Post-doctoral position: Geostatistics for natural catastrophes

Advisors Olivier Lopez CREST ENSAE IP Paris
Mails olivier.lopez@ensae.fr

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1 Short description of the research chair CARE and of the post-doctoral project

The CARE Chair of Excellence (Chair on Insurability of Emerging Risks, Allianz France - Ensae IP Paris - Fondation du risque) aims to enhance the understanding and anticipation of risks in a rapidly changing environment. The project is structured around three main axes:

1. Risk modeling
2. Risk sharing
3. Prevention.

The interplay of these three axes is designed to develop solutions to address the "insurance protection gap" (see below for a more precise description of the context).

Climate risk exhibit strong spatial correlation. This dependence disrupts the mechanisms of mutualization and risk pooling that are central to the insurance activity. The recruited post-doctoral researcher will contribute to the design of statistical / machine learning tools intended to account for spatial correlation between risks. She/he will also work on enhancing generative models, already developed by the research team of Chair CARE, to project the evolution of the risk. The results will be assessed against the deployment of adaptation and prevention measures to evaluate their impact.

2 Context: Public-private insurance protection against natural catastrophes

Adaptation to climate change increasingly requires anticipating the consequences of natural catastrophes. Insurance against natural disasters provides a financial reserve that can be mobilized, in case of incident, to rebuild and assist victims. However, the visible effects of climate change reveal an increase in the frequency and severity of extreme events, threatening the long-term viability of this economic model.

The basic principle of insurance relies on a collective model: one considers a loss random variable

$$S_n = \sum_{i=1}^{n} X_i,$$

where n is the number of policyholders and X_i is the individual loss associated with the i-th policyholder over a given time period. The insurer must determine a reserve R such that

$$P(S_n > R) \leq \varepsilon,$$

with ε close to zero (the European Solvency II regulation imposes $\varepsilon = 0.005$).

Insurance companies build this reserve through the premiums paid by policyholders, which must remain affordable so that insurance continues to serve as a low-cost protection mechanism. In the current context of natural disasters, the main difficulties are the following:

1. **Heavy-tailed distribution of the losses:** high quantiles of S_n must be estimated. Catastrophic risks often exhibit extremely heavy tails, possibly with infinite expectation when fitted from data.

2. **Strong dependence between policyholders:** large-scale events (e.g., Hurricanes Lothar and Martin in 1999) can strike vast regions, annulling the traditional benefits of risk pooling.

Under these conditions, insurability is no longer guaranteed, especially in the medium and long term. To control the required premium, insurers rely on reinsurance and on public–private risk-sharing mechanisms where the state ultimately covers losses beyond the capacity of the private sector. Even these mechanisms require adaptation. The French "Catastrophes Naturelles" regime is currently under stress[1]. The European regulator (EIOPA) and the ECB recently advocated for a European protection system against catastrophic risks, whose parameters and acceptability remain to be defined[2]. The "Insurance Gap Dashboard" launched by EIOPA[3] highlights strong disparities between European countries and the fact that a large proportion of climate-related risk remains uninsured. This gap is expected to grow without structural reform.

The objective of this PhD project is to contribute to the analysis of the risk via the development of geostatistics methods that will allow to better understand the spatial correlations between claims, in the context of heavy tail losses. The models that will be developed will contribute to designing appropriate insurance / risk transfer strategies, with the aim to reduce uninsurability. The aim is also to contribute to projections of the risk, and of the adaptation measures in the perspective of the evolution of climate risk.

3 Scientific Environment

The post-doctoral researcher will join the *Center for Research in Economics and Statistics* (CREST, UMR CNRS 9194) at Institut Polytechnique de Paris, as part of the Finance–Insurance research group. The team has recognized expertise in insurance mathematics and actuarial science, and participates in several industry collaborations, including the CARE Excellence Chair ("Chaire Assurabilité des Risques Émergents", sponsored by Allianz France). The candidate will have opportunities for collaboration with members of the chair and will benefit from industrial data and expertise. She/He will also gain visibility both in academia and in professional insurance/finance conferences.

4 Profile

- PhD in statistics, machine learning, actuarial science.
- Eager to develop applications in the insurance and risk management sectors.
- Computer skills: Python.
- Language: English, French if possible.

[1] See for example the report from French Senate, https://www.senat.fr/rap/r23-603/r23-6030.html

[2] See https://www.eiopa.europa.eu/publications/eiopa-and-ecb-joint-paper-towards-european-system-natural-catastrophe-risk-management_en

[3] https://www.eiopa.europa.eu/tools-and-data/dashboard-insurance-protection-gap-natural-catastrophes_en