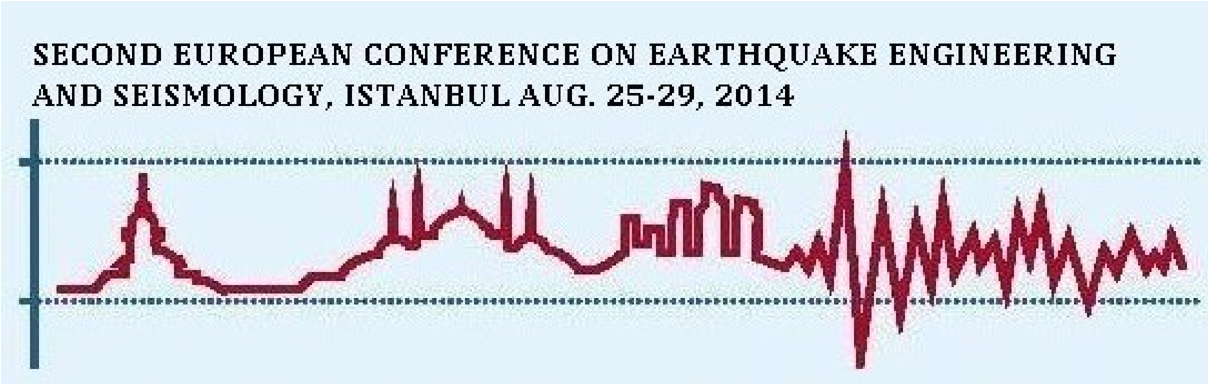

USING MIXTURES OF GROUND-MOTION PREDICTION EQUATIONS AS BACKBONE MODELS FOR A LOGIC TREE

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In probabilistic seismic hazard analysis, empirically derived ground-motion prediction equations (GMPEs) are used to compute the ground shaking at a particular site given source-, path- and site-related predictor variables. According to the SSHAC guidelines, a seismic hazard analysis should not only capture the center, but also the body and range of possible ground-motion in the area of interest. In order to capture the corresponding epistemic uncertainties, it has become common practice to combine several GMPEs into a logic tree framework. In this context, alternative models occupy the branches of the tree and the branch weights express the degree-of-belief of an expert into the corresponding models. To select appropriate models, however, is a non-trivial task. This is especially the case for regions where strong-motion data are sparse and where no indigenous model exists so that foreign models need to be applied. The assignment of suitable branch weights for the chosen set of GMPEs poses an additional challenge because inconsistencies in the assignment can easily lead to the over- or underestimation of epistemic uncertainty.

In some recent hazard studies single high-quality GMPEs have been used as so called backbone models to represent the center of the ground-motion distribution in the area of interest. These central models can then be scaled up or down in order to obtain the full range of ground-motion uncertainty for use in the logic tree. However, single models will rarely be able to perfectly represent the center of the ground-motion distribution in an area, especially if these models were developed for other regions.

We present a novel approach in which several GMPEs are combined as weighted components of a mixture model with the aim to infer a backbone model that is better suited to represent the center of the ground-motion distribution (Haendel et al., 2014). The most likely combination of models is determined from observed ground-motion observations of the target area. None of the models is considered as true or false within the mixture model approach. Instead, each model is assumed to reflect the generation mechanism of at least a part of the possible ground motions in the area of interest. Thus, information is partially transferred from those regions for which the models have been developed to the region where the observations have been produced.

The new method is used to generate a backbone model for Northern Chile, a region for which no indigenous GMPE (covering the full hazard relevant magnitude and distance range) exists. A mixture of eight subduction zone GMPEs is derived on the basis of strong-motion recordings from a dense seismic network deployed as part of the Integrated Plate Boundary Observatory Chile (IPOC, Schurr et al., 2009) and recordings collected by Arango et al. (2011). Backbone models are determined individually for interface and intraslab type earthquakes and for different oscillator frequencies. In addition to the mixture model, we also derive a new GMPE that is obtained from the Chilean dataset by regression. We are able to show that the mixture model performs better than any of the constituent GMPEs and even comparable to the inferred regression model.

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We believe that the mixture model approach might be useful to generate backbone models in situations were the number of ground-motion data is insufficient to generate an indigenous GMPE. We also think that the new method could be of value for all those research initiatives that try to develop integrated approaches for hazard assessment in e.g. Europe. Starting from a set of GMPEs applicable to a certain tectonic regime, mixture models can be determined automatically for different areas and different datasets. In this process, it is also possible to update a derived mixture as new data become available by using a Bayesian framework.

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