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SCR Calculation Using a Fault Specific Earthquake CAT Model Compared with the EIOPA Standard Formula

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Introduction

According to the new Solvency II EU Directive, each insurance company specifies the required capital, in order to ensure that it will be able to meet its obligations over the following year, with a probability of at least 99.5%. In order to accurately calculate the Solvency Capital Requirements (SCR) for earthquake perils, insurance companies can utilize either the Standard Formula (SF) as defined in technical papers approved by the European Insurance and Occupational Pensions Authority (EIOPA), or an internal Earthquake CAT model. The SF is based on past earthquake events and their corresponding insured losses, thus inheriting problems related to the incompleteness and the inhomogeneity of the historical records and lower spatial resolution of hazard (e.g. Grützner *et al.*, 2013; Papanikolaou *et al.*, 2015). Furthermore, it incorporates rough assumptions so that it can fit every insurance company in EU, only by adjusting the country factor, the risk zone weights and the correlation matrix for all Catastrophe Risk Evaluation and Standardizing Target Accumulations (CRESTA) zones in each country (European Commission, 2010).

Methodology

A newly developed Synthetic Stochastic Earthquake Catastrophe model is applied in the Region of Attica, Greece. It consists of three basic modules: Hazard, Vulnerability (including the Exposure) and Loss modules. We use a fault specific seismic hazard assessment approach for the Hazard Module, in order to address problems related to the historical records incompleteness, aiming on the reconstruction of a more complete earthquake catalogue over a larger period of time (~15,000 years, i.e. during the Holocene), obtain higher spatial resolution and calculate more realistic source locality distances. The method of seismic hazard mapping from geological fault throw-rate data was firstly introduced by Papanikolaou (2003) and Roberts *et al.*, 2004. It is based on an active faults database with 24 faults that are long enough to produce surface ruptures and can sustain damage in the Attica mainland in case of earthquake rupture, affecting the Attica Region (Deligiannakis *et al.*, 2018) (Fig. 1).

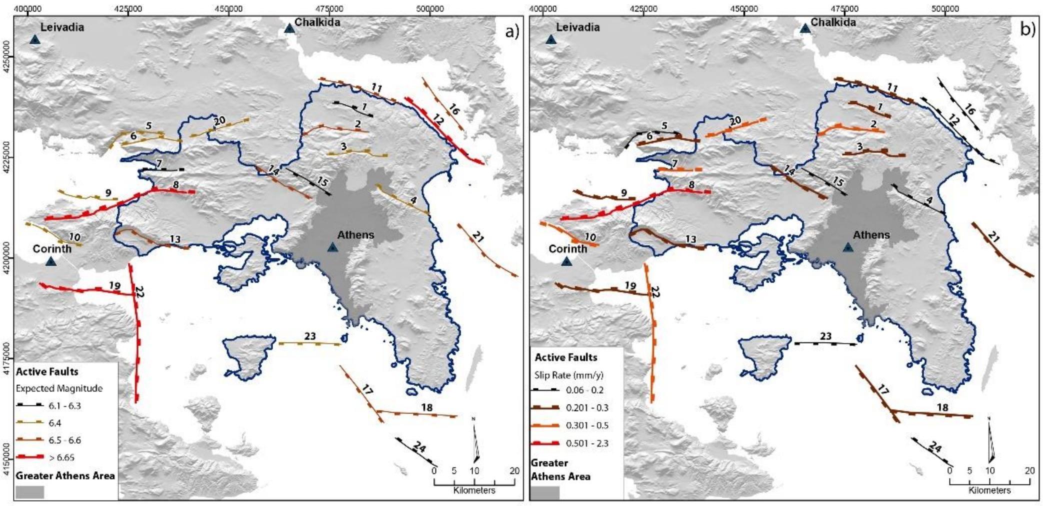

Figure 1. Map of active faults that can sustain damage within the region of Attica. Different colors and represent the maximum expected magnitude (a) and different slip-rate categories (b).

Epicenters induced by fault modeling, along with the catalogue events are stochastically simulated in order to project the future earthquakes. Attenuation relationships and amplification/attenuation factors based on the surface geologic conditions are then applied to each epicenter, in order to simulate future earthquake scenarios (Fig. 2, Left) and assess spatial distribution of the MM Intensity. The structural damage in buildings and the corresponding loss is computed using the Vulnerability Module, which is based on existing values (e.g. Sauter & Shah, 1978; Degg, 1992) (Fig. 2, Right). For the calculation of the SCR (Loss Module), a large dataset of simulated earthquake events is composed. The corresponding losses are either ranked in descending order, so that the appropriate arranged value can be selected, or a theoretical distribution is fitted over the whole sample of simulated losses.

