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Tsunami Induced Resonance in Enclosed Basins; Case Study of Haydarpasa Port In Istanbul

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Coincidence of the frequency of forcing mechanisms and the natural frequency of free oscillations in the harbors or basins leads to formation of resonance oscillations and additional amplifications in the basins. This phenomenon becomes much more critical when it is caused by a tsunamis. In the cases of tsunami induced basin resonances, the wave amplifications may occur with more and unexpected damages.
The harbor resilience against the marine hazards is important for the performance and success of recovery operations. Classifying the tsunami effects on the ports and harbors and on their functions is the main concern of this study. There are two types of impacts; direct impacts including structural damages due to strong currents, high water elevation and indirect ones because of basin resonance expose to seiche oscillations.
The sea of Marmara has experienced numerous (more than 30) tsunamis in history where a highly populated metropolitan city Istanbul is located at North coast of Maramara sea. There are numerous ports and harbors located at Istanbul Coast. Haydarpasa port (41.0033 N, 29.0139 E) in Istanbul coast near Marmara sea, as a case study is selected to test its resilience under tsunami attack by numerical experiments. There are two breakwaters in Haydarpasa port with total length of three kilometers and the shape of basins are regular. Applying numerical model (NAMI DANCE) which solves nonlinear form of shallow water equations, the resonance oscillations in Haydarpasa Port is investigated by following the method given in Yalciner and Pelinovsky, (2006). In the applications, high resolution bathymetry and topography are used and an initial impulse is inputted to the study domain in the simulations. The computed time histories of water surface fluctuations at different locations inside the harbor are analyzed by using Fast Fourier Transform technique. The frequencies where the peaks of spectrum curves indicates the amplification of waves in the respective gauge location. Therefore these frequencies are the natural frequencies of the Haydarpasa port. The peak points in the spectrum curves are selected as the the resonance frequencies of the Haydarpasa port. Furthermore the coincidence of these frequencies with the frequency of waves of extreme events are discussed and consequent amplification in the Harbor and their effects on harbor operations are discussed.