INSIGHTS AND INNOVATIONS IN NATURAL CATASTROPHE RISK ASSESSMENT

Natural catastrophe (Nat Cat) events pose significant risks to lives, property, and economies. With climate change accelerating the frequency and intensity of these events, effective risk assessment is more crucial than ever. Historically, catastrophe modelling relied on statistical analysis, but technological advancements have revolutionised the field.

Xceedance experts Monalisa Samal, Executive Vice President, Data and Analytics, and Puneet Bajpai, Senior Vice President, Risk Intelligence and Data Sciences explore how risk assessment has evolved, integrating AI, data analytics and real-time modelling to enhance resilience and preparedness.

The new definition of catastrophe

Catastrophe Perils refer to large-scale, low-frequency, high-severity events causing widespread damage to life, property and economies, and are defined by three key factors:

Speed: Natural disasters are intensifying more rapidly than before (e.g. a Category 4 hurricane forming in just 24 hours).

Scale: Climate disasters displaced over 40 million people in 2023 alone.

Synergy: Events are increasingly interconnected (e.g. wildfires followed by mudslides or cyclones exacerbating flooding).

"Imagine wildfires that move faster than a Formula One car; a hurricane's energy that output rivals 10,000 nuclear bombs; floodwaters that rise in hours, not in days, swallowing some cities as a whole – this is not science fiction," Monalisa said. "This is the reality of our time."

"We call these 'amplified natural conditions', which are sometimes caused by our actions, sometimes by our choices, and it's paid for by our ecosystems and economics."

Fundamentals of Nat Cat risk assessment

To distinguish Nat Cat risks from other types of risk, key differentiators include frequency and impact. For example, unlike fires that occur frequently but at smaller scales, Nat Cat events are rare but cause widespread devastation.

Data showing the frequency, size and location of fire risk vs Nat Cat risk shows the stark contrast between the two.

"With fire, the pattern is steady so I have a certain statistical understanding of how I can estimate or manage risk," Puneet said.

"But the pattern for natural catastrophe is so irregular it's not easy to statistically identify what would happen next year – that's where catastrophe models come in."

Catastrophe modelling explained

Catastrophe models help insurers and policymakers anticipate potential losses. At its very core, risk is assessed through four key factors: probability, hazard, vulnerability and exposure.

Event: Identifying how often and where catastrophic events are likely to happen.

Hazard: Understanding how the event spreads and affects different regions.

Vulnerability: Assessing the resilience of buildings and infrastructure.

Exposure: The financial and insurance impact – calculating potential economic and insured losses.

Catastrophe models provide valuable opportunities to understand risk from multiple perspectives and serve as a foundation for decision-making, blending scientific analysis with experience-based adjustments.

Catastrophe models guide insurers in pricing and underwriting, portfolio optimisation, claims estimation and reinsurance strategies. However, despite advancements, catastrophe models still face challenges such as data gaps, underinsurance issues and emerging risk factors such as climate change.

According to Monalisa, while the model "is always a guiding principle" the rise of technology – particularly AI – "helps us gain an alternative view of the risk".

Role of technology in risk assessment

The integration of AI and data analytics has significantly improved risk modelling across the insurance industry. AI-driven underwriting allows insurers to quickly assess property risks by analysing satellite imagery and historical data.

Additionally, AI models enhance real-time risk prediction for natural disasters such as hurricanes, wildfires and floods, enabling proactive mitigation strategies. Automated claims processing streamlines damage assessments, reducing settlement times and improving operational efficiency. These advancements enhance decision-making, optimise risk management and improve customer experience.

Monalisa described the ongoing challenge of balancing risk as "walking a tightrope" and said insurers needed to adopt measures such as parametric insurance, catastrophe bonds, AI risk models and community resilience models to strengthen Nat Cat risk management.

"With the advent of emerging risks such as climate change, the rope has become thinner and how we balance risk is really a challenge," she said.

Practical applications in the insurance industry

In March 2025, a cyclone developed off the coast of south-east Queensland, Australia, for the first time in 50 years. This alone was unusual, but the system – Cyclone Alfred – also presented a unique challenge due to its unusual path and slow movement.

The prolonged exposure to high winds and rain led to heightened damages, highlighting gaps in existing catastrophe models. This case underscores the importance of continuously updating models to account for evolving climate patterns.

Historically, cyclones affect the northern part of Australia and data informing catastrophe modelling is based on that historical information. Puneet said Cyclone Alfred has shown there are some "shortcomings or limitations" to catastrophe modelling when an event occurs that is out of the ordinary.

"When you create a catastrophe model for a specific reason, for example, for tropical cyclones in Australia, you look at the information based on thousands of historical events," he said.

"If you see some events which are a little bit out of the norm, then you need to go back and make corrections to that historical data."

The landscape of Nat Cat risk assessment is rapidly evolving, integrating technology and data-driven insights to improve accuracy and preparedness. While no model can predict disasters with complete certainty, advancements in AI, satellite imagery and catastrophe modelling enable insurers and communities to build a more resilient future. By balancing scientific modelling with real-world risk mitigation strategies, the industry can better manage the increasing challenges posed by natural catastrophes.

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