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Actuarial Perspectives on Climate Risk

CAREER DEVELOPMENT COMMUNITY
ACTUARIAL RESEARCH AND EDUCATION SUBGROUP

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Antitrust Compliance Guidelines

Active participation in the Society of Actuaries is an important aspect of membership. While the positive contributions of professional societies and associations are well-recognized and encouraged, association activities are vulnerable to close antitrust scrutiny. By their very nature, associations bring together industry competitors and other market participants.

The United States antitrust laws aim to protect consumers by preserving the free economy and prohibiting anti-competitive business practices; they promote competition. There are both state and federal antitrust laws, although state antitrust laws closely follow federal law. The Sherman Act, is the primary U.S. antitrust law pertaining to association activities. The Sherman Act prohibits every contract, combination or conspiracy that places an unreasonable restraint on trade. There are, however, some activities that are illegal under all circumstances, such as price fixing, market allocation and collusive bidding.

There is no safe harbor under the antitrust law for professional association activities. Therefore, association meeting participants should refrain from discussing any activity that could potentially be construed as having an anti-competitive effect. Discussions relating to product or service pricing, market allocations, membership restrictions, product standardization or other conditions on trade could arguably be perceived as a restraint on trade and may expose the SOA and its members to antitrust enforcement procedures.

While participating in all SOA in person meetings, webinars, teleconferences or side discussions, you should avoid discussing competitively sensitive information with competitors and follow these guidelines:

- **Do not** discuss prices for services or products or anything else that might affect prices
- **Do not** discuss what you or other entities plan to do in a particular geographic or product markets or with particular customers.
- **Do not** speak on behalf of the SOA or any of its committees unless specifically authorized to do so.
- **Do** leave a meeting where any anticompetitive pricing or market allocation discussion occurs.
- **Do** alert SOA staff and/or legal counsel to any concerning discussions
- **Do** consult with legal counsel before raising any matter or making a statement that may involve competitively sensitive information.

Adherence to these guidelines involves not only avoidance of antitrust violations, but avoidance of behavior which might be so construed. These guidelines only provide an overview of prohibited activities. SOA legal counsel reviews meeting agenda and materials as deemed appropriate and any discussion that departs from the formal agenda should be scrutinized carefully. Antitrust compliance is everyone's responsibility; however, please seek legal counsel if you have any questions or concerns.

Presentation Disclaimer

Presentations are intended for educational purposes only and do not replace independent professional judgment.

Statements of fact and opinions expressed are those of the participants individually and, unless expressly stated to the contrary, are not the opinion or position of the Society of Actuaries, its cosponsors or its committees. The Society of Actuaries does not endorse or approve, and assumes no responsibility for, the content, accuracy or completeness of the information presented. Attendees should note that the sessions are audio-recorded and may be published in various media, including print, audio and video formats without further notice.

