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

# Infrastructure resilience

*The resilience of infrastructure underpins societal wellbeing and economic prosperity. Infrastructure resilience not only minimises the disruption of critical services but also ensures the rapid recovery of communities post a natural hazard event. What new design and engineering innovations are contributing to the essential goal of reducing the vulnerability of our buildings and infrastructure networks to natural hazard risk?*

**Speakers:**

- Roger Fairclough, Climate Adaptation Platform | Neo Leaf Global *(Chair)*
- Tim Sullivan, University of Canterbury
- Liam Wotherspoon, University of Auckland
- Kaley Crawford-Flett, University of Auckland
- Amelia Lin, University of Auckland
- Charlotte Toma, University of Auckland
- Caleb Dunne, EQC Toka Tū Ake
- Kākati Royal, AECOM

# Built Environments: Horizontal Infrastructure

Liam Wotherspoon

*University of Auckland*

RNC Symposium 2024

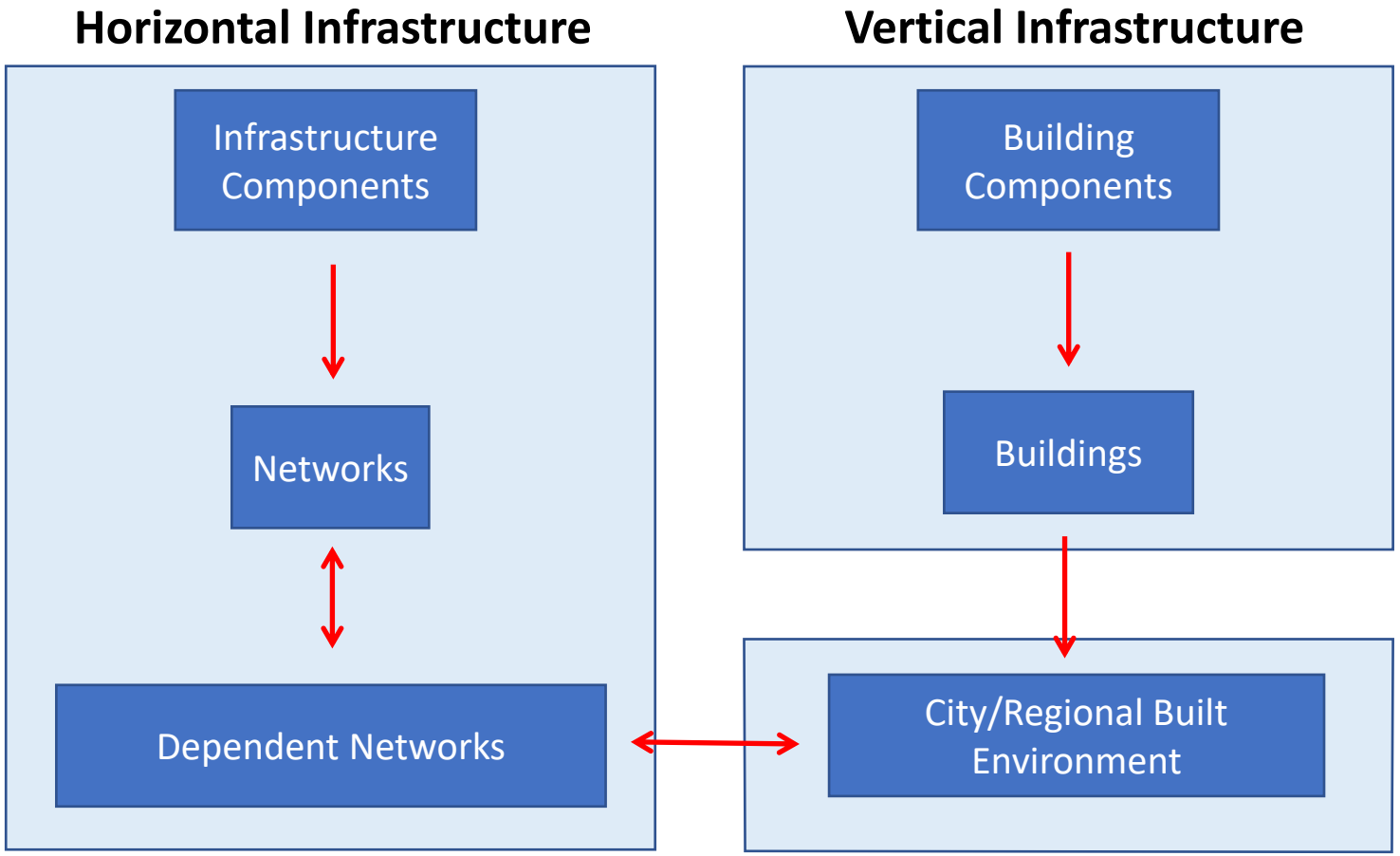
# Programme Aims

- Improve our understanding of the performance of infrastructure under various natural hazards
- Improve our approaches for design, assessment and repair
- Develop new approaches to inform decision-making and investment
- Work alongside range of stakeholder partners to provide real-world context to the research

# Team

- Over 25 academics
- Over 30 postgraduate students
- Strong collaborations with stakeholders and industry groups
  - Regional focus
  - Network focus
  - Discipline focus

# Programme Structure



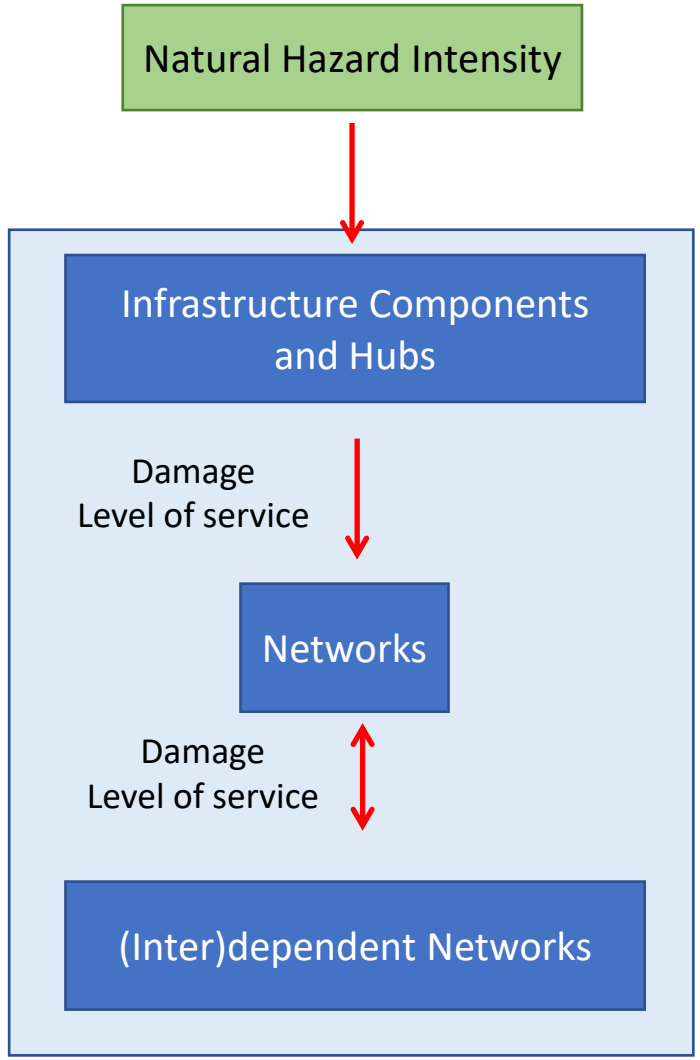
# Horizontal Infrastructure

- Network Types
  - Transport
  - Energy
  - Communications
  - 3 Waters
  - Flood Defence

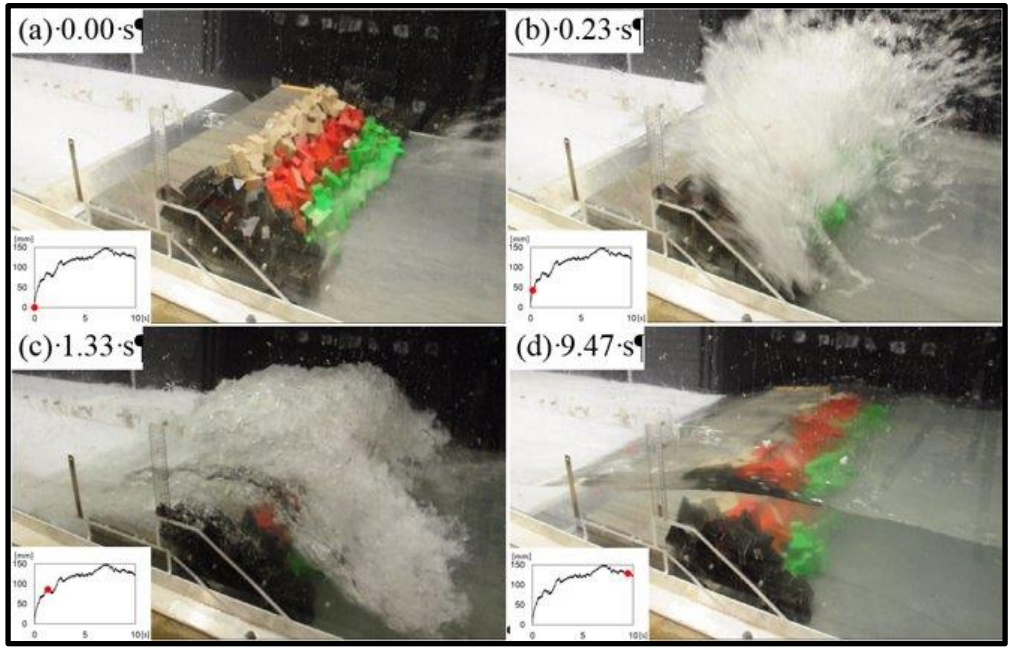
- Components and Hubs
  - Damage and level of service under different hazard intensities

- Networks
  - Capture connectivity and flow of network

- Dependant Networks
  - Influence of outage in one network on another network



# Hazards & Components



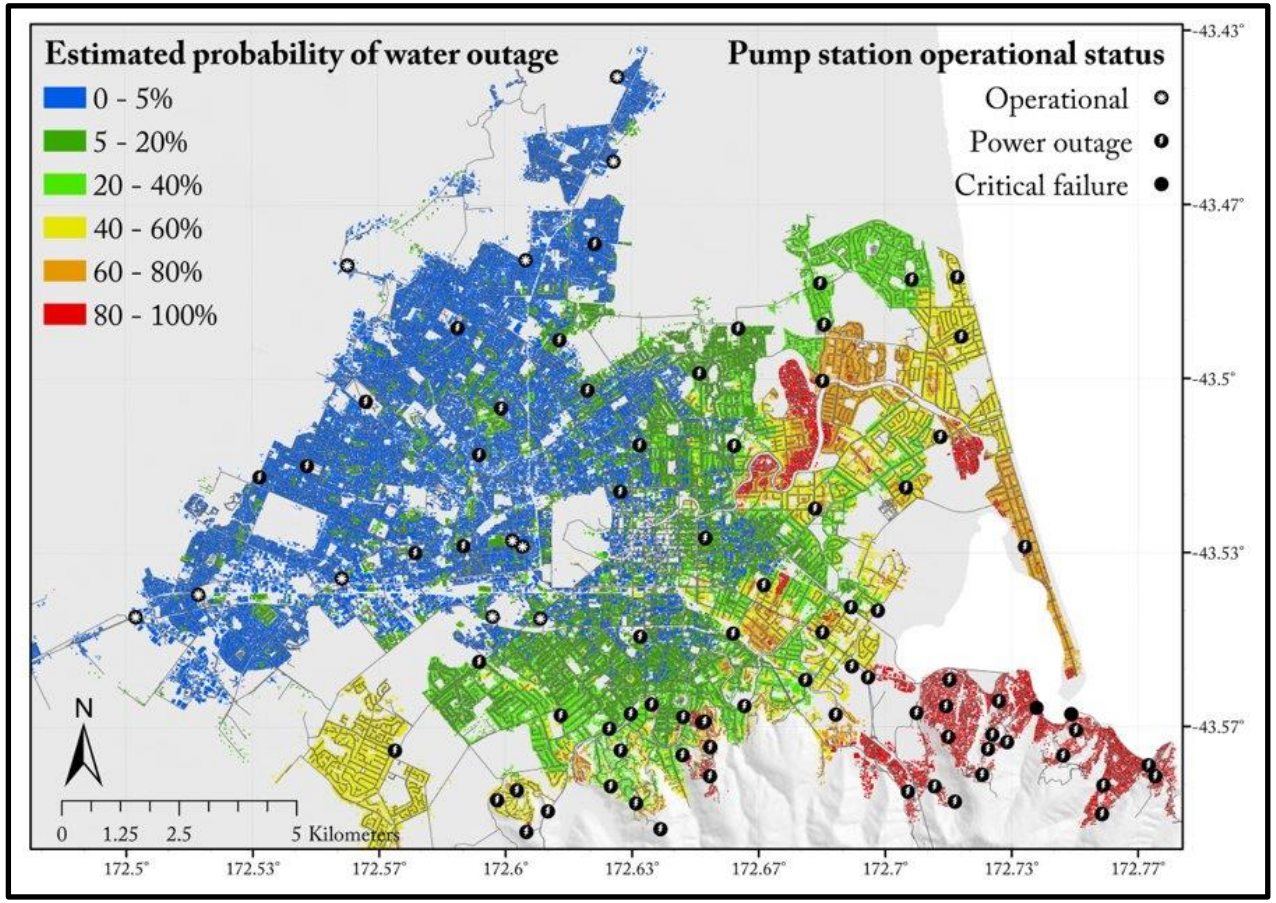

Xu et al.

Kimpton et al.

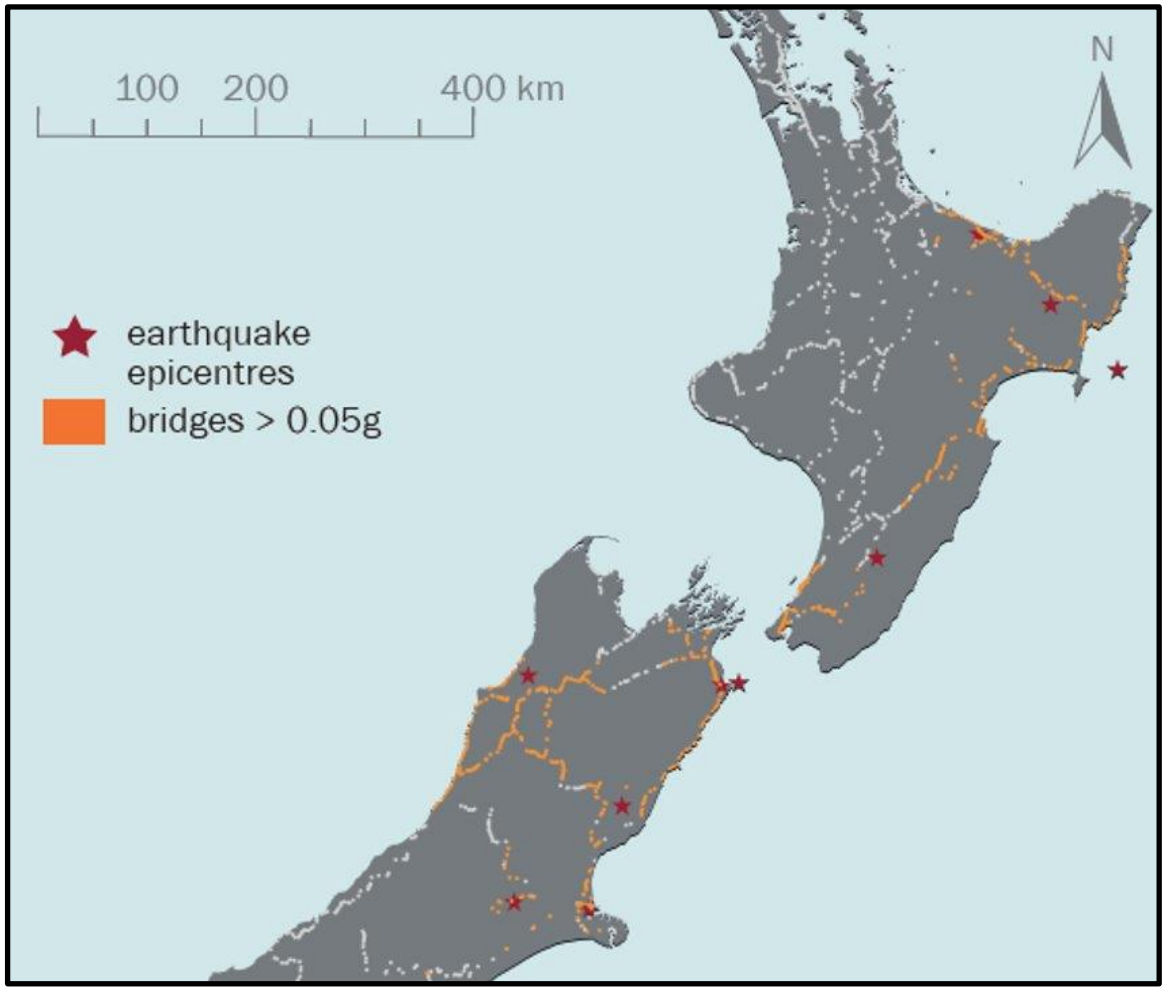
Stephens et al.

Till et al.

# Hazards & Components

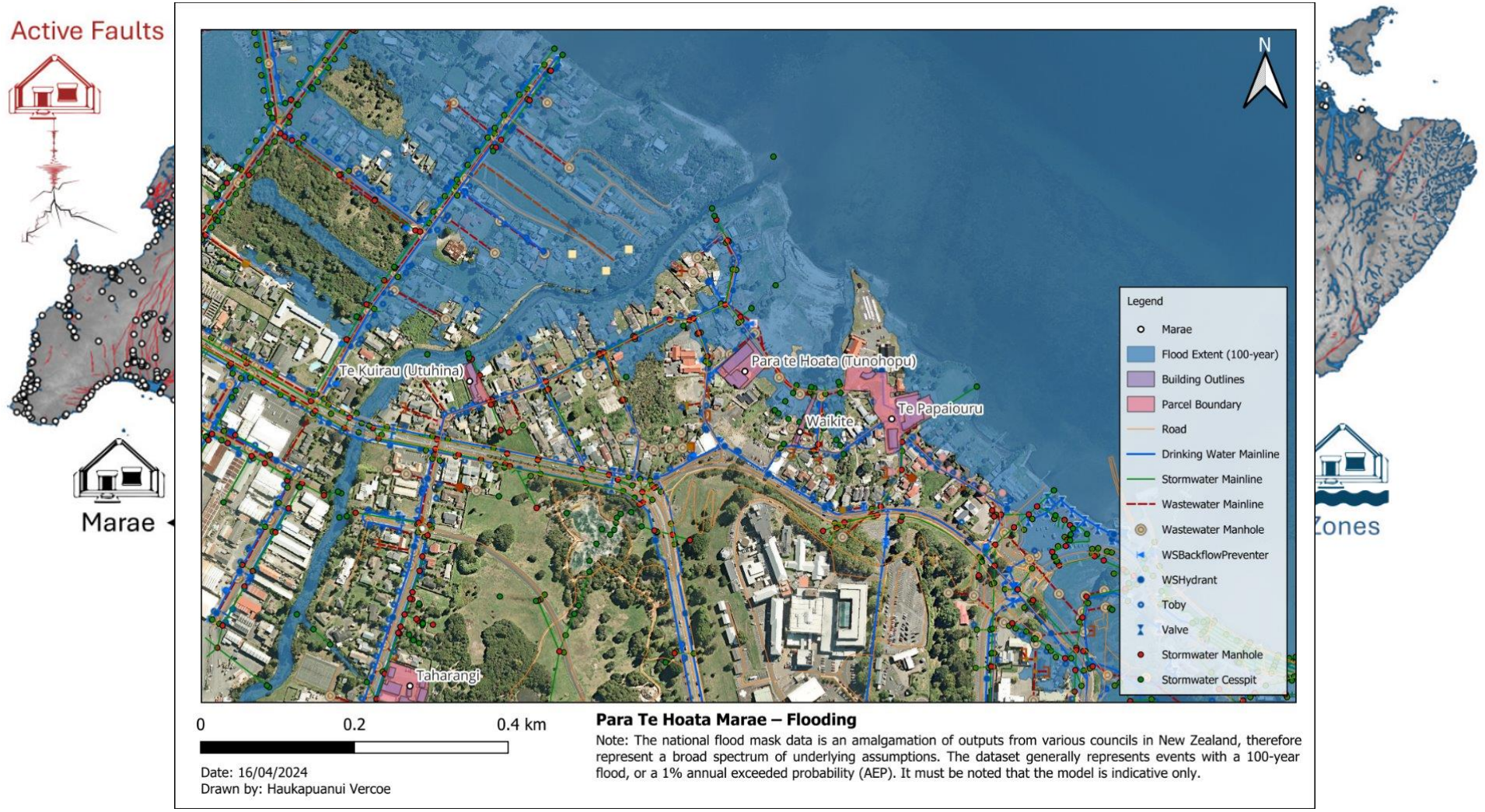



Bellagamba et al.




Lew et al.

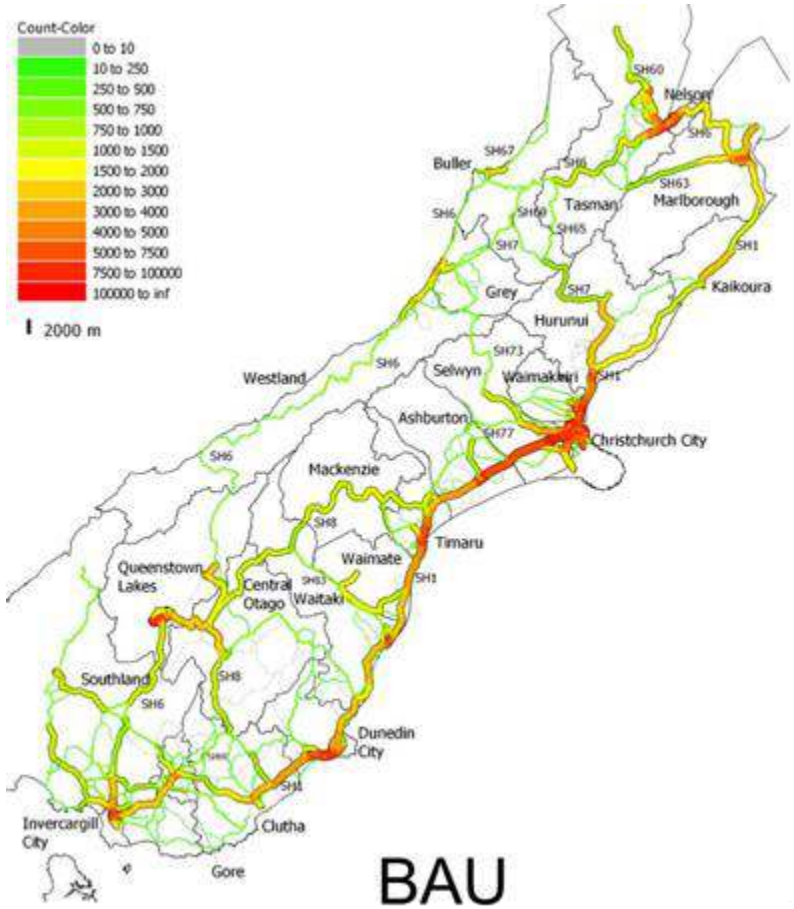
# Hazards & Hubs




Vercoe et al.

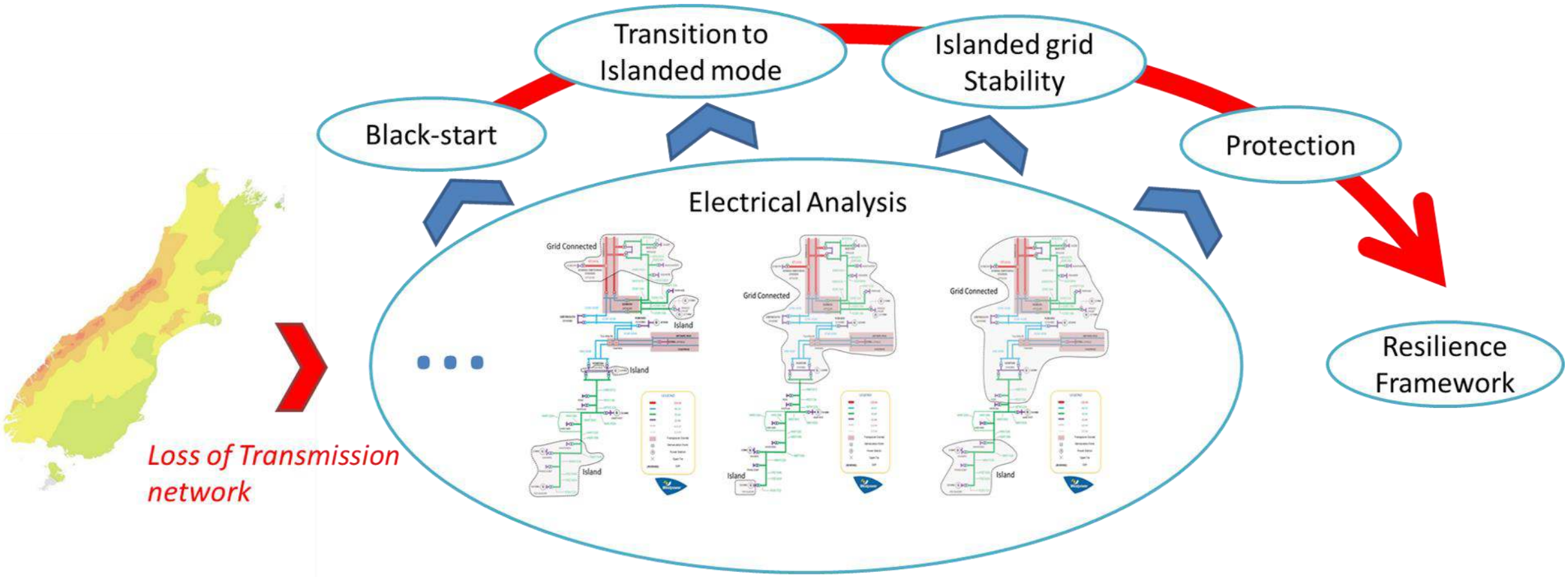
Vercoe et al.

# Networks



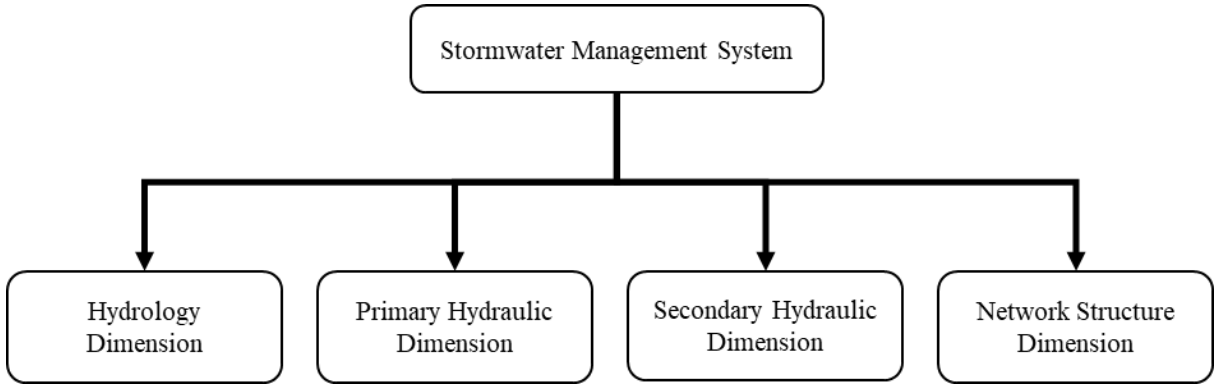

Aghababaei et al.

