Swiss Re

Fueling resilience

Climate and Wildfire Risk in the United States

A report prepared by the students of Johns Hopkins University, School of Advanced International Studies

About the project

This report was authored by students of the Johns Hopkins University School of Advanced International Studies (SAIS) as part of a practicum project in the Energy, Resources, and Environment Program. The practicum requires student teams to partner with key organizations to address critical international environmental policy challenges. Here, students collaborated with Swiss Re to further the understanding of natural disaster management policy in the United States and develop a platform for unlocking resources to build climate resilience.

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Johns Hopkins University
School of Advanced International Studies
Energy Resources and Environment Student Practicum

Authors
Dong-Thu Caohuu
Gauri Gadgil
Yasmine Jamnejad
Victoria McBride

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As climate change intensifies, the western United States faces rising exposure to longer and more costly wildfire seasons. In fact, the six most extreme wildfire seasons since 1960 have all occurred within the last 15 years, and the average cost of extinguishing wildfires in the same time period has more than tripled for the U.S. Forest Service.[1] Increasingly severe wildfire seasons are being driven by three key elements: fuel build-up from current fire management strategies, changing climate factors such as extended drought conditions and higher temperatures, and an increase in housing development in the Wildland Urban Interface (WUI). The United States is not the only country facing this challenge – Australia and Canada share similar challenges in confronting higher than average temperatures, extended fire seasons, and escalating wildfire risk.

As more government resources go to addressing immediate emergency fire events, less financial and human capacity is available to develop a sustainable wildfire management strategy. Such a strategy would incorporate the long-term impacts of climate change and human development on wildfire risk, allow for adequate levels of mitigation and planning activities, and ensure that sustainable financing is in place to meet rising costs without significant disruptions to government budgets.

Executive Summary

What are the real costs of wildfire?

Direct costs associated with wildfires are the most visible and include suppression (firefighting) costs to wildfire management agencies at the federal, state, and local level as well as recovery costs to homeowners, utilities, private landowners and public agencies. The complete cost of wildfire, however, also includes indirect impacts of fire on watersheds, tourism, property values, tax revenues, public health, and the environment. Governments shoulder some of these costs in the form of reduced tax revenues as well as long-term costs to repair watersheds, ecosystems, and infrastructure. Other indirect costs are transferred to the public in the form of lower property values, increased risk of debris flow and flooding, and health hazards from higher levels of air pollution.

Who pays to put out the fire?

Responsibility for wildfire suppression depends on whether a wildfire burns on federal, state, or local land. At the federal level, the U.S. Forest Service (USFS), under the Department of Agriculture, and the Department of the Interior (DOI) are tasked with the bulk of suppression activities. These agencies are appropriated annual funds for fire suppression, which often prove insufficient to cover costly wildfire seasons. Combined suppression costs for USFS and DOI, including supplemental emergency appropriations, have averaged around USD 1.7 billion annually over the last 10 years. Each state has a corresponding fire management agency that handles suppression activities on state lands, such as CALFIRE in California and the Oregon Department of Forestry (ODF) in Oregon. Federal Emergency Management Agency (FEMA) Fire Management Assistance Grants (FMAGs) can also provide up to a 75% federal cost share reimbursement to cover emergency fire management activities for certain eligible fires that burn beyond state funding capacity and threaten destruction at a level that would constitute a major disaster.

The financing challenge

The study highlights how funding policies for federal and state agencies prioritize wildfire suppression, often to the detriment of other forest management programs. When suppression funds for USFS run dry, as they have 8 of the last 13 years, the agency is forced into "fire borrowing," in which it strips funds from other programs such as watershed management, maintenance, recreation and education, and critical mitigation and wildfire prevention measures. Most of this borrowing is eventually paid back by Congress, but not before significant disruption has occurred to the Forest Service's operations.

States have varied methods of funding suppression costs, from California's annual budget allocation and reliance on a state emergency fund, to Oregon's use of private landowner fees and General Fund allocations to pay costs and purchase insurance. For decades these policies were sufficient to manage suppression costs because of a lower frequency of severe wildfire seasons. However, the sustainability of public funding practices is now being called into question following years of consecutive severe wildfire seasons. Over a decade ago, the USFS spent only 13 percent of its annual budget on suppression, but now spends nearly 50 percent. California's fire suppression expenditures from its emergency fund alone averaged over USD 250 million annually in the last decade, and Oregon has maxed out its catastrophic wildfire insurance the past two years in a row. As these extreme fire seasons continue, federal and state governments alike are approaching a threshold for accommodating continued increases in costs under current funding structures.

Managing wildfire risk

Building suppression capacity alone cannot be substituted for creating a sustainable wildfire management strategy. In order to adequately manage wildfire risk, governments must more fully engage to reduce risk where possible, accept and plan for the changing levels of risk they are facing, and transfer risk that is too extreme or volatile to accept.

Risk reduction strategies include identifying sustainable and robust streams for mitigation funding at both the national and sub-national levels, as well as targeted education campaigns and restrictions on building in the WUI. Accepting risk includes acknowledging a potentially higher baseline of costs to be absorbed in the long-term and taking concrete steps such as creating state funds or 'self-insurance' schemes with diverse fee payer bases to cover these costs. Covering an accepted base level of costs is key to accepting risk and benefits from a variety of inputs - general fund budget, landowner fees, and private industry contributions. Finally, transferring risk from catastrophic wildfires to the private market through innovative financing can be an integral part of risk management. This could include setting up new multi-state risk pooling facilities that leverage existing institutional infrastructure, or using risk transfer instruments like parametric-based insurance policies that could reduce government emergency outflows. State governments can also take action to support smarter markets for individual property and landowner asset insurance.

Financing the future

Currently, most states lack a sustainable financial strategy to respond to the changing climate landscape. Although individual decision-makers largely agree that the "rear-view mentality" regarding wildfire costs is no longer acceptable, the urgency of covering immediate fire suppression needs limit the resources and capacity available for long-term planning. A sustainable wildfire management strategy would anticipate growing suppression costs and ensure that financial instruments were in place to protect public budgets from disaster-induced shocks. This study argues that by taking a more holistic approach, governments can reduce volatility in annual budgets and better allocate funding for long-term mitigation, land-use planning, and community preparedness. The key building blocks of resilience include sustainable financing for suppression and mitigation as well as proper risk identification, stakeholder alignment, and public engagement. Although financing natural disasters through private insurance markets remains a frontier arena, western states have demonstrated leadership in proactively addressing climate change and now have the opportunity to redefine wildfire resiliency.

I. Drivers of extreme wildfire

Fire seasons are increasing in intensity due to changes across a host of environmental factors, causing risks and costs to rise. Record high temperatures, persistent drought, reduced snowpack and invasive species are changing forest conditions. The subsequent build-up of dead and dying vegetation is creating an excess of dry biomass in the forest understory which, when ignited, is likely to cause hotter, larger, and more dangerous fires. By 2014, record-low precipitation levels and fuel build-up have extended the Western fire season by 60-80 days above the national historical 30-year average.[2] The U.S. Forest Service (USFS) expects longer and more severe fire seasons to become a permanent pattern.

Fire management agencies have also seen a rise in wildfire suppression costs due to accelerating development of homes in at-risk areas near forests and other wildlands, known as the Wildland Urban Interface or the "WUI."

