WILDFIRE RISK INSIGHTS

Why is Getting a Full Picture of Wildfire Risk Important for Underwriting?

Betterview

What Challenges do Insurers Face when Underwriting in Wildfire Hazard Zones?

Insufficient property-level data to make precise underwriting decisions.

Existing hazard data is spread across multiple, incompatible platforms, making it difficult to analyze or make confident decisions quickly.

Without property-level vulnerability, it is difficult for insurers to engage with owners to mitigate the risk. This leads to declining coverage, extremely high premiums, and shrinking market share.

Increasing Wildfire Frequency & Severity Make These Challenges Even More Difficult

In the United States, the area burned by wildfires has increased tenfold in the past 50 years[1], and the area burned is projected to continue to increase in response to climate change[1,2]. The ongoing drought in the West is the worst since record-keeping began[3], and it is prolonging the wildfire season and increasing the intensity of wildfires[2]. Climate change is not the only factor increasing wildfire risk; trends in housing development are also a major contributor. An increasing number of homes are being built in areas along the edge of forested areas[4], an area known as the Wildland Urban Interface (WUI) (Figure 1). This results in more potential ignition sources in areas with high amounts of vegetation that can fuel potential wildfires.

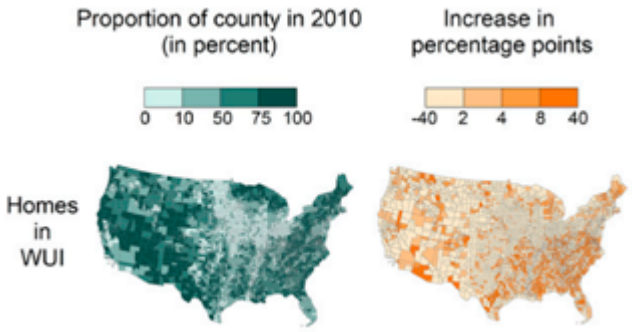

Figure 1: Home building in the Wildland Urban Interface (WUI). In green is the 2010 percentage of homes in the WUI for every county in the US. In orange is the percent increase in homes located in the WUI from 1990-2010. (Adapted from Volker et al. 2018)

Rank	State	Estimated number of properties in high wildfire hazard areas
1	California	2,040,600
2	Texas	717,800
3	Colorado	373,900
4	Arizona	242,200
5	Idaho	175,000
6	Washington	155,500
7	Oklahoma	153,400
8	Oregon	147,500
9	Montana	137,800
10	Utah	136,000

Table 1: Top 10 states by number of properties in high wildfire hazard areas[4].

The overlap between the WUI and wildfire hazard is high. In California, building homes in the WUI has resulted in the creation of 2,040,600 properties in areas with high wildfire hazard, and many other states (Texas, Colorado, Arizona, and others) have hundreds of thousands of properties in areas with high wildfire hazard[5] (Table 1).

The impact of the trends in wildfire risk on the insurance industry has been immense. Seven of the top ten costliest wildfires in US history have occurred in the last 5 years, and each has resulted in over a billion dollars in losses[5]. While all of the top 10 costliest have occurred in California, highly destructive wildfires have occurred in other parts of the country, such as the 2016 Gatlinburg, Tennessee wildfire which resulted in hundreds of millions of dollars in insured losses[6].

Rank	Year	Name	ESTIMATED INSURED LOSS	
			Dollars when occurred (in millions)	In 2021 dollars (in millions)
1	2018	Camp Fire	$10,000	$10,750
2	2017	Tubbs Fire	8,700	9,560
3	2018	Woolsey Fire	4,200	4,520
4	1991	Oakland Fire (Tunnel)	1,700	3,350
5	2017	Atlas Fire	3,000	3,300
6	2020	Glass Fire	2,950	3,070
7	2020	CZU Lightning Complex Fire	2,500	2,600
8	2017	Thomas Fire	2,250	2,470
9	2020	LNU Lightning Complex Fire	2,250	2,340
10	2007	Witch Fire	1,600	2,080

Table 2: Top 10 wildfires in the US in terms of insured loss (in millions)[5].

See the Complete Picture of Wildfire Risk

Hazard, Vulnerability, and Risk

Property insurers need accurate, consistent, and complete measures of catastrophe risk in order to appropriately price and underwrite. This catastrophe risk is driven primarily by two complementary factors influencing the property: hazard and vulnerability.