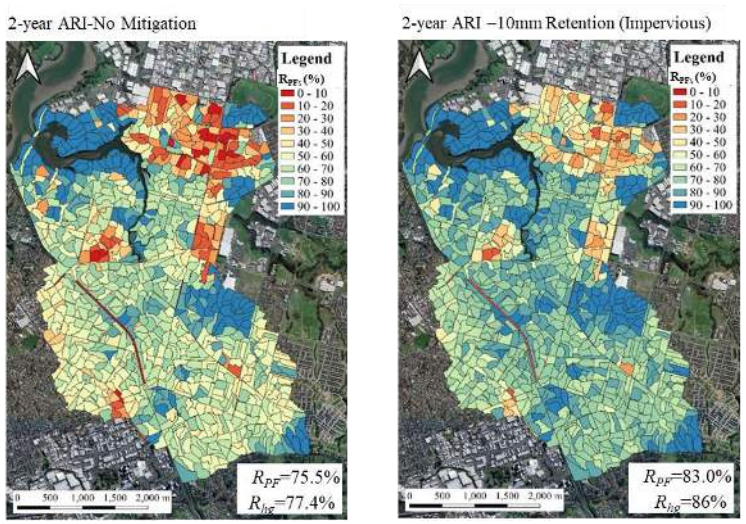
# Networks

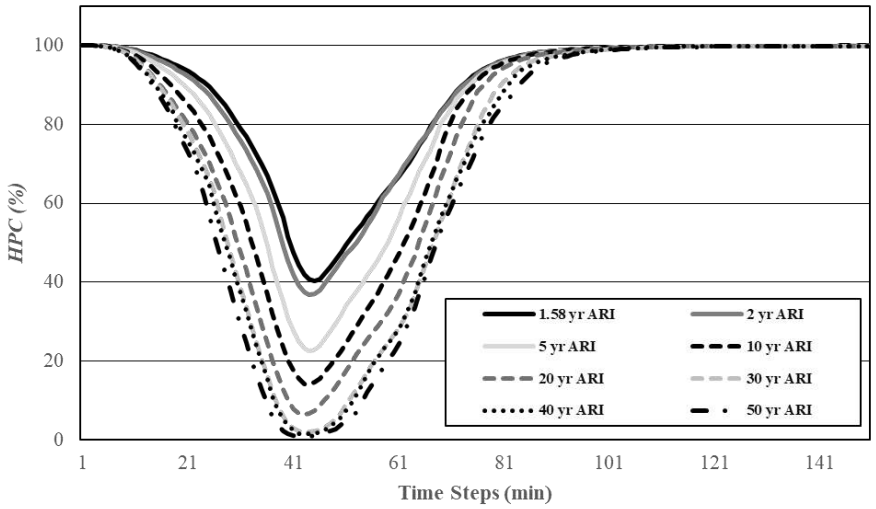


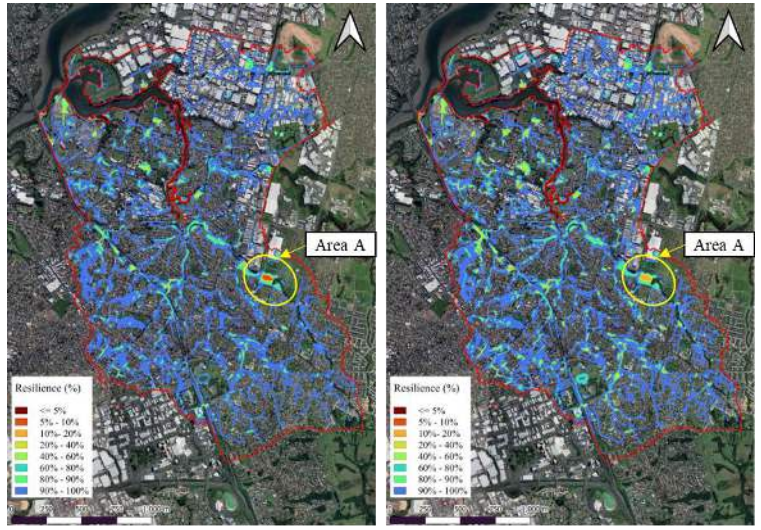

Nair et al.

# Networks



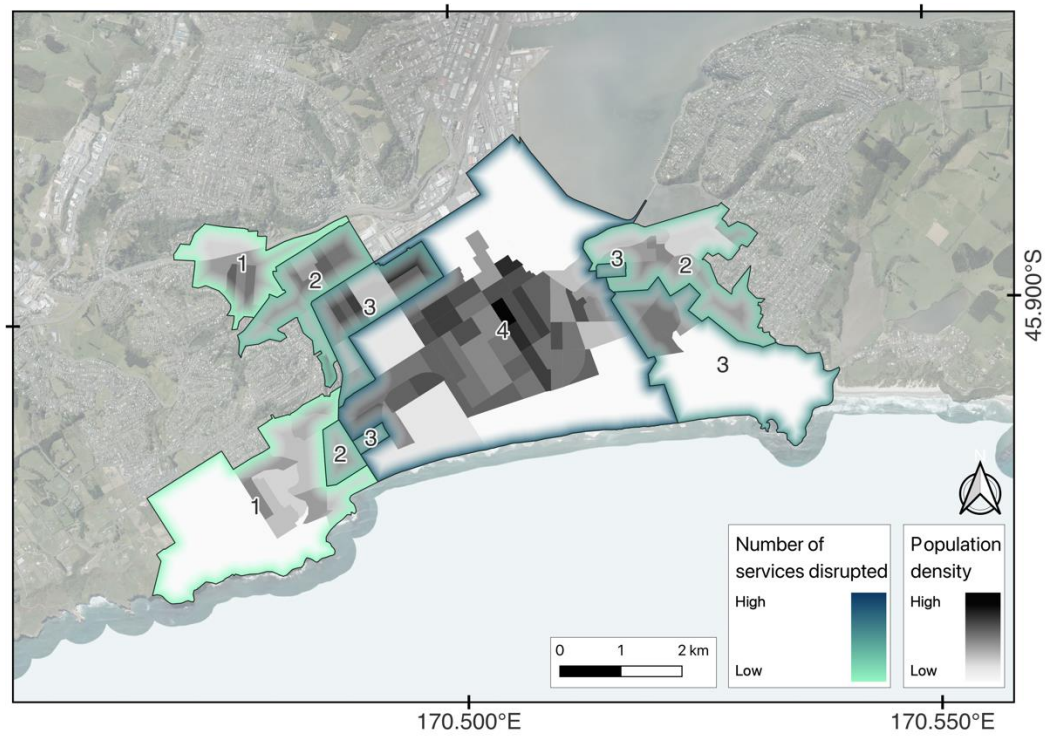



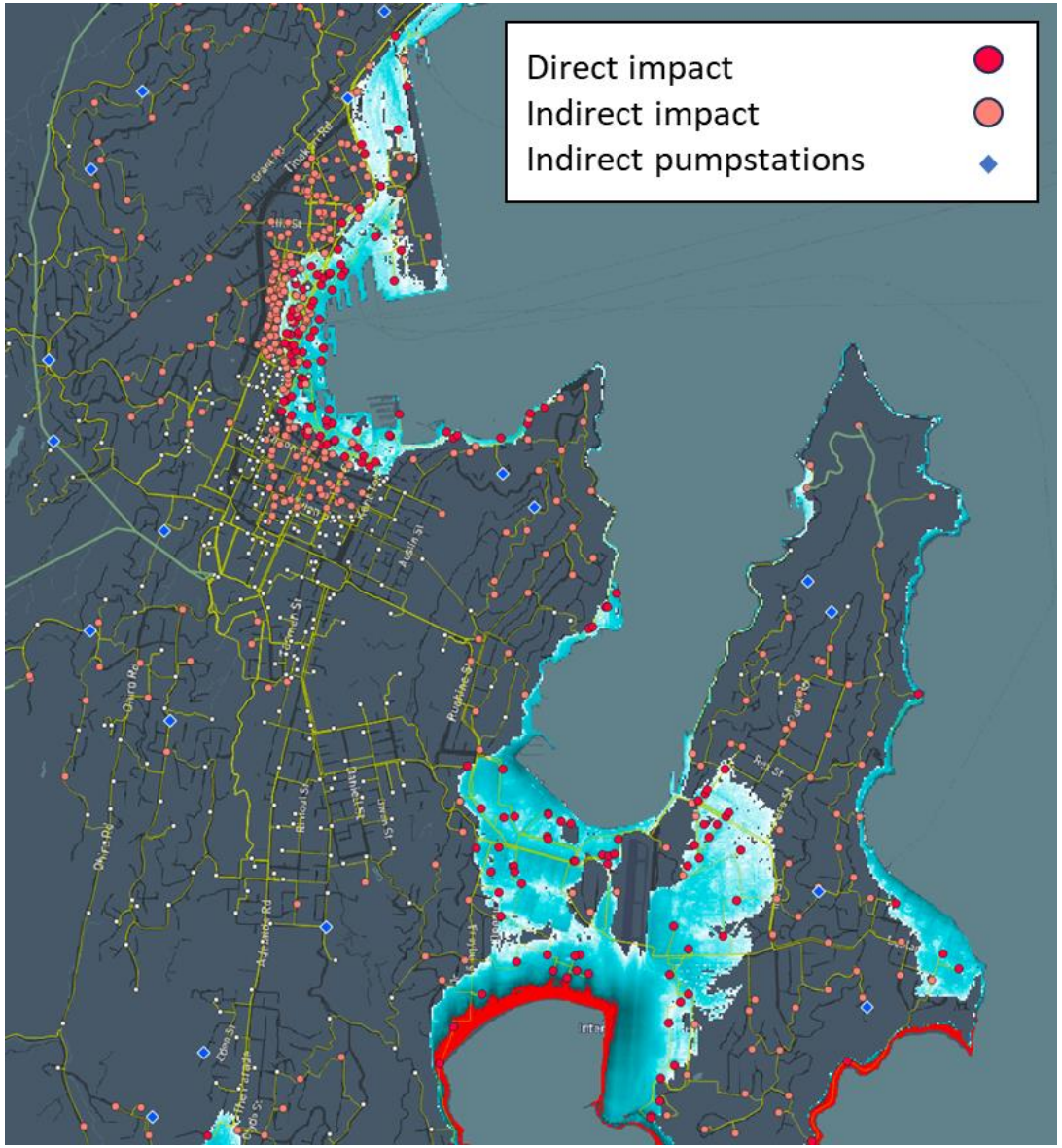




Valizadeh et al.

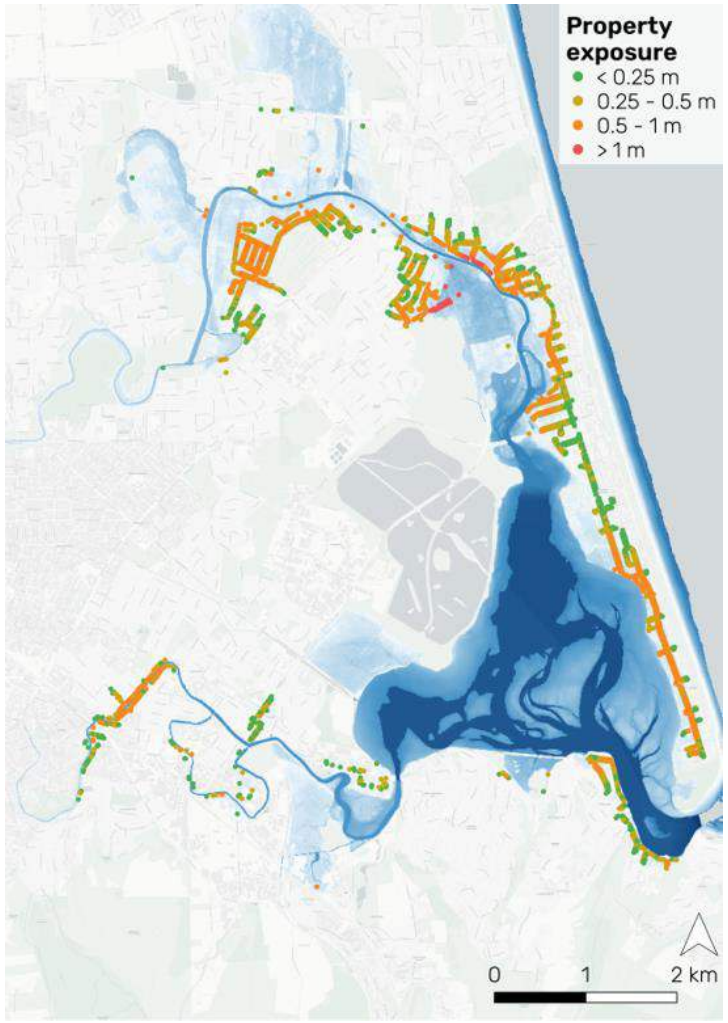
# Network Dependencies

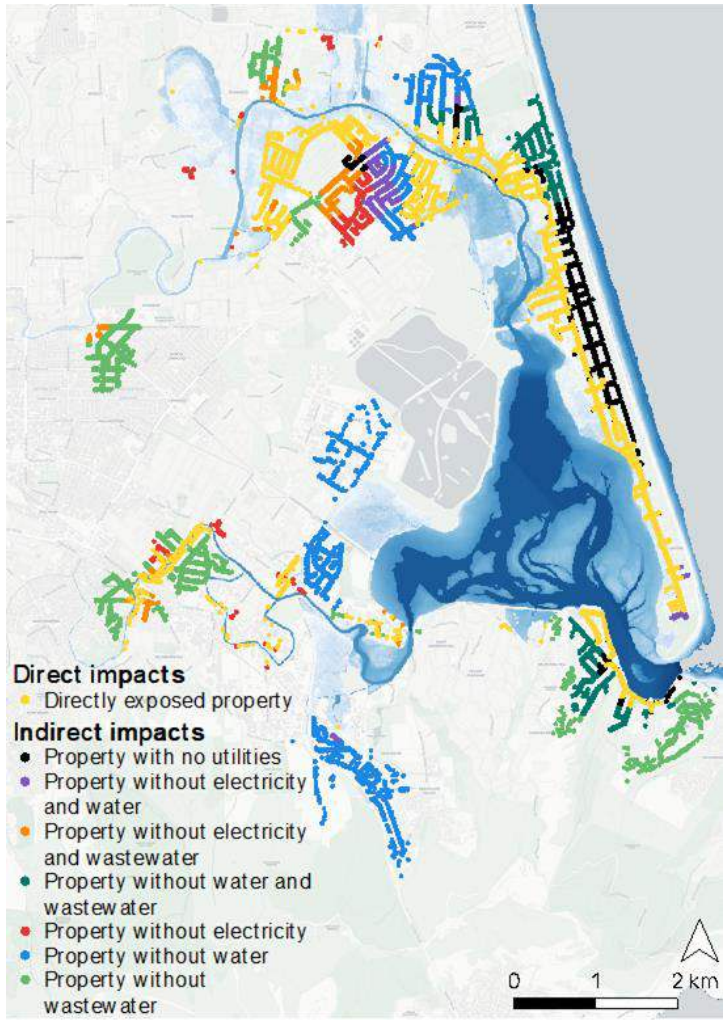



Lan et al.

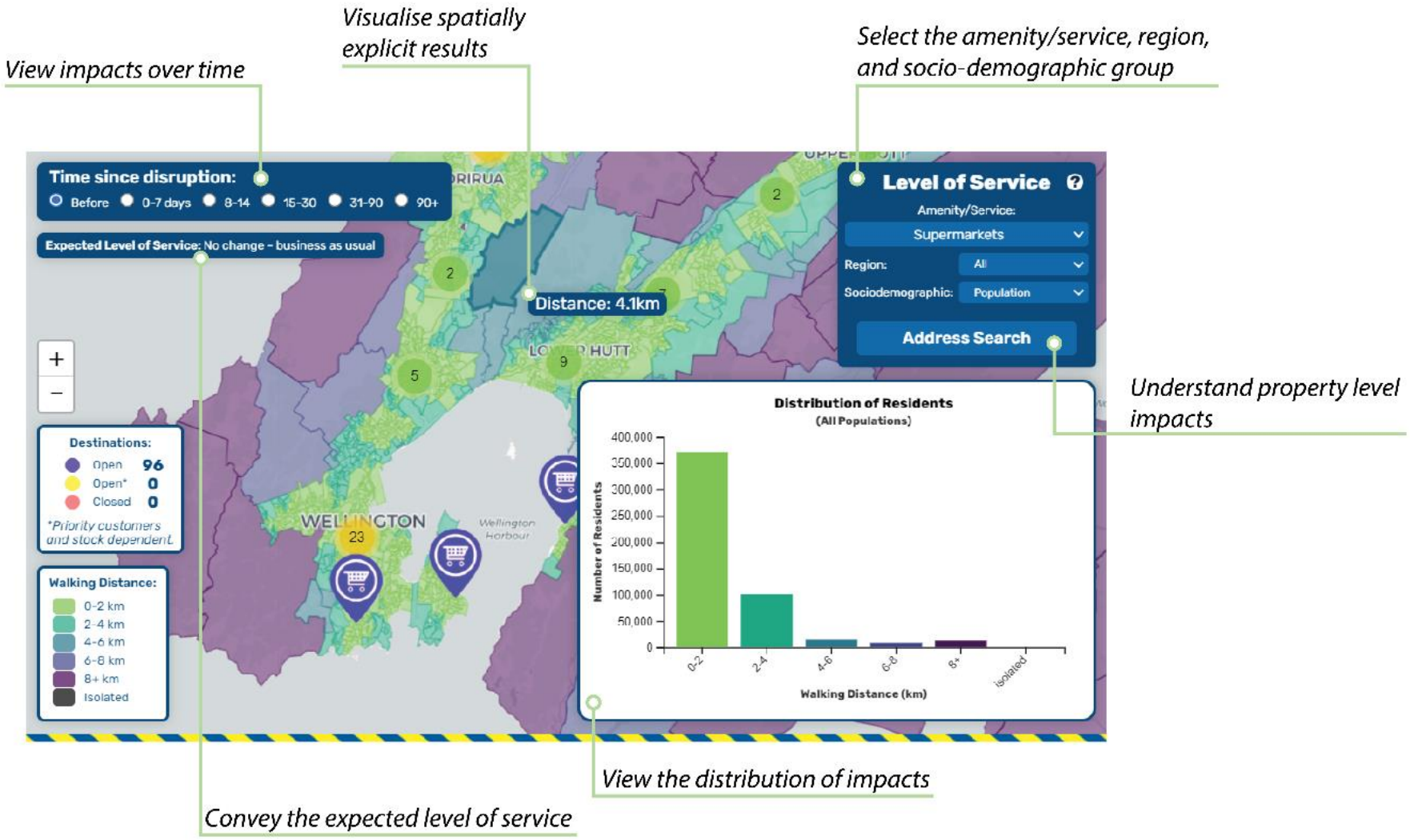
# Network Dependencies




Brunner et al.

# PELOS




Mowll et al.

# Summary

- Understanding natural hazard-induced demands on horizontal infrastructure
- Quantification of infrastructure component performance from case history observations and modelling
- Developing methods to quantify system-level performance of infrastructure networks and dependencies
- National and regional collaborations
  - Across institutions
  - Across programmes

# Slide deck omitted by presenter

# Dams, stopbanks, and flood defence systems

## The confluence of research and practice

Dr Kaley Crawford-Flett + others

*University of Auckland + others*

RNC Symposium 2024

# Dam safety regulations commence today - 13 May 2024

MB

MBIE Building Performance Team <building@

To Kaley Crawford-Flett

Reply | Reply All | Forward

Mon 13/05/2024 4:13 pm

If there are problems with how this message is displayed, click here to view it in a web browser.

BUILDING PERFORMANCE

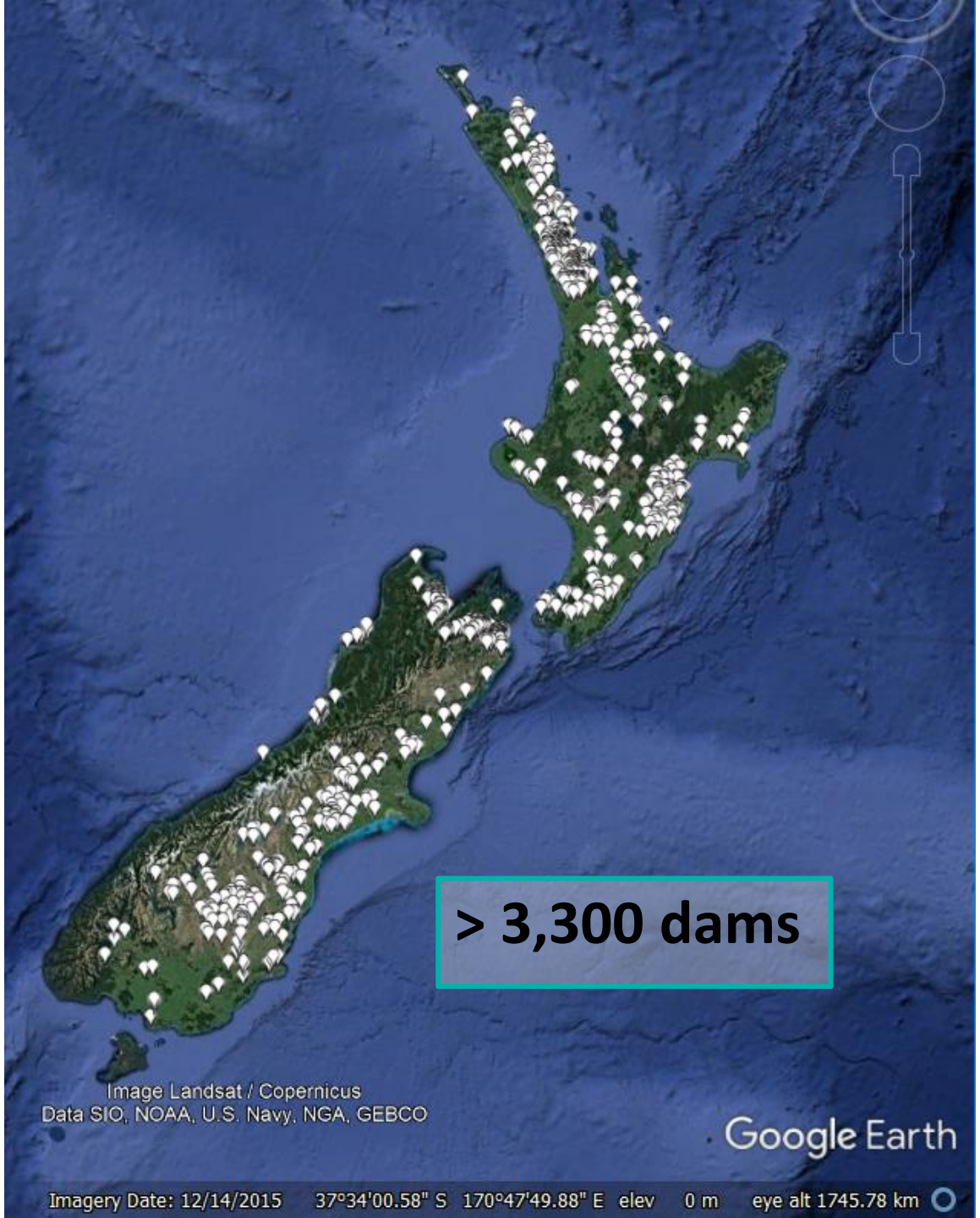
## Dam safety regulations commence today

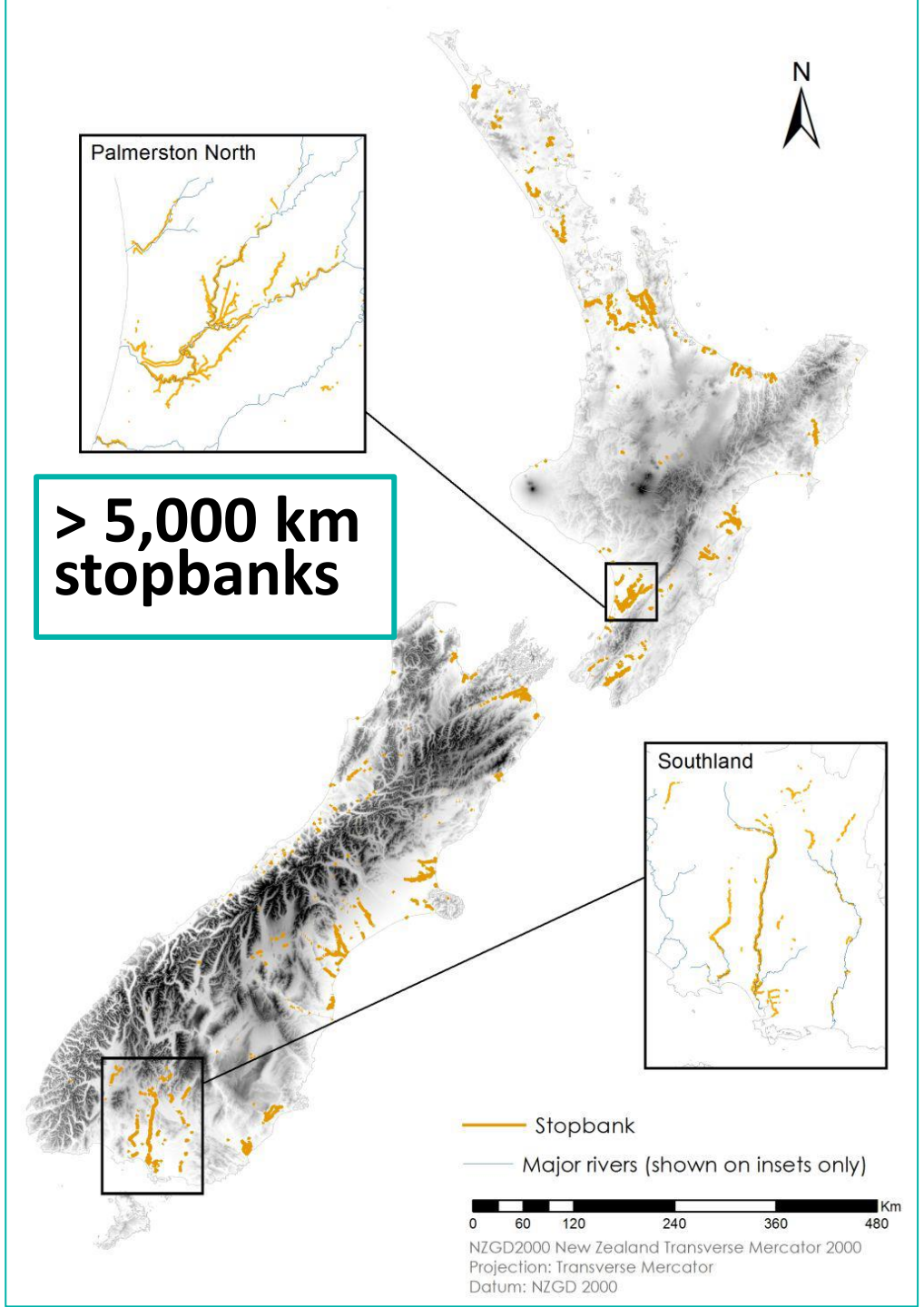
Tēnā koe,

The Building (Dam Safety) Regulations 2022 commence today – **13 May 2024**.