Fire fighting in these WUI zones requires significantly greater physical and financial resources than in uninhabited regions[3] — the major difference in cost can be attributed to the fact that many state agencies have mandates to protect homes at all costs. Almost a third of Americans live in WUI regions, with 12 million houses built in these areas nationally.[4] Western states have the highest proportion of their homes in WUI areas, with California leading in the region.[5] However, the current WUI saturation is only a fraction of development potential: 84 percent of western WUI areas have yet to be developed. As the population in these risk-prone areas grows, fire managers are likely to see fire suppression costs increase.[6]

II. The real costs of wildfire

A. Types of costs

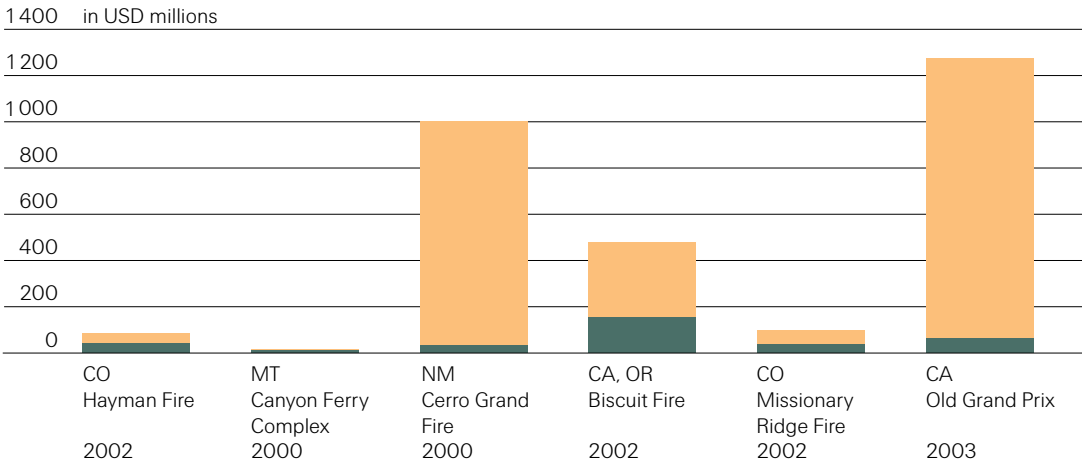
Direct costs associated with wildfires are the most visible and generally refer to suppression (firefighting) costs and immediate damages. Suppression costs per wildfire incident are based on firefighting personnel salaries, equipment, and procured assets for firefighting operations. Direct costs also include damages to private property and assets, including damage to structures and timber loss, any evacuation and medical costs, and public and commercial disruptions such as the closing of schools and businesses.

Indirect costs are more challenging to measure as they include a broad range of environmental, social, and economic losses that persist after the wildfire has been put out. Significant indirect costs include impacts on ecosystem assets, watersheds, water supply, water quality, soil acidification and erosion, long-term tourism and recreation revenue losses, property devaluation, air quality, and destruction of cultural endowments. Additional costs also include increased exposure to wildfire-induced landslides and debris flow.

B. How costs are calculated

Suppression is the center of most public discussions around wildfire impacts and costs. However, this overlooks additional direct costs of wildfire as well as a range of indirect costs that are often unaccounted for and borne by the public. Suppression costs are often only a portion of the total cost of wildfires. For example, in 2009, the Western Forestry Leadership Coalition completed a study examining six large wildfire cases in the western United States and determined that wildfire-related rehabilitation and other indirect costs range from 3 to 50 times the cost of suppression (Figure 1).[7]

Figure 1
Summary of total costs



in USD	CO Hayman Fire 2002	MT Canyon Ferry Complex 2000	NM Cerro Grand Fire 2000	CA, OR Biscuit Fire 2002	CO Missionary Ridge Fire 2002	CA Old Grand Prix 2003
Recovery and Indirect Costs	42 459 614	8 131 231	970 000 000	325 000 000	59 123 052	1 215 597 539
Supression	42 279 000	9 544 627	33 500 000	155 000 000	37 714 992	61 335 684

Source: Western Forestry Leadership Coalition (2009)

Federal wildfire reporting practices only account for the number of fires, acres burned, structural damages, and suppression costs to capture wildfire costs. However, there is ample literature emphasizing the negative social and economic externalities created by wildfires and the clear linkage between wildfires and ecosystem degradation.

One of the reasons for the lack of data reporting on recovery and rehabilitation costs is the absence of a standard methodology for valuation of indirect costs. The National Interagency Fire Coordinating Center (NIFC) collects statistics on suppression costs and direct damages, but has limited data on indirect costs. Although some information about the impact on property value, watersheds, wildlife habitats, tourism, and other long-term effects does exist at the state and local levels, the disaggregation of data across jurisdictions means that the total picture of wildfire costs remains unclear.

Uncertain property loss trends

In comparison to other natural catastrophes, insured wildfire losses have a relatively small share in the insurance industry, around 1.7 percent of total insured catastrophic losses, with USD 25 million being the designated threshold for most claims.[8] However, uninsured losses make up a significant proportion of total losses (ranging 37-57 percent in the last five years) from catastrophic wildfires.[9] In 2013 alone, severe wildfires in the U.S. caused USD 675 million in total losses and USD 290 million in uninsured loss.[10] Although 80 percent of all insured fire losses comes from California, other western states also face high levels of wildfire exposure, with total potential losses valued at USD 237 billion in reconstruction costs for the 900,000 properties and residential homes located in the most-fire prone areas.[11] However, if factoring in risk for properties located on the periphery of high-risk areas, potential damages could balloon by an additional USD 31 billion.[12]

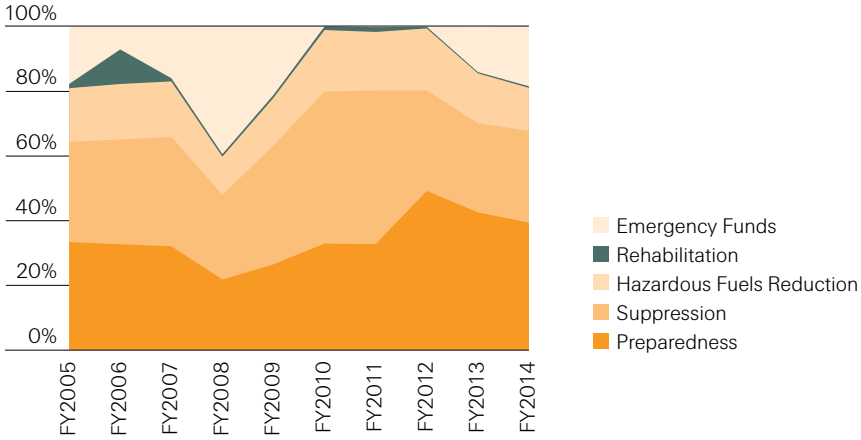
III. Who pays to put out the fire?

A. Payers and players

Federal

At the federal level, the USFS under the Department of Agriculture, and the Department of the Interior (DOI) are tasked with the bulk of suppression activities. Other fire management activities include preparedness, hazardous fuels reductions, and emergency funds (See Figure 2). These agencies receive annual appropriations for fire suppression; however, the appropriations are often insufficient to cover costly wildfire seasons. The combined suppression costs for USFS and DOI, including supplemental emergency appropriations, have averaged around USD 1.7 billion annually over the last 10 years.[13] Under the Federal Land Enhancement and Management Act (FLAME), both USFS and DOI have a Wildfire Suppression Reserve Fund, which can only be accessed following a state declaration of a fire emergency. Despite efforts by the USFS to re-focus funding to preventative programs, the actual proportion of suppression to total spending continues to average around 50 percent.

