



Award Winner

## The Hidden Climate Exposure: How Operational Fragility Becomes a Systemic Risk for Insurers

Sathiya Livingston

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### INTRODUCTION

Climate risk has become a defining preoccupation in actuarial practice, yet the profession's frameworks remain largely concentrated on external hazards—physical perils such as hurricanes, floods, wildfires, and heatwaves, or transitional pressures such as policy change and carbon pricing. What is often less explicitly examined is the climate-driven vulnerability of insurers' own operational architectures. As climate volatility grows, insurers face correlated disruptions to claims volumes and operational capacity. To address this blind spot, this essay introduces the **OFCR Framework (Operational Fragility in Climate Risk)**—a conceptual model for understanding how operational disruptions interact with claims, reserving, capital, and enterprise risk. Through two fictionalized yet realistic case studies, the essay illustrates how climate-linked operational failures distort development patterns, widen uncertainty, and challenge governance. The essay concludes by discussing how this perspective may broaden actuarial climate-risk thinking.

### CLIMATE RISK HAS MOVED INSIDE THE INSURER

The actuarial profession has made enormous progress in understanding climate risk, but much of the attention has remained anchored in the physical world—storms that damage roofs, heatwaves that affect mortality, or wildfires that erase entire communities. These are critical concerns. Yet the industry often treats climate events as if they occur at arm's length from the insurer, as though the insurer is a passive observer holding a checkbook.

This assumption is breaking down.

Climate events have the potential to disrupt the systems insurers rely upon:

- Contact centers
- Claims intake platforms
- Document-processing hubs
- Offshore operational centers
- Cloud-region dependencies
- Actuarial modeling environments
- Third-party vendor networks

This convergence creates a new category of correlated risk: climate event + operational disruption **occurring simultaneously**.

When a climate-event triggers claims *and* impairs the insurer's capacity to respond, the result is not additive loss—it is a multiplier.

What was once treated as a hypothetical risk can be viewed as increasingly relevant in climate-risk discussions. Operational fragility may function as a climate-risk accelerant.

### THE UNSEEN AMPLIFIER: HOW OPERATIONAL DISRUPTION MAGNIFIES LOSS

When actuaries model climate risk, they typically estimate:

- Frequency
- Severity
- Exposure distribution
- Vulnerability curves
- Loss development
- Capital needs

But these projections implicitly assume that the insurer's internal systems will continue to operate as expected.

The problem is that climate volatility does not respect this assumption.

When operational performance deteriorates during a climate event, the insurer's financial exposure is magnified through several mechanisms:

- **Delayed claims progression:** Disruptions to intake workflows, indexing, or initial triage slow claim setup. This delay affects inspection timing, loss mitigation, settlement pace, and ultimately severity.
- **Distorted reserving signals:** When case setup lags or documentation is incomplete, actuarial teams receive delayed or degraded data. This creates noise in triangles, complicates projections, and widens confidence intervals.
- **Extended loss tails:** Delays encourage disputes, re-openers, litigation, and worsening damage. These lengthen tail patterns and shift expected ultimate costs.
- **Elevated LAE:** Manual workarounds, overflow staffing, and inefficient routing increase loss adjustment expenses.
- **Liquidity strain:** Slower adjudication delays recoveries from reinsurers or subrogation, shifting liquidity timing.
- **Capital uncertainty:** Operational fragility introduces new volatility into emerging losses, affecting capital planning and risk appetite.

These distortions seldom appear in traditional models, yet they are increasingly fundamental to climate-driven performance.

### CASE STUDY #1: THE HEATWAVE THAT SLOWED THE SYSTEM

Consider a fictionalized multi-line insurer headquartered in the United States. Its operations depend on three major hubs:

- A claims processing unit in Manila
- A document-scanning and ingestion team in Phoenix
- A cloud region based in Singapore

During an extreme heatwave, Manila experiences rolling blackouts. Backup generators prove insufficient for sustained heat, leading to fluctuating system uptime and reduced productivity.

Phoenix simultaneously experiences elevated auto, property, and health-related claims due to record temperatures.

Meanwhile, a power-demand spike in Singapore briefly disrupts the cloud region's performance.

The insurer is hit from three directions:

- Increased claims frequency
- Impaired claims-processing capacity
- Periodic data-system delays

The combined impact reshapes the financial pattern:

- Claims linger in queues, delaying review and settlement
- Initial reserves and development signals become less reliable
- LAE increases due to manual workarounds and reprocessing
- Loss-development patterns and capital projections become more volatile

The event is not catastrophic in the physical sense, yet the financial outcome resembles that of a mid-scale catastrophe—because operational fragility became a second hazard.