Introducing the speakers

Carlos Arocha, FSA, SCR

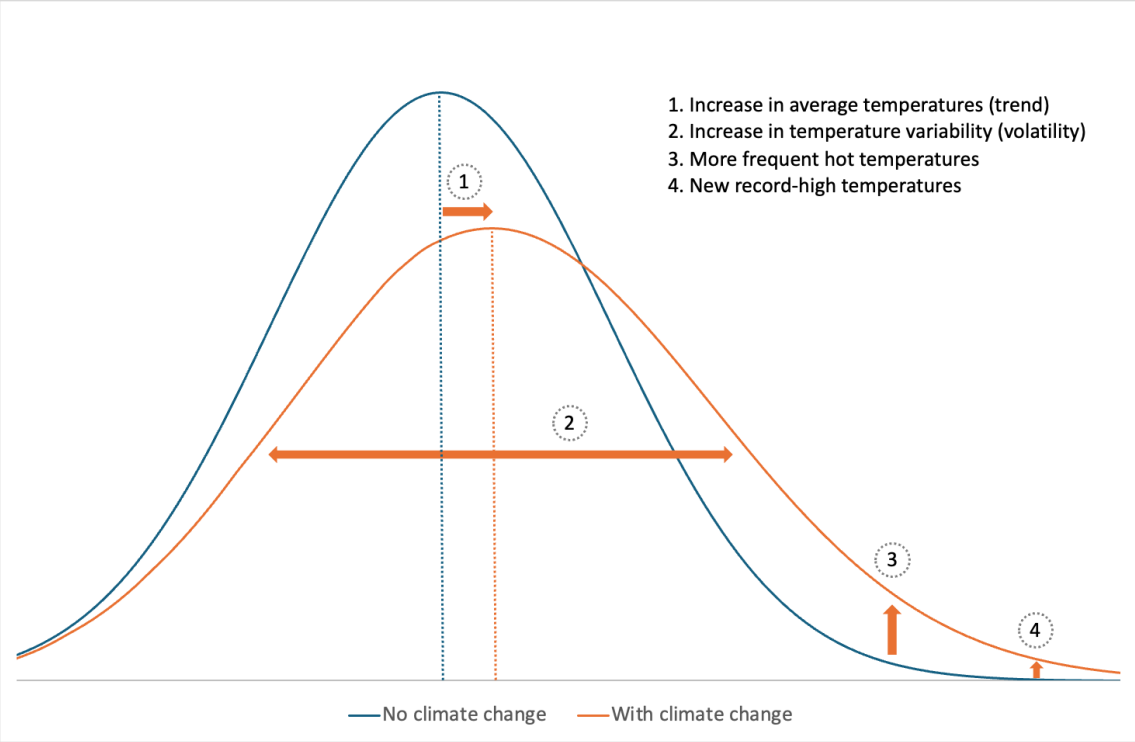
- Consulting actuary and educator
- 30+ years' experience across re/insurance; specialisms include actuarial analytics, risk modeling, data science, and financial reporting
- Strong focus on climate change risk and practical applications of machine learning
- Long-standing volunteer with the Society of Actuaries; two-time recipient of its Outstanding Volunteer Award
- Lecturer in the MS in Actuarial Science program at Columbia University

Jérôme Crugnola-Humbert, SAV, IA

- Consultant specializing in climate risk for insurers and financial institutions
- 20+ years' experience across consulting, insurance, banking, regulation, and sustainability
- Qualified Swiss and French actuary
- Active contributor to climate risk policy and research
- Chair of the AAE Sustainability and Climate-Related Risks Group (2022—2025)
- Lecturer in sustainable finance and climate risk at the University of Zurich

Climate change impact

Climate change is becoming an increasingly material risk driver for human health and L&H insurance