The regulations have been made to increase the resilience and safety of Aotearoa/New Zealand's dams by protecting people, property and the environment from the potential impacts of dam failures.

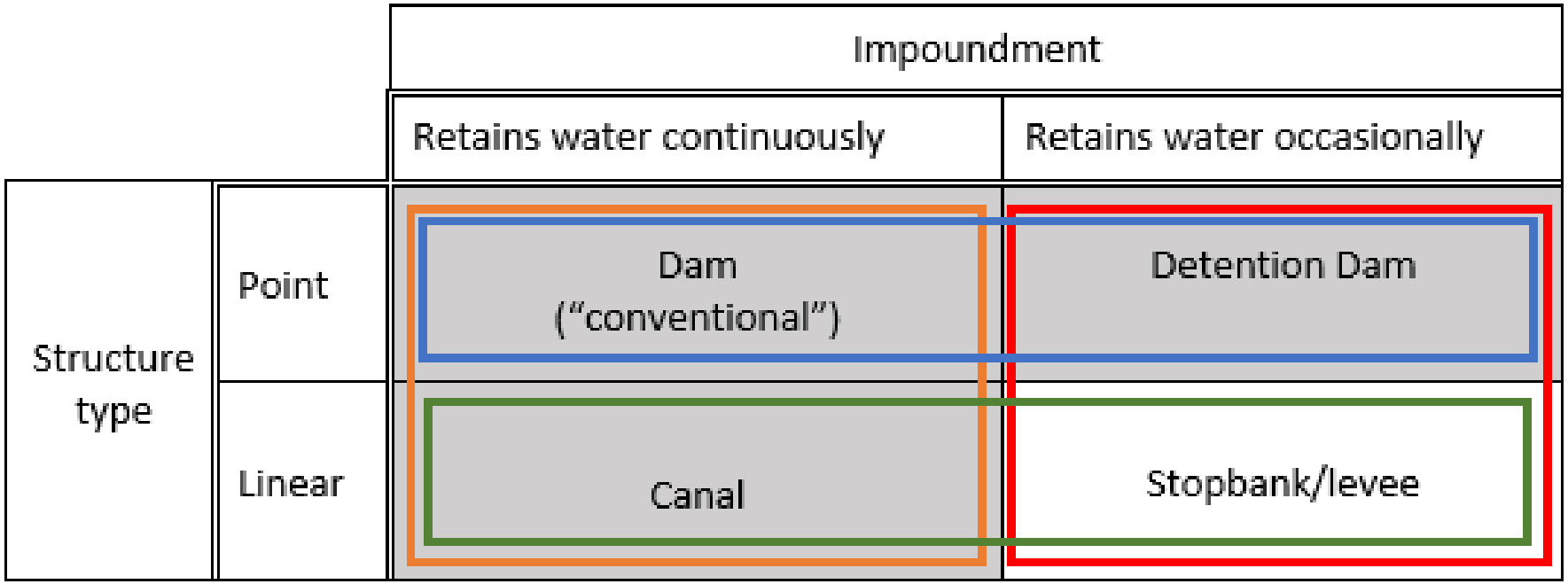
Owners of classifiable dams have until 13 August 2024 to submit their dam's classification certificate to the relevant regional authority.


> 3,300 dams
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth
Imagery Date: 12/14/2015 37°34'00.58" S 170°47'49.88" E elev 0 m eye alt 1745.78 km


N
Palmerston North
> 5,000 km stopbanks
Southland
Stopbank
Major rivers (shown on insets only)
0 60 120 240 360 480 Km
NZGD2000 New Zealand Transverse Mercator 2000
Projection: Transverse Mercator
Datum: NZGD 2000

# Dams, stopbanks, canals… same, same, but different…

# Dams, stopbanks, canals… same, same, but different…




Consider similarities and differences in terms of:

- Function: attenuation vs. routing
- Seepage loading: transient vs. steady state

- Dam Safety Guidelines & Building (Dam Safety) Regulations

- Spatial variation in:
  - Engineering properties (geotech/hydrotech/structural)
  - Hazard exposure
  - Monitoring and surveillance/performance indicators (State-of-Practice)

# Dams, stopbanks, canals… same, same, but different…

| **Performance criteria \| hazard** |  |  |
|---|---|---|
| **Dam, detention dam, canal**<br>High PIC/urban area, i.e. life risk | 1 in 10,000 AEP to PMF | 84th percentile level for the CME (deterministic), and need not exceed 1 in 10,000 AEP (probabilistic) |
| **Stopbank/levee**<br>Urban area | 1 in 100 AEP<br>(? Sometimes?) | ? |

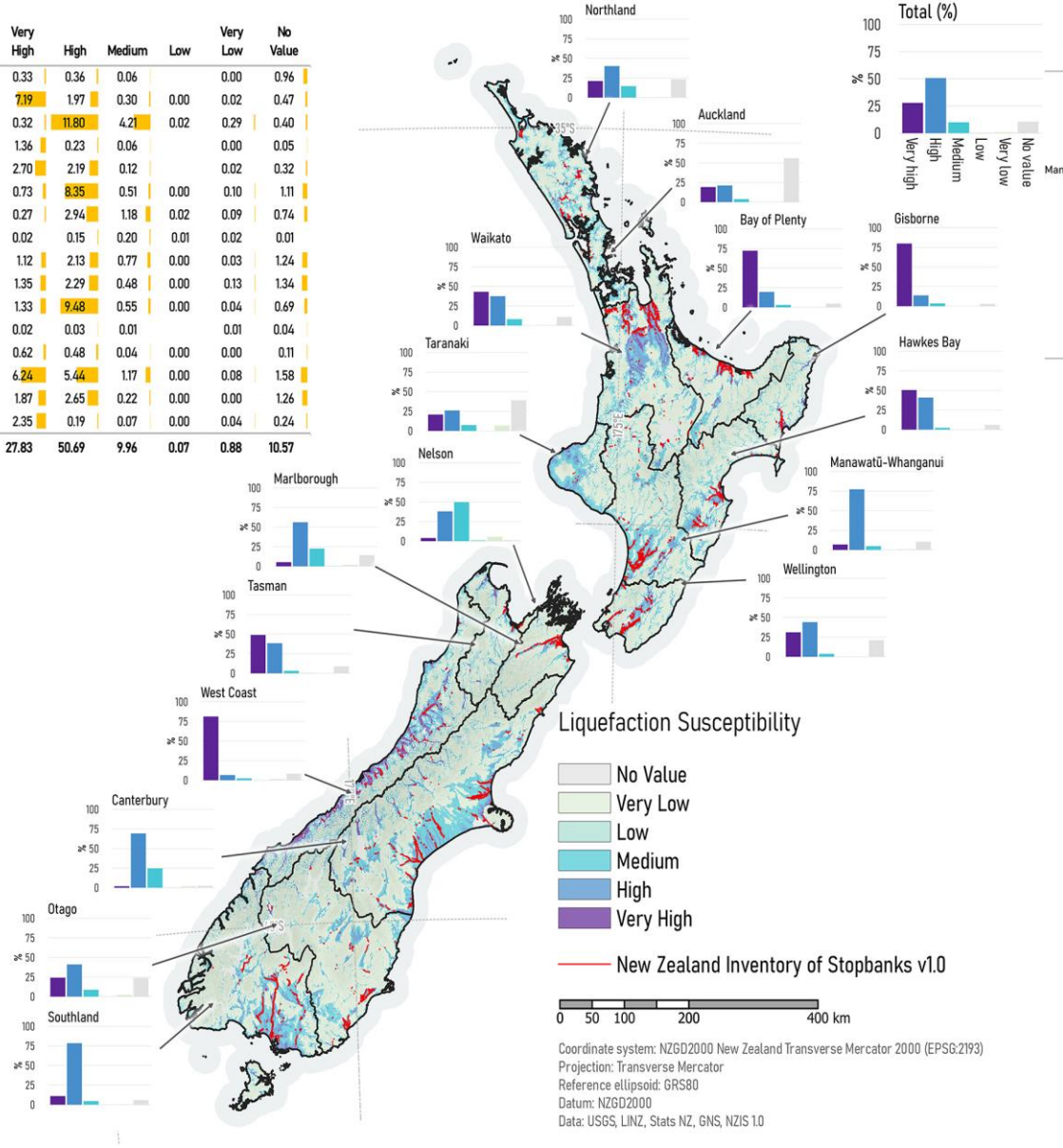
- Dam Safety Guidelines & Building (Dam Safety) Regulations
- But: no standardised flood performance criteria for populated catchments in NZ: “local risks are a local responsibility”

# How to understand and address infrastructure vulnerabilities?
## (and disconnect between hazard/risk for dams and stopbanks?)

Foundational research:

- Created inventories ("best available" data*)
  - Dams → Inform Building (Dam Safety) Regulations**
  - Stopbanks
- National hazard exposure studies (seismic & co-seismic)
  - Stopbanks (Crawford-Flett et al. 2022 – thanks to Daniel Blake)
  - Dams (underway)
- Systems engineering and operational sensitivities in combined dam-stopbank catchments
  - Thomas Wallace PhD research

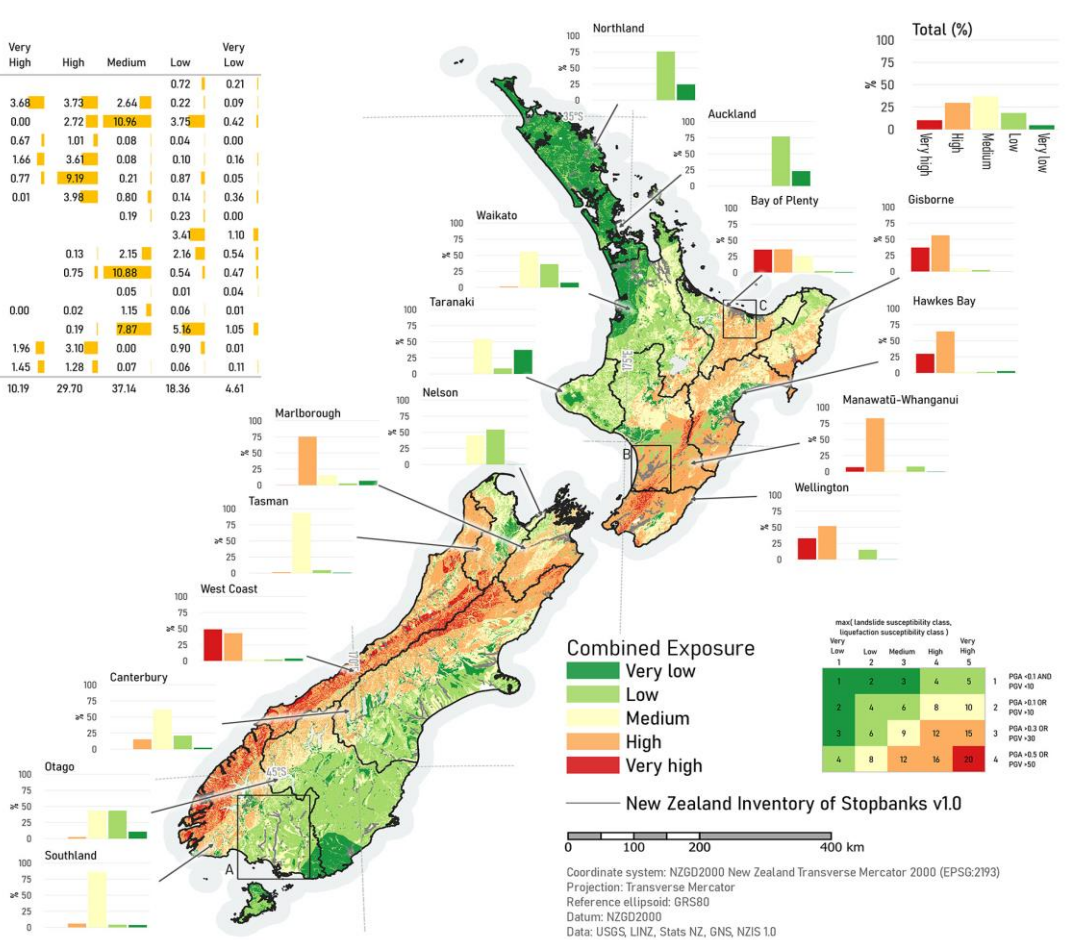
| Regional Council/ Unitary Authority | Very High | High | Medium | Low | Very Low | No Value |
|---|---|---|---|---|---|---|
| Auckland | 0.33 | 0.36 | 0.06 | | 0.00 | 0.96 |
| Bay of Plenty | 7.19 | 1.97 | 0.30 | 0.00 | 0.02 | 0.47 |
| Canterbury | 0.32 | 11.80 | 4.21 | 0.02 | 0.29 | 0.40 |
| Gisborne | 1.36 | 0.23 | 0.06 | | 0.00 | 0.05 |
| Hawkes Bay | 2.70 | 2.19 | 0.12 | | 0.02 | 0.32 |
| Manawatū-Whanganui | 0.73 | 8.35 | 0.51 | 0.00 | 0.10 | 1.11 |
| Marlborough | 0.27 | 2.94 | 1.18 | 0.02 | 0.09 | 0.74 |
| Nelson | 0.02 | 0.15 | 0.20 | 0.01 | 0.02 | 0.01 |
| Northland | 1.12 | 2.13 | 0.77 | 0.00 | 0.03 | 1.24 |
| Otago | 1.35 | 2.29 | 0.48 | 0.00 | 0.13 | 1.34 |
| Southland | 1.33 | 9.48 | 0.55 | 0.00 | 0.04 | 0.69 |
| Taranaki | 0.02 | 0.03 | 0.01 | | 0.01 | 0.04 |
| Tasman | 0.62 | 0.48 | 0.04 | 0.00 | 0.00 | 0.11 |
| Waikato | 6.24 | 5.44 | 1.17 | 0.00 | 0.08 | 1.58 |
| Wellington | 1.87 | 2.65 | 0.22 | 0.00 | 0.00 | 1.26 |
| West Coast | 2.35 | 0.19 | 0.07 | 0.00 | 0.04 | 0.24 |
| Total (%) | 27.83 | 50.69 | 9.96 | 0.07 | 0.88 | 10.57 |

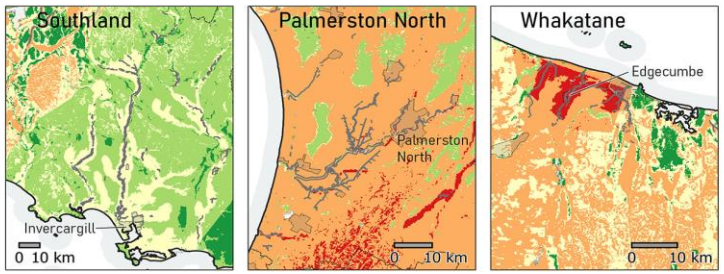




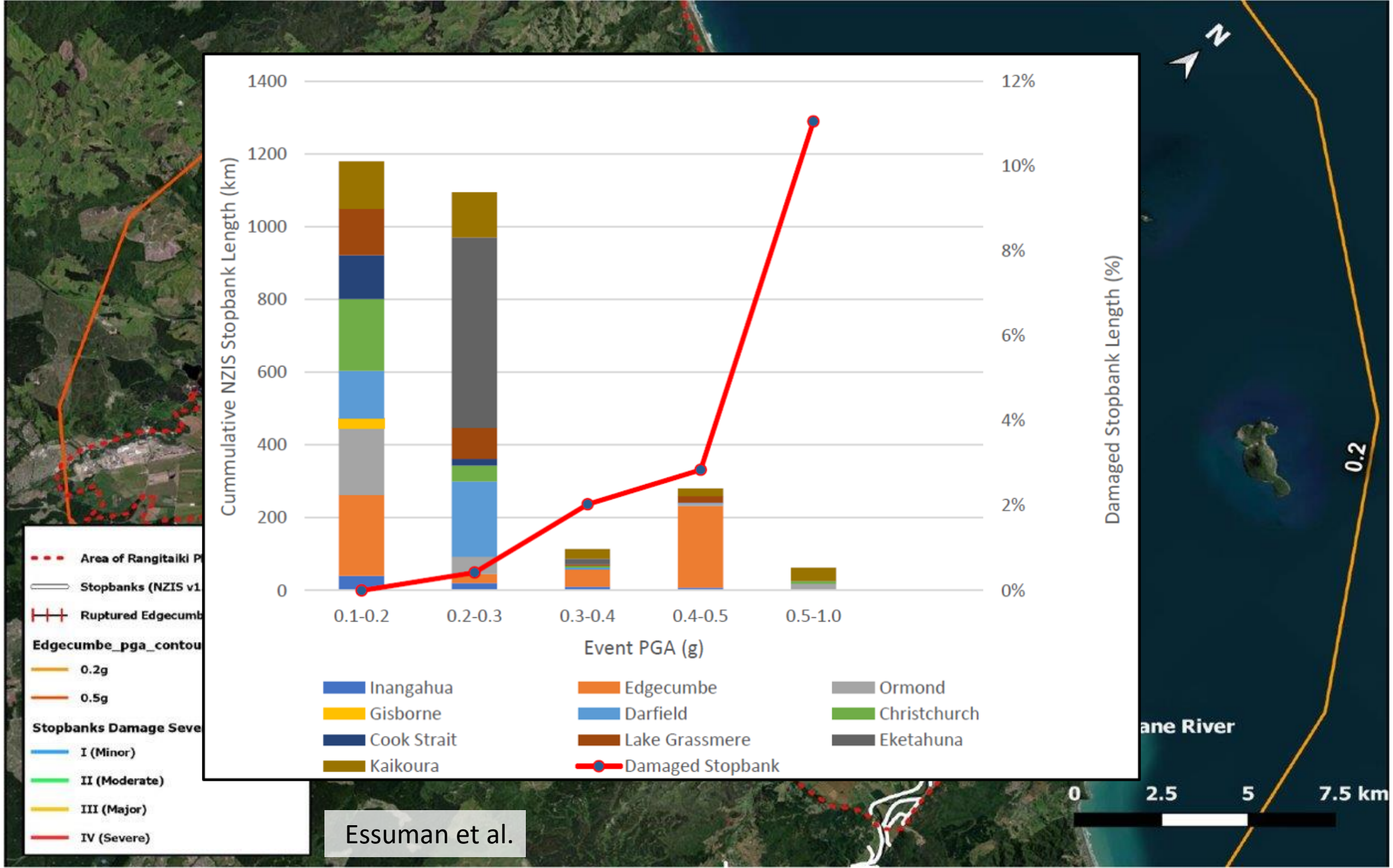


| Regional Council/ Unitary Authority | Very High | High | Medium | Low | Very Low |
|---|---|---|---|---|---|
| Auckland | | | | 0.72 | 0.21 |
| Bay of Plenty | 3.68 | 3.73 | 2.64 | 0.22 | 0.09 |
| Canterbury | 0.00 | 2.72 | 10.96 | 3.75 | 0.42 |
| Gisborne | 0.67 | 1.01 | 0.08 | 0.04 | 0.00 |
| Hawkes Bay | 1.66 | 3.61 | 0.08 | 0.10 | 0.16 |
| Manawatū-Whanganui | 0.77 | 9.19 | 0.21 | 0.87 | 0.05 |
| Marlborough | 0.01 | 3.98 | 0.80 | 0.14 | 0.36 |
| Nelson | | | 0.19 | 0.23 | 0.00 |
| Northland | | | | 3.41 | 1.10 |
| Otago | | 0.13 | 2.15 | 2.16 | 0.54 |
| Southland | | 0.75 | 10.88 | 0.54 | 0.47 |
| Taranaki | | | 0.05 | 0.01 | 0.04 |
| Tasman | 0.00 | 0.02 | 1.15 | 0.06 | 0.01 |
| Waikato | | 0.19 | 7.87 | 5.16 | 1.05 |
| Wellington | 1.96 | 3.10 | 0.00 | 0.90 | 0.01 |
| West Coast | 1.45 | 1.28 | 0.07 | 0.06 | 0.11 |
| Total (%) | 10.19 | 29.70 | 37.14 | 18.36 | 4.61 |




Crawford-Flett, K., Blake, D. M., Pascoal, E., Wilson, M., & Wotherspoon, L. (2022). **A standardised inventory for New Zealand's stopbank (levee) network and its application for natural hazard exposure assessments.** *Journal of Flood Risk Management*, *15*(2), e12777.




Essuman et al.

Stuff LOGIN

NZ NEWS / QUIZZES / SPORT / WORLD / LIST

# Council defends flood dams, investigating whether stream channels properly maintained

Marty Sharpe

# Dam, ponds burst, cause flooding in city

23 Jun 2023, 12:16 pm News

Heavy rain has caused
the outskirts of Hamilto
floodwaters down city

The ponds and dam ar
managed by Waipā Dis
used to hold stormwat
downstream areas fro

# Cyclone G
# over Gene
# Wairoa flo

Gisborne Herald

24 Feb, 2023 06:44 AM

# Genesis Energy on Wairoa flood

By Jamie Gray

27 Feb, 2023 01:11 PM

Save Share

# Flood-damaged Huntly property owner unhapp
# extra water released fr
# dam

Wednesday, 1 February 2023 • By Tamati Tiananga

Lake Waikaremoana stoush
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# Matahina Dam responsible for flooding, say residents

Apr 07, 2017, · 08:41pm 0 Share


Work on rebuilding Edgecumbe's flood wall began last week.

Matthew Littlewood

May 31, 2021, · 04:07pm 2 Share

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# $31 million Cashmere Dam to ease Heathcote river flooding

Nil Harvie

Jul 28, 2022, · 05:00am 16 Share

# Matahina Dam responsible for flooding, say residents

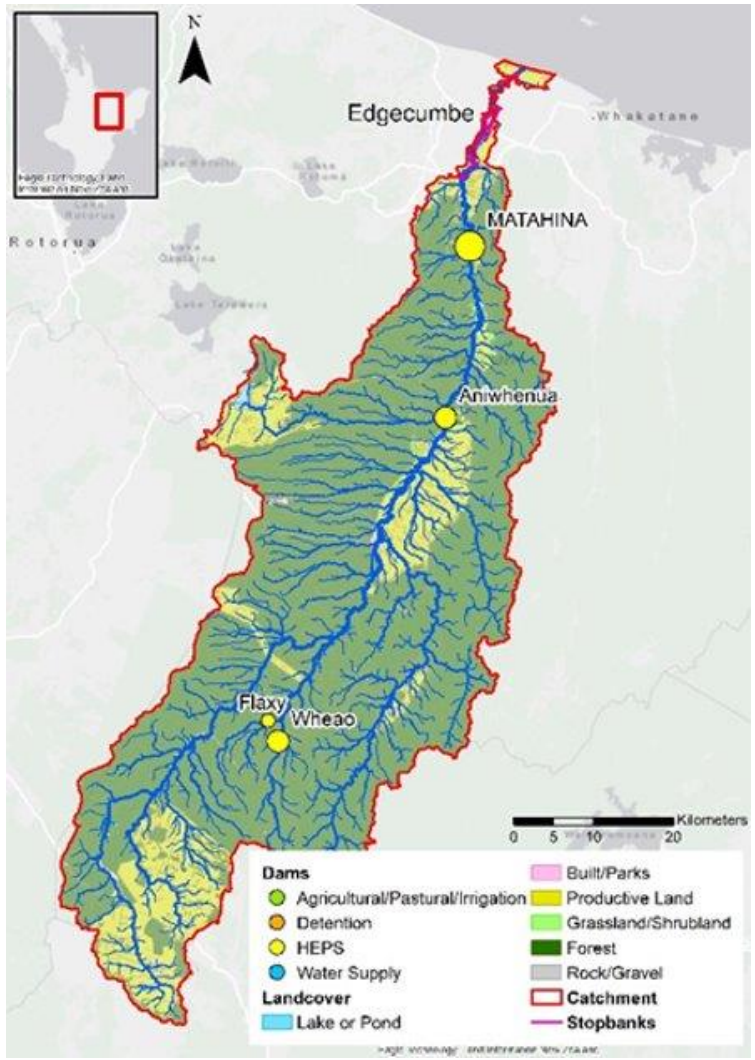
Apr 07, 2017, · 08:41pm 0 Share

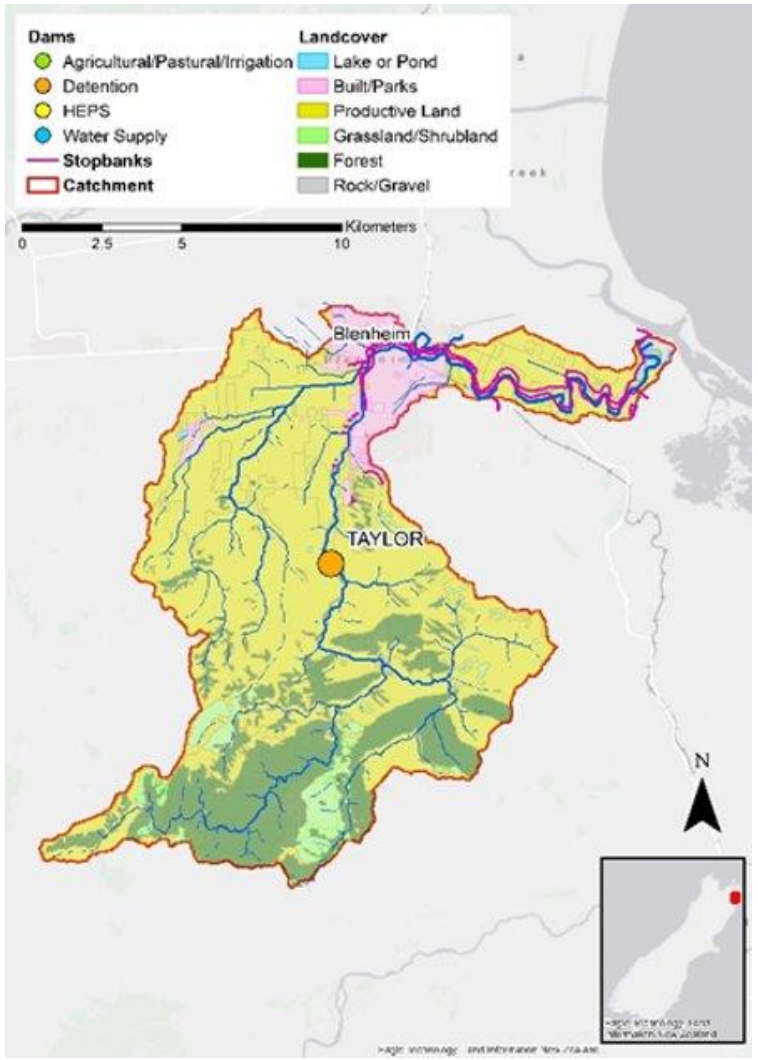
# Council denies dam to blame for flooding