### **THE INTERDEPENDENCE PROBLEM: MODERN INSURANCE IS A NETWORK OF NETWORKS**

The modern insurance enterprise is a distributed, digital, multi-site, multi-vendor ecosystem. This increases efficiency—but also introduces fragility.

Operational dependency structures have become deeply intertwined with climate-sensitive geographies:

- U.S. Gulf states (hurricanes) host major call centers
- India and the Philippines (heat, cyclones, monsoons) host processing hubs
- Western U.S. state (wildfires, heatwaves) house tech and cloud-engineering teams
- Europe (heatwaves, grid instability) contains data science centers

At the same time, these geographic concentrations intersect climate-sensitive digital infrastructure, vendor networks, and remote-work dependencies.

Climate change does not merely increase claims—it alters the functioning of the insurance machinery.

This is the interdependence problem: vulnerabilities in one part of the operational ecosystem propagate across the enterprise.

## CLIMATE RISK AS A MULTI-LAYERED SYSTEMS PROBLEM

Conceptual insights from engineering, ecology, and systems theory describe modern organizations as ‘tightly coupled systems’—networks in which stress in one node can propagate quickly across the entire structure. Insurance has quietly become one such system. What differentiates the current era from prior decades is the intensity and simultaneity of climate stressors.

From a systems and risk-theory perspective, climate volatility introduces the possibility of more geographically synchronized, prolonged, and layered stress events. Under such conditions, insurers may face scenarios in which operational vulnerabilities are triggered at the same time that claims obligations surge.

This creates **climate-induced systemic coupling**: claims intake, digital platforms, vendor networks, and actuarial pipelines cease to act independently. The insurer begins to behave like a single interconnected organism rather than a set of distributed capabilities.

In a systems context, climate risk becomes less about the frequency of a hazard and more about its ability to cause cascading failures. This reframing matters because cascading failures can produce nonlinear loss patterns, where modest operational slowdowns generate outsized financial distortions. Once delays compound and feedback loops emerge, outcomes can exceed the expectations of even sophisticated models.

In this sense, operational fragility is not simply an administrative concern—it is a systemic property of the insurance enterprise under climate stress.

## CASE STUDY #2: THE ICE STORM THAT DISRUPTED MORTALITY CLAIMS

A fictionalized life insurer based in the Midwest experiences a severe ice storm that overburdens local hospitals and elevates mortality rates among elderly populations.

What proves more damaging is the sequence of operational effects: Mail intake, customer-service staffing, remote-access infrastructure, and offshore data-entry capacity are simultaneously disrupted across multiple locations.

The result: incoming death claims stack unprocessed.

Families wait, call queues grow, complaints rise, and regulators raise concerns about delays.

Reserving becomes unstable as case estimates lag, documentation issues drive reopeners, and capital teams struggle to adjust projections with incomplete data.

The financial impact flows as much from system degradation as from the storm itself.

## INTRODUCING THE OFCR FRAMEWORK: A CONCEPTUAL MODEL FOR OPERATIONAL FRAGILITY IN CLIMATE RISK

The OFCR Framework provides a thought-leadership lens for incorporating operational-climate interdependence into climate-risk thinking. It contains five conceptual pillars.

1. **Exposure Mapping (where climate risk meets operational architecture).** This involves mapping climate-sensitive exposures across:

- Geographic nodes
- Digital infrastructure
- Staffing clusters
- Vendor locations
- Cloud regions
- Claims supply chains

The goal is to understand the climate vulnerability of the insurer's own ecosystem.

2. **Dependency Structures (where single points of failure reside).** Modern insurance relies on concentration:

- A single offshore center for a key workflow
- One cloud region for critical systems
- One vendor for indexing
- One region for customer support

Climate risk interacts with these dependencies and can turn them into systemic risk points.

3. **Propagation Channels (how operational disruption becomes financial loss).** This pillar conceptualizes how disruptions cascade into:

- Reserving uncertainty
- Tail-length extension
- LAE inflation
- Liquidity timing shifts
- Reinsurance friction
- Volatility in IBNR emergence

Propagation channels translate operational impact into actuarial terms.

4. **Resilience Levers (high-level concepts for stress absorption).** Within a thought-leadership context, resilience levers refer to conceptual categories of mitigation such as:

- Geographic diversification
- Automation of climate-sensitive workflows
- Multi-node operational designs
- Redundancy of digital infrastructure
- Climate-informed vendor governance

These are strategic concepts, not tactical corporate prescriptions.

5. **Governance Embedding (integrating operational fragility in risk thinking).** Climate-linked operational fragility can be conceptually embedded within:

- ERM frameworks
- Climate-risk taxonomies
- ORSA narratives
- Risk-appetite discussions

- Strategic risk reviews

The emphasis is on broad governance integration rather than process-level instructions.

