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

# Multihazard risk assessment

*What are the new advances in understanding and modelling individual, cascading and coincident hazards, and how are they being applied to improve hazard risk management?*

**Speakers:**

- Graham Leonard, GNS Science *(Chair)*
- Bill Fry, GNS Science
- Mark Dickson, University of Auckland
- Stuart Mead, Massey University
- Richard Turner, NIWA
- Christina Magill, GNS Science
- Juan Monge, ME Research
- Anthony Cole,Te Toi Ōhanga

# National coastal change dataset for Aotearoa New Zealand

**Resilience to Nature's Challenges: Coastal Programme**

**Mark Dickson, Murray Ford, Emma Ryan, Megan Tuck, and many others!**

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UNIVERSITY OF AUCKLAND Waipapa Taumata Rau NEW ZEALAND

THE UNIVERSITY OF WAIKATO Te Whare Wānanga o Waikato

TE HERENGA WAKA WELLINGTON VICTORIA UNIVERSITY OF WELLINGTON

UNIVERSITY of OTAGO Te Whare Wānanga o Otāgo NEW ZEALAND

# Understanding the relationship between coastal change and sea-level rise is one of the biggest challenges in coastal science

Sea-level signal obscured by myriad factors

- Earthquakes
- Sediment supply
- El Niño, La Niña
- Vegetation
- Wave climate
- Humans

**We have national datasets for SLR, waves, surge etc, but historic coastal-change data are fragmented/incomplete**

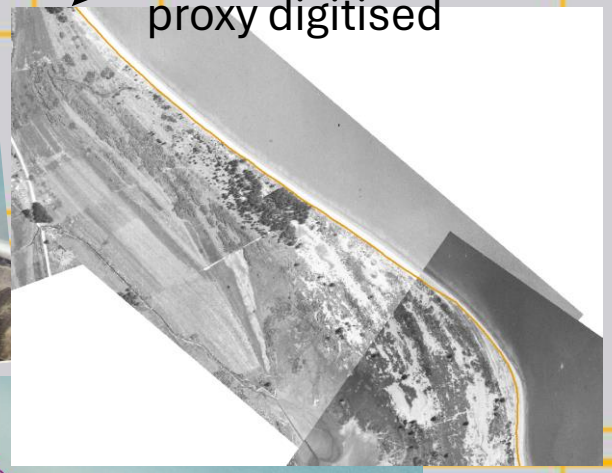
*Photo: Haumoana, New Zealand, Tim Whittaker*

RETROLENS
Historical Image Resource

Georeferencing

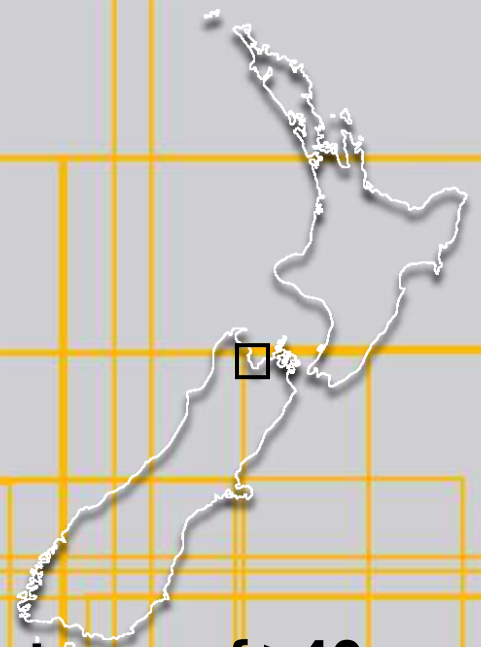

Crown archive

EOV 'shoreline' proxy digitised



Satellite imagery

Calculate rates of coastal change (DSAS)



**5 years of work, team of >40**

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# Mapping at local scale with national coverage

- > 400 AOI's
- Mapped cliff top, storm ridge, edge of (dune) vegetation
- Max coastline positions (22)
- National average of 8 coastline positions for each area

Ohiwa_28FEB2023 Ohiwa_03FEB2020 Ohiwa_26APR1974 Ohiwa_29OCT2008 Ohiwa_12OCT1945
Ohiwa_30OCT2022 Ohiwa_02OCT2018 Ohiwa_08APR2013 Ohiwa_23SEP1983
Ohiwa_02JAN2022 Ohiwa_16APR2015 Ohiwa_16MAR2012 Ohiwa_10SEP1971
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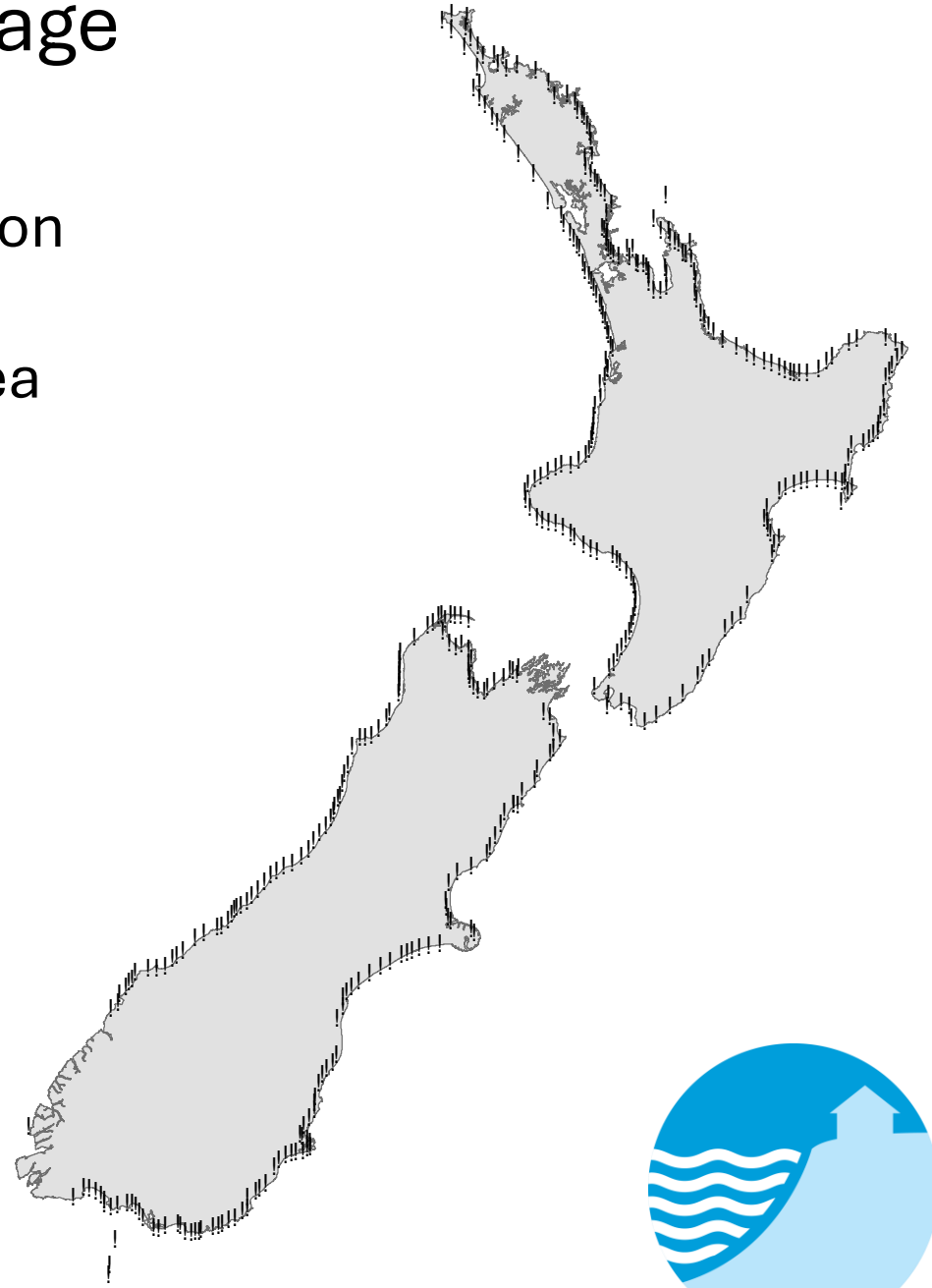

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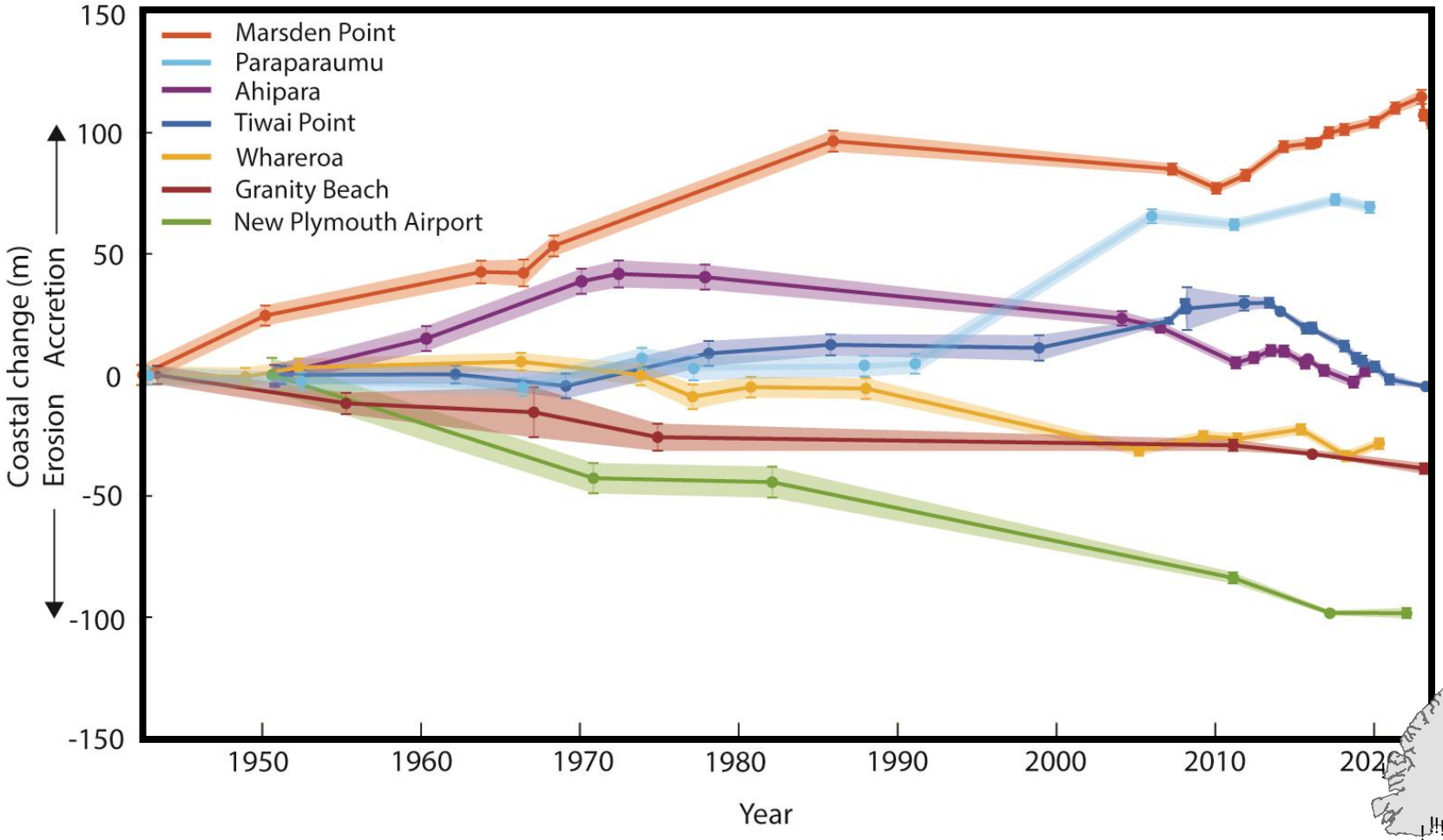
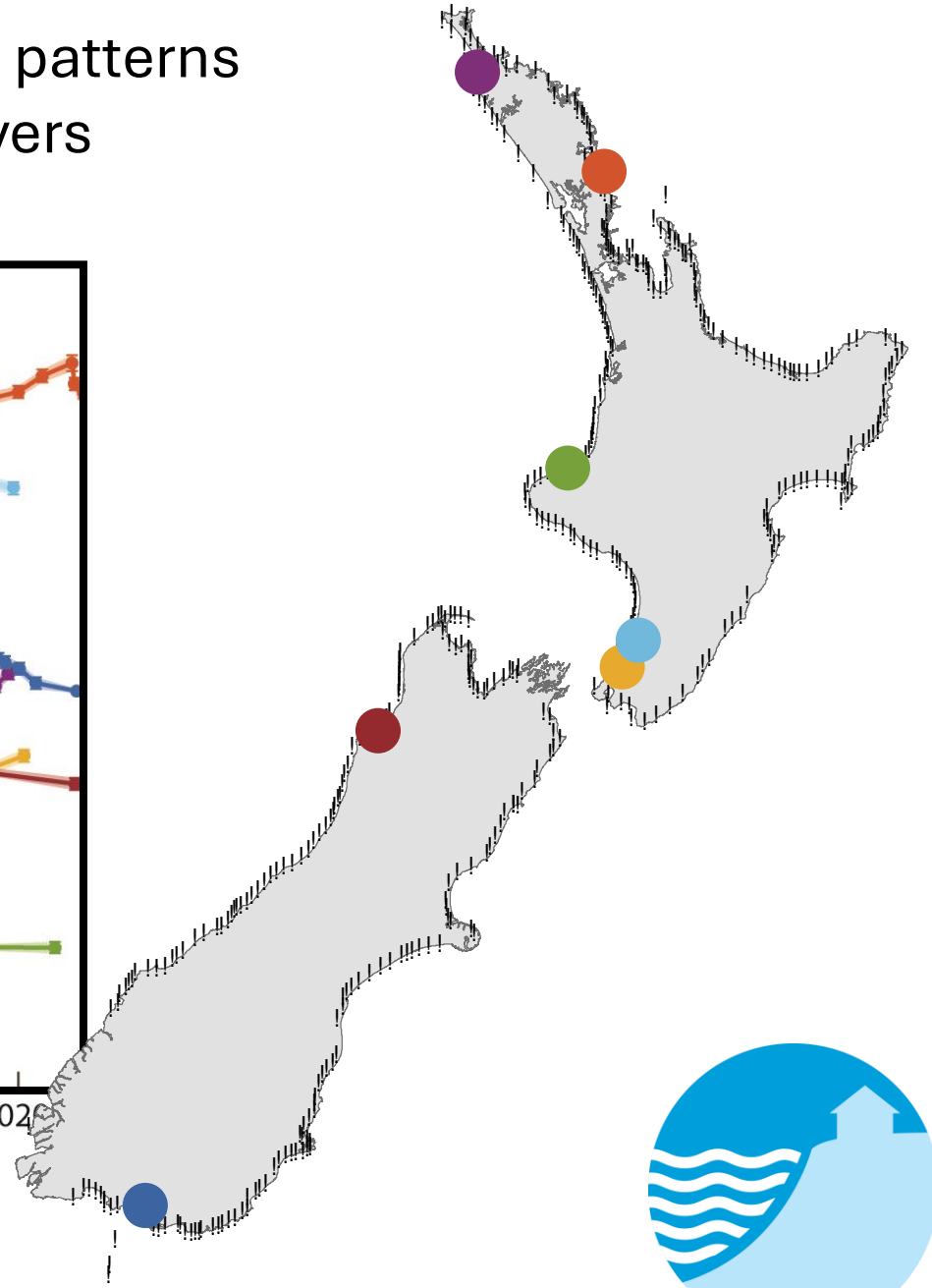
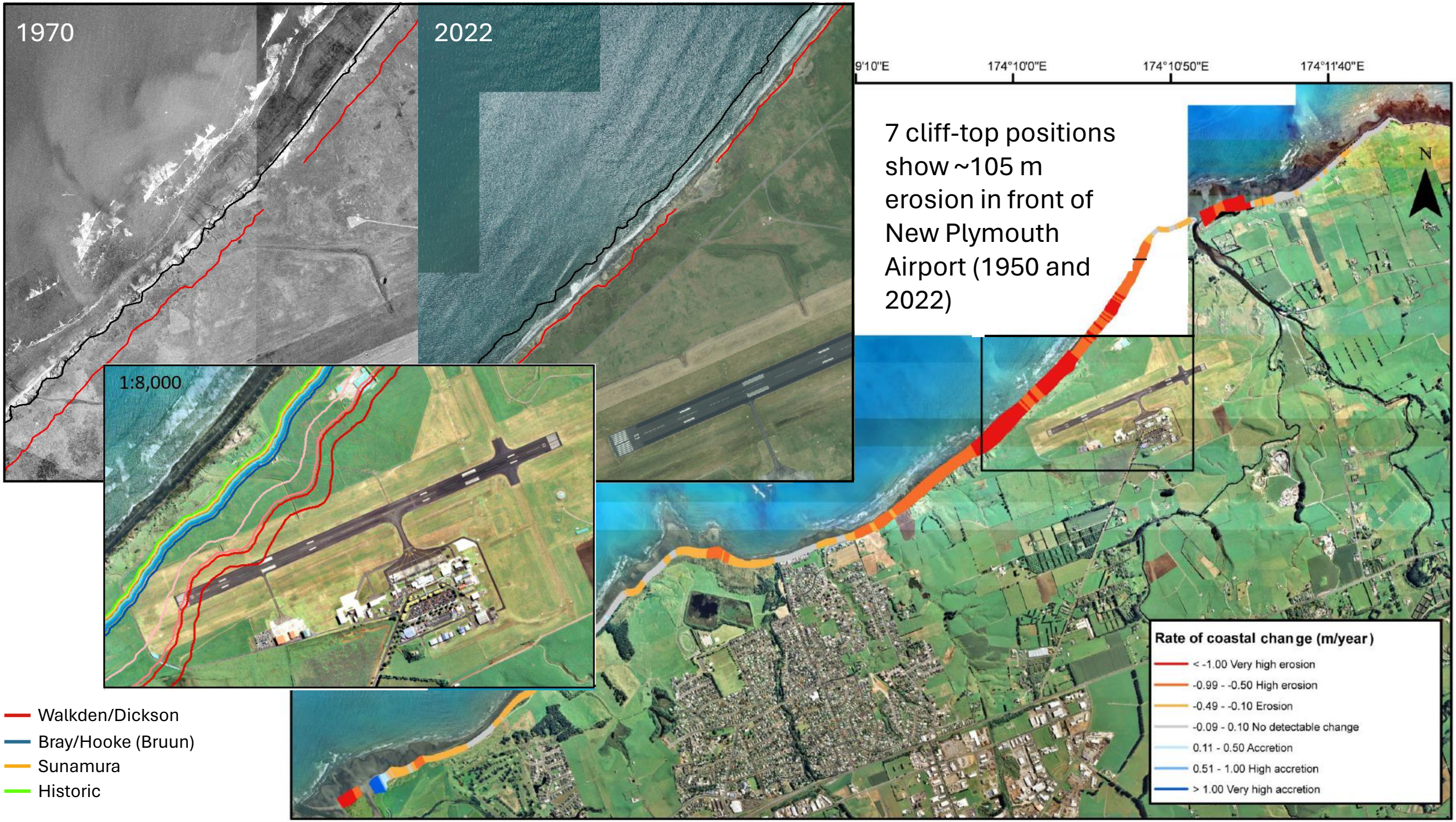
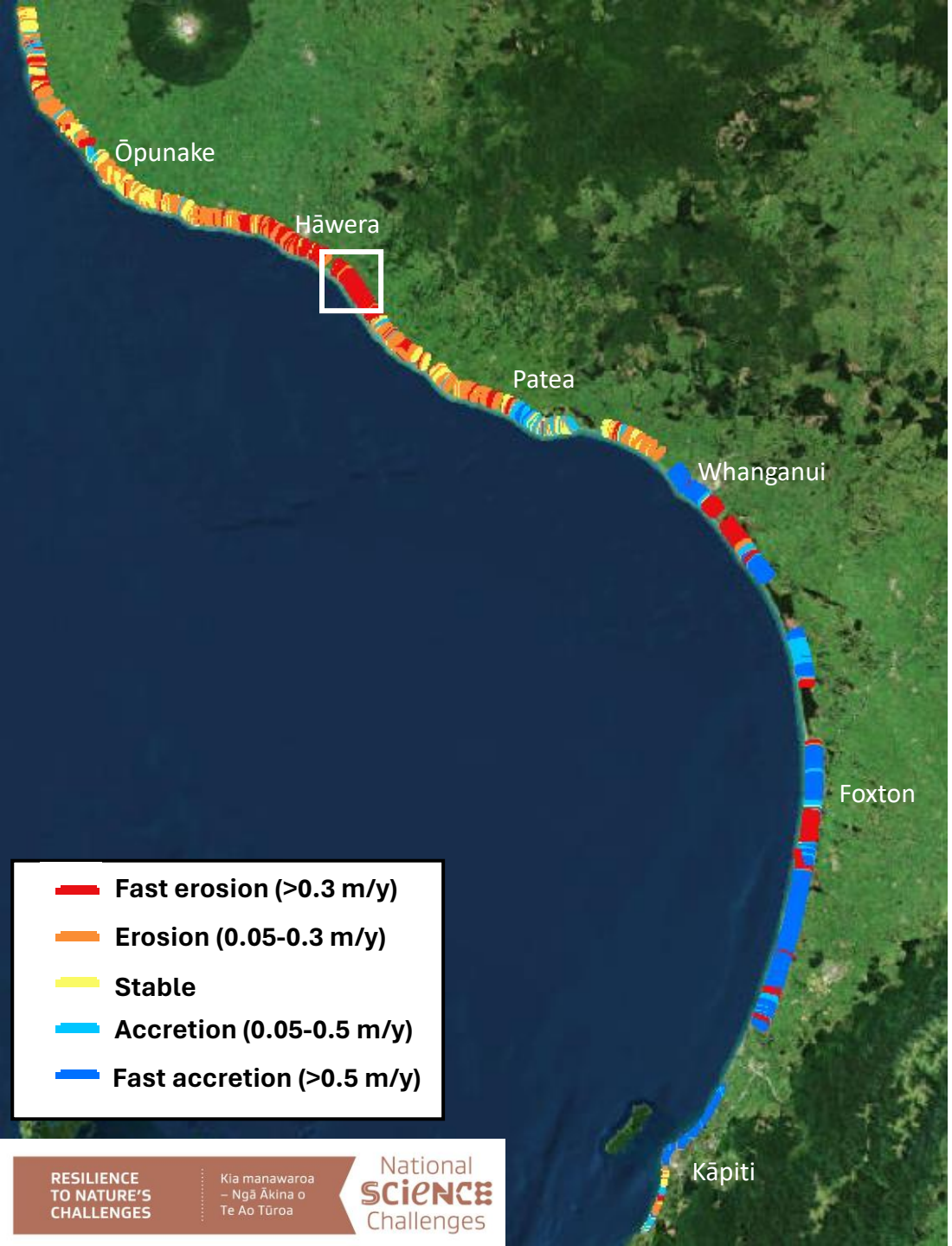
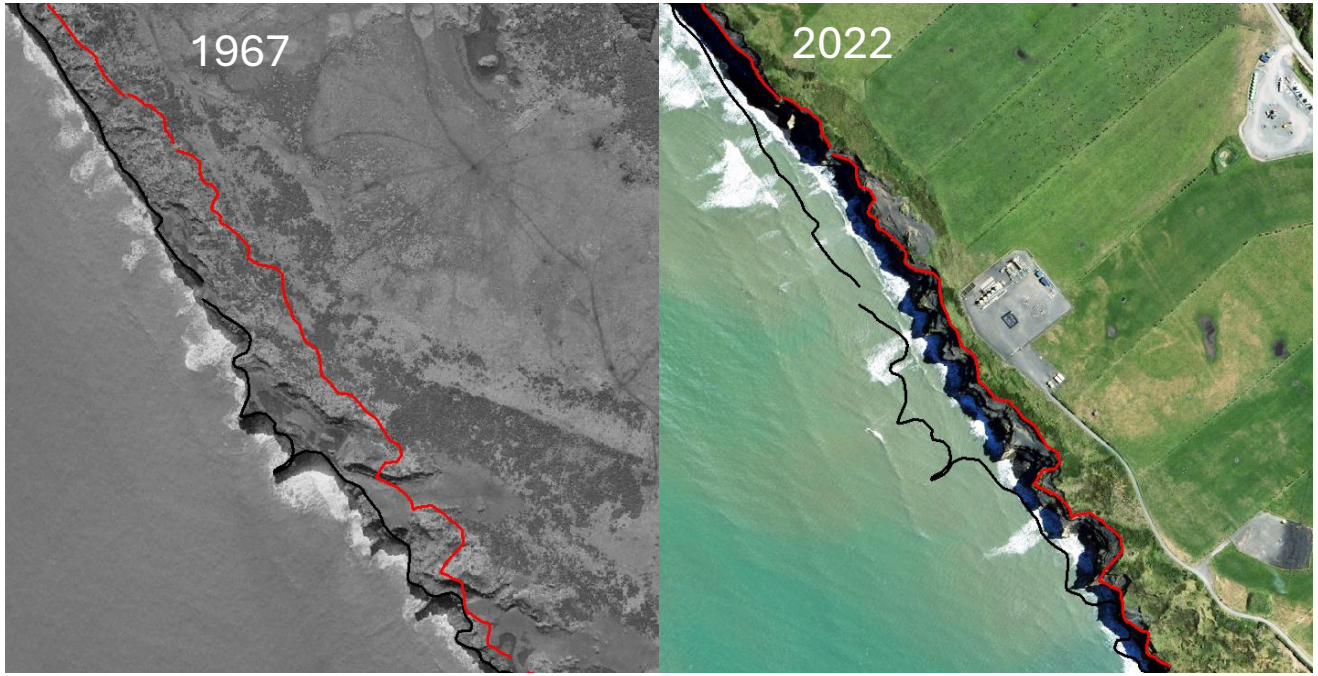
- Coastal change is complex and diverse, but there are patterns
- Baseline provided for projections, and untangling drivers