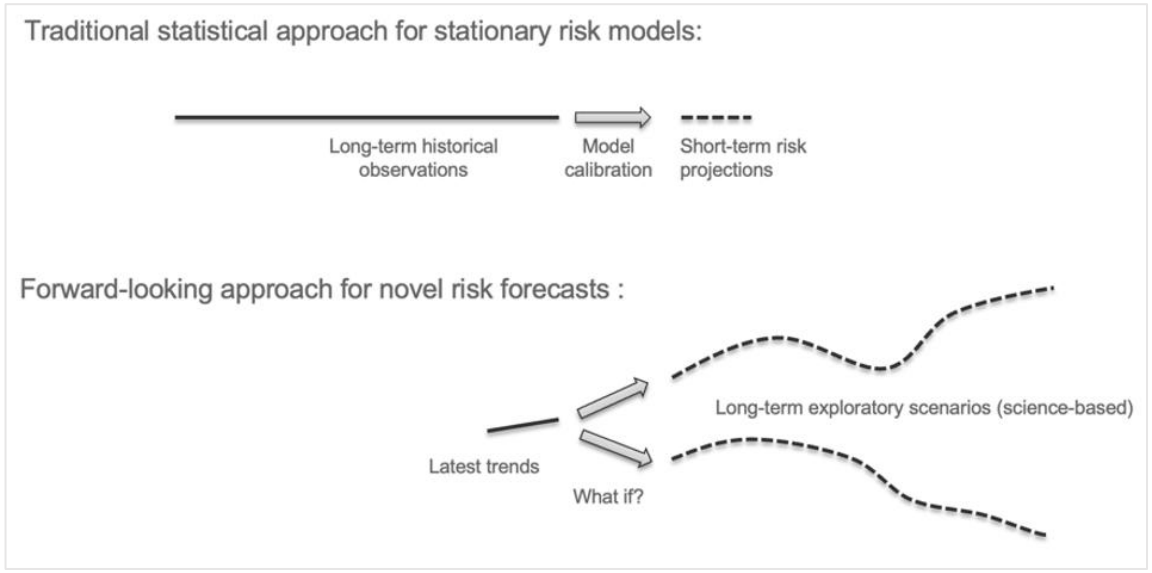


- No longer a peripheral sustainability-related concern, but a core socio-economic and financial risk issue
- Scientific evidence confirms that climate change affects human life and health, and strains healthcare systems, notably through
  - heat-related mortality and morbidity
  - spread of vector-borne diseases (e.g., ticks, mosquitoes)
  - extreme weather events (and their chronic consequences)
- P&C re/insurers have long studied physical climate risk, but L&H insurers are generally more reliant on actuarial techniques based on historical trends

Quantifying Mortality and Morbidity Impacts from Climate Risks

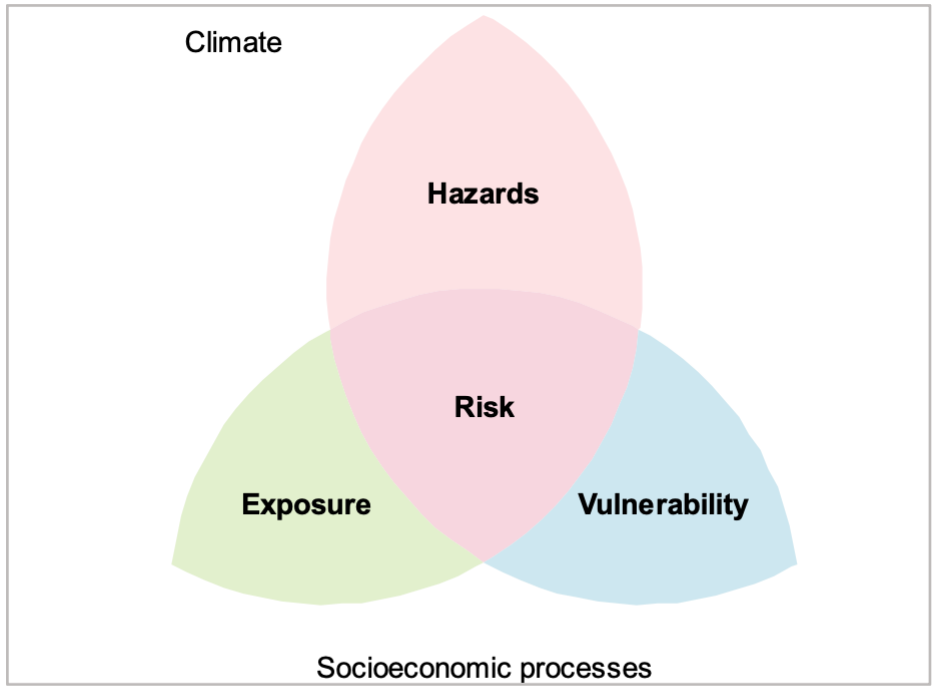
Conceptual framework for the SOA research paper

- Proposes a forward-looking, scenario-based framework to assess climate impacts on mortality and morbidity
- Recognizes climate-health risks as non-stationary, systemic, and regionally correlated, limiting reliance on historical data
- Maps risk transmission channels from climate to L&H
- Differentiates acute risks from chronic risks
- Highlights uneven impacts shaped by geography, age, socio-economic status, and adaptive capacity



