Wildfire risk: a complex problem with a multifaceted solution

Executive summary

There's an increasingly urgent need for communities, governments and financial institutions – particularly insurers - to address wildfire risks. The LA wildfires are one of the most expensive catastrophe losses ever recorded. Meanwhile, Europe and other regions have grappled with unprecedented wildfires burning millions of acres, emitting hundreds of megatons of carbon, and exposing significant sums of value at risk.

The challenge of reducing wildfire risk is often multifaceted. On the one hand, as the planet continues to warm, the environmental conditions necessary for wildfires to ignite and promulgate will become more prevalent. On the other, it's important to understand that approximately 75% of wildfires globally can be traced to human activity, underscoring the key role people play in this issue.

While there's a clear need for greater investment in resiliency (as this PwC publication notes), the nuances and challenges associated with wildfire risk merit dedicated focus and unique interventions. Understanding the complicated nature of the problem can inform integrated strategies including localized mitigation to reduce risk, innovative insurance that prices and rewards risk reduction, and technology that helps detect, forecast and coordinate response.

This paper summarizes the wildfire challenge and offers solutions set for many insurers. It first explores the breadth of the issue, including historical impacts, the risks posed by compounding hazards, and why wildfire risk is hard to model and insure—including WUI exposure growth, human-driven ignition, and modeling constraints. It then outlines an integrated solution that helps connect on-the-ground mitigation and adaptation, tech-enabled monitoring, and insurance innovation.

The call to action for insurers:

- Take steps to move from wildfire risk transfer to wildfire risk mitigation
- Broaden insurance solutions with innovative products and forward-looking risk metrics
- Leverage new technologies and data at the property, parcel, and community level to develop more precise underwriting
- Collaborate across sectors (e.g., banks, governments, real estate investors) to develop innovative risk mitigation approaches and financing solutions

What has happened: historical impacts

The integrated problem of wildfire risk

Wildfires have a variety of damaging effects, including environmental destruction, increases in human respiratory illnesses and substantial economic losses. Globally, from 2001 to 2024, wildfires have burned more than twice as much tree cover each year as they did in the twenty years prior (MacCarthy et al., 2025). Financially, a 2023 congressional report estimates that wildfires have an annual economic cost between $394 to $893 billion in the United States alone, highlighting the significant value at risk from this peril (Joint Economic Committee). This estimate encompasses diminished real estate value, exposure to wildfire smoke, income loss, watershed costs, insurance payouts, timber loss, uninsured property damage and electricity costs.

$394B–$893B estimated annual economic cost of wildfires in the U.S.
(2023 congressional report)

This problem is not isolated to the United States; Brazil, Bolivia, Russia, and Canada recently experienced nearly unprecedented wildfire events. Major fires have also recently occurred in both tropical and boreal forests for the first time in recorded history. Compounding the challenge is the fact that there is no one-size-fits-all solution for reducing wildfire risk because of numerous variables, including diversity of fuels, ignition sources, land-use patterns and suppression techniques. In addition, increasingly volatile climate conditions such as heat, drought, fuel dryness, wind and wet and dry cycles amplify wildfire risk, creating cascading impacts that stretch far beyond property damage.

Recent wildfire activity has included:

United States — The 2018 Camp Fire in Paradise, California burned over 150,000 acres, displaced 83% of the city's population, caused 85 fatalities, and resulted in roughly $12.5 billion in insured economic losses (Hanideh, et al., 2021). In January 2025, the Palisades and Eaton fires in Los Angeles County burned nearly 40,000 acres in total. Preliminary damage inspection and remote-sensing estimates indicated more than 12,000 structures were damaged or destroyed, with total economic losses estimated at $76-131 billion (multiple sources, 2025).

Europe — Greece's Evros wildfire in August 2023 burned about 230,000 acres, the largest single recorded fire in the EU since statistics began being kept (Xanthopoulos, et al., 2025). More broadly, the eight months ended August 2025 have seen wildfires burn 2.5 million acres in the EU, an eight-month record since 2006, reflecting both intense Mediterranean seasons and emerging northern hotspots (Pol, 2025).

Australia — The 2019-20 "Black Summer" wildfires burned nearly 47 million acres of land, caused billions of dollars in economic damages and produced smoke exposure linked to an estimated 429 excess deaths and 3,230 hospital admissions (Australian Bushfires, 2025; UNSW Media, 2020).

Canada — From January through August of 2025, wildfires burned 19 million acres, nearly double the 10-year average for the same period (National Wildland Fire Situation Report, 2025). In addition to severe property damage, thousands of evacuations, and deteriorating air quality, the fires released significant levels of carbon emissions into the atmosphere (NASA, 2024).

South America — In 2024, Brazil experienced exceptional fire activity amid severe drought, with an estimated 75 million acres burned (Zinn, 2025; Cassidy, 2024). Combined with long-term impacts of climate change and deforestation, fires like these in the Amazon have turned it from a carbon sink into a carbon source (NOAA Research News, 2021).

What could happen: increasing, emerging and compounding risks

Combined impacts of an increasingly volatile climate

Wildfire risk intensifies when high temperatures, drought, fuel dryness, and wind align. When the air is hot and very dry, it pulls water out of plants and dead brush, creating tinderbox conditions. Multi-year droughts compound the problem by further drying out vegetation and creating prime conditions for ignition and spread. Higher winds can raise flame length, carry embers, and make suppression difficult. These factors are captured in a metric called "Fire Weather Index," which can be used to estimate wildfire danger (Fire Danger Forecast, 2025).

Alternatively, wet winters or rainy years can spur explosive growth of grasses and brush. When heat and dry winds arrive, this new biomass cures into fast-burning "fine fuels" that carry flames quickly into shrubs and structures. This wet-then-dry sequence contributed to fires in Southern California in 2024 (Inside Climate News, 2024 South Wales during 2023-24 (New South Wales Government, 2024) and the 2021 Marshall fire in Colorado (NOAA, 2022 Marshall Fire).

Cascading and Compounding Hazards

The impact of wildfires persists even after they're extinguished. The resulting burn scar, made up of destroyed vegetation and charred soil, forms a water-repellent layer until regrowth occurs. Instead of soaking into the ground, rainfall runs off the surface, increasing the risk of significant flooding and debris flows. On a sloped surface, this runoff can reach dangerous speeds and put downstream properties and lives at risk. While flash floods and landslides can occur without a wildfire, less rainfall is needed to trigger a flood on a burned surface than on an unburned one (Flood After Fire, 2025).

The negative impacts of burned land extend beyond increased flood and landslide risk. A moderate wildfire can destroy nearly 60% of a soil's organic matter, leaving it vulnerable to wind and rain erosion. Ash deposits may alter the pH levels of soil to the point where vegetation can no longer grow. Additionally, ash can runoff into nearby waterways, potentially decreasing the water quality in impacted areas (Western Fire Chiefs Association, 2024).