Hazard measures the probability that the peril in question (hurricane, wildfire, etc.) will occur at a particular location, as well as the expected intensity if it does occur. For example, a hurricane hazard model would estimate the likelihood of different levels of hurricane wind speeds to impact a given location based on past hurricane activity, observed wind speed data, and physics-based hurricane models. Similarly, a good measure of wildfire hazard would contain the likelihood of a wildfire happening in a given location, as well as some measure of how intense wildfires in that area are likely to be. California, Oregon, Washington, and Colorado are all high wildfire hazard areas.

Vulnerability, on the other hand, measures an asset's level of protection against damage or loss for a specific peril. Vulnerability varies not based on location, but based on the physical characteristics of the exposed asset. A wood frame single story home built in 1929 will perform very differently under hurricane force winds than a brand new steel skyscraper.

This means two identical homes in New Jersey and California would have identical wildfire vulnerability – they are equally protected if a wildfire impacts their property. However, of course these homes do not have equal levels of risk — this is because California has a much higher baseline level of wildfire hazard than New Jersey.

This interplay between hazard and vulnerability in determining overall wildfire risk is demonstrated in the following table (Table 3). Risk in a high hazard area can be mitigated by creating well-protected structures, and risk in low hazard areas is elevated for properties that are particularly susceptible to these low probability but high consequence events.

In this context, it is crucial for insurance companies to have an accurate gauge of both hazard and vulnerability in order to completely assess the catastrophe risk of both their existing portfolio as well as potential new business.

Figure 2: Flames and plumes of smoke can be seen from Spring Valley overnight on July 6, 2021. (Source: Wikipedia)

	Low Hazard *New Jersey*	**High Hazard** *California*
Low Vulnerability *Home with lots of defensible space*	**LOW** WILDFIRE RISK	**SOME** WILDFIRE RISK
High Vulnerability *Home with little defensible space*	**SOME** WILDFIRE RISK	**HIGH** WILDFIRE RISK

Table 3: Hazard vulnerability matrix for determining overall wildfire risk.

Wildfire risk modeling is an emerging area of the catastrophe modeling space, and is relatively young compared to its counterparts such as hurricane and earthquake modeling. The field of wildfire risk modeling has historically been dominated by hazard, both in terms of research and development, with vendors such as RedZone and HazardHub, and portfolio risk management strategies within insurance companies. This historical focus on wildfire hazard is due both to the accessibility of many of the pertinent datasets (e.g., wildfire footprints, topographic data, climate data) as well as the challenges of assessing local vulnerability to wildfire. The problem this poses for insurers is one of insufficient context. Without property-level vulnerability insights, insurers are unable to make precise underwriting decisions and mitigate wildfire risk. There is also a problem of accessibility, as much hazard data is spread out across multiple platforms that do not interface together. However, with the advent of Artificial Intelligence (AI) and accessibility of high resolution aerial imagery, wildfire vulnerability assessment is now within reach.

With Betterview's technology, insurance companies are now able to measure wildfire vulnerability, allowing them to supplement existing hazard modeling tools to make accurate underwriting decisions quickly. They are able to access all of this data, both for hazard and vulnerability, within a single easy-to-use platform.

Defensible Space

The principle of defensible space is straightforward—keeping flammable material away from a structure reduces the probability of a structure catching fire. Defensible space provides protection against wildfire[7,8,9,10] as a physical buffer against flames and embers. It is an area around a structure that is free of flammable objects such as vegetation, wood piles, other buildings, etc. But how much area around a structure should be kept clear? And for insurers, property owners, and regulators, what is the best way to measure defensible space?

Agencies across the country recommend implementing defensible space based on a set of rules that vary across three zones: Zone 0 (0-5 feet from the structure), Zone 1 (5-30 feet from the structure), Zone 2 (30-100 feet). In California, property owners in wildfire-prone areas are required by law to implement defensible space. The legal requirements for defensible space are similar to those recommended by other agencies and also vary across three zones. The California requirements for each zone are detailed, with restrictions such as banning mulch in Zone 0, and prohibiting wood piles in Zone 0 and Zone 1. Given the detail of the regulations, determining whether a home has legally adequate defensible space requires someone to survey the property in person.

Leveraging aerial imagery and computer vision, Betterview determines defensible space at a level of precision that reveals the true protection provided by defensible space. We identify areas of vegetation, yard debris, and buildings in the standard zones (Zone 0, Zone 1, and Zone 2) (Figure 3). If flammable objects (vegetation, yard debris, and buildings) are detected inside these zones, we subtract the flammable object's area from the total area of that zone to determine defensible space. If a zone is completely occupied by flammable objects, defensible space would be 0%, and if it is free of flammable objects, defensible space is 100%. In seconds, Betterview provides a survey of defensible space for each building on a property.

