Award Winner

The Rising Heat: Catastrophe Modeling for Life and Health Insurance Amid LA's Wildfires

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INTRODUCTION

In recent years, Los Angeles has faced a dramatic rise in wildfires—both in frequency and intensity. These blazes are fueled by climate change, prolonged droughts, and urban expansion into areas naturally prone to fire. While wildfires have long been known for damaging property and natural landscapes, their impact now increasingly extends to human health and life expectancy.

Property and casualty (P&C) insurers have traditionally been at the forefront of managing wildfire risks, using catastrophe models to guide underwriting and financial reserves. But life and health insurers are just beginning to confront the full scope of these evolving risks—risks that extend beyond immediate damage to long-term health consequences.

This essay dives into how wildfires in the Los Angeles area are reshaping life and health insurance. It explores why traditional actuarial methods fall short, discusses new catastrophe modeling techniques designed specifically for life and health risks, and highlights the growing role of artificial intelligence and data analytics in better forecasting and managing these threats. The goal is to build a more comprehensive, tech-enabled approach that captures the real human cost of these environmental disasters.

REFRAMING CATASTROPHE RISK IN LIFE AND HEALTH INSURANCE

When it comes to catastrophe risk, property and casualty insurers have led the way by focusing on the immediate physical damage—homes, infrastructure, and vehicles destroyed by wildfires. But wildfires affect much more than buildings and property; they deeply impact people's health and well-being in ways that are often hidden or delayed.

For life and health insurers, this presents a complex challenge. Unlike property damage, health impacts from wildfire exposure can take months or even years to fully emerge. Issues such as chronic respiratory problems, heart complications, and mental health disorders may develop gradually, making it tough to connect these conditions directly to a wildfire event when underwriting policies or calculating reserves.

Traditional actuarial models tend to lean heavily on historical mortality and morbidity data, assuming that environmental conditions stay relatively stable. This approach is becoming less effective as climate change introduces new and interconnected risks. For example, wildfire smoke worsens existing health problems in

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vulnerable groups like older adults, low-income communities, and those with disabilities—yet insurance underwriting often lacks the detailed insight to reflect these nuances.

THE HUMAN TOLL OF LA WILDFIRES: MORTALITY, MORBIDITY, AND DISPLACEMENT

Los Angeles County, home to over 10 million people, has witnessed some of California's worst wildfires. The 2018 Woolsey Fire alone scorched nearly 100,000 acres, destroyed more than 1,600 buildings, and caused multiple deaths. But beyond the visible destruction, the health effects have been deeply felt:

- Rising Mortality: Research published in 2020 in the *Journal of the American Heart Association* linked wildfire smoke exposure to a 42% increase in sudden cardiac arrests in affected areas. Deaths also spike among seniors and those with chronic conditions.
- Long-Term Illness: Prolonged exposure to fine particulate matter (PM2.5) during wildfire seasons contributes to chronic bronchitis, worsened asthma, reduced lung capacity in children, and increased risks of stroke and heart disease.
- Mental Health Impact: The psychological trauma from wildfires rivals the physical damage. A 2021 University of California study found nearly 30% of evacuees suffered PTSD, anxiety, or depression up to a year after displacement.
- Displacement and Healthcare Access: Wildfires disrupt transportation and medical infrastructure. Clinics close, pharmacies run low on medications, and emergency responses slow down, especially hitting marginalized communities who often can't afford to relocate or find alternative care.

Together, these factors create a growing, complex mix of claims that life and health insurers must price and manage. Yet, traditional actuarial tools struggle to fully capture these intertwined health and social consequences.

TRADITIONAL MODELING LIMITATIONS AND EMERGING GAPS

Life and health insurers typically base risk assessments on historical trends, demographics, and individual health profiles—factors like age, occupation, lifestyle, and medical history. These models work well in stable settings but falter when confronted with dynamic, multifaceted catastrophes like wildfires. Key challenges include:

- Delayed Effects: Many wildfire-related health problems emerge long after the fire, making it hard to link cause and effect.
- Interconnected Risks: Wildfires often happen alongside heatwaves, power outages, and spikes in air pollution, creating overlapping risks that traditional models cannot untangle.
- Unequal Exposure: Even within the same area, individuals experience wildly different levels of exposure depending on housing quality, job type (like outdoor work), and access to clean air and healthcare.
- Fragmented Data: Health records, environmental data, and insurance claims often live in separate systems, limiting the ability to build a comprehensive risk picture.

Addressing these gaps requires a fundamental shift—a move toward models that combine actuarial skills with cutting-edge data science, real-time monitoring, and cross-disciplinary collaboration.

