Landslide hazard and risk to the built environment:
From initiation to impact

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Outline

Source → Initiation, Susceptibility, Hazard

Debris → Runout, Hazard

Debris → Impact, Risk

50 m

Data

Published: Mon Feb 14 2022 5:15 PM

Ex-Tropical Cyclone Dovi - Dob in a landslide

Ex-Tropical Cyclone Dovi wreaked havoc across New Zealand over the weekend (12-13 February), with high winds, rain and damage across the country. Our thoughts are with those who were affected and with everyone working hard in the response and clean up.
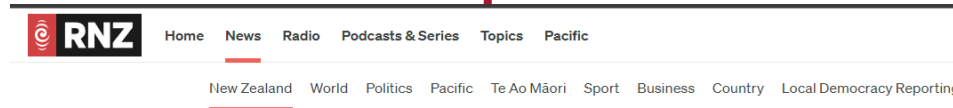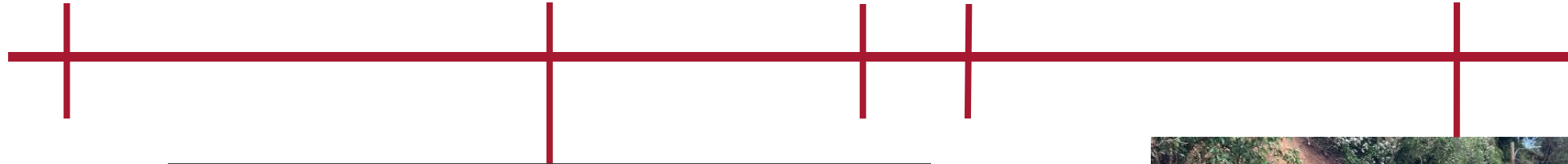
B. Rosser

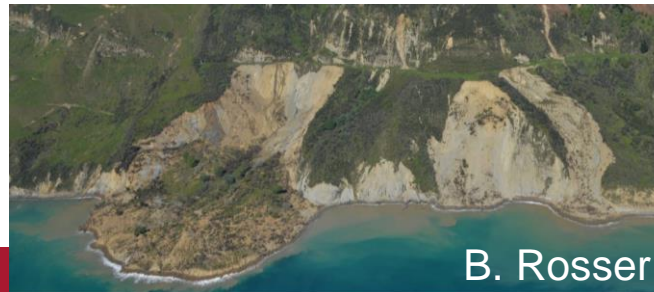July 2021   Nov. 2021   Feb. Mar. 2022   July 2022

RNZ

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NEW ZEALAND / TE AO MĀORI

Slip south of Gisborne destroys wāhi tapu and hopes of railway's reinstatement
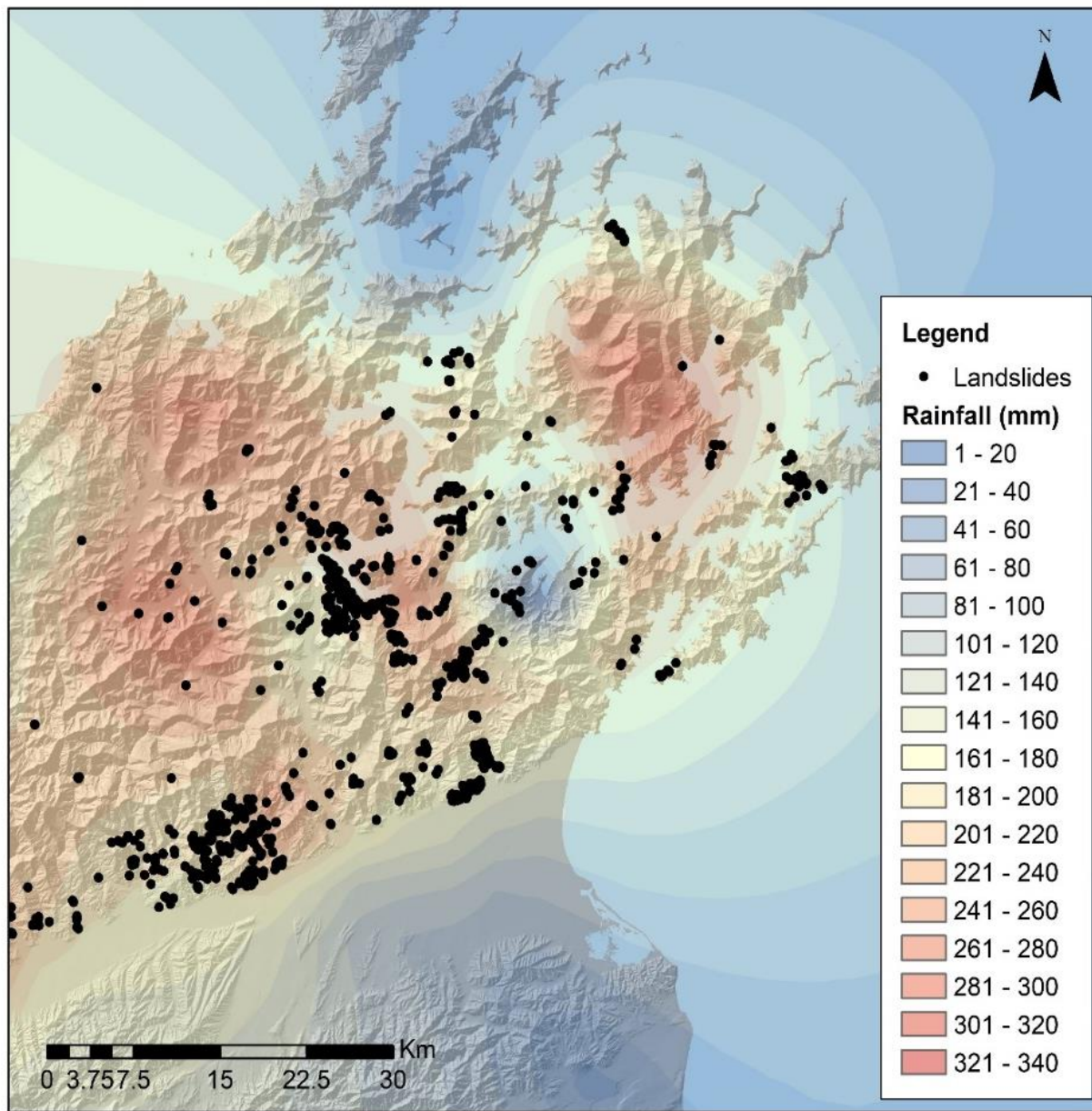
7:34 am on 29 November 2021