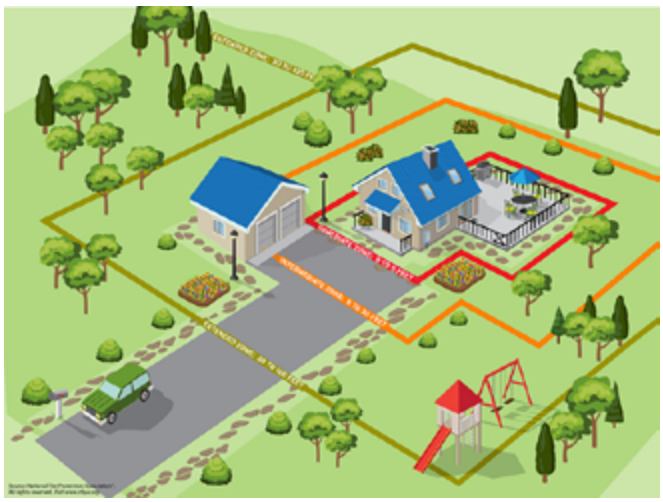

Figure 3: Defensible space zones. (Source: NFPA - Preparing homes for wildfire)

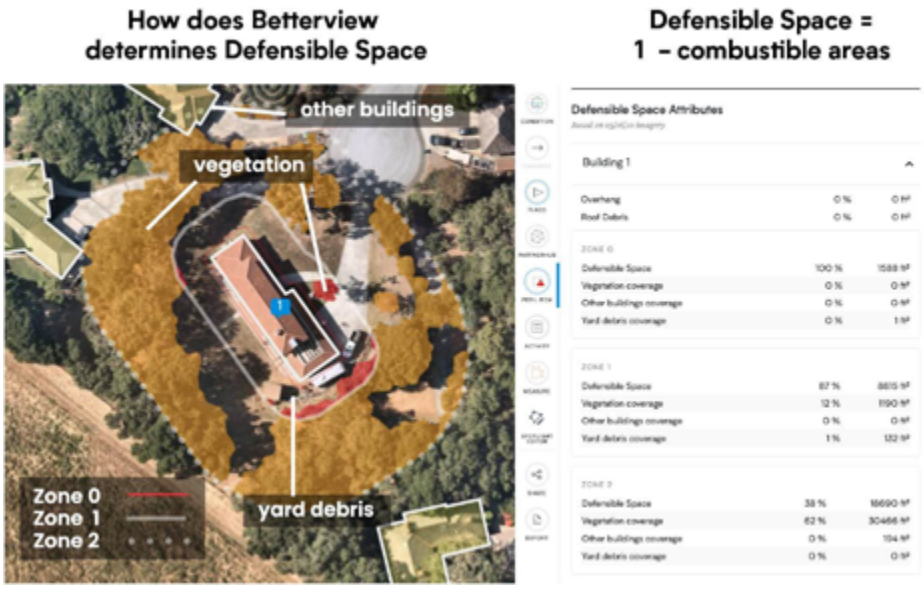

Figure 4: The Betterview Defensible Space Map.

Using data from California wildfire damage surveys, Betterview has found that our defensible space estimates are a strong predictor of structure loss. Buildings with more than 75% defensible space in Zone 0 have 1.7 times lower odds of being damaged when impacted by a wildfire. With more than 75% defensible space in Zone 1, the odds of being damaged are 1.5 less, and with more than 75% defensible space in Zone 2 the odds are 1.9 times less. Therefore, reducing vegetation in Zone 2 reduces risk the most, but when considering the relative size of the zones, a property owner should also consider clearing the much smaller Zone 0.

Wildfire Vulnerability Score

Defensible space is a key driver of overall wildfire vulnerability, but it's not the only one. Betterview determines a structure's vulnerability to wildfire based on a range of factors, which are combined in the overall Wildfire Vulnerability Score. And, because the individual factors influencing the score are made available to the user, the Wildfire Vulnerability Score provides transparent, precise, and up to date monitoring of building and property characteristics that affect overall wildfire risk.

