Preparing for Climate Futures We Cannot Predict: An Actuarial Perspective

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INTRODUCTION

Climate change challenges a foundational assumption in financial risk management: that the future will resemble the past closely enough for historical experience to remain a reliable guide. For actuaries, whose work has long relied on carefully adjusted past data and prudently stressed models, climate risk represents a fundamental shift. Physical impacts, policy responses, technological change, and evolving societal expectations introduce uncertainty that is systemic, long-horizon, and difficult to quantify with traditional methods.

The purpose of this paper is to provide a concise starting point for actuaries engaging with climate risk. Drawing on guidance developed by the International Actuarial Association (IAA), this paper reflects on three themes: what decision-makers should understand about climate risk, why traditional actuarial models struggle in this context, and how tools such as scenario analysis and artificial intelligence can support, but not replace, professional judgment. The core argument is that preparing for climate futures we cannot predict requires humility, clarity, and a renewed focus on the actuarial role as a steward of uncertainty.

CLIMATE RISK: WHAT DECISION-MAKERS NEED TO UNDERSTAND

Climate risk is often discussed as an environmental concern, but for financial institutions it is also a financial risk. Climate-related risks affect mortality and morbidity, property damage, asset values, supply chains, and the long-term viability of business models. They also interact with existing financial risks in ways that can amplify losses or undermine diversification.

Actuarial literature commonly distinguishes between three broad categories of climate risk.

- Physical risks arise from acute events such as floods, storms, and heatwaves, as well as chronic changes such as sea-level rise and sustained increases in temperature.
- Transition risks emerge from the economic, technological, and policy responses to climate change, including carbon pricing, shifts in energy systems, and changes in consumer behavior.
- Legal and reputational risks reflect evolving societal expectations, regulatory scrutiny, and litigation related to climate impacts and disclosures.

These risks do not operate independently. Policy actions taken to reduce long-term physical risk may accelerate transition risk in the short to medium term. Legal and reputational risks may arise suddenly, triggered by changes in public sentiment rather than gradual trends. For insurers, pension funds, banks,

and other risk-bearing institutions, climate risk therefore reshapes how traditional underwriting, investment, and capital decisions interact over time.

Importantly, climate risk is not confined to distant time horizons. While many physical impacts unfold gradually, their financial consequences may be felt much sooner as markets reprice risk, insurance coverage becomes constrained, or regulatory expectations change. Recognizing climate risk as a present and evolving financial issue is thus the first step toward managing it responsibly.

WHEN THE PAST IS NO LONGER A RELIABLE GUIDE

Actuarial practice has long been grounded in the careful use of historical experience. Mortality tables, catastrophe models, loss development methods, and asset return assumptions all reflect the same underlying principle: while the future is uncertain, the past provides a meaningful starting point. Climate change challenges this principle at a foundational level.

Climate-related risks evolve over time in ways that are neither stationary nor linear. Physical risks are changing in frequency and severity, but not smoothly or uniformly across regions. Transition risks may emerge abruptly, often triggered by political decisions, technological breakthroughs, or social tipping points. Legal and reputational risks can materialize even more suddenly, driven by shifting expectations of corporate responsibility.

In this context, reliance on historical data alone can be misleading. Past experience may understate future tail risk, obscure emerging correlations, or suggest a degree of precision that no longer exists. Importantly, the challenge is not simply a lack of data. Climate change introduces structural uncertainty, where the underlying processes generating risk are themselves changing.

IAA guidance emphasizes that climate risk should be viewed as a long-horizon, system-wide challenge. Its effects extend beyond individual lines of business or asset classes, influencing entire balance sheets and strategic choices. For actuaries, this requires a shift in mindset. The task is no longer to refine estimates within stable distributions, but to navigate uncertainty where the distribution itself is uncertain.

This does not imply abandoning quantitative analysis. Models remain essential tools for organizing information and testing assumptions. However, they must be interpreted with appropriate caution. In the context of climate risk, the appearance of precision should never be confused with reliability.

SCENARIO ANALYSIS AS A WAY OF THINKING

In response to deep uncertainty, scenario analysis has become a central tool for assessing climate-related risk. Yet scenarios are often misunderstood. They are sometimes treated as alternative forecasts or evaluated based on their perceived likelihood. This approach misses their primary value.

