When a natural catastrophe occurs, triggering a loss of life and extensive damage to infrastructure, the vulnerability of society and its assets is immediately brought to mind. The increasing natural catastrophe-related losses experienced by society – in particular local communities, financial and insurance sectors, and whole governments - further accentuate the vulnerability and its reach not only into the economic and financial system, but social and political systems as well.

Insured losses have been elevated over the last five years due to recurring high-loss secondary peril events such as severe convective storms, floods and wildfire. Coming after a dip in 2012–2016, the higher insured losses of 2017–2021 signal a return to long-term growth trend of 5–7%. Insurance covered USD 119 billion of last year's economic losses, the fourth highest on record, of which USD 111 billion was compensation for damage resulting from natural catastrophes.

Against this backdrop, it is clear that there is a greater need for novel risk management instruments, processes and techniques in the economic and financial system, with the view that these instruments, processes and techniques will furthermore benefit the social and political systems as well. In this regard, insurance-linked securities (ILS) solutions have been at the fore.

The project will consider two broad ambits. Firstly, it will consider the treatment, identification and validation of statistical processes for the modelling of natural catastrophes. We will propose a statistical procedure for modelling losses arising from catastrophic events which are related to different perils and geographical regions. That is, we will take into consideration the known behaviour of the catastrophic (CAT) events in the modelling: for example, earthquakes, windstorms and hurricanes (severity perils) will be modelled using heavy-tailed laws for loss amount distributions, while convective storms (frequency perils) will be modelled using lighter-tailed laws. We will illustrate it on the American and Polish natural catastrophe data. As a result of this, we will provide a rigorous statistical classification of different natural CAT hazards.

The second, and main, ambit of the project will be devoted to construction and pricing of ILS, which are an innovative way of transferring the risk of natural disasters to capital markets. The creation of ILS was motivated in part by the need to cover the large property insurance industry payouts of the early- to mid-1990s. ILS also represent a "new asset class" in that they provide a mechanism for hedging against natural disasters, a risk which is essentially uncorrelated with the capital market indices. Up to now, ILS have been mostly studied in the context of single perils occurring in single regions. However, the multi-peril and multi-region ILS transactions are gaining popularity and importance. They now stand for more than 50% of new issuance. In the project we will construct mutli-peril and multi-region ILS which are based on either indices created from industry loss estimates or the actual losses of the bond-issuing insurer. Catastrophe bonds will be of our primary interest. We will also consider a contingent convertible catastrophe bond which is a form of subordinated debt.

Finally, we will derive exact pricing formulas for the constructed ILS which are tied to natural catastrophe losses and are related to multiple perils and/or regions. In practice such prices can only be computed by means of extensive Monte Carlo simulations. Therefore, we will also derive useful approximation formulas.

We believe that the proposed project will contribute significantly to the better understanding how to manage the risk of natural disasters in the financial sector, and will provide new statistical and financial tools for the control of the multi-peril and multi-region risk. In order to achieve these goals we plan to co-operate with well-known risk research centres in Germany (School of Business and Economics, Humboldt-Universität zu Berlin), the Netherlands (Finance and Artificial Intelligence, Universiteit Twente), and South Africa (African Institute of Financial Markets and Risk Management).