Figure 2
DOI and USFS combined wildfire management appropriations FY2005–2014



Source: Congressional Research Service (2014)

State and local

State and local agencies bear substantial costs for state-protected lands. In 2010, states spent USD 1.43 billion on wildfire programs and the majority of funds were for fire suppression.[14] Each state has a corresponding fire management agency that handles suppression activities on state lands, such as CAL FIRE in California and the Oregon Department of Forestry (ODF) in Oregon. Historically, wildland fire protection agencies emerged as private landowners consolidated their self-protection activities to form local fire departments. State and local fire authorities are responsible for protecting non-federal lands, with the state assuming authority for wildland fire suppression in some or all of the private wildlands in the state. In some states, the state authority can enter into contract with a local or federal fire authority to exchange protection area responsibilities.

Emergency cost disbursements through FEMA

Federal Emergency Management Agency (FEMA) Fire Management Assistance Grants (FMAGs) also provide up to a 75% federal cost share reimbursement to cover emergency fire management activities for eligible fires. Fires must burn beyond state funding capacity and threaten destruction at a level that would constitute a major disaster.[15] In order to receive FMAG funding, governors must submit a request for a fire management assistance declaration while the fire is burning in a manner that would constitute a major disaster.[16] Between 2002 and 2012, FEMA responded to six major disaster declarations and four emergency declarations, although total FMAG funds averaged USD 71.2 million annually – more than triple the FEMA wildfire assistance during the 1990s.[17] While FEMA has responded financially to a number of wildfire disasters, some states have faced delays as long as two years to collect FMAG funds from the federal government.

B. Financing challenges

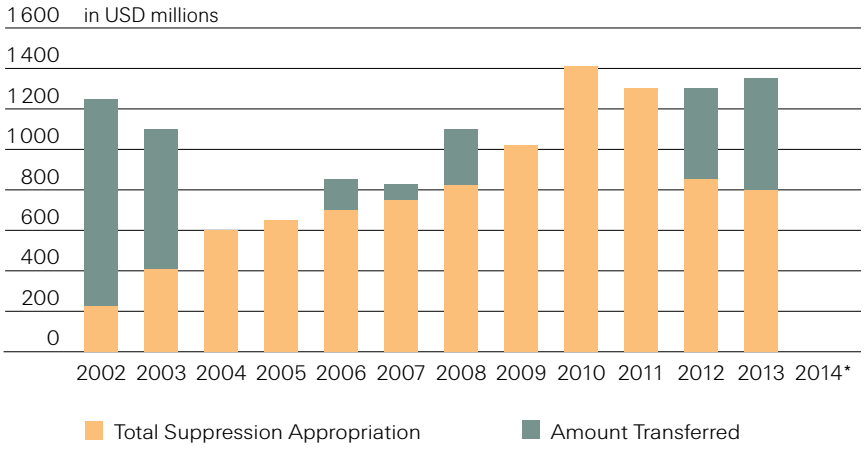
Wildfire funding policies, from the USFS to state-level fire management organizations, often place focus first and foremost on funding suppression. The large pools of funding that agencies can access for suppression are not available to fund other activities such as mitigation. In fact, budgets for mitigation are often raided to pay over-budget suppression costs, often referred to as "fire borrowing." This can create a vicious cycle whereby disruption in planned mitigation or prevention activities can actually increase future fire risk.

Appropriations for wildfire suppression activities for the USFS are determined at the national level. Each year, funds are appropriated through Congress determining allocations for all wildfire suppression in national forests, and funds are administered as wildfires occur. However, allocated funds are often insufficient compared to actual costs because budgets are based on a 10-year average and lag behind the growing cost of fighting wildfires. When suppression funding for the Forest Service enters deficit spending, as they have 8 of the last 13 years, the USFS is forced into "fire borrowing", where it strips funds from other programs such as watershed management and improvements, maintenance, recreation and educational programs, as well as critical wildfire mitigation and prevention programs (See Figure 3). Most of this borrowing is eventually paid back by Congress, but not before significant disruption has occurred to the Forest Service's critical operations.

At the state level, different states employ various methods of funding catastrophic fire suppression such as state emergency funds, landowner and forest industry fees, or private insurance. For example, California has a virtually uncapped emergency fund for fire suppression, whereas in Oregon, private landowner fees help pay for base costs and the state purchases additional coverage through insurance.

For decades these policies were sufficient to manage suppression costs because of a lower frequency of severe wildfire seasons. However, the sustainability of public funding practices is being called into question following years of consecutive severe wildfire seasons. Over a decade ago, the USFS spent only 13 percent of its annual budget on suppression, but now spends nearly 50 percent.[18] California's fire suppression expenditures from its emergency fund averaged over USD 250 million annually in the last decade,[19] and Oregon has maxed out its catastrophic wildfire insurance the past two years in a row. As these extreme fire seasons continue, federal and state governments alike are now approaching and surpassing the threshold for accommodating continued increases in costs.

Figure 3
USFS appropriations and transfers for fire suppression



* Actual expenditures have not been recorded though fire borrowing occurred.
Source: U.S. House of Representatives, Natural Resources Committee (2014)[20]

IV. The tale of two states: Case studies from California and Oregon

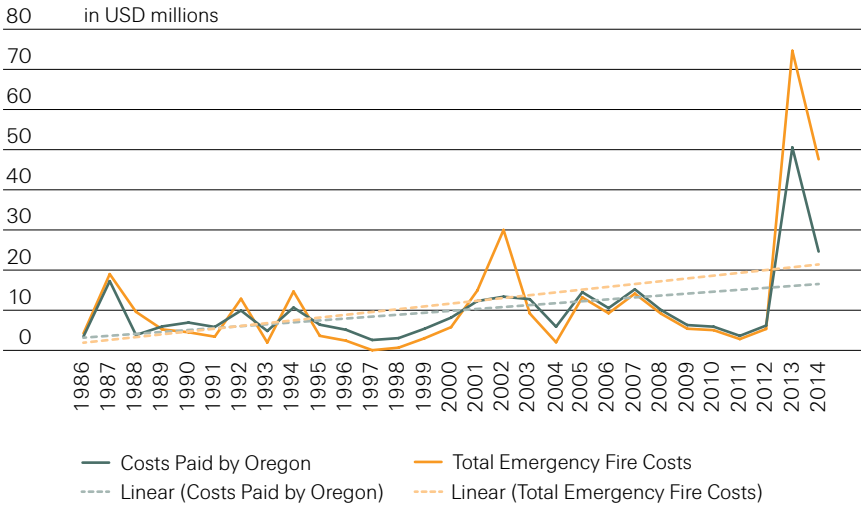
As increasing wildfire risk has become a regional norm, California and Oregon have taken two unique approaches for financing wildfire management. California has the highest loss exposure in the United States. Even with increasing levels of wildfire exposure from extreme drought, the state's large economic capacity and political landscape allow it to fund higher suppression costs through its emergency fund. In contrast, wildfires in Oregon are significantly smaller in terms of acreage and economic cost. However, the state's limited financial resources have resulted in a more diversified funding strategy that leverages private landowner participation and contributions along with a state private insurance policy to fill the financing gap.

A. Oregon: Insurance policy to reduce suppression cost volatility

While federal and state government agencies have jurisdiction over the majority of Oregon's forestlands, one-third of forestland is owned by forest industry groups and private homeowners. This pattern of forest ownership produced strong collaboration between the government, the forest industry, and homeowners in forest management and coordination around wildfire suppression and costs. This collaboration has led to the creation of the Oregon Forest Land Protection Fund (OFLPF) and a diversified wildfire management strategy. Most notably, Oregon is the only state in the U.S. to have an insurance policy for fire suppression costs.

From 1973–2012, Oregon paid USD 54 374 201 in premiums and received USD 52 023 924 in insurance payouts, meaning that the state sustained a break-even policy.[21] The policy was effective as a "cost-smoothing" measure, allowing Oregon to avoid large financial shocks from emergency fire events, and instead distribute costs more evenly through regular premium payments. By reducing budget volatility from emergency expenditures, legislatures are better able to plan for and fund other government priorities.

