Geophysical Research Abstracts
Vol. 15, EGU2013-8859, 2013
EGU General Assembly 2013

Rapid inundation estimates at harbor scale using tsunami wave heights offshore simulation and Green's law approach

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Improvements in the availability of sea-level observations and advances in numerical modeling techniques are increasing the potential for tsunami warnings to be based on numerical model forecasts. Numerical tsunami propagation and inundation models are well developed and have now reached an impressive level of accuracy, especially in locations such as harbors where the tsunami waves are mostly amplified.
In the framework of tsunami warning under real-time operational conditions, the main obstacle for the routine use of such numerical simulations remains the slowness of the numerical computation, which is strengthened when detailed grids are required for the precise modeling of the coastline response on the scale of an individual harbor. In fact, when facing the problem of the interaction of the tsunami wavefield with a shoreline, any numerical simulation must be performed over an increasingly fine grid, which in turn mandates a reduced time step, and the use of a fully non-linear code. Such calculations become then prohibitively time-consuming, which is clearly unacceptable in the framework of real-time warning. Thus only tsunami offshore propagation modeling tools using a single sparse bathymetric computation grid are presently included within the French Tsunami Warning Center (CENALT), providing rapid estimation of tsunami wave heights in high seas, and tsunami warning maps at western Mediterranean and NE Atlantic basins scale.
We present here a preliminary work that performs quick estimates of the inundation at individual harbors from these deep wave heights simulations. The method involves an empirical correction relation derived from Green's law, expressing conservation of wave energy flux to extend the gridded wave field into the harbor with respect to the nearby deep-water grid node. The main limitation of this method is that its application to a given coastal area would require a large database of previous observations, in order to define the empirical parameters of the correction equation. As no such data (i.e. historical tide gage records of significant tsunamis) are available for the western Mediterranean and NE Atlantic basins, a set of synthetic mareograms is calculated for both fake and well-known historical tsunamigenic earthquakes in the area. This synthetic dataset is obtained through accurate numerical tsunami propagation and inundation modeling by using several nested bathymetric grids characterized by a coarse resolution over deep water regions and an increasingly fine resolution close to the shores (down to a grid cell size of 3m in some Mediterranean harbors). This synthetic dataset is then used to approximate the empirical parameters of the correction equation. Results of inundation estimates in several french Mediterranean harbors obtained with the fast "Green's law - derived" method are presented and compared with values given by time-consuming nested grids simulations.