CoreLogic

A Comprehensive View of Wildfire Hazard and Risk

September 2023

Introduction

Wildfire activity is becoming more extreme and destructive with more record-breaking fire events in terms of number of structures lost and acres burned in a single event. In the western U.S., wildfires are breaking out earlier in the spring and burning well into the fall. Between 1983 and 1992, wildfires consumed an average of 2.7 million acres per year. Over the last ten years, the annual average burned amounted to 6.8 million acres per year. This was driven by three years in particular (2015, 2017, and 2020), when more than 10 million acres burned each year.

Over the last several years, as the climate continues to change, we can see that wildfire is emerging from its secondary peril status, becoming more consequential for property owners, insurers, and other stakeholders.

In response to the growing risk of wildfires, CoreLogic offers a complete suite of wildfire hazard and risk assessment products to assist insurers with all phases of the insurance lifecycle process.

Offering end to end solutions from point-of-sale acquisition and underwriting through the complexities of risk pricing and catastrophe risk and capital management, the deterministic based hazard assessment models, Wildfire Risk Score (WFRS) and Wildfire Mitigation Score (WFMS), are highly suited to the development of underwriting guidelines and for individual case-level underwriting or pricing use.

WFRS is available in 16 states, while the WFMS is a California-specific compliant wildfire hazard assessment tool that includes 12 state-mandated wildfire mitigation items.

CoreLogic also offers its U.S. Wildfire Model –a full simulation probabilistic model covering 14 states that can be used for portfolio analysis and management, as well as in the development of rating territories based on a modeled relativity analysis. The CoreLogic U.S. Wildfire Model can also be leveraged in the pricing of some products where flexibility is permitted.

This paper will elaborate on the three models and how they may be used to better assess and manage the wildfire peril.

Wildfire Risk Score

The CoreLogic Wildfire Risk Score (WFRS) is a deterministic wildfire model which evaluates the exposure of a property to wildfire in sixteen states. After assessment, the WFRS returns an easy-to-understand, normalized score on a scale of 1 to 100. The following factors are incorporated into the score:

- Fuel: Different types of vegetation cause variability in the intensity of wildfire spread, and certain species are more apt to carry wildfire. The density of vegetation is also an important factor.
- Slope: Steep slopes can accelerate fire spread and contribute to a higher intensity burn.
- Aspect: The cardinal direction which the slope is facing often carries implications about the ignitability of the fuel. For instance, southerly slopes are drier and warmer, and this makes for fertile ground from where wildfire, once ignited, may spread more easily.
- Drought: Persistent, intense drought conditions over recent years contribute to both the dead fuel load and also make live fuels drier and more susceptible to fire.
- Wind: Factors related to sustained and/or high winds that have been occurring over recent years contribute to the intensity of a fire as well, as winds can generate embers which may then be carried onto vulnerable properties or become the source of multiple spot fire ignitions that outpace suppression.
- FIREBreak+: The density of development at the location of a structure can influence the likelihood of wildfire encroachment. As development increases, areas of viable fuels tend to decrease.
- Proximity to Wildland: Large open expanses of undeveloped land can contribute to fire propagation and fire intensity. Wildland area is relevant as undeveloped areas tend to support large fires, being that they are uninterrupted avenues for fires to follow. These areas when ignited can also produce embers.
- Fire History: Areas that have burned previously often carry a certain proclivity to burn again. This factor functions to represent burn history and frequency.

The Wildfire Risk Score is calculated to reflect the current risk for address locations or geocoded coordinates. One especially dynamic aspect of the model is that it reflects reduced risk in areas where wildfires have taken place.

When a property falls near or within a previously burned area, we also calculate and include the 'pre-burn' risk score in the WFRS report. The 'pre-burn' score reflects fuel and hazard conditions in their natural, undisturbed state prior to the occurrence of a wildfire event. Over time, the composition of the vegetation within a burn scar may regrow, and the hazard will often increase to pre-fire levels.

Understanding that the vegetation composition increases future risk in a location is critical for proper long-term risk understanding. As such, the 'pre-burn' risk score is a key product differentiator of the WFRS – a feature unique to CoreLogic. It provides clients with valuable information on the long-term risk associated with a property during the underwriting process and beyond.

