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Extreme statistical properties maximum tsunami run-up – uncertainty evaluations based on non-linear shallow water models

Finn Løvholt (1), Sylfest Glimsdal (1), Stefano Lorito (2), Fabrizio Romano (2), Manuela Volpe (2), Jacopo Selva (3), and Andreas Hoechner (4)

(1) NGI, Oslo, Norway, (2) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy, (3) Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy, (4) GFZ Potzdam, Germany

The standard way of estimating tsunami inundation is by applying numerical depth averaged shallow water run-up models. However, provided that accurate high-resolution DEMs are available, which is not always the case, for a regional Probabilistic Tsunami Hazard Assessment (PTHA), applying such inundation models may be too time consuming. A faster, yet approximate, procedure is to simulate offshore surface elevations and relate them to maximum shoreline water levels, by using a set of amplification factors based on the characteristics of the incident wave and the bathymetric slope. The surface elevation at the shoreline then acts as a rough approximation for the maximum inundation height or run-up height along the shoreline. Recently, this amplification factor approach was improved to taking into account the local bathymetric profiles, and tested in the North-eastern Atlantic, the Mediterranean and connected seas (NEAM) region. Because amplification factors only provide rough estimates for the tsunami inundation height, and extensive comparison with non-linear shallow water (NLSW) simulations for six different sites in the Mediterranean region was carried out. A total of 80 NLSW run-up simulations using sources with variable earthquake moment magnitudes, faulting mechanism and location, were carried out for each test site. By dividing the inundation domain into subsections, the spatial statistical distribution for each simulation could be tabulated. In turn, the variability was analysed across all simulations, and used to compute the bias and uncertainty for the amplification factor method. It was found that by comparing all simulations, the amplification factor agreed closely with the median value of the local maximum inundation height for each subsection of the domain. In addition, a rather large lognormal uncertainty of more than 0.4 was found. While the amplification factor was found to match well the median value of the inundation height, the expected maximum run-up height over the full simulation domain was found close to the 95 percentile. Hence, the maximum inundation height typically found display an extreme offset compared to the overall expectance value over a typical study region covering a few kilometres of coastlines. This work has been supported by the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement 603839 (Project ASTARTE), and the TSUMAPS-NEAM Project (http://www.tsumapsneam.eu/), co-financed by the European Union Civil Protection Mechanism, Agreement Number: ECHO/SUB/2015/718568/PREV26.