Betterview assigns each structure on a property a Wildfire Vulnerability Score, ranging from 1 to 5. Our studies of past wildfires show that the Wildfire Vulnerability Score provides significant lift in predicting structure damage (Figure 5). Structures scoring a 1 are high-vulnerability structures and have ~1.5 times higher probability of being damaged when hit by a wildfire than average. Structures scoring a 5 are low-vulnerability structures and have approximately half the probability of being damaged when hit by a wildfire. Structures scoring a 3 have an average probability of being damaged. Of properties exposed to wildfire, most of those properties score a 3 (Figure 6).

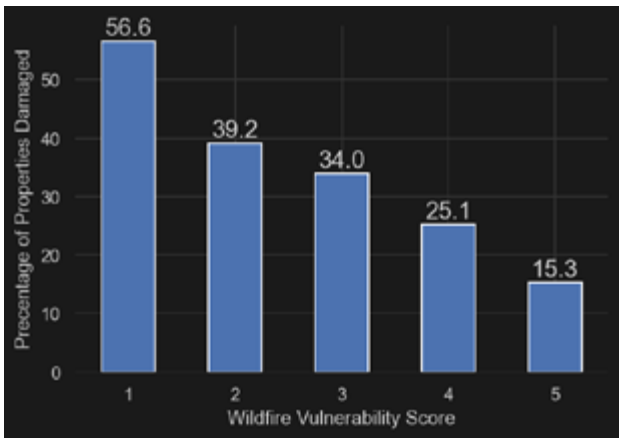

Figure 5: Percentage of properties damaged for a given Wildfire Vulnerability Score. A model with no skill would have a uniform distribution (all bars roughly the same height).

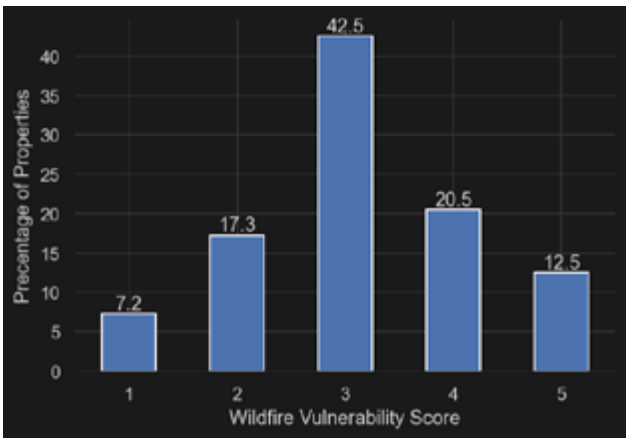

Figure 6: Distribution of Wildfire Vulnerability Scores for properties that have been exposed to wildfire.

Historical Wildfire Data

The Betterview Wildfire Vulnerability Score is based on data from 10,000 structures exposed to 34 wildfires in California and Colorado. These structures were surveyed by expert teams of fire marshalls, and the final result is a clean, highly detailed, and quality-controlled dataset of structure damage.

California surveys every property that has been exposed to wildfire. The California portion of the dataset contains data on the wildfires that have generated the largest wildfire related losses in the United States[5]. The Colorado wildfire data comes from the damage surveys performed in the aftermath of the Marshall Fire. The Marshall Fire was a rare instance where dense suburban developments were exposed to intense wildfire. Burn experiments by the Insurance Institute on Building and Home Safety (IBHS) with full size homes make it very clear that buildings in close proximity to one another can exacerbate wildfire spread[12]. Because there have been very few cases of dense suburban developments in California being exposed to wildfire, inclusion of the Marshall Fire data improves the Wildfire Vulnerability Score performance in suburban areas.

The damage surveys provide information of the degree to which a building has been damaged by wildfire. There are four damage classifications: Affected (1-9% damaged), Minor (10-25% damaged), Major (26-50% damaged), and Destroyed (>50% damaged). 33% percent of the structures in the dataset were damaged. Of all the structures in the dataset that experienced some level of damage, 94% were considered a total loss (Figure 7). Structures that are damaged by wildfires are almost always a total loss.

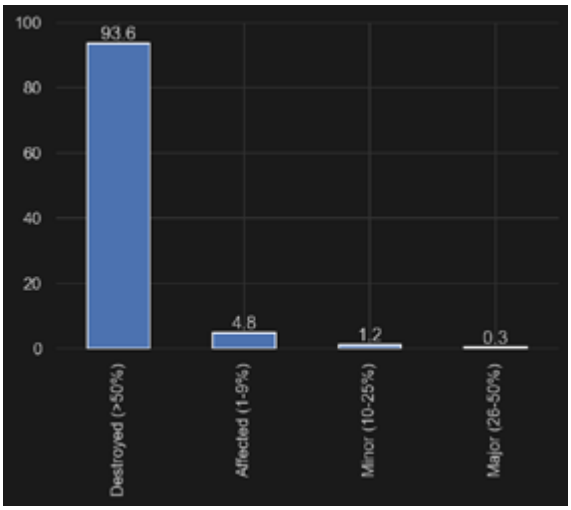

Figure 7: Distribution of damage severity among damaged structures.

