fire, CA	1,060	1,283
2003	Old Fire, CA	975	1,180
1993	Los Angeles County Fire, CA	375	544
2011	Bastrop County Complex Fire, TX	530	539
1993	Orange County Fire, CA	350	508
2012	Waldo Canyon Fire, CO	450	450
2013	Black Forest Fire, CO	293	288
1990	Santa Barbara Fire, CA	265	416
2010	Fourmile Canyon Fire, CO	210	218

*2012 estimated cost calculations based on the Consumer Price Index.

SOURCE: III N.D.

Senators Ron Wyden and Mike Crapo in 2013 (S. 1875, or the Wildfire Disaster Funding Act of 2013) and by Senators John McCain, John Barrasso, and Jeff Flake in 2014 (S. 2593, the FLAME Act Amendments of 2014), as well as President Obama's 2014 budget proposal—would shift the way federal wildfire costs are funded and create an emergency fund to help address some of these budgetary tradeoffs; however, tighter budgets all around mean that rising wildfire costs will continue to be a challenge (U.S. Congress 2013).[70]

4.3 Insured Losses

FIRE INSURANCE

Although wildfires currently account for a small percentage (1.7 percent) of overall insurance losses, this translates into billions of dollars a year and will very likely increase with worsening wildfires (RMIIA n.d.).[71] Insured losses from recent wildfires have been especially significant in California and Colorado (see Table 3), which have dense pockets of development—and in many cases very expensive property—located near fire-prone areas.[72] Of the 10 costliest fires to date, seven have occurred in California.

FLOOD RISKS AND FLOOD INSURANCE

Severe wildfires change the characteristics of the landscape, often making burned areas more susceptible to flooding for years after a fire. The soil in burned areas loses protective vegetation and is less able to absorb water, especially on steep slopes. Additionally, stream beds can become blocked by debris from the fire. Altogether, fire makes nearby low-lying or downstream areas more prone to flash flooding and mudslides in the event of major rainfall (Moody 2012; Cipra et al. 2003). The 2012 (Waldo Canyon and High Park fires) and 2013 (Black Forest fire) fire seasons in Colorado were followed by devastating flooding. Record floods triggered by heavy rains in the area in September 2013 left nine people dead, and damaged or destroyed thousands of homes and hundreds of miles of roads. In some areas, such as Manitou Springs, flooding was worsened by the impact of wildfires in previous years. El Paso County, where Manitou Springs is located, is collaborating with the FS and the U.S. Geological Survey on efforts to rehabilitate the burn area to help reduce damaging water runoff (Steiner 2014; Garcia 2013).

Wildfires can quickly change flood risks for nearby homes and properties—and flood risk can remain high for years after the fire. FEMA thus encourages homeowners in areas hit by wildfires to protect themselves and purchase flood insurance through the National Flood Insurance Program (NFIP), which also covers damage from mudflows. The taxpayer-subsidized NFIP is practically the only source of flood insurance for homes and small businesses nationwide, a risk not covered by ordinary homeowner's insurance.[73]

The NFIP made payouts of almost $56 million for the Colorado flooding events in 2013, more than a quarter of the $204 million in public aid dollars spent by the end of the year (Colorado Emergency Management 2013). Eqecat, a catastrophe risk modeling firm, estimated that the total costs of the 2013 Colorado floods exceeded $2 billion (Eqecat 2013), with an estimated 1,500 homes destroyed, 17,500 homes damaged, more than 10,000 people displaced, and significant damage to infrastructure across 17 counties (Colorado Emergency Management 2013). Clearly, not all of these costs are directly attributable to the wildfires, but the fires did raise the risk of flash flooding in some areas and contribute to the extent of damage caused.

4.4 The Significant Hidden Costs of Wildfires

Fire suppression costs, as large as they are, often represent only a small fraction of the total costs of a wildfire. Measuring and monetizing other types of costs, such as public health costs, lost economic welfare, and ecosystem damages can be complicated and is often incomplete. Some costs, such as those related to post-fire flooding risk or water quality issues, can linger for years after a wildfire. A synthesis of six case studies of major recent wildfires in the western United States estimated that total wildfire costs can range anywhere from 2 to 30 times the direct suppression costs (Figure 11) (Western Forestry Leadership Coalition 2010).[74] A study of the 2003 San Diego fire estimated that suppression costs were less than 2 percent of the total economic impact of the fire (see Figure 11) (Rahn 2009). For the 2002 Rodeo–Chediski fire in Arizona, firefighting costs were $43 million to $50 million, while costs for long-term rehabilitation and reforestation, home and property losses, and emergency public assistance added up to nearly $260 million (Snider, Wood, and Daugherty 2003).[75]

PUBLIC HEALTH DAMAGES

The public health costs of wildfires are often overlooked or underestimated (Butry et al. 2001).[76] Smoke from wildfires carries small soot particles that can enter the airways and lungs and cause significant health problems.[77] Young children, the elderly, and those with pre-existing asthma, chronic obstructive pulmonary disease, or other heart or lung problems are especially at risk (U.S. EPA 2013). Exposure to smoke can even cause death. Prevailing winds can carry smoke pollution hundreds of miles away from the source, so that even wildfires in isolated areas can have serious health impacts on populated areas downwind (Moeltner et al. 2013). In 2011, about two-thirds of the United States population, across 32 states, lived in counties affected by smoke conditions from wildfires (Knowlton 2013).[78]

The smoke from wildfires can cause significant health problems, including exacerbating asthma among young children. People with preexisting chronic obstructive pulmonary disease or other heart or lung ailments are particularly at risk. Smoke can be carried many hundreds of miles from the site of a wildfire.

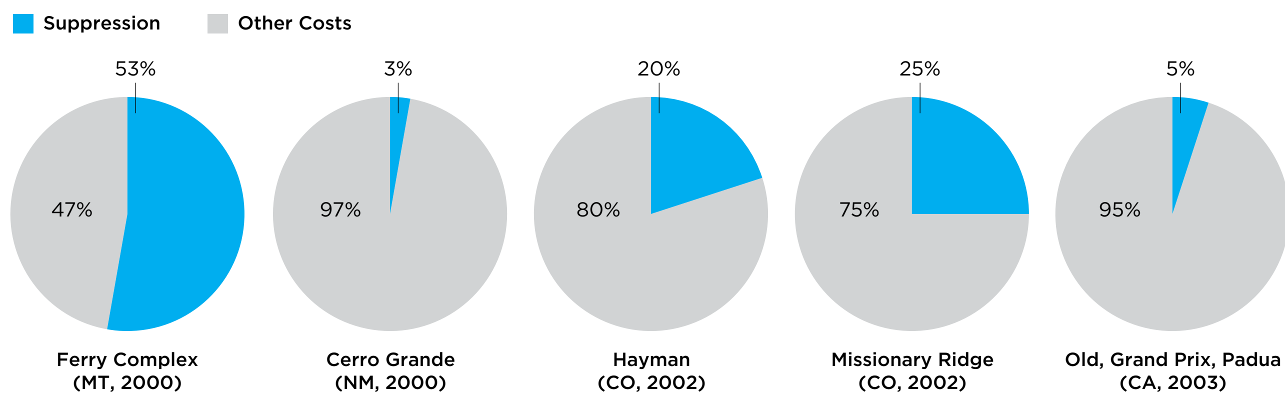
The health costs of wildfires depend on many factors such as the size and underlying vulnerability of the exposed population, the size of the wildfire, the direction of prevailing winds, and the availability of health services. One metric studied is the additional costs associated with an additional 100 acres of biomass burned. These estimates per 100 acres range from $91 to $467 (Moeltner et al. 2013; Rittmaster et al. 2006; Butry et al. 2001).

One study estimated that the 2003 southern California fires were associated with 133 additional deaths from cardiorespiratory causes (Kochi et al. 2012).[79,80,81] A recent study of the health costs of the 2009 California Station fire,[82] which affected thousands of people in Los Angeles County, estimated those costs at $9.50 per exposed person per day, if only out-of-pocket medical costs were considered. But the estimate could be much higher if one took into account the costs of all the measures people took to avoid exposure to the smoke, such as evacuating, avoiding outdoor activities, or buying face masks (Richardson, Champ, and Loomis 2012).[83] The 2008 fire season led to almost $2.2 million in inpatient hospital costs for respiratory or cardiovascular conditions in the Reno/Sparks area of Nevada caused by wildfires within a 350-mile radius (Moeltner et al. 2013).

