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Modeling tsunami generation for local tsunami early warning in Indonesia

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Magnitude-plus-epicenter based rupture models (e.g., single Okada fault with uniform slip), which are well suited for trans-oceanic tsunamis, are, however, far not enough for local tsunamis like in the case of Indonesia. Here the trench lies only 200-300 km off the coast - a distance which is comparable or even smaller than potential rupture size. This makes slip heterogeneity along and across the trench of much importance for reliable tsunami early warning. Furthermore, extremely short tsunami arrival times (about 30 min) require a-priori incorporation of as much as possible data on local geology and tectonics in order to minimize real-time uncertainty of rupture parameters.

To meet this requirements we have designed a new highly flexible tool for modeling of local tsunami generation called 'RuptGen' which incorporates (a) variable geometry of the plate interface at the Sunda trench, (b) fine discretization of the plate interface, (c) Green's function approach to generate co-seismic sea-bed uplift for arbitrary slip distribution and different crustal models, (d) various scaling relations for rupture dimensions. RuptGen is being employed as a tsunami generation tool in GITEWS (German-Indonesian Tsunami Early Warning System), in particular, for the databank of pre-computed scenarios.

In present study we use RuptGen together with another GITEWS modeling tool 'TsunAwi' (a nonlinear shallow-water FEM code) to calculate scenarios for next probable large earthquake and tsunami near city of Padang, western Sumatra. Our scenarios are based on recent data on plate interface locking derived from geodetic and paleogeodetic studies by Chlieh et al. (2007).

Due to the presence of Mentawai islands, resulting tsunami wave height in Padang is

very sensitive to rupture location perpendicular to the trench. Shallow ruptures west or under the Siberut island do not produce large tsunami in Padang even for Mw=8.5 earthquakes. In contrast, rupturing of deep locked patches between Siberut and Padang results in devastating tsunami with short arrival times even for smaller earthquakes.

We demonstrate that real-time GPS stations located at the Mentawai islands and in Padang can be used to estimate rupture parameters and to predict tsunami wave heights just in few minutes after an earthquake.