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Tsunami Risk and Vulnerability Analysis for the City of Rhodes

Evangelia T. Flouri[1,2,], Dimitrios, A. Mitsoudis[3,1], Nektarios Chrysoulakis[1], and Costas E. Synolakis[2,4,5]*

[1] Institute of Applied and Computational Mathematics, FORTH, Heraklion, Greece
[2] Dept. of Environmental Engineering, Technical Univ. of Crete, Chania, Crete, Greece
[3] Archimedes Center for Modeling, Analysis & Computation, Dept. of Applied Mathematics, Univ. of Crete, Heraklion, Crete, Greece
[4] Hellenic Center for Marine Research, Anavyssos, Attica, Greece
[5] Dept. of Civil Engineering, University of Southern California, Los Angeles, USA

ABSTRACT

The authors present a vulnerability and risk analysis of tsunami hazard for the city of Rhodes. The tsunami hazard is assessed through computed values of the maximum inundation and maximum flow depth derived from a probabilistic scenario for a 1000-year time window, which incorporates hundreds of numerical simulations with MOST code. The data needed to identify tsunami vulnerable areas are gathered combining remote sensing techniques and GIS technology with surveyed observations and estimates of population data. Tsunami risk zones are defined on the basis of both estimated maximum inundation and maximum flow depth data and results are presented using GIS.

KEY WORDS: tsunami; hazard; vulnerability; risk; Rhodes; Aegean Sea.

INTRODUCTION

Major tsunamis are rare events in the Mediterranean, where they are believed to occur a few times per century. Nevertheless, as historical records indicate, the island of Rhodes in SE Aegean has experienced severe earthquakes, such as the earthquakes of 1303, 1481 and 1741 AD, which are related, with variable degree of confidence, to the occurrence of tsunamis, see e.g. Ambraseys (1962), Papadopoulos and Chalkis (1984), Ambraseys and Synolakis (2010). Nowadays, the potential impact due to an extreme event is likely to be much greater since urban development is rapidly increasing in coastal areas.
Until 2004, there were limited studies on tsunami hazard and risk assessment, for specific locales in the Mediterranean Sea and particularly for Greece. Indicatively, Papadopoulos and Dermentzopoulos (1998) performed a qualitative tsunami risk pilot management study for Heraklion, Crete, their results being based upon the analysis of a hypothetical tsunami of a particular magnitude with no numerical modelling. Papathoma et al. (2003) and Papathoma and Dominey-Howes (2003) proposed a vulnerability approach incorporating various vulnerability factors in order to assign the so-called Relative Vulnerability Index to every building located inside the inundation zone. The latter was not derived from simulations but was rather defined as the area between the coastline and the 5m elevation contour. Their methodology was applied on a coastal segment of the western part of Heraklion and in the Gulf of Corinth. Birckmann et al (2010) analyzed the vulnerability of Cadiz, Spain and related it to what they refer to as "social dimension". Realizing that vulnerability variables are usually beyond the control of local communities, Ewing and Synolakis (2010) introduced a newer concept, the Community Resilience Index (CRI). This is tool for communities to evaluate resilience, whose factor can be modified by human intervention and thus it changes over time. They compare the response of Galveston, Texas, Tutuila, Samoa and Pacifica, California to Hurricane Ike, the 2009 Samoan tsunami and the California 2009/2010 winter storms, respectively.

In this study the authors present a vulnerability and risk analysis where the tsunami hazard is assessed by means of the outcome of multiple numerical simulations of tsunami events of a previous work, see Mitsoudis et al (2012). Specifically, vulnerable areas for the City of Rhodes are identified using results derived from probabilistic scenario for a 1000-year time window of Mitsoudis et al (2012).

Independently of the approach that one may follow in order to assess the tsunami hazard, there are specific data that have to be analyzed to subsequently identify vulnerable elements. To this end, the authors have determined the land cover/use for coastal areas from satellite images, identified and classified the main buildings and structures near the coast, and collected data for the population of the city and its seasonal variation. All the relevant data were integrated into a GIS platform and coupled with estimates of the maximum inundated area and the maximum flow depth, which were derived from the numerical simulations, to produce risk maps. These maps are presented with a GIS. This work aims into helping the city authorities to decide on suitable prevention and mitigation measures and strategies against a potential tsunami impact.

RHODES AND TSUNAMI HAZARD ASSESSMENT

Rhodes (Ρόδος) is the most populated island in the southeast Aegean region, located between the latitudes 35.85^o N and 36.5^o N and the