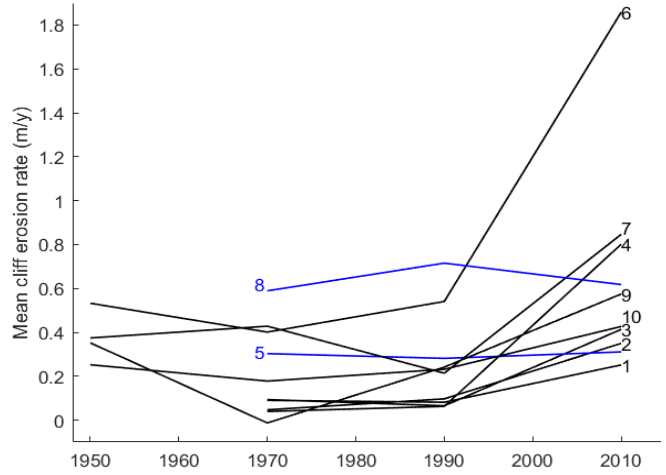

1970
2022
1:8,000
174°9'10"E
174°10'0"E
174°10'50"E
174°11'40"E
N
7 cliff-top positions show ~105 m erosion in front of New Plymouth Airport (1950 and 2022)
Rate of coastal change (m/year)
< -1.00 Very high erosion
-0.99 - -0.50 High erosion
-0.49 - -0.10 Erosion
-0.09 - 0.10 No detectable change
0.11 - 0.50 Accretion
0.51 - 1.00 High accretion
> 1.00 Very high accretion
Walkden/Dickson
Bray/Hooke (Bruun)
Sunamura
Historic




~100 m retreat (1967 to 2022) at Manutahi Wellsite

Significant acceleration in erosion rates post 1990

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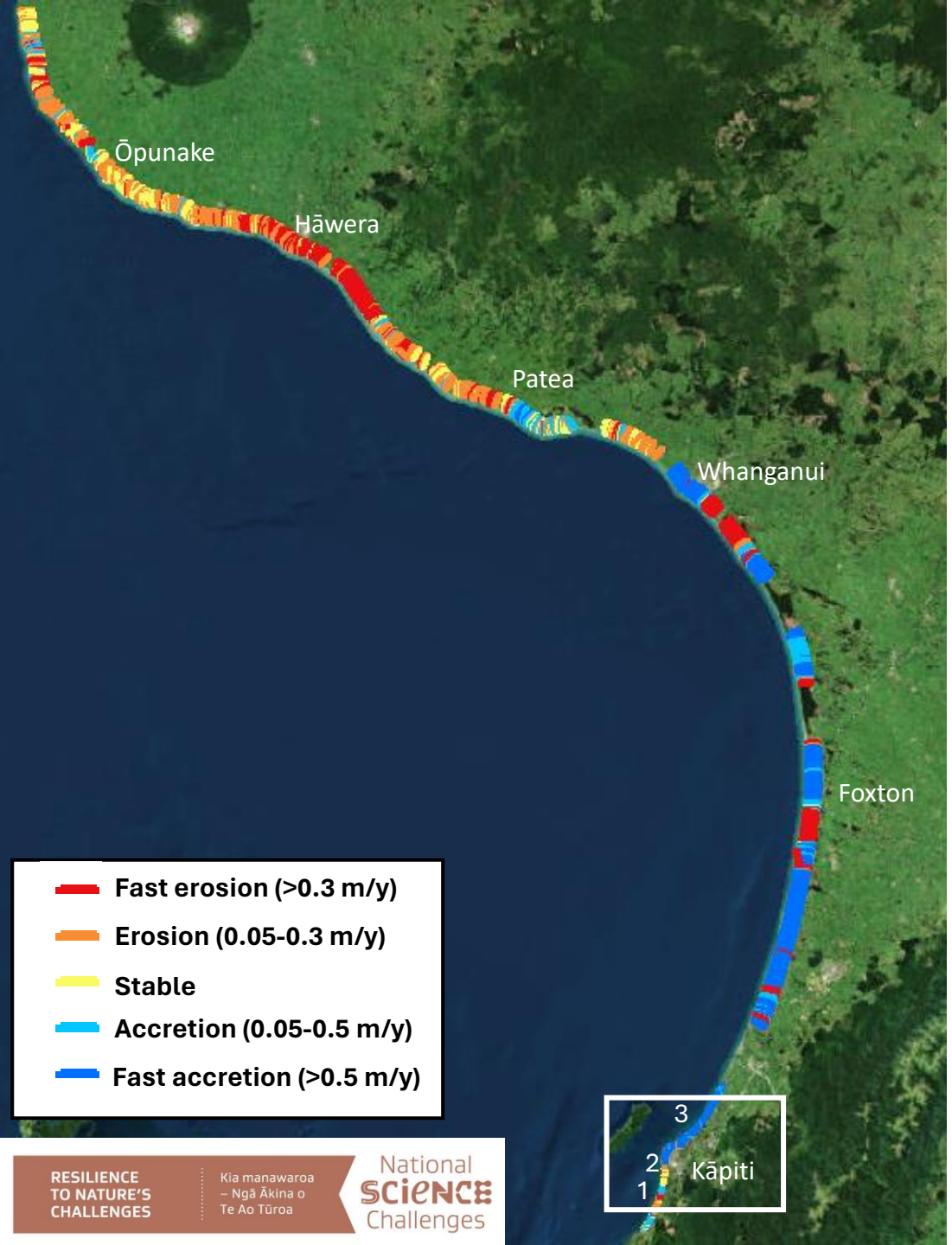


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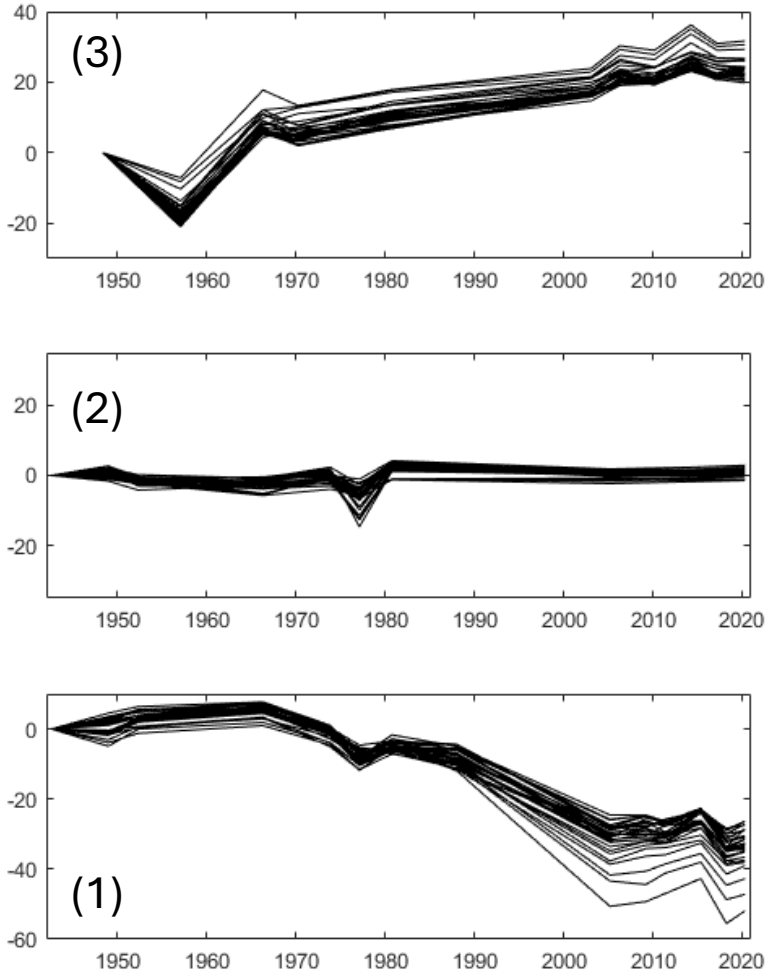
## 30 transects showing coastal change through time (m)




Coastal change (m)
**+ve accretion**
**-ve erosion**

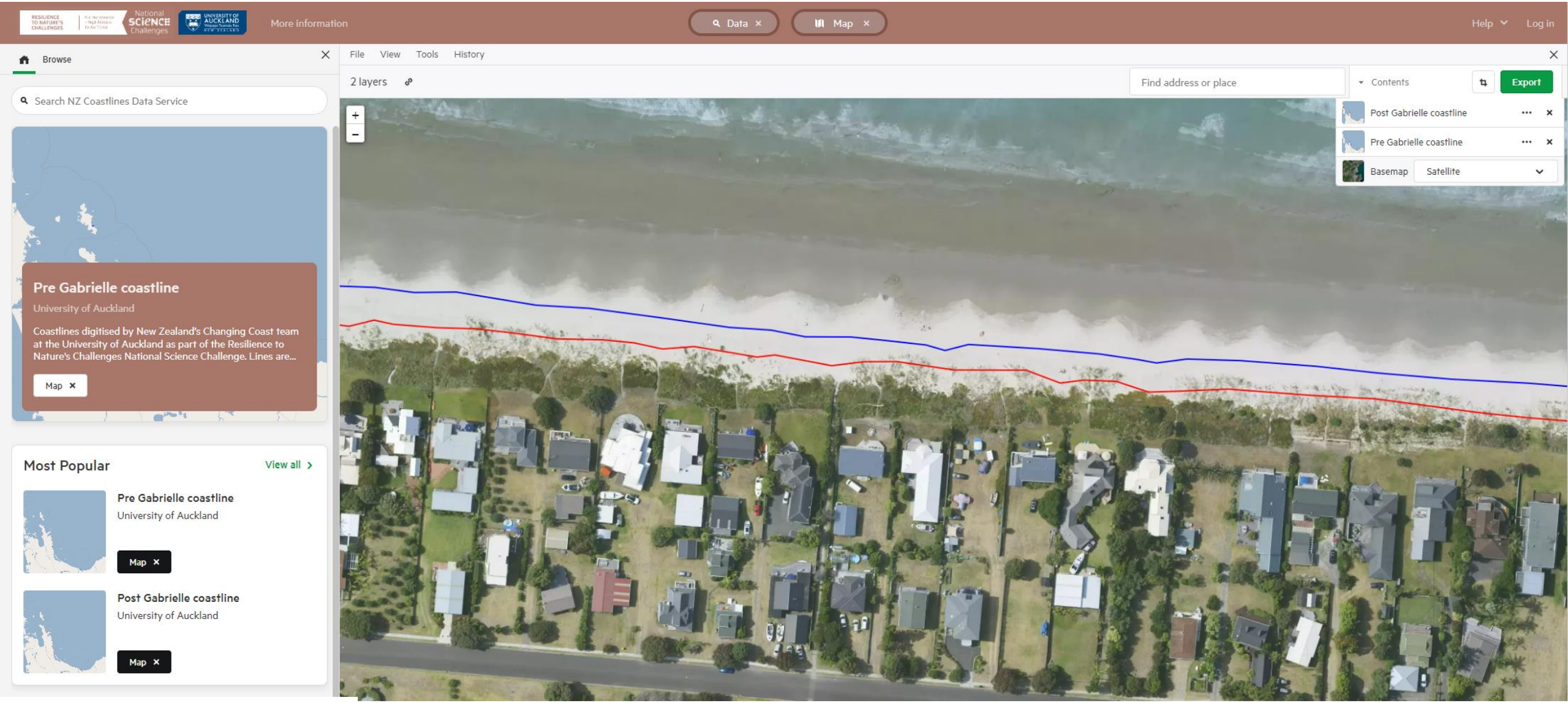
**Rapid accretion 1955-2005 (~0.5m/yr), but little accretion since this time**

**Stable (seawall)**

**Accelerated erosion from ~1990 (erosion rate ~1m/yr)**

coastalchange.nz

data.coastalchange.nz

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# Multi-hazard risk from physics-based earthquake simulators

**Bill Fry (Co-Lead Andy Nicol) and Earthquake & Tsunami Programme Team**

Wednesday 14 May, 2024

Te Papa

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

EQC Earthquake Commission Kōmihana Rūwhenua

NIWA Taihoro Nukurangi

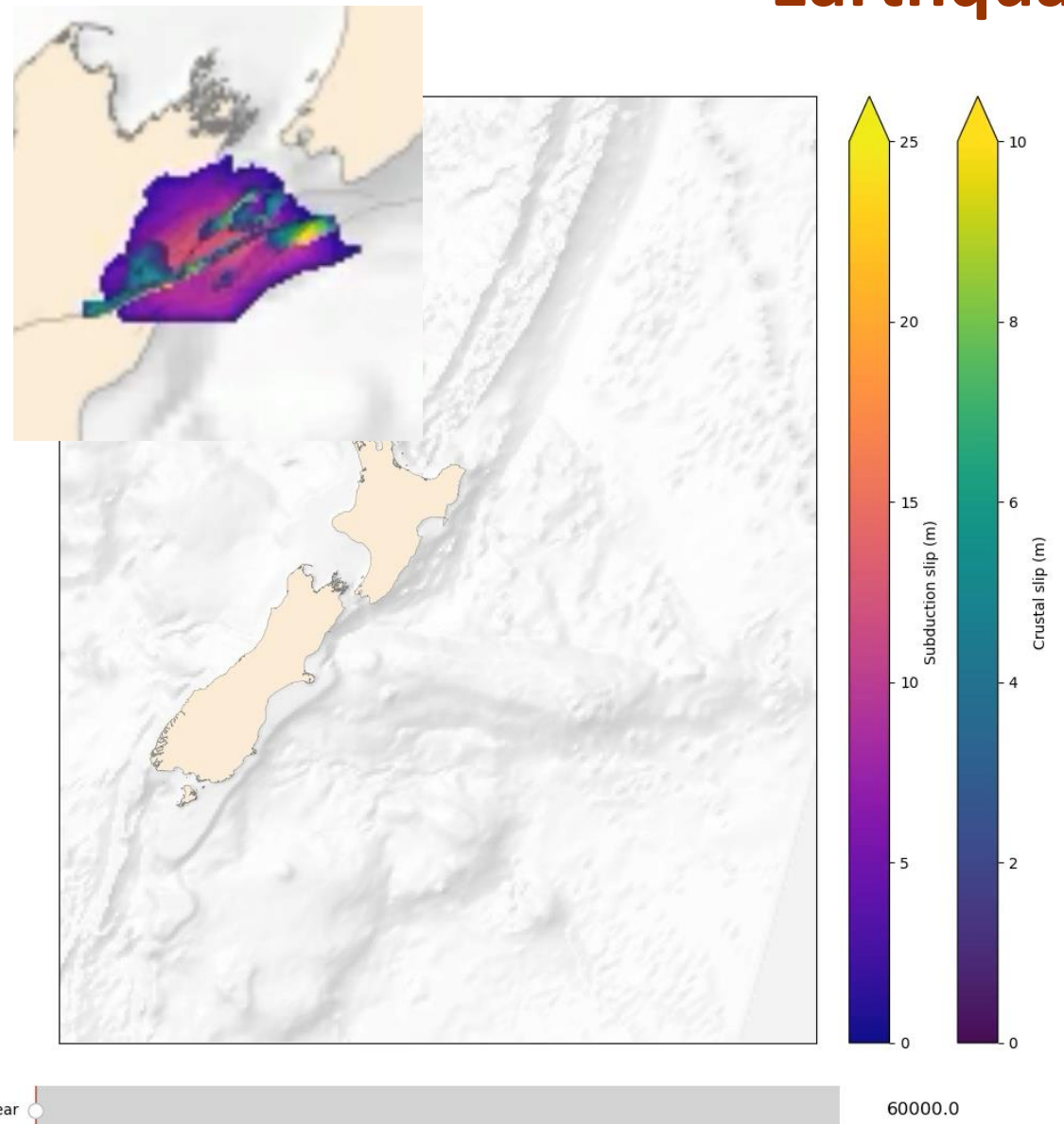
Lamont-Doherty Earth Observatory Columbia University | Earth Institute

University of Otago Te Whare Wānanga o Otāgo New Zealand

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

GNS Science Te Pū Ao

# Earthquake simulators




**Yield complex multi-fault events → interaction between faults more realistic than stochastic models**

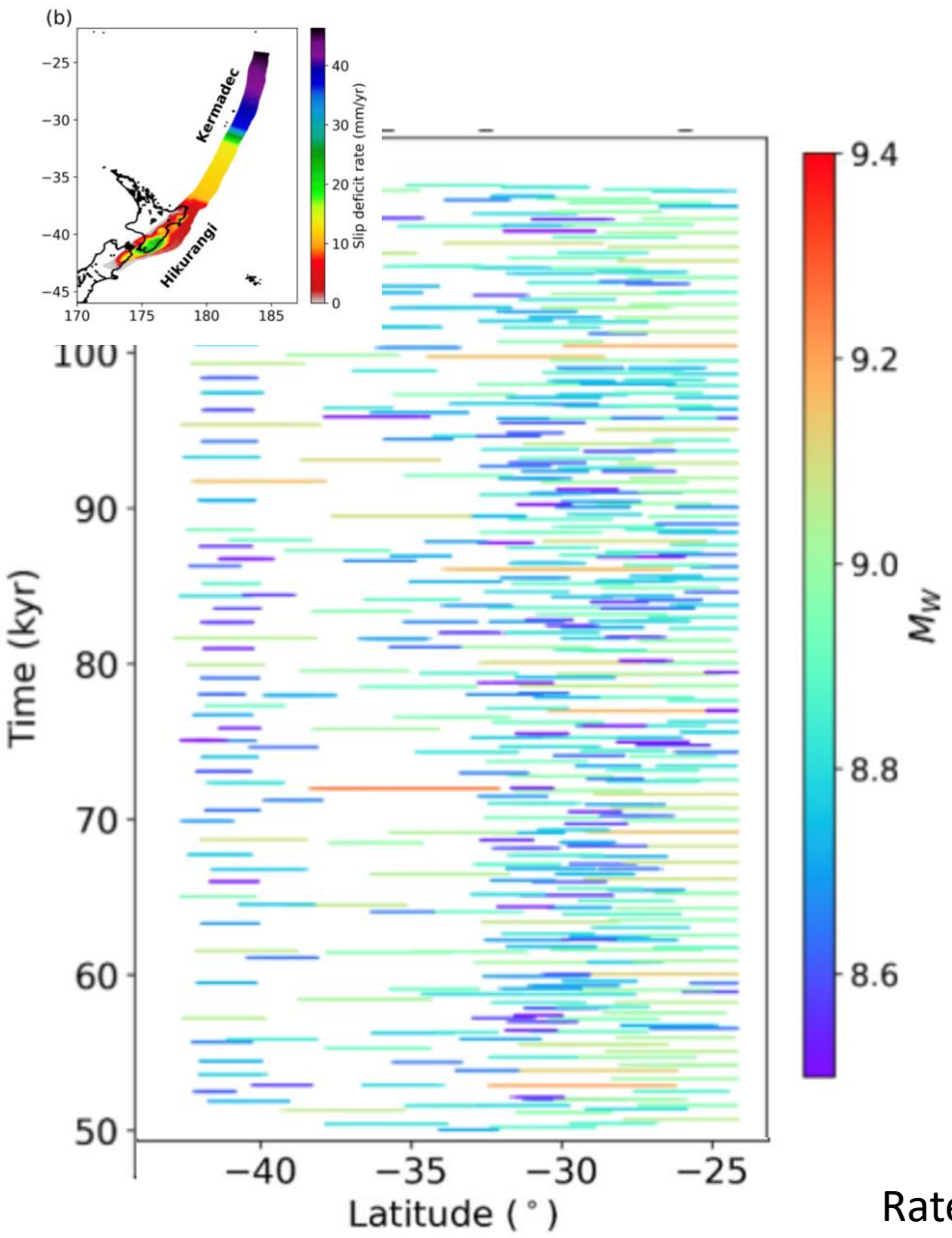
**Finite fault models possibility of including rupture directivity → possibility for more realistic ground motion than stochastic models**

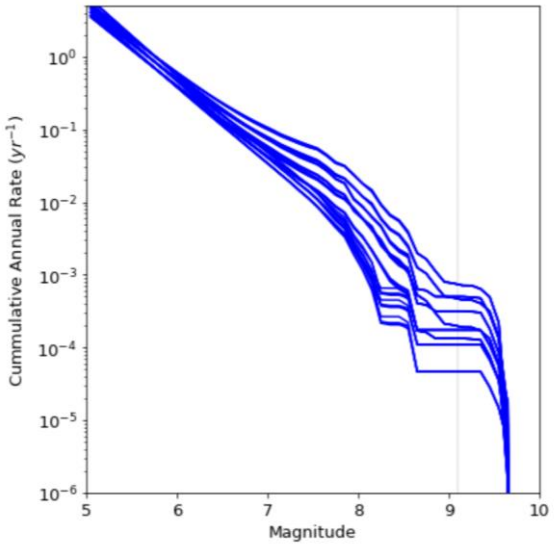
**Pathway for non-stationarity of seismicity → clustering and time-dependent hazard**

# Mmax and MCE
# Horses for Courses

Requires a conversation between endusers and originators

Ground motion in NZ -> M9.2-M9.1?
Regional tsunami in NZ M9.4?