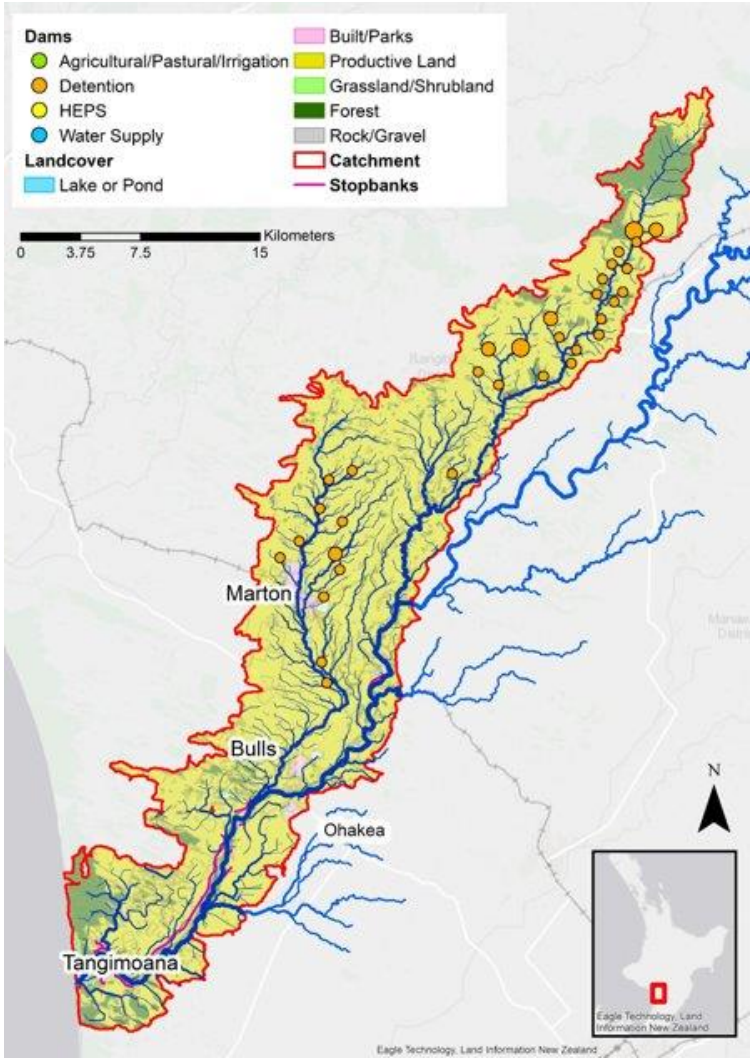
8:28 am on 7 April 2017

Share this

# Dam – stopbank systems (Wallace et al.)



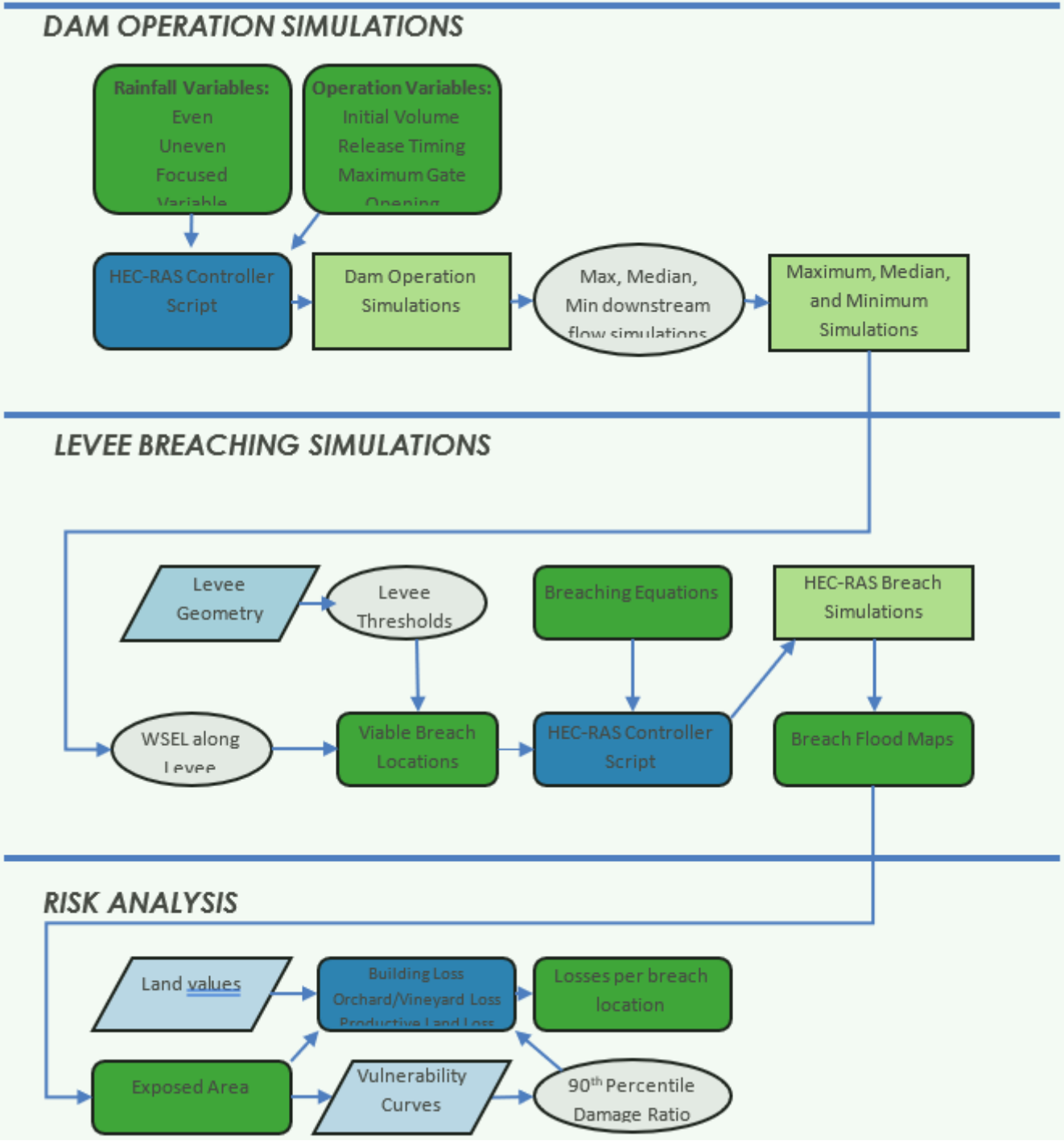



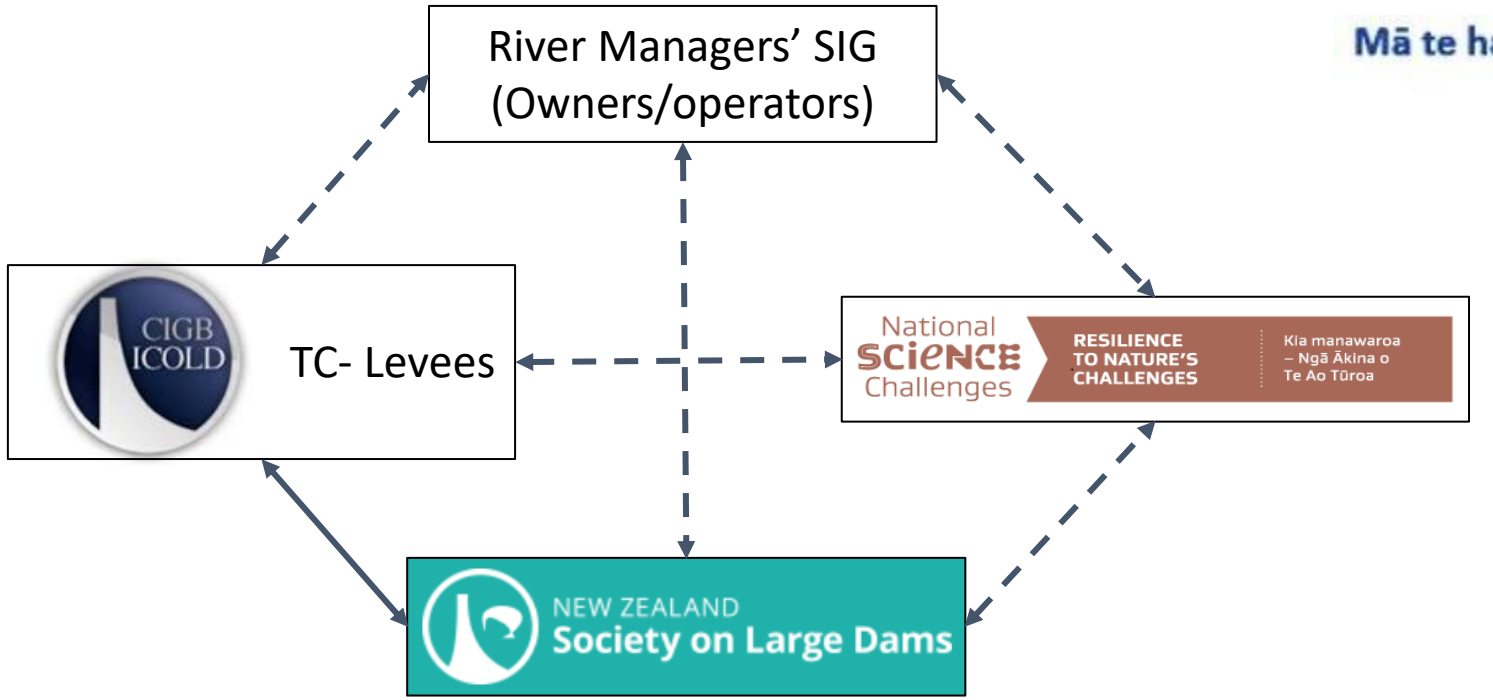
# Dam – stopbank systems

(Wallace et al.)

- Understanding sensitivity of dam operations on downstream stopbank loading
- Breach and no-breach scenarios for stopbanks
- Loss modelling to identify critical breach locations



# A foundation for future research: team effort




Mā te haumaru ō nga puna wai ō Rākaihautū ka ora mo ake tonu:
Increasing flood resilience across Aotearoa

QuakeCoRE
NZ Centre for Earthquake Resilience
Te Hiranga Rū

AF8
ALPINE FAULT MAGNITUDE 8

EXTREME WEATHER RESEARCH PLATFORM
Te Rāngai Rangahau Āhuarangi

# A foundation for future research

- A ‘prologue’ for dams and stopbank research
- Projects span research/practice/government interfaces
- Links and **relationships** to enable future research
- New Zealand focus, international knowledge-sharing
- ‘The missing middle’ – whose responsibility?

Analysis:

Spatial scale (national vs local)

Temporal scales (day vs week vs decade)

Data process (manual vs automated)

**BOTH/AND**

not

**EITHER/OR**

National Science Challenges

RESILIENCE TO NATURE'S CHALLENGES

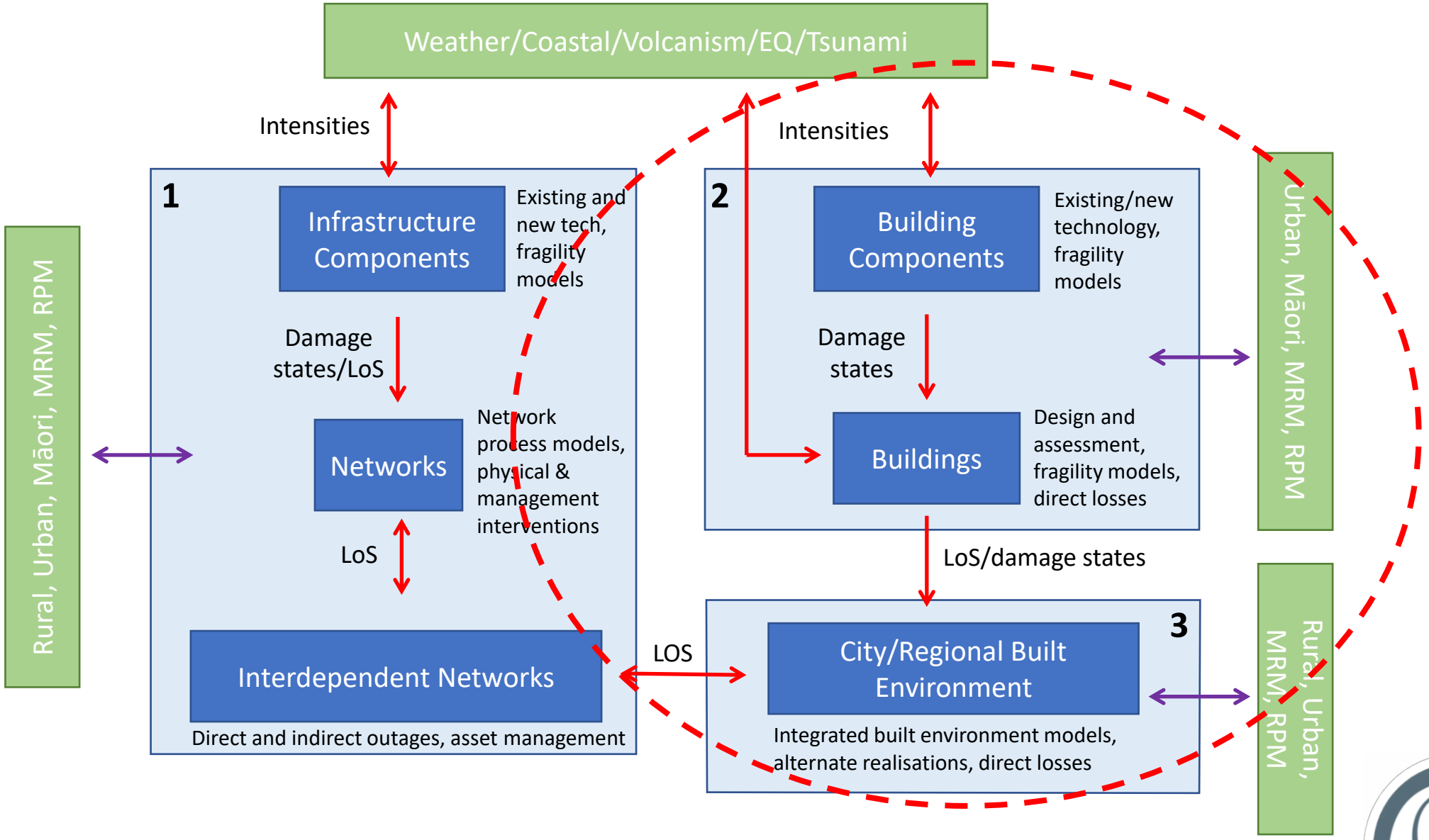
Kia manawaroa – Ngā Ākina o Te Ao Tūroa

# Overview of Vertical Infrastructure Research and Outcomes

Tim Sullivan

*University of Canterbury*

RNC Symposium 2023


Weather/Coastal/Volcanism/EQ/Tsunami
Intensities
Intensities
1
Infrastructure Components
Existing and new tech, fragility models
Damage states/LoS
Networks
Network process models, physical & management interventions
LoS
Interdependent Networks
Direct and indirect outages, asset management
2
Building Components
Existing/new technology, fragility models
Damage states
Buildings
Design and assessment, fragility models, direct losses
LoS/damage states
3
City/Regional Built Environment
Integrated built environment models, alternate realisations, direct losses
LOS
Rural, Urban, Māori, MRM, RPM
Urban, Māori, MRM, RPM
Rural, Urban, MRM, RPM

# Overview of vertical infrastructure aims

Two main research areas:

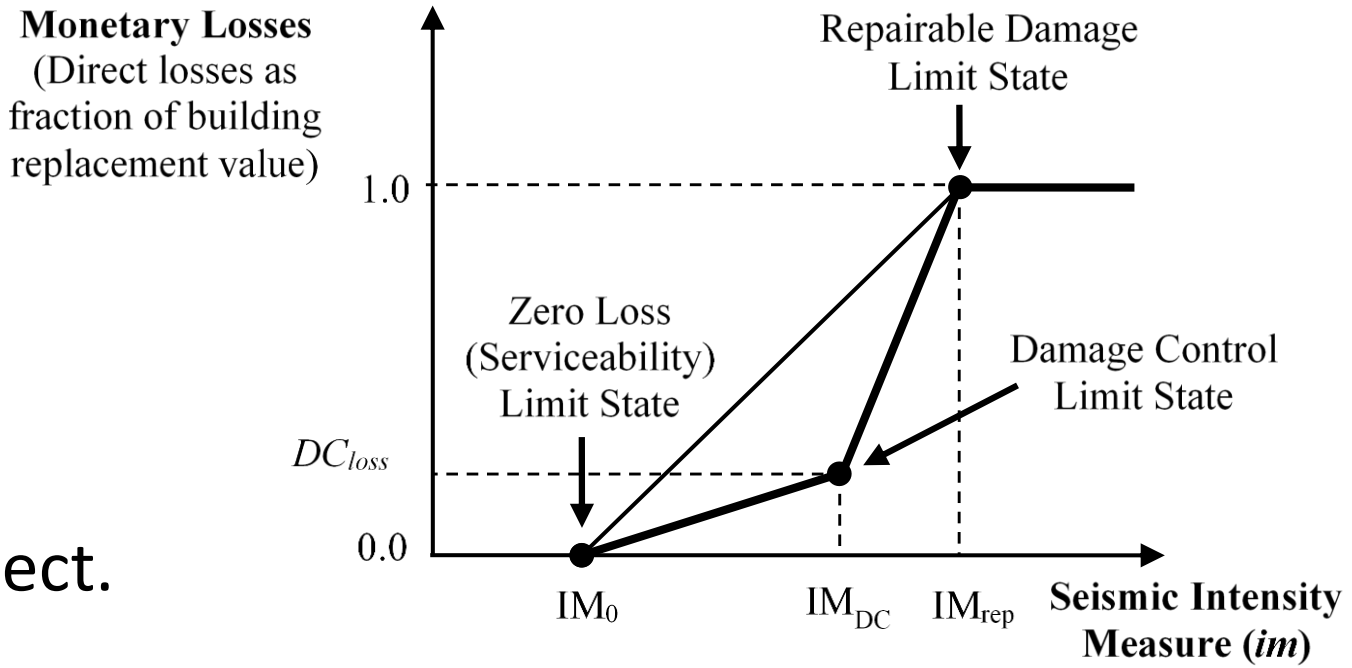
1. Quantifying and mitigating the risk (in terms of monetary losses) associated with different design solutions and building technologies.
2. Supporting the development of design and assessment standards for NZ buildings to enable enhanced performance objectives to be achieved in practice.

# Highlights related to quantification and mitigation of seismic risk

# Improved insight into the seismic risk for buildings in NZ

New tools and information developed:

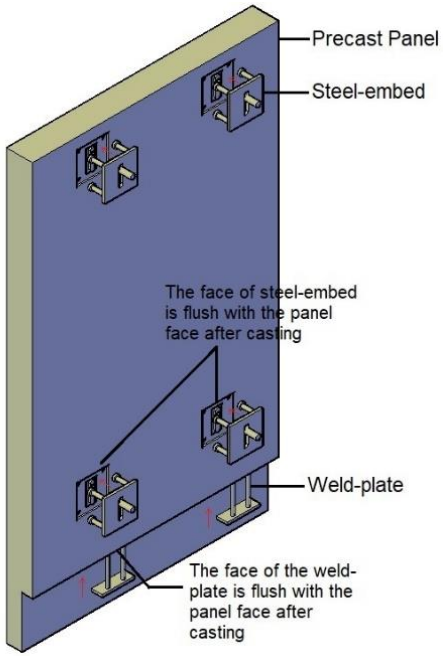
- By identifying a simplified loss-intensity relationship, a new approach to enable rapid assessment of the expected annual loss (repair cost) has been developed.
  → useful for trialling different possible design criteria.
- Has been adopted in support of the Engineering New Zealand Low-Damage Seismic Design project.

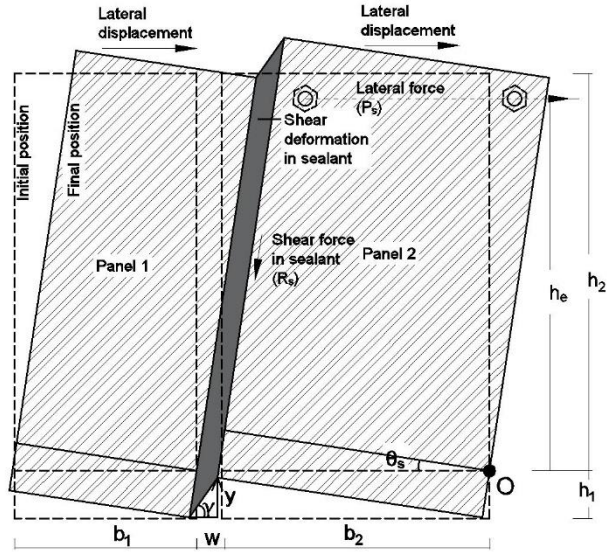


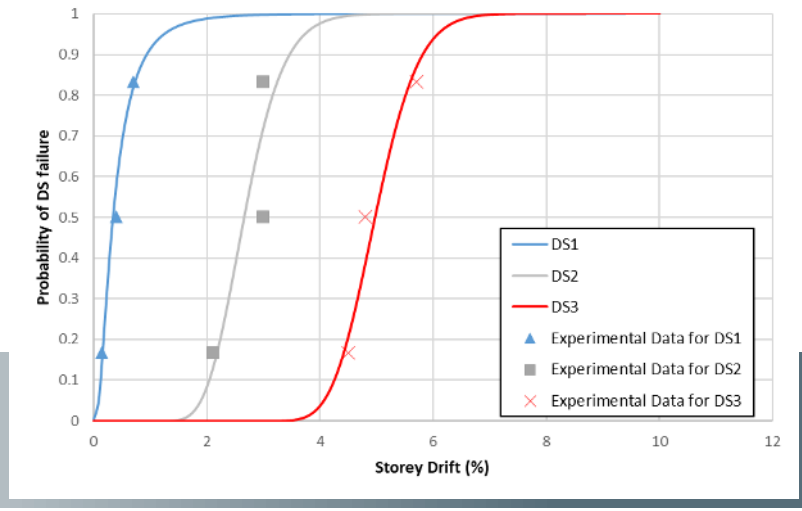

| Case study building | 4-Storey (EAL) | | 12-Storey (EAL) |
|---|---|---|---|
| | Wellington | Christchurch | Wellington |
| **Two-damage state loss model** | 0.20% | 0.12% | 0.19% |
| **Three-damage state loss model** | 0.17% | 0.07% | 0.15% |
| **Rigorous method (FEMA p58)** | 0.17% | 0.07% | 0.15% |

# New data on the fragility of building elements

Experimental Setup


→ Research work co-funded by QuakeCoRE.

→ Improved confidence in loss-assessment studies

# Improved insight into the seismic risk for buildings in NZ

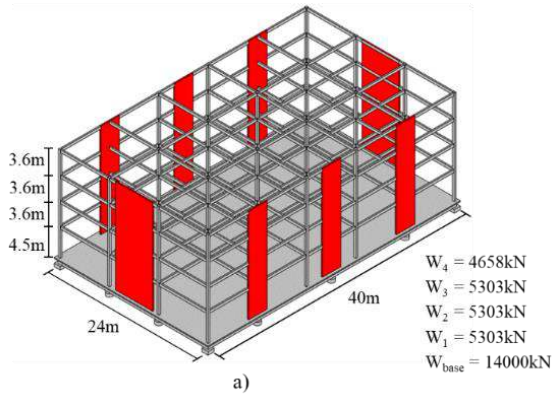
## Benchmarking performance of new code-compliant designs:

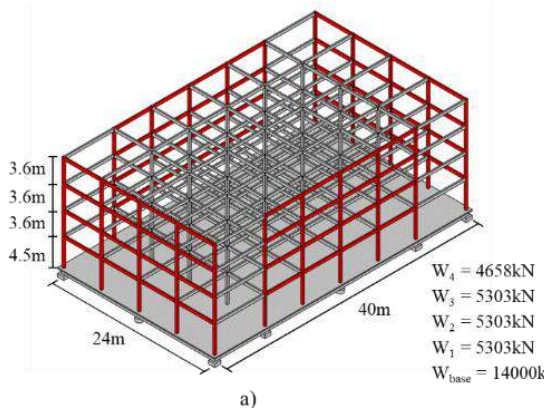
Case-study buildings designed in line with code.

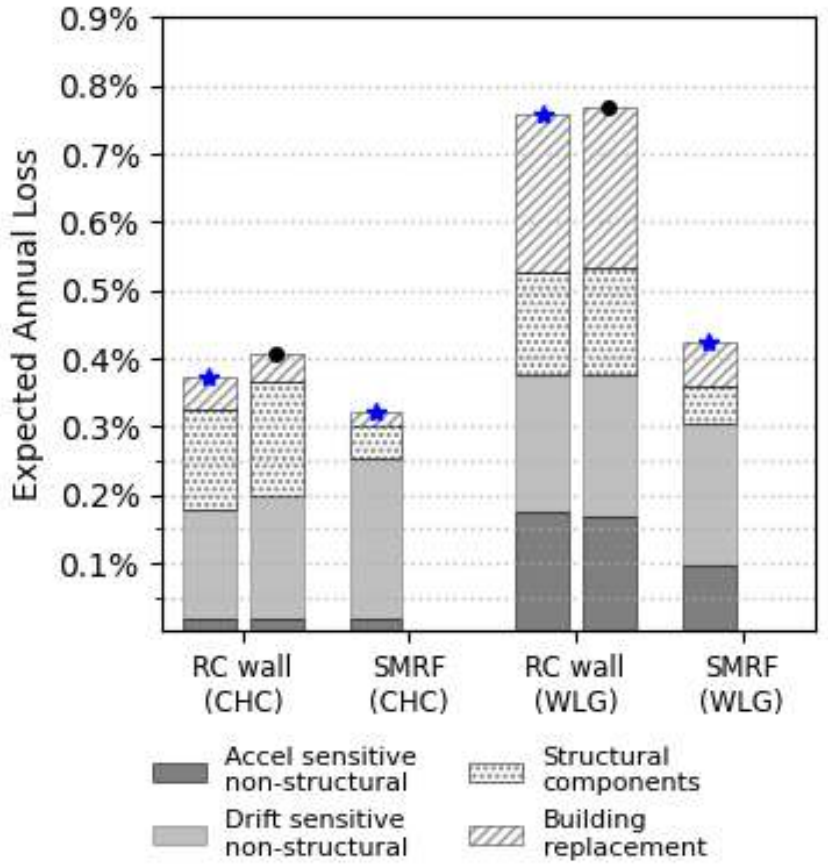
Seismic loss assessment conducted using FEMA P58 methodology with NZ-specific fragility and loss functions.

Expected annual loss (= the average repair cost divided by the building replacement cost) obtained for different building typologies designed in different regions.