Tom Kitchin, Hawke's Bay / Tairāwhiti Reporter
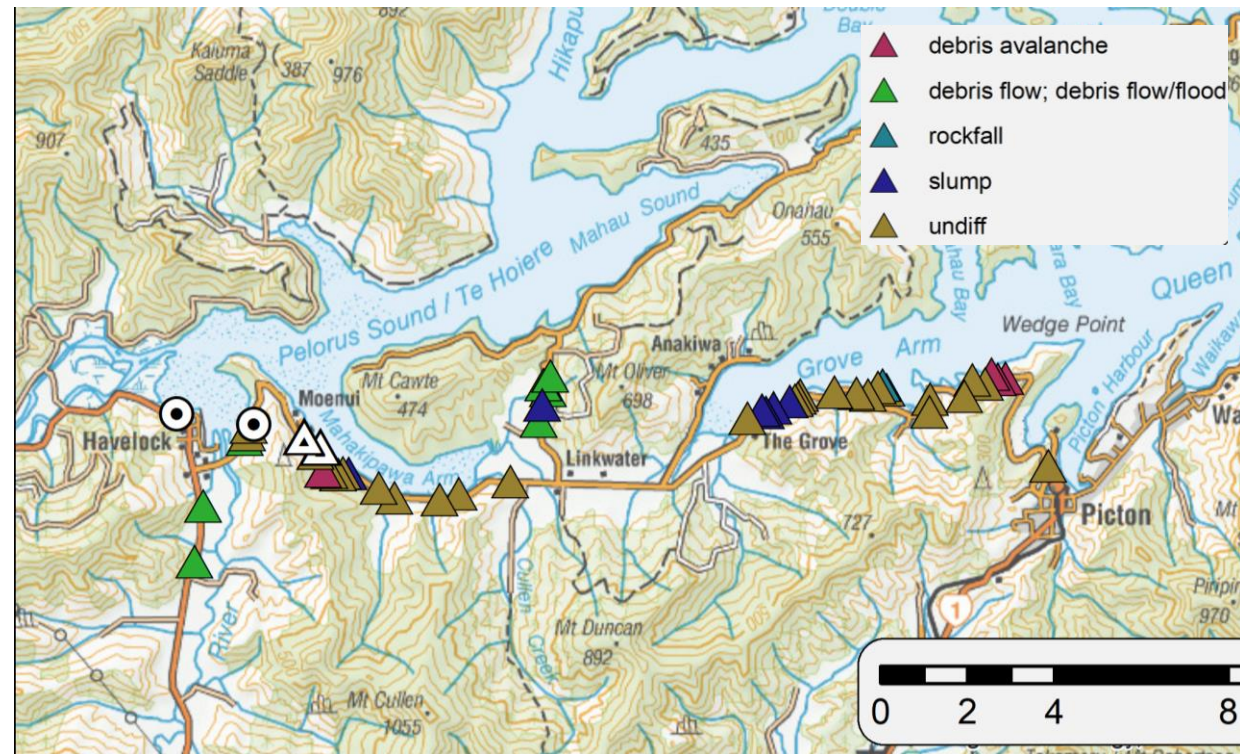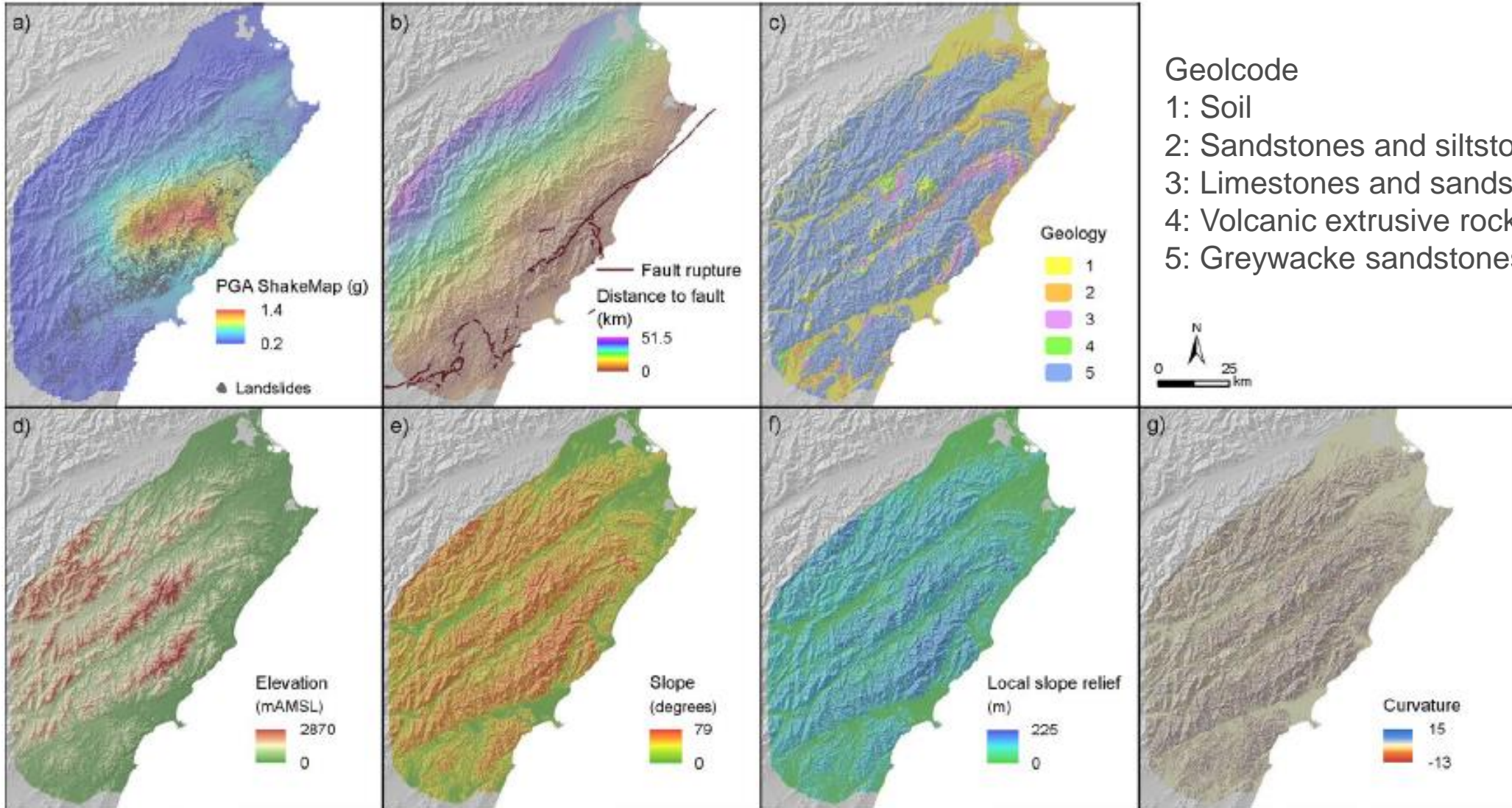@inkitchnz tom.kitchin@rnz.co.nz