Second order effects

The impacts of wildfires aren't always immediate and can take months or years to fully manifest. Human health can suffer from particulate matter (PM) from wildfire smoke. In fact, research shows smoke days can triple PM and meaningfully increase mortality, with an estimated 339,000 premature deaths per year worldwide attributable to wildfire smoke (Johnston, 2012). In extreme wildfire years, regional death tolls can spike. For example, the 2015 Equatorial Asia forest fires caused an estimated 100,300 excess premature deaths across Indonesia, Malaysia, and Singapore (Koplitz et al., 2016).

Rising wildfire risk from expanding Wildland-Urban development

Wildland-Urban Interface areas (WUI) are where housing or other developments border undeveloped natural areas, and they have expanded significantly across the world over the last 30 years. For example, in the US, housing in WUI areas grew from about 31 million to 44 million units between 1990 and 2020, now representing roughly 32% of all housing (Wildland-Urban Interface Growth in the US, 2025). In California alone, 1.2 million homes located in WUIs are at moderate or greater risk, representing over $760 billion in property value (International Code Council, n.d.). Globally, WUIs cover about 4.7% of land, yet house nearly half the world's population (US Geological Survey 2023).

When fires reach the WUI, they can be far more destructive. Homes, cars, and other manufactured materials burn alongside vegetation, producing hotter fires and more hazardous smoke. Research shows that WUI fires can release a more toxic mix of pollutants (including halogens, metals, and hazardous air pollutants) than fires that burn only trees and brush, raising health risks for nearby communities and responders (Chemical Insights, 2022). Additionally, buildings that burn in a wildfire release significantly more heat than forested material.

Human-driven ignition

Globally, human activities account for most wildfire ignitions, about 75%, though the share varies by region (Brown & Clements, 2019; Ayanz, 2012). These fires often result from downed power lines during wind events, debris burning, equipment sparks, campfires, or arson, extending the wildfire season well beyond natural lightning-caused fires. In fact, one study found that human activity-related fires made the season roughly three times longer (Balch, 2017).

Why this can be challenging

Modeling challenges

Wildfire modeling generally relies on a four-pronged approach: understanding the conditions and associated likelihood of a fire, the ignition source, how the fire may spread, and how it can be suppressed. However, challenges exist in each element. Climate factors, like drought and vapor pressure deficit, are now exceeding historical norms, making it challenging for modelers to rely on past data to assess risk in the future. Ignition sources are random, but many physical peril models are built to be deterministic, meaning they don't account for randomness. This can limit the usefulness of such models in predicting the locations of future wildfires.

Additionally, fires in WUI areas don't spread the same way they do in wild environments. Wind distributes embers and buildings ignite one another. Near-home details (e.g., roofs, vents, decks, and surrounding vegetation) and neighborhood layouts strongly influence outcomes — factors many regional models can only approximate (American Academy of Actuaries, 2022; Institute of Standards and Technology, 2025). Suppression efforts also vary from fire-to-fire and region-to-region, which matters greatly for modeling.

Urban conflagration - the term for fires that spread quickly through densely built communities - adds to the challenge. This phenomenon leads to the ignition of many structures at once due to embers and building-to-building spread and was one of the key contributors to the devastation observed in the 2025 Los Angeles wildfires. Modeling these urban conflagrations is a significant challenge because current models are generally developed to model fires in natural vegetative states, and don't fully account for how fire moves through a built environment. Factors like building materials, housing density, the presence of flammable debris, and how wind affects embers traveling between structures are crucial for predicting an urban conflagration's spread and intensity, but many of today's wildfire models do not have the necessary data to incorporate these elements.

Related, current wildfire models also struggle with granularity. Many current models related to wildfire and smoke spread have a spatial resolution of approximately 10 kilometers, which smooths over critical fine-scale variation in fuels, terrain and microclimates, and thus can be inadequate for predicting fire behavior at the scale needed for effective mitigation and response.
Compounding this problem is often a lack of consistent global resources and data to develop and train models. The US benefits from long-running, consistent fire-perimeter and severity mapping that helps calibrate and assess models. However, many other regions lack comparable open fire atlases, standardized damage inventories, and building datasets (United States Geographical Survey, 2018). The Global Wildfire Information System (GWIS), developed in 2023 to improve global coverage, has helped address some of these challenges, but major gaps and inconsistencies in hazard and loss data remain (Chen, et al., 2023).

Economic Market Fragility

Fragile economics drive (re)insurers to retreat from high-risk markets

After many recent years of elevated catastrophe losses, (re)insurers have tightened terms and, in some cases, paused new business in high-risk zones. Insured natural catastrophe losses have approached record highs in recent years, which has ultimately kept underwriting cautious. As a result, insurance has become less available and affordable in wildfire-prone areas, most notably California. Since 2019, more than 100,000 California policyholders have been dropped by the private insurance market. This has driven rapid growth in residual markets. For example, the California Fair Access to Insurance Requirements (FAIR) Plan, the state's "insurer of last resort," reached total exposure of $650 billion in June 2025 (California FAIR Plan), a 42% increase since September 2024 and a 289% increase since September 2021.

However, many regulators are responding. California's Sustainable Insurance Strategy now permits forward-looking wildfire models and reinsurance pass-throughs in rate filings, which regulators indicate promote widespread insurance availability through traditional channels (Sigma, 2025; Frank, 2025; Gallin, 2023). Prior to the rule change, insurers in California were limited to historical claims experience when setting premiums for a present year. Similarly, Colorado passed a law effective July 1, 2025, mandating that insurers incorporate wildfire mitigation into risk modeling and pricing for homeowner's insurance.

Impacts to property values and ecosystem

Recent analysis finds that since the late 2010's, proximity to high wildfire-hazard zones has begun to discount home values in California, a trend not previously observed (San Francisco Federal Reserve, 2024).

Similarly, as insurance becomes increasingly unavailable or unaffordable in high-risk areas, many participants in the housing ecosystem are impacted. Residential lenders face the prospect of increased delinquency risk, many investors face an uncertain risk-return calculus, developers may not be able to capitalize on high housing demand, and federal and local governments may be left footing the bill for damages to uninsured properties and infrastructure.

The integrated solution to wildfire risk

The complexity of predicting and mitigating wildfire risk requires solutions that go beyond one-off methods such as fire suppression or insurance coverage. No single measure can adequately address the accelerating pace of climate-driven hazards, human-driven ignitions, and expanding development in the WUI. Instead, reducing wildfire risk demands multi-pronged interventions that connect efforts on the ground, in financial markets, and through emerging technologies.