### QUANTIFICATION: CONCEPTUAL APPROACHES FOR ACTUARIES

Thought leadership on this topic includes high-level approaches actuaries may consider conceptually without specifying processes or corporate actions.

#### 1. **Climate-linked scenario design, examples include:**

- Operational outage during a climate event
- Cloud-region stress coinciding with CAT surge
- Workforce impairment during extreme heat

These scenarios highlight interdependence between hazard and operational capacity.

#### 2. **Conceptual propagation modeling.** Actuaries can think in terms of how operational delays shift:

- Reserve uncertainty
- Severity expectations
- Loss-adjustment patterns
- Tail distributions

This creates a more holistic view of risk.

#### 3. **Stress-band widening:** Operational fragility conceptually widens the band of plausible development outcomes.

#### 4. **Time-based sensitivity thinking.** Actuaries may consider how timing disruptions affect:

- IBNR emergence
- Settlement patterns
- Liquidity modeling

These conceptual tools help integrate operational fragility into climate-risk thinking without prescribing corporate processes.

### CORRELATION STRUCTURES AND THE CHALLENGE OF CLIMATE-ERA VOLATILITY

One of the most difficult conceptual challenges in integrating operational fragility into climate-risk thinking is understanding correlation. Traditional actuarial models generally assume that operational performance is uncorrelated with hazard severity. This assumption has been implicitly embedded in decades of reserving, capital modeling, and catastrophe analysis.

But climate dynamics are creating new correlation structures.

Conceptually, extreme climate events create conditions under which operational throughput may move inversely to claims volume. In such scenarios, rising claim demands can coincide with declining operational efficiency, a dynamic that runs counter to traditional modeling assumptions. Framed this way, the

interaction can be understood as a potential volatility multiplier, in which hazard stress and operational strain compound financial uncertainty.

From a thought-leadership perspective, actuaries may conceptualize this as a form of “correlation drift,” in which the relationships among operational metrics and loss metrics shift during climate events. Drift does not necessarily occur gradually. It may emerge suddenly when certain thresholds—temperature, grid instability, flooding, or infrastructure stress—are crossed.

It raises practical modeling questions: what if claim-reporting lags lengthen nonlinearly at temperature thresholds? How do loss-development patterns behave when operational capacity is simultaneously impaired across multiple continents? Conceptualizing these interactions—rather than assuming historical independence—positions actuaries to develop more resilient risk perspectives.

### **LINKING OPERATIONAL FRAGILITY TO QUANTITATIVE RISK MEASURES**

While the OFCR Framework is conceptual by design, its elements can be mapped to quantitative risk measures already familiar to actuarial practice. For example, operational fragility can be reflected in climate-linked stress testing by adjusting assumptions related to claim-reporting lags, loss-development variability, or loss-adjustment expense during extreme-event scenarios. In a reserving context, such adjustments may manifest as wider confidence intervals, altered tail factors, or increased uncertainty around IBNR emergence under stressed operational conditions.

From a capital and enterprise risk perspective, operational-climate interdependence can be incorporated through scenario-based modeling rather than point estimates. Climate scenarios that combine hazard severity with constrained operational capacity may be evaluated using existing tail-sensitive metrics, such as Value-at-Risk or Tail Value-at-Risk, to assess the sensitivity of capital requirements to correlated disruption. Importantly, the framework does not require the invention of new metrics; rather, it provides a structured way to interpret changes in familiar quantitative outputs when operational assumptions are stressed alongside climate hazards.

In this sense, the OFCR Framework functions as a bridge between qualitative risk identification and quantitative risk measurement, helping actuaries understand how climate-driven operational fragility may influence modeled outcomes without prescribing specific parameter values or modeling techniques.

### **WHY THIS RISK HAS BEEN OVERLOOKED**

Much of the industry still operates on inherited mental models built for a world where operational capacity was largely stable, and climate events were episodic rather than systemic.

Legacy frameworks often treated climate risk as external to the insurer, implicitly assuming operational stability during climate events. Operational risk and actuarial modeling were therefore frequently considered separate domains. In addition, historic datasets were not designed to capture correlated operational-climate disruptions of this nature.

As climate events grow geographically wider, more frequent, and more synchronous, operational fragility may therefore be viewed as an increasingly important systemic exposure.

### **THE EXPANDING ROLE OF ACTUARIES**

Actuaries are well positioned to contribute thought leadership on this topic due to their expertise in:

- Risk interdependence
- Capital structure
- Uncertainty quantification
- Long-tail modeling
- Scenario construction
- Enterprise risk perspectives

The profession has the analytical tools to contribute meaningfully to broadening the climate conversation beyond portfolio losses toward organizational resilience.