B. Rosser

Stuff.co.nz

Infrastructure

Initiation - EIL model inputs

Geolcode
1: Soil
2: Sandstones and siltstones
3: Limestones and sandstones
4: Volcanic extrusive rocks
5: Greywacke sandstones
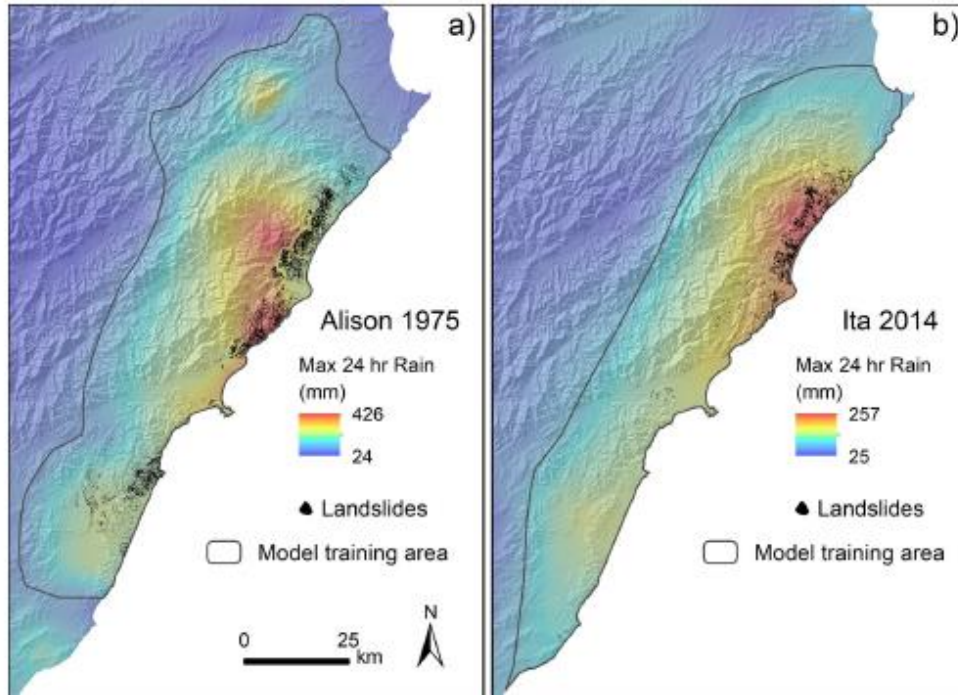
a) PGA from ShakeMap b) Distance to fault; c) Geology; d) Elevation; e) Slope; f) Local slope relief; g) slope curvature.
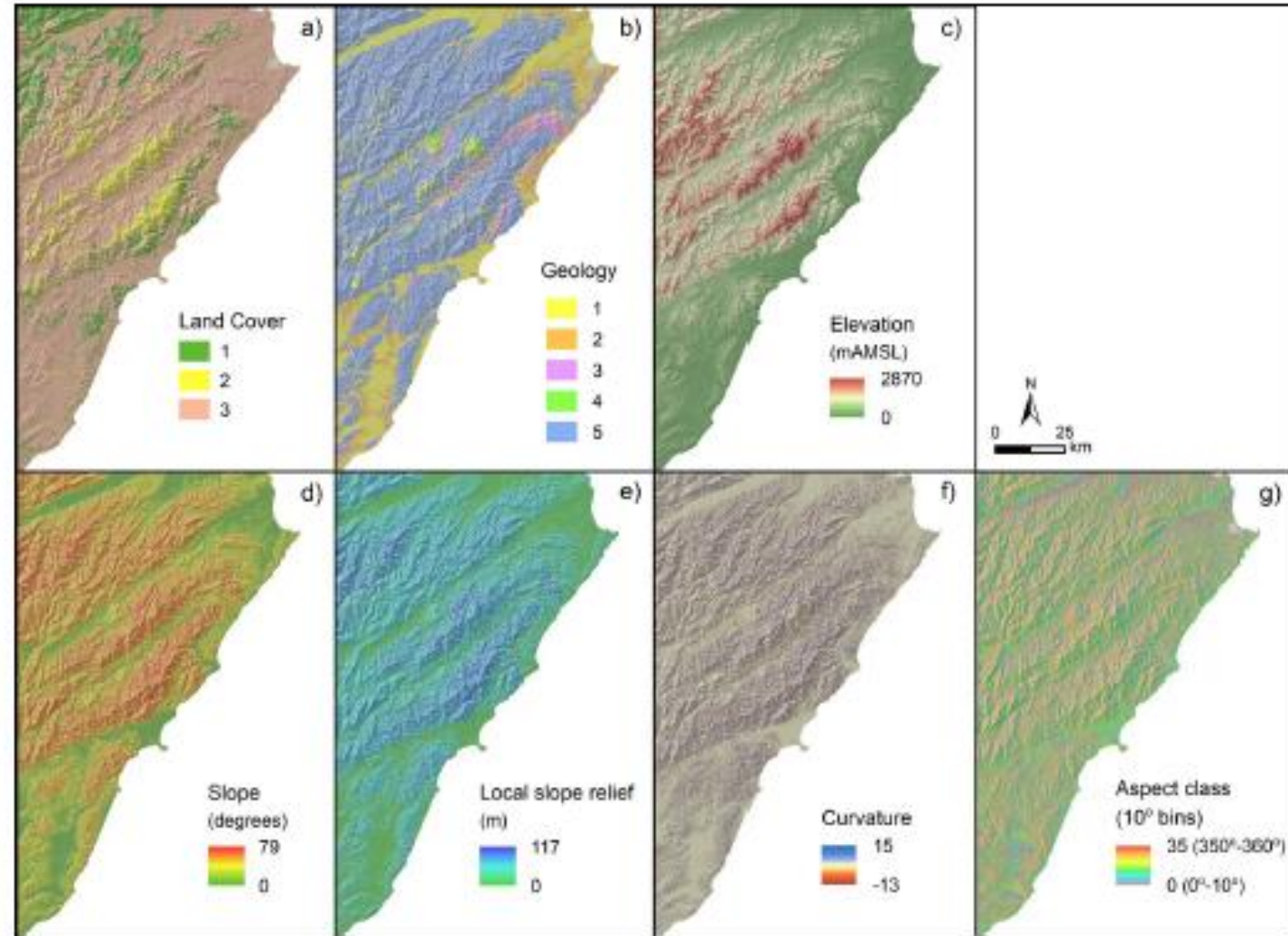
RIL model inputs

