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Landslide source of the September 2018 Sulawesi tsunami, Indonesia as inferred from spectral analyses, numerical modeling and field surveys

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The September 2018 Sulawesi tsunami was one of the two tsunamis that attacked Indonesia in 2018 which left a death toll of approximately 2000 people. The other tsunami was the Sunda Strait event on 22 December which killed nearly 500 people. In this study, we focus on the Sulawesi tsunami. The September 2018 Sulawesi tsunami was unexpected because it was generated following an Mw 7.5 strike-slip earthquake whereas such earthquakes do not produce large tsunamis due to their dominant horizontal movements. To address the Sulawesi puzzle, here we present results of tide gauge data analysis, tsunami field surveys and numerical simulations. Two tide gauge records are analyzed here recorded in 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. Our field surveys showed that tsunami runup was up to 11 m and largest runups were focused at the southern part of the Palu Bay. 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. Occurrence of several actual landslides following the earthquake, which were recorded on videos, may strengthen the potential contribution of landslides to the Sulawesi tsunami. The other supporting facts are the short-period waves on the Pantoloan tide gauge and the short inundation length of the tsunami along the Palu Bay coasts. 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.