Interventions at both the parcel and community level, ranging from ember-resistant roofs to prescribed burns, can harden structures against damage, directly reducing wildfire hazards and improving resilience at the point of greatest exposure. Technology-enabled monitoring and responses such as advances in AI, remote sensing, and sensor networks are creating real-time visibility into ignition risks and fire behavior, enabling earlier detection, more targeted suppression, and better coordination of community response. Finally, long-term risk reduction requires insurance innovation. By embedding parcel-level data, community certifications, and parametric triggers into products, insurers can create new incentives for risk reduction while maintaining market stability.

When these levers are connected, wildfire risk management shifts from a fragmented, reactive posture to a proactive system that increases resilience, reduces losses, protects communities, and supports the long-term insurability of wildfire-prone regions. The sections that follow explore each lever in turn.

On-the-ground mitigation and adaptation

Parcel-level measures

Proactively hardening homes against wildfires can reduce risk exposure, with ember-focused measures shown to deliver the biggest reduction in risk per dollar. In practice, this means Class A roofing; ember- and flame-resistant vents with enclosed eaves; ignition-resistant siding, decks, and fencing connections; non-combustible gutters; a 0-5 ft "ember-free" zone around structures; and Heating, Ventilation, and Air Conditioning (HVAC) protections such as screened outside-air intakes, Minimum Efficiency Reporting Value (MERV)-13 or better filters during smoke days, and condensers on non-combustible pads. Guidance from the California Department of Forestry and Fire Protection (CAL FIRE) on defensible space and ember-resistant construction, along with the Insurance Institute for Business & Home Safety's (IBHS) FORTIFIED-style standards, align on these priorities. Insurers are increasingly recognizing such verified upgrades with premium credits or preferred terms.

Urban planning and building codes can promote widespread adoption of such measures. In the US, fire-prone jurisdictions have increasingly worked on creating WUI overlay zones that restrict new development in the more hazardous areas, require setbacks from hazardous vegetation, and mandate that no combustible materials be placed within five feet of structures. Countries across the world are following suit. For example, Australia ties construction requirements to a site's Bushfire Attack Level, while several EU and Mediterranean countries pair settlement-protection zones with mandatory vegetation management. Industry-leading practices combine zoning that keeps the more exposed parcels from being developed with building standards that help reduce ignition risk.

Nature-based solutions can also play a key role in mitigating parcel-level wildfire risk. For example, studies show that targeted goat and sheep grazing can meaningfully lower fine-fuel loads that drive rapid wildfire spread, a practice increasingly used in European countries such as Portugal and Spain to reduce grass and brush density along the wildland–urban interface (Celaya et al., 2022). Other nature-based practices include planting less flammable vegetation such as birch or aspen, which can slow fire spread and protect more vulnerable landscapes (Marshall et al., 2024). In North America, beaver-modified riverscapes have been shown to have reduced megafire impacts compared to riparian habitats without beaver dams (Fairfax et al., 2024). Together, these interventions demonstrate how ecological processes can complement built-environment strategies to reduce ignition and enhance long-term resilience.

A 2024 Guidewire study found that home hardening measures and wildfire mitigation can reduce the risk of wildfire damage by up to 70%. Applying multiple measures is often key:

- Adopting just three resiliency points leads to a 20-25% reduction in expected loss compared to properties with no measures
- Implementing holistic measures with more than 12 resiliency points can decrease risk by up to 70% percent.

Community-scale measures

Communities can collectively reduce risk with proactive city planning and controlled burns. They can enact policies that aim to reduce the spread of fire and improve the ability of residents to evacuate in case of a fire, such as those codified in California's State Minimum Fire Safe Regulations. Outside the US, Portugal's Integrated Rural Fire Management program illustrates how national planning instruments, fuel-break networks, and local enforcement can align land-use, access, and suppression efficiency at scale. (State Alliance for Firesafe Road Regulations, 2023; Agency for Integrated Rural Fire Management, n.d.).

Prescribed burning is another impactful tool that can reduce risk within local communities. The Australasian Fire and Emergency Service Authorities Council (AFAC), which is Australia's National Council for Fire and Emergency Services describes prescribed fire as essential for life- and property-risk reduction. European authorities have reached similar conclusions for Mediterranean settings, flagging prescribed burning as a component of integrated management under rising fire danger (San-Miguel-Ayanz, et al., 2019).

Incorporating knowledge and rituals from indigenous peoples also can help. For example, in Northern Australia, First Nations-led savanna burning has become a scaled climate and risk-reduction program, with projects now covering more than 54 million acres, abating around 1 million tons of emissions annually, and generating verified carbon credits (The Nature Conservancy, n.d.).

Dr. Huairen Ye, Senior Manager of data science at Guidewire, highlighted the challenges of implementing broader scale wildfire mitigation and emphasized the need for stronger policy enforcement: “Mitigation at community and broader scales requires stronger policy enforcement and collaboration across all stakeholders. One of the key challenges today is the fragmented regulatory landscape. While some states are advancing wildfire mitigation bills, many others have little or no progress. Stakeholders increasingly rely on resilience and mitigation data to guide decisions, yet there remains a significant gap in the availability of such data. Aerial imagery offers an effective tool for assessing and verifying mitigation measures such as defensible space or vegetation management; however, the industry must continue to pursue more innovative and scalable approaches."

Financing

Cities can take steps to enact these measures through permitting and creative financing solutions across multi-sector stakeholders. For example, cities could require that any new builds or remodels require proof of ember-resistant features before granting final occupancy, a practice already in place in parts of California. Additionally, cities can mandate annual proof of defensible space maintenance. Communities like Paradise, CA (post-Camp Fire) and Austin, TX (local WUI guide) show that standard details make permitting and homeowner action much faster (FEMA, 2022; Austin Fire Department, 2025).

Funding doesn’t have to be addressed homeowner-by-homeowner either. Public-private models, including utility-backed resilience partnerships, grant matches, conservation finance (e.g., Forest Resilience Bonds), municipal bonds, and even $3-per-month customer micro-contributions, are increasingly co-funding neighborhood hardening and shared-asset protections.

Tech-enabled mitigation and monitoring

Perhaps one of the greatest tools in wildfire mitigation is technology. Advances in AI and satellite imagery have led to significant improvements in wildfire monitoring and response across the globe.

Resilience-as-a-service platforms

Bundled “resilience platforms” are emerging to help homeowners and communities assess parcel-level risk, plan vetted retrofits, document compliance for mitigation credits, and, in some markets, link financing to premium discounts. Examples include California’s Safer from Wildfires rules, which require insurers to reflect verified upgrades in pricing, and Australia’s Bushfire Resilience Rating app, which gives households a tailored risk rating, retrofit checklist, and path to insurer-recognized certification that can reduce premiums (Australian Government National Emergency Management Agency, 2024).