Finally, we closely monitor the changing climate and weather patterns for signals that affect wildfires. As recent events have shown, wildfires are starting earlier in the Spring and extending longer into Fall. Fire season is quickly being replaced by the 'Fire Year' in many areas. Some of the most damaging events are heavily influenced by the effects of wind, drought, and changes in vegetation condition. Seeing the increasing wildfire hazard across much of the Western U.S., CoreLogic wildfire scientists acted in 2021 to surgically increase wildfire risk scores to reflect these changes. This included the additions of wind and drought factors to the WFRS product, and the California fuel/vegetation layer was updated with higher resolution data to improve the identification of high-hazard vegetation types contributing to extreme wildfire events.

Validation of the Wildfire Risk score models is a continuous process. Our goal is to not only show that high risk locations are more likely to burn in wildfire events, but also that low risk locations are less likely to be damaged – by calculating a damage ratio, or the percentage of locations that are damaged, by risk grouping. We can look at individual events, or an aggregation of events, and do the following analysis. The first step is to determine which locations had damage in a selected event, or as shown in the table below, all the Single-Family Residence (SFR) locations that were damaged in a wildfire in the state of California in calendar year 2021.

After the Wildfire Risk Score is appended to each of the SFRs with damage (using the Wildfire Risk score at the time of damage, not the present score), you can summarize the results by grouping them into deciles based on the Wildfire Risk Score. As you see in the table below, you then compare the number of SFR's with damage, to the total number of SFRs in the state; the ratio of the # damaged / Total state is the damage ratio. As Table 1 shows, the damage ratios are very low for the low-risk ratings, and significantly higher than average for the high-risk locations. This validation is done routinely and has continued to show that the model is identifying the locations that are most likely to be damaged in a wildfire event.

Single Family Residential (SFR)				
WFRS Decile	2021 SFR # Damage	SFRCA Total State	2021 Damage Ratio	2021 Relativity
1-10	–	6,388,594	0.0000%	–
11-20	2	171,941	0.0012%	0.05026
21-30	8	472,907	0.0017%	0.07310
31-40	9	917,346	0.0010%	0.04240
41-50	92	299,763	0.0307%	1.32625
51-60	73	257,446	0.0284%	1.22533

61-70	211	270,333	0.0781%	3.37286
71-80	198	181,402	0.1091%	4.71669
81-90	494	302,902	0.1631%	7.04757
91-100	1,120	274,480	0.4080%	17.63283
TOTAL	2,207	9,537,114	0.0231%	

Table 1: Comparison of Actual and Fitted Risk Relativity Ratios

The data represented in the Table 1, is also shown in Figure 1, to provide a visual representation of single-family residences broken by wildfire risk score decile and the associated damage relativity.