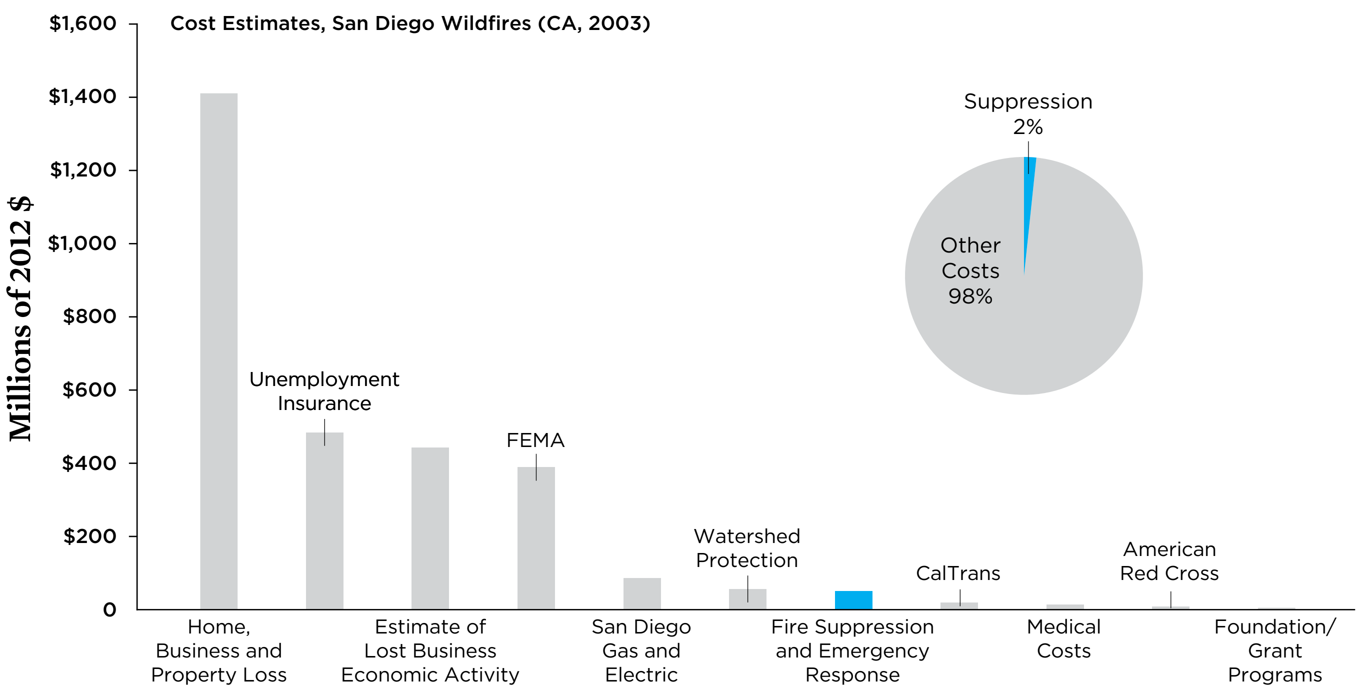
Very likely, health costs will grow over time as wildfires worsen in a changing climate. As the fire season lengthens and fires get larger, by mid-century emissions of soot may increase by 46 to 70 percent, with 10 to 27 percent more black carbon compared with today (Yue et al. 2013).

[*Severe wildfires can make burned areas, and areas downstream, more susceptible to flooding for years afterward.*]

FIGURE 11. Fire Suppression Costs as Percent of Total Cost for Select Wildfires



SOURCE: WESTERN FORESTRY LEADERSHIP COALITION 2010.



Suppression (firefighting) costs represent only a small fraction of the total money spent on wildfire management. The top row of pie charts shows suppression costs ranging from 3 percent to 53 percent for recent major wildfires in California, Colorado, Montana, and New Mexico. In the Cerro Grande fire, only 3 percent of the total costs were suppression costs while an overwhelming 90 percent of the costs were direct costs, which include private property losses, damage to utility lines and recreation facilities, loss of timber resources, and aid to evacuated residents. The lower panel shows that in the 2003 San Diego fires, only 2 percent of the total costs were suppression costs while nearly half of the costs were home, business, and property losses.

SSOURCE: RAHN 2009.

© U.S. Forest Service/Chris Stewart

Wildfires can threaten watersheds by contributing to soil erosion, increased water runoff, and debris flows, especially when combined with flash floods. These threats can linger for years after a fire. Pictured here is the Tuolumne River Watershed, near the Stanislaus National Forest, which was burned by the 2013 Rim fire in California.

TOURISM LOSSES

Wildfires often occur in or near state and national forests, which are major tourist destinations, and they often coincide with peak summer months for visitors. Partial or complete park closures, smoke in the air, and burnt or otherwise changed landscapes mean reduced revenues for the park as well as surrounding towns with businesses that depend on tourists.

A 2013 study of the effect of wildfires on tourism revenues in Yellowstone National Park estimated that in an average fire year, direct Yellowstone National Park visitor spending is $6.1 million less than would occur without any fire activity.[84] The net present value of the loss for the period from 1986 to 2011 was $206 million (Duffield et al. 2013). The 1988 fires in Yellowstone National Park, the largest wildfires ever experienced in the national park, led to hotels and lodging places closing four weeks ahead of the normal tourist season, a reduction in annual visits by 15 percent in 1988, and a $60 million loss in tourism benefits between 1988 and 1990 (Franke 2000).

The 2013 Rim fire in California, which burned for more than two months, had a significant effect on tourist visits to Yosemite National Park. It contributed to losses of $350,000 in taxes and $3.25 million in tourism spending in Tuolumne County, and more than $3.5 million in lost lodging revenue in Mariposa County (Office of Governor Edmund G. Brown Jr. 2014).[85] The 2012 Waldo Canyon fire was estimated to have cost more than $2 million in lost tourism revenues for the town of Manitou Springs in Colorado (Zuckerman 2012). Other fires have also cost millions in lost tourism.[86]

WATER SUPPLY AND INFRASTRUCTURE DAMAGES

Wildfires can threaten watersheds and cause heavy damage to such infrastructure as power lines, water supply stations, roads, and bridges. In many cases, those costs are paid for through utility bills or state and local taxes. For example, after the 2003 San Diego fires, the California Department of Transportation estimated their total loss at roughly $15 million and San Diego Gas and Electric experienced a $71 million loss in infrastructure (Rahn 2009).

Forests are important for protecting, regulating, and filtering water resources gathered from rainfall and snow, often at a lower cost than building a filtration and pumping plant. Nationwide, the National Forest System provides drinking water to more than 60 million Americans (DOI 2013). Across much of the West this is particularly significant, including the upper Colorado River basin, where nearly half of all water comes from national forests (DOI 2013). Past wildfires have contributed to massive erosion, threatening water supplies and leading to costly damage on a number of occasions including: the 1997 Buffalo Creek and 2002 Hayman fires, which together cost Denver Water $26 million in rehabilitation costs;[87] the 2000 Cerro Grande fire that cost the Los Alamos Water Utility more than $9 million and generated $72.4 million in additional costs;[88] the 2009 Station fire and post-fire rainstorms in 2010, which cost the Los Angeles County Department of Public Works $30 million;[89] and the 2011 Las Conchas fire, which forced the cities of Santa Fe and Albuquerque to shut down water supply intake systems polluted by ash (DOI 2013).

Wildfires can damage electricity poles and towers carrying transmission lines. Smoke and ash from fires can also ionize the air, creating an electrical path away from transmission lines. The loss of electricity can shut down the lines and cause power outages (Ward 2013; Sathaye et al. 2012). For example, in summer 2011, the Las Conchas wildfire in New Mexico threatened two high-voltage transmission lines that deliver electricity to about 400,000 customers (DOE 2013; Samenow 2011). In California, more frequent and intense wildfires linked to climate change are projected to put a large share of transmission equipment at risk. Some major transmission lines in the state face a 40 percent higher probability of wildfire exposure by the end of the century (Sathaye et al. 2012).

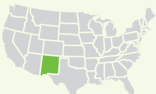
OTHER ECONOMIC IMPACTS

Wildfires are a major cause of losses to the forest products industry (Chen, Goodwin, and Prestemon 2014). For example, the 2002 Rodeo–Chediski fire in Arizona caused the loss of more than 1 billion board feet of timber—valued at an estimated $300 million—on tribal and federal lands. The fire also forced the closure of the White Mountain Apache tribe's timber company, resulting in $500,000 in lost wages. That same year, the 2002 Biscuit fire in Oregon and California also caused more than $300 million in timber losses (Morton et al. 2003).

