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Quantifying the effects of the M7.8 November 14, 2016 earthquake on rainfall-induced landslide triggering and reactivation, Kaikoura, New Zealand

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The 2016 M_w 7.8 Kaikoura Earthquake in Canterbury, New Zealand produced one of the most complex fault ruptures observed in the historical period and produced strong ground shaking. As a consequence, over twenty-nine thousand landslides were triggered over a total area of about 10,000 km^2 with the majority concentrated in a smaller area of about 3,600 km^2 (Massey et al 2018). In addition, hillslopes in the affected area were severely damaged by tension cracking and dilation. Large volumes of landslide debris generated during the earthquake remain stored in the landscape and the potential for rainfall to trigger landslides on the failed and partially failed hillslopes is anticipated to be elevated for the foreseeable future. Despite this little is known about the increase in landslide hazard and the timeframe over which this hazard will be elevated.

We used airborne LiDAR captured immediately after the earthquake (November 2016), and at six consecutive dates between November 2017 and April 2019 to develop high resolution surface change models to construct an inventory of rainfall-induced landslides and reactivated landslides following the earthquake. The results were compared with landslide inventories for a series of significant storm events between 1880 and 2019 which were compiled from various sources, including mapping from available aerial photography and satellite imagery collected between 1961 and 2019.

Analysis of the landslide inventories indicates that rainfall triggering thresholds for landslides on these highly cracked and dilated slopes is lower than before the earthquake which has resulted in a significant increase in landslide frequency for a given rainfall amount through the initiation of new landslides on weakened slopes, reactivation of existing landslides and reworking of landslide debris stored on the landscape. Most of the landslides triggered by rainfall following the earthquake were highly mobile debris flows that were strongly coupled to the channel network. Preliminary results suggest that the highest rates of post-earthquake landslide initiation (for both new and reactivated landslides) occurred in the first major storm event following the earthquake and the rate has reduced with time since the earthquake. Maximum landslide size (area) also decreased with time following the earthquake. Quantification of rates of post-EQ rainfall-induced

landsliding using LiDAR differencing and aerial photo interpretation will further our understanding of post-earthquake landscape recovery.