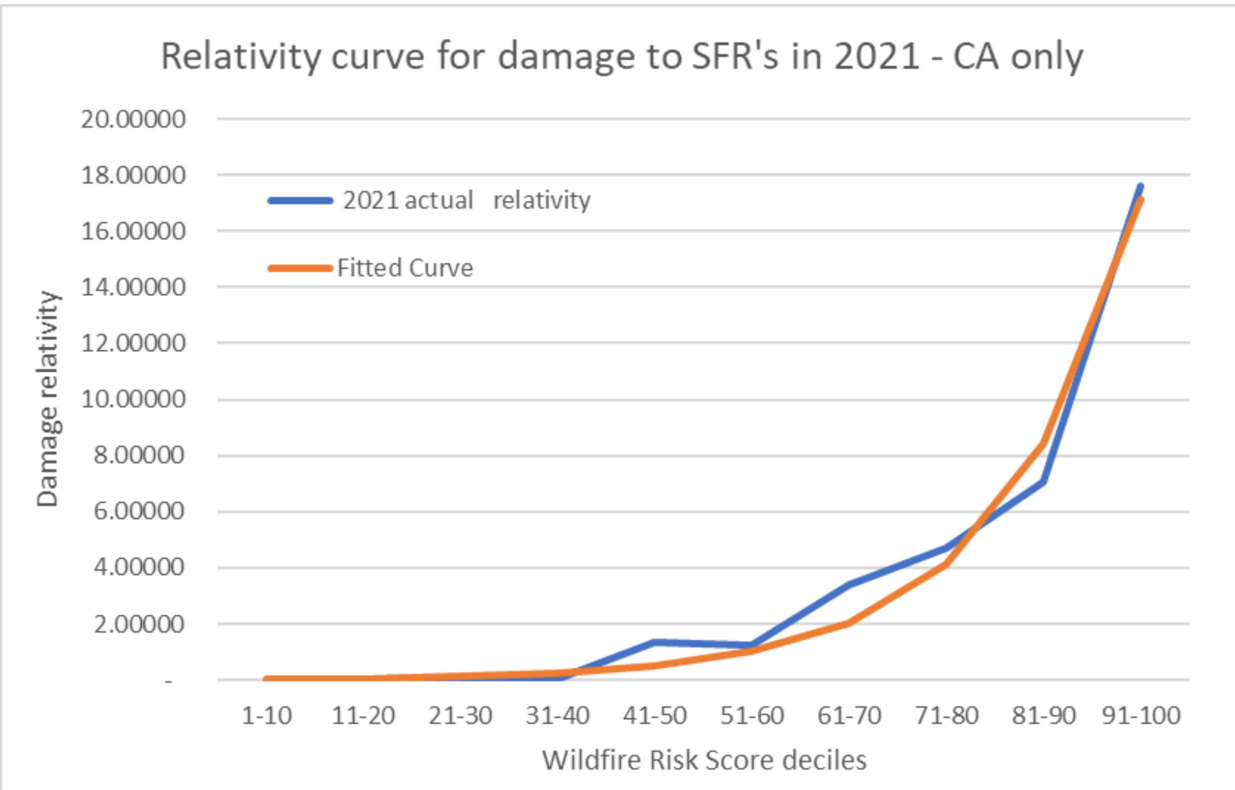

Figure 1: Comparison of Actual and Fitted Risk Relativity Ratios

Wildfire Mitigation Score (California Only)

In response to the California Department of Insurance regulation Title 10 CCR 2644.9 requiring mandatory recognition of wildfire mitigation efforts, the CoreLogic® Wildfire Mitigation Score (WFMS) was developed. This solution begins with WFRS as a basis but then leverages Artificial Intelligence (AI) and Machine Learning (ML) to identify the presence of and provide score reductions for each of the twelve community, property, and building hardening mitigation measures. WFMS is returned in a 0.1 to 100 score. There are also provisions for a carrier to enter known or verified mitigation details unique to their portfolio and generate a new Wildfire Mitigation Score based on their inputs. In keeping with the CDI's demand for transparency, policyholders can then be provided with a copy of the report in order to see what mitigation items are being counted and which remain to be done.

U.S. Wildfire Model

The CoreLogic® U.S. Wildfire Model is a full simulation probabilistic model designed to quantify wildfire risk to properties in financial terms on both a ground-up damage and insured loss basis. This model is designed both for individual properties and for portfolios of properties. The U.S. Wildfire Model provides alternate views of risk and additional loss factors that allow for more informed decisions using metrics such as:

- Average Annual Loss (AAL)
- Exceedance probability (EP Curve) on both an occurrence and aggregate basis
- Uncertainty (Standard Deviation)
- Probable Maximum Loss (PML) at 50, 100, 250, 500 Return Periods
- Tail Value at Risk (TVaR) – a risk measure that quantifies the expected loss amount given an event outside a given probability occurred

The alternate views of risk include low, average, and high-risk views, reflective of seasonal variations in fuel loads and weather conditions, with the average risk view being the default. These alternate views of risk can be selected on a regional or even local basis. The average risk view provides the most direct comparison with the Wildfire Risk Scores.

The probabilistic model employs similar data layers as those used in the Wildfire Risk Score model. Fuels are held constant and are represented in the 'pre-burn' condition previously described. In addition, the U.S. Wildfire Model incorporates the factors below in its simulation-based approach to generate wildfire events and model wildfire behavior.

- Wind Direction: This is a critical factor in the direction of fire spread. In much of the West Coast of the U.S, severe fires are strongly correlated with offshore wind flow, as onshore wind flow is much cooler and much more humid. Hence, locations along the inland margins of wildland areas relatively near the coast have reduced risk, as severe wildland fires will have a strong tendency to spread away from them, not toward them.
- Humidity: Severe, rapidly spreading fires are strongly correlated with low humidity.
- Temperature: Severe, rapidly spreading fires correlate with high temperatures.
- Size of Adjacent Wildland Areas: Properties adjacent to wildland areas broken up by substantial firebreaks in the form of rivers, lakes, major roads, agricultural fields, and developed areas of residential or commercial properties, etc. have lower risk than properties adjacent to large areas of continuous wildland. This can be a significant factor, driven by reduced chances that an ignition can spread into a large fire that is very difficult to contain.
- Frequency: Explicit consideration of the frequency of each potential wildfire event and of the full spectrum of wildfire events that can affect a given location is a critical component in determining the risk.
- Suppression: The mitigating effects of water supplies and access to firefighting resources, including aerial bombardment with water and/or fire-retardant agents, are a very important consideration, and can vary substantially from one community to another.
- Insurance Conditions: Deductibles and limits reduce an insurer's exposure to ground-up damage caused by a wildfire.