Figure 4
Oregon insurance and cost smoothing



Source: Oregon Department of Forestry (ODF) Budget Figures (1986–2014)

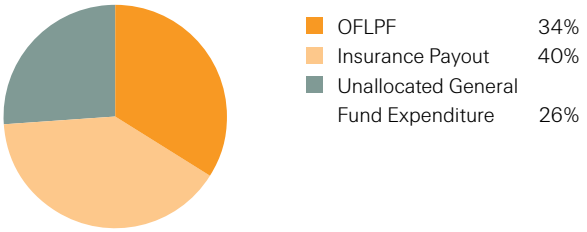
Oregon experienced devastating fire seasons in both 2013 and 2014, and maxed out its insurance policy two years in a row. The insurance policy for the 2014 fire season had a premium of USD 2 million with a payout of up to USD 25 million — available once Oregon spent over USD 20 million for emergency fire costs. The initial USD 20 million "deductible" was split between Oregon's general fund and private landowner contributions to the OFLPF. Forest landowners pay per-acre assessments for wildfire protection on private lands at a rate that varies depending on the region of the state and type of land to capture higher risks and fire protection costs. Combined with additional timber and grazing per acres fees, landowner contributions are capped at USD 15 million, with the general public responsible for large fires in excess of the OFLPF fund cap.[22]

ODF at a crossroads

While the use of private insurance has been an innovative step in managing wildfire costs, back-to-back high cost fire seasons in 2013 and 2014 have started discussions concerning the sustainability of Oregon's current funding strategy.

After the deductible and insurance payout in 2014, ODF was still accountable for USD 32 million in suppression expenditures. Oregon applied for FEMA funding, and anticipates receiving around USD 60 million in reimbursements; however, to date they have not received those funds and the timeline is uncertain. In the interim, ODF used a line of credit from the state treasury to fill the gap, though funds must be repaid within one year and with 2 percent interest. Expenditures in excess of the insurance payout are carried over in the state budget to the following fiscal year, and reduce general funds available for other government programs. In order to renew its insurance policy for the 2015 fire season, Oregon agreed to a USD 3.75 million premium and USD 50 million deductible for the same level of coverage.[23]

Figure 5
2013 and 2014 fire seasons
USD 125 169 470 in emergency fire costs



Source: Oregon Department of Forestry (ODF)

Adapting to the new normal?

Decision makers are divided over whether Oregon is experiencing cyclical fire patterns or contending with a changed fire landscape — a "new normal" driven by climate change. This difference of opinions has led to a "wait and see" attitude around altering Oregon's financing strategy for catastrophic fires. There is, however, acknowledgement of increasing costs brought on by WUI development and persistent drought conditions.

Given Oregon's broad-base of funding for wildfire costs, use of private insurance markets, and rising public awareness and urgency around this issue, Oregon is now in the position to further innovate in its approach to funding for wildfires. With sharp increases in fire suppression and insurance costs, ODF officials are increasingly aware that their current strategy for large fires may not be financially sustainable and have expressed interest in exploring new risk transfer solutions.

B. California: Unidentified risk and uncapped suppression funds

In contrast to other states, California has the advantage of being able to match its large risk exposure with unparalleled financial resources to fund wildfire suppression. Nevertheless, the state's financial capacity will be increasingly tested as environmental conditions and housing development continue to exacerbate risk. Rising temperatures and prolonged drought have ensured that rather than a fire season, California experiences wildfires year round. Currently an estimated 14.5 percent of California's homes exist in high or extreme risk regions, a figure that will only grow with unmitigated development.[24]

California's risk identification challenge

Responsibility for wildfire suppression is distributed evenly between state and federal agencies. Federal land makes up 47.7 percent of California – most of which is managed by the USFS.[25] The remaining wildlands are typically categorized as "State Responsibility Areas" (SRAs) and are under the jurisdiction of CAL FIRE. Because wildfires can occur across different jurisdictions in California, comprehensive wildfire risk and cost management is difficult to coordinate.

Differences in fire management strategies for CAL FIRE and USFS mirror how each agency perceives and responds to wildfire risk. CAL FIRE prides itself in its "initial attack" strategy and puts protecting homes and private property at the forefront of its mission. As a result, CAL FIRE typically tends to allocate more resources, both financial and physical, towards fire suppression and the protection of private property. The USFS is more focused on land management, resulting in a less aggressive suppression strategy with regards to protecting private assets.

Nevertheless, CAL FIRE and the Forest Service have a strong collaborative relationship, most visible in their successful management of a mutual-aid system where the closest resource responds first. Given that cost and resource sharing already exists between the two agencies, the next logical step is to improve comprehensive risk identification.

CAL FIRE's uncapped suppression funds

As the country's largest state firefighting agency, CAL FIRE is perceived as having a "blank check" for fire suppression. CAL FIRE is mandated to protect the 31 million acres of SRAs in California, but has taken on additional firefighting responsibilities in forestland areas where local and federal contracts are in place with the state. Large fire suppression is supported through CAL FIRE's base budget and access to a state-allocated wildfire emergency fund. This "E-fund" is a specific amount of the state's General Fund earmarked for CAL FIRE only to cover potential large wildfire costs above the agency's normal budget. The amount is determined each year based on a 5-year rolling average of past E-fund expenditures, with any unused money reverting to the General Fund. E-funds are released as soon as a fire burns for over 24 hours. In the last decade, use of the allocated E-funds averaged USD 270 million annually, with maximum expenditures exceeding half a billion dollars.[26] For the 2014–2015 season, CAL FIRE was earmarked USD 209 million for wildfire suppression out of this E-fund, which it exhausted in the first three months of the fiscal year, resulting in CAL FIRE receiving an additional USD 70 million in E-funds.[27]

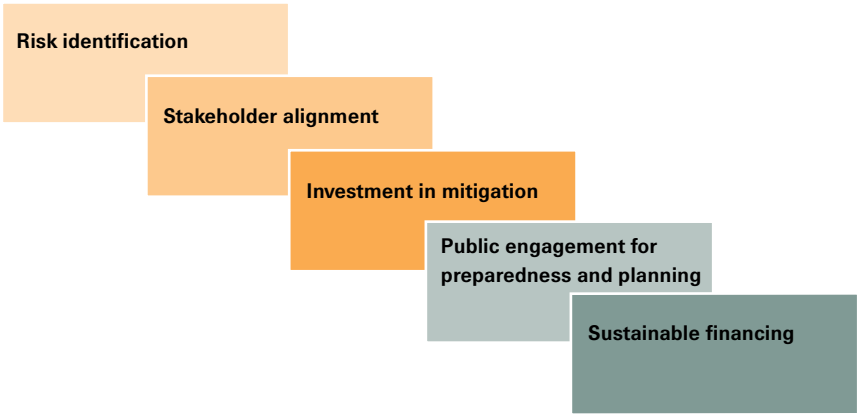
Buy in? California's controversial SRA fee

Because CAL FIRE effectively has an unlimited budget for suppression, state taxpayers are mentally disconnected from the risk they carry from the rising costs of wildfires, and the vast amount of dollars they are pouring into the E-fund. However, in an effort to transfer some of the risk ownership away from the state, California passed a controversial SRA Fee. This act levies USD 152.33 on all homes in the SRA, which corresponds to most of California's WUI zone.[28] The revenues are designated to support various wildfire prevention measures, and the USD 75 million collected annually is used for hazardous fuel reductions, defensible space inspections, fire prevention engineering, emergency evacuation planning, fire prevention education, fire hazard severity mapping, as well as implementation of the state and local fire plans. Though this fee is used to increase resilience of communities most at risk, the fee is still being fought by many residents—further indicating the lack of stakeholder alignment in California.[29] This pushback highlights the need to more effectively educate and communicate with homeowners about their personal exposure to wildfire risks.