Large fires can have complex impacts on local economies, such as wage and employment losses due to lost tourism and lost livelihoods as noted above. To be sure, there could also be beneficial effects on local employment for firefighting and post-fire remediation; however, the benefits tend to be short-term effects and usually small in magnitude.[90]

[STATE CASE STUDY 4]

New Mexico Cultural Assets and Watersheds at Risk from Wildfires



New Mexico experienced a devastating wildfire season in 2011, which affected more than 1 million acres of land—an area roughly the size of Delaware. Extreme drought and heat that year helped create the conditions for historic wildfires across Arizona, New Mexico, and Texas (NOAA 2011). The Las Conchas fire, the state's largest wildfire at the time, scorched more than 150,000 acres and incurred almost $50 million just in suppression costs (see Figure 12). It forced the shutdown of Los Alamos National Laboratory, the oldest of the nation's three nuclear weapons research facilities. The fire also burned more than 6,000 acres of tribal land in Santa Clara Pueblo, severely affecting the area around its watershed and destroying cultural sites, forest resources, plants, and animals (Santa Clara Indian Pueblo 2011). The loss of vegetation subsequently contributed to extremely damaging flooding after heavy rains in 2012 and 2013, requiring a series of FEMA disaster declarations. Then the next year, the 2012 Whitewater-Baldy Complex fire in the Gila National Wilderness and Gila National Forest broke records again, burning nearly 300,000 acres and incurring $23 million in suppression costs alone.

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The 2000 Cerro Grande fire in the Jemez Mountains of New Mexico forced the evacuation of the town of Los Alamos and shut down the Los Alamos National Laboratory (LANL). In this photo, taken nine years later, the burned landscape around LANL is still evident.

Hotter, drier conditions are elevating wildfire risks for parts of New Mexico, particularly in and around the Jemez Mountains. Weather patterns related to El Niño and La Niña can further amplify fire risks in the Southwest by affecting precipitation patterns. Data show that the average annual number of large wildfires (more than 1,000 acres) on FS land have doubled since 1970 (Climate Central 2012b). In parts of New Mexico, past practices of suppressing wildfires have led to an increase in flammable fuel load and thereby increased the risk of large fires (Margolis and Balmat 2009; Allen et al. 2002).

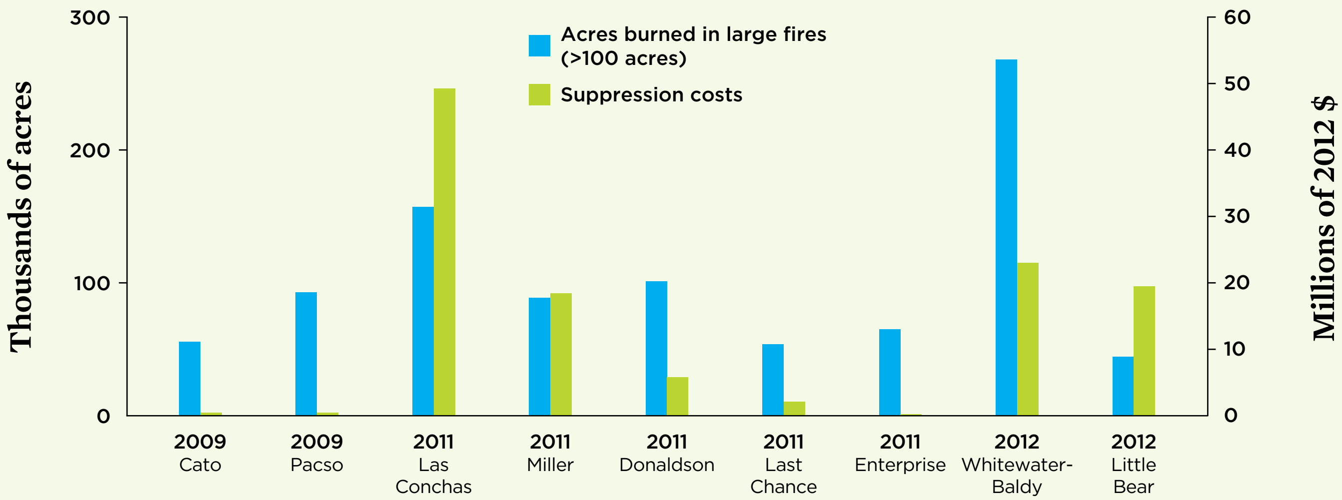
New Mexico is a large, sparsely populated state;[91] nevertheless, in some urban parts of the state such as Albuquerque, Los Alamos, and Santa Fe, development near wildfire-prone areas is raising exposure to risks and costs (Botts et al. 2013). Smoke can also reduce the air quality of towns and cities far from the fire. In 2010, more than 27,000 homes were in the WUI, 40 percent of which were second homes. This development covered 16 percent of the WUI in the state (Headwaters Economics 2014). A recent report by the New Mexico Fire Planning Task Force—which assessed which communities are most vulnerable to dangers from wildfires—identified 654 communities at risk, of which nearly half (300) were at high risk and more than a third (237) were at moderate risk (New Mexico State Forestry 2013).[92]

In New Mexico, as elsewhere, firefighting costs are often a mere fraction of the total costs of a wildfire. For example, in the case of the 2000 Cerro Grande fire in Los Alamos, in which a prescribed burn escaped control aided by high winds and drought conditions, only 3 percent of the estimated $970 million in total costs were related to fire suppression (Western Forestry Leadership Coalition 2010).[93] Fully 280 homes were destroyed and municipal water supply was disrupted for four months because of fire-damaged pipes.

More than a third of the land area of New Mexico—approximately 27 million acres—is managed by the federal government (Gorte et al. 2012). Those federal lands include five national forests (among them the Santa Fe and Gila National Forests) and a number of unique sites of great cultural value managed by the National Park Service (such as Bandelier National Monument in Los Alamos and the Gila Cliff Dwellings near Silver City). Many of these treasured areas have experienced severe wildfires as well as post-wildfire flooding, and are projected to face worsening wildfire risks in a warming world (Williams et al. 2013).

Wildfires and flooding in their aftermath pose major challenges to water supplies from the Rio Grande watershed, which provides water for more than half of New Mexico's population (Nature Conservancy n.d. a). So much ash from the 2011 Las Conchas fire accumulated in nearby reservoirs

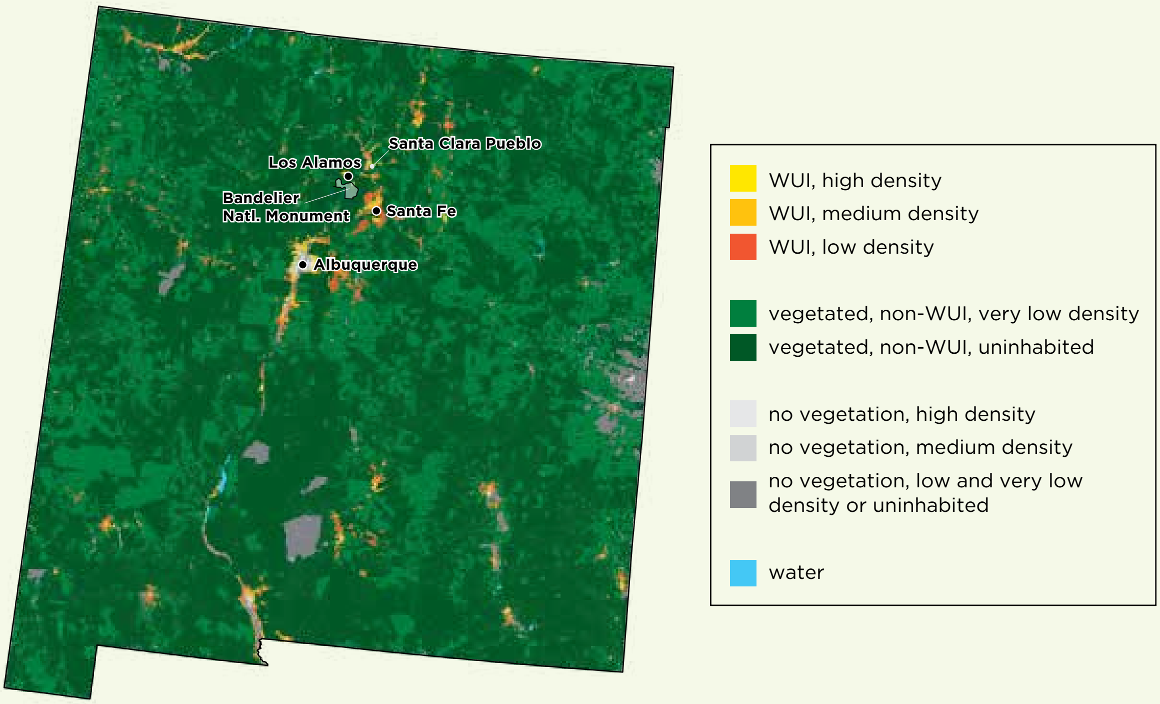
FIGURE 12. Recent Large Wildfires in New Mexico, 2009–2012



Between 2009 and 2012, New Mexico experienced nine major fires, which burned a total of 925,553 acres and incurred $119 million in suppression costs. Three of the fires—Whitewater-Baldy, Las Conchas, and Donaldson—burned more than 100,000 acres and incurred more than $5 million in suppression costs.