Quantifying Mortality and Morbidity Impacts from Climate Risks

Mapping the complex risk transmission channels of extreme weather and climate-related perils



Source: Adapted by the authors from the IPCC Sixth Assessment Report

- Identifying key climate perils for L&H insurance (including heat waves, drought, wildfires, floods, severe storms, and sea-level rise)
- Explaining of how these **hazards** translate into health outcomes through specific transmission channels, with attention to **vulnerable** populations and **exposed** regions
- Acknowledging that acute disasters may create complex dynamics such as
  - short-term mortality spikes followed by temporary dips (*harvest effect*)
  - deferred care and later health care utilization spikes (*rebound effect*)
- Evaluating adaptation measures, while cautioning that adaptive capacity is uneven and maladaptation remains a risk

Climate-adjusted models

Introducing climate-adjusted Lee-Carter models for mortality and morbidity

- Extending the Lee-Carter mortality model into a climate-adjusted specification incorporating vulnerability factors
- Models enable scenario analysis across emissions pathways and stress testing of portfolio resilience under severe climate conditions
- Morbidity framework based on health care utilization rates
- Reduced-form model variants available, i.e., where data limitations prevent reliable estimation of socio-economic sensitivity
- Modeling framework can support actuarial use cases

$$\log m_{x,t,r,s} = a_{x,r,s} + b_x k_t + \lambda_{x,r,s} C_{t,r} + \varepsilon_{x,t,r,s}$$

$a_{x,r,s}$ is the baseline log-mortality (age x, region r, socio-economic status s)

k_t is the mortality index at time t

b_x is the age-specific sensitivity to k_t

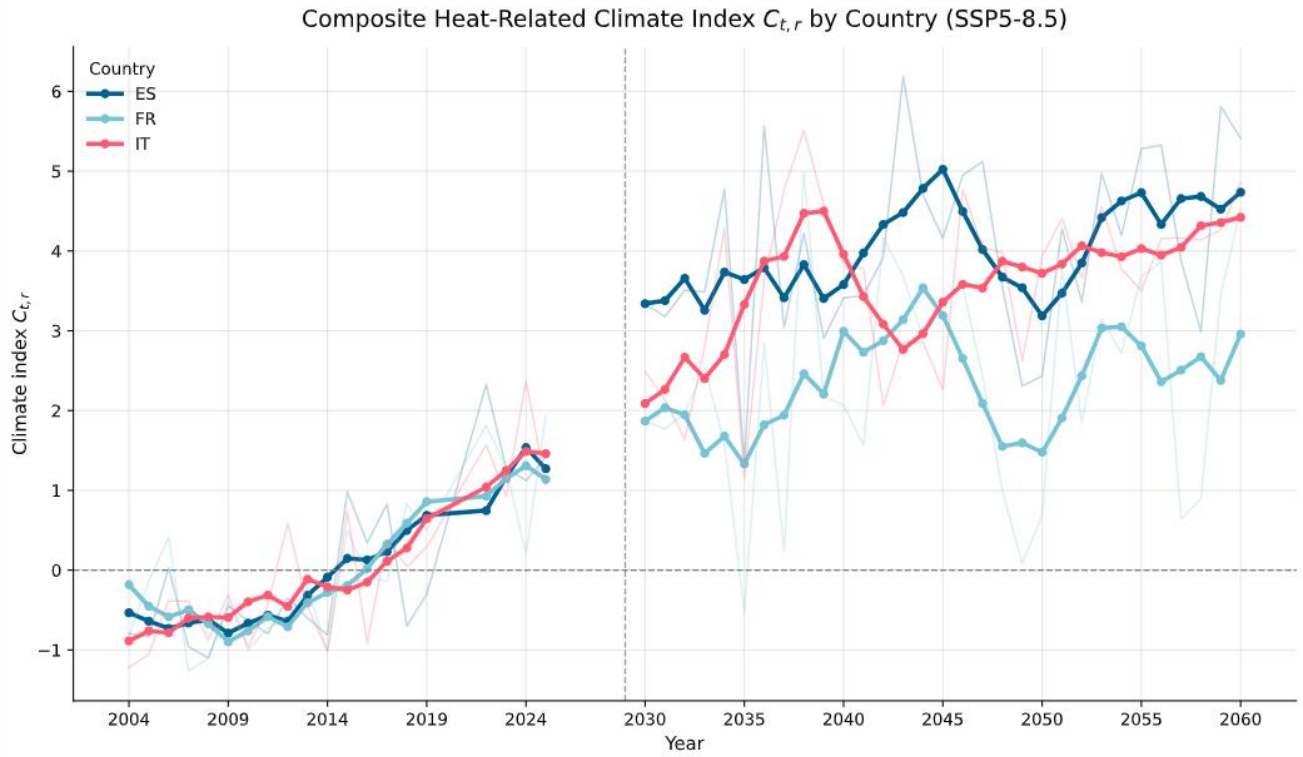
$\lambda_{x,r,s}$ is the vulnerability scaling to climate hazards

