
RESILIENCE
TO NATURE'S
CHALLENGES
Kia manawaroa –
Ngā Ākina o
Te Ao Tūroa
TE TAI WHANAKE
Growing a stronger, more resilient Aotearoa.
Te Papa, Wellington
13 & 14 May 2024

The evolving approach to catastrophic risk for Aotearoa New Zealand

Chair:
Jenna Rogers

NEMA

Sarah Holland

NEMA

Dr Bill Fry

GNS Science

Professor Tom Wilson

University of Canterbury / NEMA

Kristie-Lee Thomas

University of Canterbury

Jamie Ruwhiu

Te Rūnanga o Ngāi Tahu

Dr Richard Turner

NIWA

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Expecting the unexpected: Using earthquake simulators to prepare for and respond to natural hazards

Bill Fry (co-Lead with Andy Nicol), RNC2 Earthquake and Tsunami Programme

Huge thanks to the team that did the heavy lifting.

Monday 13 May, 2024

Te Papa

GNS Science Te Pū Ao

UC University of Canterbury Te Whare Wānanga o Waitaha Christchurch New Zealand

EQC Earthquake Commission Kōmihana Rūwhenua

NIWA Taihoro Nukurangi

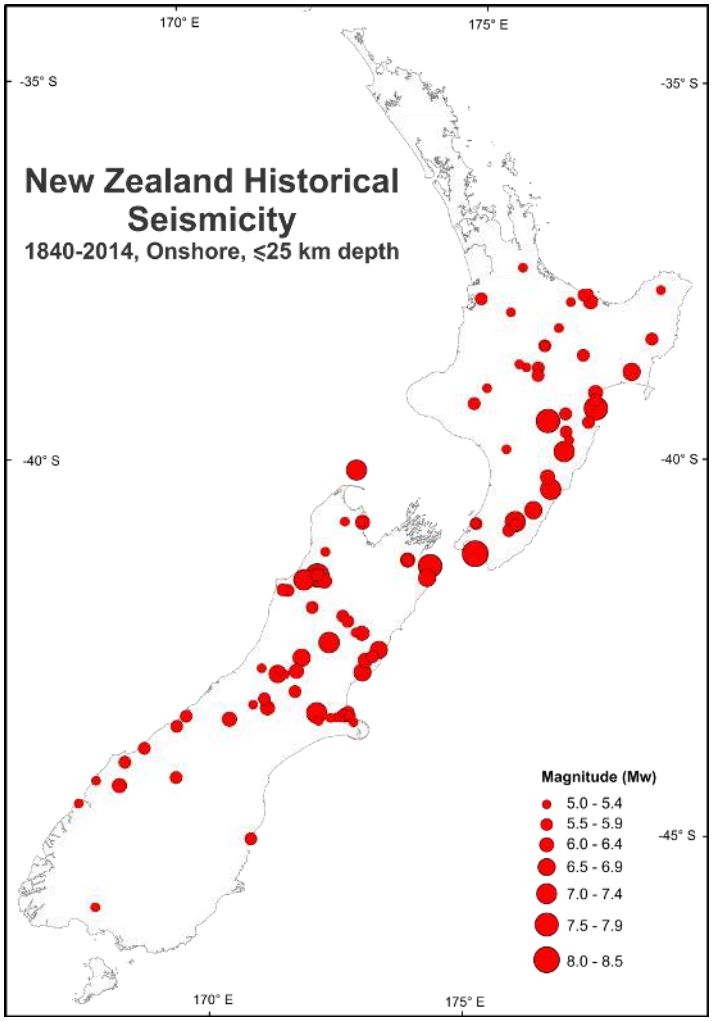
Lamont-Doherty Earth Observatory Columbia University | Earth Institute

University of Otago Te Whare Wānanga o Otāgo New Zealand

Victoria University Wellington Te Whare Wānanga o te Ūpoko o te Ika a Māui

University of Oxford

The challenge: Lack of earthquake records



Seismic (and tsunami) hazard information is typically derived from historical and prehistorical earthquakes.

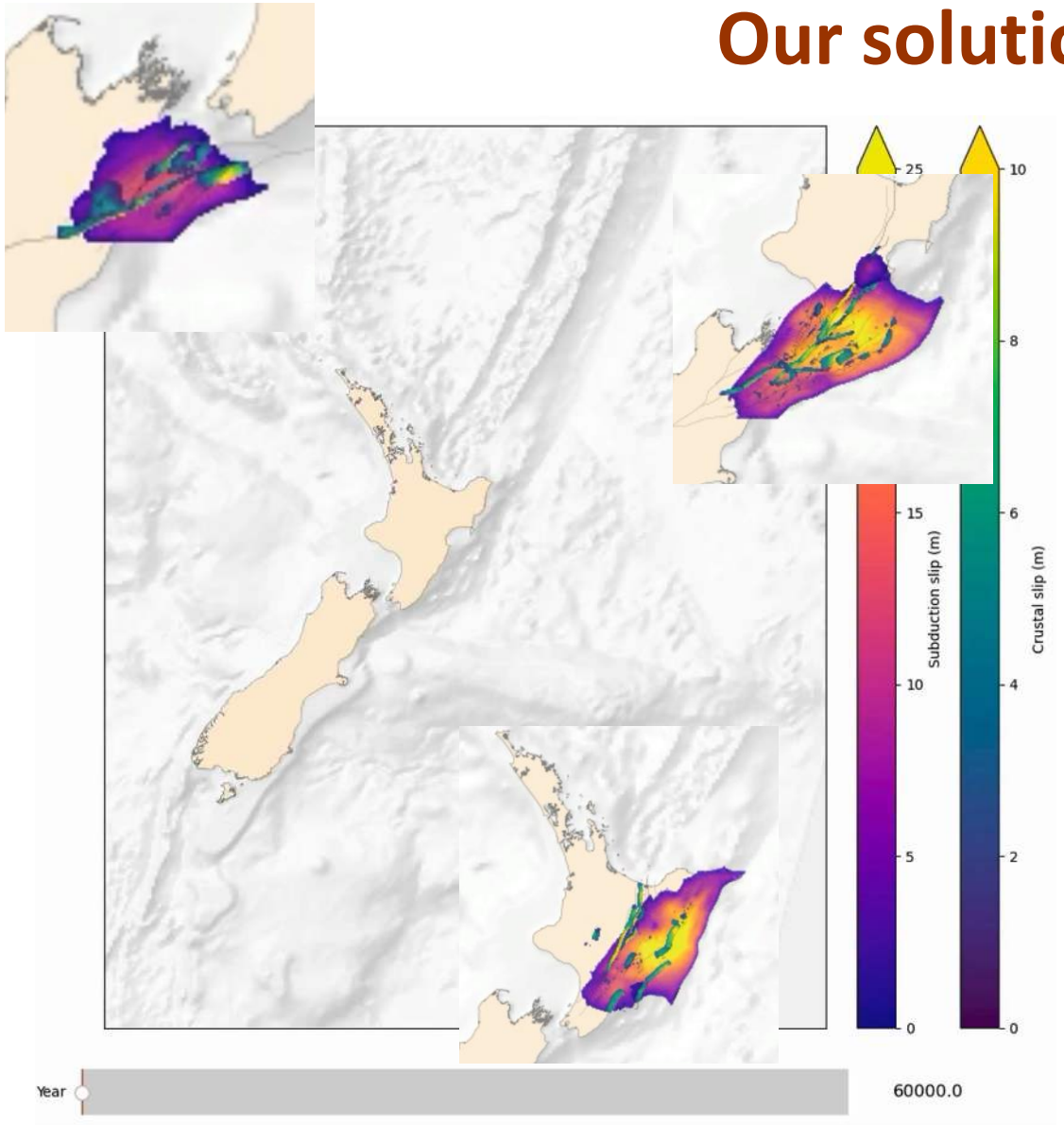
The NZ historical earthquake record of ~180 yrs is very short by geological standards.