Urban wildfire modeling

Community planning organizations increasingly use street-level wildfire models that simulate ember exposure and structure-to-structure spread across neighborhoods to stress-test evacuation routes, staging areas, and hardening priorities (Maranghides, et al., 2022; Maranghides & Link, 2025). As an example, Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO) Spark can model in seconds many hours of fire spread, supporting both planning and live operations (CSIRO, n.d.).

Remote sensing and satellite surveillance

Near-real-time fire detections (e.g., National Aeronautics and Space Administration's (NASA) Fire Information for Resource Management System FIRMS), vegetation dryness indicators, and European systems like European Forest Fire Information System (EFFIS) provide agencies and insurers with common operating pictures for ignition and exposure monitoring (NASA & US Forest Service, 2025; European Commission, 2025). The Copernicus Atmosphere Monitoring Service (CAMS) converts satellite fire radiative power into emissions and smoke-plume forecasts, enabling health-informed triggers and cross-border alerts (Copernicus Atmosphere Monitoring Service, 2024).

Beyond government programs, private-sector tech players such as Google, Zesty AI, and Microsoft have developed AI and satellite programs that can detect wildfires and provide near-real time insights on breakouts.

AI, drones, and IoT

AI-assisted camera networks, unmanned aircraft systems (drones), and fixed sensors can shorten wildfire detection time. When paired with automated response (e.g., targeted drops or autonomous patrols) and utility smart devices, they help keep fires small (Boroujeni, et al., 2024). AI can also allow for fighting wildfires under conditions where humans cannot safely intervene, such as in high danger areas or at night. Spain's Plan INFOCA (Andalusia's Wildfire Emergency Plan, Plan de Emergencia por Incendios Forestales de Andalucía), a holistic system for the prevention, monitoring, detecting and extinguishing of forest fires, managed by the Andalusian regional government added a real-time operations platform and AI-enabled drones for the 2025 season, while utilities are deploying line sensors and protective relays to detect faults and cut ignition risk (Kern, 2024).

Utility shutoff protocols

When winds, dryness, and fault risk align, utilities can execute Public Safety Power Shutoffs (PSPS) under regulatory oversight, balancing wildfire-risk reduction with impacts to health, communications, and critical services (California Public Utilities Commission, 2025). Agencies and utilities can fuse weather, fire behavior, grid status, and health data to pre-stage resources, trigger PSPS more surgically, and pre-notify vulnerable populations, reducing losses across the cascade from ignition to smoke to debris-flow risk.

As a complementary (and often less disruptive) path, Victoria (Australia) has installed Rapid Earth Fault Current Limiter (REFCL) technology that helps drastically limits fault energy on 22-kV lines—cutting bushfire-start risk and reducing reliance on broad shutoffs (Energy Safe Victoria, 2023).

Insurance innovation

Advances in underwriting and pricing

At the individual level, incorporating next-generation wildfire models that capture both hazard risk and parcel- or community-level features can help insurers better differentiate exposure and support mitigation credits. California's 2025 framework — which allows the use of catastrophe models conditioned on transparency, validation, mitigation recognition, and availability commitments — is a recent example of this approach (California Department of Insurance, 2025). Insurers can also tie premium credits to third-party verifications (e.g., IBHS Wildfire Prepared Home™), drone imagery, and community certifications.

By moving beyond blunt regional averages to property-level data, underwriters can better match premiums to actual exposure, avoiding the costly trap of underpricing high-risk homes or driving away safer customers priced out by inflated rates. Precision also can help reduce sweeping market withdrawals, a key tenet of the California framework.

Triple-I and Guidewire recently released a study revealing that insurers can still underwrite healthy risks even in high-risk areas. But to stay profitable, they often need granular property-level data and innovative analytics to help identify lower-risk properties. Granular risk assessment incorporates the different vegetation types, drought conditions, and fire-suppression success rates, in addition to more traditional variables like fuel density, slope, and aspect (Insurance Information Institute, 2025).

According to a 2024 Guidewire report, "Insurers that incorporate wildfire mitigation data into their workflows experience improved underwriting accuracy and loss prediction models." This not only benefits insurers but also provides an imperative incentive for homeowners to adopt mitigation strategies so they can pay lower premiums (Schwartz, 2024).

Parametric and ILS

Parametric covers and insurance-linked securities provide avenues for non-traditional products to improve coverage levels and close the wildfire protection gap. These policies use transparent index triggers (e.g., wildfire perimeter encroachment or smoke $PM_{2.5}$ exceedances for a set duration) to pay within days. This enables rapid payouts in times of crisis and helps provide fast liquidity for public entities and utilities.

In the catastrophe bond market, more wildfire risk was assumed in 2025 than in any previous year despite the occurrence of the Los Angeles wildfires, signaling confidence from capital markets that (re)insuring wildfire risk can still be profitable (Evans, 2025).

Community-based catastrophe insurance

Community-Based Catastrophe Insurance (CBCI) is an emerging mechanism that aggregates exposure, such as at the city or homeowners’ association (HOA) level, and facilitates the purchase of insurance on behalf of residents. This model ties coverage and price to specific, enforceable mitigation measures (e.g., vegetation management and specific home-hardening implementations) and third-party audits. Analyses show that CBCI can expand capacity and lower effective premiums, especially when paired with a parametric or insurance-linked security cover (Federal Advisory Committee on Insurance, 2022; Purwandari, et al., 2024).

Claims management

Managing claims in the aftermath of wildfires can be challenging for insurers. Claims volume and severity is high, and customers face extreme stress at the very moment they need their insurers most. Proactive claims management and fast payouts provide relief to both policyholders and insurers..

Satellite data and imagery play a key role in gaining rapid situational awareness of disasters. They enable many insurers to improve response plans, communicate proactively with policyholders, assess losses effectively, identify priority regions and allocate resources effectively (Guidewire, 2024).

Companies that provide NatCat data can be incorporated into insurers' FNOL (First Notice of Loss) process to enable informed decisions, assess losses, improve precision in claims triage, and help reduce cycle times and payment delays.

Life and health considerations

Life and health carriers can consider incorporating location-based smoke metrics, revisiting mortality-improvement assumptions by region, and adopting event-based reserving for large smoke episodes. In the US, the Society of Actuaries is scoping catastrophe modeling for wildfire-related life and health outcomes that could reframe pricing, capital, and product design in the face of these risks.

Integrated data and analytics

The amount and variety of data and analytics available to insurers today can be overwhelming. New technology start-ups are constantly innovating, and offerings have grown exponentially.

At the same time, customer demands, and regulatory requirements are growing and insurers should find a way forward that enables them to do their part so they can keep the world insurable while writing profitable business.

