Predicting Structure Loss from Wildfire

Many of the conditions which facilitate large and high-intensity wildfires are not necessarily conducive to structure (i.e. insured) loss, and this has been a considerable drawback of existing wildfire risk models. Wildfire structure-losses in the hundreds to thousands of units is a relatively new trend in the US and globally. In California, and prior to 2000, extensive structure-losses occurred on relatively isolated events, such as the 1970 Laguna Fire (382 structures) and the 1990 Painted Cave Fire (427 structures), both in Santa Barbara County along the southern coast of California. As these losses were considered relatively isolated and infrequent, there has been little interest in trying to improve prediction of structure loss. Further, as with natural disasters more broadly, quantifying the vulnerability of structures to wildfire in order to characterise risk is a function of interacting predictors at multiple spatial and temporal scales.

Catastrophic (i.e. structure-loss) risk from wildfires is generally dependent upon four groups of factors: structural construction, fuel composition and arrangement around the structure, fuel availability/flammability as a function of climate and weather variables, and human factors (see below). The likelihood of structure-loss is dependent upon each of these, but they are not all easily quantifiable.

Trying to model future structure-loss given the incompatibility between the three spatial scales, the lack of accurate data at finer scales, and the significant influence of random human factors makes it exceedingly difficult to do so. Further complicating such efforts is that probability of structure-loss is conditional upon a wildfire ignition, which is also difficult to predict with high accuracy.

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By Catherine Pigott and
John Wardman

Figure 2: Major factors known to affect structural survival and loss during wildland fires

FINE SCALE: Structural construction
- Materials (roofing, siding, windows, doors, decking)
- Potential for ember intrusion (attic vents, unenclosed eaves, gutter, roof joints, chimneys)
- Home living components (flags, flower pots, benches, toys, outdoor furniture, wood piles)

MODERATE SCALE: Fuel composition and structure
- Landscaping (ground cover, irrigation, fencing, wood features, flammability of plant vegetation)
- Surrounding fuel matrix (native vegetation composition, community landscaping, neighboring home composition)
- Topography (slope, aspect, topographic position)

COARSE SCALE: Climate/weather factors control fuel availability)
- Climatology determining fuel composition and fire season
- Climatological anomalies (drought, El Niño, Southern Oscillation, pluvial conditions)
- Meteorology during fire (temperature, moisture, wind)

HUMAN FACTORS (not measurable)
- Maintenance of structure and landscaping
- Condition of structure when evacuated (eg, were doors and windows all shut?)
- Fire suppression actions taken (eg, retardant drop, fire engine with water present)

Recent development of structure-loss datasets both nationally and in California has facilitated new research in this area to better understand predictors of structure-loss from wildfires. Both Syphard and Keeley (2019)[1] and Alexandre et al. (2016)[2] found it difficult to predict the factors contributing to structure-loss, with both noting limits to the data available and problems with data interpretation. Further, both efforts make key inaccurate assumptions likely based on lack of field observations of structure-loss fires. Their difficulties in developing predictive models, however, serve to inform the research directions at AXA XL. Also, collaborative partnerships with experts from the Leverhulme Centre for Wildfires, Environment and Society, the Insurance Institute for Business and Home Safety and the University of California, Merced exemplify our commitment to implementing the best science when developing views of wildfire risk.

References

1 Syphard, A. D., Rustigian-Romsos, H., Mann, M., Conlisk, E., Moritz, M. A., & Ackerly, D. (2019). The relative influence of climate and housing development on current and projected future fire patterns and structure loss across three California landscapes. Global Environmental Change, 56, 41-55.

2 Alexandre, P. M., Stewart, S. I., Keuler, N. S., Clayton, M. K., Mockrin, M. H., Bar, Massada, A., ... & Radeloff, V. C. (2016). Factors related to building loss due to wildfires in the conterminous United States. Ecological applications, 26(7), 2323-2338.

About the Authors

Catherine Pigott has a BSc. Mathematics and FIA. She leads AXA XL's divisional Science & Natural Perils team, which is responsible for driving applied scientific research and academic collaborations within AXA XL. The team are also responsible for third party cat model evaluations, cat model development and cross segment portfolio analytics in the area of natural perils within the division. Catherine joined AXA XL, previously Catlin, in 2009 as the Business Group Actuary for Short Tailed Treaty lines and has held several positions since then, predominately focusing on catastrophe exposed business. Catherine is based in the UK and can be reached at: catherine.pigott@axaxl.com.

John Wardman, PhD, FGS, is a Senior Specialist on the AXA XL Science & Natural Perils Team where he helps to build and inform views of catastrophe risk, assist CAT model evaluation and validation, and support product development. John's role also includes engaging with scientists and university departments from around the world, facilitating the translation of academic research into business impacting information and data.
John is based in the UK and can be reached at: john.wardman@axaxl.com.