~20 historical earthquakes > M7.

We only have 'good' prehistoric earthquake information for ~60 of ~900 known active faults (~<10%).

EQ rates and faults sub-team: Nicol, Humphreys, Stirling, Niroula, VanDissen, Seebeck

Our solution to the challenge: Earthquake cycle simulators



Our simulator results show that M8+ subduction events on the Hikurangi are usually coseismic with large crustal ruptures.

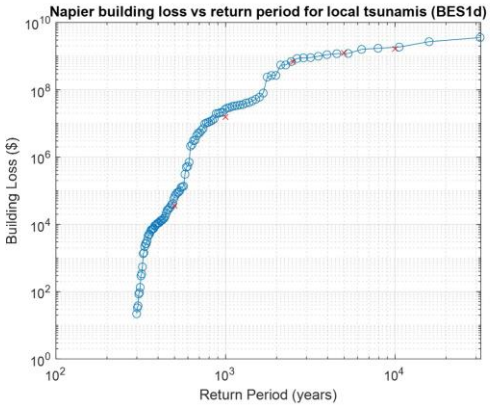
This has major implications for most Disaster Risk Reduction applications of earthquake simulators

Simulator sub-team: Howell, Penney, Liao and O'Kane

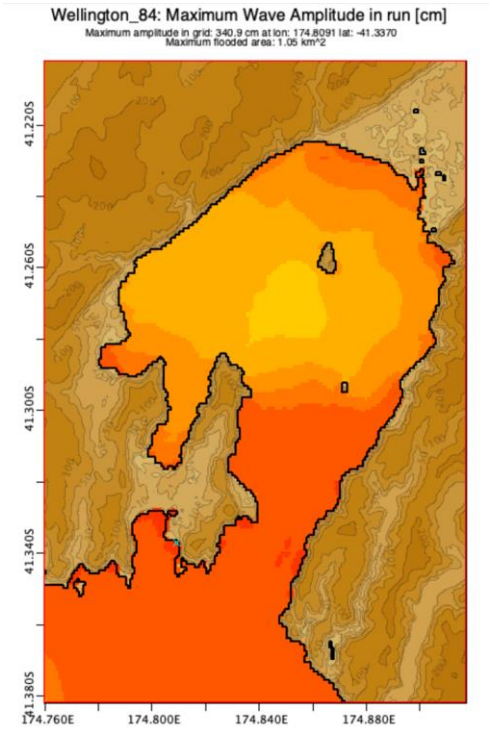
Tsunami Hazard and Risk

Tsunami sub-team: Power, Lane, Hughes, O'Kane, King, Savage, Davies

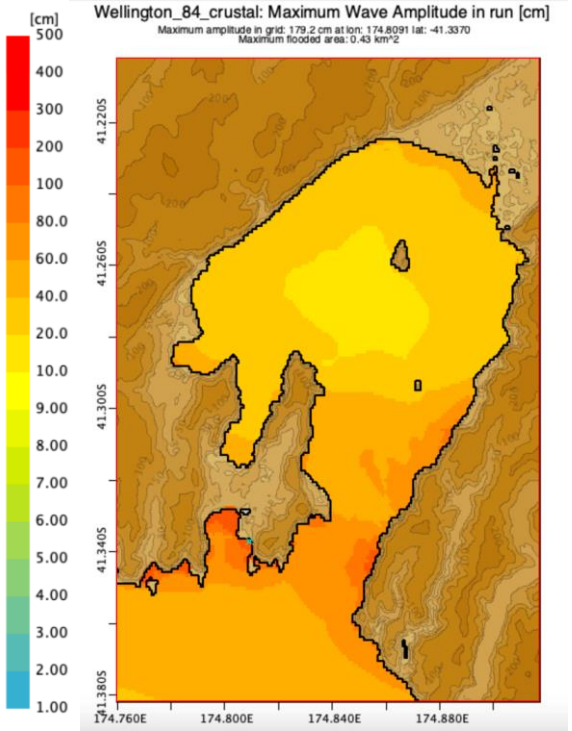
- **Event complexity is important in near-field inundation forecasting**
- **Not always an increase in the single-event maximum inundation**
- **This work doesn't necessarily increase hazard, it helps redefine our understanding to better estimate risk.**



Power et al., 2023



Subduction only



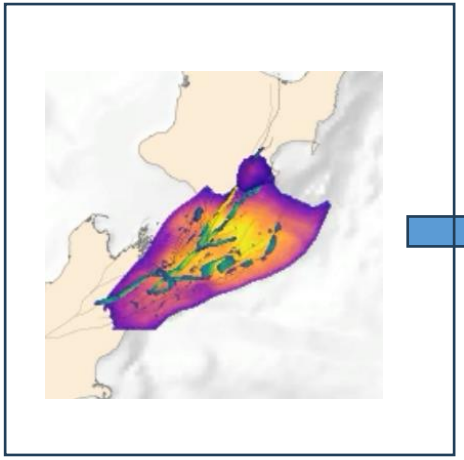
Subduction and crustal triggering

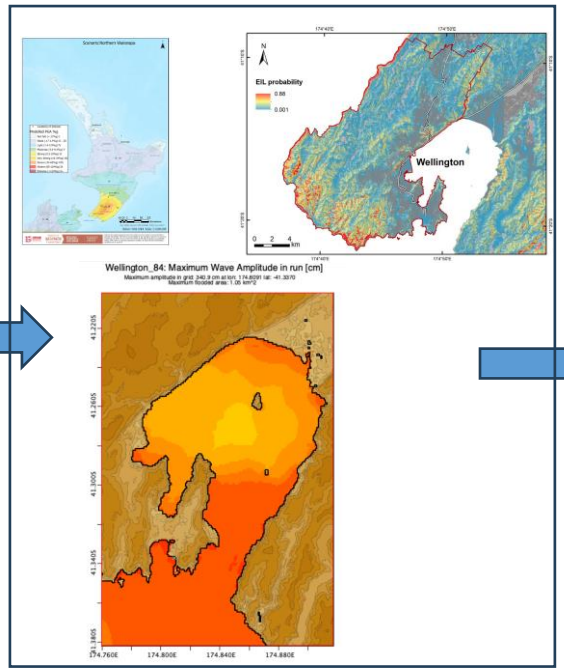
Multi-peril Hazard and Risk

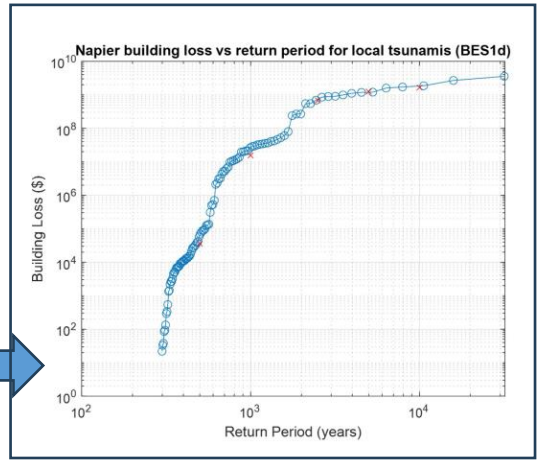
New RNC approach based on physics -- and extending to multi peril hazard