SOURCE: IMPACT DATASOURCE 2013.

FIGURE 13. New Mexico's Wildland-Urban Interface



Exposure to wildfire risk is increasing in urban parts of New Mexico—particularly in Albuquerque, Santa Fe, and Los Alamos—due to development near the wildland-urban interface (WUI). The orange and yellow areas shown in the map represent the WUI where homes are built near forests and therefore face increased risk from wildfires.

DATA SOURCE: SILVIS LAB 2012.

that the cities of Sante Fe and Albuquerque were forced to shut down some of their intake systems (DOI 2013).

Elevated wildfire risks in New Mexico mean that the state will likely continue to face mounting costs of wildfires unless measures are taken to reduce risks and exposure to them. Measures to help lower costs could include public awareness campaigns such as those run by the state forestry department, which acts a lead agency in educating residents who live in wildfire-prone areas about protecting their homes and properties (New Mexico State Forestry n.d.). In addition, fire prevention plans developed by the Fire Planning Task Force and community and county Wildfire Protection Plans can also help guide investments in protection and resilience.[94,95] Initiatives are under way to help protect the Santa Fe watershed from the impacts of wildfire through a small fee on water use to restore the watershed in the Santa Fe National forest (Margolis and Balmat 2009; Nature Conservancy n.d. b).

Nonetheless, there are limits to how much communities and forests can adapt to changing wildfire risk conditions. Ultimately, lowering our carbon emissions is critical to limiting those risks. That fact makes New Mexico's decision to withdraw from the Western Climate Initiative and repeal a proposed cap on state carbon emissions particularly short-sighted.

[***Wildfires and flooding in their aftermath pose major challenges to water supplies from the Rio Grande watershed, which provides water for more than half of New Mexico's population.***]

[SECTION 5]

What We Can Do: Policies and Practices to Help Reduce Wildfire Risks and Costs

We are seeing a dangerous and costly shift in wildfire regimes in the western United States. Even as climate change is raising current and future wildfire risks, the trend toward building more homes in wildfire-prone forested areas is compounding the problem and leading to higher costs. The federal government (particularly the FS)—and ultimately the American taxpayer—bears large costs to manage fires (DOI 2012), and those costs have been steadily rising. The key questions are whether our current approach to fighting fires is cost-effective, and whether opportunities exist to improve it by engaging more directly with homeowners and local decision makers in wildfire-prone areas.

Bringing the upward-spiraling costs under control depends on coordinated actions by federal, state, and local agencies and policy makers, as well as homeowners and private insurance companies. We can help reduce the costly impacts of wildfires, now and in the future, by reducing our exposure to, and building resilience to, wildfire risks, and by limiting our carbon emissions. Deliberate and often difficult policy choices, accompanied by adequate resources, will determine our success in limiting the risk of wildfires.

5.1 Building Resilience to Wildfire Risks

Western communities need to ensure that they are adequately preparing for wildfire risks and taking steps to limit them (see state case studies on pp. 8, 15, 25, and 34). State and local agencies will have to continue to raise public awareness of wildfire risks, especially in advance of wildfire seasons that are predicted to be severe due to hotter, drier conditions. Communities nationwide can use federal assistance to develop Community Wildfire Protection Plans.[96] Creating statewide enforceable fire codes and building codes may help ensure a higher standard of protection.

Many people, homes, and businesses are already located in wildfire-prone forested areas. For such communities, investing in fireproofing measures and creating vegetation-free buffer zones around homes and buildings are important near-term steps to help safeguard health, life, and property. When fire breaks out, a range of strategies, including staying indoors, reducing outdoor physical activity, and using protective masks[97] or air filters, may help reduce exposure to the dangers of smoke from fires (California Air Resources Board 2008). Air quality advisories are crucial to helping the public know about the risks and take precautions, especially as conditions can change quickly during a wildfire due to shifting winds and other factors.[98] Integrating existing fire smoke forecasting systems into emergency preparedness and public health efforts can help improve response capabilities.[99] In dangerous wildfire situations, however, leaving the wildfire zone for a safer place may be the best course of action. Thus, complying with advisories and mandatory evacuation orders is important to protect both homeowners and firefighters.

5.2 Reducing Exposure to Wildfire Risks

There are limits, however, to how much adaptation efforts can protect people and their homes. If current development trends continue, more people will suffer and more property will get damaged from the impacts of wildfires. Managing further development in high fire-risk areas is the single

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This home in Boulder, CO, was saved from the 2009 Old Stage fire because the homeowner created defensible space around the house. This gave the firefighters the space to use a "burn out" operation—where they set a fire inside a control line to consume fuel between the edge of the fire and the control line—to save the home.

biggest opportunity we have right now to limit the threats and costs of wildfires.

Currently, there are major challenges to the effectiveness of public policy responses to manage wildfire risks. Because they can rely on taxpayer-funded firefighting resources, private property owners moving into the WUI may have a reduced incentive to take responsibility for their own protection and invest less in measures to reduce their wildfire risks (DOI 2012). Ironically, risky choices of where to live and build homes are reinforced by the current insurance market. Most property owners in fire-prone areas do not pay the true costs of their home-siting decisions. In many cases, fire insurance premiums do not reflect the true risk, although some insurance companies are starting to require fireproofing measures as a precondition to obtain a policy.

Moving more responsibility for mitigating wildfire risks and costs to homeowners and local communities to incentivize fireproofing measures—and charging insurance premiums that reflect the true risk to properties—can lead to more thoughtful outcomes or different decisions. Over time, having local municipalities take on a greater share of the firefighting costs currently borne by the FS might also provide an incentive for better planning and zoning decisions in high fire-risk areas. Yes, this is a difficult conversation given the appeal of living in the WUI. But the fact is that unless and until there are changes to these perverse incentives, more people and property will continue to be located in harm's way—and taxpayers nationwide will pay for the resulting increase in firefighting and disaster-assistance costs.

Effective wildfire preparedness efforts depend on better alignment of the decisions made by federal, state, and local authorities. Development choices and zoning decisions lie mostly in the hands of state and local authorities, while the federal government pays a disproportionate share of firefighting costs and disaster assistance. This highlights the importance of different approaches geared toward changing private incentives, such as shifting more of the forest management and fire protection costs from public taxpayers to private land owners living in the WUI; creating economic incentives, such as tax breaks or insurance rate discounts, for investing in fire resilience; making private home fire insurance policies more restrictive; or targeted acquisition of conservation easements (Theobald and Romme 2007). A recent report from the USDA notes that, "Assigning more financial responsibility to State and local government for WUI wildfire protection is critical because Federal agencies do not have the power to regulate WUI development. Zoning and planning authority rests entirely with State and local government" (Office of the Inspector General 2006).

The federal government can support local preparedness strategies by using the latest science to map areas at high risk of wildfires and provide better forecasts of climate and weather conditions that may worsen wildfire risk. In addition, air quality monitoring and advisories issued during wildfires can help reduce their public health impacts. Ample, steady funding for these types of data collection must be a part of our climate resilience strategy.

Forest management practices will also have to reflect changing climatic conditions. Current and past land use, including timber harvesting, forest clearing, fire suppression, and fire exclusion through grazing have affected the amount and structure of fuels in some western forests, especially in ponderosa pine and dry mixed conifer forests (Stephens et al. 2012; Allen et al. 2002; Swetnam and Betancourt 1998). Measures to reduce the amount of flammable vegetation through prescribed burns and thinning are part of the FS's mandate. Such efforts, which are already challenging and costly, could become more difficult in areas with multiyear droughts followed by successive wet years. Balancing the need for ecologically necessary fires and the resulting risks to people must be carefully handled, and is harder in places where people live near forests.[100]

5.3 Limiting Future Wildfire Risks

What can we do to minimize further climate contributions to wildfire risk for the long term?

Our past carbon emissions have locked in changes for the next few decades, but our emissions choices today can help limit the pace and extent of temperature increases later this century with which we burden future generations. Simply put: We can limit future wildfire risks by cutting our heat-trapping emissions. Cutting carbon emissions is one of the best ways of reducing the pace and magnitude of climate risks, of which wildfires are just one facet.

It is neither possible nor desirable to eliminate all wildfires, but we have an opportunity to use our finite resources in a more efficient way to reduce the costs of catastrophic wildfires. With the growing risk of larger wildfires and longer wildfire seasons in the western United States, we cannot delay addressing this challenge. Steps we take now—to build resilience to wildfires in communities that are on the frontlines of risk, reduce the expansion of development near fire-prone forested areas where possible, and cut the emissions that are fueling climate change—will be crucial to help limit the impacts of wildfires on people and forests.

