The influence of rainfall on shallow landslides in New Zealand hill country

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# ABSTRACT

Understanding how rainfall events influence the pattern and magnitude of landslide response is an important research focus from geomorphological and hazard planning perspectives. In 2023, extreme weather impacted New Zealand’s North Island hill country, re-focusing attention on landslide-triggering events and the need for targeted erosion control to reduce damage to land and degradation of receiving environments. While we do not usually know when individual landslides are triggered during events, we can examine the overall spatial pattern of landslides in relation to rainfall and landscape factors such as slope, land cover and rock type. We aim to a) identify which factors most influence susceptibility to shallow landslides at the event scale and b) assess how the spatial density of landslides varies in relation to rainfall.

We focus on four large storm events that generated over 26,000 landslides within the Manawatū-Whanganui, Waikato, and Auckland regions in 2017-18 (Smith et al. 2023). High-resolution (0.5 m), before/after satellite imagery was used to map landslides within each study area. MetService weather radar data was processed to generate high-spatiotemporal-resolution gauge-calibrated rainfall grids and compute a) maximum intra-event intensities (30 min – 24-h), b) total event rainfall, and c) pre-event accumulations (10 – 90 days) that influence antecedent soil moisture. Rainfall variables were included alongside landscape factors in a logistic regression model to assess the influence of different explanatory variables.

Land cover and slope most influenced susceptibility ahead of intra-event rainfall intensities and pre-event rainfall accumulations. Of the rainfall variables, maximum 12-h rainfall normalised by the 10-y recurrence interval intensity and the 10-d pre-event accumulation normalised by mean annual rainfall had the most influence. Forest cover reduced the sensitivity of landslide spatial density to variations in slope, rainfall, and rock type, in contrast to pasture. Mean landslide density increased 3.5-fold once the maximum 12-h intensity exceeded the 10-y recurrence interval intensity by ≥25% for pastoral land on weak sedimentary rocks. This threshold is consistent with the increase in 12-h rainfall by late century under the highest levels of projected warming in New Zealand, which suggests the landslide response to storm rainfall could be significantly amplified by climate change.

# REFERENCES

Smith, H.G., Neverman, A.J., Betts, H., Spiekermann, R., 2023. The influence of spatial patterns in rainfall on shallow landslides. Geomorphology, 437, 108795.