For actuaries engaged in ORSA, capital modeling, and climate scenario design, recognizing operational fragility as a correlated climate exposure may change how uncertainty is framed in these contexts. This perspective builds on established actuarial approaches rather than departing from them.

### **CONCLUSION: CLIMATE CHANGE WILL TEST THE INSURANCE ENTERPRISE FROM THE INSIDE OUT**

Climate change is poised to challenge insurers in ways that extend far beyond underwriting. The next decade will expose how well insurance enterprises themselves can withstand disruption. Operational fragility may represent an increasingly important dimension of climate risk—a dimension that has, until now, been largely underexamined.

This essay argued that the structures enabling insurers to function—claims workflows, vendor networks, staffing models, cloud ecosystems, and digital architecture—are increasingly climate-sensitive. It introduced the OFCR Framework as a way to conceptualize this emerging class of risk and to integrate operational fragility into climate thinking at a governance and enterprise level.

The framework is intended to support interpretation of quantitative results under climate stress rather than to replace existing actuarial models or metrics. The insurance sector has long defined climate risk through the lens of the perils it insures. This analysis suggests the value of also understanding climate risk through the lens of the insurer itself. Climate change is not only reshaping the world insurers protect—it is reshaping the environment in which insurers must operate.

This analysis suggests the value of recognizing that climate risk is no longer solely a matter of external hazard, but a test of internal structure.

### **THE BROADER STRATEGIC HORIZON**

As climate volatility continues to reshape global infrastructure, supply chains, and workforce stability, insurers will increasingly face the challenge of operating in an environment where external shocks and internal capabilities are interconnected. This new landscape places a premium on intellectual frameworks that acknowledge interdependence, recognize the limits of historical data, and adapt to emerging climate-era dynamics. For actuaries, expanding climate-risk thinking to include internal operational resilience is not merely an academic exercise—it is a prerequisite for building the insurance systems of the future.

Organizations that understand this shift early may help shape the next era of risk management.

### **THE FUTURE ARC OF OPERATIONAL-CLIMATE RISK**

While climate-linked operational fragility is already visible today, its future trajectory suggests even deeper challenges—and opportunities—for insurers. Several global trends indicate that climate-era operational risk will not remain a peripheral concern but rather evolve into a central axis of enterprise resilience. Many

climate-risk scenarios consider the possibility of more temporally clustered events, creating periods where multiple regions experience stress simultaneously. In such multi-hazard environments, dependencies once assumed to be independent—such as U.S. call centers, Asian processing hubs, and European data-science teams—may experience parallel disruptions. Cross-regional operational diversity, once viewed as a safeguard, could become a source of shared vulnerability.

The growing digitization of insurance introduces new climate-sensitive touchpoints. Data centers require stable electricity and cooling; transmission networks depend on grid stability; remote-first workforces rely on climate-resilient broadband infrastructure. As these dependencies expand, so does the network through which climate-induced operational stress can propagate.

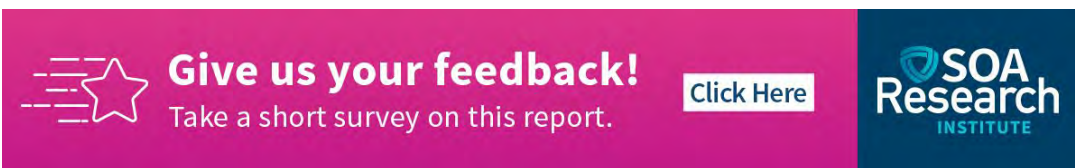
Finally, some regulatory frameworks may place greater emphasis on operational resilience alongside capital adequacy. The evolution of ORSA and climate-stress frameworks suggests a future where insurers must demonstrate not only exposure modeling sophistication but also credible strategies for maintaining continuity during correlated operational and hazard shocks.


Understanding this arc is essential: the insurers that prepare for next-generation operational-climate risk will shape new standards of industry stability.

It is, at its core, a test of internal strength. Insurers have long measured the durability of the risks they underwrite; the coming decade will measure the durability of the insurers themselves. The institutions that recognize this shift early—and respond with imagination rather than inertia—will not simply withstand the climate era. They may help shape evolving perspectives on resilience in the climate era.

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*Sathiya Livingston is a Business Development Manager – Insurance Services for Flatworld Solutions Pvt LTD. He can be reached at [Sathiya.l@flatworldsolutions.com](mailto:Sathiya.l@flatworldsolutions.com).*



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