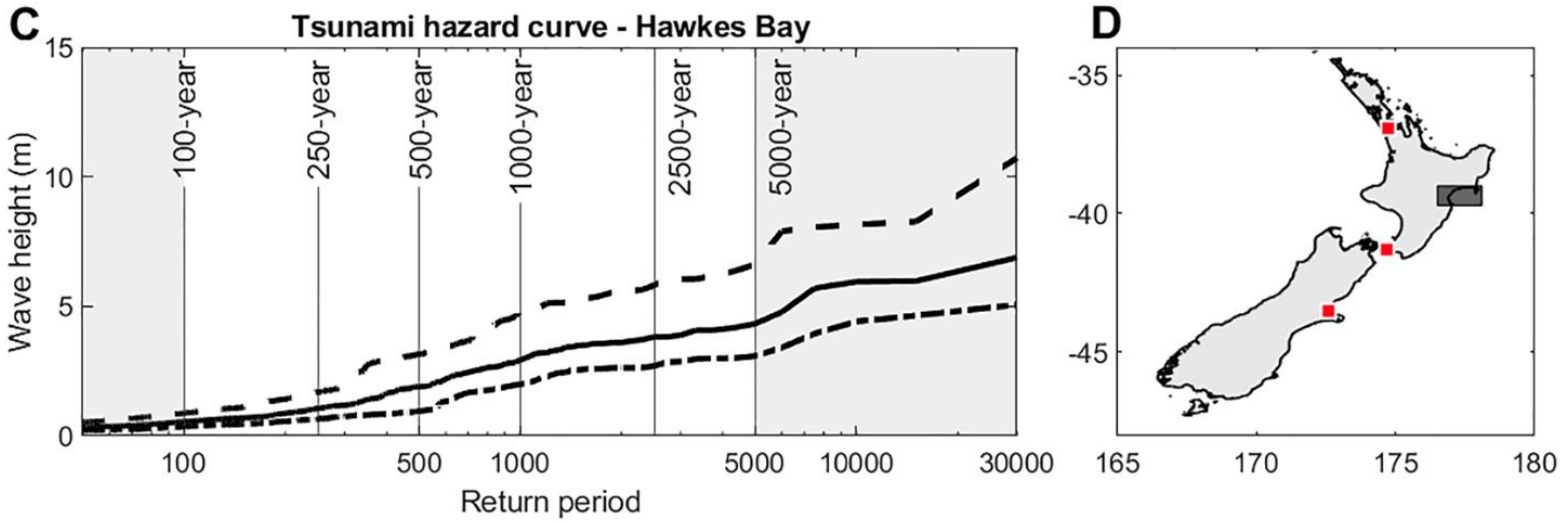


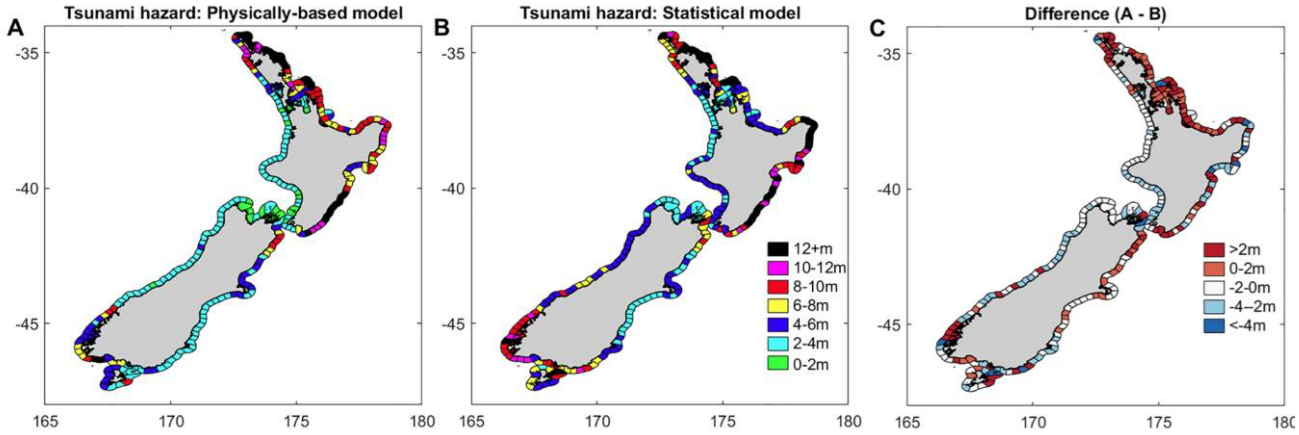

Rates from NSHM for NI (M9.1 shown in grey line)

Liao et al., 2024

# Tsunami Hazard




2500 year return hazard from local sources




Hughes et al., 2023

# Multi-hazard advice framework

| | 1 - Alpine Fault and Wairau | 2 - Full Hikurangi and upper crustal faults | 3 - Southern Hikurangi and Wellington Region faults (A) | 4 - Southern Hikurangi and Wellington Region faults (B) | 5 - Southern Hikurangi | 6 - Western offshore faults (Mascarin) | 7 - Fisherman's Fault | 8 - Northern Ohariu Fault | 9 - Northern Wairarapa Fault | 10 - Aotea-Evan's Bay Fault |
|---|---|---|---|---|---|---|---|---|---|---|
| | 7.7 Mw | 9.1 Mw | 8.5 Mw | 8.4 Mw | 8.9 Mw | 7.2 Mw | 7.2 Mw | 6.9 Mw | 7.1 Mw | 6.5 Mw |
| Expected ground shaking (MMI) | MMI 7 | MMI 9 | MMI 9 | MMI 9 | MMI 9 | MMI 5 | MMI 7 | MMI 5 | MMI 6 | MMI 9 |
| Density of EIL | 3 - high | 4 - very high | 4 - very high | 4 - very high | 4 - very high | 3 - high | 3 - high | 3 - high | 3 - high | 4 - very high |
| Likelihood of severe shaking | likely | highly likely | highly likely | highly likely | highly likely | unlikely | likely | unlikely | unlikely | highly likely |
| Likelihood of exceeding very high landslide density | highly likely | highly likely | highly likely | highly likely | highly likely | likely | highly likely | likely | likely | likely |
| Likelihood of inundation | highly unlikely | highly likely | unlikely | unlikely | highly likely (-) | highly unlikely | highly unlikely | highly unlikely | highly unlikely | highly unlikely |

# Multi-hazard modelling framework

**Merging multi-peril, including geo-perils, extreme weather, climate change….**
**And impacts and risks from those perils….**
**Will, in the future (this decade), happen in an integrated system in which physics-informed simulations are queried through AI algorithms.**

**Synthetic seismicity presents the leading strategy to facilitate the incorporation of earthquakes and tsunamis into these models.**

**Thank you for your kind attention.**

**b.fry@gns.cri.nz**

# Modelling volcano multi- and cascading hazards

Stuart Mead, RNC Volcanoes team,
RNC Multihazard risk team

RNC Symposium 2024

# Volcanic perspective of multihazards

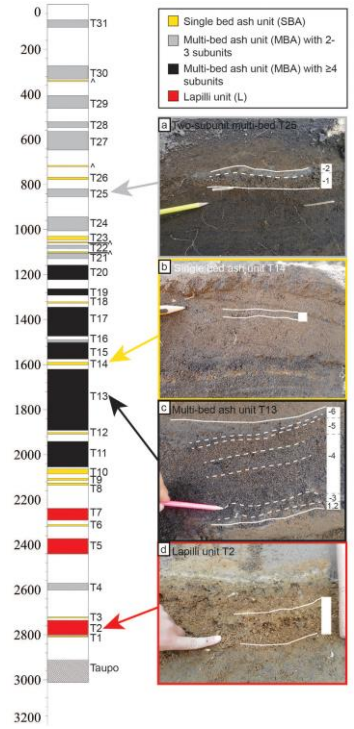
Left: Ruapehu 1995 (GNS)

Right: Chaitén Town (USGS)

Impact is time-varying, across a massive input space:

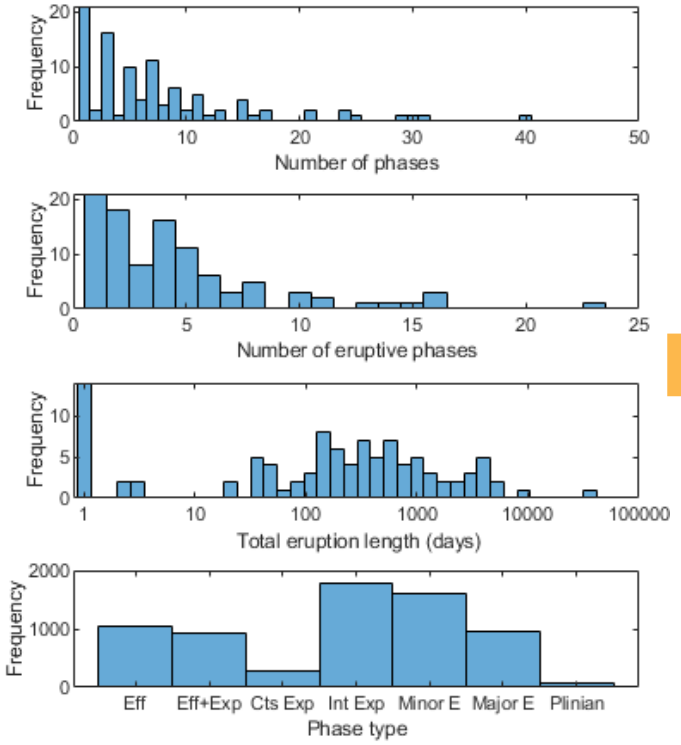
$$\int \Big[ \text{P(eruption)} \rightarrow \text{P(Size)} \rightarrow \text{P(style)} \rightarrow \text{P(duration)} \rightarrow \begin{matrix} \text{P(Lahar)} \rightarrow \text{P(lahar inputs)} \\ \text{P(PDC)} \rightarrow \text{P(PDC inputs)} \\ \text{P(Ash)} \rightarrow \text{P(Ash inputs)} \end{matrix} \rightarrow \text{P(intensity)} \Big] \, dt$$

# Āhea riri ai ngā maunga puia? When will our volcanoes become angry?



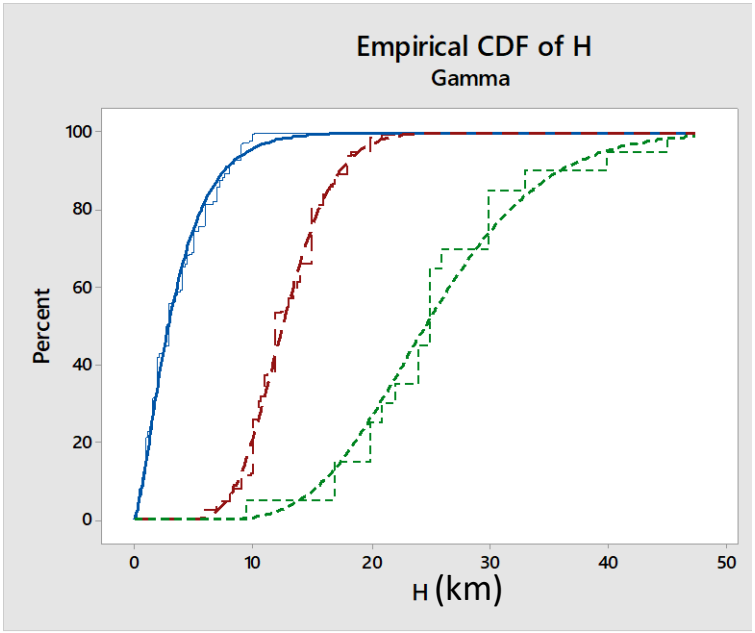

**Data**

## Forecast eruption timelines




**Statistics**

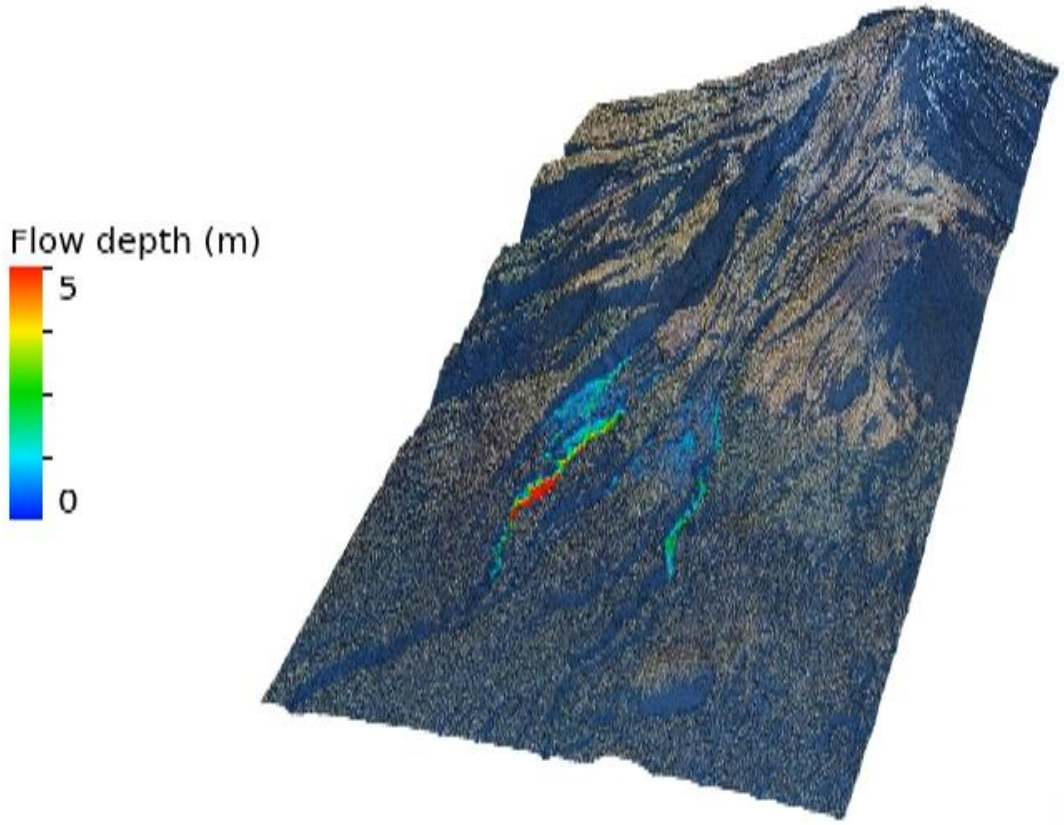
## Define resulting hazard inputs




# Providing continuous estimates of phenomena…

# Simulate hazards

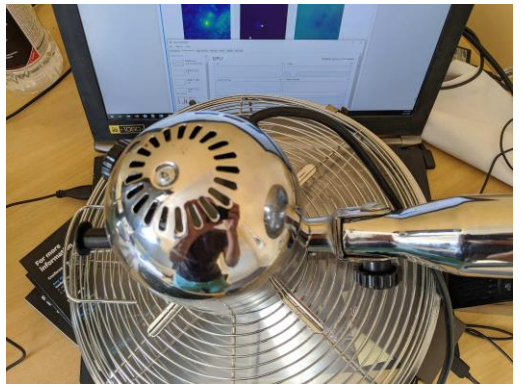
Define the spatial distribution of intensity



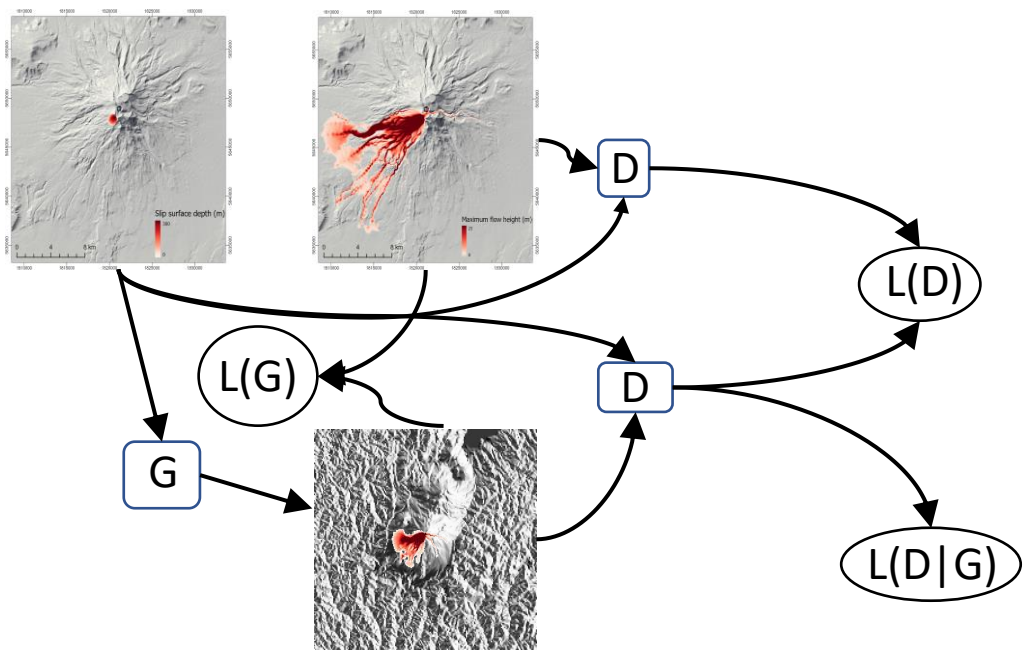

…but simulations are discrete!