- Vulnerability: Properties with different structural characteristics perform differently in wildfires, e.g. a fire will burn and consume a structure of combustible material like wood, but may be less likely to cause significant damage to a building constructed with non-combustible materials. The following factors can influence the vulnerability: defensible space, roofing class, ignition resistant siding, sprinklers, combustible attachments, fire-resistant doors, dual pane tempered glass windows, and community fire awareness. Other structure mitigations include constructing eaves with fire-resistive materials, covering vent openings with corrosion-resistant and non-combustible wire mesh or screen to reduce firebrands from entering structures, locating propane tanks at least 30 feet from any structure, using metal gutters and keeping gutters clear, using tempered glass for skylights, etc.

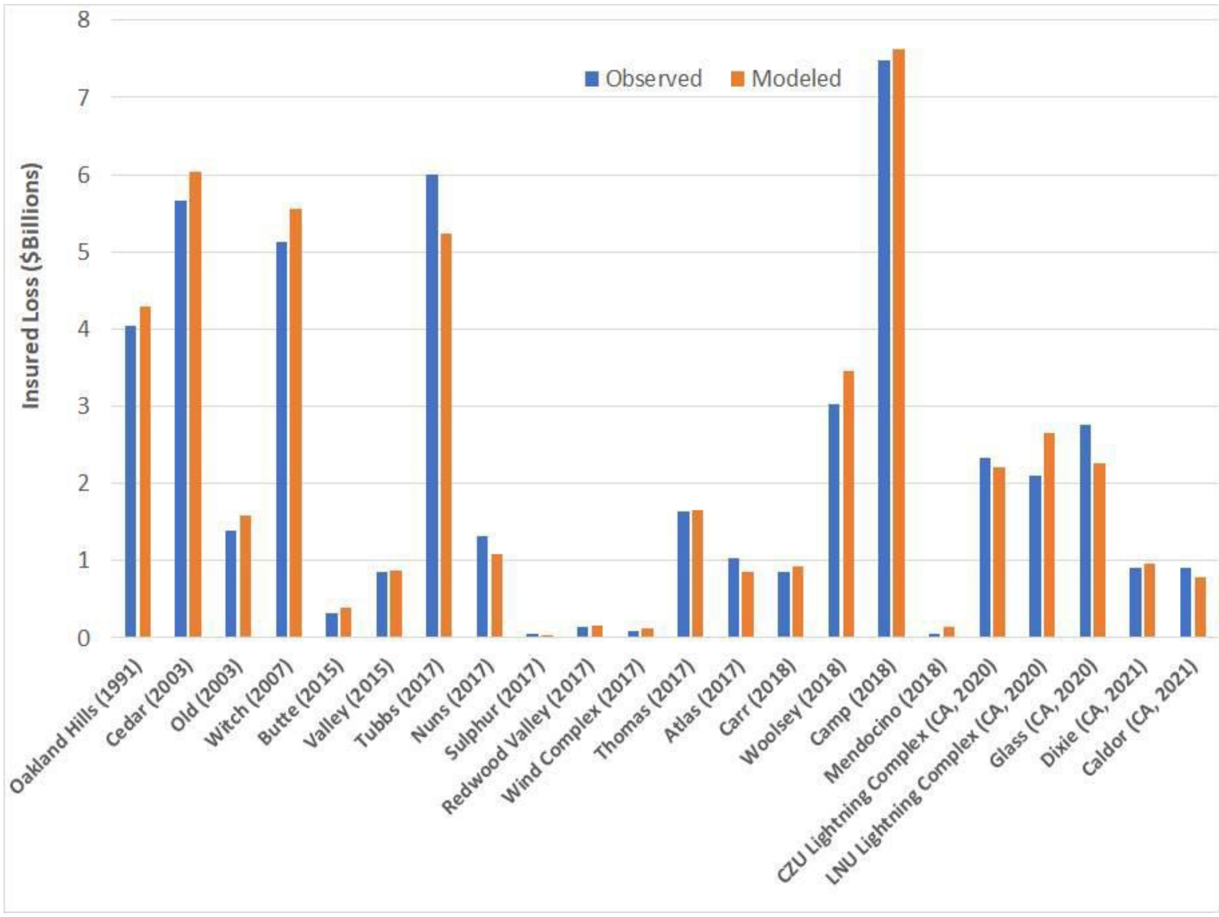

Figure 2: Residential Insured Losses in California 1991

Figure 2 compares CoreLogic's modeled losses with the observed losses for California's historical wildfire events for the state's residential exposures. The modeled losses demonstrate reasonable agreement with the reported losses.

Comparison of the WFRS and U.S. Wildfire Model

WFRS has long been an essential tool for screening, risk selection, underwriting and pricing. Using the WFRS and a probabilistic model in tandem, however, brings even more power to assess higher risk properties, as the use of both allows quantification of structural vulnerability and completed mitigation techniques to measure the overall portfolio risk.

The CoreLogic WFRS considers fuel, topographical features, wind, drought, and the relative distance from a property to wildland and higher hazard fuels (to account for the potential threat from ember ignitions.)

Higher weights are given to fuel-based metrics, and lower weights are assigned to topography. The resulting Wildfire Risk Score may be placed into one of the following four risk classifications: Low, Moderate, High, and Extreme. The higher the score, the greater the relative level of wildfire hazard. The probabilistic U.S. Wildfire Model builds upon the base of the Wildfire Risk Score model inputs and further considers fire weather conditions, frequency of past fires, fire suppression, mitigation measures, and building characteristics to assess the susceptibility of properties to damage.

In recent years, CoreLogic released significant model updates to include the latest high resolution vegetation data, accounting for the increased hazard in certain fuel types. We also updated fire propagation into the built environment and revised the vulnerability component based on recent wildfire experience.