Underwriters, claims adjusters, and other insurance professionals need new data and technology at their fingertips directly within core systems, supporting them throughout the insurance lifecycle.

An integrated cloud platform like Guidewire helps insurers make this a reality. Through Guidewire Marketplace, a curated insurance ecosystem of Guidewire extensions, insurers have access to hundreds of P&C-relevant solutions that enhance their technology capabilities and offerings to customers, agents, partners, and employees.

Conclusion

Climate change has driven an increase in wildfire scale, cost, and breadth of impacts. The effects of wildfires will continue to grow as climate change intensifies. Across the globe, fires in California, Europe, and Australia underscore that these events are not seasonal or regional phenomena but a global, year-round peril. Beyond direct destruction of property and ecosystems, wildfires generate cascading impacts such as degraded air quality, heightened landslide risk, and disruptions to housing markets and community stability. These compounding effects mean that the true cost of wildfire extends far beyond insured losses, affecting public health, infrastructure, and long-term economic resilience.

At the same time, wildfire remains uniquely difficult to predict and model. Their ignition sources are often random, their spread is shaped by both natural and built environments, and their aftermath creates complex second-order risks. Traditional models struggle with these dynamics, particularly in densely built wildland–urban interfaces where building materials and neighborhood layouts can drive unexpected outcomes.

Yet capabilities are improving; new generations of catastrophe models, advances in remote sensing and AI, and increasingly granular property-level data are beginning to give insurers and policymakers sharper tools to anticipate risk and design more effective interventions. There are real risk-reduction actions that can be taken, including property-level mitigation and active monitoring.

Despite the scale of the challenge, there are proven actions that can meaningfully reduce wildfire risk. Parcel-level hardening, community-scale planning, prescribed burning, and nature-based solutions all help reduce ignition potential and slow fire spread. Technology-enabled monitoring and response is giving governments, utilities, and insurers near-real-time visibility into ignition risks and fire behavior. Together, these approaches demonstrate that wildfire risk is not an intractable problem.

Wildfire risk is complex, global, climate driven, human-exacerbated, and economically destabilizing. This challenge necessitates an integrated solution that combines on the ground mitigation, technology-enabled monitoring, and insurance innovation to shift the trajectory.

A multifaceted solution for insurers to help tackle the complex problem of wildfire risk includes:

1. Shift from risk transfer to risk mitigation by leveraging advanced models and rewarding verified homeowner mitigation.
2. Broaden the risk-transfer toolkit with parametric solutions, catastrophe bonds, and community-based approaches.
3. Collaborate across the housing ecosystem with governments, lenders, developers, and utilities to scale financing and incentives for resilience.
4. Integrate life and health considerations, addressing smoke as a recurring and severe peril.
5. Lead through education and advocacy, equipping customers and policymakers to act at scale. Collectively, these actions can reduce losses, stabilize insurance markets, and protect public health. For insurers, the opportunity is clear: to move beyond absorbing wildfire risk and help reshape its trajectory. The time for action is now.

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References & Sources

Pol, A. (2025, August 21). **Record EU wildfires burned over 1 million hectares in 2025: analysis.** Phys.org. https://phys.org/news/2025-08-eu-wildfires-million-hectares-analysis.html. Relevance: EU-2025 burned area record (obs, EFFIS-derived).

CAL FIRE. (2025, January 12). **Palisades Fire Incident Update.** https://www.fire.ca.gov/incidents/2025/1/7/palisades-fire/updates/. Relevance: acreage and preliminary structure-damage context (obs; preliminary).

CAL FIRE. (2025, January 31). **Eaton Fire Incident Page**. https://www.fire.ca.gov/incidents/2025/1/7/eaton-fire. Relevance: acreage, containment date, DINS references (obs).

Los Angeles County. (2025, January). **Palisades Fire – LA County Recovers (damage assessment maps).** https://recovery.lacounty.gov/palisades-fire/. Relevance: county DINS visualization and caveats (obs; preliminary).

Los Angeles County. (2025, January). **Eaton Fire – LA County Recovers (damage assessment maps).** https://recovery.lacounty.gov/eaton-fire/. Relevance: county DINS visualization and caveats (obs; preliminary).

Claims and Mitigation Management Alliance. (2025, January 22). **California Wildfire Loss Estimates Rise.** https://www.theclm.org/Magazine/articles/california-wildfire-loss-estimates-rise/3192. Relevance: insured loss band for LA-2025 (est.).

Celaya et al. (2022, February 26). **Livestock Management for the Delivery of Ecosystem Services in Fire-Prone Shrublands of Atlantic Iberia.** https://www.mdpi.com/2071-1050/14/5/2775. Relevance: livestock management for fire prevention.

UCLA Anderson Forecast. Li, Z. & Yu, W. (2025, March 3). **Economic Impact of the Los Angeles Wildfires.** https://www.anderson.ucla.edu/about/centers/ucla-anderson-forecast/economic-impact-los-angeles-wildfires. Relevance: macroeconomic loss band ($76–$131B) (est.).

Copernicus Atmosphere Monitoring Service. (2023, December 12). C**anada produced 23% of the global wildfire carbon emissions for 2023.** https://atmosphere.copernicus.eu/copernicus-canada-produced-23-global-wildfire-carbon-emissions-2023. Relevance: emissions share (obs/model GFAS).

MacCarthy, J. et al. (2025, July 21) **The Latest Data Confirms: Forest Fires are Getting Worse.** World Resources Institute. https://www.wri.org/insights/global-trends-forest-fires. Relevance: Wildfires have burned twice as much tree cover from 2001 to 2024.

Joint Economic Committee. (2023, October 16). **Climate-Exacerbated Wildfires Cost the U.S. Between $394 to $893 Billion Each Year in Economic Costs and Damages.** https://www.jec.senate.gov/public/index.cfm/democrats/2023/10/climate-exacerbated-wildfires-cost-the-u-s-between-394-to-893-billion-each-year-in-economic-costs-and-damages. Relevance: Financial impact of wildfires in the US.

CarbonBrief. (2025, August). **Analysis: Record UK wildfires have burned an area twice the size of Glasgow in 2025.** https://www.carbonbrief.org/analysis-record-uk-wildfires-have-burned-an-area-twice-the-size-of-glasgow-in-2025/. Relevance: UK-2025 record burned area (GWIS-derived; obs).

Xanthopoulos et al. (2025). **Overview 2023: Greece: Lessons Not Learned.** International Association of Wildland Fire. https://www.iawfonline.org/article/overview-2023-greece/. Relevance: Provides statistics on size of 2023 Evros Fire.