# Simulating across the input space

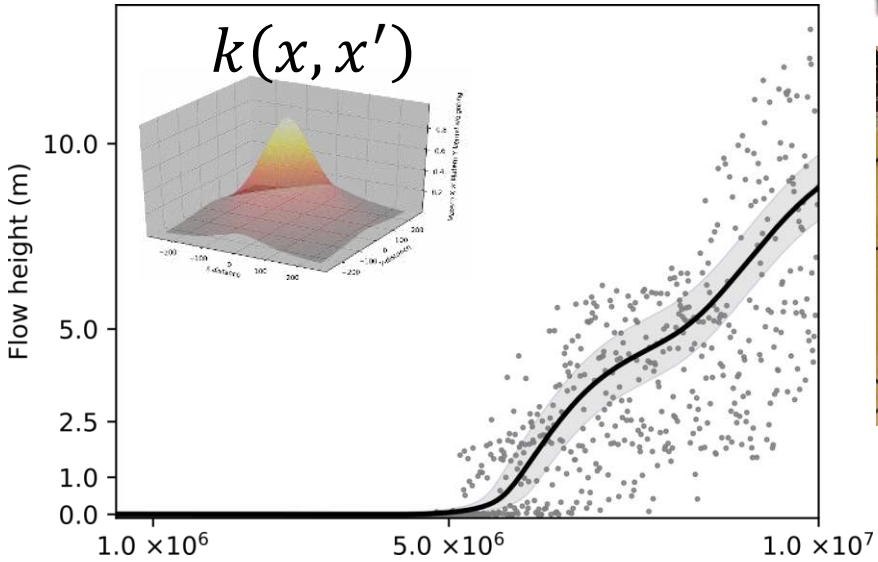
Define the *functional* distribution of intensity using surrogates



## Adversarial Networks (*Deepfakes*)



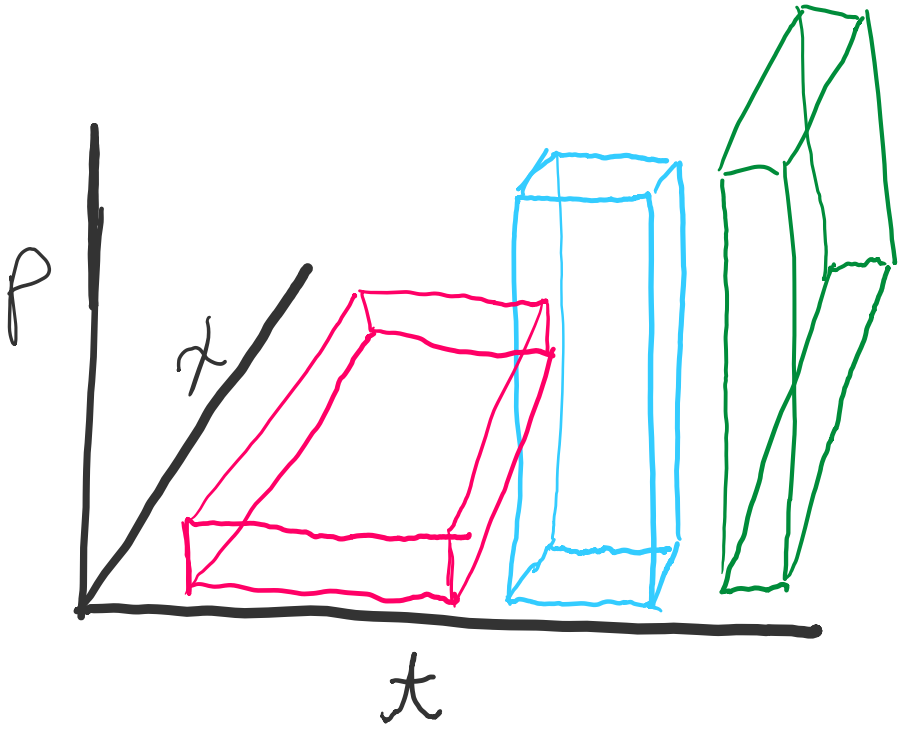

## Gaussian Processes

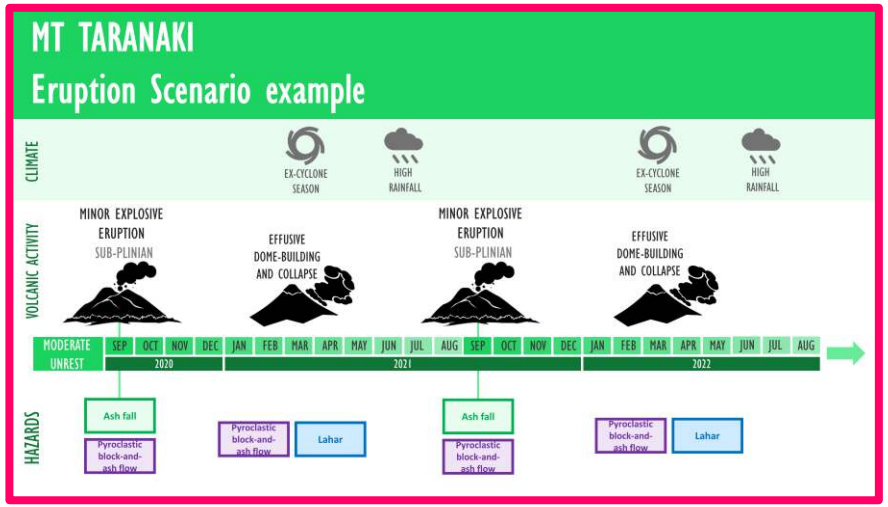


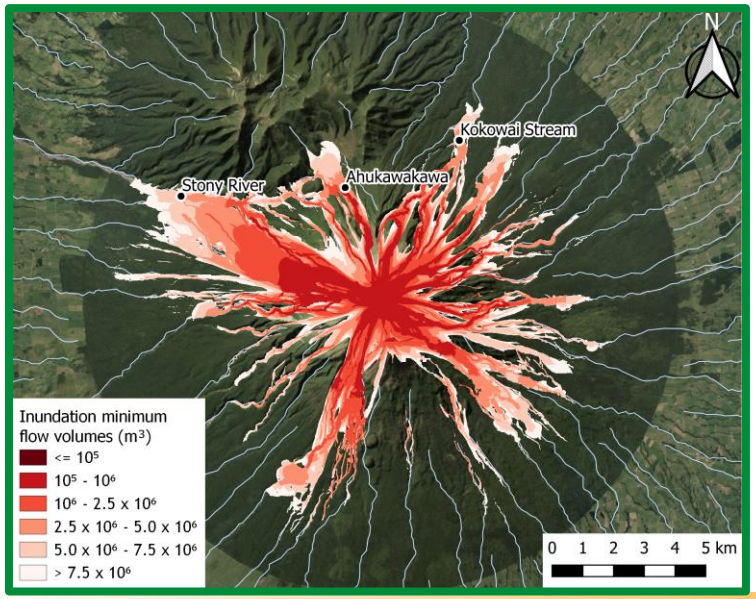

## $10^5$ faster simulations, full input spaces!

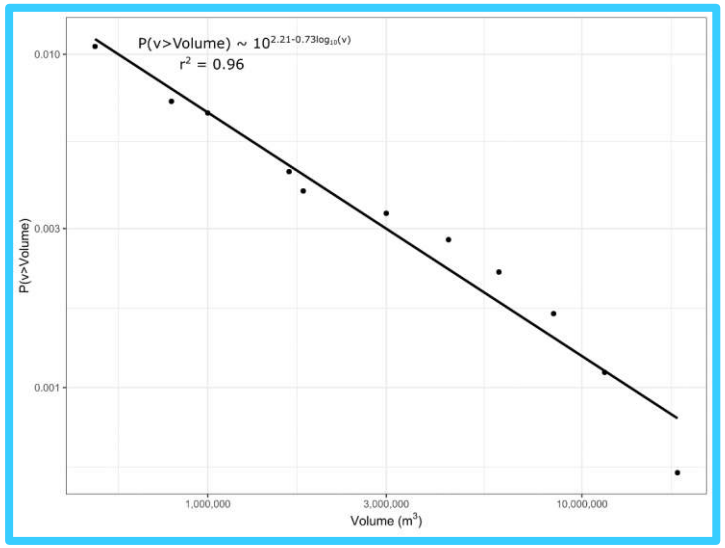
# Delivery to stakeholders

Scenarios, hazard maps are a subset of the space

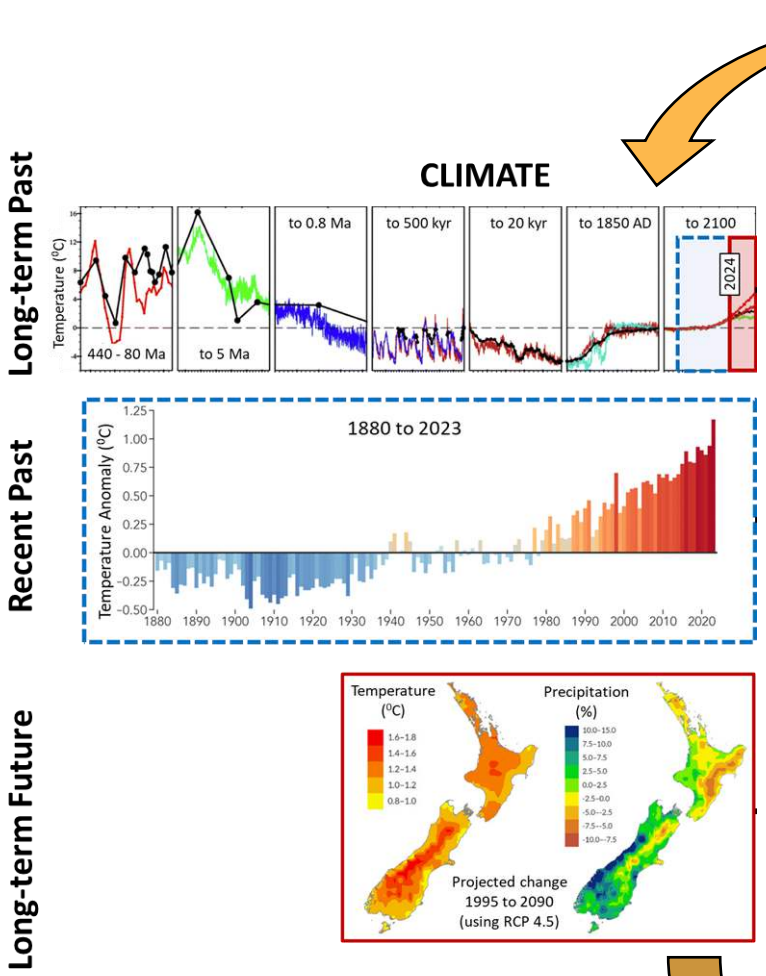


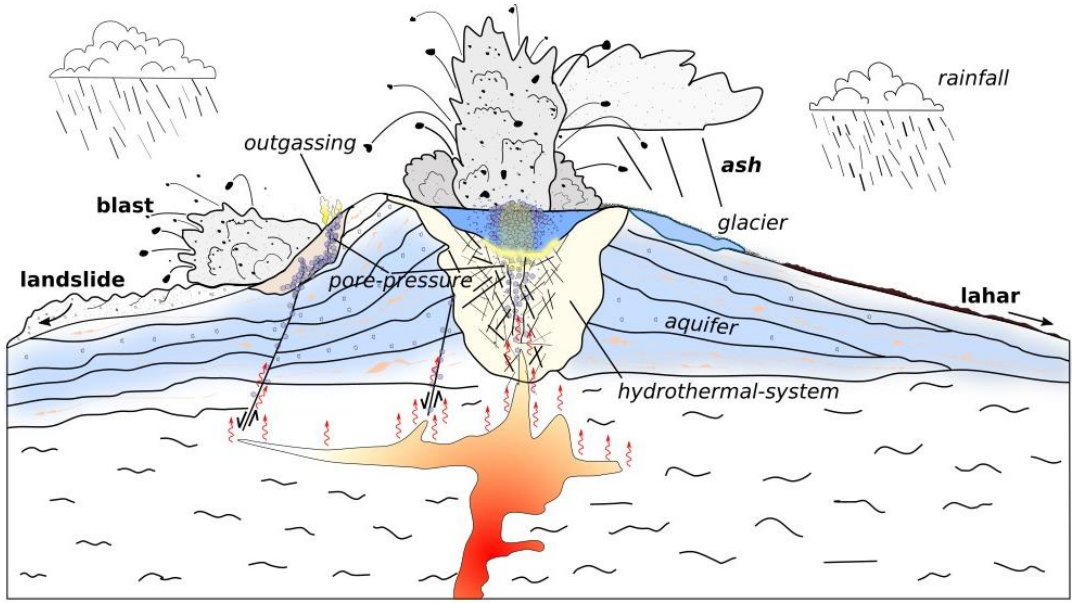



# The future: Feedbacks in the climate



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# Weather-related hazards and impacts:

# Multi-Hazard Risk Assessment

## High resolution modelling of high-impact weather scenarios, and Auckland ex-tropical cyclone case study.

Richard Turner (NIWA)

14 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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NIWA Taihoro Nukurangi

# What are the new advances in understanding and modelling individual, cascading and coincident hazards, & how are they being applied to improve hazard risk management?

- How do other resilience approaches sit alongside risk?
- How do intensive single peril approaches integrate as multi-hazard?
- How can we rapidly get ahead of supporting a surge in building and infrastructure constructure? In many large cases these are being 'fast-tracked'…
- How can all of this be applied to adaptation and retreat decision support for climate change (e.g. with MfE and local government) across hazards?

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# Major Ex-tropical Cyclone

## Dataset development: 35 (36) scenarios from 5 (6) historic storms.

- Most Scenarios 1.5 km, but several at 330 m, and some downscaling to ~few metres (CFD or wind-tunnel); Some scenarios with warmer (+2 C) seas for future climate indications.
- 330 m simulations and CFD/wind tunnel shown to add significant additional detail at the city scale. (e.g., Harbour bridge flow)
- New Zealand land mass itself has little influence on the storm track for ex-tropical cyclones. Encounters with land do weaken storm, but re-intensification possible when storm track goes over the sea again, e.g. Cook and Taranaki.
- Need many more scenarios – more storms, more shifts, more on climate change impacts om TC to ex-TC transition, complementary with renanalyses (ERA-5, Barra, NZRA)

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# High Winds and Ex-tropical Cyclone

Muizz Shah – PhD (in progress) - building scale CFD simulations (interfaced with RiskScape to apply fragility functions and get detailed impacts) plus wind tunnel experiments over Auckland CBD.

Amir Pirooz and Stuart Moore completed simulations over high-wind event over Auckland Harbour Bridge.

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

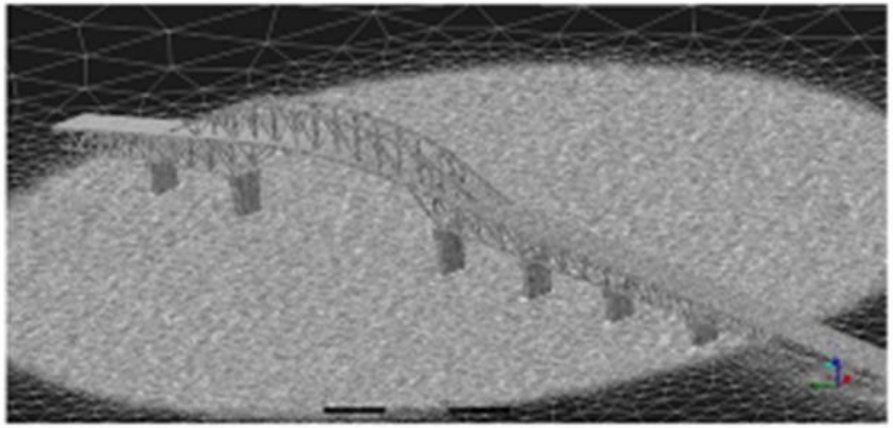
Open Access

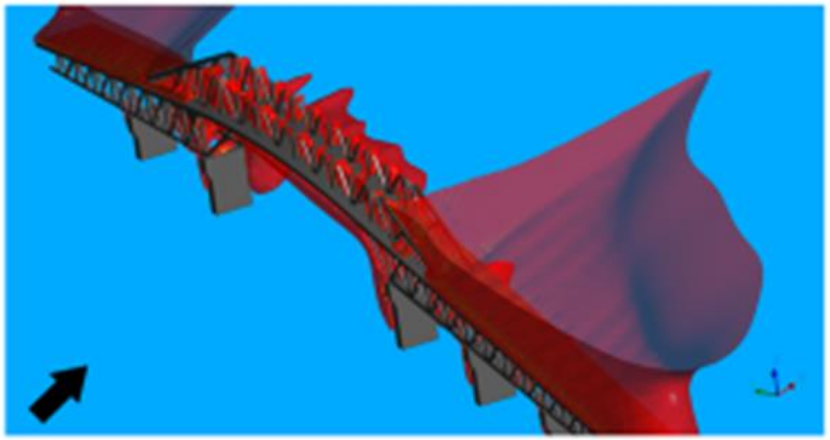
**Coupling High-Resolution Numerical Weather Prediction and Computational Fluid Dynamics: Auckland Harbour Case Study**

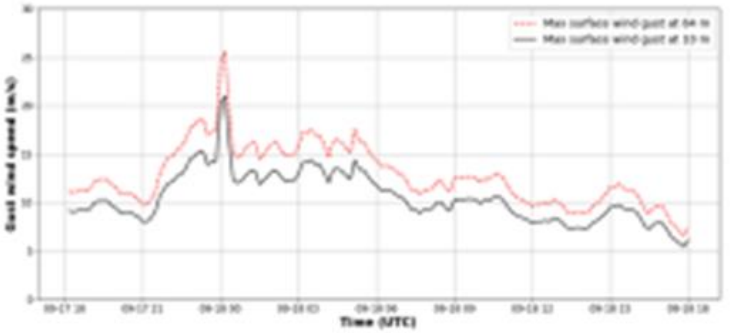
by Amir Ali Safaei Pirooz [1,*], Stuart Moore [1], Richard Turner [1] and Richard G. J. Flay [2]

[1] Meteorology and Remote Sensing, NIWA, Wellington 6021, New Zealand
[2] Department of Mechanical Engineering, University of Auckland, Auckland 1023, New Zealand
* Author to whom correspondence should be addressed.

Academic Editor: Philip A. Rubini







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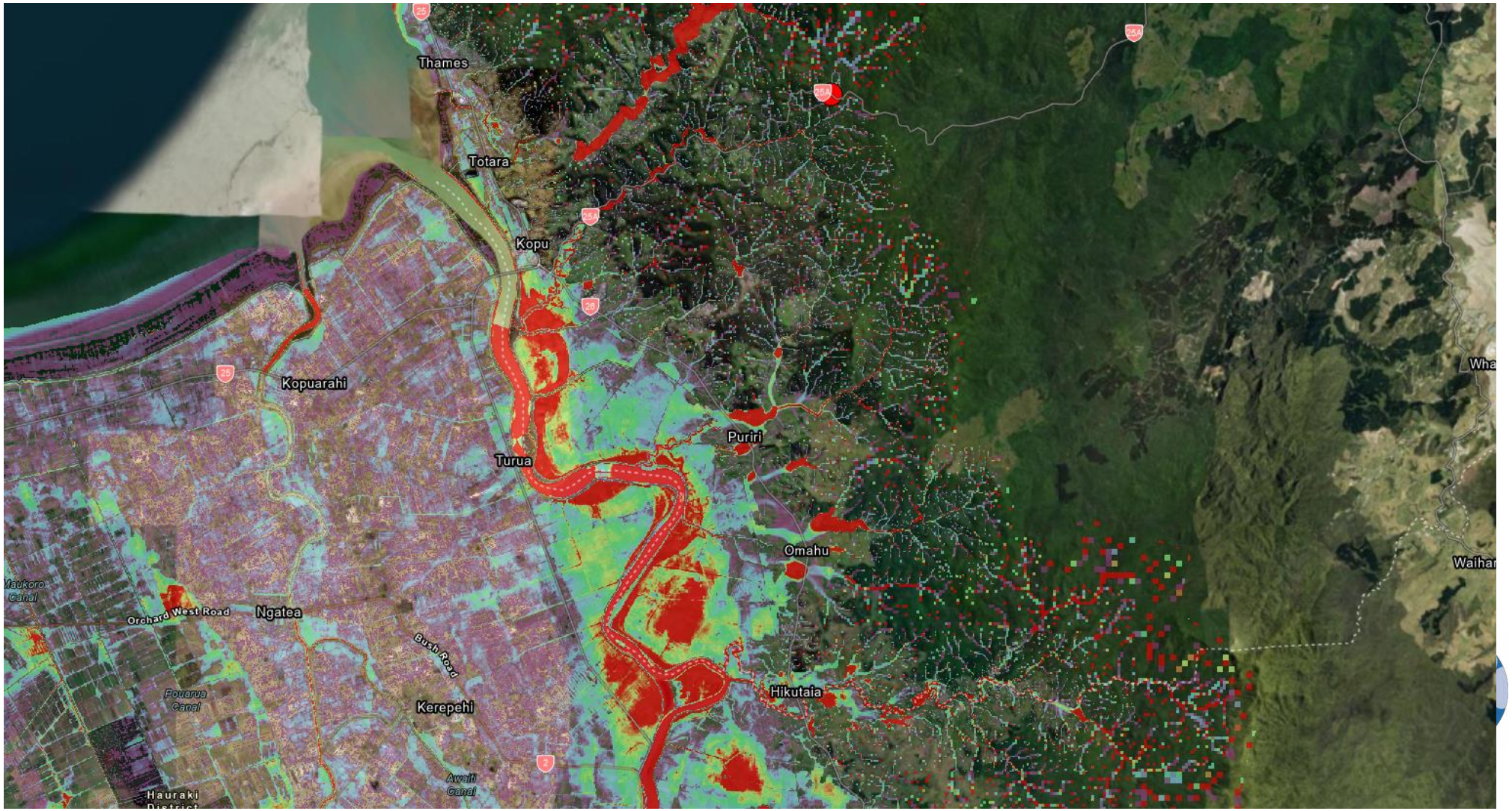
# BG Flood inundation – Cyprien Bosserelle (Pam shifted SW)



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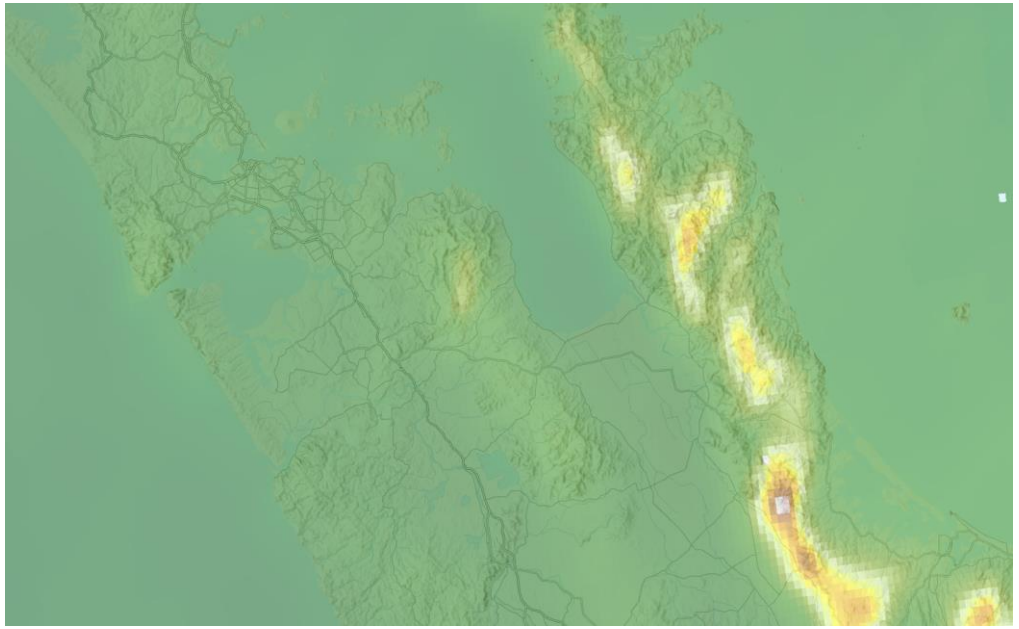
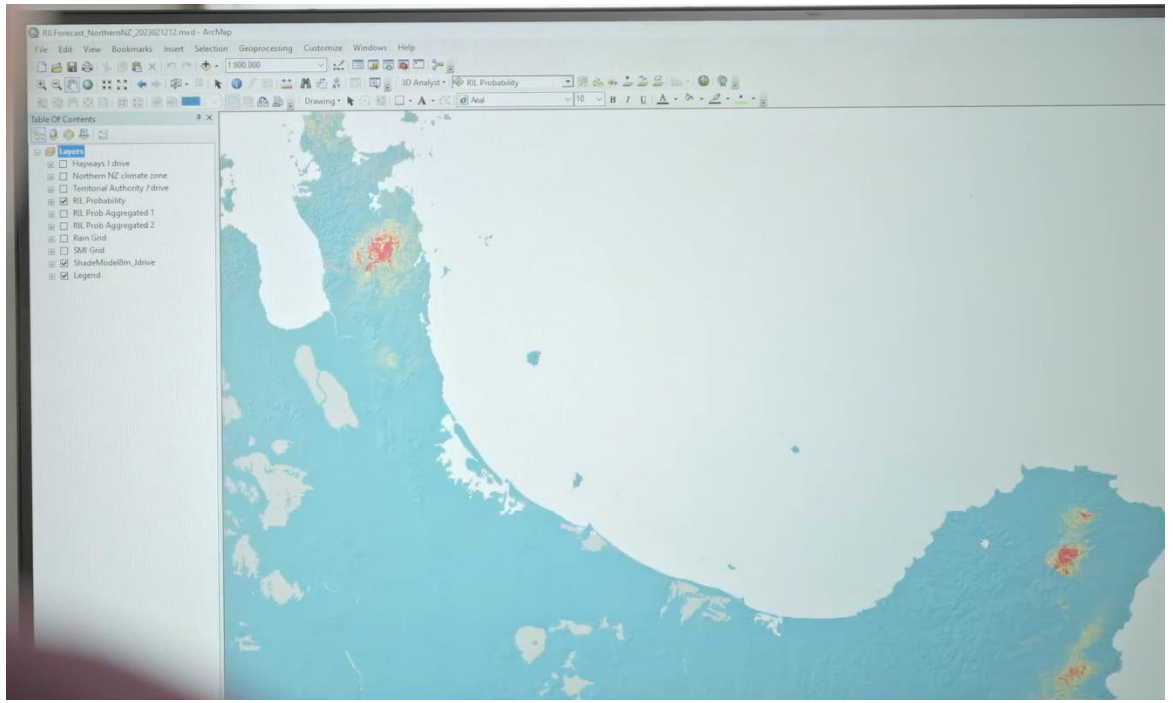
# Extreme Ex-tropical Cyclone