V. What does it mean to be resilient in the context of wildfire?

While the high cost of suppression is often the top concern for fire management departments, legislators, and other decision-makers, building resilience to wildfire is more than simply funding suppression and covering property losses. The key building blocks of resilience include sustainable financing for suppression and mitigation as well as proper risk identification, stakeholder alignment, and public engagement.

Building blocks of resilience



A. Risk identification

Wildfire activity is effected by several factors – temperature, atmospheric conditions, drought, forest conditions, and triggering events – creating complexity in predicting wildfire activity. What is clear is that the western wildfire season has grown from five months on average in the 1970s to seven months today, in some places extending to a year-round season.[30] However, there is debate among various decision-makers as to whether catastrophic fire seasons seen in recent years are part of cyclical wildfire patterns or indicative of a "new normal" brought on by climate change. This can lead to a "wait and see" attitude regarding planning for future wildfire costs, further exacerbating fuel build-up and high risk areas.

Limited metrics for the full exposure to risk created by development in the WUI reflects a key gap in risk identification. Property owners do not pay nearly the full cost of fire protection and, in some states, have mandated access to insurance, creating a moral hazard.

B. Stakeholder alignment

The broad array of key stakeholders, including legislators, local, state and federal agencies, utility providers, and forest industry groups are currently united around the importance of sustaining suppression resources to manage increased wildfires. However, different attitudes concerning who should bear the most responsibility have stalled action on wildfire mitigation. Legislators face tremendous political pressure from their constituents to support large fire agency budgets, given the dilemma that little political capital is earned from funding mitigation projects. This subsequently sends the signal to fire agencies that budgetary requests for large suppression funding are more feasible than mitigation funding. Industry groups operating in wildland areas are generally the most pro-active about managing their individual risk. However, more activity is needed to sustain active collaboration across groups to enhance and share best practices in risk management. For example, the Lifelines Council in San Francisco was created in 2009 to bring together risk management operators, including SFPUC, AT&T, PG&E, and the SF Municipal Fire Department to streamline city emergency planning and to identify areas of risk interdependency.[31] This type of multi-stakeholder collaboration could potentially be scaled to create an integrated risk management strategy through a regional platform like the Western Governors' Association.

C. Investment in mitigation

Mitigation is at the core of reducing wildfire risk but it is too often underfunded by state governments and vulnerable to budget reductions at the federal level. While discussions of suppression planning and costs are essential to understanding the risk that wildfire poses to state and local budgets, mitigation planning and financing is key to risk reduction. States have underinvested in wildfire mitigation, and the volume and costs of catching up often seem staggering and insurmountable. The system in place has taxpayers and decision makers alike relying on emergency interventions rather than on systemic policy reforms. When a crisis is at hand, funds are always made available to put out critical fires and protect homes. Meanwhile, the costs of these catastrophic wildfires erode resources and focus from prevention and mitigation programs, which only exacerbates the problem.

Mitigation activities cover a range of actions including forest management, land use zoning, community education, and institutional structures. Forest management can include actions such as hazardous fuels reduction including thinning of vegetation, building of fire breaks, and creation of defensible spaces around infrastructure or homes. As a key driver for high suppression costs is development in the WUI, smarter land use zoning at the local and state level can also be seen as an essential mitigation activity. Federal support for state and local mitigation projects is available through FEMA's Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation grants (PDMs) but experiences across various states suggest that many states are unable to take advantage of available funds due to a lack of information to prepare eligible and successful mitigation projects.[32]

D. Public engagement for preparedness and planning

Any long-term strategies around wildfire resilience cannot be realized without effective public engagement and increased communication. Implementing more holistic long-term funding strategies requires public support and building such support requires greater education about the rising costs and risk of wildfire and the broad impacts of increased wildfire severity. One critical goal is affecting individual and household-level behavior and building awareness of personal risk among residents of fire-prone states. To this aim, broader education can increase understanding of the link between wildfire and urban area issues like air quality, watershed management, and service reliability.

VI. Fire knows no boundaries: International comparisons

The western United States experiences the most extreme wildfire activity in the country. However, the region is not alone in facing the challenge of increasing intensity and cost of wildfires. In particular, Canada and Australia are at risk of similar wildfire impacts and, despite differing institutional structures, fire environments and patterns of land ownership, both cases may provide useful lessons for the United States.

A. Canada

Fire suppression costs in Canada have ranged from USD 500 million to USD 1 billion annually over the past decade, with over 6 million acres burning each year. Of this, 3 percent of wildfires account for 97 percent of burned area. Natural Resources Canada predicts the area burned annually will double by the end of the century, leading to significant strain on existing budgets.[33] For example, Ontario estimated that in order to maintain current levels of fire response success, the province will need to increase fire suppression resources two-fold. In 2005, in an effort to address rising wildfire costs, highlighted by the severe 2003 fire season in western Canada that amassed over CAD 1 billion in suppression costs and incurred hundreds of millions of dollars in personal property damage, the Canadian Council of Forest Ministers introduced a national wildfire strategy to integrate federal and state fire management. Nonetheless, provincial premiers remain concerned that firefighting strategies across federal and state jurisdictions are too disjointed, restricting available resources, and thus contributing to larger wildfire costs.[34]

While most provincial fire management agencies fund suppression from general revenues, several unique financing strategies have been tested throughout Canada. Only one province has used insurance to manage fire suppression costs. In 2003, Alberta purchased a policy with a CAD 12.5 million deductible for up to CAD 50 million in coverage. The policy coincided with one of the worst fire seasons in years, leading to a full payout of CAD 50 million. Ultimately, Alberta chose not to renew the policy when faced with cost-prohibitive increases in premiums.[35] None of the provinces currently use private insurance to manage suppression costs, citing affordability barriers, but there has been a demonstrated interest in risk transfer mechanisms.

Canadian provinces have also pursued cost-sharing strategies to engage multiple stakeholders and diversify funding for suppression costs. In Quebec, the forest industry and the provincial government have partnered in bearing the cost of fire management in the province's southern regions. In 2004, British Columbia initiated a cost-sharing program where 'clients' such as forest industry, private landowners, utilities, railways and the federal government contributed almost a quarter of the province's fire suppression budget. The emerging range of cost management strategies both illustrates ways to incorporate a diverse range of fee payers for state funds and highlights the role that regional solutions could play in managing a shared challenge.[36]

The United States and Canada have also established collaborative relationships to exchange firefighting resources across their shared border. The Reciprocal Forest Fire Fighting Arrangement (CANUS) allows for movement and direct sharing of firefighting resources. In addition, several states and provinces have formed mutual aid association, including the Great Lakes Forest Fire Compact and the Northwest Wildland Fire Compact.[37]

B. Australia

In an average year, insurable losses from wildfire damage run approximately AUD 80–100 million, with most property losses incurred in southern and western Australia during the September to March fire season.[38] However, severe fire seasons in 2002–3, 2006–7, 2009, and 2013 have caused notably higher suppression costs and major asset losses. More strikingly, Australia has also seen greater harm to life than the United States or Canada. For one, Australia has maintained its bushfire policy which puts responsibility on homeowners to either 'leave early' or 'stay and defend' their property. The intent of the policy was to avoid late evacuations and the attendant risk to life. However, the 2009 Black Saturday fires in Victoria, which took over a month to contain, left more than 170 people dead and resulted in insured losses exceeding AUD 1 billion. This event has prompted rethinking of evacuation policy and how to manage increased impacts of large wildfires.[39]

There are significant differences in fire management funding strategies between the United States and Australia. One notable distinction is Australia's historical reliance on levies on the insurance industry as a major source of funding for firefighting. In the state of New South Wales (NSW), insurers still contribute approximately 75 percent of the funding for the NSW fire brigade and the Rural Fire Service.[40] By contrast, in 2013, the state of Victoria removed these levies from insurance premiums and now collects property value-based fees, following recommendations of the Victorian Bushfires Royal Commission, which was assigned to suggest improvements to fire management in the wake of the 2009 Black Saturday bushfires.[41] Both methods of funding provide a more diverse fee payer base in comparison to relying solely on government funding. Property-value based fees, however, have likely reduced underinsurance rates and more equitably spread costs based on risk exposure. Further, the Insurance Council of Australia, which represents private insurers and reinsurers, works with local, state, and territorial governments through the Insurance Disaster Response Organization to coordinate response in the event of natural disasters. The incorporation of property-value based fees to create a diversity of funding for wildfire suppression costs and engagement with the insurance sector are aspects of Australia's wildfire strategy that can be adapted for American conditions.