BOX 3.

The Policy Landscape

The threat of wildfires is a major policy concern, both in individual western states suffering wildfires and at the federal level where decisions are made about firefighting budgets and disaster assistance. There are important initiatives proposed or already under way that could help communities become safer and keep our forests healthier.

NATIONAL OPPORTUNITIES

1. **Changing how federal fire suppression costs are funded.** With the recent series of severe wildfire seasons, there are growing concerns over the high costs of fire suppression, which are putting a strain on federal firefighting budgets and ultimately on taxpayers. Faced with limited budgets, the DOI and USDA have been forced to move money from other areas to their suppression budgets. Thus, funding for fire suppression has come at the expense of investments on long-term proactive fire management and land management efforts, such as hazardous fuel reduction, which in turn raises the risk of wildfires in future years. Recent proposals from President Obama and Congress are intended to change this harmful dynamic. As part of his 2015 budget proposal,[101] President Obama announced a new funding plan, whereby separate emergency funds would be available for fighting large wildfires similar to funding for other types of extreme

continued

The Policy Landscape *(continued)*

disasters such as hurricanes. Separate emergency funds would lessen the pressure on budgets for other critical forest management activities. The proposal is similar to the framework of legislation proposed by Senators Ron Wyden (D-OR) and Mike Crapo (R-ID), the Wildfire Disaster Funding Act of 2013 (S. 1875), and legislation proposed by Senators John McCain (R-AZ), John Barrasso (R-WY), and Jeff Flake (R-AZ), the FLAME Act Amendments of 2014 (S. 2593). A similar bill has also been introduced in the House of Representatives (H.R. 3992) by Congressmen Mike Simpson (R-ID) and Kurt Schrader (D-OR).

2. **Creating a national conversation on funding resilience to reduce wildfire risks efforts.** Funding large wildfire suppression through disaster funds does not address many of the underlying drivers of wildfire risk such as climate change and development in the WUI. A broader conversation about a more effective use of public funds to help manage wildfires and protect people in a hotter, drier world is necessary, especially if there continue to be escalating numbers of people and homes in fire-prone areas. One step would be to **create a climate resilience fund** to help communities invest in preparedness activities such as creating and implementing wildfire protection plans. President Obama has proposed this type of fund as part of his 2015 budget proposal but Congress will need to authorize the resources needed to make the fund operational.
3. **Using the framework of the National Cohesive Wildland Fire Management Strategy** as a way to better coordinate federal, state, and local efforts to reduce and manage wildfire risks and improve their effectiveness. The cohesive strategy will address the nation's wildfire problems by focusing on three key areas: restoring and maintaining landscapes, investing in fire-adapted communities, and improving response to wildfires.

STATE AND LOCAL OPPORTUNITIES

1. **Creating greater public awareness of wildfire risks** among frontline communities and providing incentives for homeowners and communities to take protective steps. Adopting Community Wildfire Protection Plans or participating in the National Fire Protection Association's Firewise Communities program are just two potential ways to do this.
2. **Bringing private insurers into policy discussions.** The changing views of insurance companies toward insuring wildfire risk are a critical part of building resilience. Some are already taking note of the growing costs of wildfires and in some cases are growing wary of insuring high-risk properties, or they are requiring homeowners to take protective measures before they can be eligible for a policy. Insurance premiums that better reflect risk, and encourage measures to reduce it, can help build resilience.
3. **Addressing the risks of wildfires to infrastructure and water supplies** in the western states. For example, the Western Watershed Enhancement Partnership, launched in 2013, brings the USDA and DOI together with local water users to identify and mitigate risks of wildfire to parts of the nation's drinking water supply, irrigation, and hydroelectric facilities (DOI 2013). Similar partnerships and pilot projects to protect forest and watershed health, and to plan in advance for wildfires, are being launched in many western states including Arizona, California, Colorado, Idaho, Montana, New Mexico, and Washington.
4. **Highlighting fire management initiatives from states.** Some states that have faced severe wildfire seasons have taken important steps to protect their residents and encourage them to take protective measures. **California** has strict building codes and requirements for vegetation-free zones for homeowners in wildfire-prone areas, and also charges each homeowner an annual $150 fee to help fund fire management efforts. A wildfire taskforce commissioned by **Colorado** Governor John Hickenlooper has recommended a number of steps, including building codes and a fee for residents living in fire-prone areas, to encourage mitigation of wildfire risks. In **Montana**, recent legislation that passed with bipartisan support has changed how Montana funds fire suppression costs by setting aside funds ahead of the fire (Montana Legislature 2013). The fund is capped at $100 million. In **New Mexico** there are efforts under way to help protect the Santa Fe watershed from the impacts of wildfire using a small fee on water use.

[ENDNOTES]

1 *Even in places that have historically experienced severe fires as a natural phenomenon, there is concern that unusual warming currently and in the future may inhibit the natural succession after fire of forests and other vegetation types back to previous forest/vegetation types that existed in those landscapes for many previous centuries and millennia. See, for example, a brief discussion about this in the context of some lodgepole pine types in the northern Rockies in Stephens et al. 2013.*

2 *The annual average acres burned from 1985 to 1999 was 3,208,986. From 2000 to 2013, the annual average was 6,791,653 (NIFC n.d. b).*

3 *The costs have more than doubled from an annual average of $0.64 billion from 1985 to 1999 to more than $1.6 billion from 2000 to 2013, all in 2012 dollars (source: NIFC n.d. b).*

4 *Research also indicates that, in other areas outside of forests in the American West, it is possible that warming combined with less precipitation could cause a decrease in wildfires, especially in some shrub and grassland ecosystems that are prone to fire in the present climate. That could happen because drought conditions could limit the amount of biomass available to burn in these types of ecosystems (NRC 2011).*

5 *The overall pattern of drier-than-average conditions during 2011 created ideal wildfire conditions across most of the southern United States during the year, and the driest areas of the Southern Plains experienced above-average wildfire activity (NOAA 2012).*

6 *In some areas of the western United States, such as the Pacific Northwest and western Colorado, studies show that the warm phase of the Pacific Decadal Oscillation is associated with more area burned by wildfire than in the cool phase (Hessl, McKenzie, and Schellhaas 2004; Schoennagel et al. 2007).*

7 *The Schoennagel et al. 2007 paper examines interannual and multidecadal relationships between fire occurrence and the El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and Atlantic Multidecadal Oscillation (AMO). They find that years of combined positive AMO and negative ENSO and PDO phases represent "triple whammies" that significantly increased the occurrence of drought-induced fires.*

8 *The El Niño Southern Oscillation mechanism is a complex interplay of ocean surface temperatures and air pressure differentials between the east and west Pacific Ocean in tropical latitudes. By influencing jet stream patterns and moisture in the air, it is a major source of variability in precipitation and other climate factors in the Southwest. (It also affects weather patterns in the Northwest.) In particular, it is known to affect fire occurrence in the Southwest (Westerling and Swetnam 2003; Swetnam and Betancourt 1990).*

9 *A dry La Niña period can cause outsized risks of large wildfires, especially if preceded by a rainy El Niño period during which vegetation that serves as fuel builds up. Data show that the largest fire years in the Southwest and mountain states occur after a wet-dry sequence or an El Niño-La Niña sequence (Westerling and Swetnam 2003).*

10 *This study uses satellite data from the Monitoring Trends in Burn Severity project. The data are not available for years prior to 1984, but, unlike other wildland fire datasets, they do include all land ownership classes, not just public lands.*

11 *This study used the Omernik ecoregions. See* http://www.epa.gov/wed/pages/ecoregions.htm.

