Hydroclimatic drivers and sediment load contributions of a shallow earthflow in a headwater catchment

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# ABSTRACT

Earthflows are persistent agents of geomorphic change in Aotearoa’s soft-rock hill country, often occurring on crushed mudstone and argillite. Earthflows may therefore provide a continual source of fine-grained sediment to the channel network. Excess fine sediment degrades receiving environments and reduces their cultural, recreational, and economic value, and is expected to increase under climate change (Neverman et al. 2023). A better understanding of the drivers and dynamics of earthflow displacement and their contributions to catchment sediment loads is needed to improve existing models to support erosion mitigation policy and planning.

We present insights from four years of monitoring the dynamics and sediment load contribution of an 80,000 m2 shallow earthflow located in the Haunui research catchment, a headwater tributary of the Manawatū River, New Zealand. Complementary proximal sensing technologies provide data on sub-daily to multi-year displacement rates, annual volumetric change, and hydroclimatic conditions, allowing phases of earthflow displacement to be linked with hydrological drivers. Continuous GNSS, monitoring pegs, and pixel-tracking reveal maximum displacements of 0.25 m day-1 and 17 m yr-1, with displacements greatest in the earthflow toe. Annual displacements average between 6 m yr-1 in the head to 9 m yr-1 in the toe. A 3-fold variation in annual displacement is observed between monitoring years. This variation is reflected in preliminary estimates of sediment contributions to the stream network, which vary from 950 ± 4,900 to 19,000 ± 6,400 tonnes between years.

Phases of displacement coincide with sub-annual fluctuations in piezometric head measured at the failure surface, which remains saturated year-round. Continuous displacement is observed during winter–spring when piezometric head remains above an identified threshold. Accelerations follow higher-magnitude rainfall only when piezometric head exceeds this threshold. Displacement ceases over summer–autumn when the piezometric head remains low. Total displacement is determined by the magnitude and temporal distribution of rainfall during periods of elevated piezometric head. Our findings illustrate the importance of event- and seasonal-scale hydroclimatic conditions in determining the dynamics and sediment load contributions of shallow earthflows in headwater catchments.

# REFERENCES

Neverman, A. J., Donovan, M., Smith, H. G., Ausseil, A. G., & Zammit, C. (2023). Climate change impacts on erosion and suspended sediment loads in New Zealand. *Geomorphology*, 427, 108607. OPEN ACCESS: <https://www.sciencedirect.com/science/article/pii/S0169555X23000272>