Landslide modelling – 24 hour rolling precip (from all scenarios) accumulations provided to landslide experts at GNS (Andrea Wolter) from the selection of storms





GNS SCIENCE TE PŪ AO

National SCIENCE Challenges

RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa – Ngā Ākina o Te Ao Tūroa

NIWA Taihoro Nukurangi

# Storm surge modelling – Zhonghou Xu - NIWA

National SCIENCE Challenges

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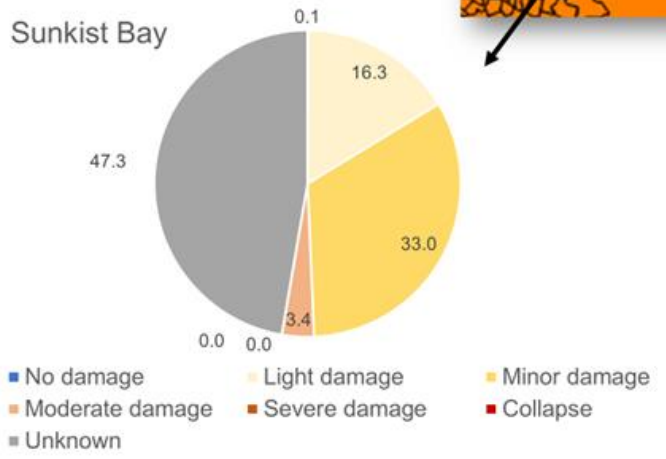
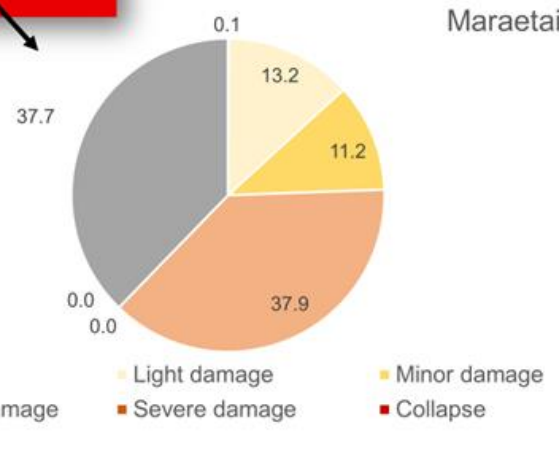
NIWA Taihoro Nukurangi

# What are the new advances in understanding and modelling individual, cascading and coincident hazards, & how are they being applied to improve hazard risk management?

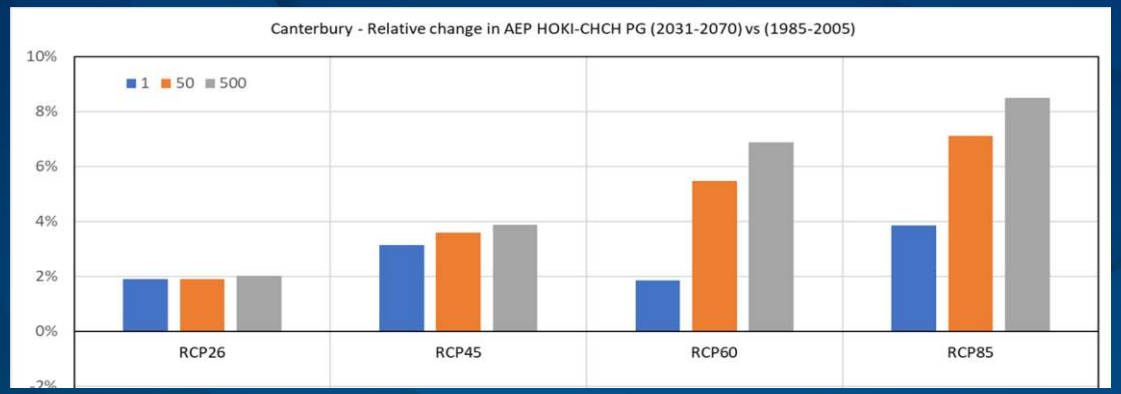
*RNC PhD researcher Muizz Shah – wind movement through buildings. Photo: Stuff*

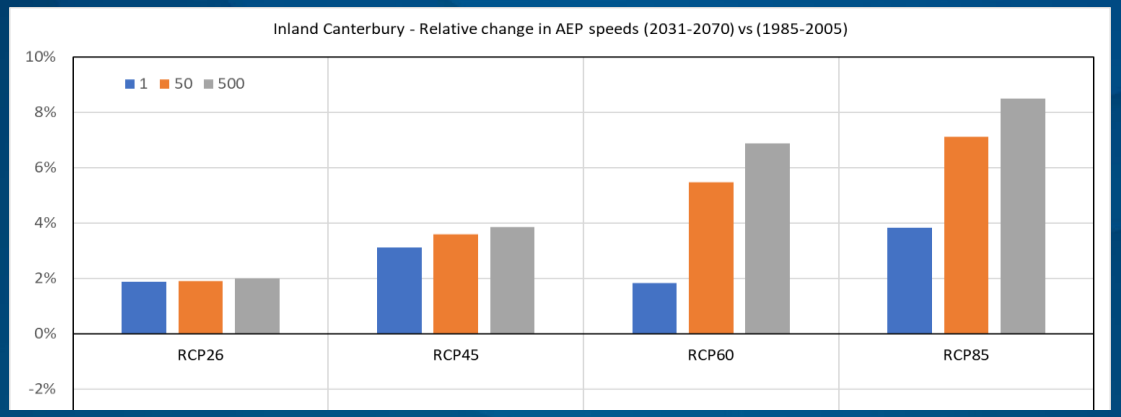
*Wind damage on the West Coast. Photo: Opus, Build Magazine*

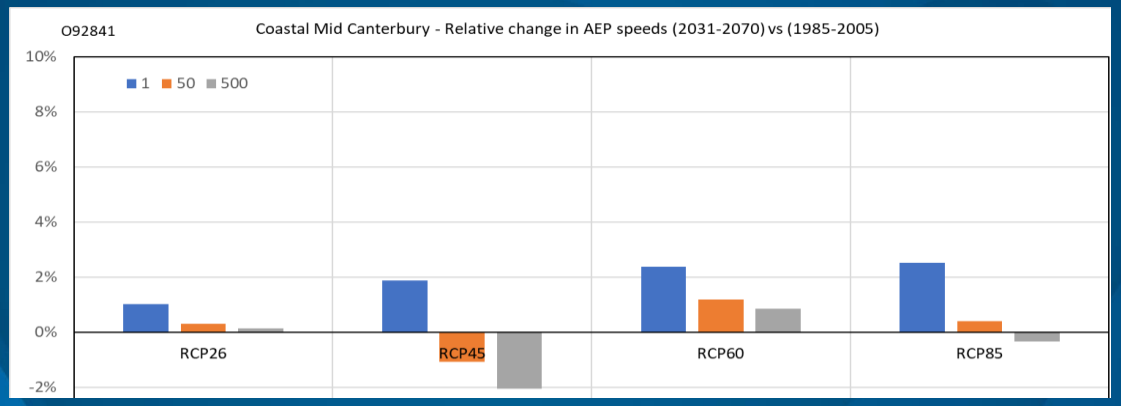


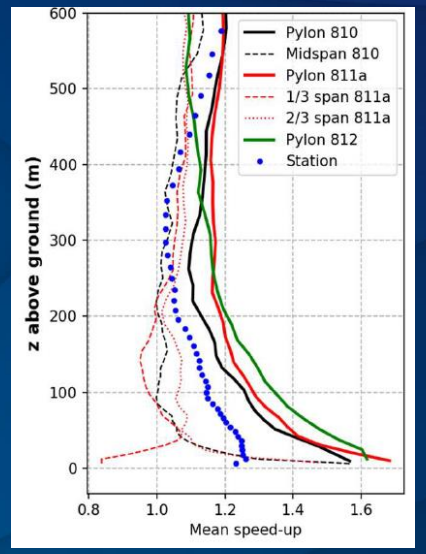
# Climate Change

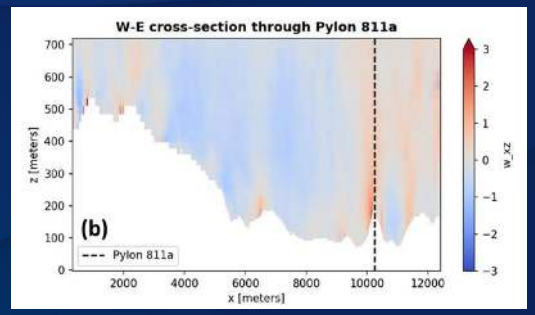



## CFD




UNIVERSITY OF AUCKLAND
Waipapa Taumata Rau
NEW ZEALAND

TRANSPOWER

wsp

NIWA
Taihoro Nukurangi

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**To do:**

**Continue to analyse data collected and make use of datasets already created.**

**More & finer downscaling climate change CMIP6 and impacts especially**

**With respect to shifts in storm tracks and TC to ex-TC transition and to extend hi-res climatology backwards through integration with reanalysis datasets (ERA-5, Barra, NZRA).**

**So far, even the many different weather hazard impacts have been modelled in RiskScape as intensive single-perils. These need to be aggregated sensibly in determining total losses etc.**

RISKSCAPE®

# Risk modelling to inform land-use and emergency resource planning

Christina Magill

Te Tai Whanake 14 May 2024

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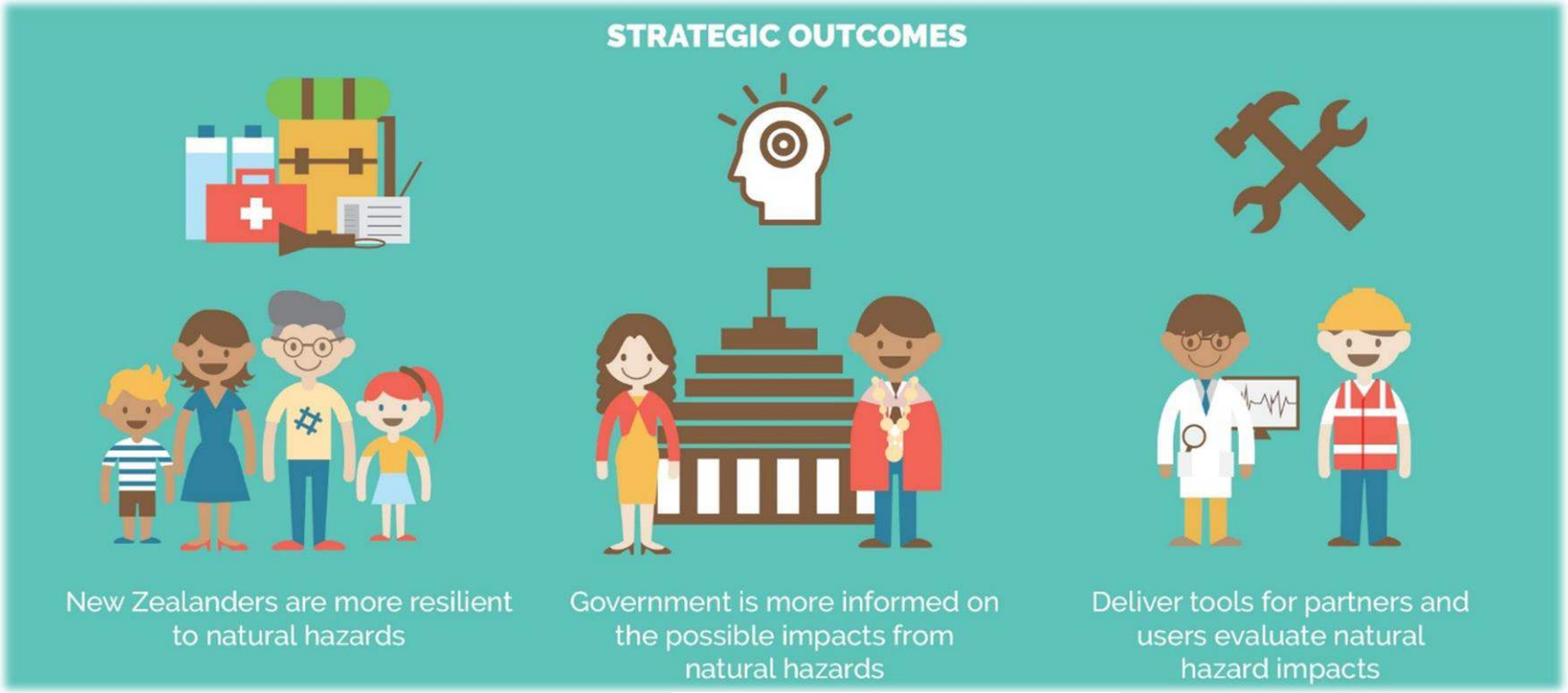
# Who we are

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catalyst expert open source solutions

