Investigation for the Tsunami and Earthquake Source of the 2018 M7.5 Sulawesi Earthquake

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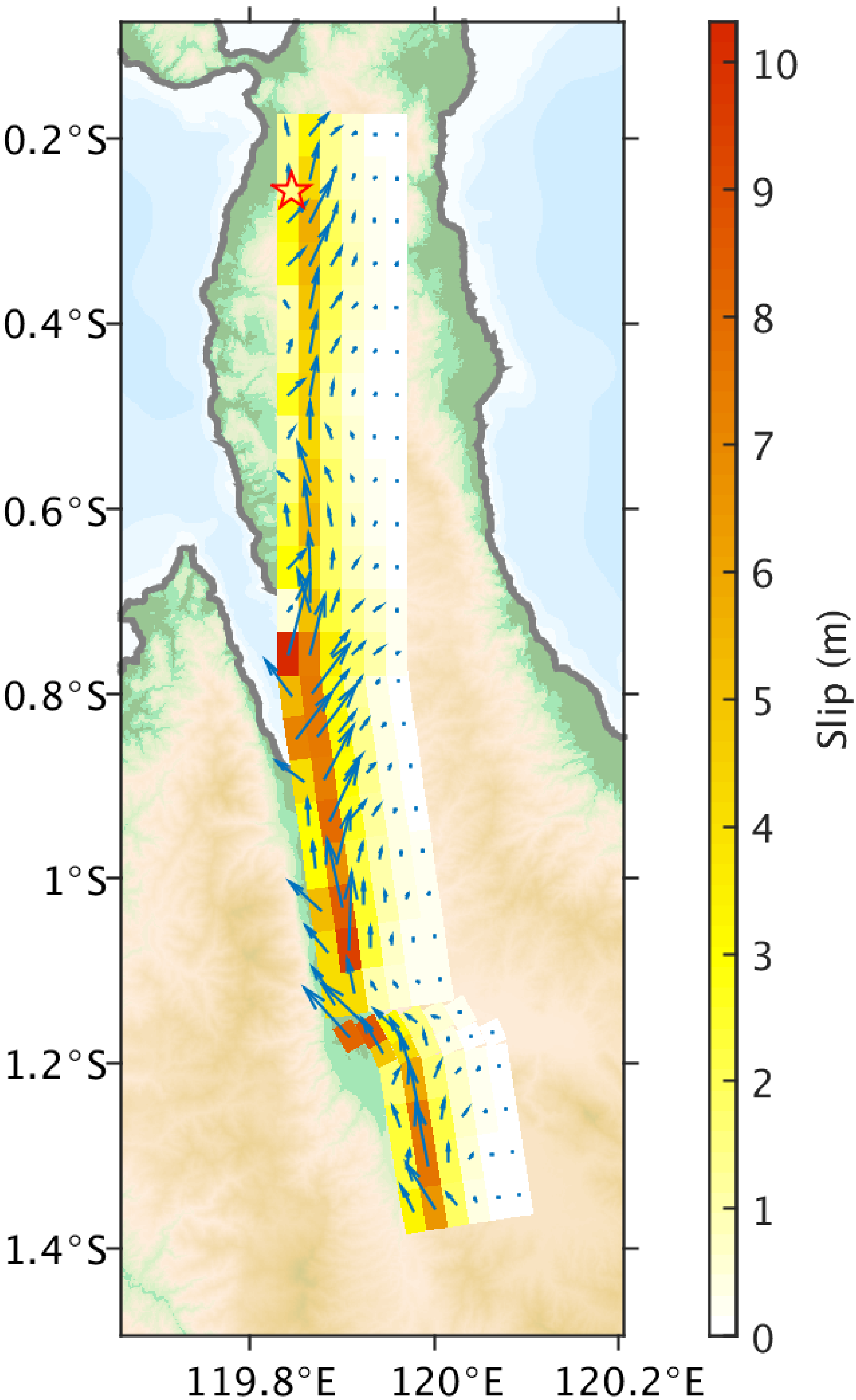
A devastating tsunami struck the bay of Palu, Indonesia after the M7.5 (U.S. Geological Survey; USGS) Sulawesi (Palu) earthquake. This earthquake mechanism was a left-lateral strike slip fault. Large horizontal offsets of up to 5 meters were measured near the bay area by satellite images. According to the researches of Bao et al. (2019, Nat. Geosci.) and Socquet et al (2019, Nat. Geosci.) a rupture velocity 4.1 km/s was suggested indicating that this earthquake was a supershear event. The tsunami was recorded by two tide gauges: 2-m wave height was observed by a tide gauge at the port of Pantoloan in the Palu bay, and 20 cm wave height observed by a ~200-km-far tide gauge at Mamuju port. In addition to the tide gauges, up to 10 m runups were measured near the coastal area by field surveys (Omira et al., 2019, *Pageoph*; Muhari et al., 2019, *JDR*). Other than the earthquake, landslide events were captured by videos which also induced local tsunamis.

Our analyses showed that the tsunami leading wave at the Pantoloan port may have directly induced by the earthquake rupture deformation, but the initial tsunami waves at Mamuju port should be from the source outside the bay or the earthquake source area. We applied the back-tracing method and the result indicates that the potential tsunami source for Pantoloan located inside the bay but the source for Mamuju should located outside the bay at about 2°S, 119.3°E.

To understand the tsunami induced only from the fault deformation, we utilized the InSAR data and tsunami waveform at Pantoloan to estimate the source of the earthquake. Two InSAR datasets of ascending and descending data from Sentinel-1 operated by the European Space Agency were used in this study.

The InSAR images revealed clear traces of the rupture. We assumed a fault plane consisted of 27 by 6 subfaults along the traces and performed a source inversion. In our inversion, the two InSAR datasets constrained horizontal land deformations in two different azimuths and the tsunami waveform constrained the vertical deformation at the offshore area. The combination of the InSAR and tsunami data provided complete information for the rupture deformations.
Our result suggested that the rupture extended southward from the epicenter and changed its direction or strike at the bay where also showed a large asperity of a 10 m slip (Figure 1). The rupture changed the strike again at near 1.2°S and had an offset slip there. In addition to the dominant strike-slip components, normal fault components were also estimated at the asperity area which agrees with the finite fault solution of USGS and the plate motion recorded by GPS (Socquet et al., 2006, *JGR*). Our model reconstructed the tsunami waveform at Pantoloan and the offset data by InSAR. However, we underestimate the inundations and runups for the coastal area. The local landslides may explain for the high inundations and runups.



0.2°S
0.4°S
0.6°S
0.8°S
1°S
1.2°S
1.4°S
119.8°E
120°E
120.2°E
10
9
8
7
6
5
4
3
2
1
0
Slip (m)