RiskScape modelling for each scenario

Model statistics based on suite of loss estimates







Risk sub-team: Power, Horspool, Hayes, McGill, Kaiser

Conclusions

We present a new framework in which ground motion + earthquake induced landslide + tsunami inundation risk can be calculated within a multi-peril framework that has the potential to capture complex fault interaction and temporal clustering of earthquakes.

With strong push from UN (IOC and WMO), virtual twins are coming. Our approach is the current top candidate to account for telluric hazards and link them to coastal processes driven by climate change these systems.

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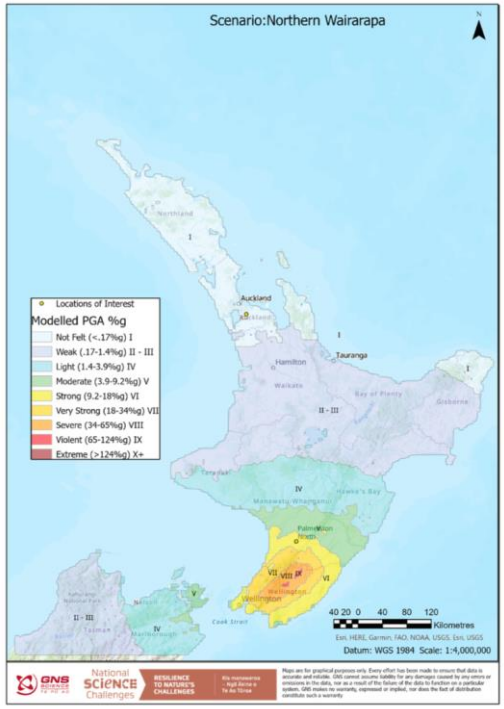
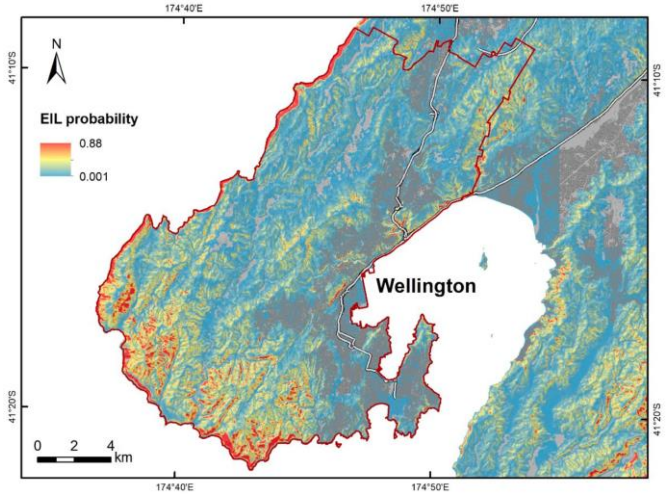
Response Testing



Ground motions (Horspool)

Earthquake Scenario	Landslide Density (within the 0.2 g PGA Extent?)			
	Auckland	Palmerston North	Wellington	Historical
rqs759464	0.1%	0.4%	0.7%	0.6%
rqs1237478	0.1%	0.2%	0.2%	-
rqs19118	0.1%	0.2%	0.2%	-
rqs37817	0.1%	0.2%	0.3%	-
rqs292713	0.1%	0.3%	0.7%	-
rqs1844079	0.1%	0.2%	0.2%	-
rqs1002623	0.1%	0.3%	0.8%	-
rqs950175	0.1%	0.2%	0.2%	-
rqs1010458	0.1%	0.2%	0.2%	-



Landslide density from scenarios (Massey and Lukowic)

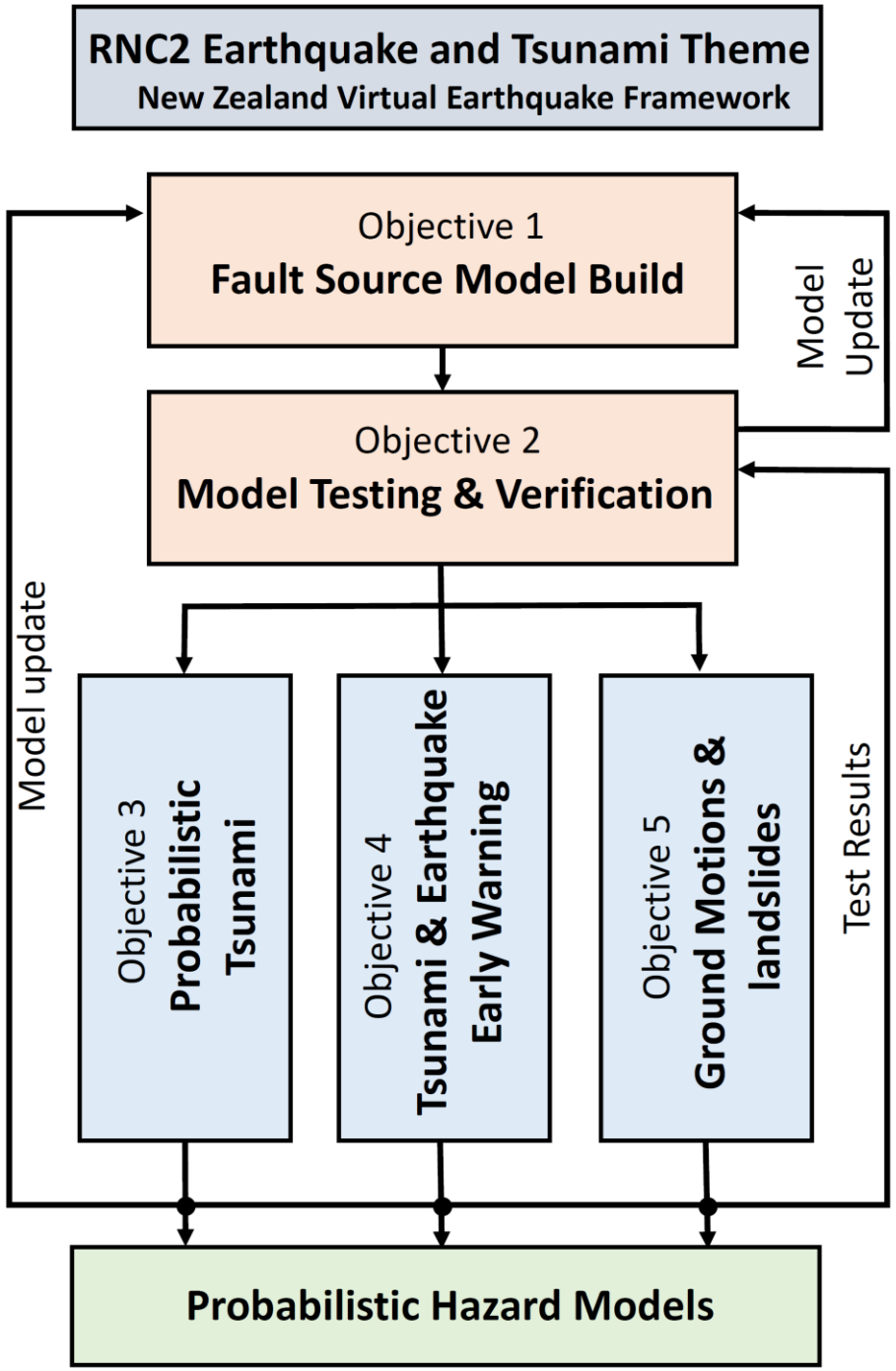
Scenario #	Name	Mw	Wellington	Palmerston North	Auckland
1	Alpine Fault and Wairau	7.7			
2	Full Hikurangi and upper crustal faults	9.1			
3	Southern Hikurangi and Wellington Region faults (A)	8.5			
4	Southern Hikurangi and Wellington Region faults (B)	8.4			
5	Southern Hikurangi	8.9			
6	Western offshore faults (Mascarin)	7.2			
7	Fisherman's Fault	7.2			
8	Northern Ohariu Fault	6.9			
9	Northern Wairarapa Fault	7.1			
10	Aotea-Evan's Bay Fault	6.5			