12 *For the period 1916 to 2003, the study found that roughly 39 percent of the fire area burned can be related directly to climate.*

13 *Many studies on forests and wildfires use Robert G. Bailey's ecoregion classification (Bailey 1995).*

14 *These data are only for land owned and managed by the Forest Service. Differences in prior forest management practices and responses for these lands compared with lands managed by other agencies and private land could influence these trends.*

15 *The annual number of large wildfires has increased from approximately 140 during the period from 1980 to 1989 to 165 in the period from 1990 to 1999 to 252 in the period from 2000 to 2009. The decadal averages are for reported wildfires greater than 1,000 acres on all federally administered public land in the 11 western states in the contiguous United States. These numbers were generated from federal wildland fire occurrence data, which cover the period from 1980 to 2012 (USGS 2013).*

16 *Whereas the Climate Central estimate was for just Forest Service land, the UCS 2013 number is for all federal public land in the West (i.e., Forest Service, Bureau of Land Management, National Park Service, Fish and Wildlife Service, etc.).*

17 *Land-use histories have had relatively little effect on fire risks in the mid-elevation altitudes, which makes the strong climate attribution of risks clearer to discern.*

18 *The projected temperature increases for the 11 western U.S. states are derived from the NOAA Regional Climate Trends and Scenarios (Figure 20) for the U.S. National Climate Assessment report. They are projected annual mean temperature increases mid-century (2041 to 2070) compared with the reference period of 1971 to 1999. The range of projected temperature increases in the western United States by mid-century (2040 to 2070) represents a choice of two possible futures: one in which we drastically reduce heat-trapping emissions (the projected low end of a lower-emissions pathway) and one in which we continue with "business as usual" (the projected high end of a higher-emissions pathway).*

19 *For the entire western United States, the area burned could increase from 73 percent to 656 percent, depending on the ecoregion. This increase is the median increase in annual area burned across 14 ecosystem provinces classified in Bailey 1995. The methods used to calculate these estimates come from Littell et al. 2009. Note that these numbers are based on statistical models that do not take into account fuel availability: for example, the fuel in a region will likely run out (i.e., some tree species could shift their range or experience die-back) before it sees the highest increases in area burned. The calculations also do not account very well for extreme fire years.*

20 *Using an ensemble of 15 climate models, the study projects an increase in area burned of 24 percent to 124 percent, depending on the ecoregion, in the 2051 to 2065 timeframe. The results show that, overall, the western United States will see a 60 percent increase in area burned. The following are the increases by ecoregion: Desert Southwest (124 percent), Rocky Mountains forest (71 percent), Eastern Rocky Mountains/Great Plains (62 percent), Nevada Mountains/Semi-desert (56 percent), Pacific Northwest (42 percent), and California coastal shrub (24 percent). The projections are less robust in the Pacific Northwest and the California coastal shrub ecoregions (Yue et al. 2013).*

21 *Based on research of the relationship between fire occurrence and interannual to decadal climatic variability (such as the ENSO, PDO, and drought) as well as changes in land use patterns in the twentieth century, Hessl, McKenzie, and Schellhaas 2004 suggests that a correlation with the PDO phases may make long-term fire planning using the PDO possible in the Pacific Northwest. Williams et al. 2013 uses an ensemble set of downscaled global climate model outputs for the southwestern United States to forecast what they call a "Forest Drought Stress Index." It shows that by 2040 or so, average drought stress conditions affecting forests may be near the level of the worst droughts of the past 1,000 years.*

22 *The range depends on the method used to calculate the increase in burned area—a regression-based approach based on observed empirical relationships or parameterization.*

23 *Current estimates are that, globally, landscape fires (which encompass wildfires, prescribed burns, burning of tropical forests, peat fires, agricultural burning, and grassland fires) release approximately 2 petagrams (2 gigatons) of carbon into the atmosphere each year (van der Werf et al. 2010).*

24 *Those states (in decreasing order of the percentage of fossil fuel emissions to which the wildfire emissions are equivalent) include Alaska, Idaho, Oregon, Montana, Washington, Arkansas, Mississippi, and Arizona.*

25 *Between January 1, 2014, and February 22, 2014, California experienced 606 wildfires burning a total of 1,195 acres, an increase of 3.5 times the number of wildfires and twice the area burned compared with a five-year average for the same time period (CAL FIRE 2014b).*

26 *Snowpack levels as of February 27, 2014. The statewide average of 24 percent is disaggregated as follows: 15 percent of normal levels for this time of year in the Northern Sierras, 32 percent in the Central Sierras, and 24 percent in the Southern Sierras.*

27 *The proximate cause was a hunter's illegal campfire that escaped and spread in the Stanislaus National Forest.*

28 *The study evaluated 10 categories of lost environmental benefits for eight ecosystems identified within the burn area: food provisioning, raw materials, medicinal resources, air quality, climate stability (carbon sequestration), moderation of extreme events, soil retention, biological control, water regulation, soil formation, pollination, habitat and biodiversity, aesthetic information, recreation and tourism, and science and education. They were calculated using dollar values for ecosystem services before and after the fire, all derived from a benefit-transfer methodology that used estimates from other comparable locations with similar attributes. Those estimates come from economic studies using a variety of techniques such as replacement cost, avoided cost, hedonic pricing, and contingent valuation. For more details see Batker et al. 2013.*

29 *Private property losses include associated declines in local and state tax districts.*

30 *The connection between climate change and future wildfire projections for the grass and shrubland area in southern California is uncertain. Active wildfire years in these ecosystems tend to be more strongly associated with moisture levels in previous growing seasons that help vegetation grow. Precipitation projections are more variable across climate models, thus the impact on vegetation is more uncertain. In Northern California, scientific evidence points to growing forest wildfire risks due to hotter, drier conditions, driven largely by climate change.*

31 *The study found that in Northern California fire risks could increase +15 percent to +90 percent by the end of the century, depending on how much temperature increases. In Southern California the change was -29 percent to +28 percent, although in parts of San Bernardino fire risks definitely increased with temperature. The study did not model the effect, if any, of climate change on the Santa Ana winds.*

32 *These include the 1991 Oakland Hills fire, which cost $1.7 billion in insured losses (about $2.6 billion in 2012 dollars); 2003 wildfires in San Diego and San Bernardino Counties, which cost more than $2 billion in insured losses (about $2.46 billion in 2012 dollars); and the 2007 wildfires in Southern California, which caused an estimated $1.6 billion in insured losses (about $1.73 billion in 2012 dollars) (RMIIA n.d.).*

33 *The study evaluates wildfire risk by looking at: fuels—trees, grass and brush that feed fuels; slope—the grade of the surrounding land that affects the speed and intensity of a wildfire; and access—condition of roads leading to the area.*

34 *A county-by-county list of the at-risk homes is here:* http://iinc.org/attachments/countylist.pdf.

35 *According to data from the California Department of Insurance, in 2011 insurers underwrote policies for residential property worth more than $3 trillion across the state. Private insurers were responsible for a majority of the policies, with less than 1.25 percent covered by the California FAIR Plan, the state-backed insurer of last resort (IINC and Verisk Insurance Solutions 2012).*

36 *The Communities at Risk list was a requirement from Congress created in the wake of an extremely active fire season in 2000. Under the 2001 National Fire Plan, all states are required to maintain this list as a way to better identify areas of vulnerability ahead of a fire and direct resources accordingly. As of June 24, 2014, 874 communities were on the list.*

37 *The study found that per 10 $\mu g/m^3$ wildfire-related PM2.5, acute bronchitis admissions across all ages increased by 9.6 percent, chronic obstructive pulmonary disease admissions for ages 20 to 64 years increased by 6.9 percent, and pneumonia admissions for ages 5 to 18 years increased by 6.4 percent.*

38 *For example, as part of its public awareness campaign, CAL FIRE has urged homeowners and communities to create 100 feet of "defensible space," buffer areas around homes and buildings that are free of any flammable vegetation such as grass, trees, or shrubs and can help slow or stop the spread of fires.*

39 *The 2014 draft plan recognizes the state's risk of a substantial increase in annual burned area under future climate change scenarios and makes a number of recommendations to reduce these risks.*

40 *The extensive spread of introduced plant species that are highly flammable, such as Asian and African grasses, is also contributing to more fire and ecosystem changes in some areas.*

41 *Federal government agencies have defined the wildland-urban interface as follows: "The urban wildland interface community exists where humans and their development meet or intermix with wildland fuel." There are three categories of communities included in this definition: "The* Interface Community *exists where structures directly abut wildland fuels; the* Intermix Community *exists where structures are scattered throughout a wildland area; and the* Occluded Community *generally exists in a situation, often within a city, where structures abut an island of wildland fuels (e.g., park or open space)" (Federal Register 2001).*

42 *Among the intermountain western states, WUI growth rates are: Nevada (63 percent), Arizona (34 percent), Colorado (21 percent), Montana (19 percent), Utah (18 percent), and Idaho (17 percent).*

43 *Of the total properties identified, just over 268,000 homes fall into the "very high risk" category alone, with total residential exposure valued at more than $41 billion.*

44 *The number of homes and businesses in these wildfire-prone areas is growing partly because of population growth and the expansion of towns and cities. Another significant factor over the last few decades has been a growing pattern of suburbanization and exurbanization, which contributes to WUI expansion (Hammer, Stewart, and Radeloff 2009). Population and housing growth in the West has occurred at a much faster pace than any other part of the country except the Southeast. More people also own vacation homes in these areas because of their location in beautiful natural landscapes and proximity to recreational opportunities (Hammer, Stewart, and Radeloff 2009). Overall, these changes have increased the number and probability of homes and businesses being damaged or destroyed by wildfires, alongside a host of other challenges such as habitat destruction, threats to wildlife, and difficulties for forest management.*

45 *California state law requires that homes located in high-risk areas where the state has firefighting responsibility (so-called State Responsibility Areas) to maintain a 100-foot defensible-space buffer zone around buildings (or the property line) that is free of brush or vegetation. The law also requires that new homes be constructed of fire-resistant materials (California Fire Code 2013).*

46 *Research also shows that the presence of conservation easements could aid fire management by clustering development more closely and allowing more wildland area available for unsuppressed fires and prescribed burns (Byrd, Rissman, and Merenlender 2009).*

47 *1.1 million live in red zones, out of the total state population of 5.2 million (I-News Network 2013).*

48 *Based on a Colorado State University study showing development in the WUI increasing from 715,500 acres in 2000 to 2.1 million acres by 2030 (Theobald and Romme 2007). The Colorado maps from the study are available here:* http://csfs.colostate.edu/pdfs/Current_projected_WUI.pdf.

