EGU21-14159, updated on 21 Oct 2021
https://doi.org/10.5194/egusphere-egu21-14159
EGU General Assembly 2021

The Sensitivity of Tsunami run-up to Earthquake Source Parameters and Manning Friction Coefficient in High-Resolution Inundation Simulations

Steven J. Gibbons[1], Stefano Lorito[2], Marc de la Asunción[3], Manuela Volpe[2], Jacopo Selva[2], Jorge Macías[3], Carlos Sánchez-Linares[3], Malte Vöge[1], Roberto Tonini[2], Piero Lanucara[4], Sylfest Glimsdal[1], Jan Christian Meyer[5], Fabrizio Romano[2], and Finn Løvholt[1]

[1]The Norwegian Geotechnical Institute (NGI), Oslo, Norway
[2]Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy
[3]Universidad de Málaga, Málaga, Spain
[4]CINECA SuperComputing Applications and Innovation, Rome, Italy
[5]The Norwegian University of Science and Technology (NTNU), Trondheim, Norway

Advances in GPU-based High-Performance Computing (HPC) facilities, combined with improvements in GPU-optimized shallow water models for tsunami inundation, allow us to perform large numbers of numerical simulations of earthquake-generated tsunamis on high-resolution numerical grids. Large numbers of simulations are necessary to investigate the multi-dimensional parameter space that defines the tsunami hazard, including situations where the tsunami is generated outside major tectonic structures, where fault geometry is uncertain and can take widely different orientations. With over 1500 numerical simulations, we perform suites of systematic parameter searches to investigate the sensitivity of inundation at the towns of Catania and Siracusa on Sicily to changes both in the earthquake source parameters and in the specification of the Manning friction coefficient. The inundation is modelled using the GPU-based Tsunami-HySEA code on a system of nested topo-bathymetric grids with a finest spatial resolution of 10 meters. We consider tsunamigenesis by large earthquakes with uniform slip where the location, focal depth, fault dimensions and slip, together with the angles of strike, dip, and rake, are defined by the standard Okada parameters. We consider sources both close to the shore, in which significant co-seismic deformation occurs, and offshore, where co-seismic deformation is negligible. For the offshore earthquake sources, we see systematic and intuitive changes in the inundation with changes in strike, dip, rake, and depth. For the near-shore sources, the dependency is far more complicated and co-seismic deformation becomes significant in determining the inundation. The sensitivity studies provide clear guidelines as to the necessary resolution for source discretization for Probabilistic Tsunami Hazard Analysis, with a need for a far finer discretization of local sources than for more distant sources. For a small number of earthquake sources, we study systematically the inundation as a function of the Manning Friction Coefficient. The sensitivity of the inundation to this parameter varies greatly for different earthquake sources and topo-bathymetry at the coastline of interest. An understanding of all

these dependencies is needed to better understand the consequences of tsunamigenic earthquake models with more complex geometries, and in quantifying the epistemic uncertainty in the tsunami hazard.

This work is partially funded by the European Union's Horizon 2020 Research and Innovation Program under grant agreement No 823844 (ChEESE Center of Excellence, www.cheese-coe.eu). Computational resources made available through Sigma2/UNINETT on Saga at NTNU, Trondheim, Norway (in project nn5008k) and through PRACE on Marconi-100 at CINECA, Rome, Italy (through PRACE grant Pra21_5386/TsuHazAP).