Summary multihazard impacts, including strong motion, EIL and tsunami inundation

Summary

Coseismic megathrust-crustal fault deformation is a thing, we need to deal with it

By probing the variability in complex rupture behaviour, synthetic seismicity is poised to become a juggernaut in earthquake and tsunami hazard and risk science.


RNC2 Earthquake and Tsunami Theme
New Zealand Virtual Earthquake Framework
Objective 1
Fault Source Model Build
Model Update
Objective 2
Model Testing & Verification
Model update
Test Results
Objective 3
Probabilistic Tsunami
Objective 4
Tsunami & Earthquake Early Warning
Objective 5
Ground Motions & landslides
Probabilistic Hazard Models

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Kaikōura Earthquake fault rupture (photo Kate Pedley)

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Slide deck omitted by presenter

Te Rūnanga o Ngāi Tahu Total Registered Members

Queensland
2.9%

New South Wales
1.7%

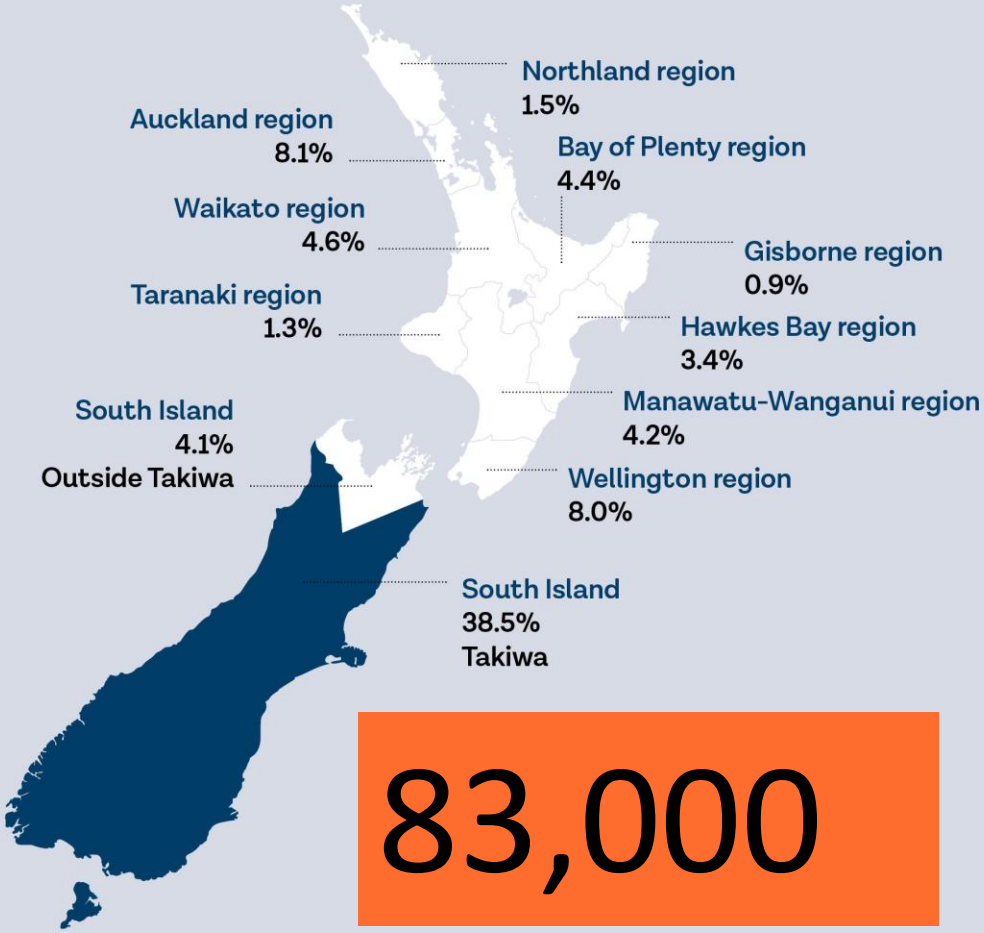
Victoria
1.2%

Western Australia
1.2%