The IAA's work on climate-related scenarios emphasizes that scenarios are not predictions. Rather, they are structured explorations of plausible futures, designed to expose vulnerabilities, highlight trade-offs, and resilience under different conditions. Their purpose is not to answer the question "What will happen?" but to explore "What could happen, how would it affect us, and how should we respond?"

This distinction is particularly important for climate risk. Climate outcomes unfold over decades, while many financial decisions are made over much shorter horizons. Scenario analysis helps bridge this gap by allowing institutions to test decisions against long-term forces that are already in motion, even if their timing and magnitude remain uncertain.

Furthermore, effective climate scenarios combine quantitative analysis with narrative context. Numerical outputs alone can obscure critical assumptions about policy choices, technological adoption, or behavioral change. Narrative elements help decision-makers understand why outcomes differ across scenarios and how risks interact. In this sense, scenario analysis is as much a communication tool as it is a modeling technique.

For actuaries, scenario analysis aligns naturally with professional judgment. It encourages consideration of multiple futures, avoids over-reliance on point estimates, and supports governance processes that prioritize robustness over optimization. The actuarial contribution lies not in selecting the "right" scenario, but in ensuring that decisions remain defensible across a range of credible futures.

AI AND ADVANCED ANALYTICS

Advances in artificial intelligence and data analytics are reshaping how climate risk is measured and analyzed. High-resolution climate models, machine learning algorithms, and large geospatial datasets offer new insights into hazards, exposures, and vulnerabilities. Used appropriately, these tools can significantly enhance actuarial work.

AI is particularly effective at identifying patterns in large and complex datasets. It can improve hazard mapping, refine exposure assessments, and process unstructured data such as satellite imagery or climate simulations. In areas such as flood risk, wildfire exposure, or health impacts of extreme heat, advanced analytics provide valuable support for risk identification and monitoring.

However, AI systems are essentially constrained by the data on which they are trained. They perform best when future conditions resemble the past. Climate change undermines this assumption. Regime shifts, feedback loops, and tipping points are precisely the situations where historical data provides the least guidance. In such contexts, AI may generate outputs that appear precise while masking deep uncertainty.

There is also a risk that increasingly sophisticated models create a false sense of confidence. Highly granular results can give the impression that uncertainty has been resolved when it has merely been transformed. For decision-makers, this can be more dangerous than openly acknowledged uncertainty.

The actuarial role in an AI-enabled environment is therefore not diminished but strengthened. Actuaries are trained to question assumptions, assess model risk, and communicate uncertainty clearly. AI should be viewed as a supporting instrument, not a substitute for professional judgment. Governance, transparency, and interpretability remain essential, particularly when climate-related decisions have long-term and potentially irreversible consequences.

THE ACTUARY'S ROLE IN AN UNCERTAIN CLIMATE FUTURE

Climate change elevates the importance of actuarial judgment, communication, and governance. As institutions grapple with uncertain futures, actuaries serve as interpreters between climate science, advanced analytics, and decision-makers. This role extends beyond model construction to include explaining limitations, challenging overconfidence, and ensuring that uncertainty is neither ignored nor overstated.

Embedding climate risk into enterprise risk management, ORSA (Own Risk and Solvency Assessment) processes, and investment governance requires more than technical capability. It requires a willingness to engage with uncomfortable uncertainty and to support decisions that remain robust even when outcomes diverge from expectations. In this sense, actuarial professionalism is as important as actuarial technique.

CONCLUSION

Climate change confronts financial institutions with futures that cannot be addressed through familiar modeling techniques alone. In this environment, the value of actuarial expertise lies not in forecasting a single outcome, but in helping organizations navigate uncertainty responsibly.

The IAA's work on climate risk highlights that scenario analysis is most effective when used as a framework for thinking rather than a tool for prediction. Advanced analytics and AI can enhance insight, but they do not eliminate uncertainty, nor do they replace professional judgment. If anything, their growing influence increases the importance of governance, interpretation, and clear communication.

Preparing for climate futures we cannot predict is ultimately about decision-making. The most enduring contribution actuaries can offer is not certainty, but perspective. As such, the central question should not be whether projections will be accurate (they won't), but whether decisions made today remain sound across a range of plausible futures.

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