NEXT-GENERATION MODELING FRAMEWORKS: FROM SCENARIO ANALYSIS TO AI-DRIVEN INSIGHTS

Emerging technologies and innovative modeling techniques are beginning to fill these gaps:

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- Scenario-Based Models: Instead of relying on past averages, these models simulate a variety of future wildfire scenarios, factoring in wind patterns, smoke spread, and evacuation behaviors. This helps insurers visualize potential outcomes and prepare accordingly.
- Agent-Based Models (ABMs): ABMs simulate how individuals behave during catastrophes—how they move, make decisions, and differ by demographics—allowing more granular assessment of exposure risk across populations.
- Stochastic Mortality Models: These models integrate environmental factors like air quality and temperature to dynamically project mortality risks, helping insurers design products and pricing that adapt to evolving conditions.
- Remote Sensing and GIS: Satellite data and geographic mapping provide real-time views of fire spread, overlaid with demographic information, pinpointing populations at greatest risk.
- Artificial Intelligence (AI) and Machine Learning: AI can process massive amounts of claims, electronic health records, and public health data to identify trends and predict peaks in health impacts from wildfire seasons.
- Natural Language Processing (NLP): NLP tools analyze clinical notes and insurance claims to detect underreported health effects linked to wildfire exposure, such as chronic stress or sleep disturbances.

Together, these tools mark a shift from reacting to wildfire risks after the fact toward anticipating claims and intervening earlier to reduce severity.

PRACTICAL APPLICATIONS: UNDERWRITING, PRODUCT DESIGN, AND CLAIMS MANAGEMENT

Applying catastrophe modeling in life and health insurance can transform operations:

- Better Underwriting: Environmental exposure scores can refine individual risk profiles, allowing for more precise underwriting. People living in high-smoke areas, for instance, can be assessed differently.
- Dynamic Pricing: Premiums might adjust in near real-time based on air quality, mobility data, or even wearable health devices.
- Innovative Products: Insurers could offer short-term life insurance covering wildfire seasons or packages that combine life, health, and evacuation support.
- Claims Automation: AI can triage claims post-disaster, prioritizing those most urgent and speeding up payments for severe cases.
- Proactive Outreach: Predictive models can flag high-risk clients and trigger health alerts or evacuation advice before conditions worsen, potentially reducing claims.

REGULATORY AND ETHICAL CONSIDERATIONS

With greater use of AI and real-time data comes responsibility:

- Privacy: Using geolocation, medical records, and wearable data demands strict safeguards and clear consent processes.
- Fairness: Models must be tested rigorously to prevent biased pricing that unfairly affects groups based on race, income, or neighborhood.
- Transparency: Regulators may require insurers to disclose model assumptions, conduct stress tests, and clearly communicate risks to consumers.

Ethical catastrophe modeling means balancing technical accuracy with fairness and societal good.

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IMPLICATIONS FOR REINSURANCE AND CAPITAL MARKETS

Reinsurers and investors are also evolving how they manage wildfire risks:

- Mortality Catastrophe Bonds: Similar to property catastrophe bonds, these pay out if wildfire-related deaths exceed certain thresholds.
- Parametric Reinsurance: Contracts triggered by objective data—like air quality indexes or satellite fire detection—allow faster financial relief.
- Risk Pooling: Industry or regional pools spread wildfire losses more evenly across insurers.
- Climate-Aligned Investments: Asset managers factor climate risks into portfolios, influencing insurers' capital and returns.

This merging of actuarial science, finance, and climate data promises new ways to handle systemic risks posed by wildfires.

CONCLUSION: TOWARD A RESILIENT FUTURE

The wildfires sweeping through Los Angeles reflect a rapidly changing risk landscape. For life and health insurers, traditional models no longer capture the full, evolving impact of these disasters on human health and mortality.

This essay calls for a fresh modeling approach—one that blends actuarial rigor with AI-powered analytics, real-time data integration, and ethical vigilance. The future of catastrophe modeling in life and health insurance lies where technology, human behavior, and environmental change meet.

To protect public health and build resilience, insurers must evolve beyond risk managers into proactive partners supporting climate adaptation and societal stability.

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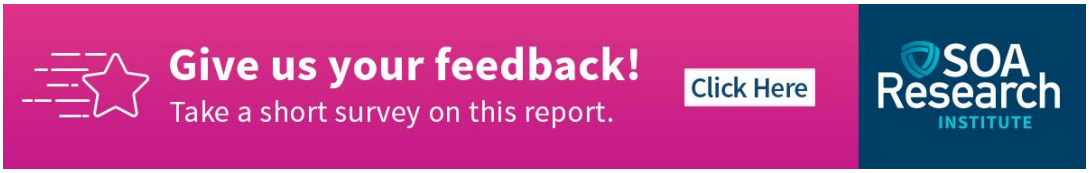

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