Unknown
10.5%

Australia Other
1.7%

Non-New Zealand/Australia
1.3%



Northland region
1.5%

Auckland region
8.1%

Bay of Plenty region
4.4%

Waikato region
4.6%

Gisborne region
0.9%

Taranaki region
1.3%

Hawkes Bay region
3.4%

Manawatu-Wanganui region
4.2%

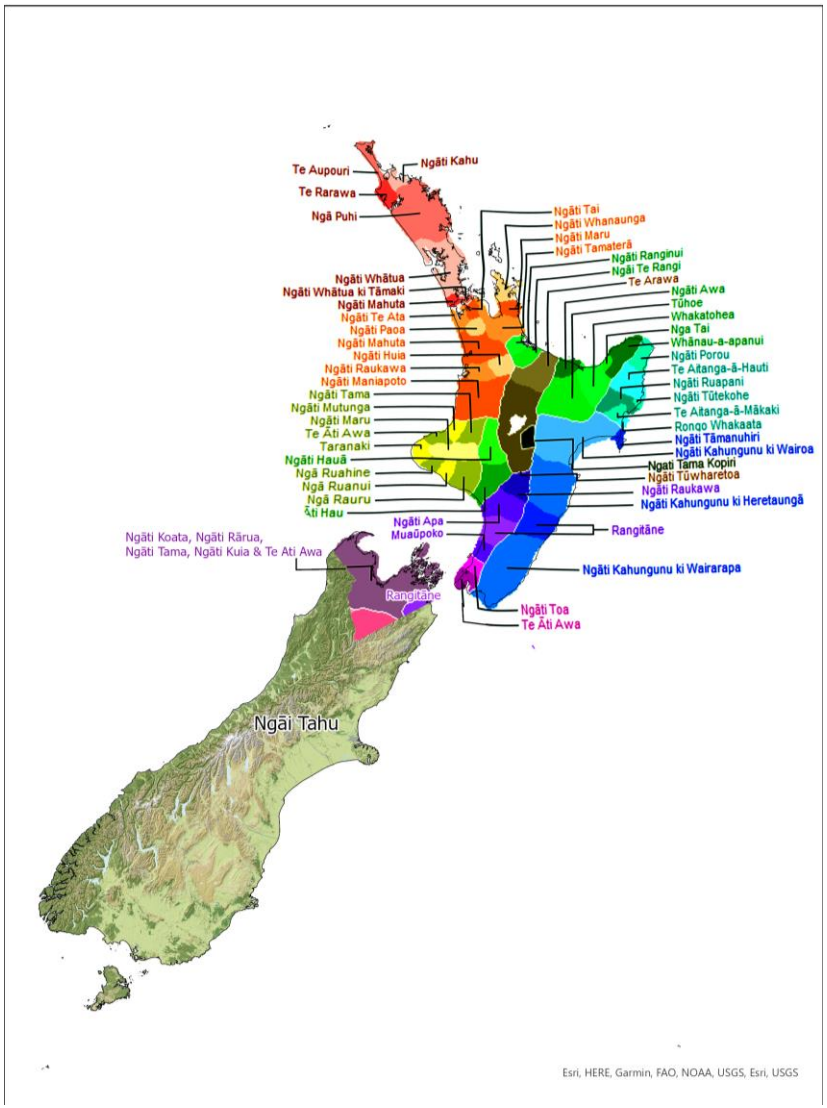
South Island
4.1%
Outside Takiwa

Wellington region
8.0%

South Island
38.5%
Takiwa

83,000

Iwi Structure – New Zealand



New Zealand Population

5,124,000

NZ Māori Population

904,100

Ngāi Tahu Registered Members

83,000

New Zealand – Area (Square km)

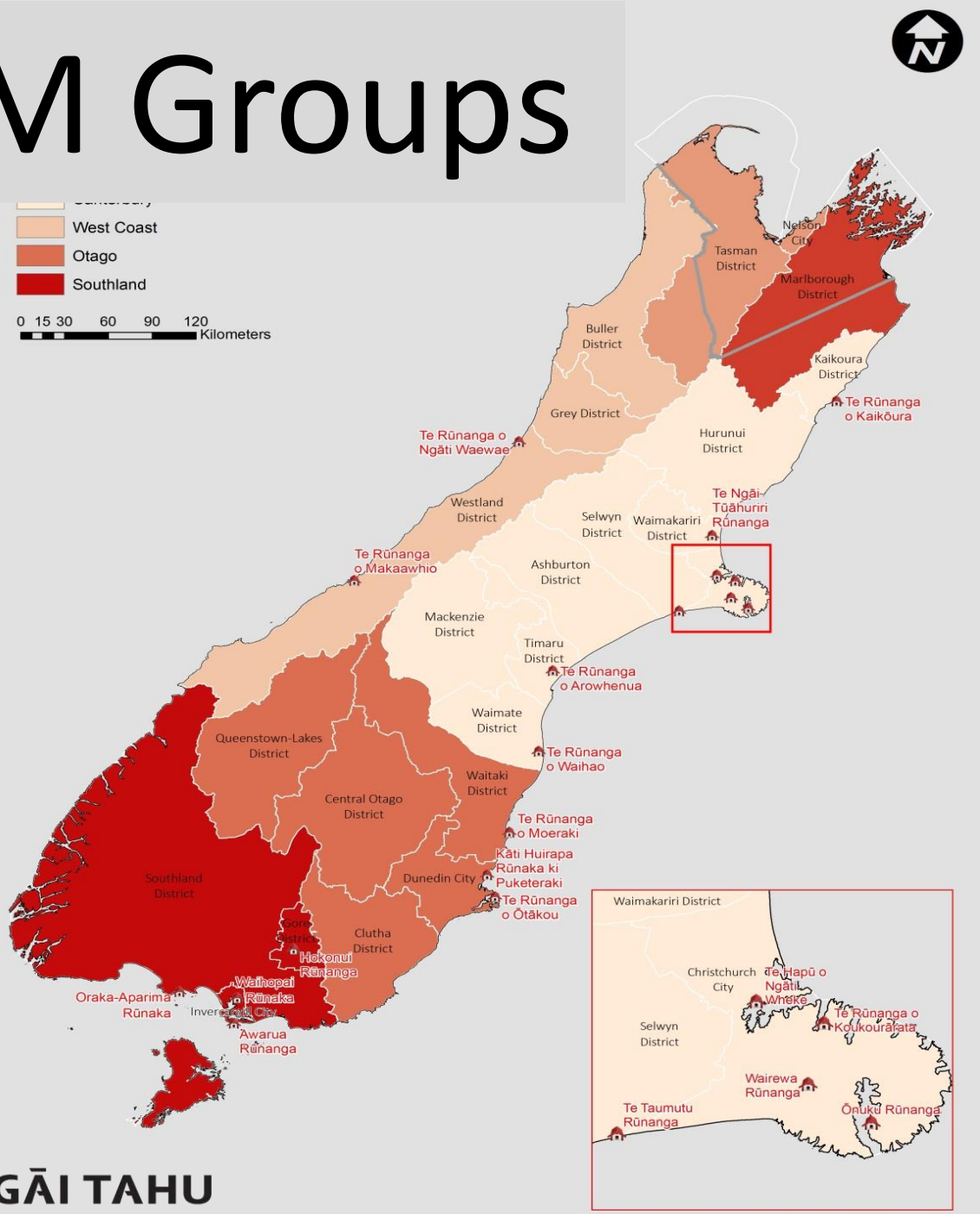
268,021

Ngāi Tahu Takiwa (Square km)

140,533

Te Rūnanga o NGĀI TAHU

CDEM Groups



Te Rūnanga o NGĀI TAHU

NOTE: Papatipu Rūnanga areas of interest may overlap CDEM Region boundaries

Starlink & Emergency Pods

Digital online tools

Mana Whenua Emergency Facilitators

AF8 & Rū Whenua

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Catastrophe Plenary:

What to realistically expect from future events: high-impact weather scenarios.

