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A Comparison of Tsunami Impact to Sydney Harbour, Australia at Different Tidal Stages

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Abstract : Sydney Harbour is an iconic location with a dense population and low-lying development. On the east coast of Australia, facing the Pacific Ocean, it is exposed to several tsunamigenic trenches. This paper presents a component of the most detailed assessment of the potential for earthquake-generated tsunami impact on Sydney Harbour to date. Models in this study use dynamic tides to account for tide-tsunami interaction. Sydney Harbour’s tidal range is 1.5 m, and the spring tides from January 2015 that are used in the modelling for this study are close to the full tidal range. The tsunami wave trains modelled include hypothetical tsunami generated from earthquakes of magnitude 7.5, 8.0, 8.5, and 9.0 M_W from the Puysegur and New Hebrides trenches as well as representations of the historical 1960 Chilean and 2011 Tohoku events. All wave trains are modelled for the peak wave to coincide with both a low tide and a high tide. A single wave train, representing a 9.0 M_W earthquake at the Puysegur trench, is modelled for peak waves to coincide with every hour across a 12-hour tidal phase. Using the hydrodynamic model ANUGA, results are compared according to the impact parameters of inundation area, depth variation and current speeds. Results show that both maximum inundation area and depth variation are tide dependent. Maximum inundation area increases when coincident with a higher tide, however, hazardous inundation is only observed for the larger waves modelled: NH90high and P90high. The maximum and minimum depths are deeper on higher tides and shallower on lower tides. The difference between maximum and minimum depths varies across different tidal phases although the differences are slight. Maximum current speeds are shown to be a significant hazard for Sydney Harbour; however, they do not show consistent patterns according to tide-tsunami phasing. The maximum current speed hazard is shown to be greater in specific locations such as Spit Bridge, a narrow channel with extensive marine infrastructure. The results presented for Sydney Harbour are novel, and the conclusions are consistent with previous modelling efforts in the greater area. It is shown that tide must be a consideration for both tsunami modelling and emergency management planning. Modelling with peak tsunami waves coinciding with a high tide would be a conservative approach; however, it must be considered that maximum current speeds may be higher on other tides.

Keywords : emergency management, sydney, tide-tsunami interaction, tsunami impact
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