Study of resonant modes of the harbour of Siracusa, Italy, and of the effects of breakwaters in case of a tsunami event.

Gianluca Pagnoni and Stefano Tinti
University of Bologna, Physics and Astronomy, Geophysics, Bologna, Italy (gianluca.pagnoni3@unibo.it)

The eastern coast of Sicily has been hit by many historical tsunamis of local and remote origin. This zone and in particular Siracusa, as test site, was selected in the FP7 European project ASTARTE (Assessment, Strategy And Risk Reduction for Tsunamis in Europe - FP7-ENV2013 6.4-3, Grant 603839). According to the project goals, in this work oscillations modes of the Siracusa harbour were analysed with focus on the typical tsunami periods range, and on the protecting effects of breakwaters by using linear and non-linear simulation models.

The city of Siracusa is located north of the homonymous gulf and has two harbours, called "Piccolo" (small) and "Grande" (grand) that are connected through a narrow channel. The harbour "Piccolo" is the object of this work. It is located at the end of a bay facing east and bordered on the south by the peninsula of Ortigia and on the north by the mainland. The basin has an area of approximately 100,000 m2 and is very shallow with an average depth of 2.5 m. It is protected by two breakwaters reducing its mouth to only 40 m width.

This study was carried out using the numerical code UBO-TSUFD that solves linear and non–linear shallow-water equations on a high-resolution 2m x 2m regular grid. Resonant modes were searched by sinusoidal forcing on the open boundary with periods in a range from about 60 s to 1600 s covering the typical tsunami spectrum.

The work was divided into three phases. First we studied the natural resonance frequencies, and in particular the Helmholtz resonance mode by using a linear fixed-geometry model and assuming that the connecting channel between the two Siracusa ports is closed. Second, we repeated the analysis by using a non-linear simulation model accounting for flooding and for an open connection channel.

Eventually, we forced the harbour by means of synthetic signals with amplitude, period and duration of the main historical tsunamis attacking Siracusa, namely the AD 365, the 1693 and the 1908 tsunami events. In this last case our attention was also focused on quantifying the role of the existing breakwaters in mitigating the incoming tsunami.