Richard Turner (NIWA)

13 May 2024

Te Tai Whanake

Te Papa, Wellington

NIWA Taihoro Nukurangi

Final RNC2 Conference
May 2024

Thanks to all the project leads and researchers in the Te Huarere me te Ahi Pūkākā (Weather and Wildfire Theme) of RNC2

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Kia manawaroa – Ngā Ākina o Te Ao Tūroa

NIWA Taihoro Nukurangi

What does the latest science tell us about what we can expect from future events?

What is the new approach to national planning for catastrophes, and how can we avoid the worst consequences, and make conscious choices about the risk we prepare for and manage?

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New advances.

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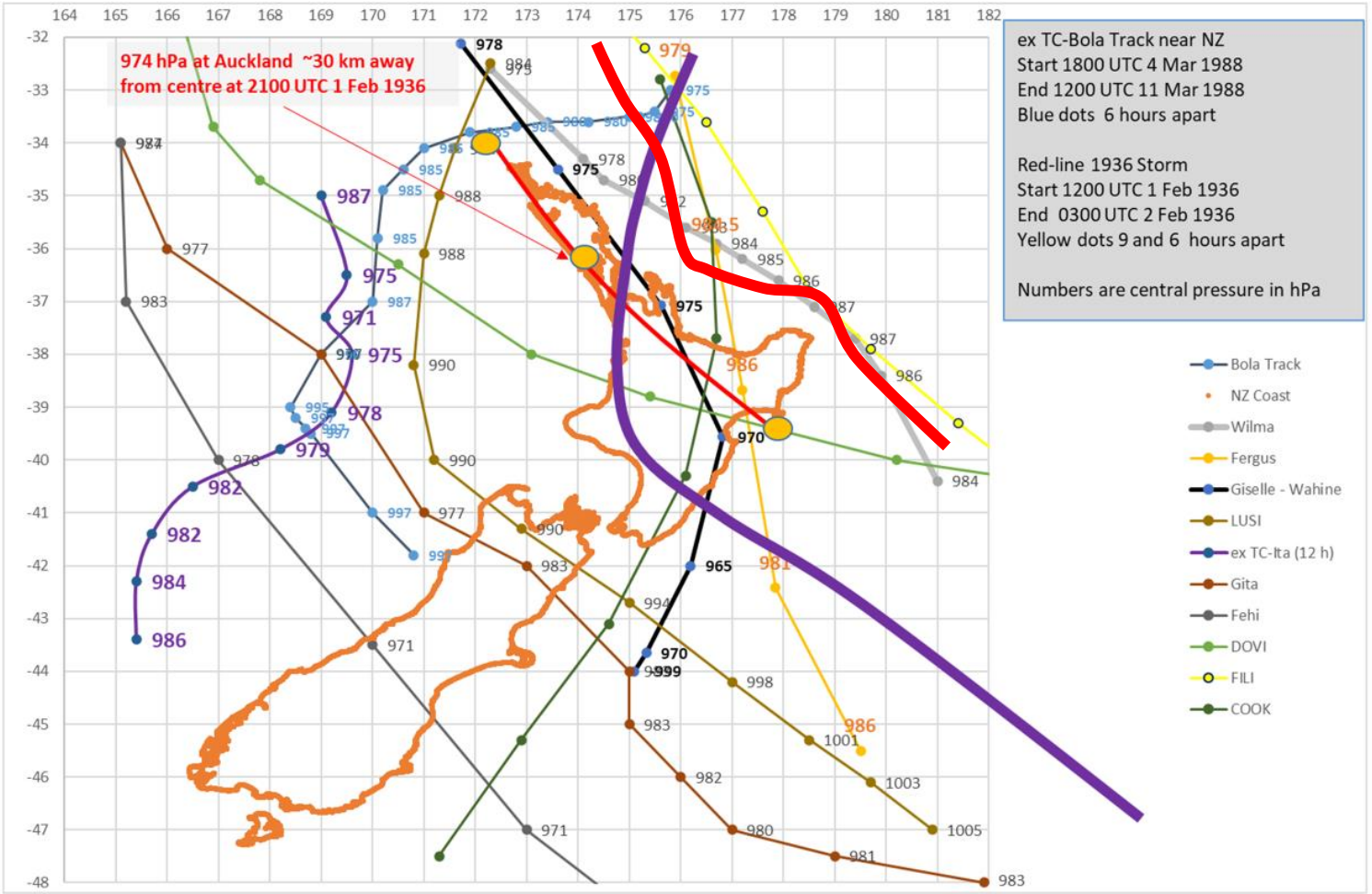
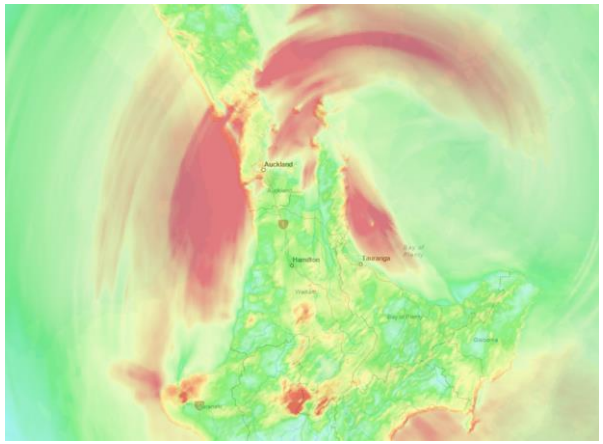
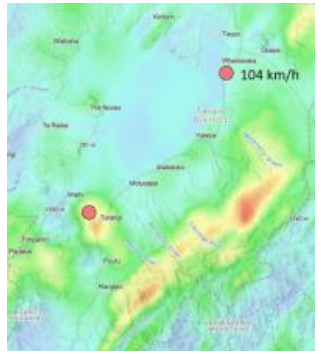
Major Ex-tropical Cyclone

