Earthquake risk model

Executive summary

In this project a joint effort of seismologists and mathematicians resulted in a quantified risk estimation and a simulation tool, used by Aegon Hungary. The investigation is based on a mix of recent data and historical observations and it is able to quantify not only the risk at a given area but also the accurateness of this risk estimator.

Challenge overview

Insurance companies face a hardly estimable risk, when they have earthquake-risk in their portfolio. There are some re-insurance companies who deal with catastrophic insurance, 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 seismology 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 areas joined their forces - and it turned out that it is indeed possible: the mathematicians were able to adapt the approaches to this seismic problem.

Implementation of the initiative

Aegon Hungary expressed interest in a cooperation, where experts work together in order to quantify the risk of their earthquake-insurance portfolio, with the aim of 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 seismologists from the GeoRisk Ltd worked together.

The problem

The main task was to quantify the loss distribution of the given portfolio of quake-insurances. Here the challenge was mainly in

- developing a spatial model for estimating the parameters of possible earthquakes;

- working out a formula for allocating estimated loss to a given earthquake.

The above results then – together with a more or less standard estimation of the quake frequency and magnitude distribution – allowed us to develop a software, which is able to simulate thousands of years of quake locations and intensity, together with the respective losses.
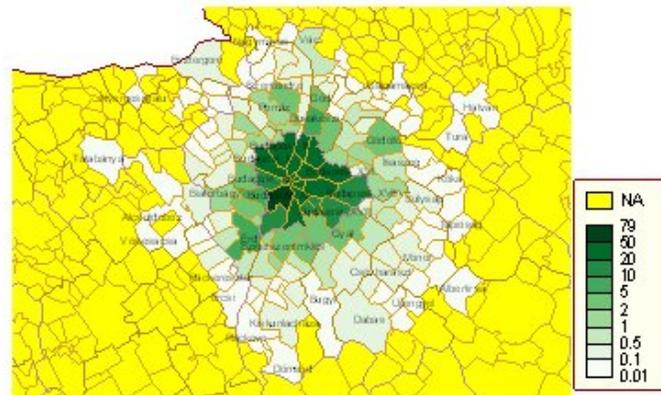

Figure 1: Map of Budapest and its surroundings with the estimated earthquake loss, based on a shifted version of the historical 1561 earthquake, in Millions of HUF

Results and achievements

The merger of the two approaches

- based on recent accurate data of – luckily – smaller earthquakes and

- the use of historical major earthquakes

resulted in a unified model, which is capable of simulating earthquakes for long periods (several thousands of years) together with the estimated insurance losses. This is shown on maps, as illustrated in Figure 1 for Budapest and its surrounding, showing one of the worst possible scenarios, caused by a theoretically possible, slightly shifted version of the earthquake in 1561. The simulator is based on the free statistical software R and it reproduced the observed data reasonably well.

The results have shown that indeed the earthquake-losses have heavy tail, but there is only a very slim chance for a major earthquake affecting the seismically moderately active Budapest region.

Lessons learned and replicability

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

Contacts, references

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