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Continual interaction between the Minahassa subduction interface and the Palu-Koro strike-slip fault in Sulawesi, Indonesia.

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Two major fault systems host M_w>7 earthquakes in Central and Northern Sulawesi, Indonesia: the Minahassa subduction interface and the Palu-Koro strike-slip fault. The Celebes Sea oceanic lithosphere subducts beneath the north arm of Sulawesi at the Minahassa subduction zone. At the western termination of the Minahassa subduction zone, it connects to the left-lateral Palu-Koro strike-slip fault zone. This fault strikes onshore at Palu Bay and then crosses Sulawesi. Interseismic GNSS velocities indicate that the Palu-Koro fault zone accommodates about 4 cm/yr of relative motion in the Palu Bay area, with a ~10 km locking depth. This shallowly locked segment of the Palu-Koro fault around the Palu Bay area ruptured during the devastating, tsunami-generating, 2018 M_w7.5 Palu earthquake. This complex event highlights the high seismic hazard for the island of Sulawesi.

We have a >20-year record of GNSS velocities on Sulawesi, where the densest cluster of monument sites surrounds the Palu-Koro fault, specifically around Palu Bay, whereas the rest of the island is less densely covered. High quality estimates of interseismic velocities reveal second-order complex patterns of transient deformation in the wake of major earthquakes: the velocities in northern Sulawesi and around the Palu-Koro fault do not follow their interseismic trends after a major subduction earthquake has occurred, for several years after the event. This effect of transient deformation reaches more than 400km away from the epicentre of the major earthquakes. Surprisingly, a deviation from the background slip rate on the Palu-Koro fault is not accompanied by a deviation from the background (micro)seismic activity.

We construct a 3D numerical model based on the structural and seismological data in the Sulawesi region. We investigate the post-seismic relaxation pattern from a subduction earthquake and determine whether the slip rate on the Palu-Koro fault changes due to this earthquake through forward model calculations. With a modelling focus on the 1996 M_w7.9 and 2008 M_w7.4 earthquakes that ruptured the Minahassa subduction interface, this study outlines the triggering of transient deformation and continual interaction between the Minahassa subduction interface and the Palu-Koro strike-slip fault.