Toka Tū Ake EQC

# The RiskScape Journey

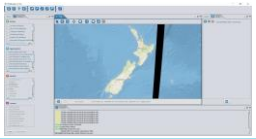
**2004**

Research Programme Launched

RiskScape

**2006**

RiskScape Software Launched



**2017**

External Software Review

catalyst

**2018**

New RiskScape Engine Build Commences

**2019**

National End-user Workshops

**2022**

RiskScape Open-source Release


**2022**

RiskScape Platform & Graphical User Interface

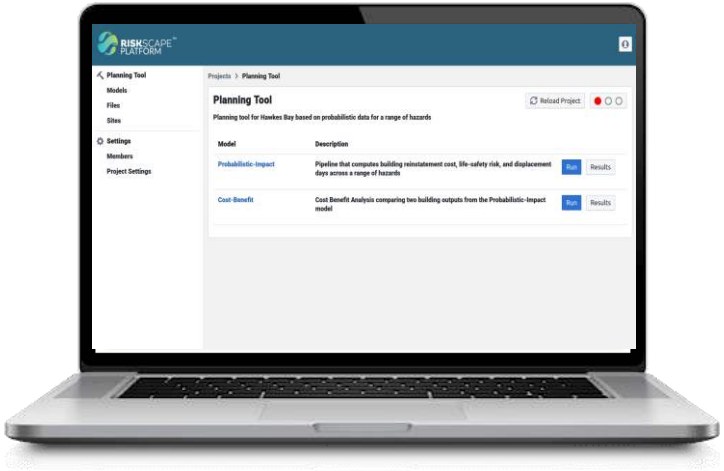
**2023**

RiskScape Platform released

RISKSCAPE®

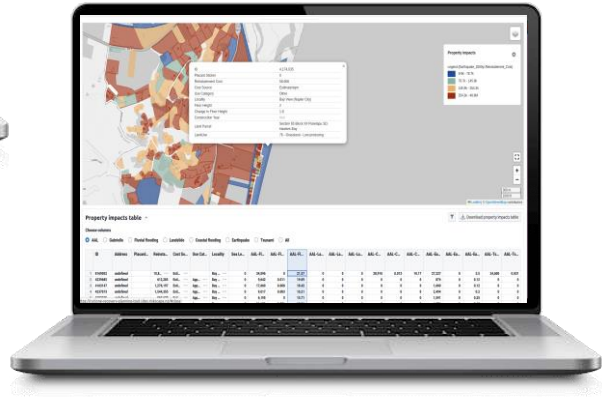
RISKSCAPE ECOSYSTEM

## Platform

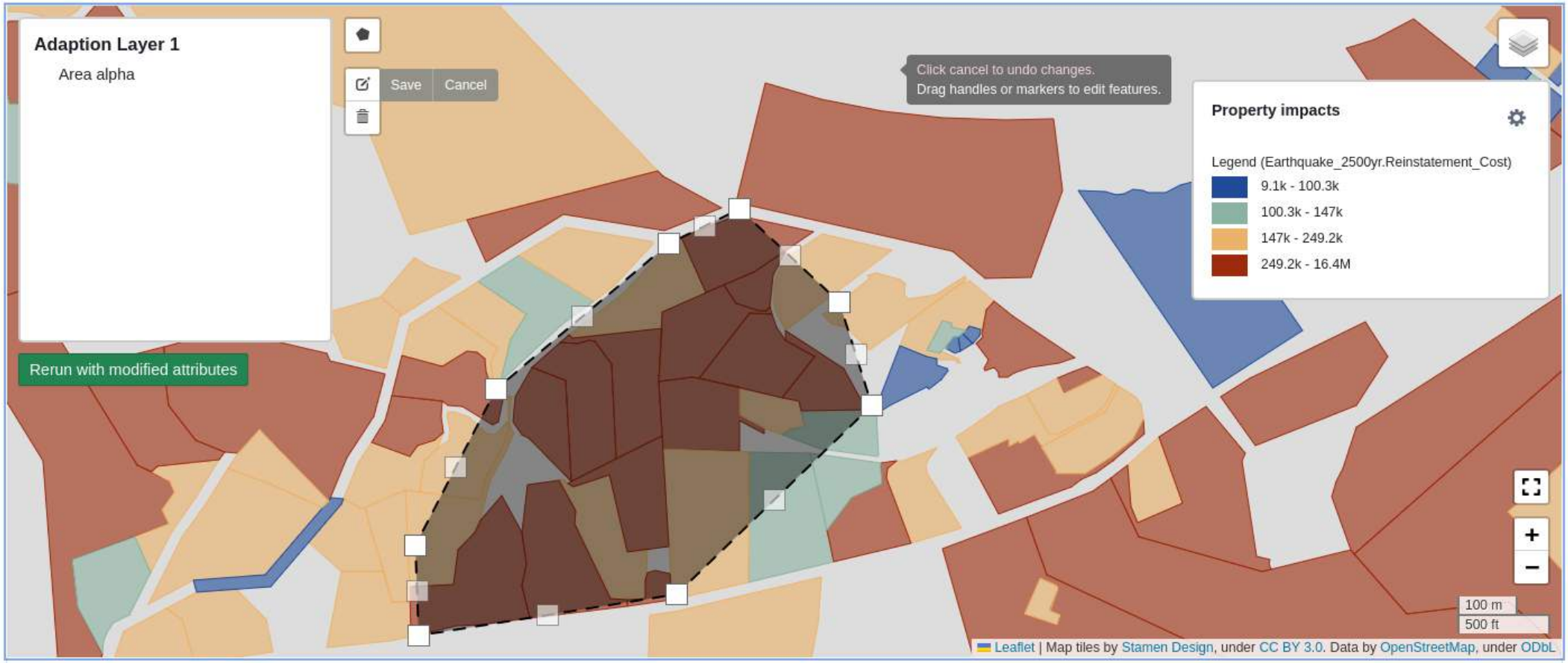



## Engine

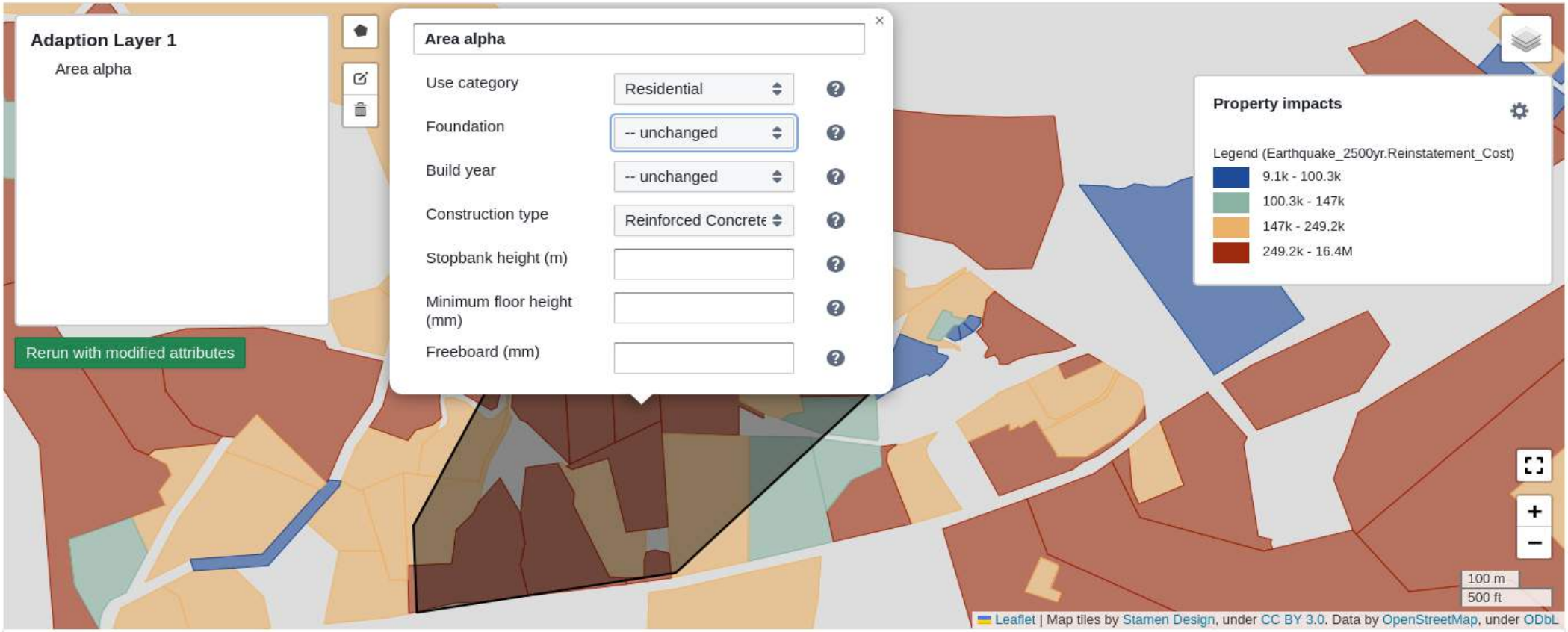
## Microsite



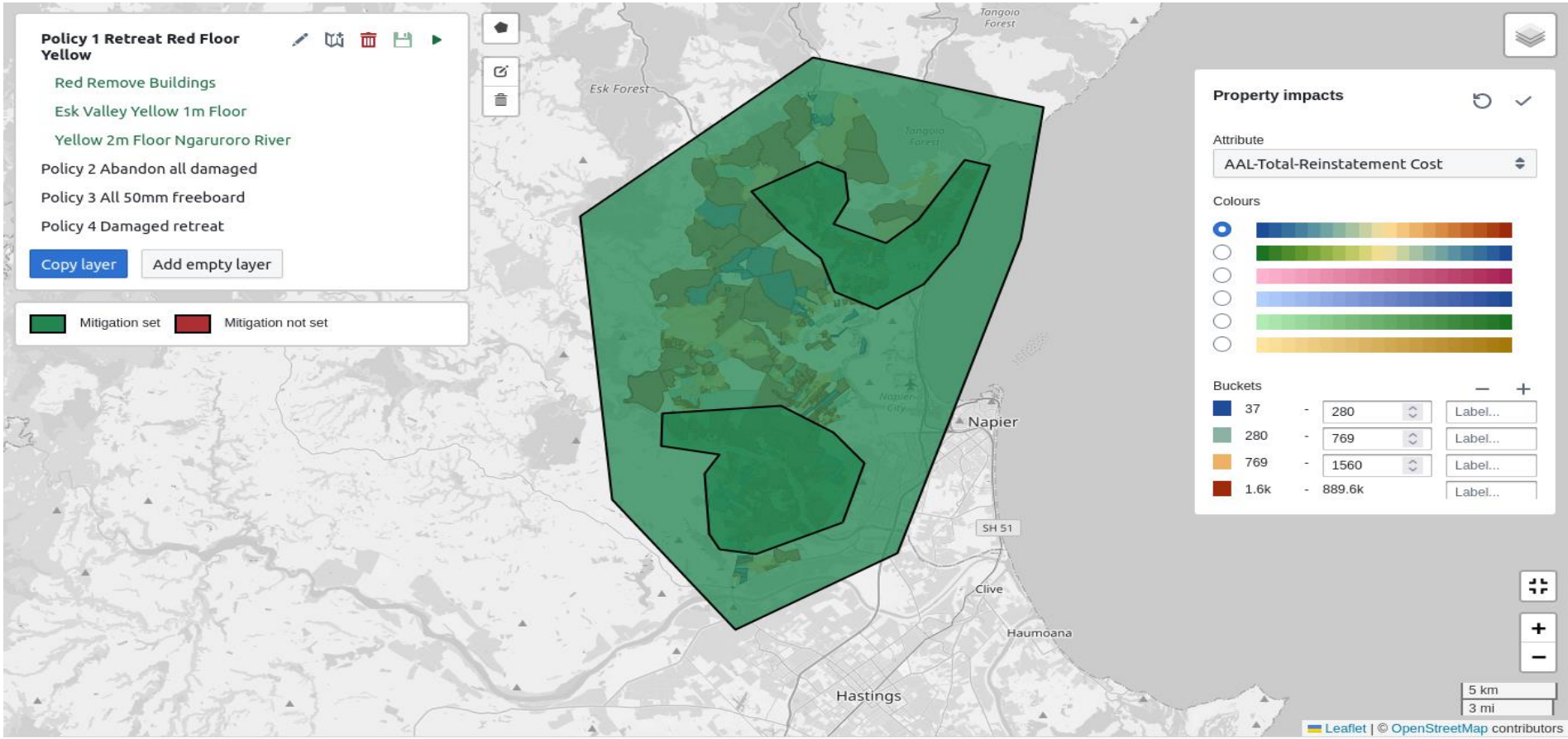
# Cyclone Gabrielle recovery – Select an adaptation layer



# Define a policy option for adaptation layer



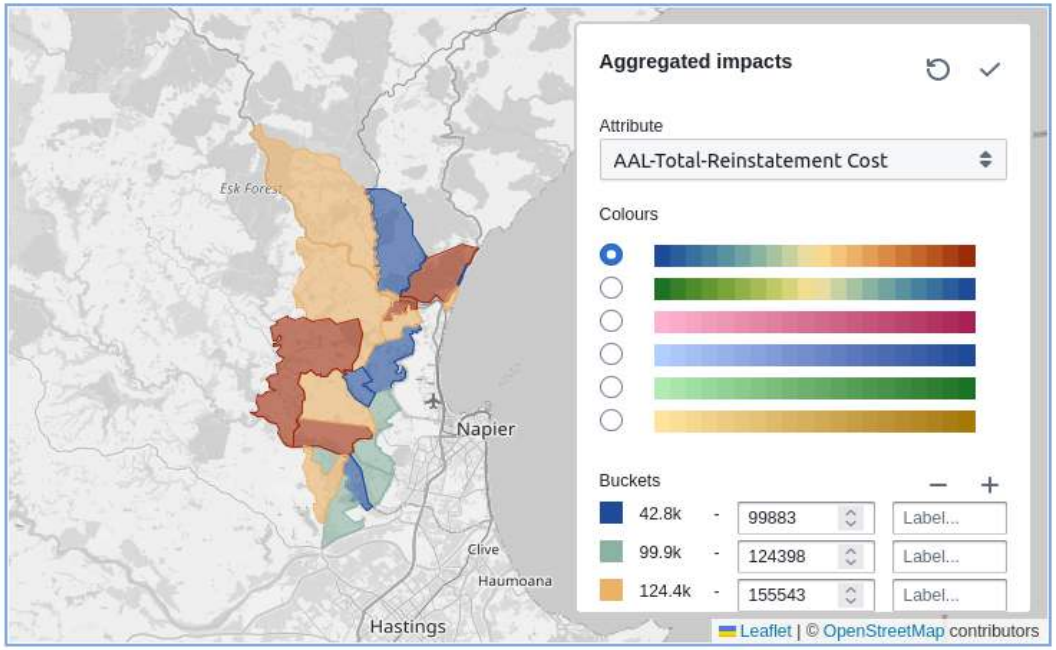
# Multiple adaptation layers as policy options



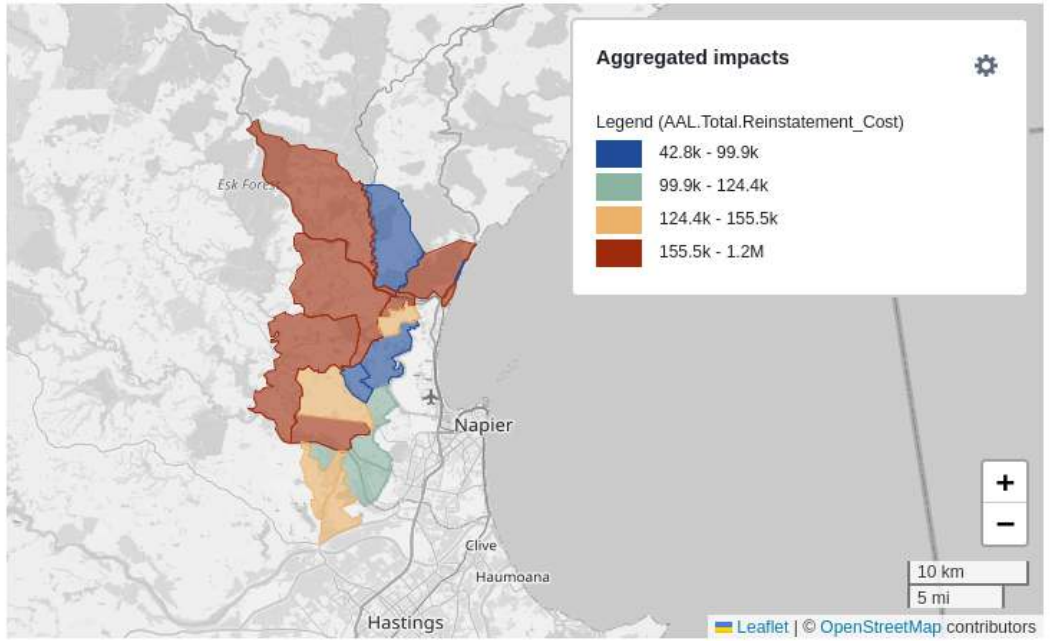
# Compare policy scenarios within microsite

**Map view comparison**

**Policy 3**




**Do Nothing**



# Orewa land-use planning – temporal changes in exposure (land parcels intensified per year)

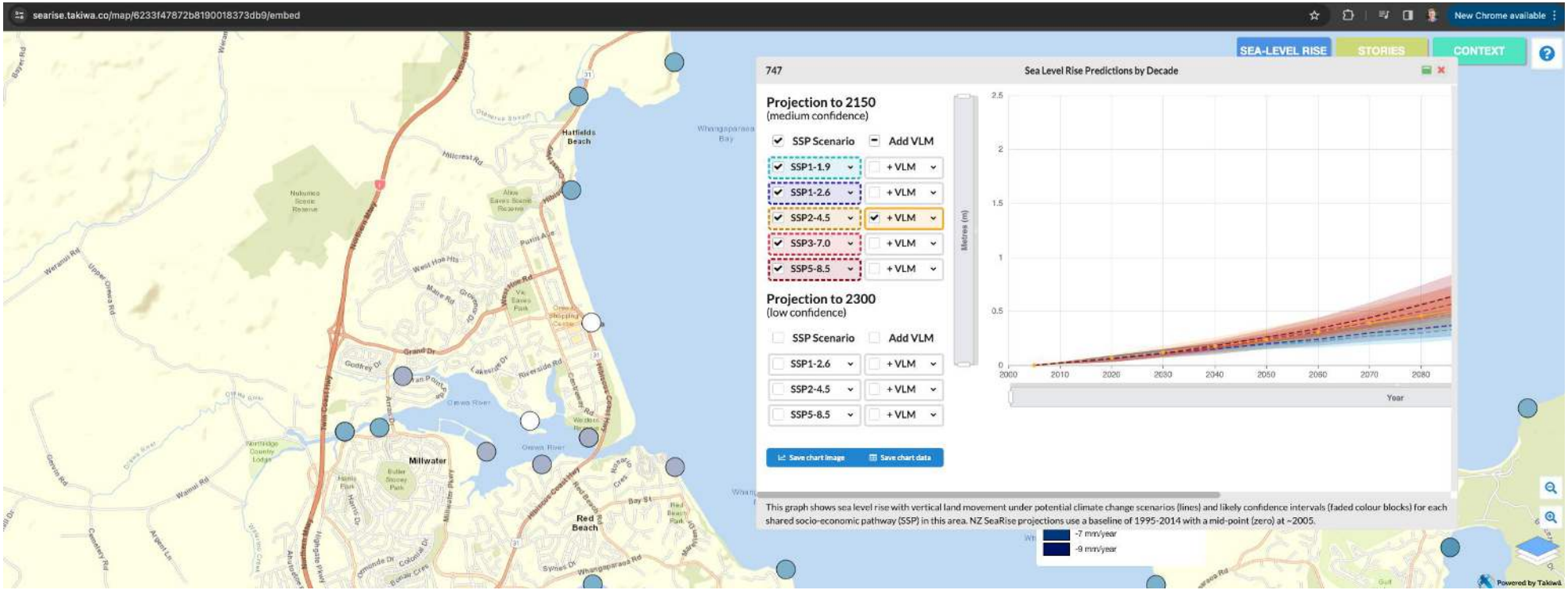
2023

2040

2080

2120

# Orewa land-use planning – temporal changes in hazard




RiskScape Extracts Sea Level Rise Data from NZSeaRise Website for a given SSP and confidence level

# Orewa land-use planning – add coastal flooding

2023

2040

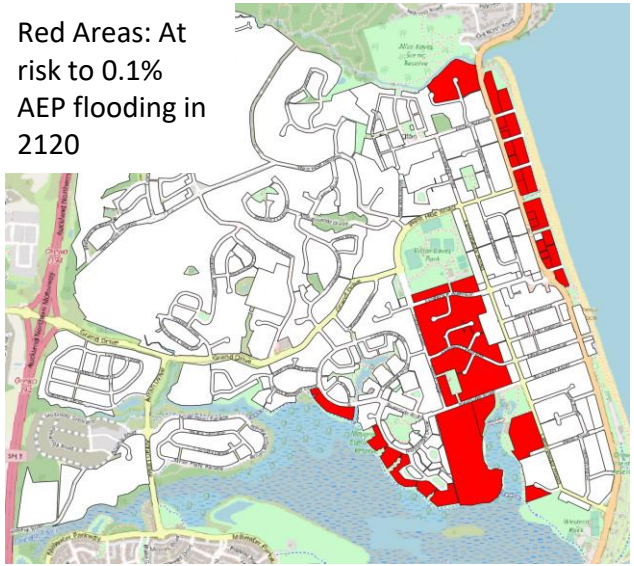
2080

2120

# Orewa land-use planning – future risk with interventions

## *Identify High Risk Areas*

Red Areas: At risk to 0.1% AEP flooding in 2120

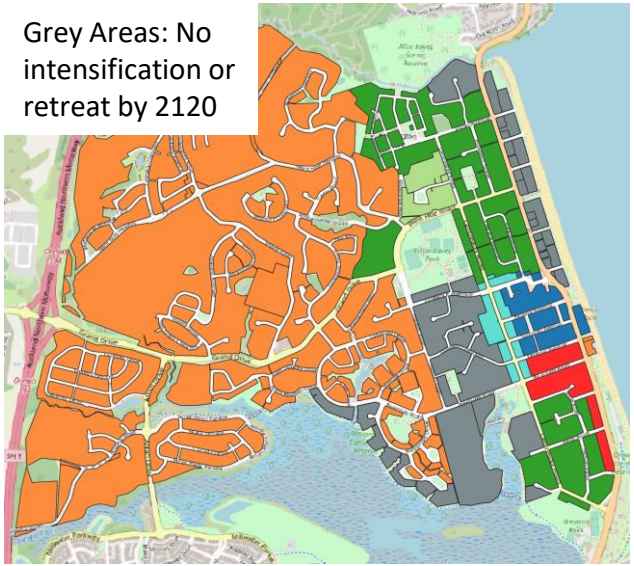


## *Modify Land Use Planning*

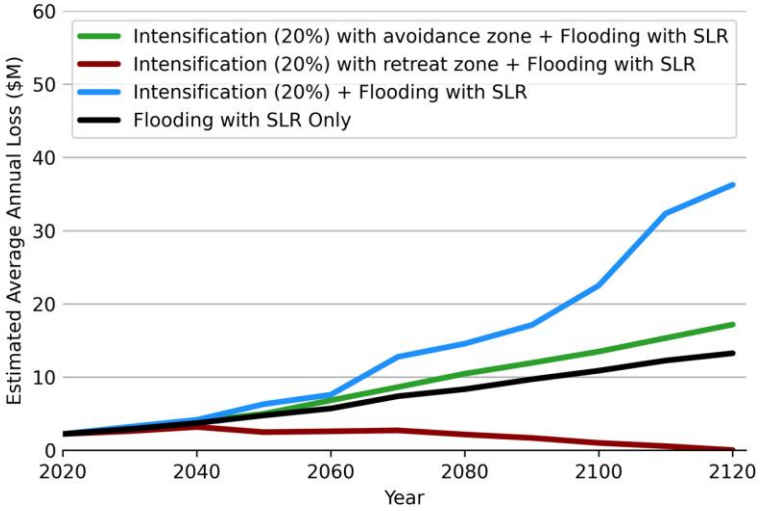
*1) Avoid development in high risk areas*

*2) Retreat from high risk areas*

Grey Areas: No intensification or retreat by 2120



## *Change in Risk With Interventions*



RISKSCAPE™

Getting Started | Download | Community Forum

# Highly customisable spatial data processing for multi-hazard risk analysis

www.riskscape.org.nz

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Kia manawaroa – Ngā Ākina o Te Ao Tūroa

# GRAPHICAL METHODS TO MAP HAZARD-TO-WELLBEING RISK

Juan Monge, Nicky McDonald and Garry McDonald

RNC Symposium - TE TAI WHANAKE

Te Papa, Wellington 2024

m.e research

# GROSS DOMESTIC PRODUCT (GDP)

- GDP used since WWII to measure growth and progress
- GDP leaves out many important aspects such as:
  - Human wellbeing
  - Planetary sustainability
  - Distributional dimensions
- Any other comprehensive alternative that includes all of the above?

## Japan GDP: Natural disasters hit economic growth

14 November 2018

Share

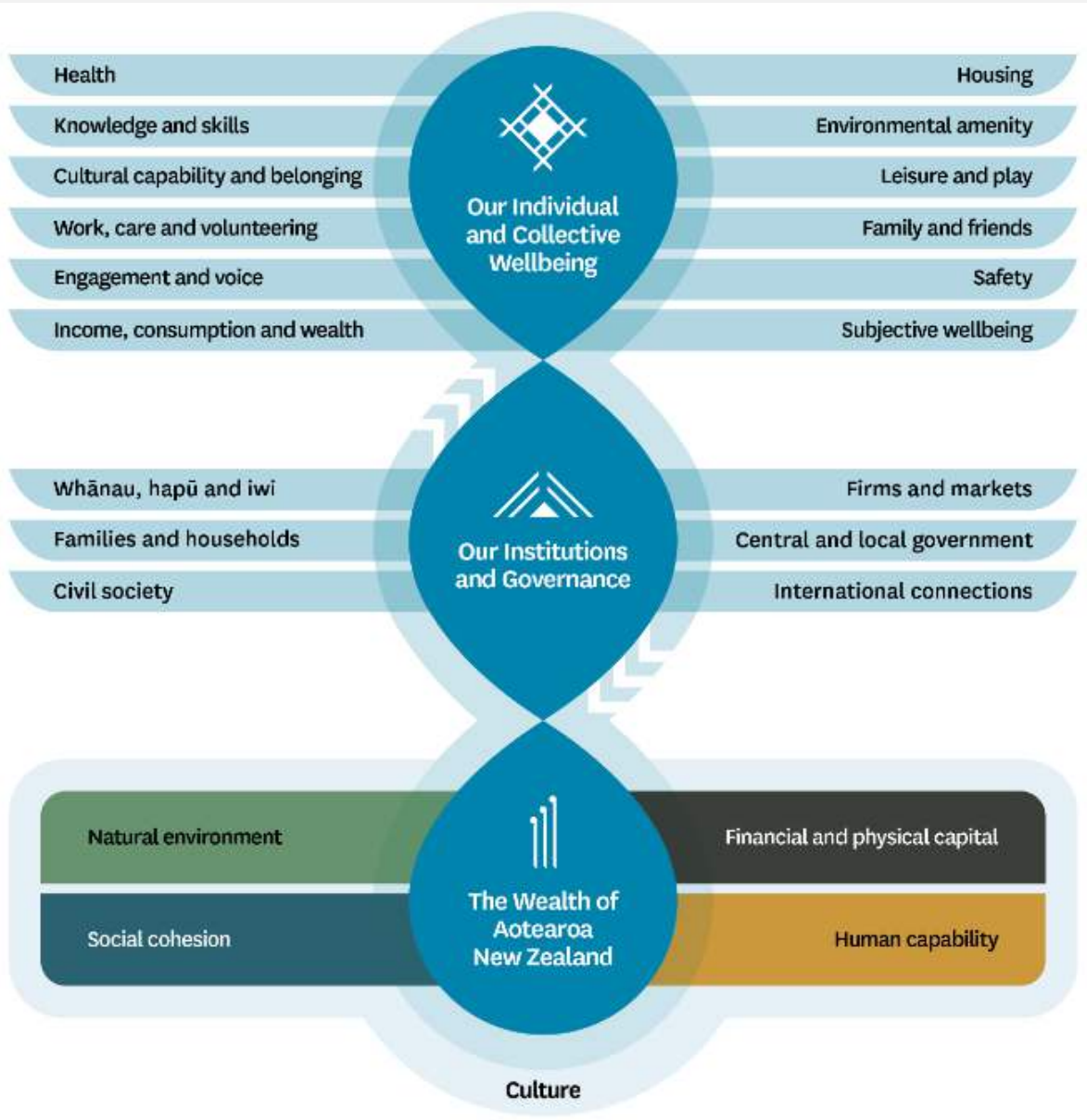
**Japan's economy shrank in the third quarter as natural disasters hit spending and disrupted exports.**

## New Zealand falls into recession, as impact of cyclones takes toll

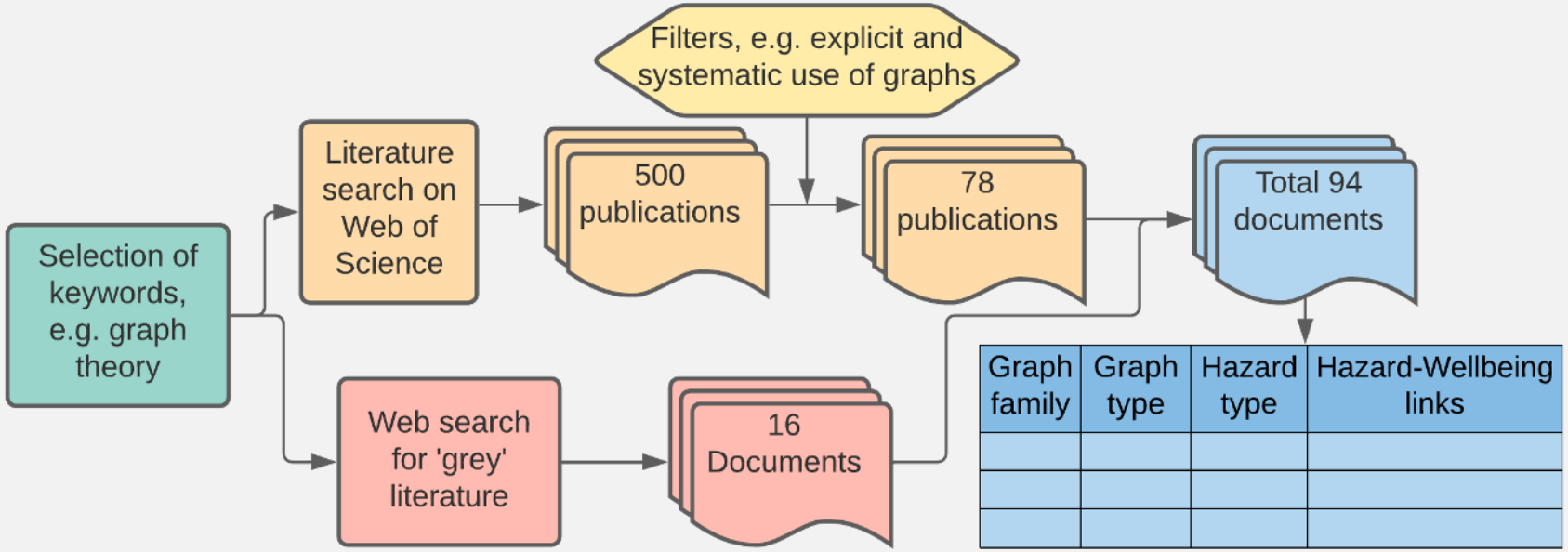
**As the economy shrinks by 0.1% in the March quarter, officials say the impacts of cyclones Hale and Gabrielle worsened the economic outlook**

# WELLBEING

- Wellbeing – measures "the aspects that matter the most to people and that, together, shape their lives"
- Different versions in different countries
- Gap between concept and policy
- Common denominator
  - Measure connections and changes over time
  - Trade-offs and synergies
- How about using graphs?