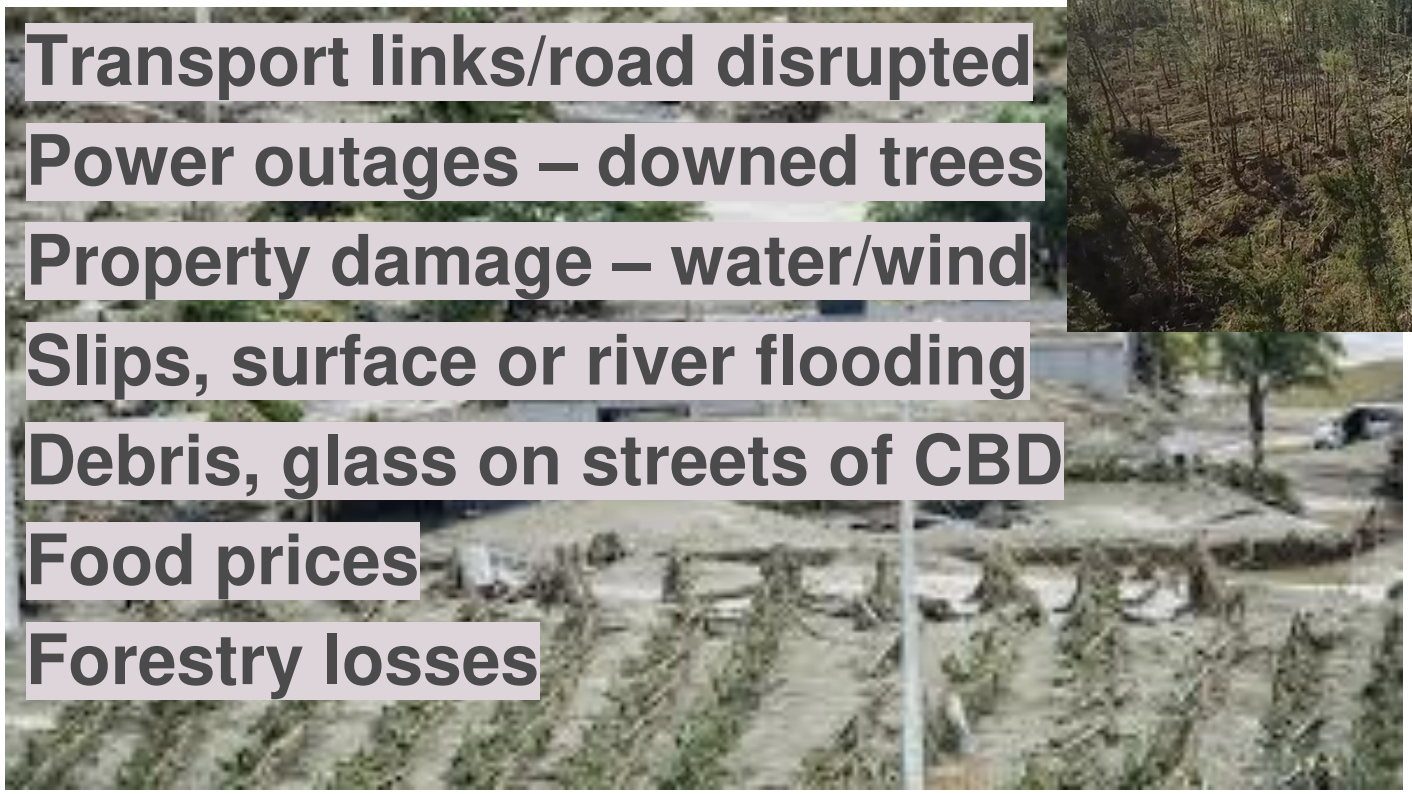
What to expect:





Impacts:





- Transport links/road disrupted
- Power outages – downed trees
- Property damage – water/wind
- Slips, surface or river flooding
- Debris, glass on streets of CBD
- Food prices
- Forestry losses

- Gabrielle, slips, wind, and floodwater inundation all caused damage but in different locations. Loss of life.

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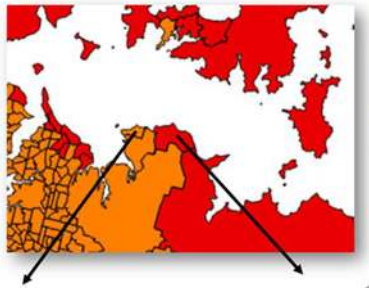
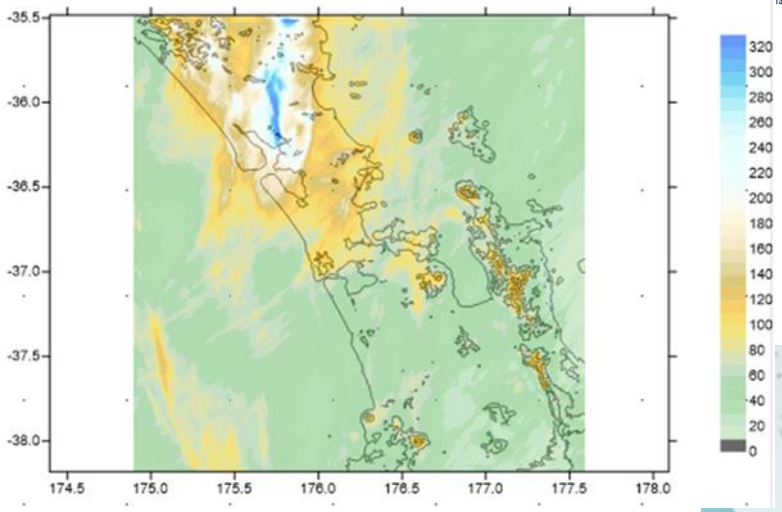
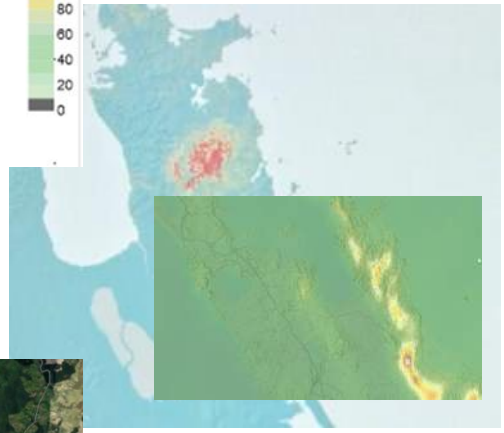
Taihoro Nukurangi

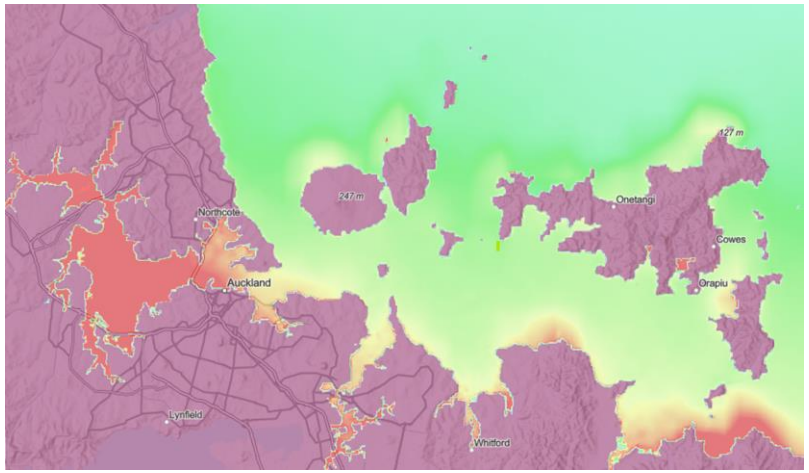
RNC PhD researcher Muizz Shah – wind movement through buildings. Photo: Stuff