49 *Governor John Hickenlooper created the Task Force on Wildfire Insurance and Forest Health through Executive Order B 2013-002. The group was asked to identify and reach agreement on ways to encourage activities, practices, and policies that would reduce the risk of loss in WUI areas and provide greater customer choice and knowledge of insurance options. On September 30, 2013, the task force formally submitted its report and recommendations to the governor (Wildfire Insurance and Forest Health Task Force 2013).*

50 *Community Wildfire Protection Plans are voluntary plans for which the federal government provides assistance as part of the Healthy Forests Restoration Act of 2003.*

51 *In response to increasing demand for more accurate and up-to-date wildfire risk information across the state, the Colorado State Forest Service (CSFS) established the Colorado Wildfire Risk Assessment Portal (CO-WRAP) (Colorado State Forest Service 2013). The goal of the project is to provide a consistent, comparable set of scientific results to be used as a foundation for wildfire mitigation and prevention planning in Colorado. The results were completed in December 2012. The CSFS developed the CO-WRAP in order to deliver the information quickly and seamlessly to stakeholders. Through CO-WRAP, the CSFS is creating awareness among the public and providing state and local government planners with information to support mitigation and prevention efforts. See* http://www.coloradowildfirerisk.com.

52 *Many of these wildfire risk mitigation measures are described in the "Are You FireWise?" brochure:* http://csfs.colostate.edu/pdfs/wholenotebook.pdf.

53 *Forty-seven percent of land in the conterminous 11 western states is public land. In Alaska this is nearly 62 percent. This land is managed mainly by four federal government agencies: the Bureau of Land Management, the Forest Service, the National Fish and Wildlife Service, and the National Park Service. Smaller areas are managed by the Department of Defense and the Department of Energy.*

54 *The authors define high fire-risk areas to include those that have always experienced high-intensity, stand-replacing wildfires (e.g., lodgepole pine forests), as well as areas that have historically had low- or variable-intensity wildfires but have more recently experienced high-intensity wildfires because of a legacy of fire suppression (e.g., southwestern ponderosa pine forests).*

55 *The 1908 Forest Fires Emergency Act authorized the FS to spend whatever necessary to combat the increasing wildfires throughout the country. Shortly thereafter, during a devastating set of fires in Idaho, Montana, and Washington in 1910 the FS spent more than $1 million in firefighting costs. In 1935, the FS instituted the "10 a.m. policy," whereby the aim was to contain any fire by 10 a.m. the morning after it was discovered. In 1971 the "10 acre" policy was added with the aim to restrict wildfires to less than 10 acres.*

56 *Major milestones include a) the 1995* Federal Wildland Fire Management Policy & Program Review, *b) the 2000 report* Managing the Impact of Wildfires on Communities and the Environment: A Report to the President in Response to the Wildfires of 2000, *and c) the* National Cohesive Wildland Fire Management Strategy, *now under way, which will lead to the 2014 National Action Plan.*

57 *The majority of fire management funding (more than 70 percent) has been allocated to the FS mainly because it is the oldest of the four federal land-management agencies that had focused on fire protection and has more forestland under its management than the DOI agencies that together receive about a third of the funding. The U.S. Congress allocates funding for wildfire protection, which is used for protection of federal lands, providing assistance for state and local fire protection, and other purposes.*

58 *These agencies include the California Department of Forestry and Fire Protection, the Colorado Division of Fire Prevention and Control, the Montana Department of Natural Resources and Conservation, and New Mexico State Forestry.*

59 *The 2003 California wildfires, which occurred near the Los Angeles metropolitan area, demonstrate the devastating impacts of fires near densely populated areas (Radeloff et al. 2005).*

60 *The costs rose with the amount of adjacent private land area until the proportion of private land reached approximately 50 percent. After that, costs stopped rising, likely because of cost-sharing agreements between the FS and local or state authorities. Once private lands become the major part of the area affected by the wildfire, local/state authorities will likely pick up a greater share of firefighting costs.*

61 *For example, during the 2002 fire season, two-thirds of the total suppression costs of $1.6 billion went to private contractors (FS, DOI, and NASF 2003).*

62 *In practice, the protection of private property is often prioritized above the protection of natural resources (Calkin et al. 2013). Federal efforts to protect WUI property also contribute to increasing the cost of fire suppression and have led to a diversion of funds away from other uses such as protecting natural resources.*

63 *Most of that (993,000 acres) burned as a result of 119 large fires (each of a size greater than 100 acres).*

64 *Between adverse age and stocking characteristics of the forests, more than 2.8 million acres of Montana forests are at high risk for pine beetle infestation. The drought has contributed to conditions that reduce the health of trees and their ability to withstand beetle infestations. Winter temperatures have also not been cold enough to kill off the beetle population. Lodgepole pine and ponderosa pine are the chief species susceptible to beetle damage in the western United States, with lodgepole pine trees older than 80 years being the most at risk. On federally owned land in Montana, an estimated 71 percent of all lodgepole pine trees are 80 years of age or older. Lodgepole pine in this age category covers an estimated 2.2 million acres. On state or privately owned lands (including tribal lands), an estimated 29 percent of lodgepole pine are in this same category, and account for 116,000 acres (Montana DNRC n.d.).*

65 *Measuring the benefit of expenditures on fire suppression is a complex task. A study looking at two different wildfires in Montana in 2003, one near a densely populated area and one in a more rural area, found that suppression costs were higher for the more urban fire. However, compared with the value of residential property within the fire perimeter, suppression costs were disproportionately high for the rural fire (Calkin et al. 2005a; Calkin et al. 2005b).*

66 *The Forest Service manages 17 million acres (18 percent of total land area) and the Bureau of Land Management manages 8 million acres (8.5 percent of total land area) in the state. Adding in areas managed by the Fish and Wildlife Service and other federal agencies brings the total to nearly 30 percent.*

67 *For example, data from 1996 to 2006 in Montana show that putting out small fires (less than 10 acres) cost an average of $4,070 per fire, whereas the largest fires (greater than 5,000 acres) cost 606 times more, at more than $2.5 million per fire (Montana DNRC 2007).*

68 *In Colorado, the rising costs of fire suppression caused by expansion of the WUI is not shared equitably since all state taxpayers, not just those who choose to live in the WUI, must shoulder the costs (State of Colorado 2002).*

69 *Under the Federal Fire Prevention and Control Act of 1974, state and local fire departments can be reimbursed for fighting fires on federal lands.*

70 *More about the Wyden-Crapo bill is online at* http://www.energy.senate.gov/public/index.cfm/2013/12/wyden-crapo-introduce-bipartisan-wildfire-funding-reform-legislation; *for President Obama's budget proposal, see Wilson 2004.*

71 *For comparison, hurricanes and tropical storms account for 40.4 percent of insured losses, tornadoes 36 percent, winter storms 7.1 percent, terrorism 6.3 percent, earthquakes 4.7 percent, and wind/hail damage 3.8 percent.*

72 *A major 2007 fire season in southern California, fanned by Santa Ana winds, led to insured losses of $2.3 billion (California Department of Insurance 2013). The 2003 San Diego wildfires, which burned nearly 740,000 acres and destroyed more than 3,600 homes, caused insured losses of nearly $2.4 billion (IINC and Verisk Insurance Solutions 2012). In 2012, insured losses in Colorado reached more than $567 million (RMIIA n.d.), in large part because of the Waldo Canyon fire. Insured losses from the 2013 Black Forest fire in Colorado reached nearly $293 million (RMIIA n.d.), the third time in four years those losses for the state exceeded the $100 million mark (Jergler 2013).*

73 *In 2012 Congress passed the Biggert-Waters Flood Insurance Reform Act to put the heavily indebted NFIP on a more solid financial footing. Although some of the reforms were subsequently rolled back, a key provision related to floods in the wake of wildfires is still in force. Specifically, it exempts individuals and businesses purchasing new flood insurance policies in the wake of wildfires from the standard 30-day waiting period for coverage to become effective (FEMA 2012). That exemption helps people get insurance coverage in areas where flood risks may have suddenly changed due to wildfire.*
The reform provision in this bill created an exception to that requirement for property

- *That is affected by flooding on federal land,*
- *Where the flooding is caused, or exacerbated by, post-wildfire conditions on federal land, and*
- *For which flood insurance was purchased not later than 60 days after the wildfire containment date.*

Source: FEMA 2012.