→ useful for assessing impact of new design criteria… informing both NZ SRWG and Low-Damage Design Project

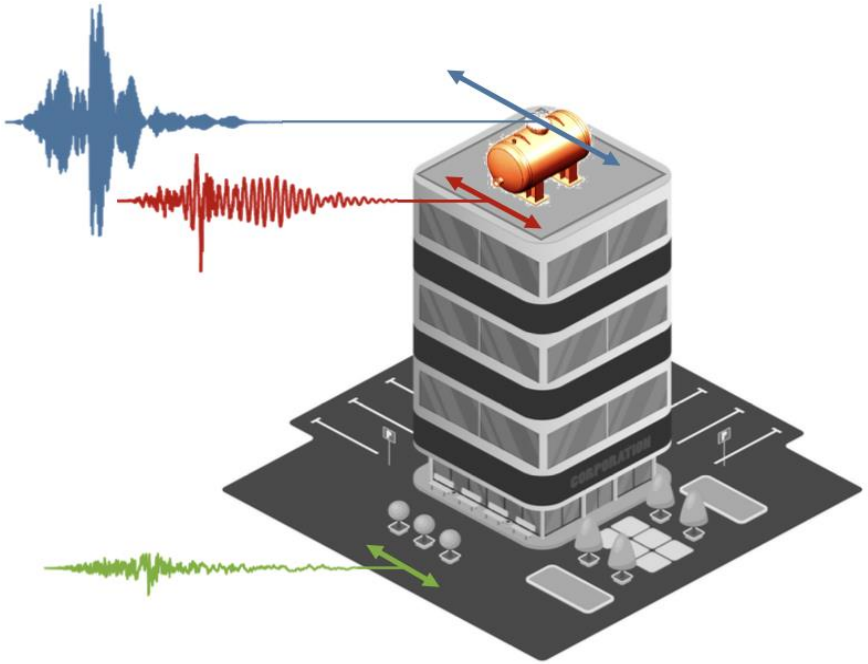


# Highlights relevant to the design of New Buildings

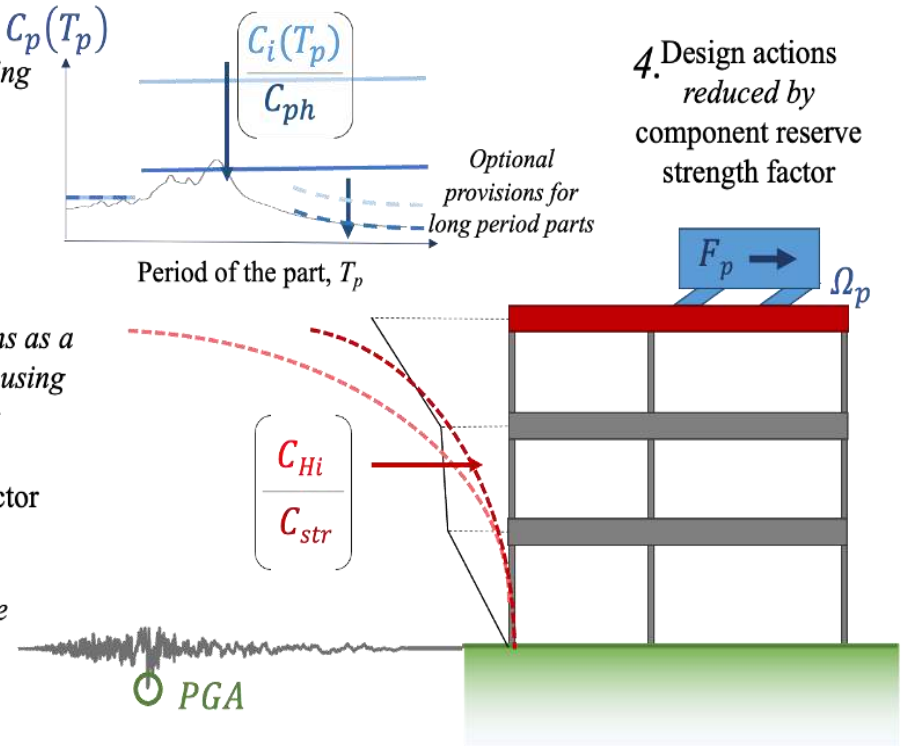
# New design actions for parts and components in buildings



3. *Amplification of part response using* spectral shape factor *reduced by* component response factor

2. *Distribution of peak floor accelerations as a function of peak ground acceleration using* floor height amplification factor *reduced by* structural nonlinearity reduction factor

1. *Ground motion excitation at base considering limit state design* peak ground acceleration

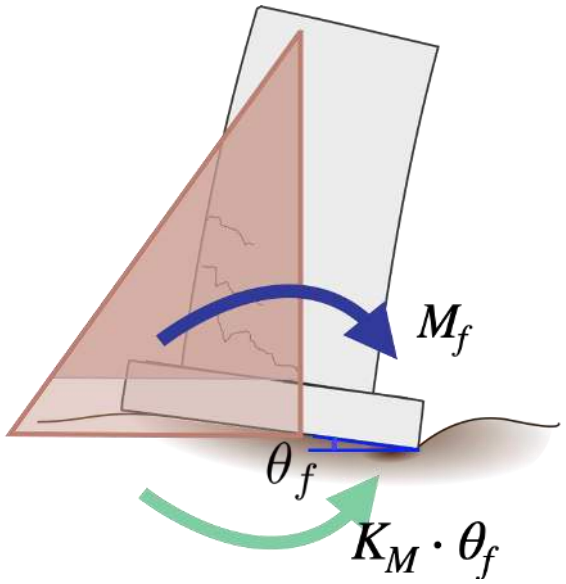



4. Design actions *reduced by* component reserve strength factor

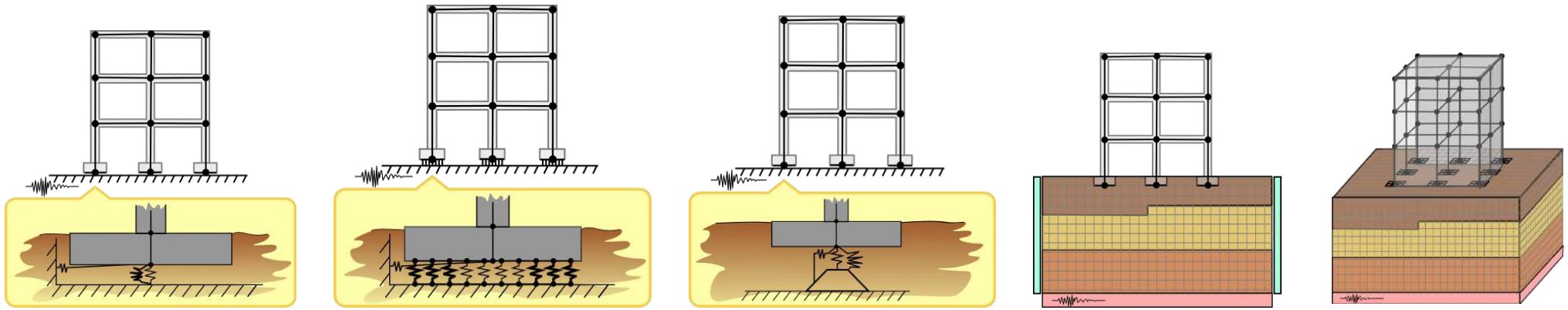
→ Research work co-funded by EQC and QuakeCoRE.

→ Has lead to draft revisions to NZ seismic loadings standard (TS 1170.5)

# Simplified means of accounting for soil-structure interaction




- New guidance on modelling frame buildings on shallow foundations with soil springs
- New guidance on design of rocking foundations for mid-rise buildings
- Work supporting the inclusion of a simplified rocking foundation design approach in draft TS 1170.5
- Work supporting a SESOC short course for practicing engineers on design, assessment and simulation of soil structure interaction for practice
- Additional papers in development on quantification of rocking behaviour, new spring-based modelling methods, and improvements to seismic assessment considering SSI

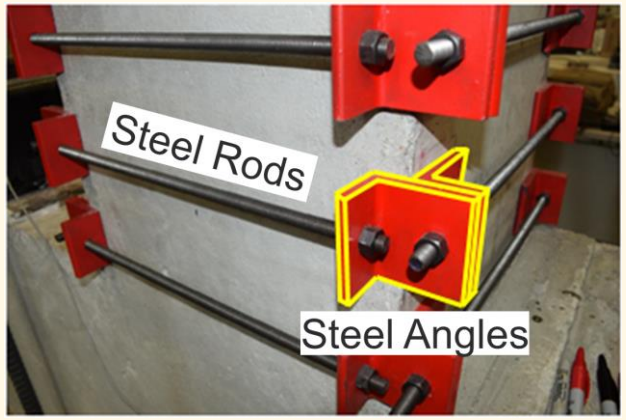


# Highlights relevant to the assessment and rehabilitation of existing buildings

# New retrofit and repair options for RC columns

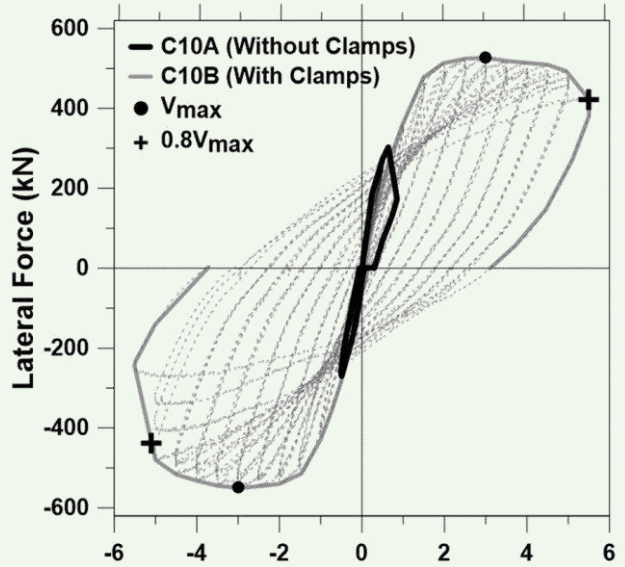
Damage after 2023 Turkey EQs

**How to retrofit and/or repair RC columns in large building inventories?**


Proposed P.T. Clamps for retrofit and repair

## Results



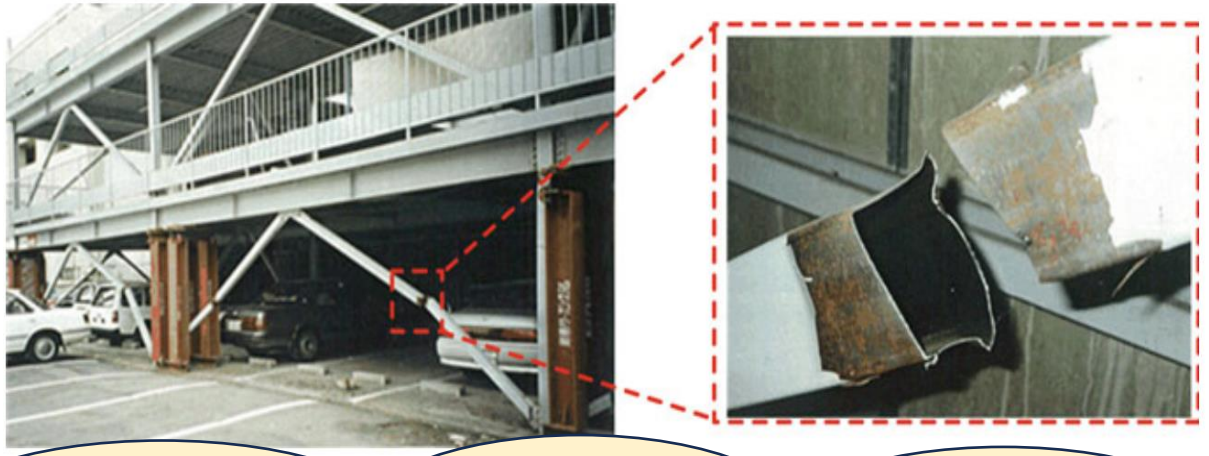

- Increase in Lateral-load Resistance
- Increase in Drift Capacity

# Identifying post-earthquake repair needs for steel structures

New tools and information developed:

- The Canterbury earthquakes highlighted uncertainties engineers face when assessing the residual capacity of steel structures post-EQ.
- Research is developing a fracture model to assess steel structures under under low-cycle fatigue conditions.

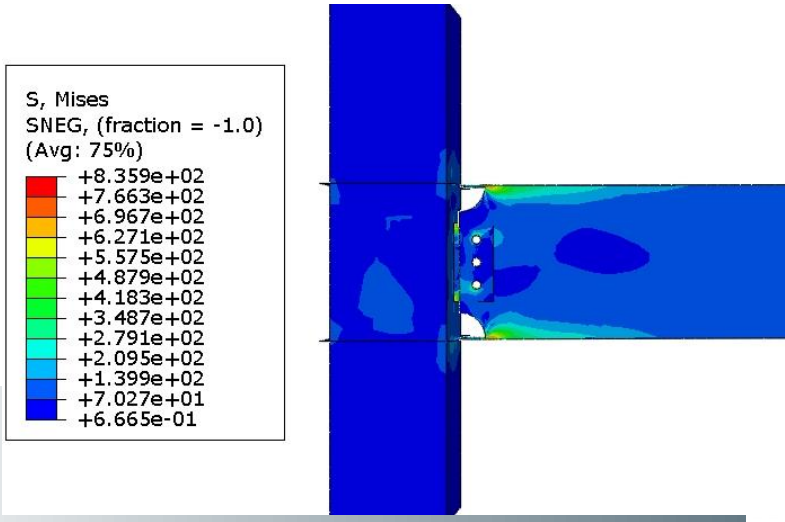
→ Will aid engineers (and insurers) making post-earthquake decisions.

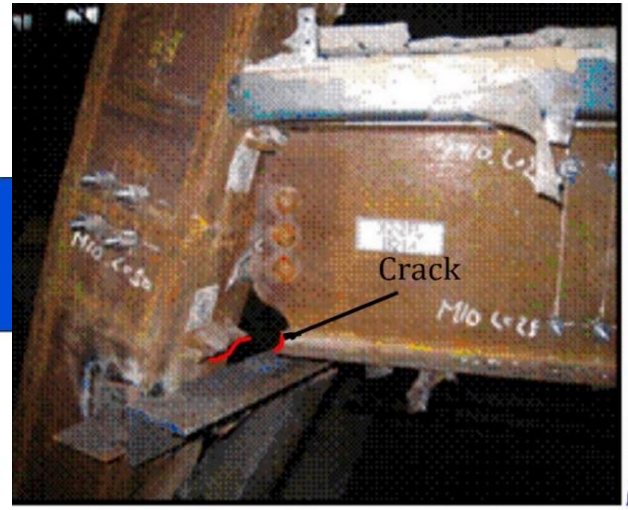


Leave the Structure as is?

Repair the structure?

Replace the structure?



# Performance-based Engineering for Tribal Property and Infrastructure Development

- Thesis by Kākati Te Kākākura Royal
- Resilience to Natures Challenge Symposium

- 14th May 2024

Delivering a better world

aecom.com

## Purpose

To provide an overview and summary of my research in the context of New Zealand history and the future direction of the tribe.

The general purpose of today is to stimulate discussion and offer my thoughts.

# What are we going to focus on?

1 Historical context – The three dominant themes.

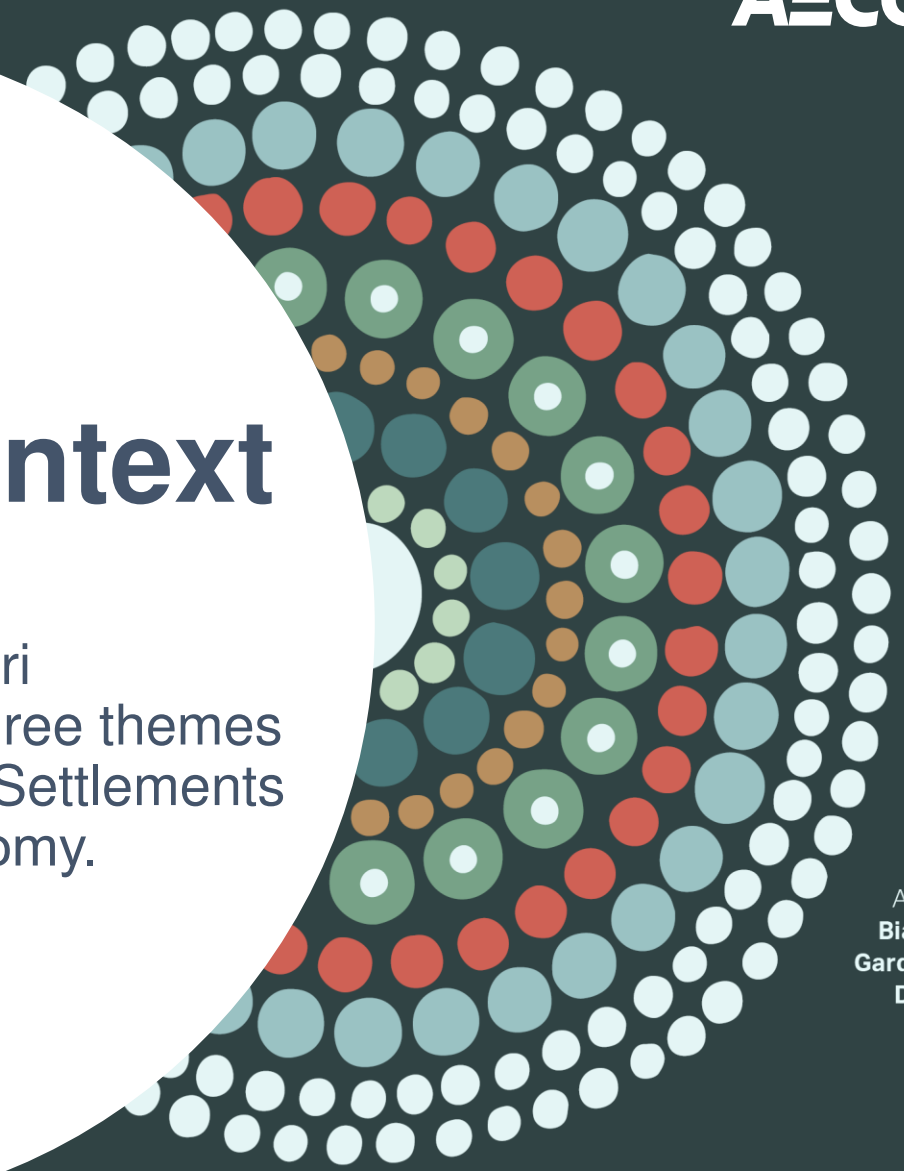
2 Current context: Post-settlement situation appraisal.

3 My response through research

4 Future development and recommendations

# Historical Context

- Science and Maori
- Colonisation History: the Three themes
- Tribal Corporations: Treaty Settlements and the Māori economy.



Art by
**Bianca Gardiner Dodd**

# A historical perspective on the relationship between the scientific community and the indigenous Māori world

1

Linear progression

- Ptolemy
- Galileo
- Kepler
- Newton
- Einstein

2

19th Century.

- Contact is made
- Our people are busy
- The whole religious progression happens
- European Medieval history condescend into a century

3

1863 Manuscript tribal priest discussing:

- Tribal traditions creation of the universe
- Eratosthenes equation
- Johan Meadlers theory

4

Implications.

- Meadler was wrong but they are discussing the idea
- They are writting in Greek
- The tribe modernisers quickly

5

Conclusion.

- We automatically adopt technology and knowledge
- The idea that we're stuck in a medieval static spiritual world is probably wrong

6

The point.

- The tribe are probably Popperians
- We modernise not westernise
- We have our own knowledge systems as well

# How to eat the elephant? One bite at a time.

1 Story of New Zealand's colonisation often told describing Māori as impoverished due to loss of land by fraudulent sales and confiscation.

2 With many good stories there follows a redemptive arc where Māori finally regain some of their land and are compensated by way of Treaty Settlements.

3 The catalyst for this redemption led by three pivotal themes emerging in the disquiet part of the 19th/20th century which I group under the following.

4 The three dominant themes
(1) A Quest for Social Justice
(2) Cultural Revitilisation and Restoration
(3) Creativity, Enterprise and Entreprenuership.

5 Expressions of these themes include:
- Advancing Treaty Claims
- Māori Education
- Māori Television and Radio
- Tribal Corporations
- Tribal Government

6 It is the latter theme I allocate the majority of my focus.

# Demystifying Treaty Settlements: History of Tribal Corporations

**Political Context of 1984**

- In 1984, New Zealand underwent significant political changes.
- Robert Muldoon called for a snap election and lost to the fourth Labour government. Forced us into Financial Crisis.
- The economic landscape was largely Keynesian, with a closed economy and conservative policies. Big think projects fall over.
- In the UK, Margaret Thatcher's government was advancing privatisation led by thought leaders such as Milton Friedman in the 60's and 70's.
- This period is largely known as Rogernomics after Roger Douglas, Minister of Finance. Advances neoliberalism, reducing government intervention and establishing implementing market-oriented policies.

**Legislation and Settlements:**

- The Fourth Labour Government initiated the process of neoliberalism in New Zealand.
- Two crucial legislations were passed:
    1. *State-owned Enterprise Act 1986* established Corporations and
    2. *Waitangi Tribunal Amendments Act 1986*, extended the powers of the Waitangi Tribunal to investigate historical Treaty grievances and make recommendations to the government .
- The settlement process began, with Waikato and Ngāi Tahu being the first to address their claims.
- The traditional formula for seeking redress predominantly focused on Ngāi Tahu, Waikato, and Fisheries claims, citing grievances against the Crown's actions or inactions contrary to the Treaty of Waitangi.
- Since 1995, 86 Treaty settlements have been signed into law, totalling approximately $2.6 billion (excluding relativity payments).
- Three tribes have surpassed the $1 billion mark in settlements.
- However, several iwi, including Ngāpuhi, the largest iwi by population, are yet to settle, but they are poised to receive significant redress packages.

**Treaty Settlements**

1. Cash and Commercial Assets.
2. Cultural Redress.
3. Apology from the Crown.
4. Rights:
    - Right of First Refusal (RFR)
    - Relativity Mechanism
    - Tino Rangatiratanga
    - Note, Water Rights outside scope and still not settled.

**Implications**

1. Government doesn't deal with informal village structures: what's an iwi?
2. Tribes must have a commercial vehicle to vest treaty settlement assets in.
3. Government forces us to adopt: Corporations and Charitable Trusts.
4. Māori were the neoliberal experiment of the 80's.
5. Water was not negotiated.

# Situation Appraisal

- The Māori Economy
- Iwi Investment Analysis
- Our contribution to New Zealand's Economy
- New Age for the Tribe

# MAORI ECONOMY OUTLOOK (RBNZ, 2018)

| 775,800 | 68% | $17B | $68.7B | 5% |
|---|---|---|---|---|
| Māori Population | Working Age | GDP Production | Asset Valuation | Annual Growth |

# The Māori Economy.


Figure 1. Three perspectives of the Māori economy (RBNZ, 2018).

**Approximate Definition.**

- The concept of the Māori economy defies conventional definition due to its unique nature.
- At its core, the Māori economy encompasses the quantification of assets owned and the monetary activity generated by Māori.
- However, it diverges from the traditional notion of an economy due to the absence of fiscal authority or a reserve bank.
- Conclusion: Māori Economy does not exist, it is an adjunct of the wider national economy.

# Iwi Investment Analysis – 30 years since first Treaty Settlement


Table 1. Summary of investment strategies (TBD, 2023).

| | Total assets $, million | Asset classes | Largest asset class | Capital allocated to this class | Management approach | Gearing |
|---|---|---|---|---|---|---|
| Ngāi Tahu | 2,214 | 6 | Property | 39% | Largely active | 16 |
| Ngāpuhi | 88 | 5 | Fishing | 38% | Largely passive | 3 |
| Ngāti Awa | 180 | 6 | Primary industries | 44% | Mixed | 6 |
| Ngāti Pāhauwera | 101 | 5 | Forestry | 58% | Largely active | 19 |
| Ngati Porou | 298 | 6 | Financial assets | 51% | Largely passive | 7 |
| Ngāti Toa | 795 | 5 | Property | 78% | Largely active | 46 |
| Ngāti Whātua Ōrākei | 1,573 | 2 | Property | 97% | Active | 12 |
| Raukawa | 238 | 6 | Property | 32% | Mixed | 0 |
| Tūhoe | 406 | 7 | Financial assets | 51% | Largely passive | 0 |
| Waikato-Tainui | 2,207 | 6 | Property | 66% | Largely active | 10 |

**Introduction to Iwi Investments.**

- Combined assets of approximately $8.1 billion are covered, representing around 69% of all post-settlement iwi assets.
- The challenging financial climate in 2023 resulted in decreased returns and financial losses for many iwi due to global market declines.

**Investment Strategies and Approaches:**

- Similar corporate structures – commercial holdings group with a cultural purpose.
- Various investment approaches are adopted, with different levels of gearing and management styles across asset classes.
- Largely invest in property and primary sector.

# Our contribution to New Zealand economy, property and infrastructure

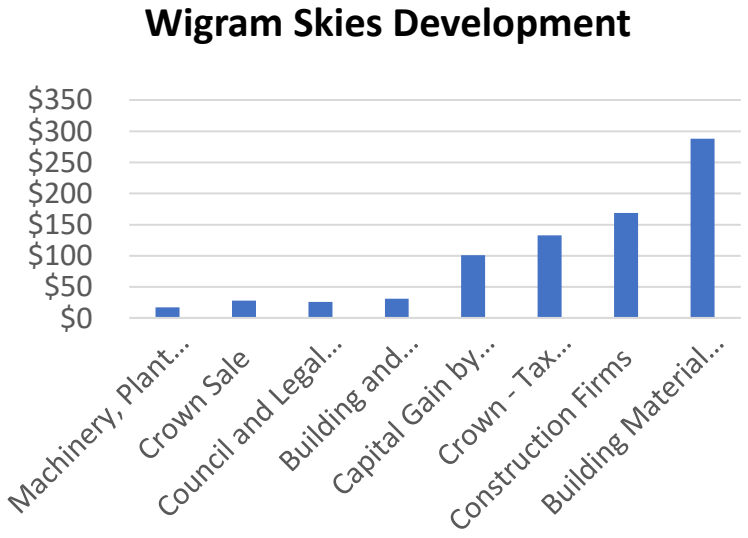
**Public Works Act 1956**

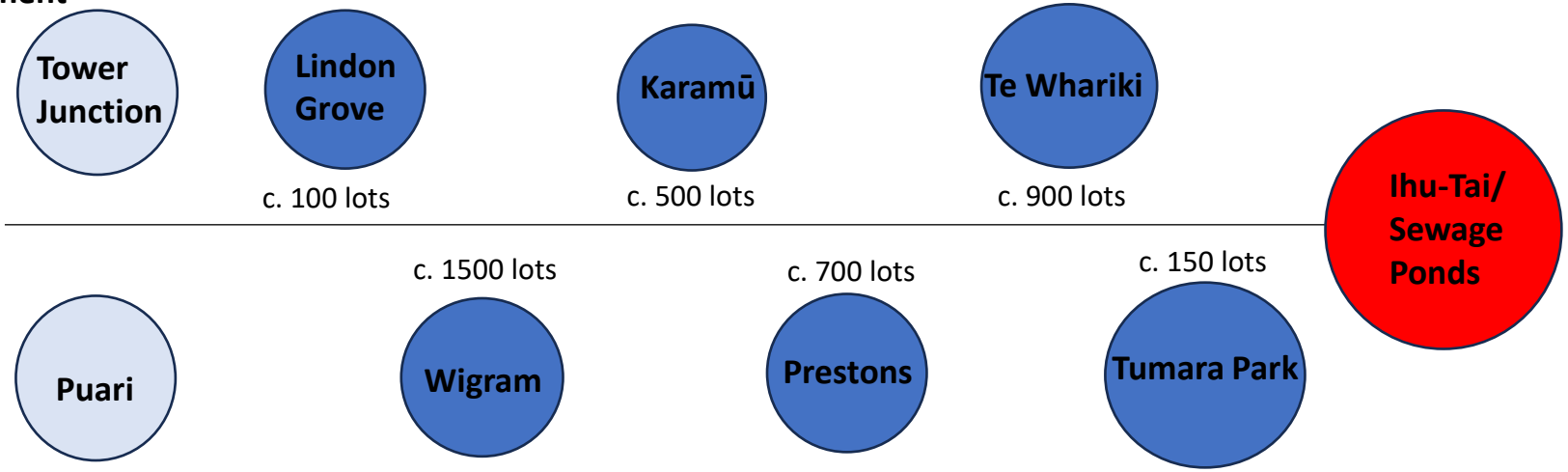
- Māori land compulsory taken for public interest and benefit
- Primary infrastructure on reserves set aside for things like mahinga kai

**Town and Country Planning Act, the 1967 Ratings Act and the 1967 Māori Affairs Amendment Act**

- The nasty trifecta that killed Māori land – dead capital
- The actual justification for the urban drift and Māori heading into the cities.
- Māori not allowed to build on their reserves because they generated cheap resource for farmers.