VII. Building resilience

Building suppression capacity cannot be substituted for creating a sustainable resilience strategy. Despite growing acknowledgement of the urgency of dealing with wildfire costs, there is uncertainty in the minds of decision makers around the future of wildfire that prevents a holistic climate resilience strategy. Risk instead needs to be acknowledged and managed, which requires a full incorporation of the following strategies.

A. Risk identification

On a macro-level, governments should improve risk identification to overcome the uncertainty around the full cost of wildfire, which is often obscured by overlapping fire suppression efforts between federal, state and local authorities and does not adequately value indirect damages like impacts on ecosystems and air pollution. Risk metrics that provide a clear picture of combined federal and state outlays for fire suppression and creation of metrics for indirect damages are key to complete risk identification. Though there have been some attempts to quantify indirect costs, most of these efforts have focused on specific fire events at a local level. Further study of the methods to quantify indirect costs, and more complete databases of federal and state outlays, would allow for a clearer analysis of total exposure to risk.

On a micro-level, households and property owners need to be given better and more actionable information about the risk to their property from wildfire. While many jurisdictions produce maps of high fire danger areas, these maps must be translated into understandable risk for property owners. A model for this type of engagement is the Colorado Wildfire Risk Assessment Portal, which allows property owners to search by their address to see their specific risk from wildfire. Users are then led directly to risk reduction resources appropriate to the level of wildfire risk identified.[42] This interactive tool is a strong model that more states should use as a building block for managing risk to development that has already occurred in the WUI.

B. Risk reduction

Risk reduction strategies include identifying sustainable streams for mitigation funding, targeted education campaigns, and zoning restrictions on building in the WUI.

Sustainable funding for mitigation
At the federal level, 'fire borrowing' from mitigation funds undermines the ability of the Forest Service to carry out regular mitigation activity over the full range of areas in need of hazardous fuel reduction and other mitigation activities. Legislation currently under consideration by Congress would transfer the cost of fighting some of the most severe wildfires from the USFS budget to federal emergency funds, allowing mitigation and other Forest Service priorities to access their full budget allocation.

State, county, and local governments are implementing a wide range of approaches to achieve their wildfire risk management objectives with over 184 mitigation programs running in 27 states. In the context of shrinking state budgets, most states lack a separate revenue stream for mitigation programs. Current state policies, like the SRA fee in California, can provide a starting point for raising mitigation funds. However, the next generation of similar fees should be designed based on a more dynamic risk assessment for designated areas.

WUI development and zoning
Several states have building codes aimed at ensuring new homes in high fire hazard areas are built using less flammable materials and encourage the creation of defensible space around homes. However, many state and local zoning policies still continue to permit development near forested areas, raising overall exposure to wildfire risk. Reducing the risk from WUI development requires zoning laws to strictly limit building in the WUI or mandate that homeowners in new WUI developments carry insurance policies that reflect their actual risks from wildfire.

C. Risk acceptance

Accepting risk includes acknowledging a potentially higher baseline of costs to be absorbed in the long-term and taking concrete steps such as creating state funds or 'self-insurance' schemes with diverse fee payer bases to cover these costs. Covering an accepted base level of wildfire costs is key to accepting risk and benefits from a variety of inputs – general fund budget, landowner fees, and private industry contributions.

D. Risk transfer

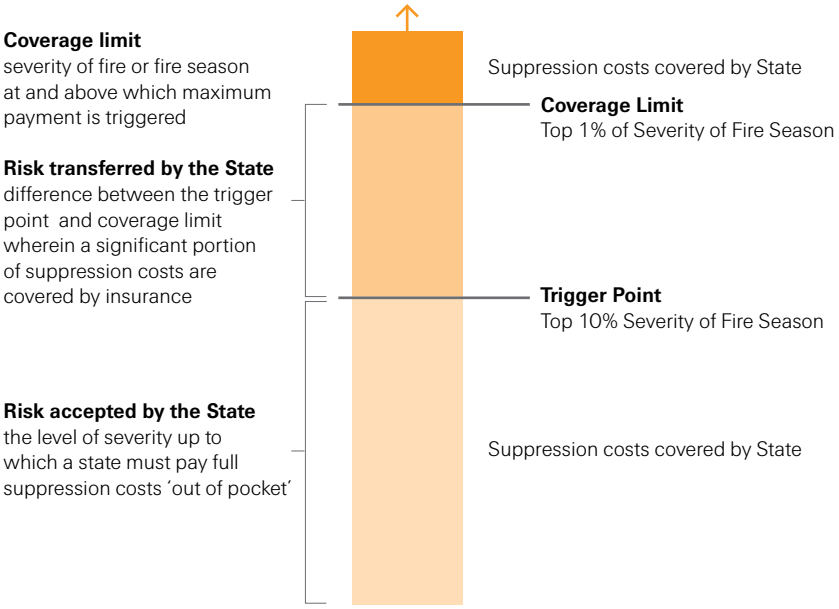
Transferring risk to private markets can support fiscal planning and reduce risk to states struggling with the management of volatile wildfire costs. At a household level, state governments can enact legislation to support smarter markets for individual property and landowner asset insurance policies. On a larger scale, states could use risk transfer instruments, like parametric-based insurance policies and bundled catastrophe bonds for wildfire and flood-related events, to minimize emergency outflows and reduce disruptions to government budgets. Finally, additional existing regional policy institutions could be leveraged to establish a multi-state wildfire risk pooling facility.

Increasing property insurance coverage
Homeowners in the western United States are often under or uninsured for wildfire loss. Wildfire insurance is rarely mandated by states, though required by some mortgage terms, and because property owners do not bear the costs of suppression there is often insufficient incentive to adequately insure. Greater coverage of homeowner insurance can both reduce financial exposure to damages and provide incentives to property owners to pursue mitigation and fire preparedness.

Parametric insurance
Parametric insurance instruments use either event parameters or catastrophe models to immediately calculate the payout of an insurance policy instead of on-the-ground after-the-fact assessments of costs and damages. These instruments aim to closely mirror actual damages, but allow for a more rapid payment when a catastrophic event occurs. Index-based triggers for parametric policies are designed to be objective measures that reflect the severity of an incident. In the context of wildfire, a parametric policy could be triggered by a combination of acres burned, wind speed, number of days without precipitation, humidity and temperature levels, and lightning activity. These measures would be overlaid with zones of cost exposure from WUI development or existence of critical infrastructure. Use of parametric policy would allow states to in effect 'pre-fund' part of their most severe wildfire suppression costs and receive inflows of cash more quickly than under traditional policies.

