Doğu Akdeniz Bölgesindeki Tarihsel Tsunamiler, Potansiyel Tsunami Kaynakları ve Tsunami Simülasyonları

Historical Tsunamis, Potential Source Regions and Tsunami Simulations in the Eastern Mediterranean Region

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Anahtar Kelimeler: Tsunami, Eastern Mediterranean, earthquake, simulation

ÖZ Hızlı deforme olan ve yoğun deprem aktivitesine sahip bölgelerden birisi olan Doğu Akdeniz Bölgesinin en belirgin tektonik yapıları Afrika Levhasının Avrasya levhası altına kuzeye doğru olan dalma batması ile oluşmuş Helenlik ve Kıbrıs Yaylarıdır. Bölge, tarihsel ve güncel dönem içerisinde şiddetli depremlerin gözlendiği yoğun deprem aktivitesine sahiptir. Bu çalışmada öncelikle Helenik ve Kıbrıs Yayları göz önünde bulundurularak tarihsel dönemde meydana gelen ve tsunami yarattığı rapor edilen depremler listelenmiştir. Daha sonra, Girit-Rodos adası (08 Ağustos 1303 Girit Mw ~8.0 ve 1481 Rodos Mw~7.5) ve Kıbrıs Yayı (11 Mayıs1222 Mw~7.5) boyunca oluşan büyük depremler ile gözlenen tsunami dalgalarının su seviyesi yükseklikleri, dağılımları ve teorik varış zamanları Okada (1985) yöntemine dayalı olarak geliştirilen TUNAMI-N2 ve AVI-NAMI programları ile hesaplanmıştır. Elde edilen sonuçlar, kıyı topoğrafyası, deniz tabanı düzensizlikleri (deniz dağları, volkanlar vb) ve yakın kıyı batimetrisinin tsunami dalga simülasyonlarında dalganın ilerlemesi, yansıma, kırılma ve saçılmaya uğramasında oldukça önemli parametreler olduklarını göstermiştir.

ABSTRACT *Prominent tectonic features of the Eastern Mediterranean which is one of the most seismically active and rapidly deforming region on the continents are Cyprus and Hellenic Arcs formed by the northward subduction of the African Plate under the Eurasian Plate. This region is characterized by intense seismic activity with strong earthquakes in historical and recent times. In this study we have analyzed the historical data of tsunami manifestation on the eastern Mediterranean region with particular attention to Hellenic and the Cyprus arc and then we have calculated the water surface elevation distributions and theoretical arrival times for Crete – Rhodes (08 August 1303 Crete Mw~ 8.0 and Rhodes Mw~7.5) and Cyprus earthquakes (11 May 1222 Paphos Mw~7.5) that are known the largest and well-documented seismic events using the numerical models TUNAMI N2 and AVI-NAMI based on the method of Okada (1985). Obtained results indicate that the coastal topography, sea bottom irregularities (sea mounts, volcanoes etc.) and near-shore bathymetry are crucial components in tsunami wave simulations in order to affect the wave propagation, reflection, refraction, diffraction effects and coastal amplifications.*

INTRODUCTION

The kinematics and active deformation of the Eastern Mediterranean, which is evolved as a result of the interaction between the African, Arabian and Eurasian plates, are controlled by the westward motion of Turkey relative to Europe, the continental collision between NW Greece-Albania and Apulia-Adriatic platform in the west and the presence of the Hellenic subduction zone to the south (Papazachos and Comninakis, 1971; McKenzie, 1978; Dewey and Şengör, 1979; Spakman et al., 1988; Taymaz, 1990; Taymaz et al., 1990, 1991; Nyst and Thatcher, 2004).

The Eastern Mediterranean region is one of the best examples to illustrate and study the dynamic process and evolution of subduction system through time, relation between the geologic and morphologic features, earthquake and tsunami generations. Throughout its history, there have been many strong and destructive earthquakes that caused tsunami waves and affected the eastern Mediterranean coasts. In addition to the historical documents, geological, archeological studies and many trench analyses also demonstrate numerous earthquakes caused to occur strong tsunami waves in the region (Ambraseys, 1962; Ambraseys and Melville, 1995; Guidoboni et al., 1994; Guidoboni and Comastri, 2005a,b; Sbeinati et al., 2005; Fokaefs and Papadopoulos, 2006; Yalçıner et al., 2000, 2003).

In this study we have calculated tsunami wave heights as well as their distribution function for Paphos earthquake of May 11, 1222 (Yolsal et al., 2007), for Crete earthquake of August 8, 1303 (Yolsal et al., 2007) and for Rhodes earthquake as illustrative examples depicting the characteristics of tsunami propagation, and effects of coastal topography and of near-shore amplification (Figure 1).