# LITERATURE ON GRAPHICAL METHODS




Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

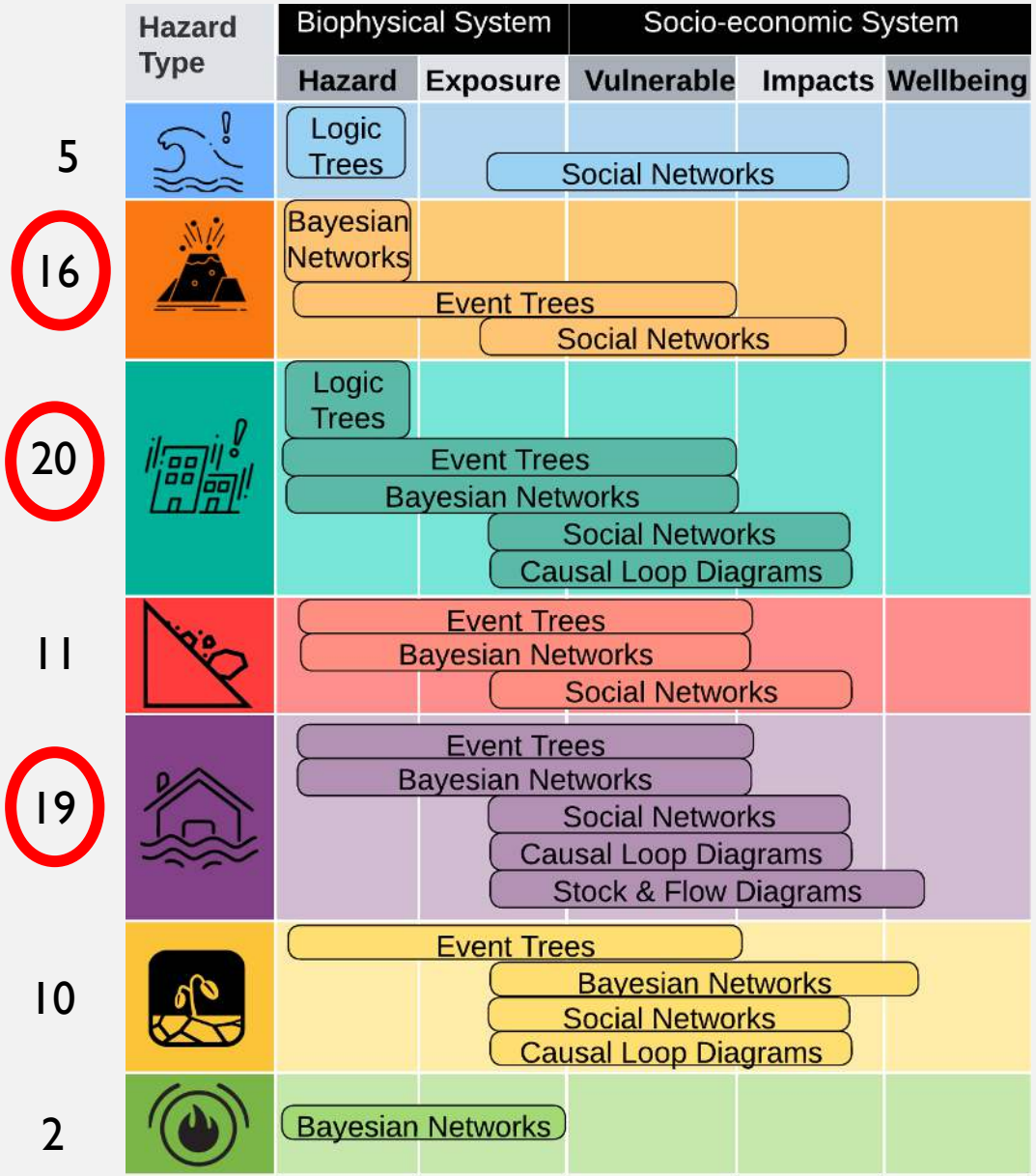
Review

## A review of graphical methods to map the natural hazard-to-wellbeing risk chain in a socio-ecological system☆

Juan J. Monge [a,*], Nicola McDonald [b], Garry W. McDonald [b]

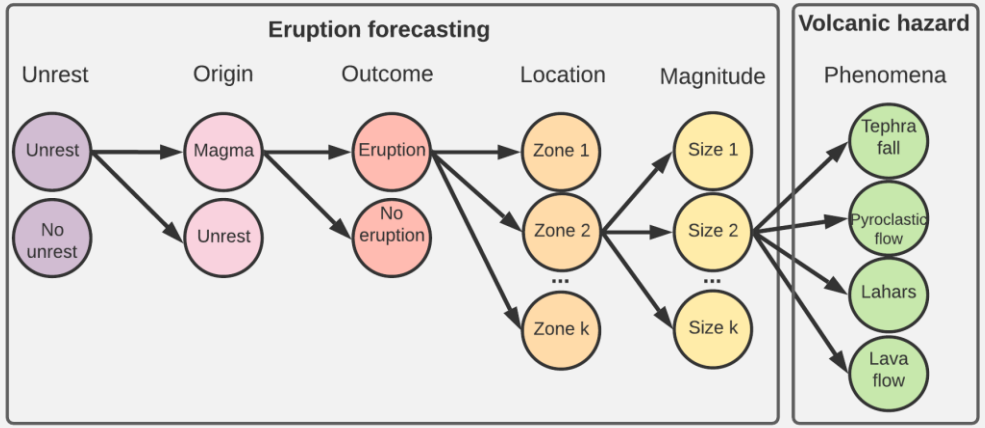
# RESULTS

- Well-developed - earthquakes, floods and volcanic hazards
- Hazards to vulnerabilities
  - Probabilistic graphs
- Direct and indirect impacts
  - Social networks
  - System Dynamics diagrams
- Few studies considering wellbeing
- Nascent independent literature on wellbeing

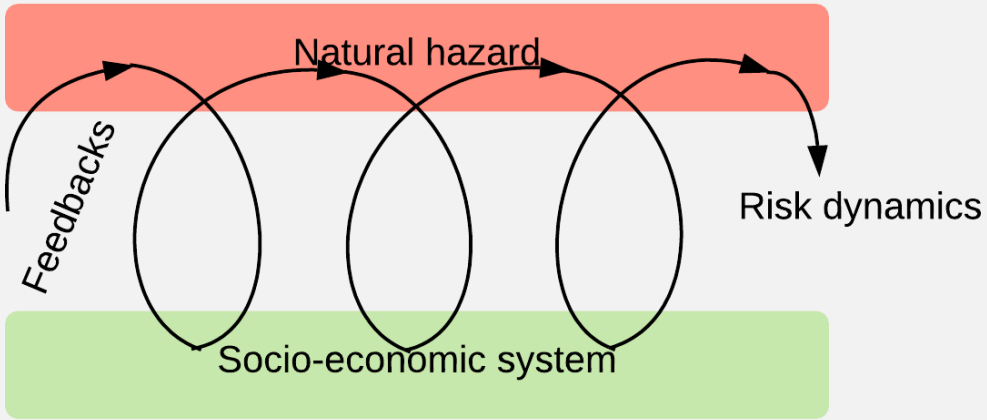


# RESULTS

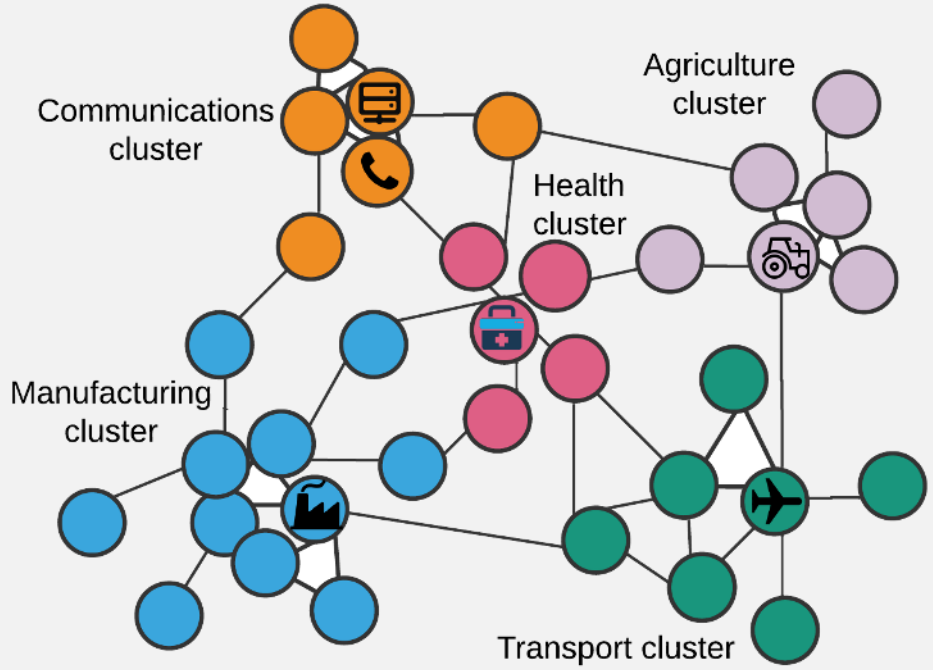
- Biophysical systems
  - Graphs based on probabilistic
  - Hazards → direct impacts on infrastructure
- Social systems
  - Graphs based on wider socio-economic linkages and dynamically adaptive behaviours
  - Direct impacts → indirect impacts




Source: Marzocchi and Bebbington (2012)



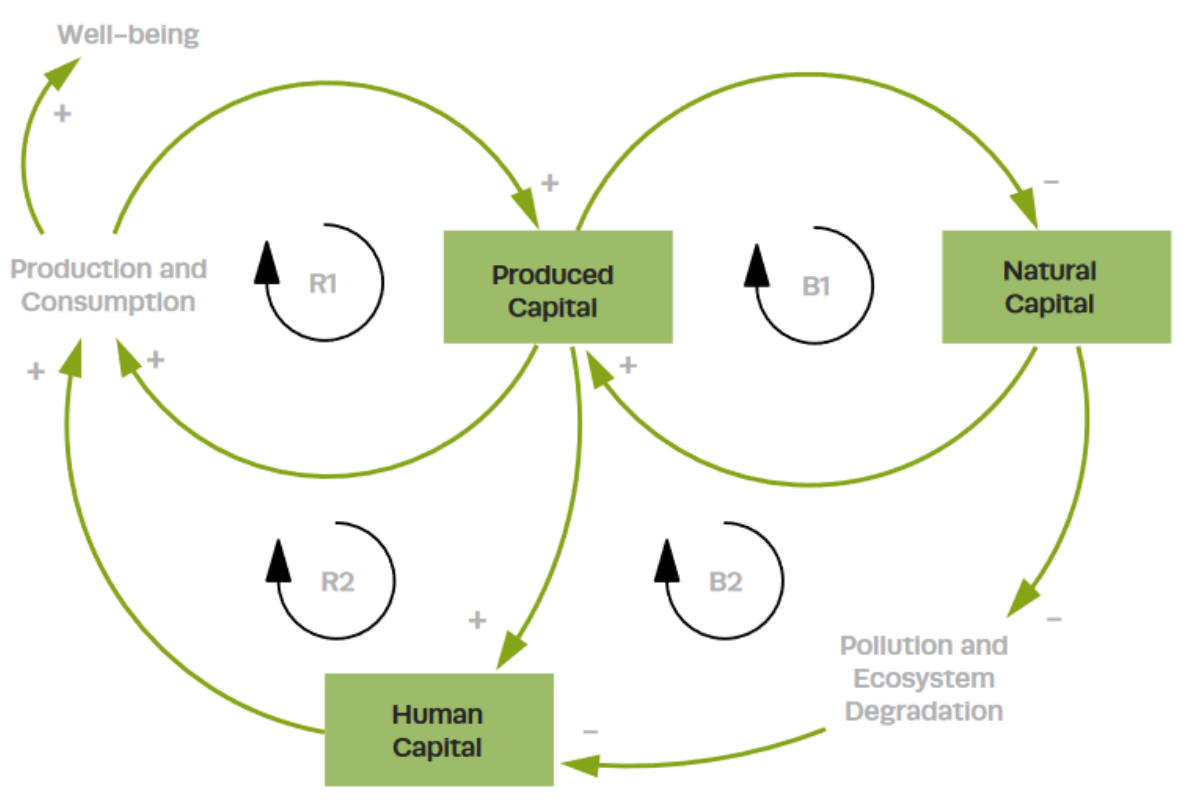

Source: Di Baldassarre et al., (2015)



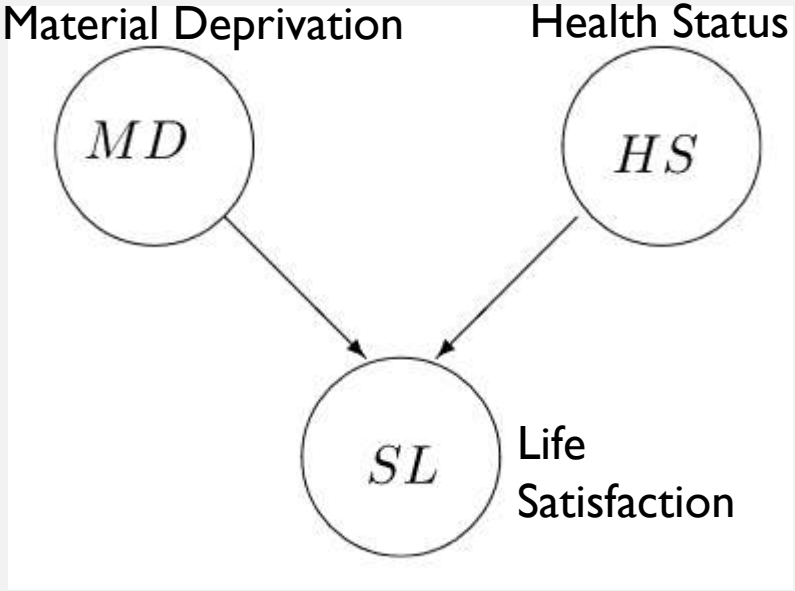

Source: Chopra and Khanna (2015)

# GRAPHS USED FOR WELLBEING

- Collins et al. (2014) used a causal loop diagrams
- Ceriani and Gigliarano (2020) used Bayesian networks




Source: Collins et al. (2014)




Source: Ceriani and Gigliarano (2020)

# CONCLUSIONS AND NEXT STEPS

- Graphical methods used as engagement tools and exploratory models
- Nascent literature on the characterisation of wellbeing's multi-dimensionality using networks and SD diagrams
- The possibilities to use common methods, or combinations of these, are numerous
- Graph-based, distilled simulation models that can be used by experts from different backgrounds



# REFERENCES


- Marzocchi, W. and Bebbington, M.S., 2012. Probabilistic eruption forecasting at short and long time scales. *Bulletin of volcanology*, *74*, pp.1777-1805.
- Chopra, S.S. and Khanna, V., 2015. Interconnectedness and interdependencies of critical infrastructures in the US economy: Implications for resilience. *Physica A: Statistical Mechanics and its Applications*, *436*, pp.865-877.
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- Collins, R., Sakhrani, V., Selin, N., Alsaati, A. and Strzepek, K., 2014. Using inclusive wealth for policy evaluation: the case of infrastructure capital. *UNUIHDP and UNEP. Inclusive Wealth Report*, pp.179-200.
- Ceriani, L. and Gigliarano, C., 2020. Multidimensional well-being: A Bayesian networks approach. *Social indicators research*, *152*, pp.237-263.

National Science Challenges

RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa – Ngā Ākina o Te Ao Tūroa

# Risk perspectives (Heretaunga)

Anthony Cole *me ōna tīpuna*

*Manu Kura mō Ngā Manu o te Whatu*

RNC Symposium 2024

# Introduction

- Ngā Manu o te Whatu
- Creative activities training
- Five full-time staff
- RMA/protection/MCD
- Well-being and cultural survival
- Marae/hapū based
- Indigenous transdisciplinarity
- Te Kaihautū

# Project aim

- Explore our (Heretaunga) risk perceptions and their implications for well-being

# Background

- We whakapapa to Ngā Hapū o Heretaunga
- Our training activities focus on measuring progress towards Māori community well-being and cultural survival
- We are aware of numerous hazards
- But had never really stopped to think about how we **perceive risk** or how *risk perception* influences the decisions we make
- This project raised lots of questions. For example:
- Why are our (Māori community) perceptions of risk different from those of local businesses and government?
- Whose perceptions of risk should we follow?

Home / Hawkes Bay Today

PREMIUM

## Petition against Maraekakaho quarry gains 1200 signatures

By James Pocock

21 Mar, 2024 01:27 PM · 3 mins to read

Save · Share


A sign protesting the Tūpore Infrastructure quarry and its expansion at Maraekakaho. Photo / NZME

RNZ Home News Radio Podcasts & Series Topics Te Ao Māori Pacific IndoNZ 中文

New Zealand World Politics Pacific Te Ao Māori Sport Business Country Local Democracy Reporting

NEW ZEALAND / HEALTH

## Havelock North campylobacter study estimates 8320 were infected

5:38 pm on 13 July 2020

Share this

Tom Kitchin, co-host of The Detail
@inkitchnz tom.kitchin@rnz.co.nz

The number of people infected in the Havelock North campylobacter crisis in 2016 was much higher than previously estimated, new research suggests.


Stuff

## Close to 60 people hospitalised from 2016 Havelock North gastro outbreak, study finds

Gianina Schwanecke

December 17, 2021, · 02:05am · Share


A new study has found 58 people were admitted to Hawke's Bay Hospital in relation to the 2016 campylobacter outbreak in Havelock North, compared to previously reported estimates of 42. (File photo)

STUFF / THE DOMINION POST


Stuff

NZ NEWS / QUIZZES / SPORT / WORLD / LISTEN

May 13 2024

Transport Minister gives update on regional roading projects ... watch live

## 'We know this whenua and how its waters behave' – Māori voice missing from Cyclone Gabrielle response

Karanama Ruru

Eight people in the region lost their lives and hundreds lost their homes after the region's rivers burst their banks and inundated vast tracts of land.

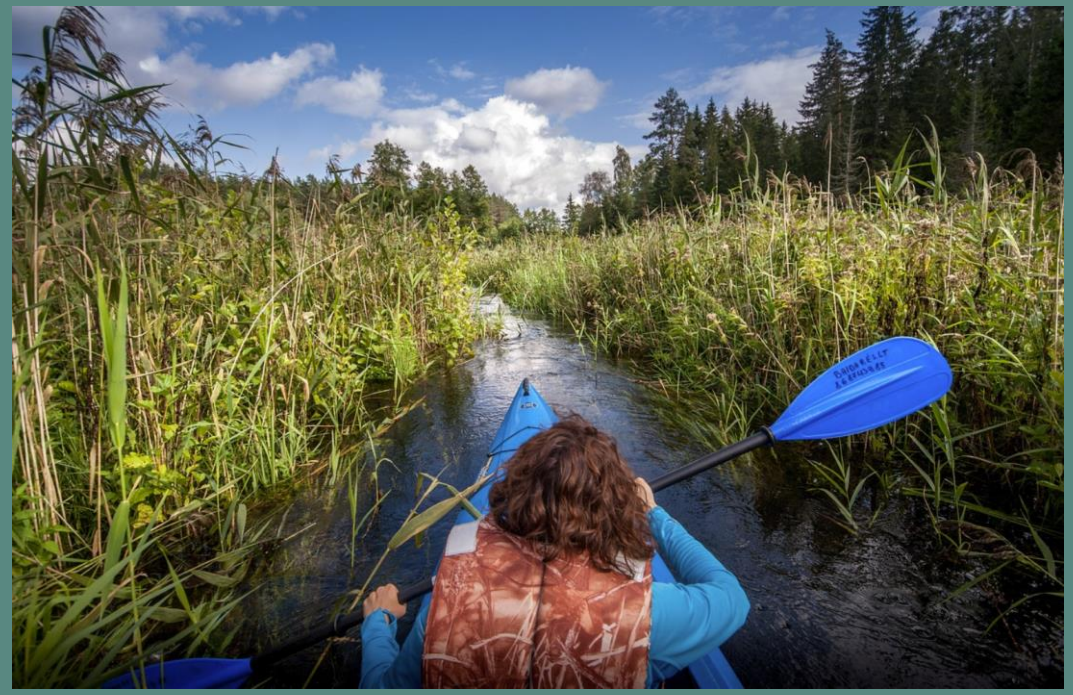
Thousands of people were infected by drinking water from contaminated bores. Four people died and others were left permanently disabled.