Dynamic data

Rainfall and soil moisture can be static or dynamic
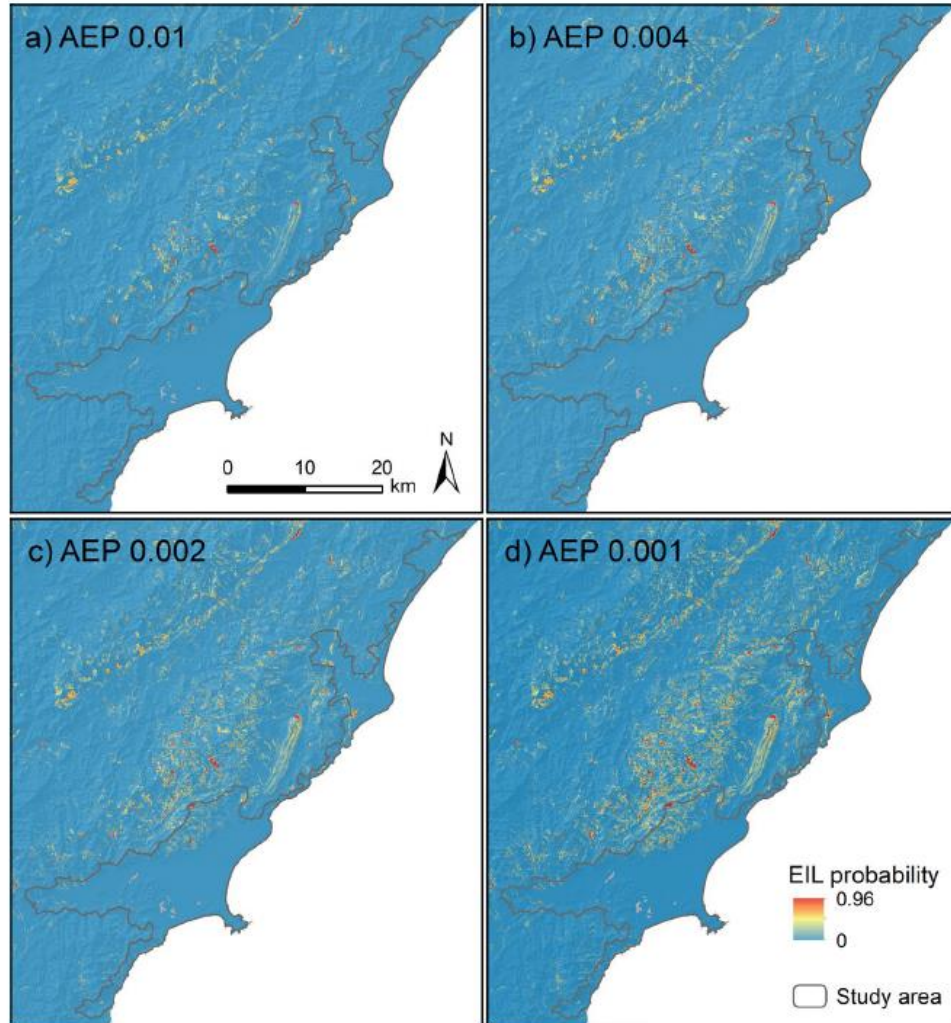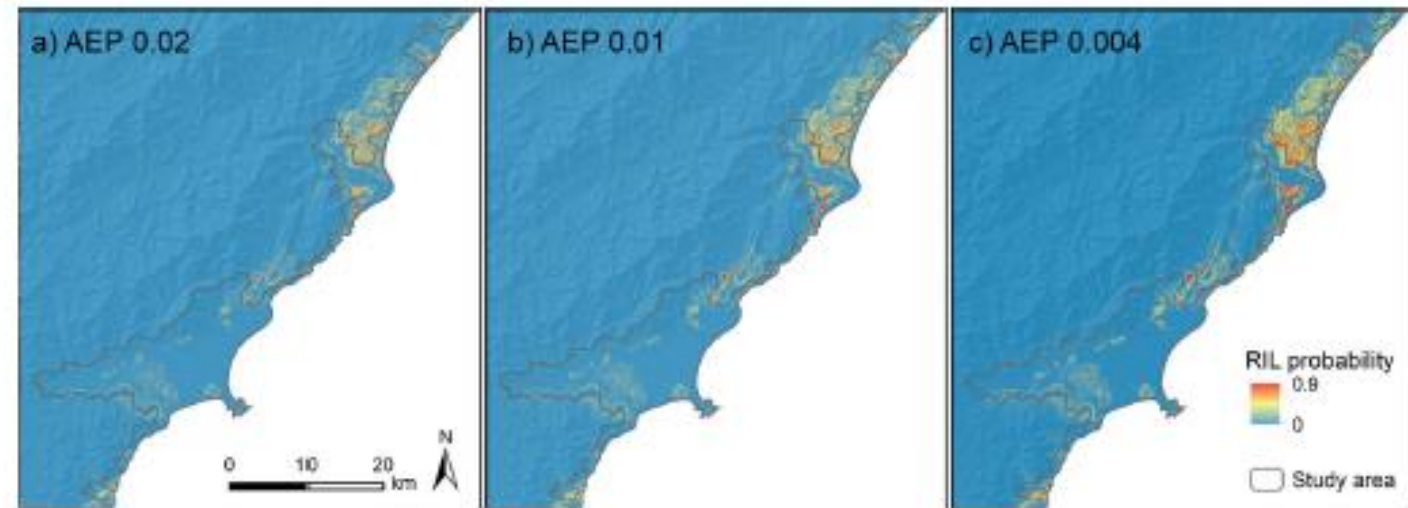Rainfall can adapt to climate change forecast scenarios

