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Seismic shaking scenarios for city of Zagreb, Croatia

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Abstract

The wider area around the city of Zagreb is one of the seismically most active regions in Croatia where many strong events have been reported in the past. Due to the large population and socio-economic importance of this region, advanced seismic hazard and risk assessment for this area is of high importance. While seismic hazard gives probability that an earthquake will occur and outlines possible levels of shaking it lacks detailed information about the impact of a specific, usually stronger event. Therefore, this information must be supplemented in some other way in order to obtain reliable ground-motion prediction. Since the 1880 Mw = 6.2 historic earthquake is the most significant event, de-facto governing hazard assessment for the wider Zagreb area, our goal is to explore effects of such an occurrence happening today. To facilitate this, we simulated two ground shaking scenarios stemming from a large earthquake happening on two different hypocentre locations (Kašina and North Medvednica fault).

Key words: numeric simulation, ground motion, earthquake, central Croatia

The wider area around the city of Zagreb is one of the seismically most active regions in Croatia where many strong events have been reported in the past. Due to the large population and socio-economic importance of this region, advanced seismic hazard and risk assessment for this area is of high importance. While seismic hazard gives probability that an earthquake will occur and outlines possible levels of shaking it lacks detailed information about the impact of a specific, usually stronger event. Therefore, this information must be supplemented in some other way in order to obtain reliable ground-motion prediction. Since the 1880 Mw = 6.2 historic earthquake is the most significant event, de-facto governing hazard assessment for the wider Zagreb area, our goal is to explore effects of such an occurrence happening today. To facilitate this, we simulated two ground shaking scenarios stemming from a large earthquake happening on two different hypocentre locations (Kašina and North Medvednica fault).
In this work, we assessed ground shaking in the wider region around the city of Zagreb by computing broadband seismograms using a hybrid technique. In a hybrid technique, low frequency (LF, f < 1 Hz) and high frequency (HF, f = 1–10 Hz) seismograms are obtained separately and then reconciled into a single time series. The LF simulation of the wave propagation in the complex 3D media is computed using a deterministic method while the HF part is estimated using the stochastic methodology of [1]. For the purposes of the simulation, we assembled the 3D velocity and density model of the crust in the wider Zagreb region (Fig.1).

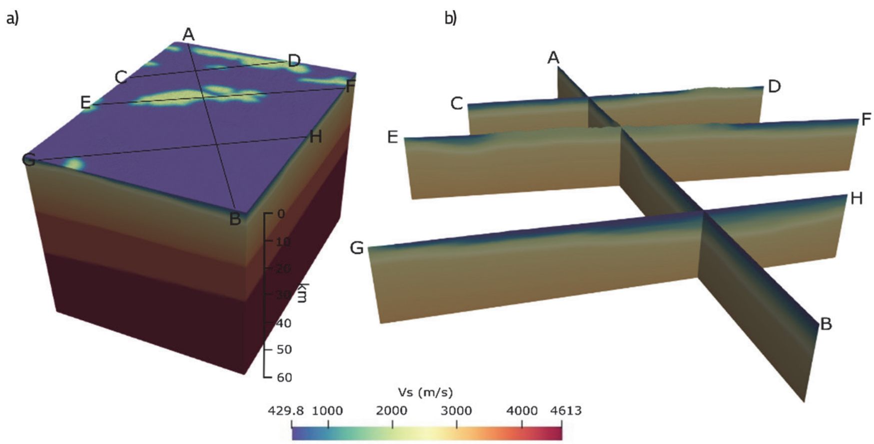

Figure 1. a) 3D shear wave (Vs) velocity model for the wider Zagreb area; b) Four cross sections of the model (only top 10 km are shown)

The model consists of a detailed description of the main geologic structures that are observed in the upper crust. It covers 60 km × 80 km area around the city of Zagreb, extends to the depth of 60 km and is embedded within a greater regional EPCrust crustal model [2]. To test and evaluate the model accuracy, we apply the hybrid technique to the March 22nd, 2020 Mw = 5.3 event and four smaller (3.0 < Mw < 5.0) events. We compare the measured seismograms with the synthetic data and validate our results by calculating the goodness of fit for the peak ground velocity values and the shaking duration. Lastly, we calculate broadband waveforms on a dense grid of points for the Mw = 5.3, March 22nd 2020 and Mw = 6.2, 1880 historic event. From computed waveforms, we generate the shakemaps (Fig.2) to determine if the main expected ground-motion features are well-represented and whether the results of our approach can be applied in other disciplines.

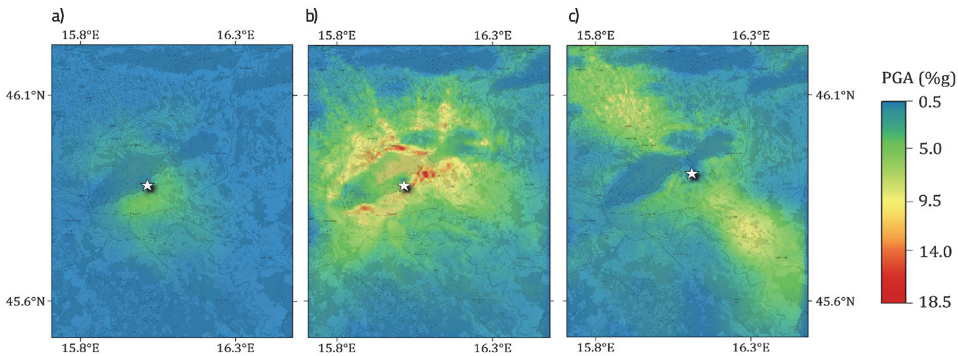

Figure 2. Peak ground acceleration (%g) for periods T > 1s for a) Mw = 5.3, 2020 event; Mw = 6.2, 1880 historic event on b) North Medvednica fault and c) Kašina fault

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