



The 2018 Lombok and Palu, Indonesia, earthquakes: Loss data uncertainties, cascades and implications

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In 2018, Indonesia was affected by a series of seismic events that have given rise to new implications for preparedness, risk mitigation and risk assessment. Between July 28 and August 19, Lombok was struck by five lethal earthquakes of magnitude 5.9 to 6.9. Then on September 28, a tsunamigenic earthquake of magnitude 7.5 occurred in Central Sulawesi. These events showcased the complexities in earthquake risk, with multiple events occurring consecutively on different active (but blind) fault segments in Lombok and cascade of triggered hazards in Palu (earthquake-submarine landslide-tsunami, earthquake-liquefaction-mudflow).

The Lombok earthquakes occurred in the northern part of the island and caused the loss of 566 lives. Damage occurred from eastern Bali to western Sumbawa and the final tally exceeded 216,000 houses of which over 75,000 heavily damaged or destroyed. Indonesia's National Disaster Management Authority (BNPB) assessment estimated 945 and 185 million USD in damages and losses.

Rural building stock in Lombok has evolved from wooden vernacular to less resistant unreinforced masonry. Due to deforestation the preferred structural system for the reconstruction will be low-cost (but stronger) reinforced masonry.

The Palu earthquake was of a completely different nature causing a cascade of hazards with tremendous consequences. A submarine landslide is thought to have triggered the tsunami that devastated coastal settlements around Palu Bay. Unprecedented mudflows triggered by liquefaction added to the destruction and loss of life. Damage due to ground shaking was also significant causing the collapse of several major structures in Palu.

BNPB reported nearly 68,500 damaged houses irrespective of damage level. Remote sensing imagery analysis across most of the affected region identified 14,650 damaged or destroyed buildings. The big majority of these were in the areas affected by tsunami or mudflows (no overlap between these areas). Unlike Lombok, ground shaking damage to the region's low-rise housing was not extensive. A temporary shelter program for 14,400 homeless families previously living in the tsunami and mudflow areas is currently on-going, until new permanent settlements are constructed in areas not exposed to liquefaction, tsunami and landslide risk.

The Palu earthquake is reported by BNPB to have caused the loss of 2101 people, while 1373 are missing. Many of these were in the mudflow areas. Such high loss of life related to liquefaction is unprecedented. Liquefaction triggered mudflows have thus become a new "secondary" seismic hazard.

BNPB's assessment estimated 1030 and 190 million USD in damages and losses. Around 30% of the damages and 40% of the losses were allocated to Sigi regency although only 8.9% of the damaged buildings (assessed by remote sensing) and 1.3% of the houses reported to have been damaged were in Sigi.

Both events were the subject of intensive rapid damage estimation exercises. The Lombok earthquakes, up to August 5, were assessed by the Karlsruhe Institute of Technology - CEDIM, while the Palu earthquake was assessed by the World Bank using the GRADE methodology.