74 *The list of wildfires studied was: The Canyon Ferry Complex fire (Montana, 2000), the Cerro Grande fire (New Mexico, 2000), the Hayman fire (Colorado, 2002), the Missionary Ridge fire (Colorado, 2002), the Rodeo–Chediski fire (Arizona, 2002), and the Old, Grand Prix, Padua Complex fire (California, 2003) (Western Forestry Leadership Coalition 2010).*

75 *These other costs included costs for long-term rehabilitation of $40 million, reforestation costs totaling $90 million, home and property losses adding up to another $125 million, and $2.5 million spent on emergency public assistance. This estimate does not include revenue lost from tourism, short-term job losses, loss of recreation opportunities, water supply damage, destruction of natural and riparian habitat, loss of endangered species, and intangible losses such as emotional trauma from the fire.*

76 *A study of the economic costs of a devastating fire season in northeastern Florida in June and July 1998 estimated that additional asthma-related health care expenditures due to the wildfires ranged from $325,000 to $700,000, part of a total economic impact estimated to be at least $600 million. The 1998 fire season was one of the worst that Florida has seen. Approximately 500,000 acres burned across 18 northeastern Florida counties that compose the St. John's River Water Management District. Weather patterns associated with an unusually strong El Niño-Southern Oscillation, including a serious drought, were the major causal factor (Butry et al. 2001).*

77 *These particulates are classified by size as PM10 (those that are 10 microns or less in diameter) and PM2.5 (those that are 2.5 microns or less in diameter). Smaller particles, also called fine particles, are potentially more harmful because they are more easily inhaled and can penetrate deeper into the lungs (U.S. EPA 2013).*

78 *The overwhelming burden of health impacts from landscape fires (encompassing wildfires, prescribed burns, burning of tropical forests, peat fires, agricultural burning, and grassland fires) falls on some of the poorest regions of the world in sub-Saharan Africa and Southeast Asia. A recent study estimated that the average mortality from exposure to such fires was 339,000 deaths annually, of which 157,000 were in sub-Saharan Africa and 110,000 in Southeast Asia (Johnston et al. 2012).*

79 *The event included 14 wildfires between October 21, 2003, and November 4, 2003.*

80 *The mean estimated total mortality-related cost associated with the 2003 southern California wildfire event was estimated to be approximately $1 billion, with a range of $172.9 million to $1.7 billion. These estimates were calculated by multiplying the 133 excess deaths by the value of statistical life estimate ranging from $1.3 million to $13 million (in 2008 dollars). The approach is the same used by the Environmental Protection Agency is its calculations of the benefits of improved air quality for regulatory purposes (Kochi et al. 2012).*

81 *Another study also found that the 2003 wildfires were associated with a slightly lower average birth weight for babies that were exposed to the smoke in utero, and that this effect was most pronounced for those exposed during the second trimester of pregnancy (Holstius et al. 2012).*

82 *The Station fire lasted from August 26, 2009, to October 16, 2009, burning approximately 161,000 acres. It was started by an arsonist in the Angeles National Forest and spread to nearby areas in Los Angeles County, becoming hard to contain because of a variety of adverse conditions. The fire was responsible for the deaths of two firefighters and the loss of 89 homes and 22 commercial buildings. The total suppression costs as of October 17, 2009, amounted to $95,300,000 (U.S. Forest Service 2009).*

83 *According to the study, the all-in estimates could be nine times as high, up to $84.42 per exposed person per day.*

84 *Based on direct expenditures within the 17-county Greater Yellowstone Area per out-of-area visitor of $187.85 (in U.S. dollars).*

85 *The park generates an average of $76 million per day in revenue from tourism, and nearby counties including Tuolumne, Mariposa, Merced, and Madera are also dependent on the revenue generate from tourism.*

86 *A study on the tourism impact of the 2003 San Diego wildfires found that they resulted in a $4.4 million loss in visitor spending compared with 2002 (Rahn 2009). A devastating fire season in Florida in 1998 was estimated to have cost $61 million in losses for hotel revenues and $77.2 million in non-hotel–related tourist spending (Butry et al. 2001).*

87 *This included dredging the Strontia Springs Reservoir, treating water, and reseeding the forests in the watershed.*

88 *These additional costs included emergency rehabilitation, restoration, and flood mitigation costs.*

89 *The cost was associated with removing sediment from debris basins.*

90 *One study of 11 western states found that, in the short term, employment in counties affected by large wildfires increased 1.54 percent more than the statewide average and wages increased 0.90 percent. Counties adjacent also experienced an increase in average wages of 0.43 percent although employment stayed the same (Nielsen-Pincus, Ellison, and Moseley 2012).*

91 *New Mexico is the fifth largest and sixth least densely populated of the 50 U.S. states.*

92 *This annual assessment of communities at risk is prepared by all states in accordance with the Healthy Forest Restoration Act of 2003. Communities identified at risk are encouraged to prepare Community Wildfire Protection Plans, which the New Mexico Fire Planning Task Force reviews and approves.*

93 *Another recent study used a range of ratios of total costs to suppression costs from the Western Forestry Leadership Coalition 2010 study, which were between 1.9 and 29, with a midpoint of 12.7 (Impact DataSource 2013). Based on this, the study estimated that the full costs of recent major New Mexico wildfires far exceeded suppression costs.*

94 *Wildfire mitigation is not required by law for WUI residents, and the state only recommends that homeowners use best wildfire mitigation practices. However, owners of private commercial forests are mandated to follow rules and regulations related to forest fire prevention, and the New Mexico police has the authority to order compliance in accordance with mitigation order and arrest any violators.*

95 *Communities in the WUI have the option to develop these plans with federal assistance.*

96 *The Healthy Forests Restoration Act (HFRA), which was passed by Congress on November 21, 2003, and signed into law by President Bush on December 3, 2003, encourages the development of Community Wildfire Protection Plans (CWPPs) as outlined in Title 1. Communities at their discretion can develop a CWPP, a broad plan developed together by local citizens and state and federal agencies. These protection plans are grounded on the requirements of the people in the community and can focus on various issues such as wildfire response, hazard mitigation, community preparedness, and structure protection.*

97 *In this context, protective masks refer to respirators that filter out particulates and fit snugly, not the simple one-strap masks that are familiar to the public but not effective in protecting against smoke pollution.*

98 *The Environmental Protection Agency's AIRNow website is a standard source for air quality data around the country:* http://airnow. gov/index.cfm?action=aqibasics.aqi. *A number of states maintain their own data, e.g., California* (http://www.arb.ca.gov/html/ds.htm), *Colorado* (http://www.colorado.gov/airquality/air_quality.aspx), *Montana* (http://www.deq.mt.gov/ FireUpdates/default.mcpx)*, and New Mexico* (http://drdasnm1.alink.com).

99 *These fire smoke forecasting systems include tools created by the FS through the AirFire research team* (http://www.airfire.org) *and NOAA's Hazard Mapping System* (http://www.ospo.noaa.gov/Products/land/hms.html).

100 *For example, in 2010 a prescribed burn in the Helena National Forest of Montana escaped and burned more than 2,000 acres of adjoining private and FS land (Lincoln Ranger District 2010).*

101 *This is also part of the ongoing implementation of the Obama administration's Climate Action Plan.*

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Playing with Fire

How Climate Change and Development Patterns Are Contributing to the Soaring Costs of Western Wildfires

[***Hotter, drier conditions and growing development in wildfire-prone areas are driving up the risks and costs of wildfires in the western United States.***]

This report explains how climate change and development in wildfire-prone areas are driving up the risks and costs of wildfires; points out why current policies and practices may be worsening the situation; highlights the many different impacts and costs of wildfires; and provides recommendations for what we can do to limit these costs. Case studies on California, Colorado, Montana, and New Mexico provide a more in-depth look at relevant issues in these states.

We have an opportunity to use our resources better to manage wildfires and help protect people. Coordinated action, with a fresh focus on resilient choices, is needed from federal and state agencies and policy makers tasked with forest management, fire management, local agencies tasked with zoning regulations, communities located in high fire-risk areas, and insurance companies. Incorporating the latest science to improve wildfire mapping and prediction, making investments in fire-safety measures, and better forest management practices can help address the need for human safety and long-term forest health.

Steps we take now—to build resilience to wildfires in communities that are on the frontlines of risk, to reduce the expansion of development near fire-prone forested areas, and to cut the emissions that are fueling climate change—will be crucial to help limit the impacts of wildfires on people and forests.

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