

Flood risk model

Executive summary

In this project a joint effort of hydrologists and mathematicians resulted in a quantified risk estimation and a simulation tool, used by Aegon Hungary. The investigation used the most up-to-date models both in hydrology and statistics and the simulator quantifies not only the risk of a given real estate insurance portfolio, but also the accurateness of this risk estimator.

Challenge overview

Real estate insurance is an important part of the insurance business. Within this portfolio flood-risk is one of the most serious problem, since it is difficult to be estimated due to its relative scarcity. There are some reinsurance companies who deal with such risks, but their solutions are in general not based on the work of local experts. This is what we intended to overcome. There is local knowledge both in the area of hydrology as well as in the application of stochastic models, but the challenge was to create an adequate and easy-to-use tool for the actuaries which they can use whenever they plan to introduce a new product or just to evaluate the price and risk related to the existing ones. In this work different approaches were used from flood frequency analysis through modeling flood duration to estimating the risks for different building-types.

Implementation of the initiative

Aegon Hungary expressed interest in a cooperation, where experts work together in order to quantify the risk of their real-estate insurance portfolio with respect to floods. The task was the production of a software, which is able simulate realistic scenarios. The insurance company sponsored the cooperation, where actually mathematicians from Eötvös Loránd university and hydrologists worked together. Mathematicians were responsible for the modeling, while the hydrologists provided data about the so-called floodplain sections, which were the units in case of dyke breaches.

The problem

The main task was to quantify the possible losses in the given portfolio of real-estate insurances. Here the challenge was to combine preliminary knowledge about flood frequencies and sizes at certain sites to a joint model for the whole Hungary. These results together with an analysis of the possible losses due to the floods allowed us to develop a software, which is able to simulate floods for thousands of years, together with the estimated losses for these years.

Results and achievements

The most important steps of the flood generating algorithm are the following:

1. Number of floods for the given year (from the nonhomogenous Poisson process, whose parameters are determined by MCMC methods)
2. Random generation of the affected upstream stations, based on the joint distribution of the flood occurrences
3. Simulation of the flood peaks from a suitable time-dependent generalised Pareto distribution (these are supposed to be conditionally independent)
4. Simulation of the duration of the flood (by regression model)
5. The shape of the flood (random choice from the observed sequences, by transformation)

Based on the above, the software is capable of simulating floods for long periods (several thousands of years) together with the estimated insurance losses. The simulator is based on the free statistical software R and it reproduced the observed flood frequencies and sizes reasonably well. As there were not many floods with dyke failures in the period under investigation, it was much harder to model the insurance losses, so here some foreign experience was used.

The results have shown that indeed the flood losses have heavy tail, but the amounts were in general smaller than those of estimated previously by reinsurance companies. However, the parameters of the nonhomogenous Poisson process indicate that there is a chance for increasing flood-frequency with a corresponding increase in risk in the future.

Lessons learned and replicability

The cooperation was successful, the results are used – thus the planning and calculation of flood insurance risk is more accurate, resulting in fair prices and a more manageable capital allocation. The methods are transferable to the case of other major rivers and real estate insurance portfolios, providing that there is enough information about the flood riskiness of the individual contracts in the portfolio.

Contacts, references

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