At the aggregate level, the Wildfire Risk Score and the U.S. Wildfire Model are generally well correlated. Due to the specific purposes of each model, when dropping down to the property level, some degree of divergence is anticipated.

The WFRS provides a view of the hazard, based on fuel and topography that affects fire behavior. On the other hand, the U.S. Wildfire Model perspective combines both the hazard and structure characteristics. Much of the variance between the models can be explained by the broad range of aggregated simulated events, and the inclusion of property characteristics and secondary risk modifiers that are available as inputs to the U.S. Wildfire Model (that are not integrated into the Wildfire Risk Score). In some cases, including these characteristics as inputs (i.e., Defensible Space Zones, Class A roof covering, Fire resistive siding materials) can reduce the risk and the subsequent AAL.

Below are scenarios where a high WFRS and lower AAL may occur:

- Due to the proximity of hazardous fuels to the property and a lower fire frequency, it is possible to have a high Wildfire Risk Score with a low AAL. For example, certain fuels are known to be highly combustible, and this would influence the WFRS. If ignition frequency is low, this could lead to lower AALs.

- The U.S. Wildfire Model accounts for suppression, whereas the WFRS does not. Areas with high suppression actions may help to slow fire spread even in higher hazard areas. This may produce lower AAL results.

- The vulnerability characteristics, which include roofing, siding, perimeter clearance, and community mitigation *significantly* influence the U.S. Wildfire Model's results. On the other side, the WFRS does not consider structure characteristics. Vulnerability calculations are particularly sensitive to the definition of the structure being analyzed.

Below are the factors that may create a low WFRS but a higher AAL:

- The U.S. Wildfire Model represents long-term fuel conditions. The current WFRS reflects recent fuel conditions that may be lower due to previous fires. The pre-burn WFRS represents fuel conditions before the fire occurred and is more closely aligned with the U.S. Wildfire Model. When comparing results of the two models, we recommend using the WFRS pre-burn value (where available) and comparing that to the U.S. Wildfire Model results.

- Recent urban development can drastically change the fuels that are present on the ground, as the density and quantity can vary greatly at or near the location. For such areas undergoing recent development, the U.S. Wildfire Model will reflect the pre- development fuels and the WFRS will reflect the current fuels presently on the ground.

