Award Winner

Where There's Smoke There's Fire: Actuarial Considerations in Catastrophe Modeling

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While catastrophe models contend with countless hypotheticals, they reveal one certainty in the wake of the 2025 LA area wildfires: catastrophes are here to stay. The two largest of the LA wildfires, Eaton and Palisades, rank in the top ten deadliest[1] wildfires in California history and the top three most destructive.[2] Insured losses are estimated to range between $28 to $75 billion with total losses exceeding $250 billion,[3] squarely establishing the LA wildfires to be the costliest natural disaster in U.S. history. Wildfires' immediate effects are already battering the insurance industry in an existential crisis,[4] but the numbers only tell part of the story. Indeed, this is only the beginning, for the health and life insurance industries face repercussions,[5] not only in the immediate time horizon, but also decades down the line. Actuaries of any field must therefore adapt to the shifts in the wind: pricing and prediction mechanisms are now only part of the picture. A holistic actuarial practice centered around risk reduction and resilience is key to the survival of people, infrastructure, and the industry itself.

Modern catastrophe modeling took root in the 1950s,[6] but there has yet to be an official definition of "catastrophe" consistent across all insurance disciplines. The property and casualty (P&C) industry defines natural or manmade disasters that are unusually severe as catastrophes when claims surpass a dollar threshold of $25 million.[7] On the other hand, there is no such agreed upon dollar threshold for the health and life insurance industries. An August 2024 report published by the SOA Research Institute does, however, define traditional catastrophes as low frequency, high severity events, further noting that the term "catastrophe" has recently broadened "to recognize risks from downstream consequences and the accumulating impact of the initial" events that are higher frequency and lower severity than traditional catastrophes.[8] In light of these considerations, this essay will define catastrophes as either 1) low frequency, high severity events in the traditional sense; or 2) events that occur at relatively higher frequency and lower severity. Both types of events are catastrophes in the sense that, in the long term, costs add to significantly high exposure.

The definition of "catastrophe" is not the only aspect of P&C catastrophe modeling from which the life and health insurance companies may draw inspiration; life and health actuaries can learn from their P&C counterparts whose approach to catastrophe insurance would be best to adopt—or reject—for their own practice. The home insurance industry in the state of California has largely managed the risk of wildfires by either raising prices or taking its business out of the state entirely.[9] Allstate received the go-ahead to raise rates by 34% last August,[10] and State Farm recently obtained legal approval to soon raise premiums by 17%.[11] But for the insurance industry to weather the catastrophic storms to come, increasing prices or withdrawing businesses in risky locations is only a short-term solution. The fact that only $28-75 billion

was insured out of the LA wildfires' total losses of $250 billion indicates that even now, insurance industries are markedly limited in their ability to cover catastrophic costs.[3] The traditional insurance mechanism in the face of catastrophe is already broken, and no amount of catastrophe modeling can single handedly diversify the risk away. To remain solvent in the era of climate change, insurers must look to risk reduction and resilience as additional tools in the actuary's toolbelt.

The immediate effects of wildfire on morbidity and mortality include burns, smoke exposure, asthma flare-ups, and death.[12] The long-term effects, however, are more enigmatic due to the lack of relevant longitudinal data and the connection that was only recently made between catastrophes and their downstream consequences.[13] Despite these limitations, scientists have strong reason to believe that wildfire may leave lingering health problems in individuals years after the incident. A 2024 study concluded that the 2018 Camp Fire in Paradise, California alone may have killed 12,000 Californians prematurely as a result of smoke exposure.[14] Just as how the requirement of flame-resistant materials in building codes is an essential part of P&C risk reduction, preventative care is key to risk reduction in life and health insurance. While P&C risk reduction focuses on reducing the physical spread of wildfire between homes,[15] life and health risk reduction would focus more on regular health check-ups for common issues after the fire had already happened. For example, health screenings often include tests for lead in the body,[16] which is a rampant wildfire pollutant. Early detection of health complications may lead to more effective treatments, better outcomes, and cheaper healthcare in the long run.[17] Building up preventative care would set the stage for resilience as well in the event that people fall ill as a result of wildfire complications.

Although there is no panacea for an issue as complex and consequential as wildfire risk management, holistic and constructive steps can still be taken to mitigate such catastrophes. Until recently, traditional insurance has largely operated by diversifying away accidents via risk pooling. But climate change is neither an accident, nor can its risk be diversified away amongst policyholders. By adopting an approach that focuses not only on modeling but also considers the processes before (i.e., risk reduction) and after (i.e., resilience) a catastrophe, life and health actuaries can better manage risks to morbidity and mortality. Insurers are dealing with a fundamental change in the natural landscape that has changed the underlying risk profile of everyone, and actuaries must embrace the new risk paradigm of catastrophe modeling. The profession is not alone in this endeavor, however: collaboration with scientific communities across a slew of interconnected disciplines can help actuaries think outside the box and enhance their models with domain knowledge unique to non-actuarial experts. The challenge may seem monumental, but the insurance industry is undoubtedly capable of fighting wildfire with fiery resolve.

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