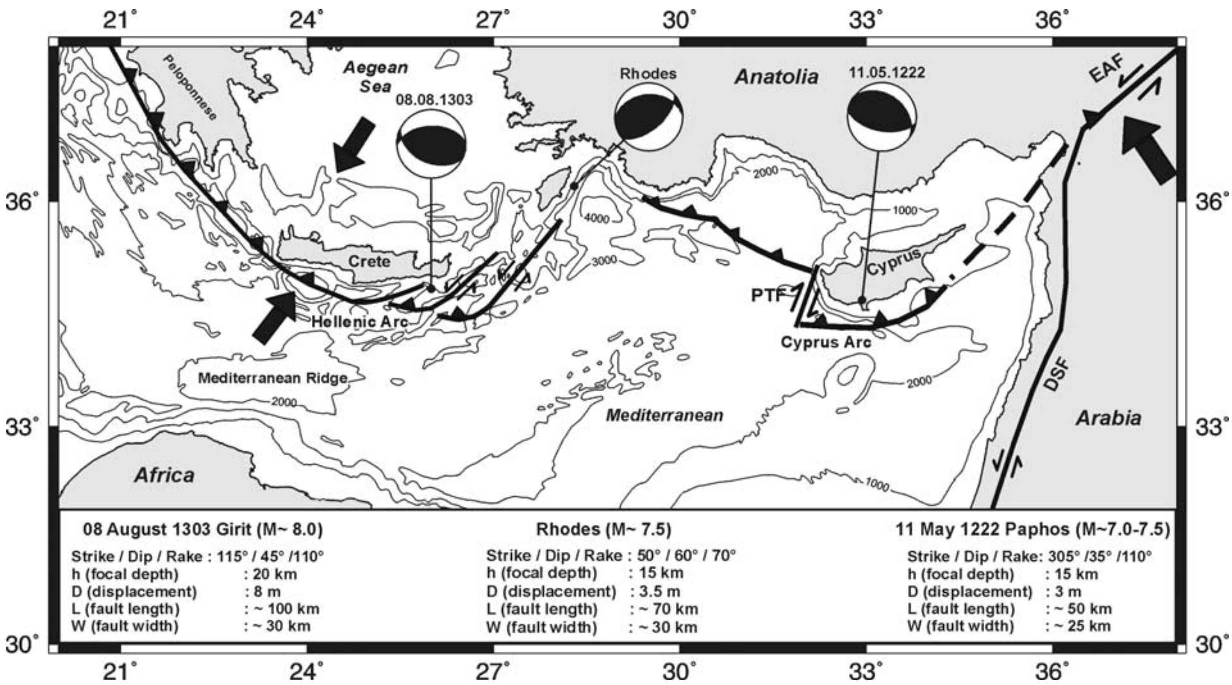

Figure 1. Summary sketch map of the faulting and bathymetry in the eastern Mediterranean Sea region with the locations and source mechanism parameters of studied Crete, Rhodes and Cyprus earthquakes. *EAF:* East Anatolian Fault; *DSF:* Dead Sea Fault; *PTF:* Paphos Transform Fault. Bathymetric contours are shown in every 1000 metres provided by GEBCO (1997), and Smith & Sandwell (1997*a*, *b*).

THEORY AND METHOD

Tsunami generation caused by large earthquakes is modeled by initial water surface displacement identical to the vertical deformation of the ocean bottom due to faulting. Numerical simulations involve the initiation and propagation of tsunami waves that are series of large waves of extremely long wavelength and period generated by an impulsive undersea disturbance or activity near the coast or in the ocean. Earthquake geometry (source depth, strike, dip, slip angles), amount of slip on the fault, size (seismic moment), location (distance from shore and centroid depth) and beach geometry (water depth and beach slope) are important parameters of numerical models for tsunami simulations. Therefore, to better understand the tsunami generation, the geometry and evolution of potential source regions and the source rupture processes along the main fault zones should be known and define in detail.

RESULTS

Identified strong tsunami events in Eastern Mediterranean reflect an apparent recurrence interval to be about 150-200 years and because of large tsunami recurrence, the memory of tsunamis is short lived. Thus, the compilation of reliable tsunami databases is of great importance for evaluating the tsunami risk assessments, early warning operations and numerical simulations for the studied region. Also, assuming the probability of occurrence of destructive tsunamigenic earthquakes, tsunami wave simulations provide us to evaluate tsunami hazard at coastal plains of the eastern Mediterranean Sea region. Obtained results indicate that the coastal topography, sea bottom irregularities (sea mounts, volcanoes etc.) and near-shore bathymetry are crucial components in tsunami wave simulations in order to affect the wave propagation, reflection, refraction, diffraction effects and coastal amplifications. Thus, we tentatively suggest that future oceanographic and marine geophysical research should aim to improve the resolution of bathymetric maps, particularly for the details of continental shelf, and those of seamounts.

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