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Recent advances in modeling coastal tsunami hazard based on the geological record

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In operational tsunami hazard assessment in a given area or oceanic basin, such as currently being performed in the US under the auspice of the National Tsunami Hazard Mitigation Program (NTHMP) (URI is in charge of developing inundation maps for the US East Coast, in collaboration with UoD), one has to model wave generation and coastal inundation resulting from all the relevant geological sources leading to Probable Maximum Tsunami (PMT) conditions. This typically includes co-seismic as well as landslide tsunami sources, the latter being comprised of Submarine Mass Failures (SMF) and subaerial slides, including volcanic flank collapse. Here, we review how the author and co-workers have used the geological record and related parameters to design and model relevant PMT scenarios for co-seismic and SMF tsunamis and subaerial slides. In particular, for SMFs along the US East Coast, a probabilistic Monte Carlo approach, based on slope stability analyses, was first used as a screening tool to estimate overall alongshore SMF tsunami hazard (Grilli et al., 2009). Consistent with the PMT approach, this was followed by siting extreme SMFs in areas deemed at higher risk where sediment availability and seafloor morphology indicated such SMFs were possible. The largest known historical SMF, the 165 km3 Currituck slide complex, was used as a proxy for the most extreme SMF and to maximize wave generation, it was modeled as a rigid slump (Grilli et al., 2015). Large slumps have been shown to have the potential for generating very large tsunamis in recent case studies (Tappin et al., 2008, 2014). The approach for modeling rigid SMF motion and the resulting wave generation is based on using a combination of simple analytical laws of motion verified in laboratory experiments (Enet and Grilli, 2007) and advanced non-hydrostatic models (Ma et al., 2012, 2013; Shi et al., 2012; Grilli et al., 2015; Tappin et al, 2014). Effects of SMF deformation/rheology on tsunami generation will also be discussed and illustrated using numerical modeling. Slides, both SMFs and subaerials, that are closer to debris flows, have also been modeled as heavy fluids. This will be illustrated, by the case of the possible flank collapse of the Cumbre Vieja Volcano (La Palma, Canary Islands), whose extreme 450 km3 scenario yields the dominant PMT in then North Atlantic Ocean basin (Abadie et al., 2012; Harris et al., 2012; Tehranirad et al., 2015).

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