World Wildlife Fund. (2025). **Australian Bushfires.** https://wwf.org.au/what-we-do/australian-bushfires/. Relevance: Provide statistics on the 2019-2020 bushfires in Australia.

UNSW Media. (2020, September 22). **Smoke-related health costs of 2019-20 bushfires estimated at $1.95 billion.** University of New South Wales. https://www.unsw.edu.au/newsroom/news/2020/09/smoke-related-health-costs-of-2019-20-bushfires-estimated-at--1-. Relevance: Quantifies the health impact of Australian 2019-2020 Bushfires.

Canadian Wildland Fire Information System. (2025). **National Wildland Fire Situation Report.** https://cwfis.cfs.nrcan.gc.ca/report. Relevance: Gives live report on how many fires are burning in Canada and the amount of land they have burned this year in the US and Canada.

National Aeronautical and Space Administration. (2024, August 28). **New NASA Study Tallies Carbon Emissions From Massive Canadian Fires.** https://www.nasa.gov/earth/new-nasa-study-tallies-carbon-emissions-from-massive-canadian-fires/. Relevance: Impact of 2023 Canadian wildfires on carbon emissions and climate change.

Borchers Arriagada et al. (2020, August). **Unprecedented smoke-related health burden during the 2019–20 bushfires in eastern Australia**. Medical Journal Australia 213(6). https://www.mja.com.au/journal/2020/213/6/unprecedented-smoke-related-health-burden-during-2019-20-bushfires-eastern. Relevance: health impacts (obs/est.).

Hanideh, S., et al. (2021, October 9). **Wildfire impacts on education and healthcare: Paradise, California, after the Camp Fire.** Natural Hazards, 111(1):353–387**.** doi: 10.1007/s11069-021-05057-1. Relevance: ~$12.5B insured economic losses (est.).

Reuters. (2025, August 18). **Canada's 2025 wildfire season second-worst on record with 7.8M ha burned**. https://www.reuters.com/business/environment/canadas-wildfires-could-continue-into-fall-says-government-2025-08-18/. Relevance: area burned (obs; running season).

NOAA Research News. (2021, July 14). **Deforestation, warming flip part of the Amazon from carbon sink to source.** https://research.noaa.gov/deforestation-warming-flip-part-of-amazon-forest-from-carbon-sink-to-source/. Relevance: synthesis/explainer (obs/model).

Cassidy, E. (2024, August 4). **Fires rage along Brazil's deforestation frontier.** NASA Earth Observatory. https://earthobservatory.nasa.gov/images/153175/fires-rage-along-brazils-deforestation-frontier. Relevance: 2024 Amazon fire activity (obs).

Zinn, A. (2025, June 24). **Brazil records 62% jump in area burned by forest fires: monitor.** Phys.org. https://phys.org/news/2025-06-brazil-area-forest.html. Relevance: Number of hectares burned in 2024 in Brazil.

Our World in Data. (2025, June). **Wildfires** (GWIS-derived trackers). https://ourworldindata.org/wildfires. Relevance: burned-area trend context (obs).

European Forest Fire Information System – Fire Danger Forecast. (2025). **Fire Danger Forecast.** https://forest-fire.emergency.copernicus.eu/about-effis/technical-background/fire-danger-forecast#:~:text=Information%20on%20these%20indices%2C%20which,org/10.24381/cds.0e89c522. Relevance: Explains how the forest fire danger model in Europe are created.

U.S. Army Corps of Engineers. (2025). **Flood After Fire.** https://www.nwp.usace.army.mil/Missions/Flood-Risk-Management/Flood-After-Fire/. Relevance: Secondary effect of wildfire is flooding.

Western Fire Chiefs Association. (2024, April 14). **How Does Wildfire Affect Soil and Vegetation?** https://wfca.com/wildfire-articles/wildfire-affect-soil-vegetation/. Relevance: Outlines impact of wildfires on soil and water quality.

The University of Sydney. (2021, December 13) **Black Summer bushfire season cost farmers up to $5 billion.** https://www.sydney.edu.au/news-opinion/news/2021/12/13/black-summer-2019-20-bushfires-cost-farmers-5-billion-australia.html#:~:text=A%20new%20report%20by%20the,(at%20least%20$279%20million). Relevance: Economic and biodiversity impacts of the 2019-2020 Australian bushfires.

Johnston, F., et al. (2012, February 18). **Estimated Global Mortality Attributable to Smoke from Landscape Fires.** Environmental Health Perspectives, 120(5):695–701. doi: 10.1289/ehp.1104422. Relevance: Study that quantifies the health impact of particulate matter from wildfires.

Koplitz, S., et al. (2016, September 19). **Public health impacts of the severe haze in Equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure.** Environmental Research Letters 11 (9). https://iopscience.iop.org/article/10.1088/1748-9326/11/9/094023. Relevance: Study that quantifies the health and mortality impact of 2015 wildfire smoke in Equatorial Asia.

United States Department of Agriculture – Forest Service. (2025, April 30). **Wildland-Urban interface growth in the U.S.** https://research.fs.usda.gov/nrs/projects/wuigrowth#research. Relevance: estimates count and percentage of US homes that are in the WUI.

International Code Council. (n.d.) **Fire-resistant construction in the wildland-urban interface.** https://www.iccsafe.org/products-and-services/wildland-urban-interface/. Relevance: how many homes in CA are at risk of wildfire in WUI.

Brown, P. & Clements, C. (2019). **FAQ on fires, humans and global change.** Weather, Climate & Human Systems Lab. https://www.weatherclimatehumansystems.org/faq-on-fires-humans-and-global-change? Relevance: US statistics on human wildfire ignition rates.

Ayanz, J. et al. (2012, March). **Comprehensive Monitoring of Wildfires in Europe: The European Forest Fire Information System (EFFIS)**. **Approaches *to* Managing Disaster**, doi: 10.5772/28441. Relevance: European statistics on human wildfire ignition rates.

Balch, J. et al. (2017, February 27). **Human-started wildfires expand the fire niche across the United States.** Proceedings of the National Academy of Sciences 114 (11) 2946-2951. https://doi.org/10.1073/pnas.1617394114. Relevance: Human impact on length of wildfire season.

Chemical Insights (N.D.). **The Human Health Impacts of Wildfire Smoke**. https://chemicalinsights.org/wildfires. Relevance: Information on the different chemical makeup of WUI wildfires.

Harries, M., et al. (2022, October 26). **A Research Agenda for the Chemistry of Fires at the Wildland–Urban Interface: A National Academies Consensus Report. Environmental Science & Technology** (56). https://doi.org/10.1021/acs.est.2c07015. Relevance: Chemical makeup of WUI fires different than other wildfires.

