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Tsunami-hazard assessment based on subaquatic slope-failure susceptibility and tsunami-inundation modeling

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Due to their smaller dimensions and confined bathymetry, lakes act as model oceans that may be used as analogues for the much larger oceans and their margins. Numerous studies in the perialpine lakes of Central Europe have shown that their shores were repeatedly struck by several-meters-high tsunami waves, which were caused by subaquatic slides usually triggered by earthquake shaking. A profound knowledge of these hazards, their intensities and recurrence rates is needed in order to perform thorough tsunami-hazard assessment for the usually densely populated lake shores. In this context, we present results of a study combining i) basinwide slope-stability analysis of subaquatic sediment-charged slopes with ii) identification of scenarios for subaquatic slides triggered by seismic shaking, iii) forward modeling of resulting tsunami waves and iv) mapping of intensity of onshore inundation in populated areas.

Sedimentological, stratigraphical and geotechnical knowledge of the potentially unstable sediment drape on the slopes is required for slope-stability assessment. Together with critical ground accelerations calculated from already failed slopes and paleoseismic recurrence rates, scenarios for subaquatic sediment slides are established. Following a previously used approach, the slides are modeled as a Bingham plastic on a 2D grid. The effect on the water column and wave propagation are simulated using the shallow-water equations (GeoClaw code), which also provide data for tsunami inundation, including flow depth, flow velocity and momentum as key variables. Combining these parameters leads to so called «intensity maps» for flooding that provide a link to the established hazard mapping framework, which so far does not include these phenomena. The current versions of these maps consider a 'worst case' deterministic earthquake scenario, however, similar maps can be calculated using probabilistic earthquake recurrence rates, which are expressed in variable amounts of destabilized slopes and thus variable tsunami inundations.