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Tsunami hazard scenarios for the northern Bulgarian Black Sea coast

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The Black Sea is located in the Anatolian sector of the Alpine-Himalayan orogenic system. In this region the African and Arab plates are moving to the north and to the west colliding with the Eurasia tectonic plate. In this study we focused on the northern Bulgarian Black Sea coast, where devastating earthquakes occurred in the past, during the Ist century BC, 543 AD, 1444 and 1901, all of them with estimated magnitudes M>7.0 causing tsunami waves. An evaluation of the possible seismic sources and maximum credible earthquake magnitude is made to build tsunami hazard scenarios for the northern Bulgarian coastline, including Shabla-Kaliakra seismic zone. The numerical code UBO-TSUFD is used for the tsunami simulations, coupled with bathymetry and relief data. The initial conditions of the generated tsunami waves are calculated using the method proposed by Okada supplemented with focal mechanisms information and fault geometry. We consider three seismic sources (SS I, SS II and SS III) which are tested for three different earthquake magnitudes M7.0, M7.5 and M8.0. To increase the resolution of the results we use nested grids, as the finest one (space resolution 50 m) is focused on the coastline between the city of Varna and Cape Kaliakra. We built simplified local tsunami hazard maps based on the computed water column on the coast for all nine tsunami scenarios in the studied region. The potentially threatened inundation zones are marked with different colors and vary between 0 and 5 m, depending on the selected magnitude. SS I poses the highest risk of potential tsunami flooding with the calculated water column for the northern part of the Bulgarian coast reaching more than 1.5 m, even for M7.0. When M7.5 is considered, the tsunami heights rise to 2.3 m and assuming M8.0, the water column exceed 4 m. The gulf of Bourgas is partially protected by Cape Emine, located to the north. It should be noted that the Romanian coast and more precisely the shores to the north of Constanta are seriously affected by the modelled scenarios, as the calculated inundation heights exceed 2.5 m for M8.0. The results for SS III show the lowest values of the vertical water column inland. The modeling estimates the sea level variations in certain points computing synthetic mareograms. Virtual mareograms near Varna, Balchik and Albena resort displays the evolution of the initiated tsunami heights in time. SS II and SS III have similar behavior for all three magnitudes. The dominant tsunamigenic source with extremely high waves is SS I.

In addition, the impact of these three seismic sources on the entire Black Sea coast is examined through the coarse grid of 500 m, the propagation field and the maximum computed tsunami heights.

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