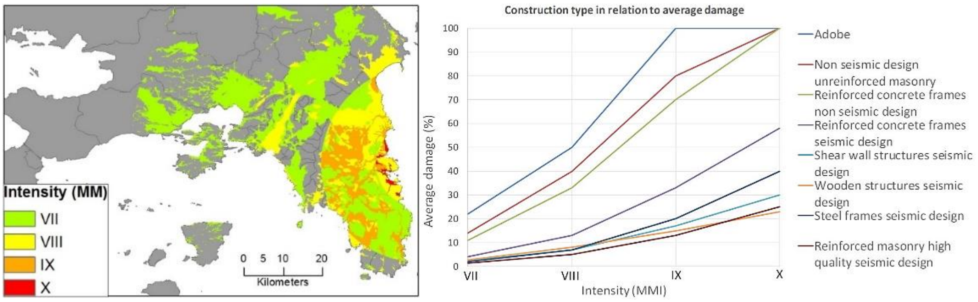

Figure 2. Left: Simulated earthquake event related to an active fault offshore eastern Attica. The modelled epicentre of the M6.6 event. Right: Vulnerability curves for different construction types, in relation to the Modified Mercalli intensity scale.

Results - Conclusion

Overall, for the whole Attica Region buildings inventory, the SCR calculated using the SF is overestimated by 15% compared to the hereby presented EQ CAT Risk Model. However, in 7 out of 10 CRESTA Zones in Attica, the SCR calculated by the SF was 3 – 57% higher, while in the remaining 3 cases it was 19 – 49% lower. These variations result from the differences on the spatial analysis, the local site conditions and the variations in seismic intensity recurrences throughout the same CRESTA Zone. For example, in CRESTA Zone "14" (Figure 3, left) the postal codes with low or zero intensity VIII recurrence are the ones with the largest insured values and thus the Earthquake CAT Model estimates a 57% lower SCR than the SF. Similarly, our model calculates the smallest SCR for the CRESTA Zone "16", compared to the rest of the CRESTA Zones of Attica. Nevertheless, there are still some Postal Codes within that Zone that have experienced intensity VIII and even IX in low recurrence (Figure 3, right). However, this CRESTA Zone is attributed to an extremely low CRESTA relativity factor (0.6), which seems to result in an SCR 55% lower than our model.

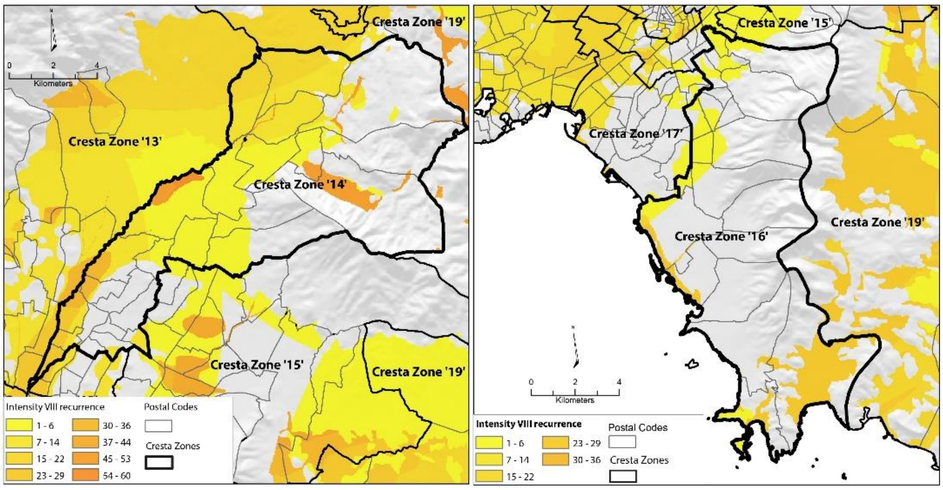

Figure 3. Fault Specific Seismic hazard map of the CRESTA Zone '14' (left) and "16" (right). Color variations show how many times the localities in the map have received enough energy to shake at intensity VIII over the past 15kyrs

Acknowledgements

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