Fairfax et al., (2024). **Impacts of beaver dams on river-scape burn severity during megafires in the Rocky Mountain region, western United States** in Florsheim, J.L., O'Dowd, A.P., and Chin, A., eds., Biogeomorphic Responses to Wildfire in Fluvial Ecosystems: Geological Society of America Special Paper 562, p. 131–151, https://doi.org/10.1130/2024.2562(07). Relevance: nature-based solutions.

American Academy of Actuaries. (2022, January). **Wildfire: An Issue Paper.** https://www.actuary.org/wp-content/uploads/2022/01/Wildfire.2022_.pdf. Relevance: Outlines complexity of wildfire modeling for insurance.

National Institute of Standards and Technology. (2025, May 7). **Wildland-Urban Interface (WUI) Fire Spread and Modeling.** https://www.nist.gov/programs-projects/wildland-urban-interface-wui-fire-spread-and-modeling?utm_source=chatgpt.com. Relevance: Complexity modeling WUI wildfires.

U.S. Department of Agriculture – Forest Service. (2023, June 15). **Wildfire letter of intent 2023.** https://www.fs.usda.gov/inside-fs/leadership/wildfire-letter-intent-2023?utm_source=chatgpt.com. Relevance: 98% of wildfires contained within 24 hours.

United States Geological Service. (2018, September 7). **Monitoring Trends in Burn Severity** https://www.usgs.gov/centers/eros/science/monitoring-trends-burn-severity?utm_source=chatgpt.com#overview. Relevance: Information on U.S. daily wildfire data source.

Chen, Y. et al. (2023, November 28). **Multi-decadal trends and variability in burned area from the fifth version of the Global Fire Emissions Database (GFED5).** Earth System Science Data (15) 5227–5259. https://doi.org/10.5194/essd-15-5227-2023. Relevance: Discussing spatial resolution and quality of GFED5.

Headtler, J. (2025, May 15). **Californians deserve a clearer view of what's driving skyrocketing insurance costs.** CalMatters. https://calmatters.org/commentary/2025/05/public-catastrophe-model-insurance-crisis/?utm_source=chatgpt.com. Relevance: Recent insurance issues in California regarding future wildfire risk modeling.

California Department of Insurance. (2024, June 13). **Commissioner Lara unveils next steps in his strategy to expand coverage options for Californians in areas of high wildfire risk.** https://ksqd.org/wp-content/uploads/2024/06/061324_Cat_Modeling_Insurer_Commitments_FINAL.pdf?utm_source=chatgpt.com Relevance: California can now use forward looking catastrophe models.

Hoover, K. & Riddle, A. (2021, December 16). **U.S. Forest Ownership and Management.** Congressional Research Service. https://www.congress.gov/crs_external_products/IF/PDF/IF12001/IF12001.2.pdf. Relevance: Separation of ownership of US forests.

Guha-Sapir, D., et al. (2023). **Closing Climate and Disaster Data Gaps: New Challenges, New Thinking.** United Nations Office for Disaster Risk Reduction. https://www.undrr.org/media/91937/download?startDownload=20250827. Relevance: How European wildfire responsibility is split between stakeholders.

Sigma. (2025, January). **Natural catastrophes: insured losses on trend to USD 145 billion in 2025.** https://cwrrr.org/research-reports/sigma-1-2025-natural-catastrophes-insured-losses-on-trend-to-usd-145-billion-in-2025/. Relevance: Natural catastrophe loss projection.

Frank, T. (2025, July 18). **E&E News – California leapfrogs Florida in US insurance risk.** Consumer Watchdog. https://consumerwatchdog.org/in-the-news/ee-news-california-leapfrogs-florida-in-us-insurance-risk/. Relevance: How much FAIR Plan insures.

Gallin, L. (2023, February 10). **Global Property Cat Rates-on-Line Up 27.5% at Jan 1 Renewals: Guy Carpenter.** Reinsurance News. https://www.reinsurancene.ws/global-property-cat-rates-on-line-up-27-5-at-jan-1-renewals-guy-carpenter/?utm_source=chatgpt.com. Relevance: Global climate change impacts on insurance.

State Alliance for Firesafe Road Regulations. (2023, October 6). **Board of Forestry and Fire Protection 2023 Regulations and Priority Review.** https://cdnverify.bof.fire.ca.gov/media/z5qnr3i3/rpc-3-3-fire-safe-rules-safrr_adamfk.pdf. Relevance: Outline's California's policies on safe wildfire evacuation.

Agency for Integrated Rural Fire Management. (n.d.) **Planning instruments national plan for integrated rural fire management.** https://www.agif.pt/en/planning-instruments-national-plan-for-integrated-rural-fire-management. Relevance: Explains Portugal's fire management program.

National Position on Prescribed Burning. (2019, November). Australasian Fire and Emergency Service Authorities Council Limited. https://knowledge.aidr.org.au/media/9206/national_position_prescribed_burning_2021.pdf. Relevance: Importance of prescribed burns.

San-Miguel-Ayanz, J. et al. (2019, October 31**). Forest Fires in Europe, Middle East and North Africa 2018.** Publications Office of the European Union. https://dx.doi.org/10.2760/1128. Relevance: Prescribed burning works in Mediterranean environments.

The Nature Conservancy. (n.d.). **Fighting Fire With Fire** https://www.nature.org/en-us/about-us/where-we-work/asia-pacific/australia/stories-in-australia/fighting-fire-with-fire/. Relevance: Incorporating indigenous knowledge to prescribed burning in Australia.

Federal Emergency Management Agency. (2022, December). **Paradise, California: Rebuilding Resilient Homes after the Camp Fire.** https://www.fema.gov/sites/default/files/documents/fema_paradise-california-rebuilding-resilient-homes_case-study.pdf

Austin Fire Department. (2025, July 10). **Guide to 2024 WUIC Proximity Zones Ignition-Resistant Construction.** https://www.austintexas.gov/sites/default/files/files/Fire/Prevention/WUI-Proximity-Zones---Guide-to-Construction.pdf?utm_source=chatgpt.com. Relevance: Resources for ignition resistant home construction.

California Department of Insurance. (2025, July 24). **Reform made real — California Department of Insurance completes final evaluation of innovative forward-looking model to address California's coverage crisis.** https://www.insurance.ca.gov/0400-news/0100-press-releases/2025/release052-2025.cfm. Relevance: California can now use forward looking catastrophe models.

Insurance Information Institute. (2025, May 12). **Getting Granular to Find Lower-Risk Properties Amid Wildfire Perils.** https://www.iii.org/sites/default/files/docs/pdf/triple-i_hazardhub_case_studies_05122025.pdf. Relevance: Importance and unique aspects of granular wildfire risk assessment.