$C_{t,r}$ is the climate exposure

$\varepsilon_{x,t,r,s}$ is a random error capturing unexplained residual variation

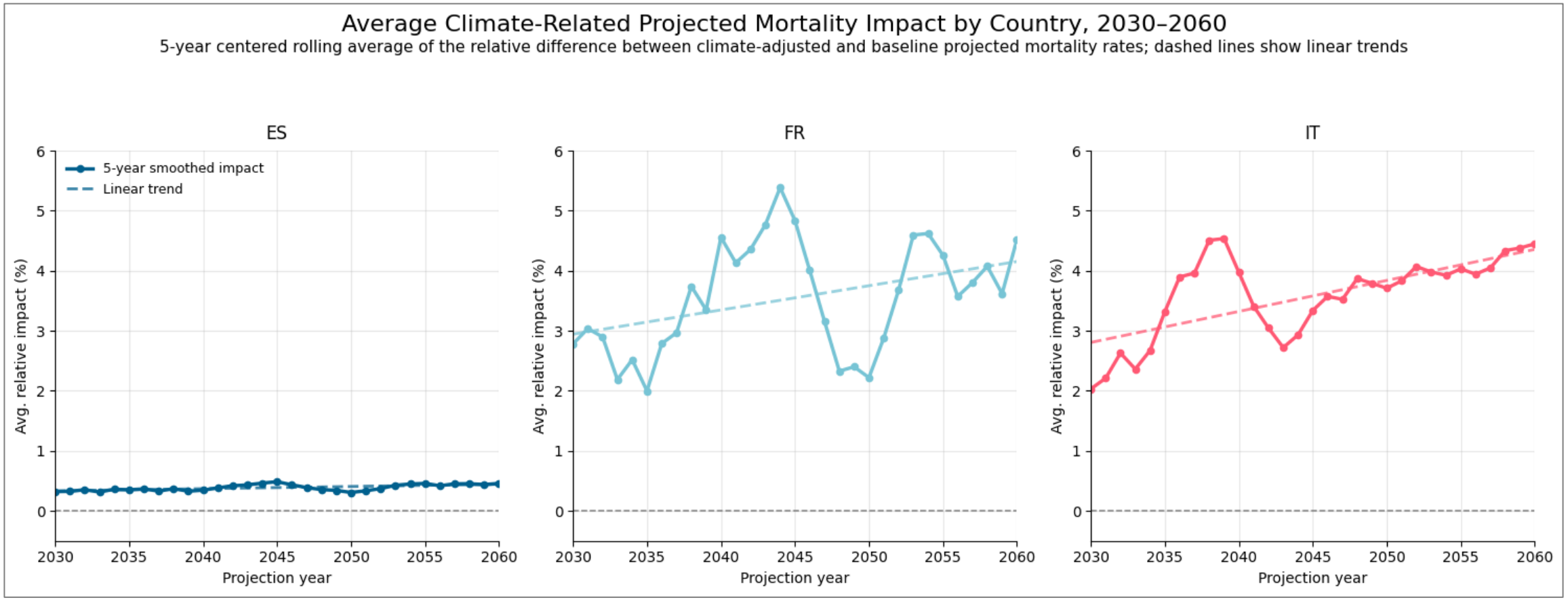
Case study

A reduced-form application of the modeling framework for three European countries