Model outputs

EIL
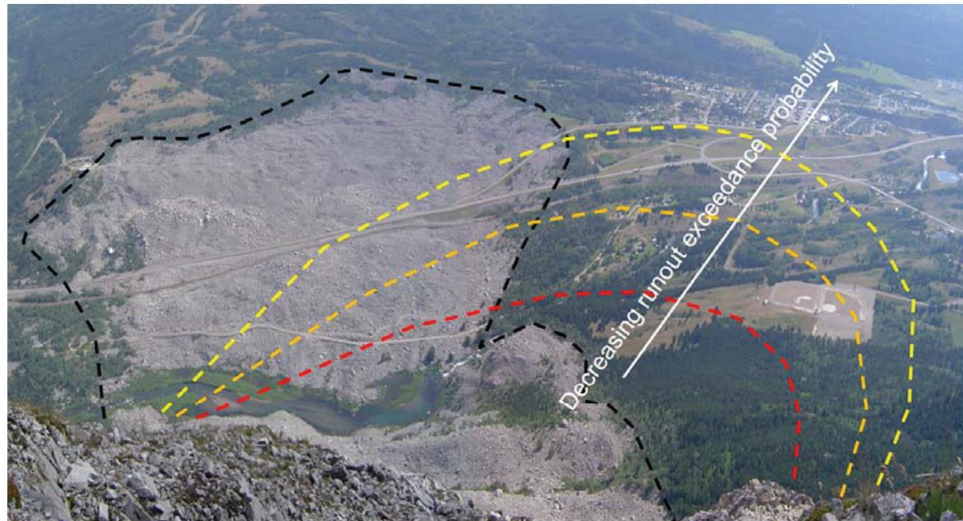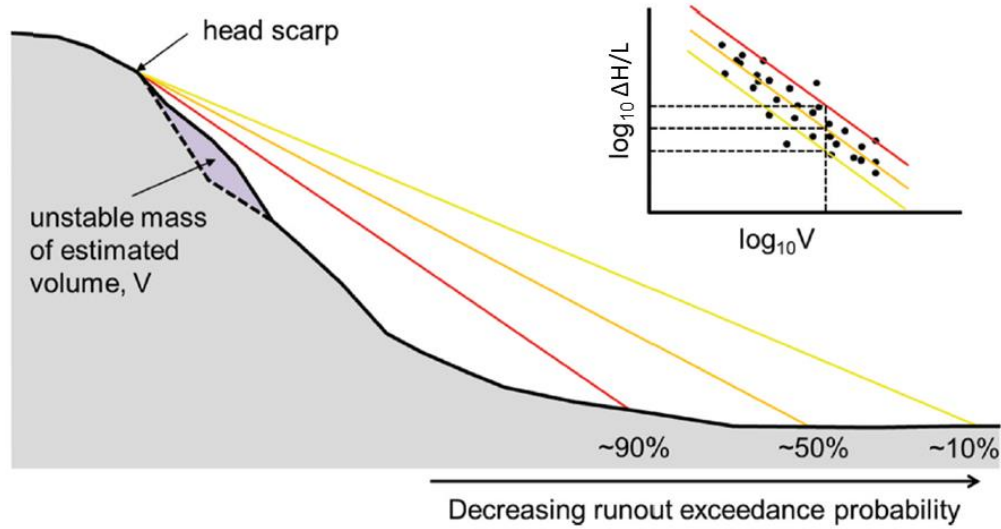