Predictive Analytics Model

Betterview's Wildfire Vulnerability Scores are calculated at the building level and are based on detections made by Betterview's computer vision models, as outlined in Table 4.

Several factors that, upon initial inspection, appeared to improve predictive power were ultimately left out of Betterview's Wildfire Vulnerability Score, as this suggested predictive power was actually hazard-correlated and not a true measure of vulnerability. For example, the data suggests that buildings in close proximity to one another are less likely to be damaged in a wildfire. However, this signal is a byproduct of the distribution of hazard within the dataset. Wildfire hazard is higher on the wildland-urban

Factor	Description
Defensible Space (Zones 0, 1, 2)	More defensible space means less combustible material near a home
Yard Debris (Zones 0, 1, 2)	Yard debris can be ignited by embers, and then the yard debris can ignite the building
Rust	Rust on roofs is strongly correlated with loss, corresponding to the many metal roof farm buildings that are destroyed by wildfire
Tree Overhang	Overhang can be ignited by embers, and then the branches can ignite the roof of a building
Roof Debris	Combustible debris on the roof can be ignited by embers and then burn the structure
Roof Material	Material such as clay tile provides more protection from embers and burning materials that can be blown onto a roof than other more vulnerable roof materials like asphalt shingle

Table 4: Factors used by the model when predicting structure survival.

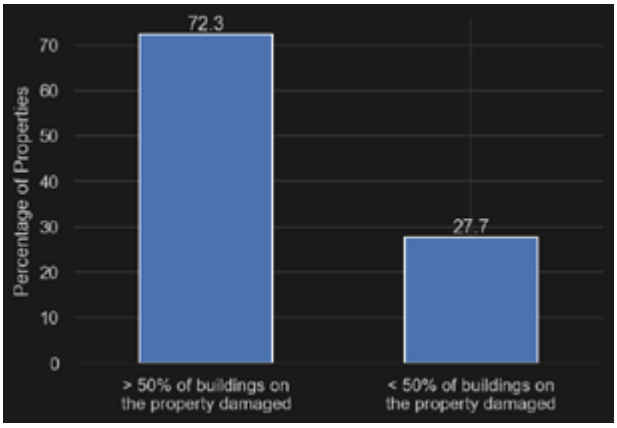

Figure 8: Wildfire often leaves some buildings on a property undamaged: of multi-building properties that had at least one building damaged, 27.7% of those properties had fewer than half of the buildings damaged.

interface (WUI), which tends to be sparsely developed, than in suburban and urban communities, which tend to have more dense building development. While this signal is real, it is not a reflection of vulnerability and should be captured by a robust wildfire hazard model. By capturing the nuances of this and other risk factors including the Defensible Space mentioned in the above section, the Betterview Wildfire Vulnerability Score is both more accurate and more transparent. Such granular results also empower insurers to engage with policyholders to mitigate risk.

Building vs. Property Vulnerability

The California survey data demonstrates clearly that buildings on the same property can suffer different degrees of damage despite nearly identical location (i.e., identical hazard) (Figure 8). Further, we found through our research that all of the factors that affect wildfire vulnerability are unique to a building, and that scoring at the parcel level can miss important risk factors, particularly when they pertain to smaller out-buildings or sheds (Figure 9). For this reason, Betterview's Wildfire Vulnerability Score is generated at the building level, providing the most complete and differentiated view of wildfire susceptibility on the market.

Prevent Avoidable Losses & Protect More Homes & Businesses

A good measure of wildfire risk requires both a measurement of the hazard impacting the location as well as the vulnerability of the exposed asset. Insurers can access both of these critical data points through

Figure 9: A property with five buildings affected by the LNU Lightning Complex Fire ($2.34 billion in losses). Wildfire Vulnerability Scores shown in green, yellow, and orange shapes (top). The buildings were all surveyed by fire marshals: three were destroyed, one suffered minor damage, and one was undamaged (top). The buildings with the least/no damage had the most defensible space (middle). Imagery from shortly after the fire confirms the damage reports from the fire marshals (bottom).

Figure 10: Wildfire Hazard and Vulnerability of a property as seen on the Betterview user interface (UI).