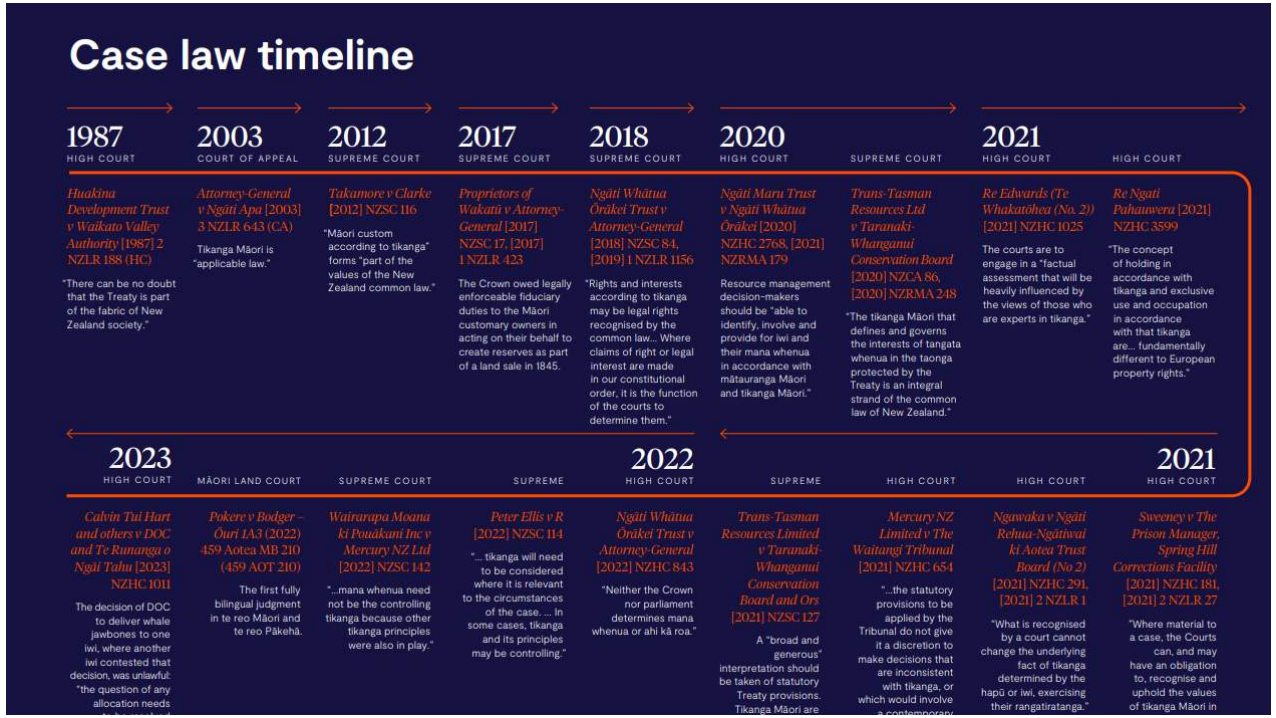

**Tribal Corporate Property and Infrastructure development**



# Legal Infrastructure

- Māori are New Zealands economic externality sink – rates, taxes, land, pollution etc.
- In the last 50 years Māori have won many cases in the Courts. Ngāi Tahu were confirmed their rangatiratanga in 1998
- There are strong political, economic, fiscal, demographic and technological reasons to dissolve the tribal corporations.

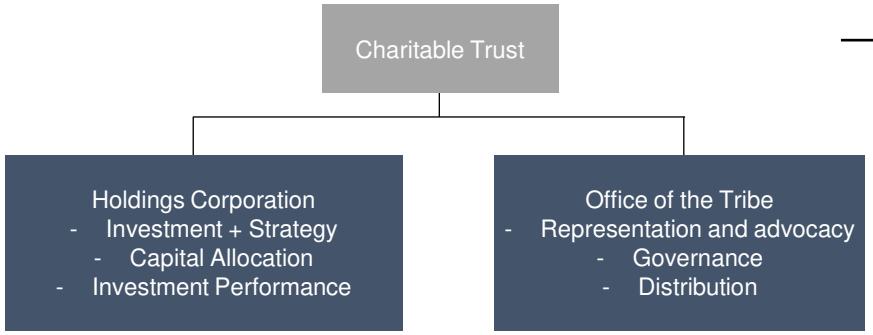


# Away from Co-governance toward Tribal Government.

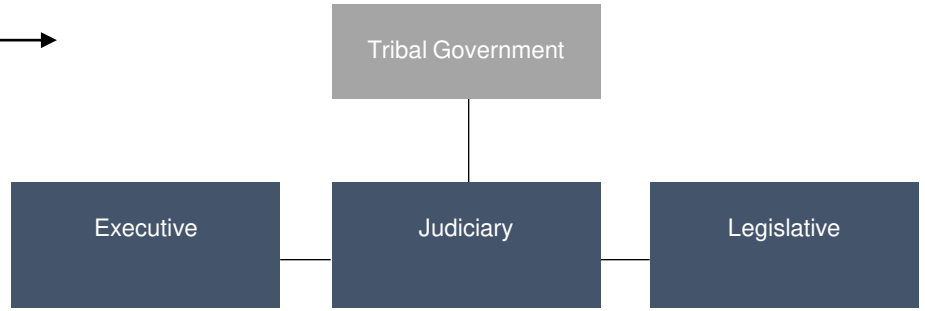
**Key Trends and Transitions**

- From Tino Rangatiratanga to Regulatory and Fiscal Authority
- From Tribal Corporations to Tribal Government
- From Business Development to Economic Development
- From Corporate Policy and Iwi Management Plans to Legislation and Standards
- Disolving the Corporate Model and adopting a West-minster Parliamentary System.


**Tribal Corporate Structure**




**West-minster Parliamentary System**



# How to create a Competitive Investment Climate: The Equation for Tribal Economic Prosperity

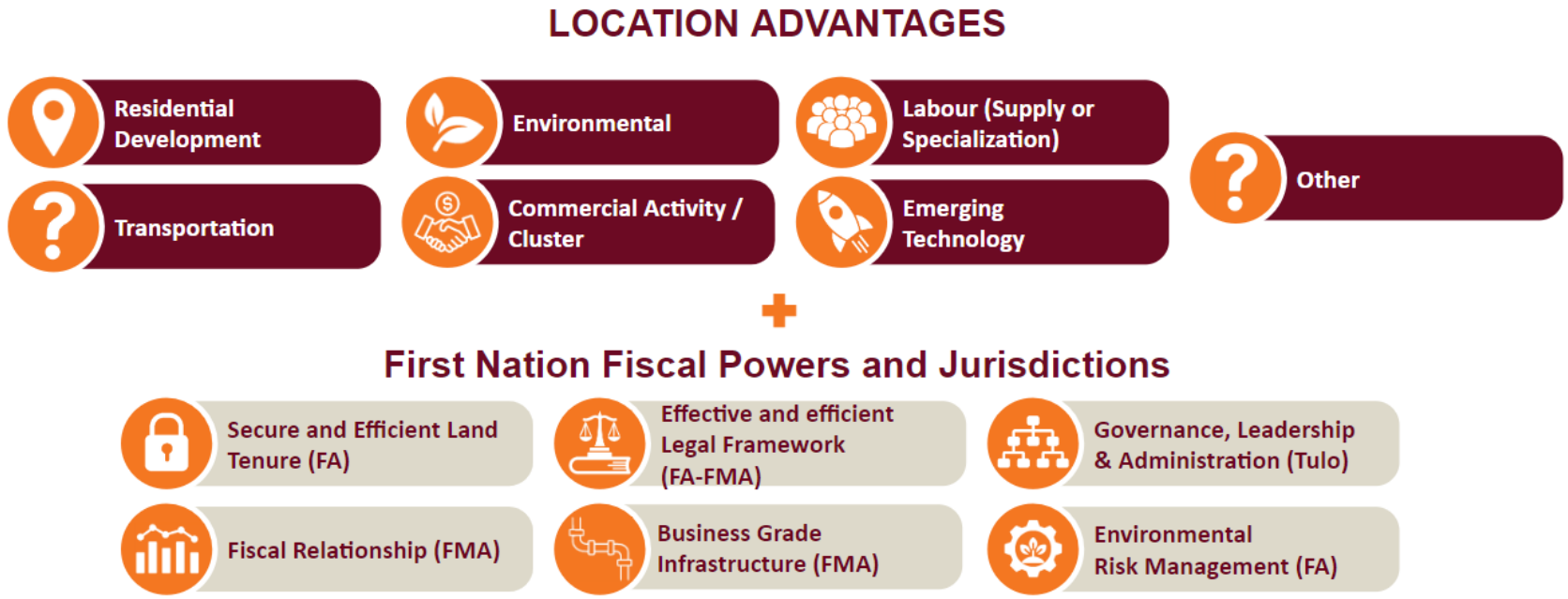
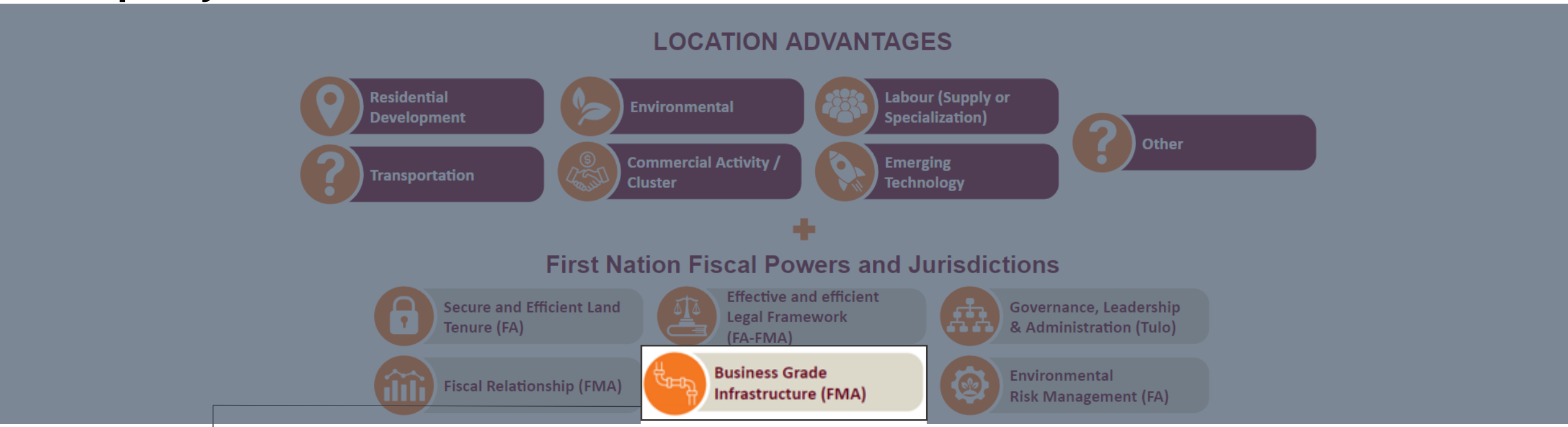



Figure 2. Competitive Investment Climate(Le Dressay, 2018).

# The role of Property and Infrastructure in The Equation for Tribal Economic Prosperity



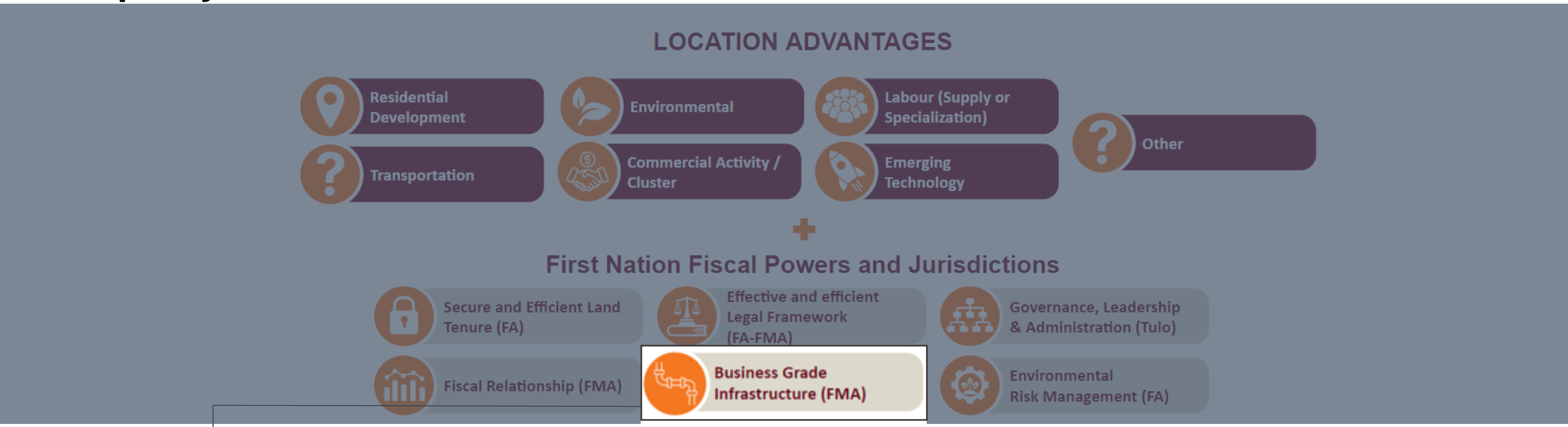

## = INVESTMENT IN ADVANTAGES, MORE PUBLIC REVENUES, IMPROVED PUBLIC SERVICES

**Efficiencies: Build Faster and Cheaper**

**Finance challenge: Access to Cheap Capital, administration and collection of tax and rates**

**Better Performing Assets: My Research.**

# The role of Property and Infrastructure in The Equation for Tribal Economic Prosperity




= **INVESTMENT IN ADVANTAGES, MORE PUBLIC REVENUES, IMPROVED PUBLIC SERVICES**

Efficiencies: Build Faster and Cheaper

Finance challenge: Access to Cheap Capital

**Better Performing Assets: My Research.**

# My Research

- Why performance based?
- Interviews
- Māori Performance Assessment Procedure

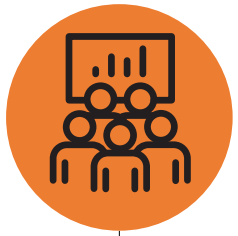
Art by
Bianca
Gardiner
Dodd

# Overview of Performance-based Earthquake Engineering (PBEE)

Prescriptive standards → Performance-driven design

1994 Northridge Earthquake

- 22,000 people displaced
- $35 billion of losses (50% insured)
- Market tailspin



Early 2000's emphasise PB seismic design and design philosophies of buildings.

- SEAOC Vision 2000
- FEMA 273
- FEMA 356 guidelines

My Research

- The application and adaption of FEMA-P58 for the tribe – MPAP.

1997 ATC-40 Report lays the foundation for earthquake engineering methodologies

ATC-58 Project

- FEMA P-58 – a comprehensive methodology that shifts the focus from code compliance to performance objectives.

# Summary of Research

1

Research concerning the seismic **performance** expectations of buildings for Ngāti Toa and Ngāi Tahu.

2

What do we get from this:

- Adaptation of the FEMA P-58 Framework.
- New Seismic Performance objectives.
- Tribal Seismic Rating System.
- A Framework to integrate Māori interests into technical engineering.

3

How did we do it:

- Conducted interviews for 6 months across both the North and South Island.

4

Results of those interviews include:

- New seismic performance objective proposed.
- Consequence functions.

5

Future Focus:

- Focus on other tribes
- Focus on other tribal seismic performance objectives
- Focus on different engineering disciplines.

6

Current focus:

- Securing funding to progress tribal seismic rating system into something like GreenStar Rating system.

# 1. Interviews – Determine Performance Objectives

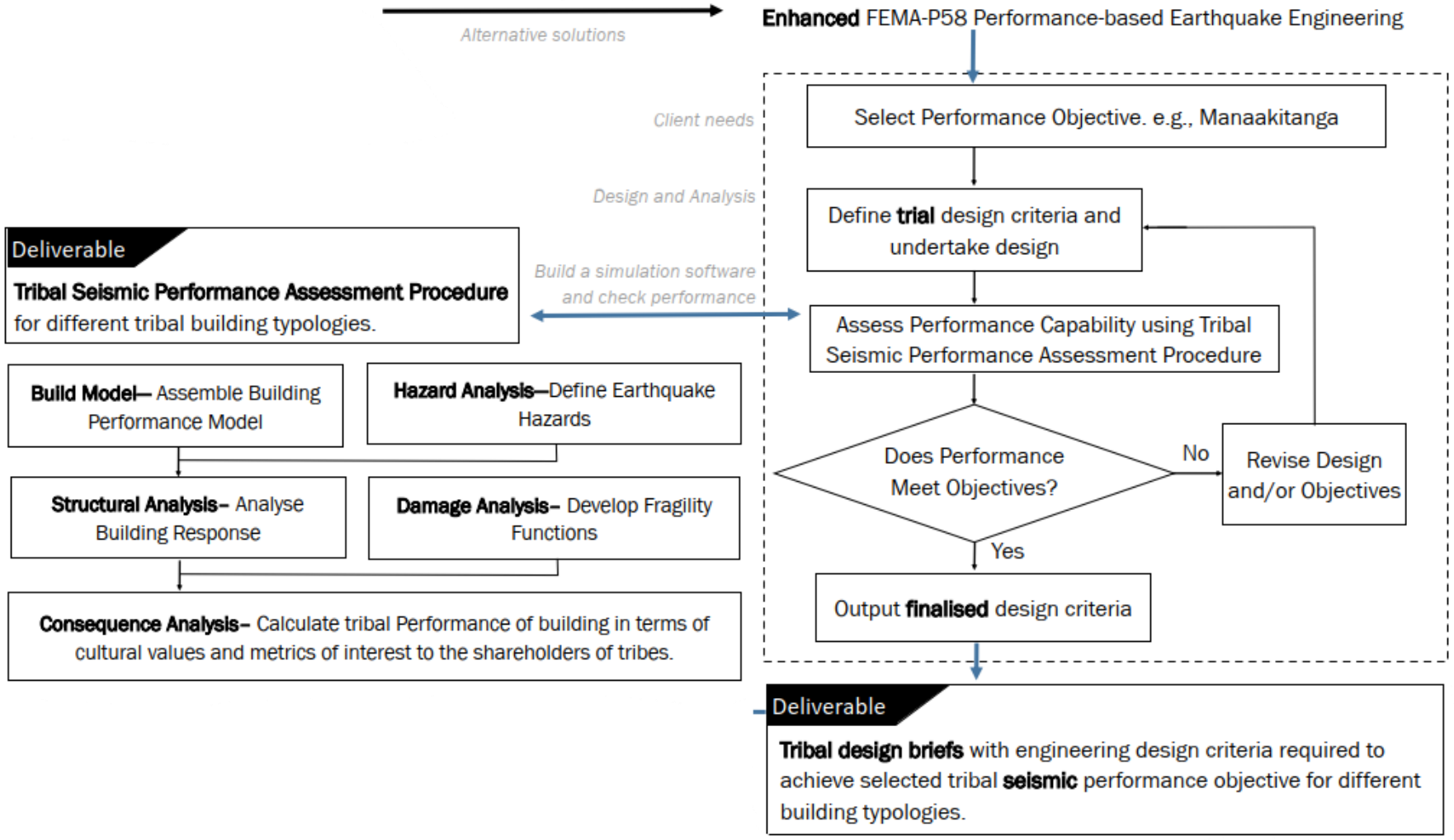
- Interviews were conducted.
- Tribal performance objectives determined - manaakitanga.
- Acceptable damage expectation and resulting consequences that a tribal building may experience in future earthquakes.

- The interview results show varying levels of damage to different damageable components in a house and their ensuing consequences on the loss of the manaakitanga
- Used as input to the PACT software.

Table 2. Consequence functions relating loss of manaakitanga to damage states for different damageable components in light-timber frame residential buildings (Royal, 2023).

| Damageable Component | Damage State | Loss of Maanakitanga (LOM) | |
|---|---|---|---|
| | | Average LOM for lower quantity | Average LOM for upper quantity |
| Plaster Board | Light-cracking | 2 | 4.5 |
| | Cracking of plaster board | 6 | 7 |
| | Buckling and Fallout | 9 | 10 |
| Cladding | Cracking | 6 | 7.5 |
| | Fallout | 8 | 10 |
| Roof | Loss of water tightness | 9 | 10 |
| | General damage | 8.5 | 10 |
| Floor | Micro-cracking | 3.5 | 6.5 |
| | Cracking | 6.5 | 8.5 |
| | Complete Failure | 9 | 10 |
| Windows | Visible damage | 8 | 10 |
| Kitchen and Bathroom | Kitchen damage | 4 | 10 |
| | Toilet damage | 5 | 10 |

# 2. Adapt FEMA P – 58:1 Performance-based Earthquake Engineering Māori Performance Assessment Procedure



# 3. Design, Modelling and Analysis

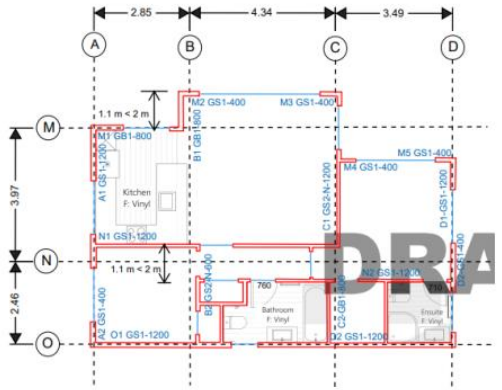
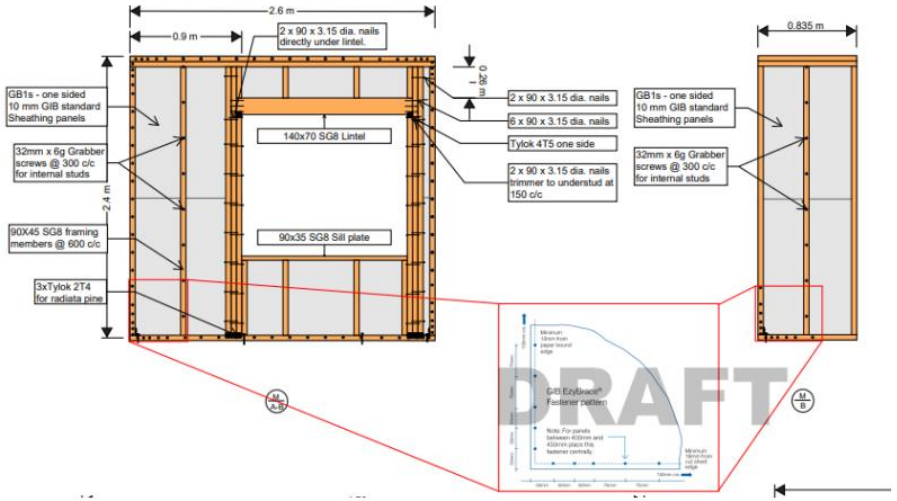
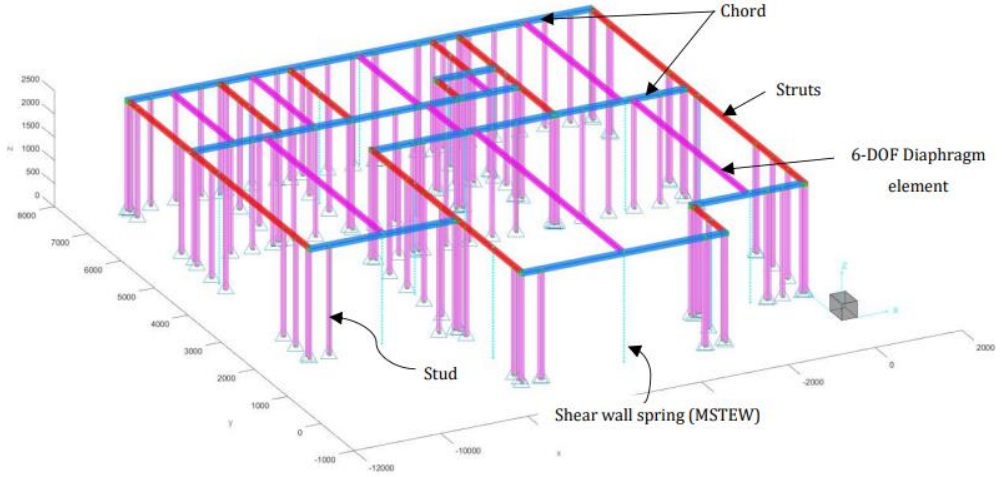



Figure 84. Hypothetical layout and plan for the residential building case-study.



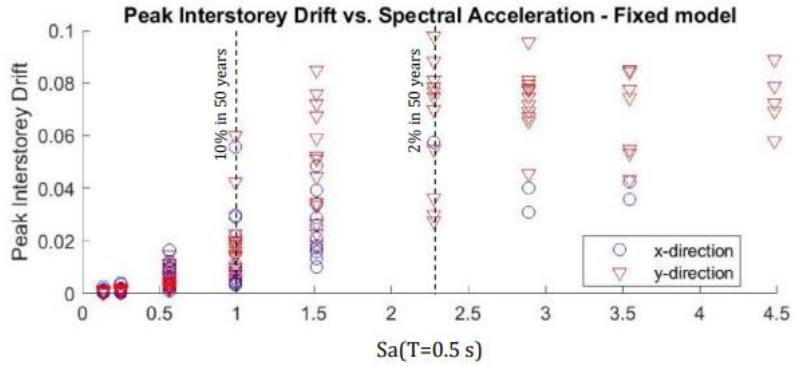
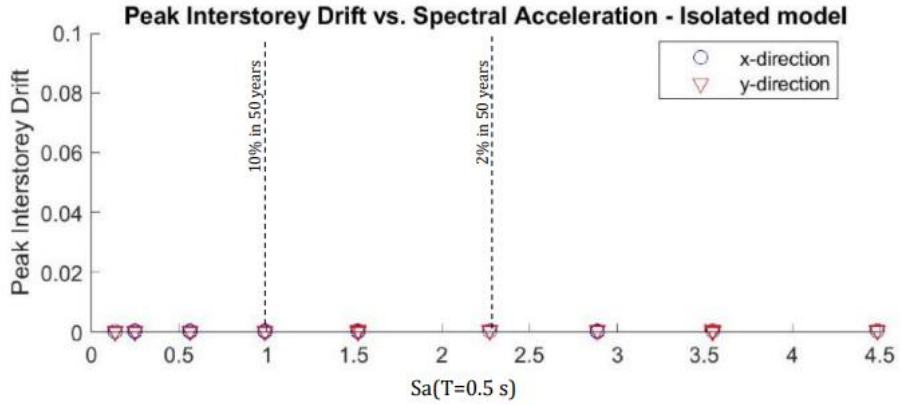




Figure 106. Interstorey drift demands from NLTHA for fixed-base light timber frame model.



# Quantification of Seismic Performance: Consequence Analysis

1 FEMA-P-58-1 methodology to compare seismic loss assessments between fixed-base and base-isolated light-frame wood buildings.