- The U.S. Wildfire Model considers urban conflagration (where the primary fuels are the adjacent structures rather than vegetation) and the spread of fire into the built environment. To the extent a location is affected by urban conflagration, this may lead to higher AAL results.

Any additional deviations between the WFRS and AAL are constantly evaluated to systematically locate, understand, and improve the outputs for both models.

Employing both the WFRS and the U.S. Wildfire Model

As we can see from the discussion above, a property with a high (or low) WFRS doesn't measure expected loss, but instead measures the *likelihood* of high (or low) damage based on the physical surroundings of a structure.

A property with low AAL and high WFRS indicates that the current wildfire hazard is high, but based on the modeled AAL, the chance of significant damage is relatively low due to the building characteristics or other fire science metrics accounted for in the model. Such metrics include spread, suppression, and severity of fires.

Considering these dynamics between the two models, below is a scenario to showcase how WFRS and the U.S. Wildfire Model can be used in tandem to allow for further success in accurately pricing policies and assessing risk:

Risk Selection Scenario:

As illustrated in Figure 3 below, a user would start with the WFRS as the primary view of risk until the scores exceeded a certain threshold. From this point, metrics from the U.S. Wildfire Model could be employed in a secondary review of the property. This additional review could involve using the AAL and/or PML, which account for factors not considered in the WFRS – like property mitigation that adjusts the vulnerability of the structure. The WFRS can provide further insights, essentially determining that the higher the WFRS, the more one should weigh the standard deviation of annual loss (on top of the AAL itself) in developing an AAL-based underwriting guideline. This would ensure that the guideline would be more commensurate with the risk to the actual structures.

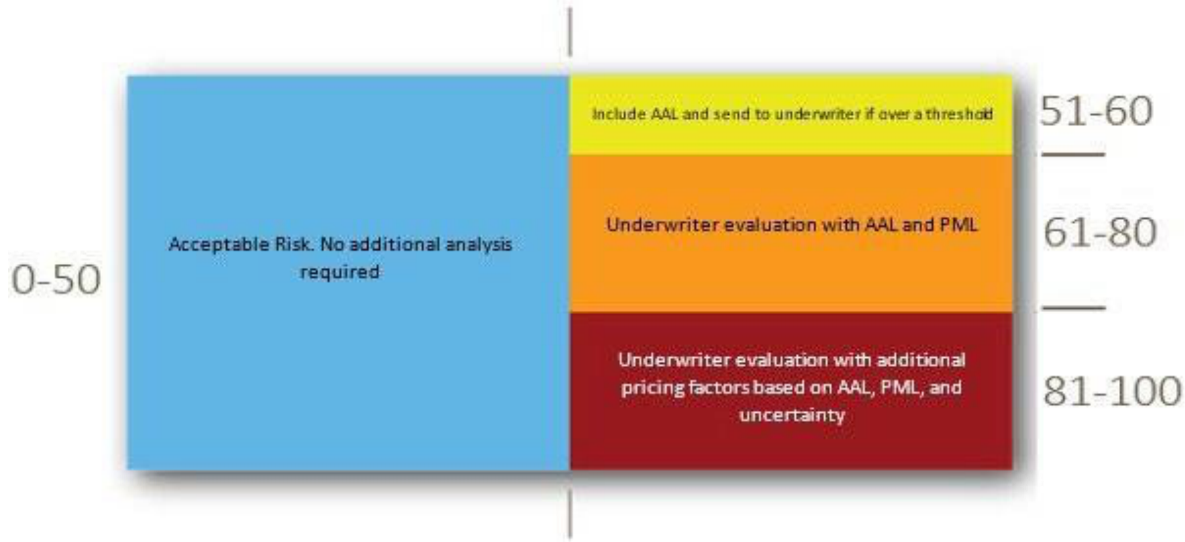

Figure 3: Example underwriting rules schema

Pricing and premium adjustments based on AAL would be subject to regulatory review and approval – based on state requirements. Premium adjustments are more widely available in the non-admitted market, and less so in the typical standard homeowner line. On the commercial side, it may be possible to include a CAT modeling section in the IRPM debits/credits schedule to account for an AAL metric.

In the above scenario, the U.S. Wildfire's AAL would be considered when the pre-burn WFRS exceeds 50. The AAL measures the rate of risk from a long-term view with lower uncertainty at aggregated levels but higher degrees of uncertainty at the site level. The AAL is based on 300,000 annual simulations of what could happen during a given year.

