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FRAT1.0 - an example of applying the Geomorphologic Regression approach for detailed single location flood risk assessment

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Introduction

In (re)insurance industry two different types of flood risk assessment models are used. The first group of models bases on flood zones which describe the flood risk along rivers. The risk zones depict the probability (e.g. on average once a 100 years) of each location in a country being flooded. Zone based tools are generally used by primary insurance companies for risk selection and premium calculation. Additionally, zoning models help to determine the flood exposure of entire portfolios by providing the proportions of risks located in the different flood risk zones. This information can then be used to calculate the annual expected loss of a portfolio.

The second group of models calculate flood losses for a series of historic and/or probabilistic events. Their major objective is to reflect the correlation of larger river systems to have a flood event at the same time. These types of models are mainly used by reinsurance companies for structuring and pricing non-proportional business of entire portfolios or large accounts. In principle, probabilistic flood models can also be used for flood risk assessment of pure single location risks. But results are not always reliable due to the lack of a sufficient number of modeled events and, consequential, the limited area covered or the limited number of losses per location.

Therefore, flood risk zones are a better means for the assessment of single location risks. However, digital maps which depict the flood hazard on a national level are only available for very few countries in the world. This abstract describes a simple but accurate method to determine flood risk zones along rivers and the implementation of such zones into a detailed flood risk assessment tool for single location risks.

The Geomorphological Regression Method

Due to the lack of comprehensive digital flood risk zones for many countries with high flood exposure Swiss Re developed a model which yields nation-wide 50 to 500 year flood extents. The model is called Geomorphological Regression since it uses a novel method of multiple non-linear regression analysis (MARS) and geomorphological catchment attributes as parameters.

The underlying assumptions of the Geomorphological Regression Model are that, firstly, naturally flowing rivers shape their channel and flood plain according to basin inherent forces and characteristics. Secondly, the flood water extent strongly depends on the shape of the flood plain. E.g. in V-shaped valleys one would expect high water levels but a small flood extent. In contrast, the flood extent in low land flood plains might be large but water levels are low. In this case only small differences in elevation might be sufficient to be safe from flooding. The inherent forces of a river can be described by flood water volume and catchment descriptors like catchment area, slope etc., whereby flood water volume can also be described by catchment attributes including climate or any other rainfall information. The characteristics of a location with respect to its situation inside a flood plain can be defined by the vertical and horizontal distance to the relevant river.

In the model the probability of any location being inside a flood risk zone is dependent on the three parameters horizontal and vertical distance to the next river and the catchment area of the next river at that point. The regression model was calibrated and validated at known flood risk zones in the US. In a second validation study with independent flood zone data in the UK the ability of the model to provide reasonable flood risk information in a different environment to the US could be approved. The prediction success of the methodology was such that Swiss Re decided to apply for a patent.

The flood risk assesment tool for the Czech Republic

In a joint venture with the Czech company MultiMedia Computer (MMC) Swiss Re made its know-how on flood risk delineation available to Czech insurance market in form of the “Flood Risk Assessment Tool” FRAT 1.0. The objective of FRAT was to improve the flood risk assessment in the Czech Republic as a response to the devastating flood events in 1997 and 2002.

FRAT 1.0 is designed as a stand-alone software solution (CD-ROM) for use by insurers when assessing and pricing primary property business. The tool offers two basic functionalities. First, the user, for instance a risk manager or insurance agent, enters information about the location of a premise by full address (street, house number, city). The address, or part thereof, is located and transformed into geographic co-ordinates, which are used for flood risk zoning analysis.

Secondly, the system returns information about the flood risk of the selected location and highlights it on a visualisation screen. The tool distinguishes six different flood risk zones (zones ranging from 1, very low, to 6, very high risk) and the "historically observed maximum flood boundary".

FRAT 1.0 flood risk zoning is based on the best DTM available in the Czech Republic. The DTM features a horizontal resolution of 10 m, i.e. there is a reading of the elevation every 10 m.

The address database used in FRAT 1.0 is the most up-to-date geo database currently available in the Czech Republic and covers about 70% of addresses in insurance portfolios (“CEDA” database). This makes it possible to locate the co-ordinates of individual doorsteps in the 75 largest cities of the Czech Republic. The position of the premises in question is visualised on a map. The system uses Atlas CR 150 and city maps (scale 1:10,000) for approximately 75 cities of the Czech Republic.

Conclusions

FRAT is now used by almost all property insurers in the Czech Republic, allowing them to identify high exposed risks and more accurately price flood risks. While the first and most important step is to have proper flood risk assessment tools based on detailed flood risk zones in place, there is a wider trend towards risk dependent pricing functionalities, accumulation control and finally also event based models for peak loss estimations.

The determination of flood risk zones and the implementation of flood risk assessment tools are expensive tasks which ideally should be commissioned by public bodies and insurance associations. Approaches are available, its only a matter of willingness to have flood risk zones determined and assessment tools implemented.