2 It introduces a new measure, quantifying the expected annual loss of manaakitanga.

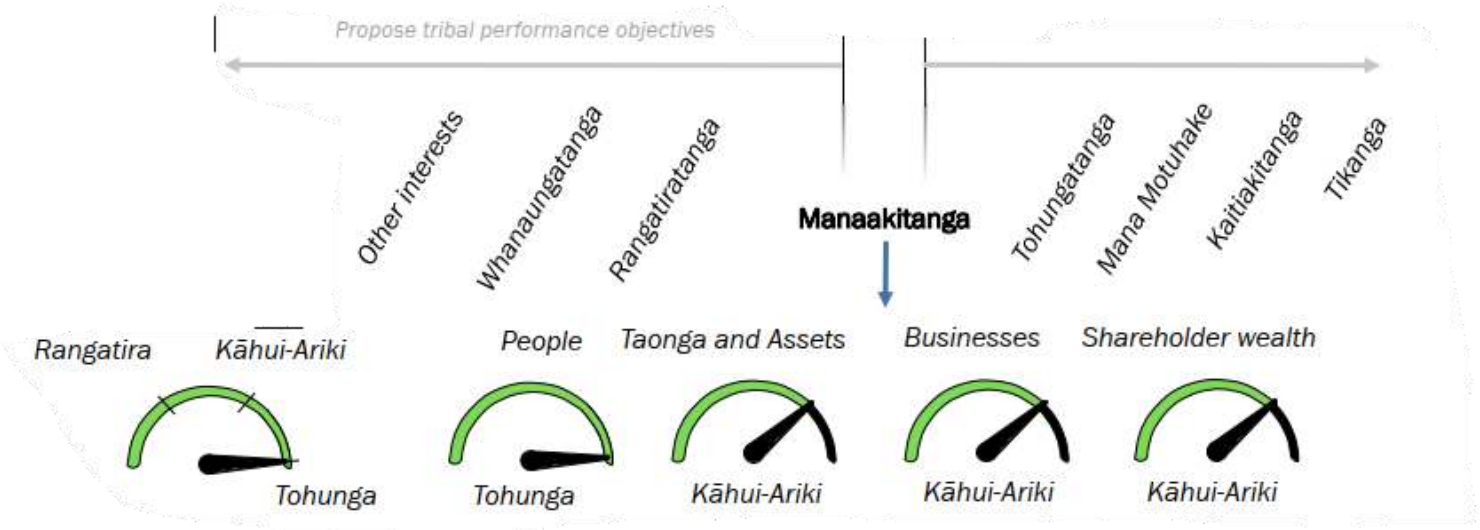
3 Despite intentionally favouring fixed-base buildings, the analysis demonstrates significantly lower seismic losses and manaakitanga loss for base-isolated buildings, with a slight cost increase

4 The Net Present Cost for base-isolated buildings remains stable, suggesting recoverable costs within 10 years.

5 framework and PACT Process to incorporate the quantification of manaakitanga loss.

# Next Steps: Māori Seismic Rating System

- Apply the framework to real projects around the country across all engineering disciplines.
- Continue to refine and adapt the rating system until commercially viable.
- Take to market as a commercial rating system.



# Thank you.

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National Science Challenges

RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa – Ngā Ākina o Te Ao Tūroa

# Resilience and Net Zero – Friends or Foes?


Charlotte Toma

*Waipapa Taumata Rau - University of Auckland*

Work contributed by Dr Max Stephens and Rosa Gonzalez


RNC Symposium 2024

Toka Tū Ake EQC

BRANZ

QuakeCoRE

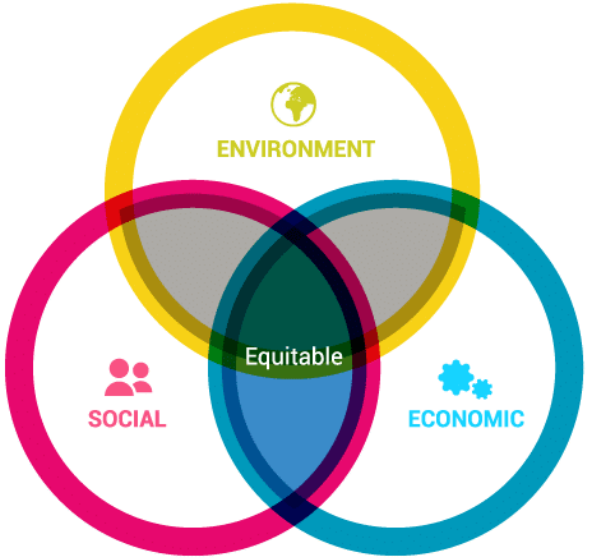
NZ Centre for Earthquake Resilience

*Te Hiranga Rū*

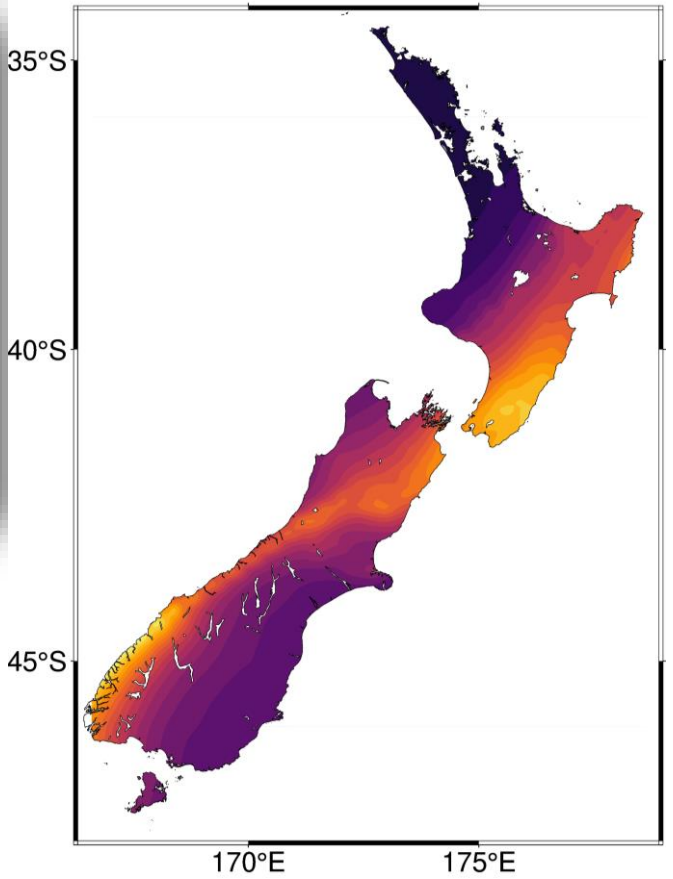
# Net Zero Carbon by 2050

**Climate Change Response Act and Zero Carbon Amendment 2019**

- Limit global warming
- Reduction Targets for GHG Net Zero by 2050
- Built Environment 15-20% of NZ Emissions

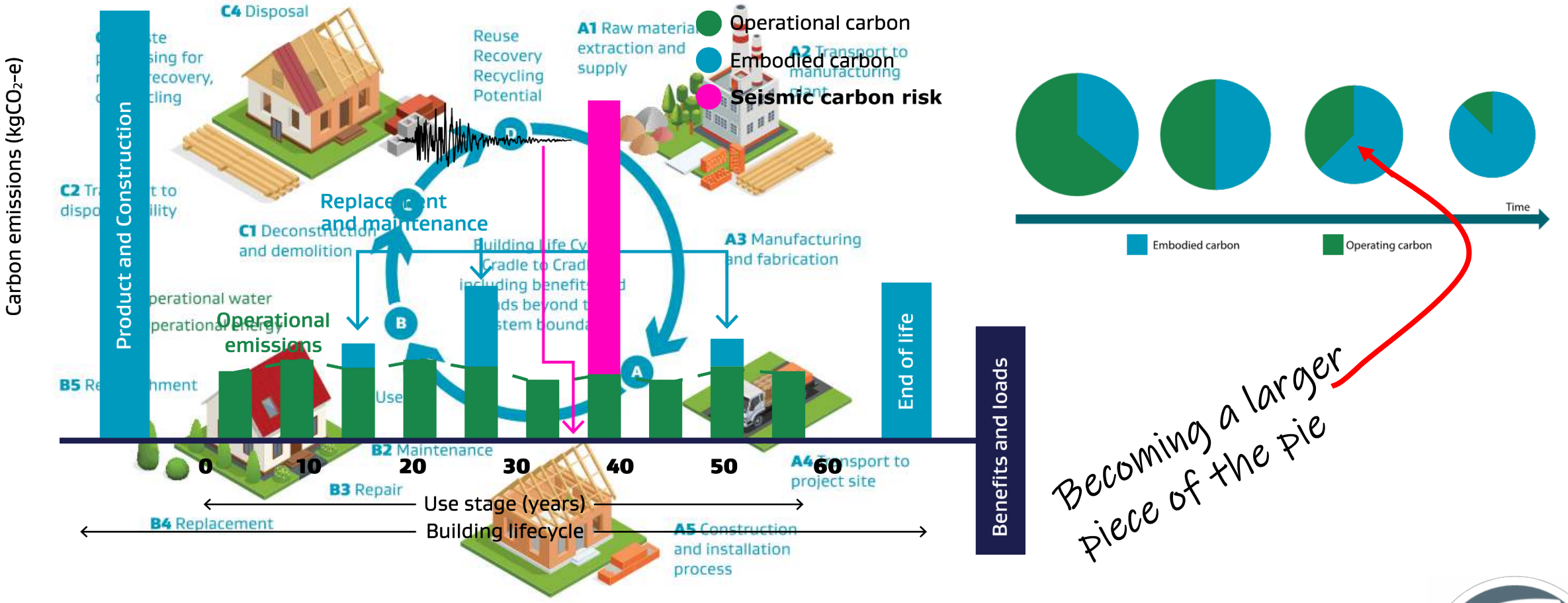



# Designing for Resilience




**Risk = Hazard Probability x Consequence**

# Carbon in our Built Environment




Life cycle stages of a building and their associated modules – *MBIE Whole-of-life Embodied Carbon Emissions Reduction Framework 2020*

# Where does the perception of a trade-off come from?

**Design for Resilience –**

- Design for a higher performance objective/demand
- Adopt Low Damage Design principles…
- Seek redundancy in load paths
- Design for repairability
- Use of protection system i.e base isolation, dampers

# Where does the perception of a trade-off come from?

**Design for Resilience –**

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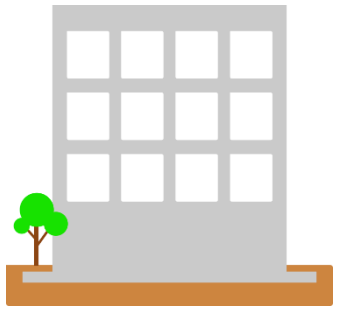
- Use of protection system i.e base isolation, dampers

**Questions:**

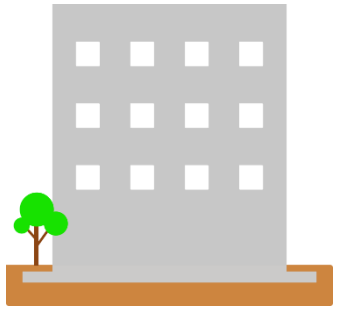
- How do seismic design characteristics effect carbon profile?
- What contributes most to the seismic carbon risk?
- **Does Resilience come with a carbon cost?**

# Does Resilience come with a carbon cost?

Design strategies



*Code minimum*



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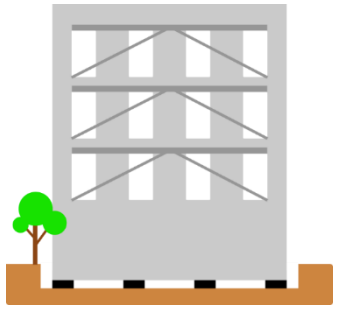
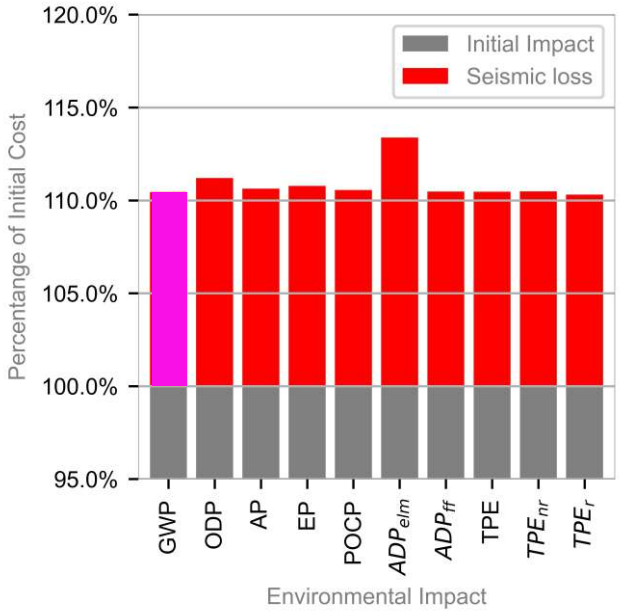
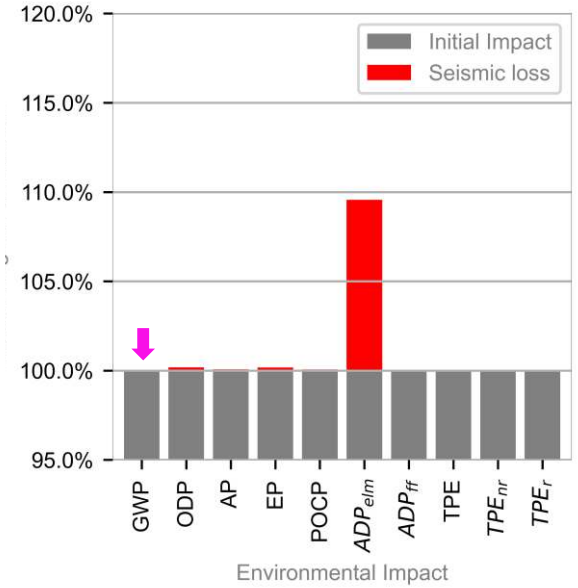


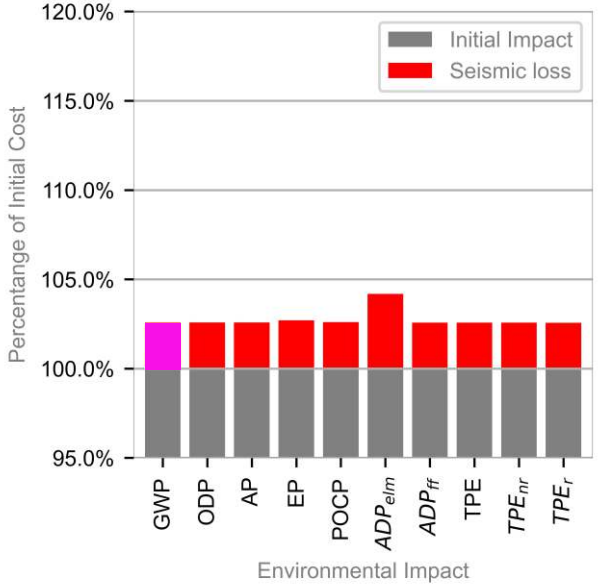
*Protective Systems*




Code Minimum – Moment Frame

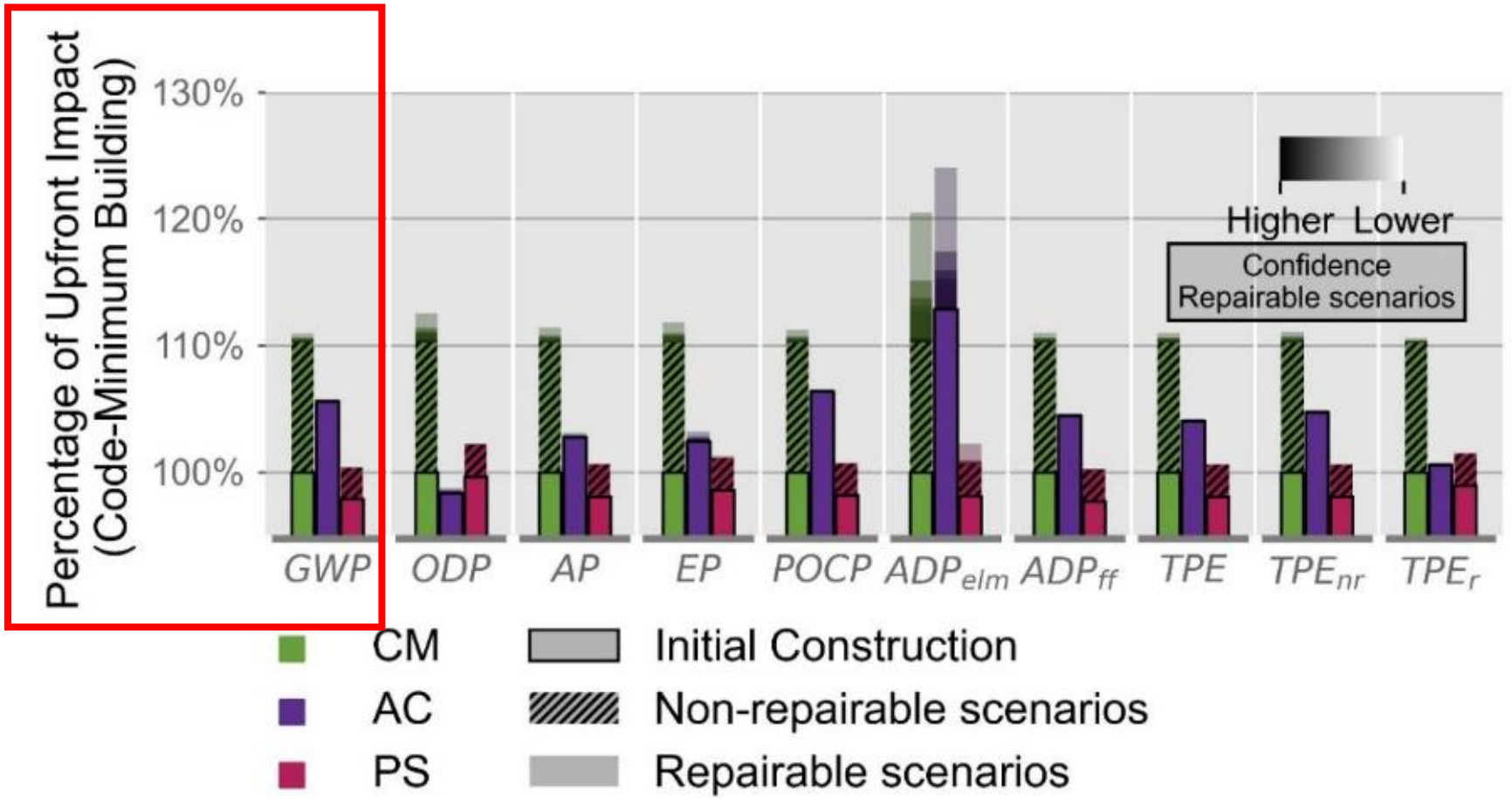



Above Code – EBF

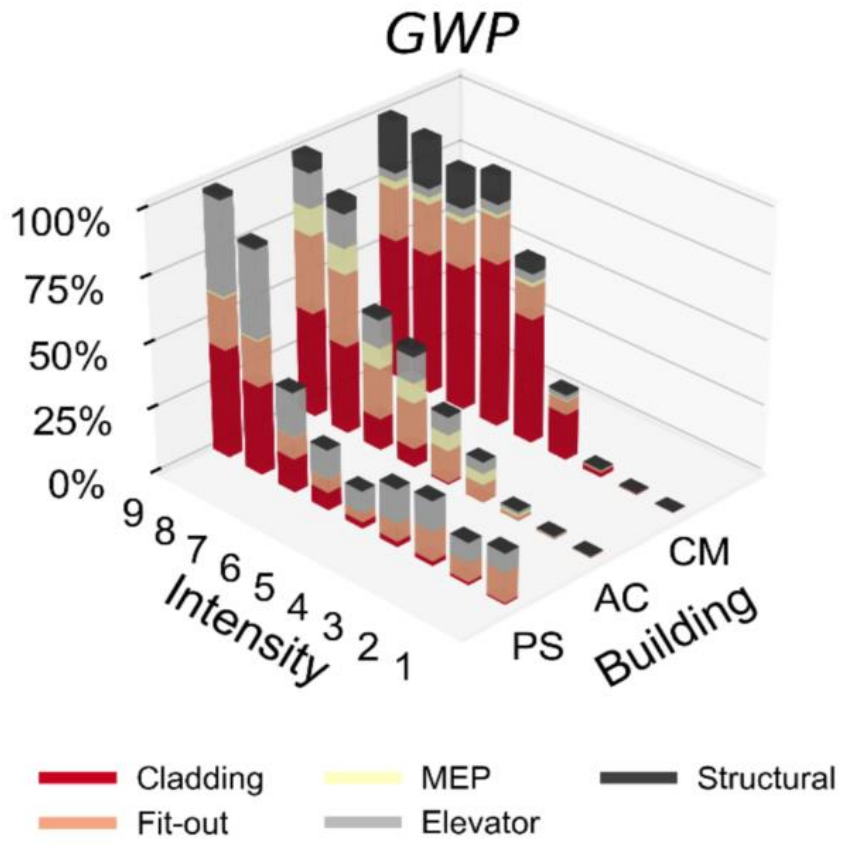



Protection System– Base Isolation

# Does Resilience come with a carbon cost?

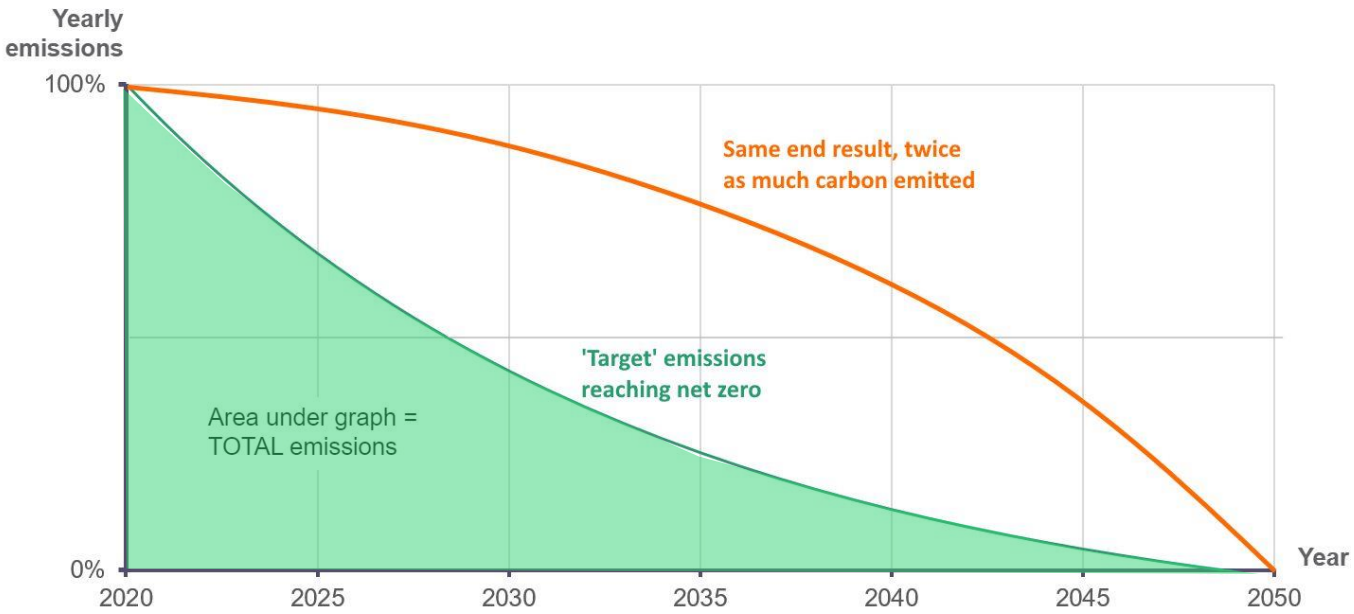


# Does Resilience come with a carbon cost?




- Probability of total loss drives carbon risk
- Repairability important
- Non-structural element damage
- Drift key parameter

# Upfront versus whole-of-life?




1. Future emissions are **uncertain**
2. The future is likely to be **decarbonised**
3. We cannot **control** future emissions
4. Future emissions are **less damaging**

**"**Global modelled pathways that limit warming to 1.5 or 2 degrees involve **rapid and deep and immediate** greenhouse gas emissions reductions in all sectors **this decade."**

**- IPCC**

# Would this have been the outcome if Carbon had been on the table from the beginning?

Photo from: https://nzhistory.govt.nz/page/christchurch-earthquake-kills-185

Photo from: https://blog.realestate.cornell.edu/2016/03/07/redeveloping-the-cbd-christchurch-5-years-after-the-earthquake/

National Science Challenges

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# Thank you!


Charlotte Toma

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RNC Symposium 2024

**Whatungarongaro te tangata, toitū te whenua**

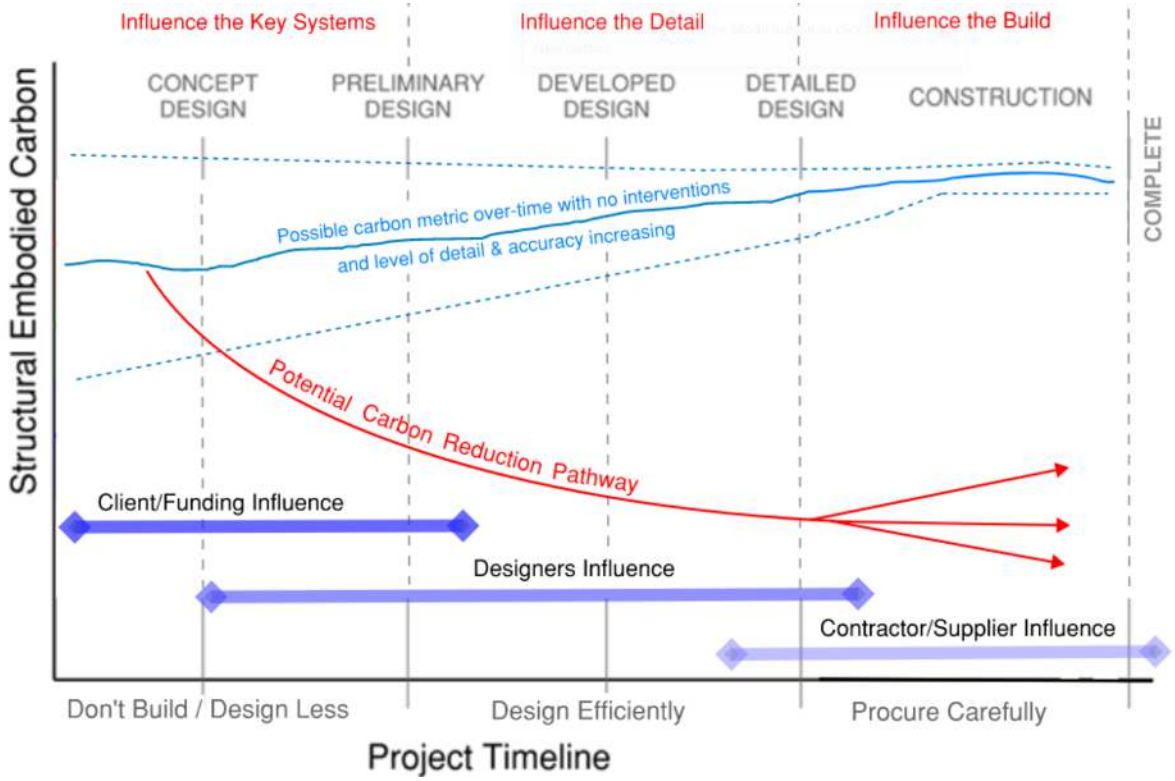
As people disappear from sight, the land remains

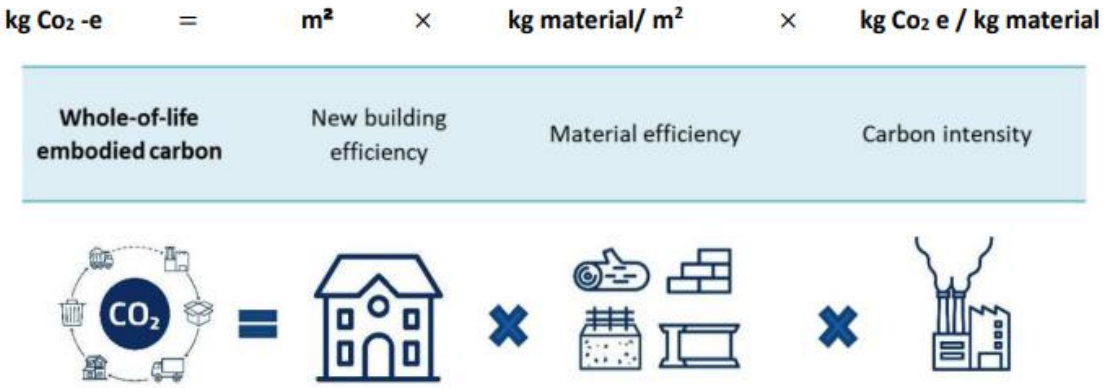
# What is the impact of our current design thinking?