Schwartz, T. (2024, October 3). **Analyzing the Effectiveness of Wildfire Mitigation Measures: A HazardHub Analysis.** Guidewire. https://www.guidewire.com/resources/blog/technology/analyzing-the-effectiveness-of-wildfire-mitigation-measures. Relevance: Quote attribution.

Evans, S. (2025, August 21). **Cat bond market assumes more wildfire risk in 2025 than any prior year.** Artemis. https://www.artemis.bm/news/cat-bond-market-assumes-more-wildfire-risk-in-2025-than-any-prior-year/. Relevance: Insurance assumed more wildfire risk in 2025 than any other year.

Federal Advisory Committee on Insurance. (2022, September 29). **Innovative Risk Transfer Solutions.** https://home.treasury.gov/system/files/311/Community-Based%20Catastrophe%20%20Insurance.pdf. Relevance: Explains CBCI.

Purwandari, T., et al. (2024, October 7**). Community-Based Disaster Insurance for Sustainable Economic Loss Risk Mitigation: A Systematic Literature Review.** Risks (12): 158. https://doi.org/10.3390/risks12100158. Relevance: CBCI can expand capacity and lower effective premiums.

Guidewire. (2024, June 20). **Harness Satellite-Powered Natural Catastrophe Data with ICEYE's New Guidewire Cloud Integration.** https://www.guidewire.com/about/press-center/press-releases/20240620/harness-satellite-powered-natural-catastrophe-data-with-iceyes-new-guidewire. Relevance: Importance of satellite data for wildfire loss identification and resource allocation.

Australian Government National Emergency Management Agency. (2024, March 6). **Protecting Australian homes with a bushfire resilience rating app.** https://www.nema.gov.au/about-us/media-centre/protecting-australian-homes-bushfire-resilience-rating-app. Relevance: New bushfire rating app helps protect Australian public.

Maranghides, A., et al. (2022, March). **WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology.** National Institute of Standards and Technology. https://doi.org/10.6028/NIST.TN.2205. Relevance: WUI fire mitigation techniques.

Marshall et al., (2024, October). **Can green firebreaks help balance biodiversity, carbon storage and wildfire risk?** Journal of Environmental Management. https://www.sciencedirect.com/science/article/pii/S0301479724021698 Relevance: green firebreaks and reduced risk of wildfire spread.

Maranghides, A. & Link, E. (2025, March). **WUI Fire Evacuation and Sheltering Considerations.** National Institute of Standards and Technology. https://doi.org/10.6028/NIST.TN.2262r1. Relevance: Information for WUI communities to develop communication and evacuation plans.

CSIRO. (n.d.). **Spark: Predicting bushfire spread.** https://www.csiro.au/en/research/technology-space/ai/Spark. Relevance: New technology to predict wildfire spread.

NASA & US Forest Service. (2025). **FIRMS US/Canada.** https://firms.modaps.eosdis.nasa.gov/usfs/map/#d:24hrs;@-100.0,40.0,4.1z. Relevance: Realtime wildfire data in US and Canada.

European Commission. (2025). **EEFIS – Current Situation Viewer.** https://forest-fire.emergency.copernicus.eu/apps/effis_current_situation/. Relevance: Realtime wildfire data in Europe.

European Commission. (2024). **Global fire monitoring.** Copernicus. https://atmosphere.copernicus.eu/global-fire-monitoring. Relevance: How CAMS accurately monitors wildfires.

Boroujeni, S., et al. (2024, January 4). **A comprehensive survey of research towards AI-enabled unmanned aerial systems in pre-, active-, and post-wildfire management.** Information Fusion (108). https://doi.org/10.1016/j.inffus.2024.102369. Relevance: How drones and AI are used to mitigate wildfire spread.

Kern, H. (2024, November 1). **Exchange of Experts in Civil Protection INFOCA - Forest fire Operational Centre.** Exchange of Experts in Civil Protection. https://civil-protection-knowledge-network.europa.eu/system/files/2024-11/eoe-infoca_field_report-1.1.pdf. Relevance: Spain's Plan INFOCA implemented drones which help real-time monitoring.

California Public Utilities Commission. (2025, August 19). **Public Safety Power Shutoffs (PSPS).** https://www.cpuc.ca.gov/PSPS/. Relevance: Information on public safety power shutoffs and wildfires.

Energy Safe Victoria. (2023). **Rapid Earth Fault Current Limiter (REFCL) reports.** https://www.energysafe.vic.gov.au/about-us/our-organisation/reports/rapid-earth-fault-current-limiter-refcl-reports. Relevance: REFCL technology is designed to reduce the risk of electrical assets igniting bushfires.

World Wildlife Fund. (Date Unknown). **Wildfire: A Crisis Raging Out of Control** https://wwf.panda.org/discover/our_focus/forests_practice/forest_publications_news_and_reports/fires_forests/. Relevance: 75% of wildfires started by humans globally.

NASA. (2024). **Wildfire Digital Twin" Pioneers New AI Models and Streaming Data Techniques for Forecasting Fire and Smoke.** https://science.nasa.gov/science-research/science-enabling-technology/nasa-wildfire-digital-twin-pioneers-new-ai-models-and-streaming-data-techniques-for-forecasting-fire-and-smoke/?utm_source=chatgpt.com. Relevance: Many current models related to wildfire and smoke spread have a spatial resolution of approximately 10 kilometers, which smooths over critical fine-scale variation in fuels, terrain and microclimates, and thus is inadequate for accurately predicting fire behavior at the scale needed for effective mitigation and response.

Wong et al., Fire Ecology. (2025). **Understanding drivers and dynamics of potential heat release in wet sclerophyll forests.** https://fireecology.springeropen.com/articles/10.1186/s42408-025-00394-z Relevance: normalizing by area and burn duration shows that burning structures release roughly 100–1,000× more heat intensity per unit area than forest fuels.

US National Oceanic And Atmospheric Administration. (2022, January 7). **Wet, then dry extremes contributed to devastating Marshall Fire in Colorado.** https://www.climate.gov/news-features/event-tracker/wet-then-dry-extremes-contributed-devastating-marshall-fire-colorado. Relevance: 2021 Marshall Fire in Colorado.

US Geological Survey. (2023). **The global wildland-urban interface**, F. Schug, Avi Bar-Massada, Amanda Carlson, H. Cox, Todd Hawbaker, D. Helmers, Patrick Hostert, D. Kaim, Neda K. Kasraee, S. Martinuzzi, Miranda Mockrin, Kira Pfoch, Volker C. Radeloff. https://www.usgs.gov/publications/global-wildland-urban-interface, Relevance: WUI covers 4.7% of land but houses 50% of world's population.

California FAIR Plan, Key Statistics & Data. (2025). https://www.cfpnet.com/key-statistics-data/. Relevance: Statistics regarding California FAIR plan.