As a simplified example, a parametric insurance policy for suppression costs replaces estimated losses for the number of acres burned during a fire season to determine insurance payouts. Because states/provinces currently budget fire suppression annually, it is reasonable to structure a wildfire parametric product based on total acres burned per fire season. The policy would then issue payouts in the event of an extreme fire season where the number of acres burned exceeds the threshold of 90th percentile acres burned in the last ten years. Based on this parametric design, Oregon would have received payments for the three most extreme fire seasons in the last 15 years – 2002, 2007 and 2013. Payouts from such policies would provide states with quick and significant suppression cost coverage in the most extreme fire years. Use of such policies could provide additional benefits over traditional insurance instruments as the payout is triggered quickly, meaning that a small state like Oregon would not have to depend on borrowing funds from the Treasury to cover gaps. This policy could be tailored to include rebates after claims-free years that could be earmarked for increased wildfire mitigation activities, and pooling risk with other states could reduce premiums on the policy.

Parametric wildfire policy financial coverage[43]



Risk pooling – The Western Wildfire Insurance Facility

Risk pooling is a mechanism to bring together multiple entities facing a similar risk and create an insurance pool that can reduce transaction and administrative costs in order to provide coverage at a lower cost that participants can better afford. An example of this type of pooling to manage climate-related risk is the CCRIF SPC (formerly the Caribbean Catastrophe Risk Insurance Facility), which brings together Central American and Caribbean nations facing tropical storm and earthquake risk. The CCRIF aggregates the region's risk, allowing countries to pool their individual risk into a larger, more diversified portfolio, and has resulted in an estimated 40 percent reduction in premium costs.[44] The facility has successfully provided coverage and liquidity to Caribbean nations hit by intense tropical storms or quakes and struggling to cope with the costs and impacts of storm damage. For example, in 2008, CCRIF paid out approximately USD 6.3 million to Turks & Caicos Islands after a direct hit by Hurricane Ike and, more recently, Haiti received a payout of USD 7.75 million, approximately 20 times their premium, following the devastating 2010 earthquake.[45] In 2014, the CCRIF SPC expanded to offer protection against torrential rainfall events (Excess Rainfall); eight countries participated in the pilot, with three (Anguilla, Barbados and St. Kitts and Nevis) receiving a payout during the first year.[46]

In the context of wildfire, western states could pool together, potentially with Canadian provinces, to create a Western Wildfire Insurance Facility. Several states and provinces, including Oregon, Washington, and the Canadian province of Alberta and British Columbia, have explored or expressed some level of interest in private insurance products. Creation of a risk pool would allow states to better access insurance policies that can smooth peak suppression costs from the most expensive catastrophic wildfires. A key to successful risk pooling is creating and maintaining trust between pool participants and confidence that participants are paying fair premiums. Western states and Canadian provinces are well positioned in this respect as they have a long history of wildfire resource sharing from which to build. Existing multi-state coordinating bodies, such as the Pacific Coast Collaborative or the Western Governors Association, could be leveraged as venues for discussion and coordination of risk pooling, while the role of pool administrator could be an independent third party to ensure fair policy terms. This pool administration role could be played by an independent facility created under the auspices of the Pacific Coast Collaborative or by the creation of a stand-alone facility. Further, organizations such as the National Association of State Foresters, which brings together U.S. State Foresters to discuss policy issues around forest health and wildfire, could serve as a venue for building consensus around forest management practices necessary to participate in a risk pool.

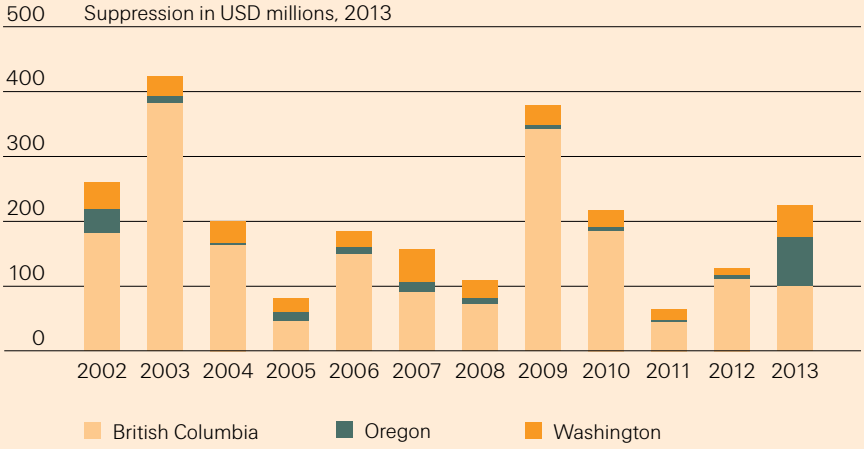
VIII. Financing the future

At the moment, most states lack a sustainable financial strategy to respond to the changing climate landscape. Although individual decision-makers largely agree that the "rear-view mentality" regarding wildfire costs is no longer acceptable, the urgency of immediate fire suppression needs limit the resources and capacity available for long-term planning. A sustainable wildfire management strategy would anticipate growing suppression costs and ensure that financial instruments were in place to protect public budgets from disaster-induced shocks. By reducing volatility in annual budgets, governments can better allocate funding for long-term mitigation, land-use planning, and community preparedness. As part of this holistic approach, governments can engage private markets to develop necessary financial instruments, including parametric transfer solutions, to support better risk management. Governments should leverage current public awareness around wildfire and related climate conditions to build support for these policies. Although financing natural disasters through private insurance markets remains a frontier arena, western states have demonstrated leadership in proactively addressing climate change and now have the opportunity to redefine wildfire resiliency.

IX. Designing a risk pool for Oregon, Washington and British Columbia

A risk pool between states in the Pacific Northwest and British Columbia would be a natural extension of administrative "connective tissue" between wildfire managers across state borders. Moreover, all three entities have expressed some level of interest in weather-derivative instruments, private insurance, and/or a regional risk pool. Despite the geographical similarities between the states, there are significant asymmetries between their respective levels of exposure to large suppression costs. British Columbia bears the greatest amount of risk, more than triple the suppression costs accrued in Oregon and Washington combined. The aggregate suppression cost exposure for the region varies year to year, with the most severe wildfire seasons occurring approximately every four years, reaching as high as USD 423 million in 2003, and averaging over USD 202 million for the past ten years. By combining their respective exposures, the risk pooling facility could achieve a scale that is more attractive to private market participants, manage risk at a lower cost, and institutionalize risk management on a regional scale. Forming a risk pool composed of additional states or provinces in different areas of the West, with varied risk factors – climatic condition, wildland health, and human activity – could also further improve the diversity of the pool.

