Landslides on Maungakiekie/One Tree Hill (Auckland), from a 1-in-200-year rain event

**Gabriel Abazu**1 and Martin Brook1

1School of Environment, University of Auckland

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# ABSTRACT

January 2023 was Auckland’s wettest month since records began, with 539 mm recorded at Albert Park, central Auckland. The heaviest rainfall produced widespread flooding across Auckland on Friday 27 January, which NIWA described as at least a 1-in-200-year event. On that day, Auckland's Albert Park gauge recorded 280 mm of rain in <24 hours and 211 mm in <6 hours. This intense rainfall caused thousands of landslides, many on coastal cliffs and populated inland areas, including hundreds that affected residential housing. In particular, 15 landslides occurred on Maungakiekie/One Tree Hill, the first time in living memory (possibly since forest clearance by humans), that landslides have occurred on this volcano. While Maungakiekie had 15 discrete landslides, most of the other Auckland Volcanic Field cones showed very limited slope failure, with single landslides on the northern slopes of both Mt Albert and Mt Hobson.

At Maungakiekie/One Tree Hill, landslides were most widespread on western and northern slopes, forming between 120-145 m above sea level, and on slopes of ~30°. Typically, landslides initiated as shallow translational failures that evolved downslope into earthflows, with increased mobility exhibited by landslides on steeper slopes, such as the southern breached craters. All the landslides are shallow (0.5-2 m thick), occurring in residual soil, colluvium, and/or fill. The fill material exists because Māori cut into the slope at the back of the terrace and dumped the spoil over the front to enlarge the terrace tread. This resulted in oversteepening of the original 30° slope on the terrace riser. Thus, (historic) human influence on landslide location is also evident. No landslides were deep enough to penetrate weathered Maungakiekie scoria (erupted ~60 ka BP). Indeed, headscarp exposures reveal the landslides occurred in soils overlying hard, impermeable volcanic ash from the Three Kings eruption (~27 ka BP), which has created a pervasive shear plane, above which the saturated soils then failed. Limit equilibrium modeling revealed the slopes typically exhibit factors of safety of ~1.1. Landslides were absent from eastern flanks because of the more limited Three Kings Ash cover there, and therefore increased local permeability of the scoria materials.