National SCIENCE Challenges

RESILIENCE TO NATURE'S CHALLENGES

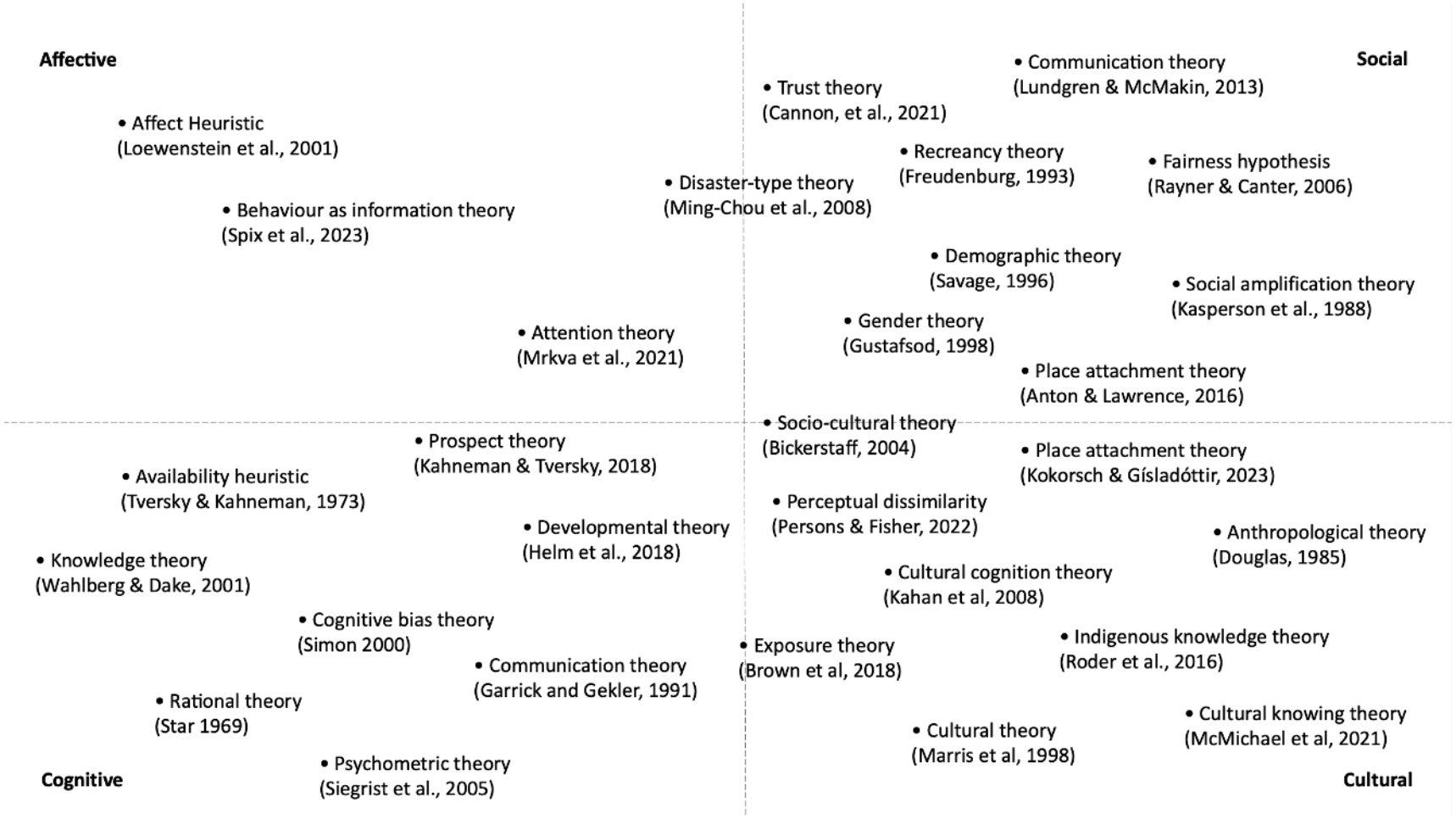
Kia manawaroa – Ngā Ākina o Te Ao Tūroa

# Wayfinding journey

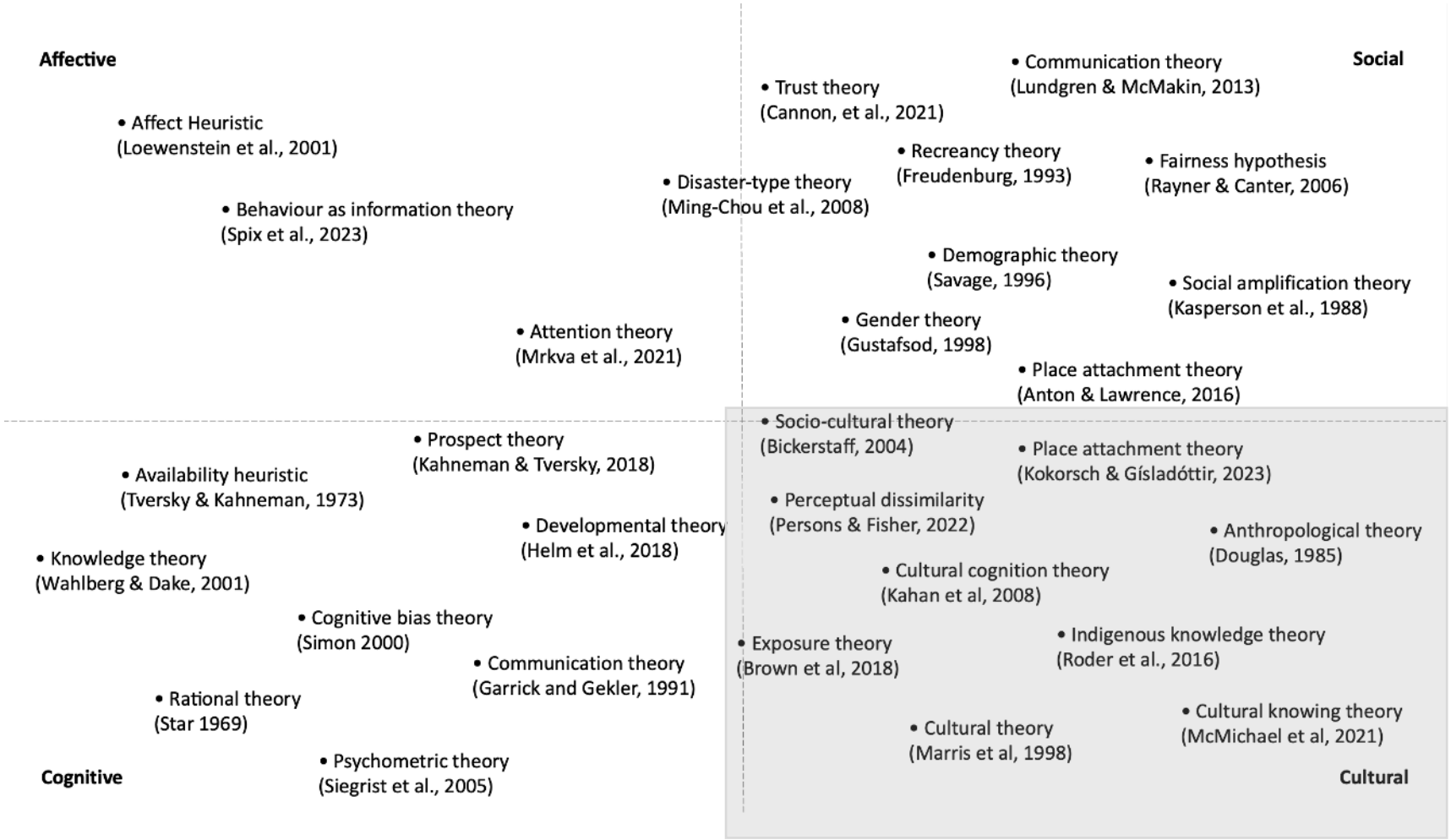


RNC Symposium 2024

# Literature review and risk perception landscape



# Literature review




## Concerns

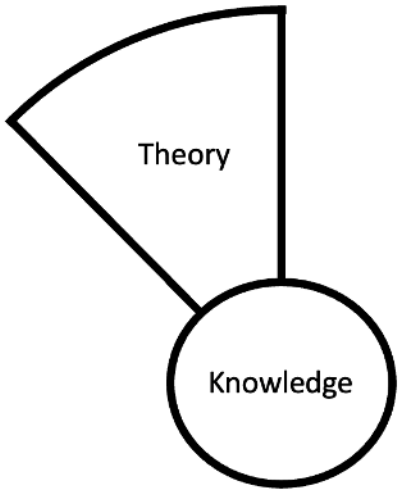
1. Research *on indigenous communities*

2. Disciplinary & interdisciplinary can create barriers to knowing

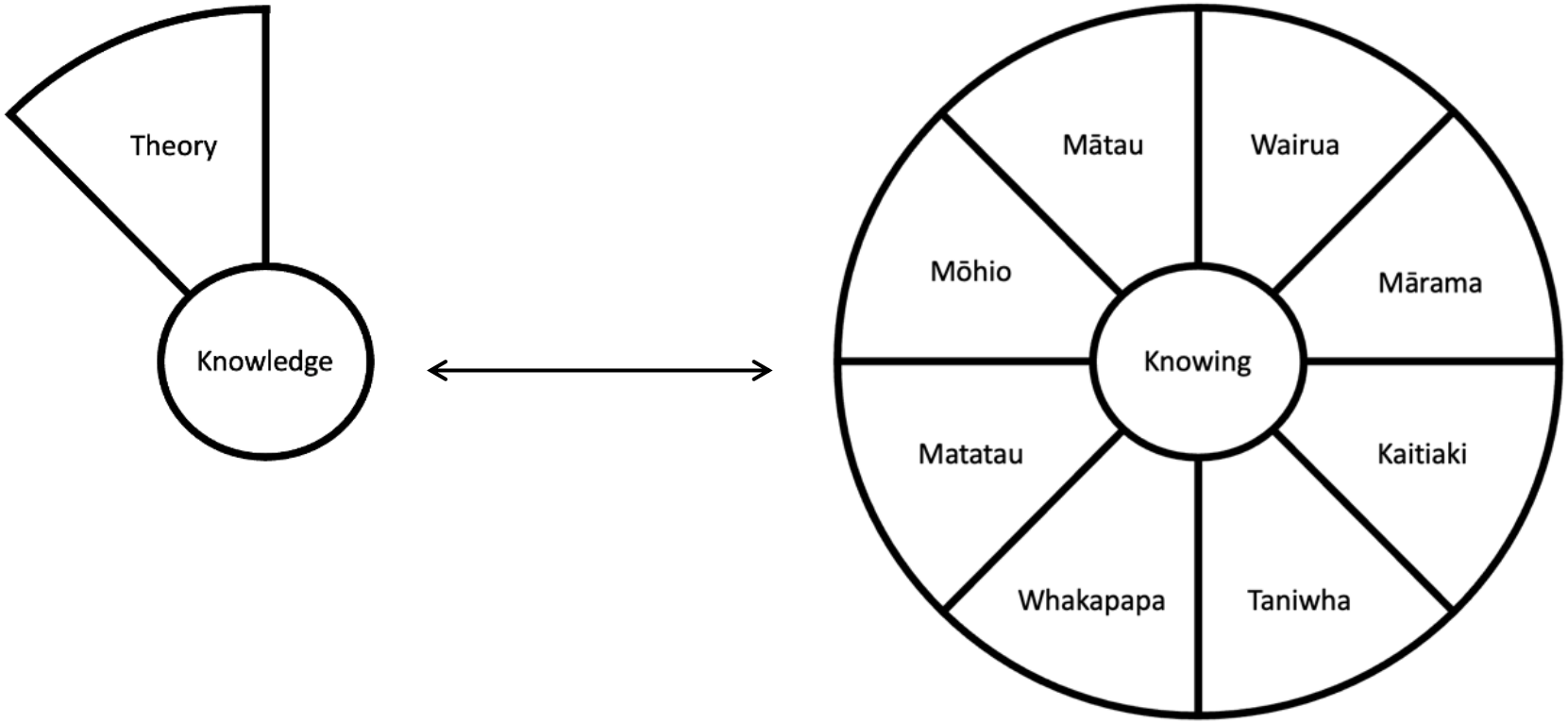
3. Some key ideas are theoretically ungrounded

4. Scientific vocab used to explain indigenous realities (e.g., indigenous knowledge)

# What is indigenous knowledge?



# What is indigenous knowledge?



# Risk perception in the Māori language

- Worldview is encoded in language
- No pre-colonial linguistic analogues
- We did find similarities in meaning
- Po te rere kore (transl. after you have finished running here, annihilation and destruction)
- Early warning provisions (e.g., kaitiaki, taniwha, wairua)
- Risk management (e.g., kawa, karakia, mauri stones, Pā, tapu, intertribal marriage)

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Rangatiratanga

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# Risk perception in the Māori language

Ngā Kete e Whā + Taonga tuku iho

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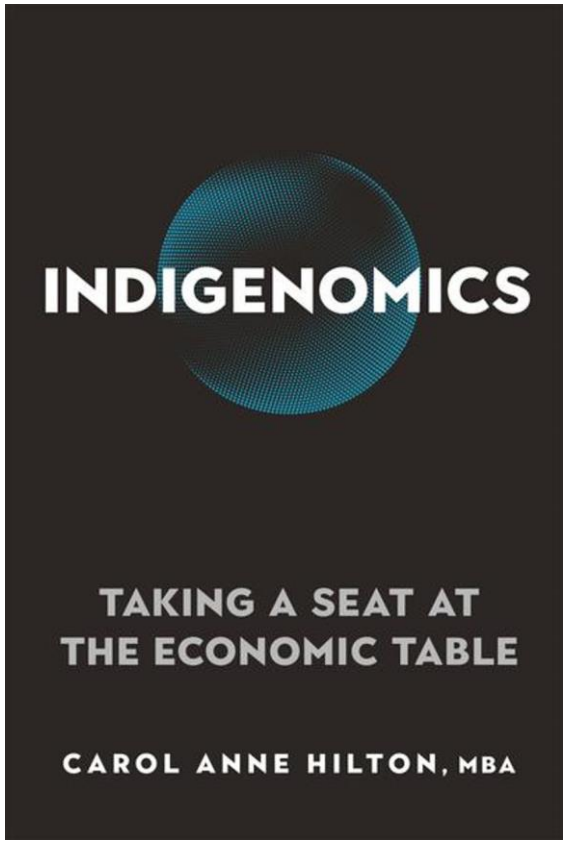
- No pre-colonial linguistic analogues
- We did find similarities in meaning

Rangatiratanga

- Po te rere kore (transl. after you have finished running here, annihilation and destruction)
- Early warning provisions (e.g., kaitiaki, taniwha, wairua)
- Risk management (e.g., kawa, karakia, mauri stones, Pā, tapu, intertribal marriage)

# Rangatira (chiefly behaviour)

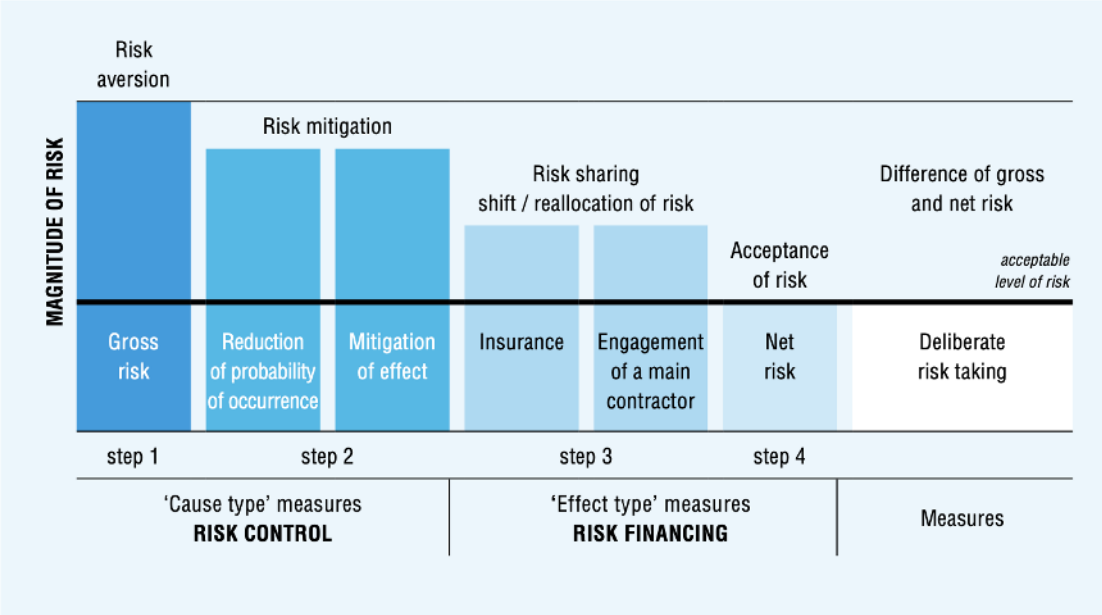
- Protection is not about a defensive position. It draws our attention to duties, obligations and responsibilities
- *… it is the sense of responsibility and managing of risk that is at the very centre of Indigenous existence and reality (Hilton, 2021, pg. 25)*
- Our risk perception is an expression of duties, obligations and responsibilities
- These are things that enhance our mana




*… it is the sense of responsibility and managing of risk that is at the very centre of Indigenous existence and reality* (Hilton, 2021, pg. 25)

# The published literature

- Avoid
- Mitigate
- Relocate the risk
- Accept the risk
- Deliberate risk-taking
- Risk perception is an expression of avoidance aspirations
- Skillfulness in avoiding, mitigating and relocating is what enhances reputation

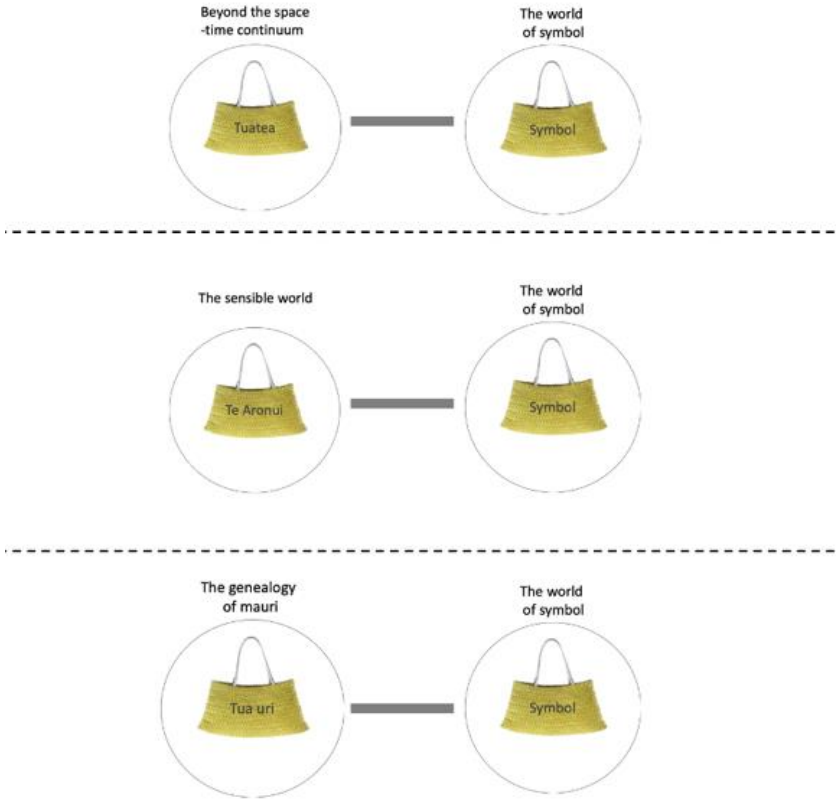



*Source:* Fekete (2009)

# Ngā Kete e Whā (perception)

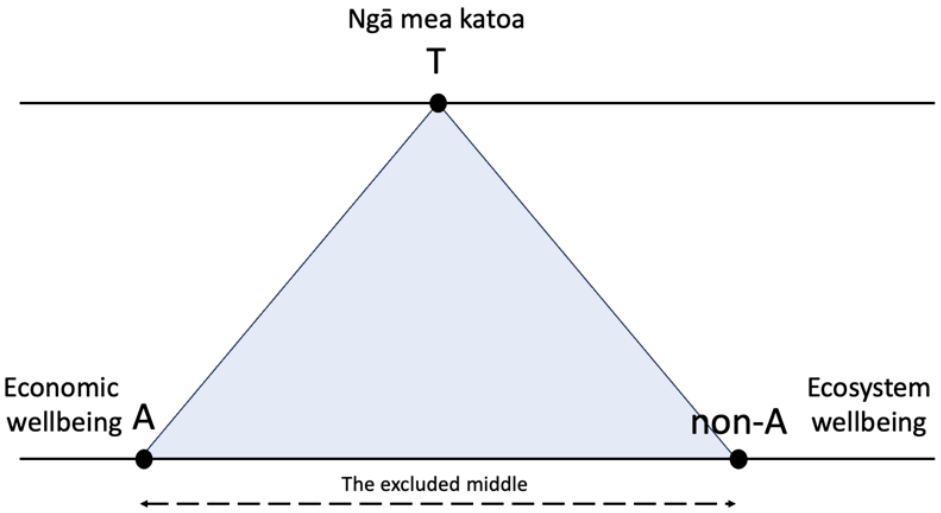
- There are patterns and levels in our perception of reality (e.g., whakapapa and our worldview)
- Our communities have remarkable perceptual and linguistic complexity
- We tend to draw on others to help build our risk perceptions (collective perceptual intelligence)
- This locates our risk perception experiences in the domains of strong and indigenous transdisciplinarity
- There is a ‘perceptual robustness’ that is an emergent property of collective perceptual intelligence

Our worldview



# Taonga tuku iho (inherited treasures)

- Our cultural values express inclusive logic
- Our Tīpuna used exclusive logic sparingly (e.g., tapu and noa)
- Our risk perceptions are not constrained by categorical logic (classical A and non-A)
- In the published literature we noticed that risk perceptions are *mutually exclusive*
- Our risk perception draws on dual logic
- Strong and indigenous transdisciplinarity



National SCIENCE Challenges

RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa – Ngā Ākina o Te Ao Tūroa

# Take home messages

RNC Symposium 2023

# Take home messages

- Transdisciplinarity can include coordination of knowledge development across, between and beyond the disciplines
- The domain of strong transdisciplinarity (Western science)
- The domain of indigenous transdisciplinarity (marae/hapū context)
- The empirical quantification of risk has its place (but predictive power and track record are also important)
- There are valid worldview, epistemological and experiential reasons for paying more attention to the *risk perceptions* of our Māori communities

# The end

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