RIL

GNS Science

Debris - Runout

- **Catchment area: ~8 ha**
- **Source:**
  - Volume: ~2000 m^3
  - Material: saturated sandy colluvium
  - TCs, overhanging material
- **Debris:**
  - Volume: ~15000 m^3
  - H/L: 0.5
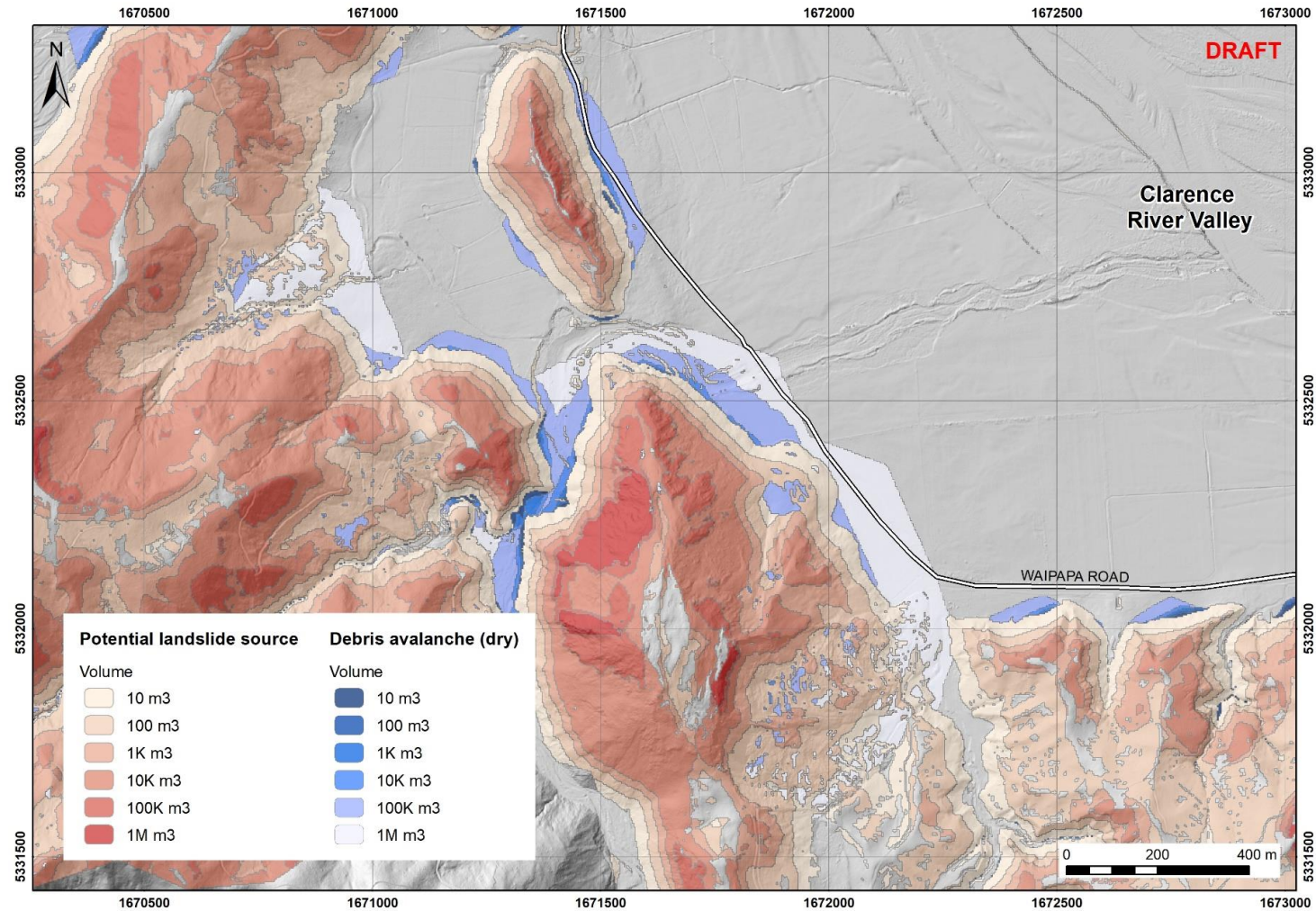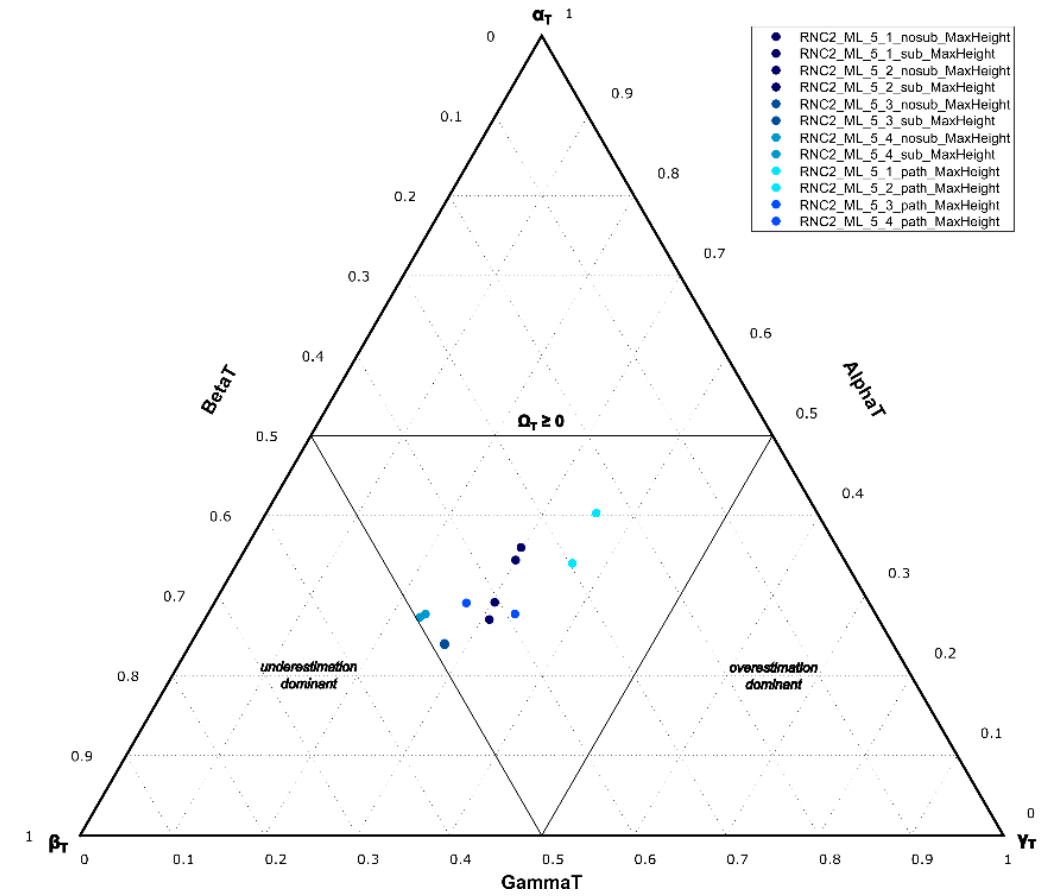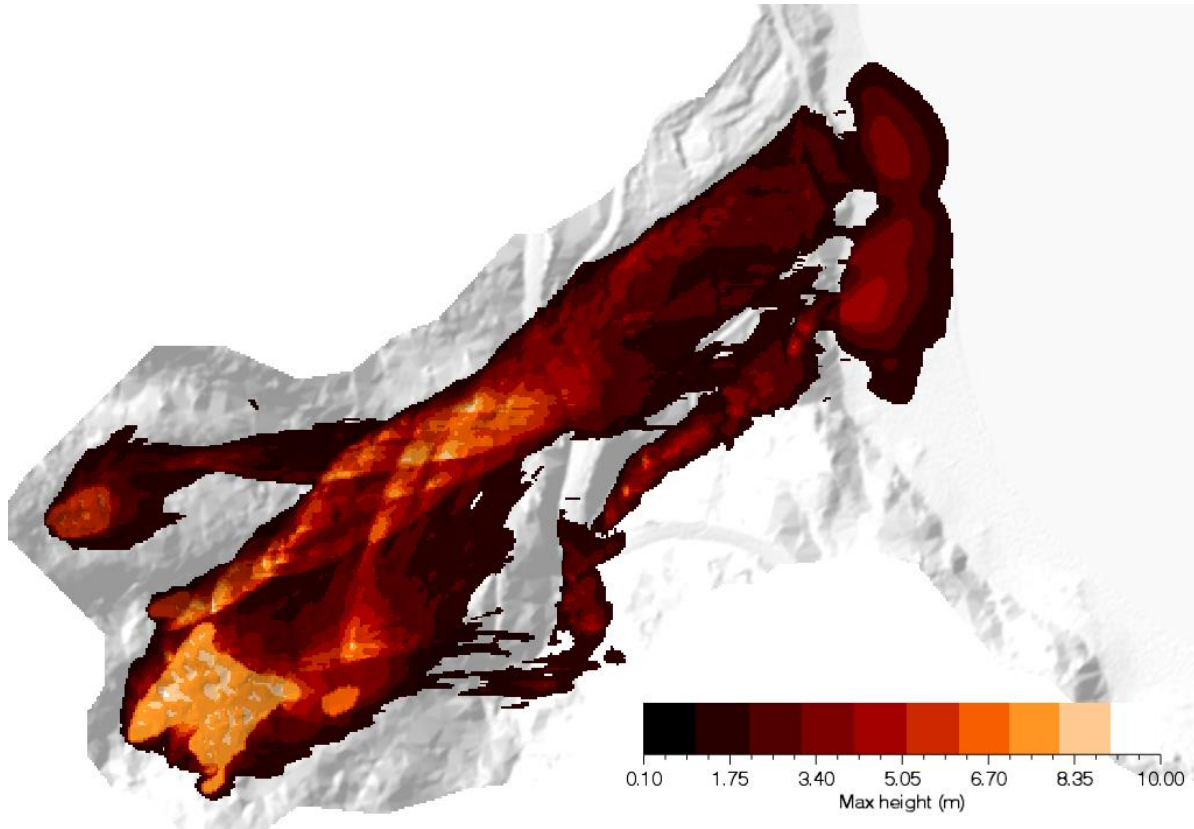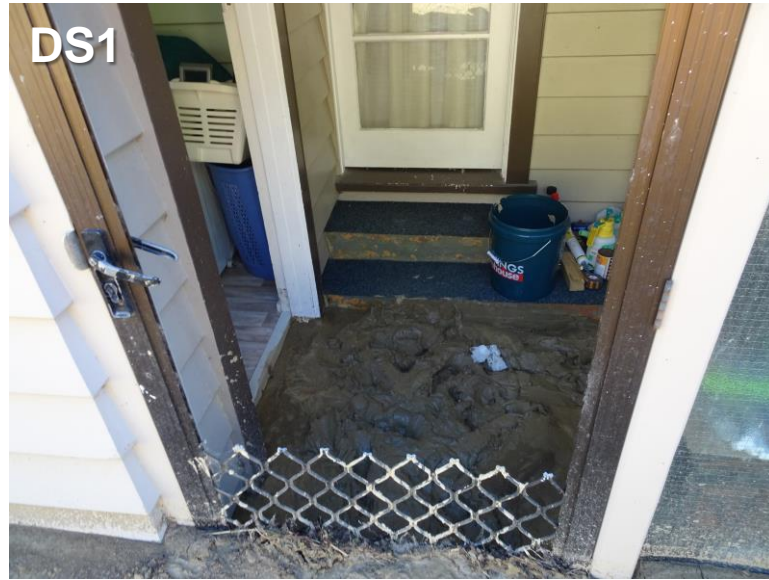 - Max debris height: 2 m
  - % inundated: 44%

