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Case study of small harbor excitation under storm and tsunami conditions

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Simultaneous nearshore and interior-to-ports wave and current measurements for small ports are not common, and few, if any, benchmarking cases at sufficient resolution exist to help validate numerical model of intermediate waves, or even long waves. The wave conditions inside the old Venetian harbor of Chania, Greece and offshore were measured and studied from 2012 to 2015. The construction of this harbor began in the 14th century, and since then, its layout has been modified to adapt to different social and to economic conditions. It is divided into a western and an eastern basin. The eastern basin is used by recreational vessels and fishing boats throughout the year. The western basin has an exposed entrance to the north, and it is essentially functional half of the year, because of the severe overtopping and flooding that occur during the northern winter storms.

Our work is motivated by the necessity to protect the monument from severe winter storm conditions and allow safe mooring and all other recreational activities that take place in the exposed western basin. Two earlier studies had proposed the construction of a low crested breakwater near the harbor entrance. The first design has been partially constructed, while the second never materialized. The main disadvantage of both studies was the lack of any wave field measurements. At the same time, second order or complimentary phenomena such as harbor resonance had not been considered.

To address the lack of field data, the offshore wave climate has been monitored since October 2012 using an AWAC 600kHz instrument, deployed at 23m depth. The response of the western and eastern basins of the harbor was measured with a TWR-2050 (deployed at 5.5m depth) and an RBRDuet T.D./wave (deployed at 2m depth) pressure gauges respectively. Significant wave heights ranging up to 5.8 m with significant periods of up to 10 sec were measured. The harbor pressure gauges are now being re-deployed in other locations to collect enough information to infer the resonant modes of the basins excited during storm conditions.

The deployment position of the pressure gauges is based on numerical modeling results. We have employed the fully nonlinear Boussinesq module of COULWAVE using a high resolution (2m cell size) relief model and an idealized TMA directional wave spectrum. The wave field and low frequency energy distribution in the basin are captured by both numerical modeling and field measurements. The field measurements agree well with the numerical modeling analysis, providing insight as to the causes of severe disturbance and useful information that should be considered for an effective solution to the protection of the harbor.

Our measurements appear the first ever nearshore measurements of waves and currents for a 2+ year period duration in Greece. The work is also being used for validation tsunami inundation models for civil defense applications in Crete.

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