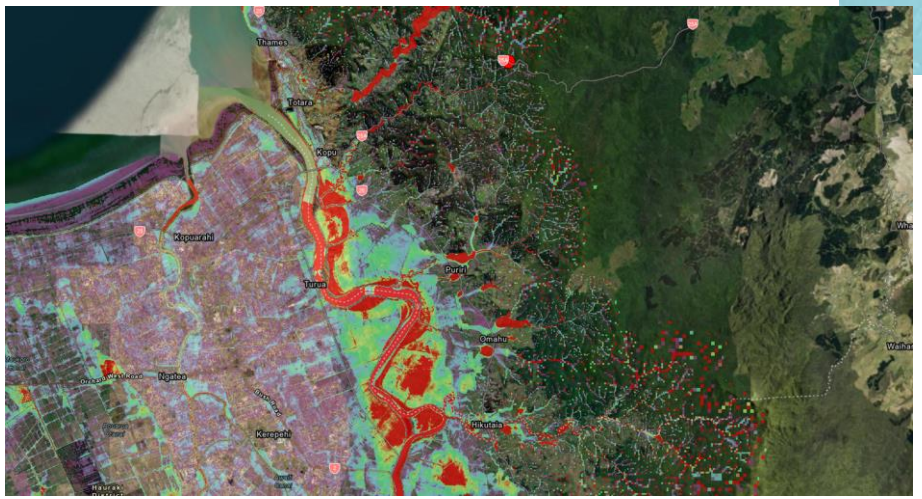


Wind damage on the West Coast. Photo: Opus, Build Magazine









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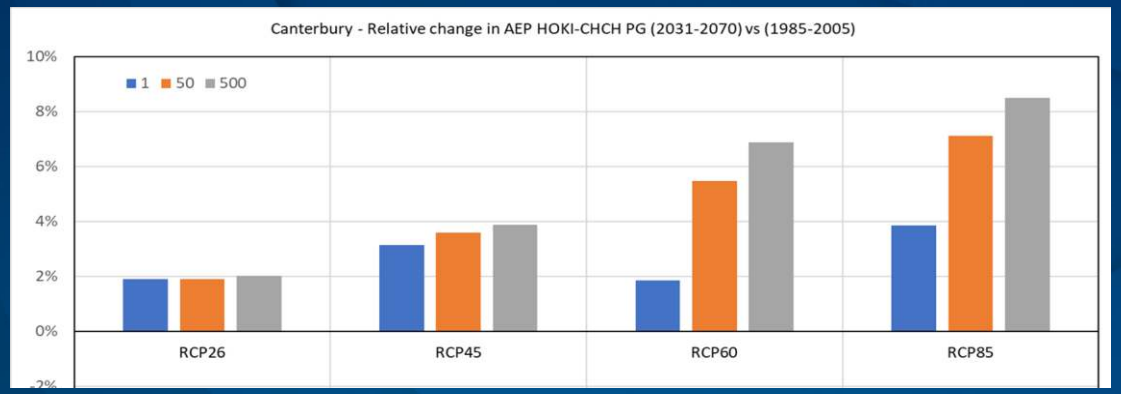
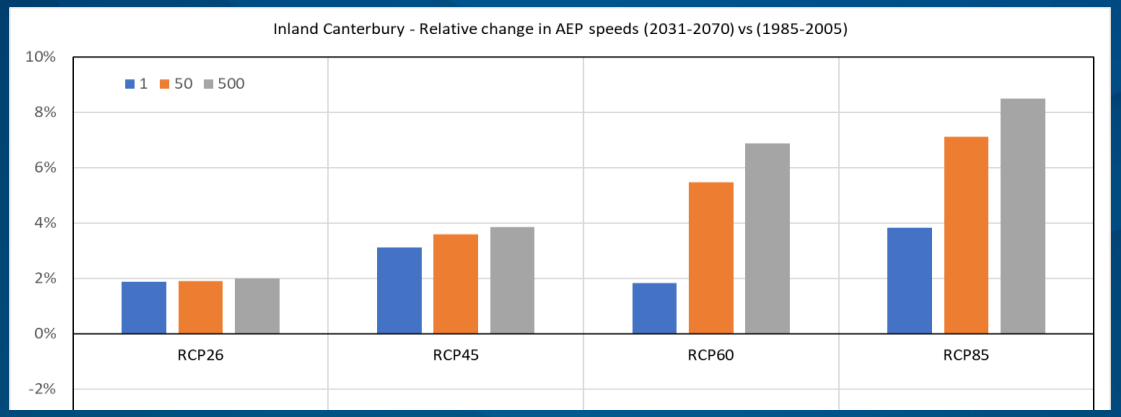
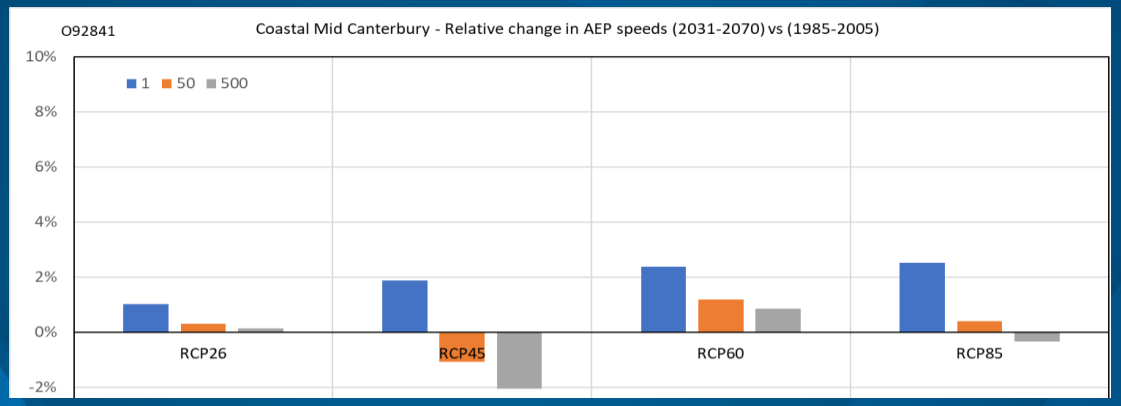
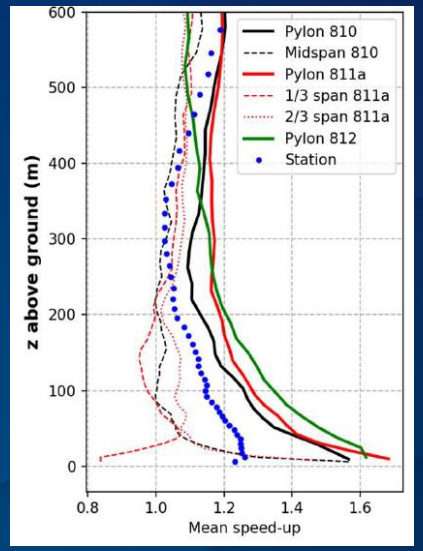
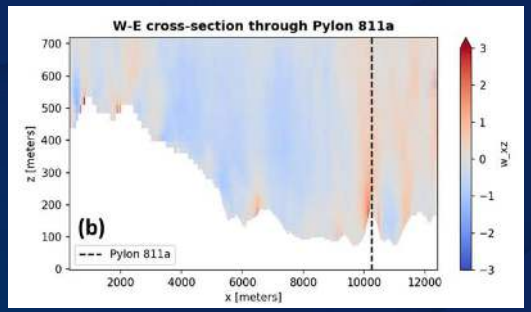
Climate Change











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Weather – major storms – not just ex-Tropical cyclones; (lee slope windstorms; winter snow; wildfire – more regional and so maybe not nationally catastrophic)

- **Harden assets (key infrastructure) where justified – account for climate change, sea-level rise in planning.**

- **Continue work on improved warning systems and communications.**