Betterview Wildfire Risk Insights:

- Hazard – Third party hazard modeling vendors via Betterview's PartnerHub
- Vulnerability – The Betterview Wildfire Vulnerability Score and Defensible Space map

The combination of the two complementary data points allows insurance carriers to flag buildings based not only on how wildfire-prone their location is, but also based on how susceptible they are to experiencing a loss if hit by a wildfire. The power from these data points is unlocked through their combination. By leveraging only one, insurance companies miss out on important aspects of catastrophe risk when pricing and underwriting.

By excluding vulnerability and focusing exclusively on wildfire hazard, insurers may opt not to write policies for structures that have mitigated wildfire risk through reduced vulnerability, thereby potentially missing out on good risks. Conversely, by excluding wildfire hazard and only considering vulnerability, insurance companies may over-index on some features of the property that are only relevant when the property is exposed to wildfire, thereby also missing out on business opportunities.

The presence of both property-level vulnerability insights and regional hazard data gives Betterview users a complete and actionable view of wildfire risk. When insurance agents and underwriters have the right insights, they can proactively work with policyholders at a higher risk of wildfire damage, recommending mitigation measures such as vegetation clearance, tree overhang or roof debris removal, truly protecting homes and businesses.

Consider these two properties (Figure 11) that are located in areas with a high likelihood of wildfire (i.e., high hazard):

These neighboring homes were hit by the 2020 River Fire (Figure 11 & 12): the top left home with a Vulnerability Score of 4 and a large amount of defensible space, survived. The bottom right home with a score of 2 and no defensible space, was completed destroyed.

For the destroyed building, much of the vegetation within Zones 0-2 burned, contributing to the total loss of this home (Figure 13). This example shows the importance of both property-level vulnerability insights and regional hazard data. But don't just stay in the mindset of repair and replace, you can do much more and become an insurance hero!

Figure 11: Two neighboring homes that were in the 2020 River Fire.

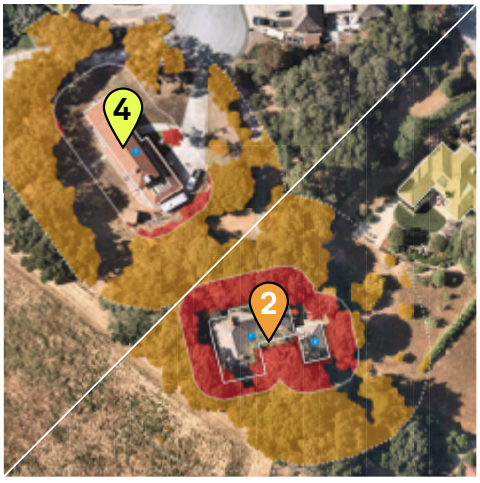

Figure 12: Imagery of both homes with defensible space maps. Wildfire Vulnerability Scores shown in yellow and orange shapes.

Figure 13: The aftermath of the wildfire that destroyed the bottom right building (blue marker) in Figure 11 & 12.

From Repair and Replace to Predict and Prevent

The main driver of wildfire vulnerability is lack of defensible space, and depending on the cause of it, lack of defensible space may be more or less mitigatable. Betterview has found that for the highest risk properties — those with little defensible space in wildfire hazard areas, the most common driver of indefensible space is vegetation, meaning a major driver of wildfire risk in these areas is actually under control of property owners. From the above example (Figure 11 & 12, bottom right home), wildfire risk would have been 2.6 times lower if the property owner had removed all the vegetation on the property. What if the insurance company could have stepped in and helped them save the property, avoid massive disruption, loss, and pain, and been the hero to help avoid this tragic event? You can be that hero.

With Betterview, rather than wait for disaster to clear the vegetation, and any structures along with it, you can use our predictions to prevent the loss in the first place. With a complete picture of wildfire risk, you can protect the homes and businesses that need your help the most. Betterview provides a single, easy-to-use platform that houses both property-level vulnerability and regional hazard data, allowing you to make accurate underwriting decisions quickly. Schedule a demo with us now to experience the power of predict and prevent!

SCHEDULE A DEMO

> But don't just stay in the mindset of repair and replace, you can do much more and become an insurance hero!

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Madeleine leads Betterview's Data Science team, which crafts datasets used to train Betterview's models, evaluates models to measure and improve performance, and conducts studies to quantify the value of Betterview's data for insurance carriers. Madeleine received her PhD from Columbia University and has held positions at Guy Carpenter and Blackboard Insurance.

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