Aggregate exposure 2002–2013



Illustrations based on data from:

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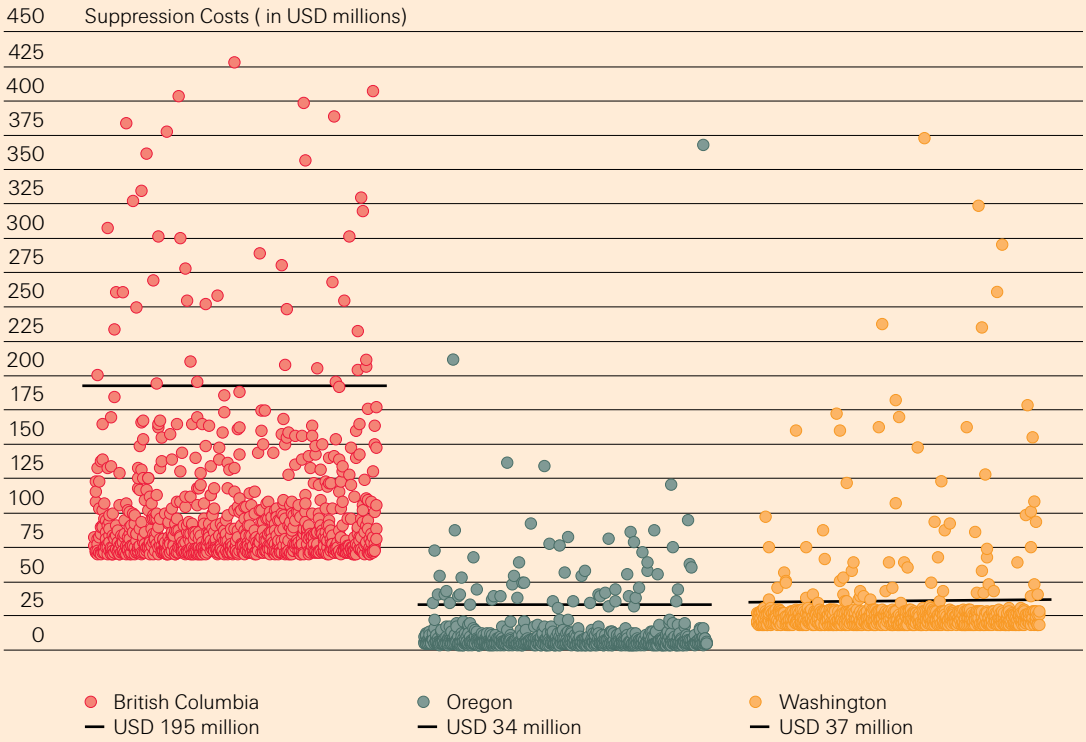
The model simulated 1000 fire season scenarios to determine the loss-payout threshold for risk pool participants, using a parametric trigger of '90th percentile of acres burned.' In terms of suppression cost severity, the policy is designed to cover the 1-in-14-year fire season (7–8% probability of payout). Using loglinear cost curve assumptions for acres burned, the model estimates payout thresholds of USD 195 million for British Columbia, USD 34 million for Oregon, and USD 37 million for Washington.

Loss-payout thresholds for British Columbia, Oregon, Washington risk pool



Premiums and payouts

The modeled insurance premiums for each participating state are calculated assuming 100% ceded to the program. However, the percentage ceded could be negotiated individually by states depending on their premium budget. Given the regional scope of the model, where parametric insurance coverage would also complement traditional indemnity insurance policies, a coverage limit of 100% is presumed to be more reasonable. The corresponding average claim size reflects total 'end of fire season' payments. However, different states may prefer payouts for large individual wildfires, which requires determining trigger points for individual fires (not modeled). Others might prefer a "stop-loss cover", meaning that once the accumulated threshold trigger is reached, a payout is initiated and continues to be made until exhausted.

Participant	British Columbia	Oregon	Washington
Probability of payout in given fire season	7%	5%	8%
Trigger point (Acres burned)	486 031	52 712	109 720
Trigger Point (USD million)	194.90	33.89	36.67
Premium (USD million)	19.49	2.54	6.64
Average Claim Size (USD million) (if policy is triggered)	109.79	21.13	36.09

* The risk premium calculation is based on the assumption that the insurer is seeking a banded profit margin set at 10-40-60 relative to insurance payment outflows.

** The resulting premium and expected annual payout is based off of estimated costs fitted to a lognormal distribution re-calculated 1000 times.

Appendix

Appendix A

2002–2013 individual and cumulative wildfire suppression costs and acreage loss estimates for British Columbia, Oregon, and Washington.

British Columbia

Year	Suppression (CAD millions)	Suppression (2013 USD millions)	Acres Burned
2002	170.40	170.16	348 645
2003	371.20	358.70	654 959
2004	164.50	153.91	544911
2005	47.20	42.79	85 469
2006	159.00	140.34	344 131
2007	98.80	84.47	72 748
2008	82.10	67.56	32 717
2009	382.10	321.33	611 385
2010	212.10	173.77	833 112
2011	53.4	42.32	31 145
2012	133.6	104.30	275 880
2013	122.2	94.09	45 119

Oregon

Year	Suppression (USD millions)	Suppression (2013 USD millions)	Acres Burned
2002	30.00	37.66	99 168
2003	9.18	11.30	8 619
2004	2.02	2.42	5 941
2005	13.20	15.31	11 609
2006	9.24	10.40	11 270
2007	14.13	15.49	54 733
2008	9.13	9.82	7 487
2009	5.39	5.75	7 034
2010	5.04	5.31	6 121
2011	2.81	2.90	2 637
2012	5.33	5.41	17 547
2013	74.63	74.63	104 167

Washington

Year	Suppression (USD millions)	Suppression (2013 USD millions)	Acres Burned
2002	33.15	41.61	9 628
2003	24.97	30.73	11 743
2004	28.93	34.65	10 723
2005	17.99	20.87	6 690
2006	21.98	24.74	60 560
2007	47.49	52.07	114 317
2008	24.73	26.59	26 176
2009	30.08	32.11	32 057
2010	25.81	27.22	13 151
2011	16.30	16.84	25 430
2012	11.84	12.02	68 347
2013	50.53	50.53	126 219

Cumulative loss

Year		Suppression (2013 USD millions)	
2002		249.42	–
2003	–	400.73	–
2004	–	190.98	–
2005	–	78.97	–
2006	–	175.49	–
2007	–	152.03	–
2008	–	103.97	–
2009	–	359.19	–
2010	–	206.30	–
2011	–	62.06	–
2012	–	121.72	–
2013	–	219.25	–

Appendix B

Estimation of acres burned (X), lognormal distribution

British Columbia	μ = 10.9759
	σ = 1.5068
	p(If X = 486031) = .9
Oregon	μ = 9.2851
	σ = 1.0670
	p(If X = 52711.5) = .9
Washington	μ = 10.1953
	σ = 1.0037
	p(If X = 10972 0) = .9

Appendix C

Cost Approximation based on acres burned

British Columbia	y = 73.733e2E-06x
Oregon	IF(x < 52711.5) y = 4.5684e3E-05x
	IF(x ≥ 52711.5) y = .00087339x – 16.349374
Washington	$y = 5E\text{-}09x^2 - 0.0005x + 31.34$

Appendix D

Probability of Trigger Insurance Payout

None = Y < Trigger Limit

Excess = Y Trigger Limit and < Coverage Limit

Max = Y > Coverage Limit

British Columbia	Insurance Payout Outcomes		
	None	Excess	Max
Probability	91.8000%	4.1000%	4.1%
Profit margin	10%	40%	60%

Oregon	Insurance Payout Outcomes		
	None	Excess	Max
Probability	95.8000%	3.1000%	1.1%
Profit margin	10%	40%	60%

Washington	Insurance Payout Outcomes		
	None	Excess	Max
Probability	93.0000%	4.0000%	3.0%
Profit margin	10%	40%	60%

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Authors
Dong-Thu Caohuu
Gauri Gadgil
Yasmine Jamnejad
Victoria McBride
Johns Hopkins School of Advanced International Studies (SAIS)

Faculty Advisor
Celeste Connors

Swiss Re Advisor
Alex Kaplan

Prepared by:
The Johns Hopkins University, School of Advanced International Studies

Graphic design and production
Swiss Re Corporate Real Estate & Logistics/
Media Production, Zürich
Photographs: Getty images

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Swiss Reinsurance Company Ltd
Mythenquai 50/60
P.O. Box
8022 Zurich
Switzerland

Telephone +41 43 285 2121
Fax +41 43 285 2999
www.swissre.com

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