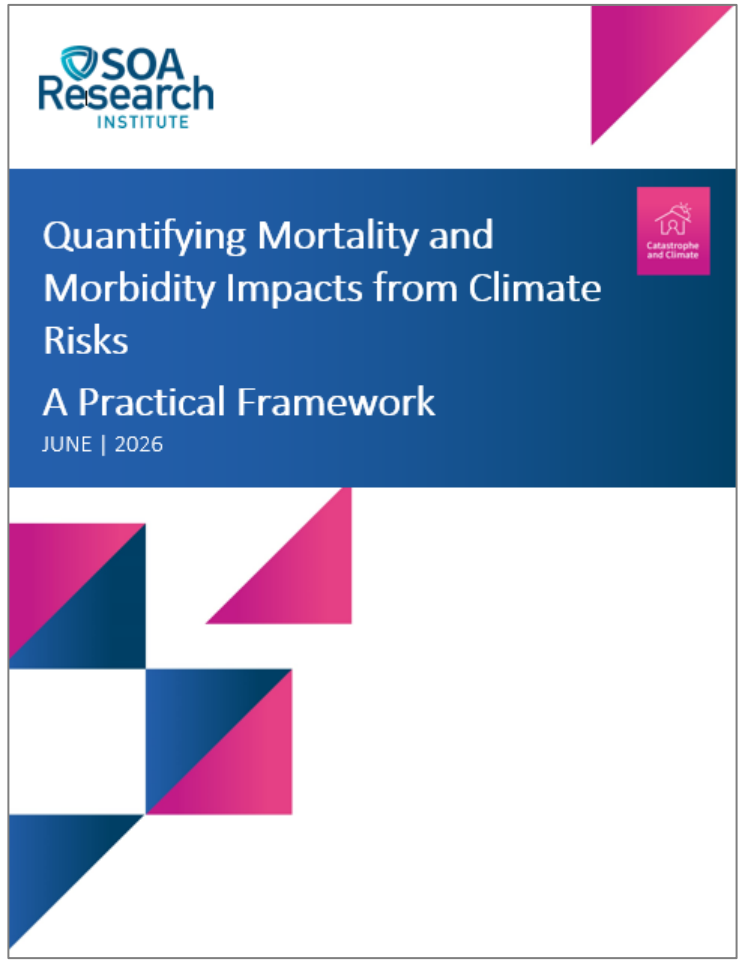
- Scenario SSP5-8.5 “high emissions”
- Mortality calibrated from 2004 to 2025 (excl. 2020/2021 due the COVID-19)
- Climate index is a linear combination of
  - **temperature anomaly:** annual difference between average daily maximum temperature and the average daily maximum temperature
  - **extreme heat days:** annual number of days where the daily maximum temperature exceeds the historical threshold (95th percentile)
  - **heat wave duration:** number or days that belong to heat wave episodes (heat wave episode defined as a run of at least six consecutive extreme heat days)

Sample output



Takeaways

- Limited climate risk modeling on the L&H insurance side
- Climate risk is no longer a peripheral sustainability-related concern, but a core socio-economic and financial risk issue
- Research paper treats climate-health risks as non-stationary, systemic, and regionally correlated, limiting reliance on historical data
- Modeling framework based on a climate-adjusted Lee-Carter model, including an extension to healthcare utilization rates
- Case study illustrates climate risk impacts under a specific parameterization
- This research paper will be presented at ImpACT 2026 (Pittsburgh, PA, Oct. 25-28, 2026)



Publication subject to final approval by the POG

Questions?