# Friend or Foe?

- How should we be predicting loss? – this is difficult
- What will be the carbon intensity in future buildings?
- What is the actual life of our buildings (new build)?
- When should we strengthen/reuse vs demolish/rebuild?
- How do incorporate seismic carbon risk into BfCC Carbon Assessment Methodology

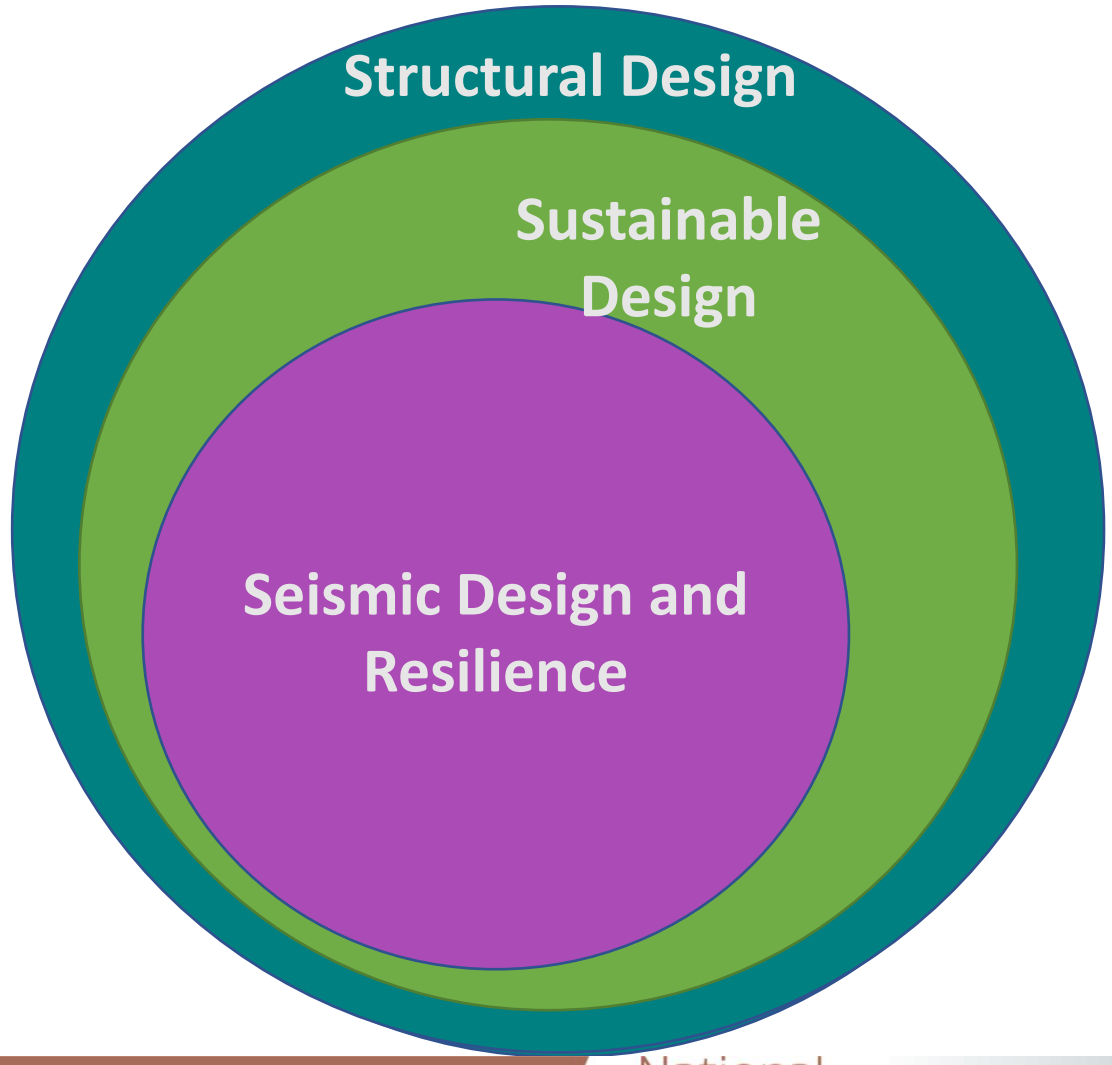
# What if Carbon Drove our design?



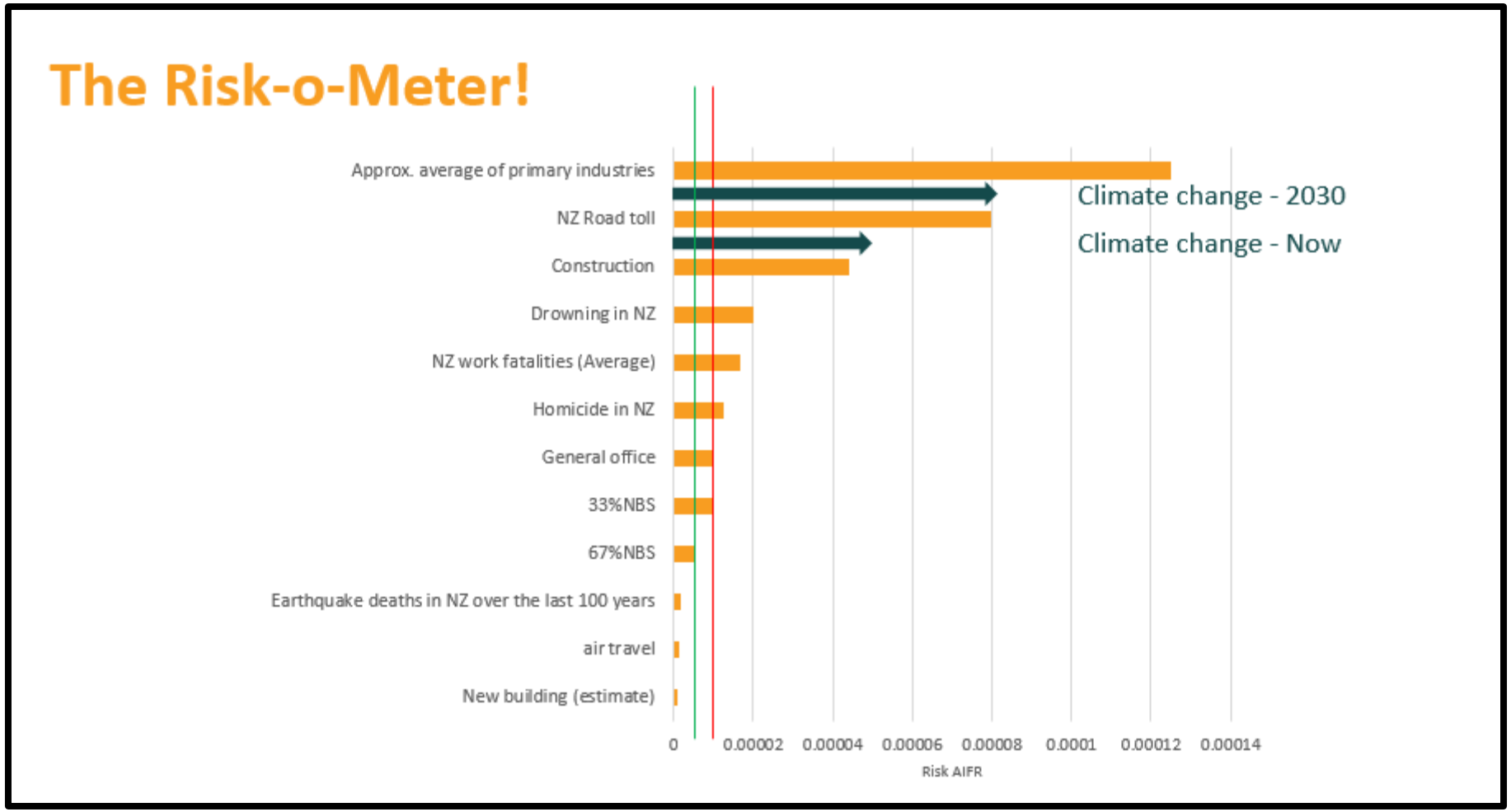




MBIE (2022) Technical Methodology: Whole of Life Embodied Carbon 2022

# What if Carbon Drove our design?



# Risk Perception



“Increased ***frequency*** and ***severity*** of extreme weather events.”

**- IPCC**

**hazard** **consequence**

**Acute risks**

**Earthquake**

**Cyclone**

**Flood event**

**Chronic risks**

**Sea level rise**
**Temperature rise**
**CO2 concentrations**
**Cryosphere loss**

Adaptation versus Mitigation

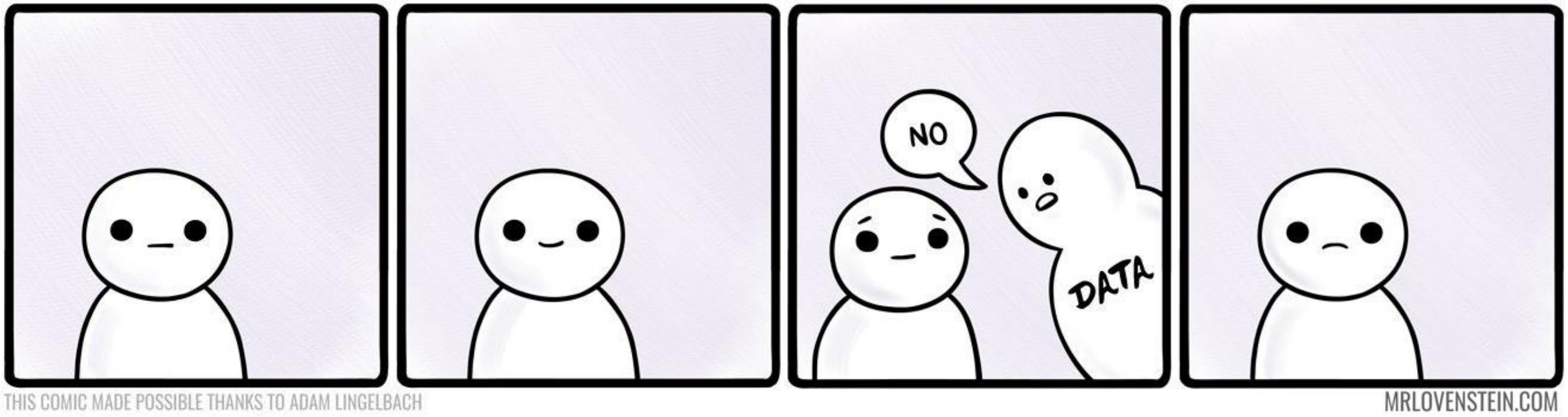
# After the Research

Caleb Dunne

*EQC Toka Tū Ake*

RNC Symposium 2024

# Research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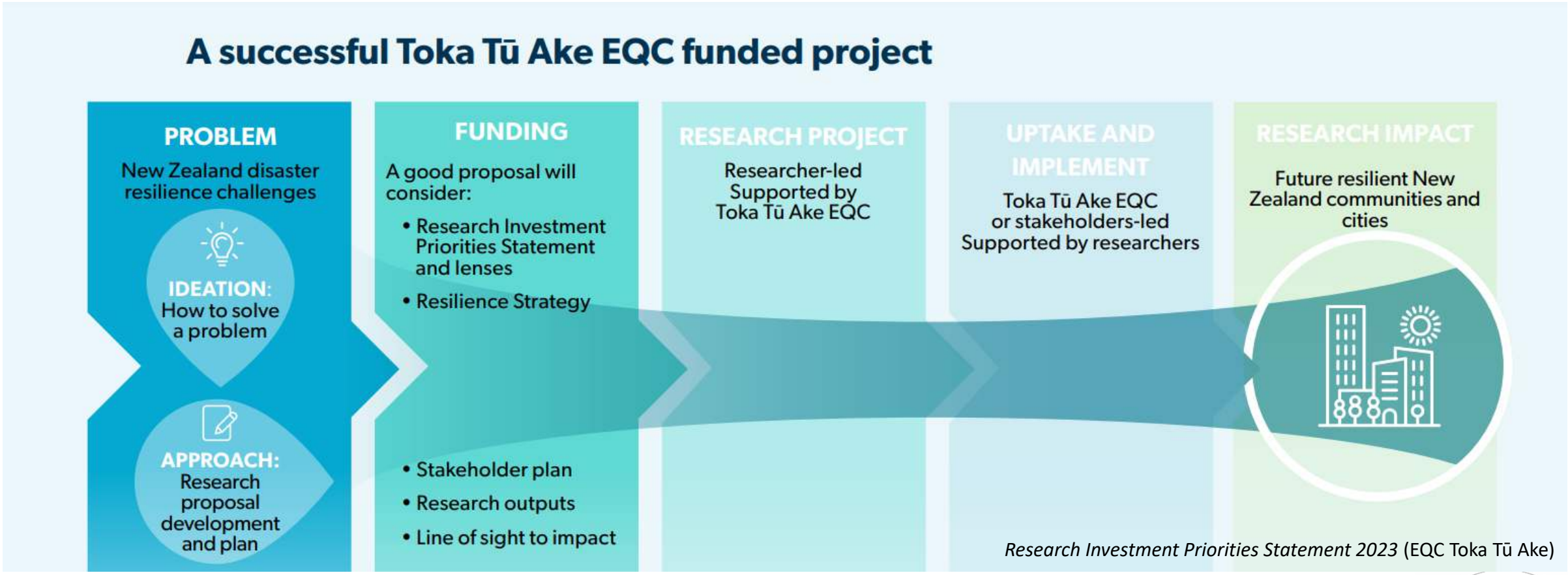
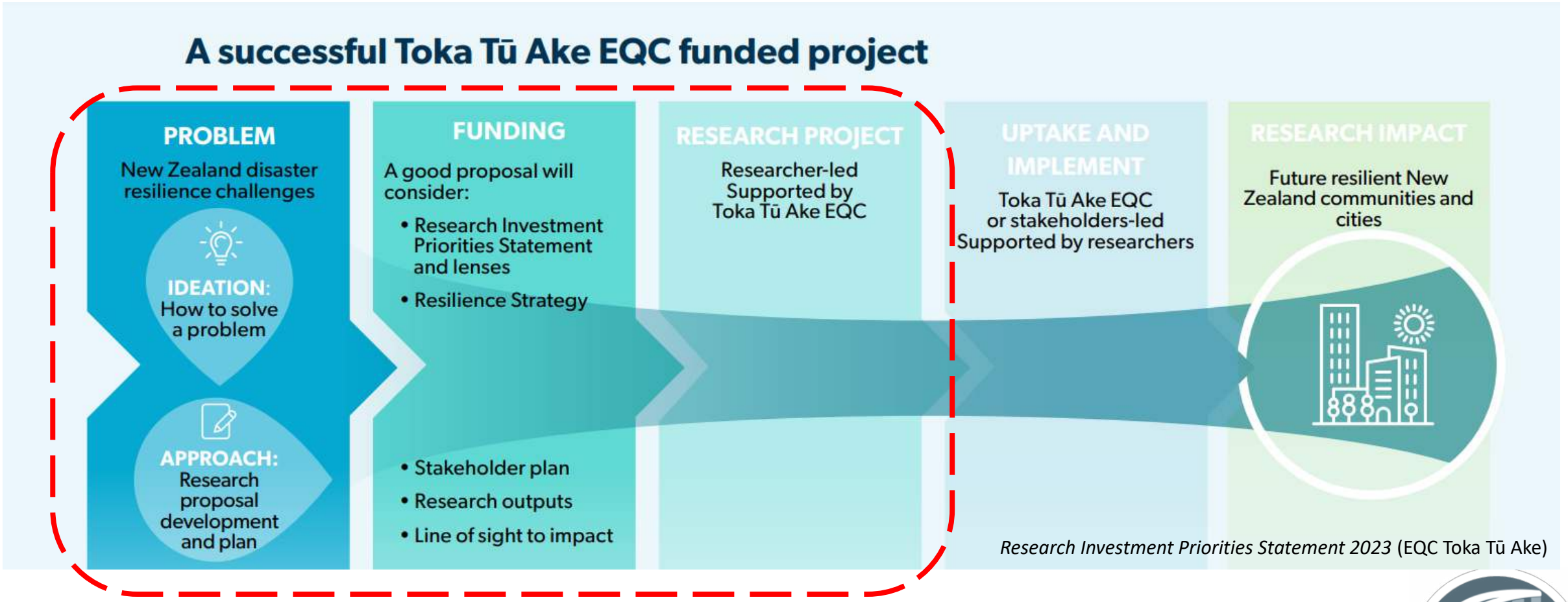
# Research




*Research Investment Priorities Statement 2023* (EQC Toka Tū Ake)

# Research




*Research Investment Priorities Statement 2023* (EQC Toka Tū Ake)

**"The Research"**

# Research

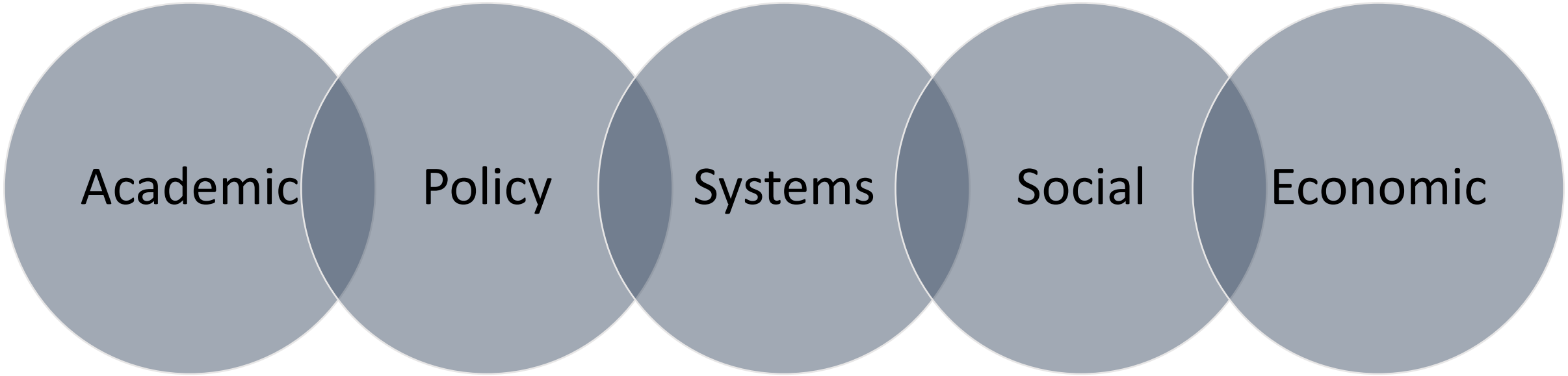
*"Science is expected to make contributions to the attainment of explicit societal goals and advance development. An inability to demonstrate impact can jeopardise support for public investments in science over the long term."*

The Impact of Science Discussion Paper (MBIE, 2017)

*"MBIE [defines] research impact as 'A change to the economy, society, or environment, beyond contribution to knowledge and skills in research organisations.'"*

The Impact of Research Position Paper (MBIE, 2018)

# Research

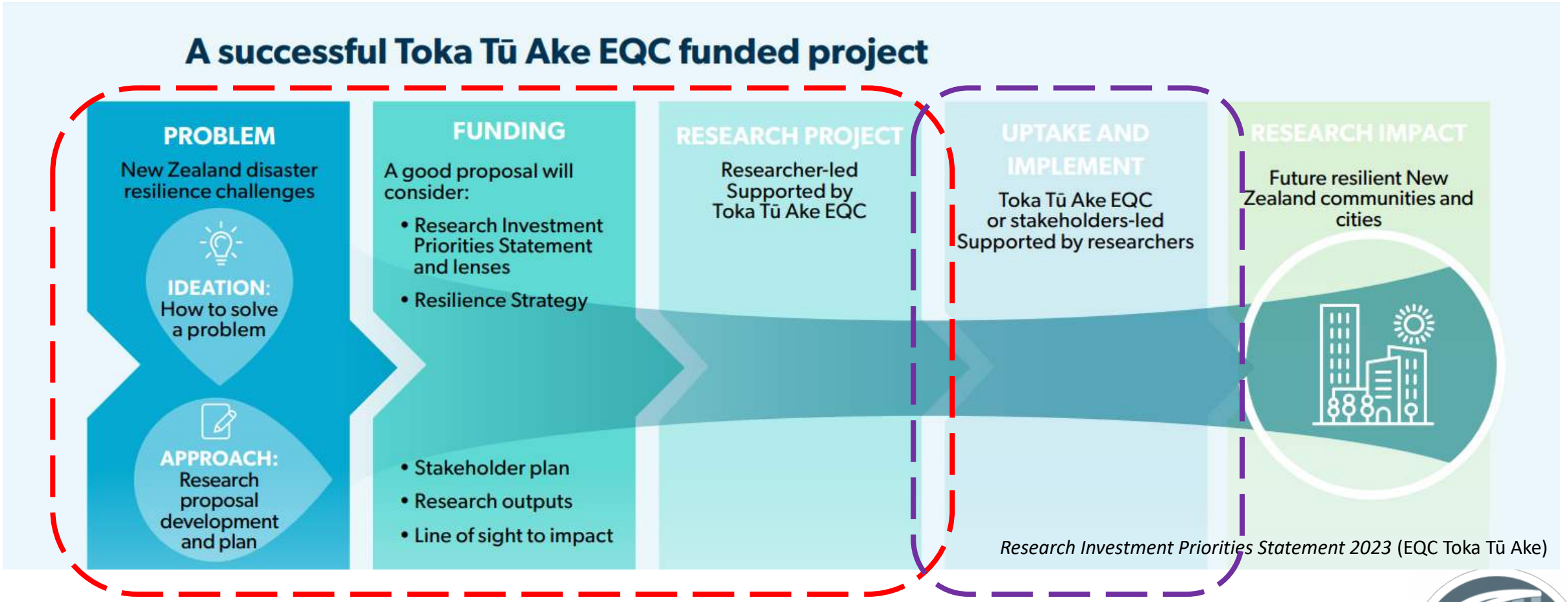



Short Term

Mid Term

Long Term

# Research




*Research Investment Priorities Statement 2023* (EQC Toka Tū Ake)

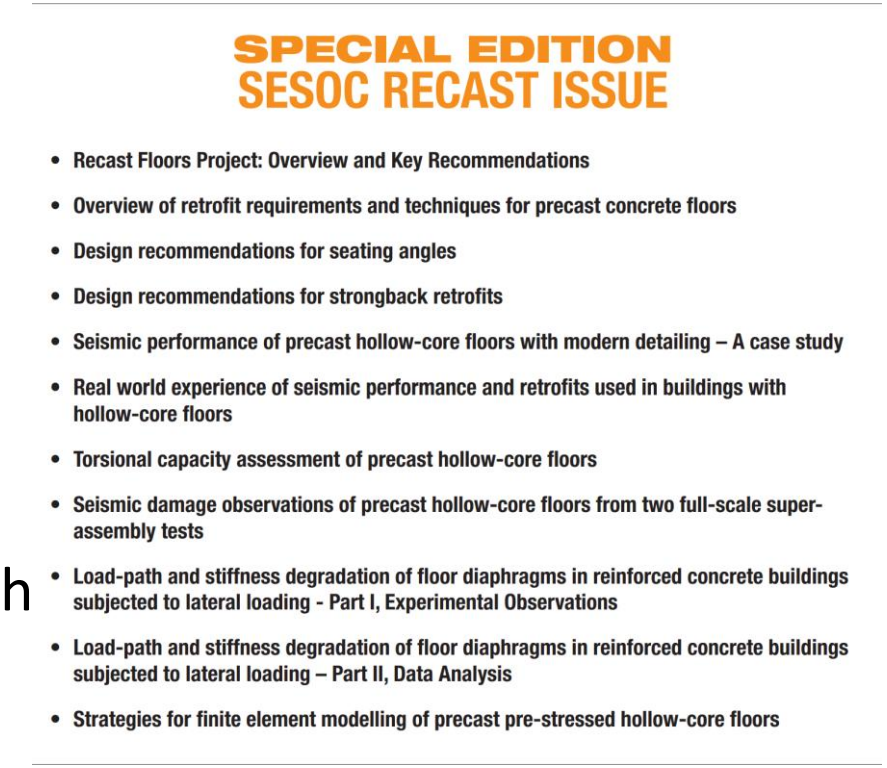
**"The Research"** **"Science to Practice/Policy"**

# Case Study – ReCast Floors

- 2010/2011 – damage observed to precast floors in the Canterbury Earthquake Sequence
- 2016 – damage/collapse observed to precast floors in Kaikōura earthquake

- 2018 – ReCAST Floors Project begins

- April 2022 – Summary of ReCAST Floors Project research findings published via SESOC Journal Special Edition



SPECIAL EDITION
SESOC RECAST ISSUE

- Recast Floors Project: Overview and Key Recommendations
- Overview of retrofit requirements and techniques for precast concrete floors
- Design recommendations for seating angles
- Design recommendations for strongback retrofits
- Seismic performance of precast hollow-core floors with modern detailing – A case study
- Real world experience of seismic performance and retrofits used in buildings with hollow-core floors
- Torsional capacity assessment of precast hollow-core floors
- Seismic damage observations of precast hollow-core floors from two full-scale super-assembly tests
- Load-path and stiffness degradation of floor diaphragms in reinforced concrete buildings subjected to lateral loading - Part I, Experimental Observations
- Load-path and stiffness degradation of floor diaphragms in reinforced concrete buildings subjected to lateral loading – Part II, Data Analysis
- Strategies for finite element modelling of precast pre-stressed hollow-core floors

- **November 2022 – MBIE removes the deemed to comply method for the design of hollow-core floors from B1/VM1**

# Case Study – Residential Portal Frames

- 2010/2011 – observed high levels of damage to “newly designed” homes in the Canterbury Earthquake Sequence

- 2014 – Research  begins
- 2015 – *SR337 Design Guidance of Specifically Designed Bracing Systems in Light Timber-framed Residential Buildings*

- **2020 – Engineering New Zealand published design guidance for Residential Portal Frames**

# Takeaways

- Research should be about improving society.
- Know what type of benefit the research will deliver.
- Identify your line-of-sight to implementation.
- Engage early.

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- Research should be about improving society.
- Know what type of benefit the research will deliver.
- Identify your line-of-sight to implementation.
- Engage early.
- (End users need to be willing and interested in picking it up).

# After the Research Implementation

Caleb Dunne *cdunne@eqc.govt.nz*

Research Team *Research@eqc.govt.nz*

RNC Symposium 2024