Debris – Regional runout modelling

McDougall, 2017

Debris – Site-specific runout modelling

# Debris - Impact

DS1

DS2

DS3

DS4

DS5

Building Damage

Damage state (DS)	Damage classification	Description of the observed damage	Damage Ratio (DR)
DS0	None: No damage	Damage is outside building footprint	0
DS1	Insignificant: Minor non-structural damage	Superficial (non-structural) inundation or <10% of building footprint is undercut	0 – 0.2
DS2	Light: Non-structural damage only	Superficial (non-structural) inundation or <10% of building footprint is undercut	0.2 – 0.4
DS3	Moderate: Reparable structural damage.	Structural damage or house is displaced	0.4 – 0.6
DS4	Severe: Irreparable structural damage.	Structural damage or house is displaced	0.6 – 0.8
DS5	Critical: Structural integrity fails.	Impact induced collapse or >50% of building is undercut	0.8 – 1.0

Putting it all together….

Field data → damage ratios → fragility functions → future impact
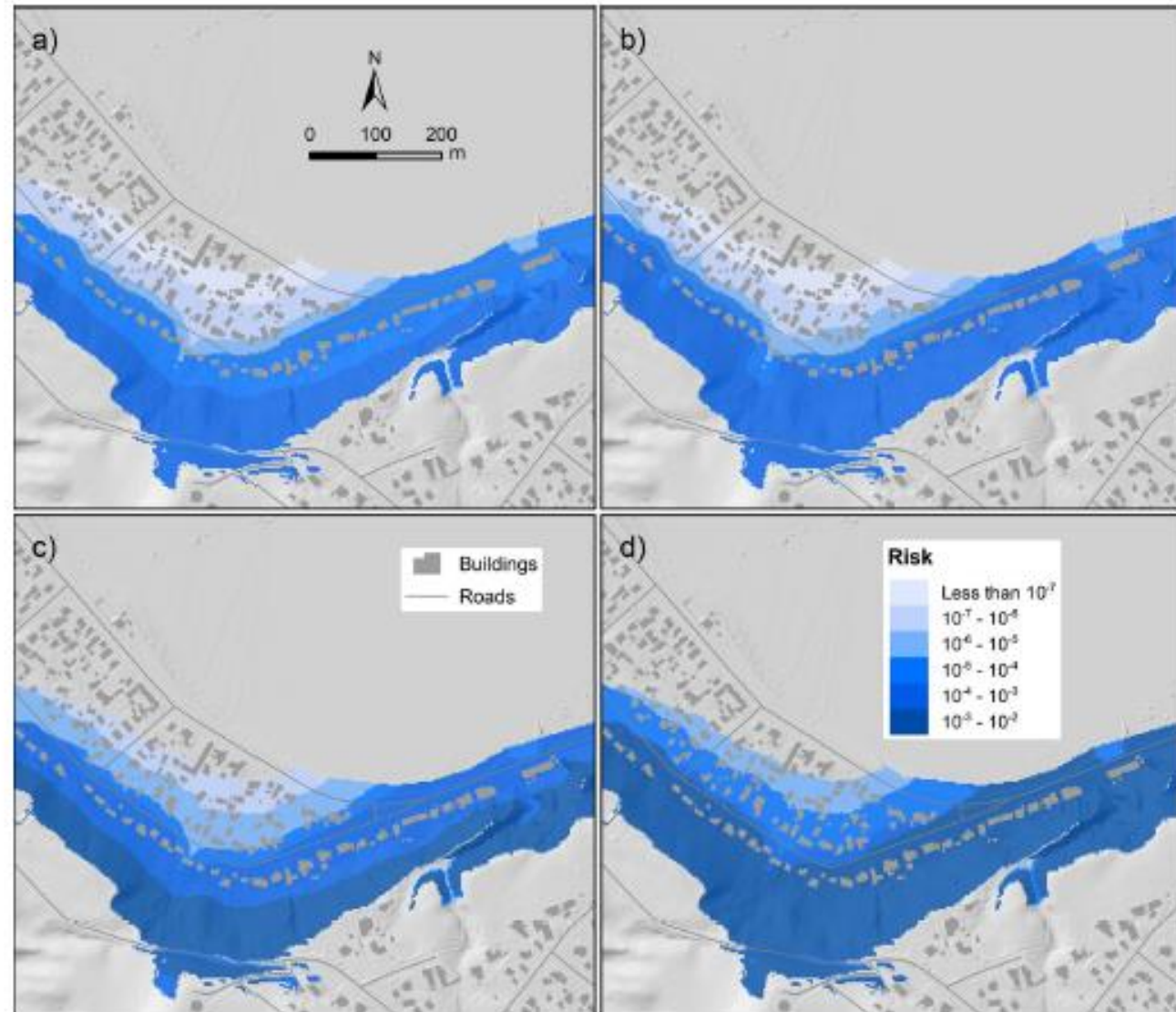
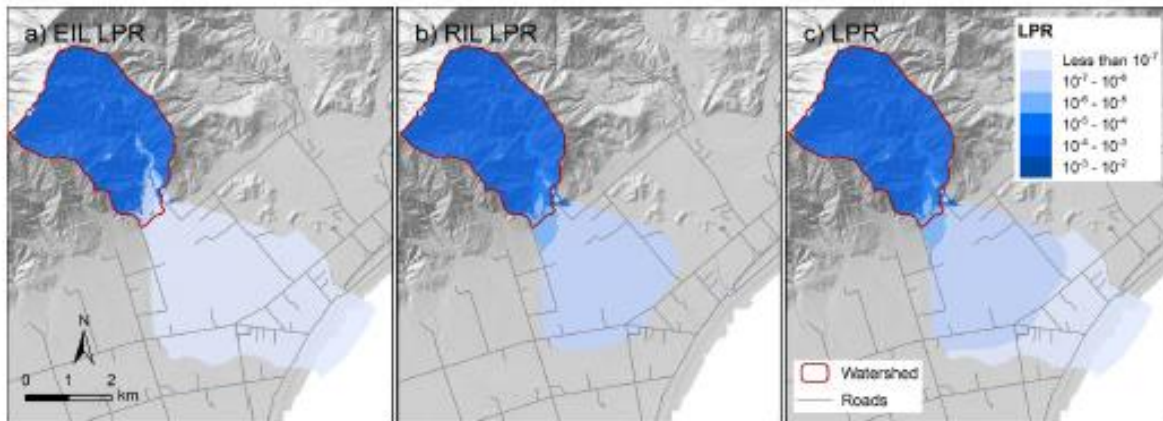$$DR = \frac{cost\ to\ repair}{cost\ to\ replace}$$
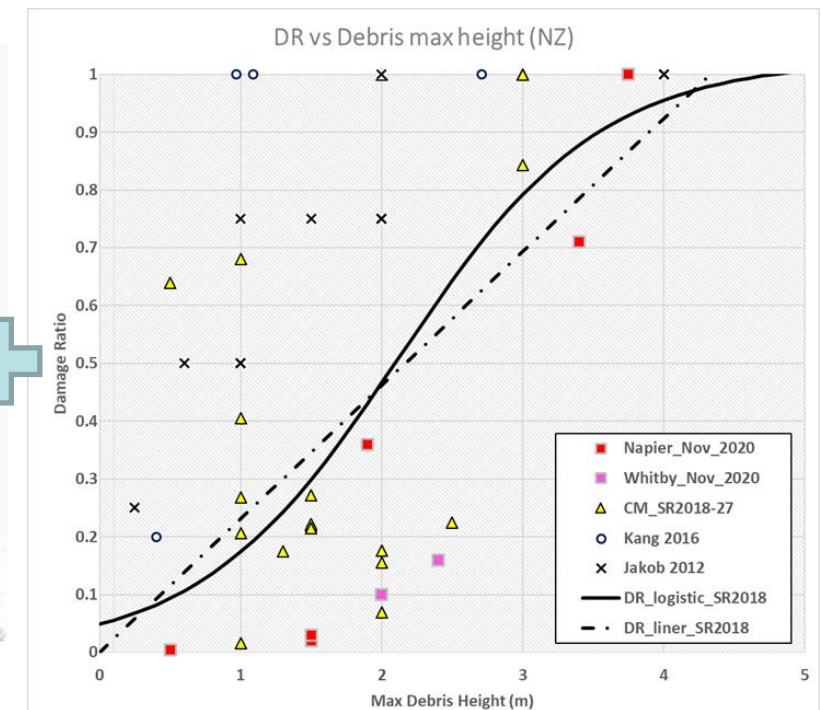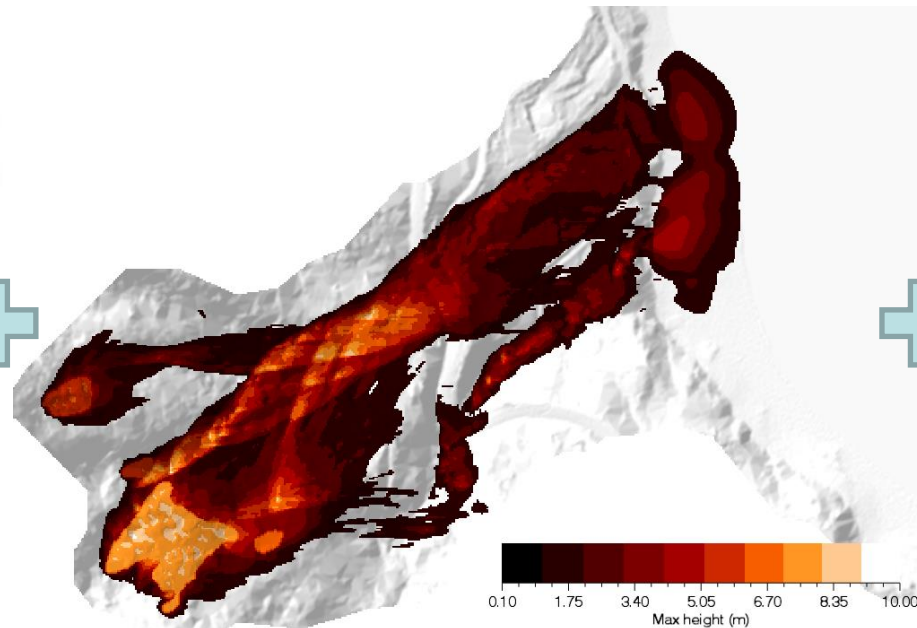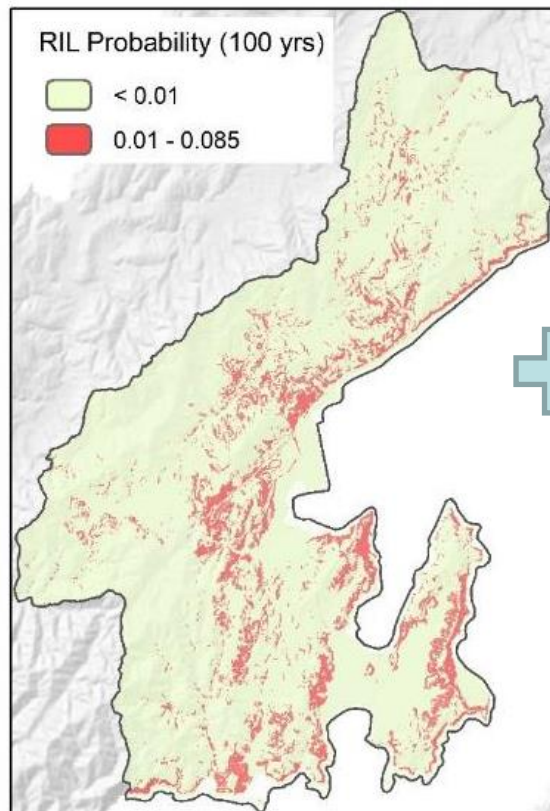
Landslide Risk

$$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$$

Catchment Scale

Township Scale

a) AIFR (66% occupancy), b) Best – LPR,
c) RCP 2.58 Rainfall Inputs, d) RCP 2.58 Rainfall Inputs + Vulnerability of 1

Summary

- **Inventories are key!**
- **Regional vs. site-specific scale**
- **Hazard models still have large uncertainties**
- **These propagate through to risk**
- **"Good enough science" debate**

Tēnā koutou.