Using this information, an insurance professional could select a set of similar properties with low, moderate, high, and extreme WFRS and associate the aggregated AAL to each score level and calculate a pure premium accordingly.

Figure 4 shows the relationship between the pre-burn WFRS and the loss cost from the U.S. Wildfire model for all residential properties in California. The chart compares the ratio of the AAL's (long-term average expected loss) to the reconstruction cost value (RCV's) of the corresponding properties, relative to the pre-burn WFRS. This shows a significant correlation between WFRS and the loss cost (dividing the AAL by the RCV produces a normalized loss cost) on an aggregate level. This was done by totaling up all the AAL's and RCV's for each WFRS decile, and then the Total AAL/Total RCV ratio can be calculated for each decile.

Figure 4 shows, the average AAL/RCV increases as the score increases, which reinforces that the models have significant correlation. We also see that the models are not perfectly correlated, which is not unexpected based on the differences in how the models are developed and used.

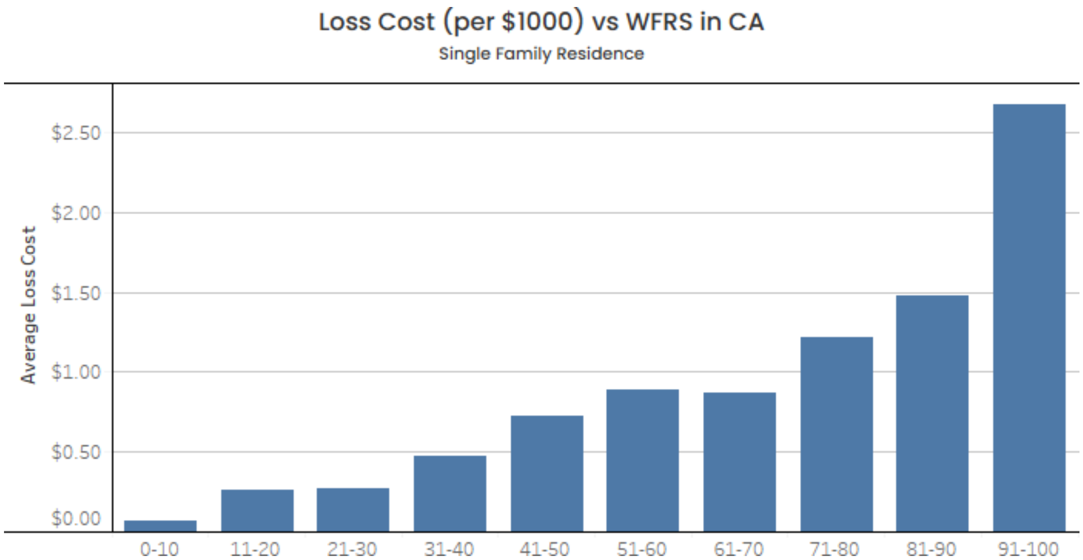

Figure 4: Agreement between probabilistic model and pre-burn Wildfire Risk Scores

In addition to the scenario presented above, the following are some additional value-added uses for an insurance carrier to consider with respect to using both WFRS and the U.S. Wildfire Model in tandem.

Underwriting Applications

- Risk selection and eligibility
- Inspection management
- Portfolio management and optimization
- Exposure concentration management
- Risk reduction strategies
- Attracting low risk policies and avoiding adverse selection

Rate Making Applications

- Individual risk pricing
- Territory relativity development
- Rating factor development
- Evaluating deductible strategies

Rating Agency & Reinsurance Applications

- Quantify portfolio performance over time

Conclusion

The CoreLogic suite of wildfire hazard and risk assessment products provide insurance carriers with a complete set of professional, science-based analytical tools to compete in today's rapidly changing environment. We incorporate the latest AI/ML techniques to deliver the most robust solutions and granular wildfire information available. From providing an understanding the physical hazard characteristics in Wildfire Risk Score, to demonstrating the reduction in potential loss provided by mitigation actions delivered by Wildfire Mitigation Score, to giving users power of a fully probabilistic U.S. Wildfire model, CoreLogic is your single source for all things wildfire.

Contact Us

If you have any questions or require assistance, please contact your Account Services Professional or insurancesolutions@corelogic.com