TSUNAMI POTENTIAL IMPACT IN THE LEVANTINE BASIN AT THE ISRAELI COAST BY EARTHQUAKES AND BY SUBMARINE LANDSLIDES USING VERY HIGH RESOLUTION COASTAL GRIDS

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Abstract

This paper presents detailed quantification of tsunami impact by application of a very high resolution numerical model studying a number of the worst tsunami feasible scenarios in the eastern Mediterranean and their impact on the Levantine coasts, focusing particularly on the Israeli coast.

Keywords: Bathymetry, Levantine Basin, Models, Waves

Introduction

The study reported here [1] is the first stage in thepreparation of a data bank of potential tsunami scenarios for the Israeli coast, which would enable early tsunami warning upon receipt of tsunami alerts from regional tsunami watch centers being established under the IOC/UNESCO Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas ICG/NEAMTWS) or from local tsunami detection sea level sensors operated by IOLR. Here we present outcomes of a numerical study of the impact of tsunami scenarios for a number of the worst potential events in the eastern Mediterranean's sea, focusing on their impact on the Israeli coast.

Study overview

The simulations were carried out by a state of the art open source numerical model named GeoClaw. It is based on a larger software package called ClawPack that is aimed to solve hyperbolic partial differential equations up to 3 space dimensions, including nonlinear systems of conservation laws. Furthermore, a special feature of the numerical method is its adaptive mesh refinement (AMR), which enables the implementation of meshes with a large range of scales, property that is extremely important when one is interested in solving problems with a multitude of geometric scales, such as for tsunamis. The adaptation of the code and other changes were checked against well accepted benchmark runs.

Two mechanisms for tsunami generation were considered: i) submarine earthquake resulting from the Crete-Helenic arc, and ii) submarine landslides induced by earthquakes at the Dead Sea Transform. Based on older studies [2], the worse cases were chosen accordingly. The movement of the undersea terrain was modeled for the above two mechanisms. Our results were compared with those of older studies and showed agreement for the large scale features. The modeling of the sources in the GeoClaw package is in general a description of the time change of the sea ground. In order to generate these changes, we reconstructed models that describe both earthquakes and landslides. Schematically, the model for the earthquake is taken as a translation of certain quadrilateral region (the moving region) in a linear way. For landslides, a volume in a general form of half elliptic paraboloid is sliding on given chosen track and velocity profile (depends on time). Significant progress has been made by implementing high resolution digital bathymetric and topographic data. The nearshore (shallower than 500m) bathymetry and the topographic data at the coast and river estuaries are on a grid of about 5m cell size.

Results

Maps for maximum inundation, maximum set down, maximum wave height and various time snapshots are produced. The maps for inundation and set down were generated by supplementary Matlab codes which were developed by the first author. Because the solution is found on an adaptive grid (that is also time dependent), one has to interpolate it on a uniform grid for the various snapshots in order to create maximum or minimum maps. For the maximum wave height we introduced for the GeoClaw package a list of sea level gauges located at the lines of zero sea level. From the raw output of a run, we filter out time intervals where the grid is coarse and the information is inaccurate. Next step is to write the maximum of the waves for each gauge point. Example of an inundation map at Haifa bay coast is shown in Fig.1 for the case of an 8.3 earthquake off the eastside of Crete.

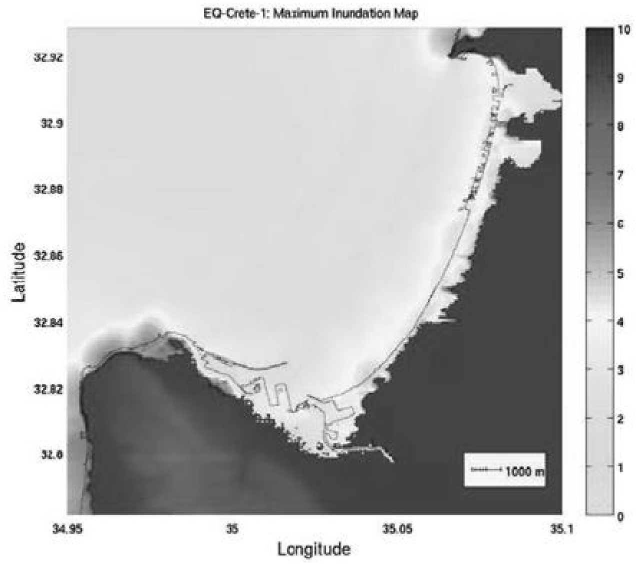

Fig. 1. Example of a maximum inundation map at the Haifa Bay induced by a 8.3 magnitude earthquake off SE Crete.

In order to understand the generation, evolution and dispersion of the tsunami waves, animations were produced. They enable observing complex wave refraction, wave reflection and wave-wave interactions, and the corresponding forcing on the nearshore and coastal structures, cliff, beach erosion, etc.

The presentation will show results of computed flow velocities, flow flux and momentum at various positions and times, where structures such as breakwaters, coastal cliff and other structures are located, as well as the extreme forces assessed for these locations.

References

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