Source Models of the Two September and December 2018 Indonesia Tsunamis Based on Spectral Analyses and Numerical Modeling

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Indonesia was struck by two tsunamis in September and December 2018 in Sulawesi and Sunda strait, respectively. The combined fatalities from the two events were ~2500 people which made 2018 as one of the deadliest year for Indonesia in terms of natural disasters. The 2018 twin tsunamis were unique because both events were not generated by typical earthquake-generated seafloor deformation. The Sulawesi tsunami in September 2018 was most likely associated with a large submarine landslide (Heidarzadeh et al., 2018, Pure & Appl. Geophys. 176) and the Sunda event was of volcanic origin. Therefore, there have been intense speculations in the scientific community about the origins and mechanisms of these twin tsunamis without any clear clues about the source mechanisms so far (February 2019). Our methodology here to address the puzzle of the 2018 twin tsunamis is analyzing the observed tide gauges records of both events and then applying numerical simulations. For the Sulawesi tsunami, two tide gauge records were analyzed belonging to Pantoloan (inside the Palu Bay) and Mamuju (outside the Palu Bay). Maximum tsunami trough-to-crest heights of 380 and 24 cm, were measured in Pantoloan and Mamuju, respectively. Spectral analyses of the tide gauge records revealed dominating wave periods of 3.6–4.4 and 10 min at the aforesaid stations, respectively. Spectral results indicate that the tsunami source dimensions should have been most likely in the range of 3.4–4.1 km and 32.5 km, for inside and outside of the Palu Bay, respectively. We were able to reproduce the two observed tide gauge records using numerical simulations. However, the maximum simulated runup was approximately 2 m which was less than the observed runup of 11 m. It is likely that a secondary source, i.e. submarine landslide(s), has contributed to the tectonic source of the tsunami. We identify the southern part of the Palu Bay, around the latitude of -0.82°S, as the most likely location of a potential landslide based on our backward tsunami ray tracing analysis. For the Sunda tsunami, four tide gauges were analyzed revealing wave amplitudes in the range of 44-139 cm. The dominating period of the waves were ~7 min which are shorter than tsunamis generated by earthquakes. We have considered several landslide scenarios and conducted numerical modeling in order to reproduce the observed tsunami waves on the tide gauges and propose a source model for this tsunami.

Keywords: Tsunami, Indonesia, Sulawesi, Krakatoa Volcano

