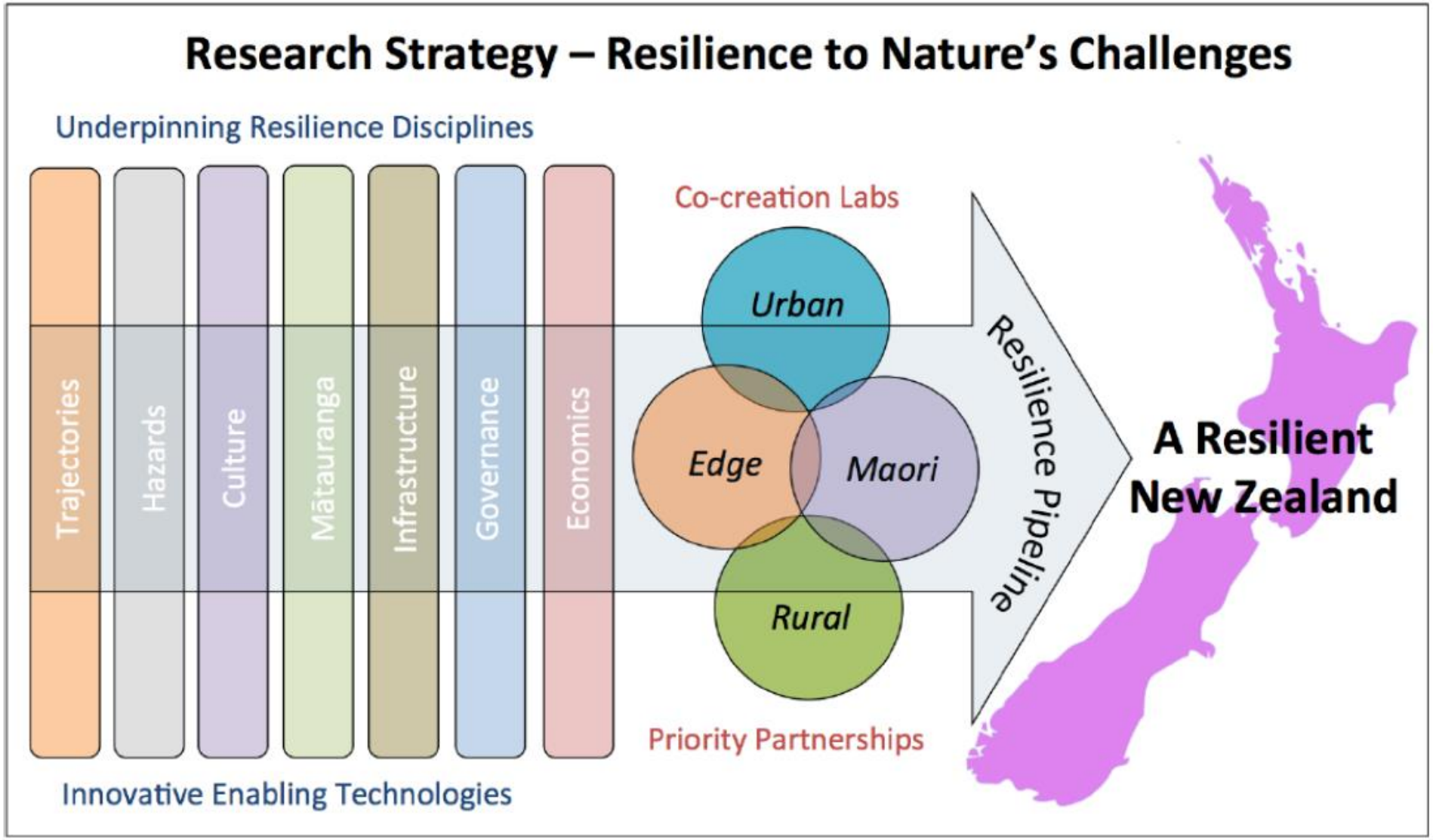
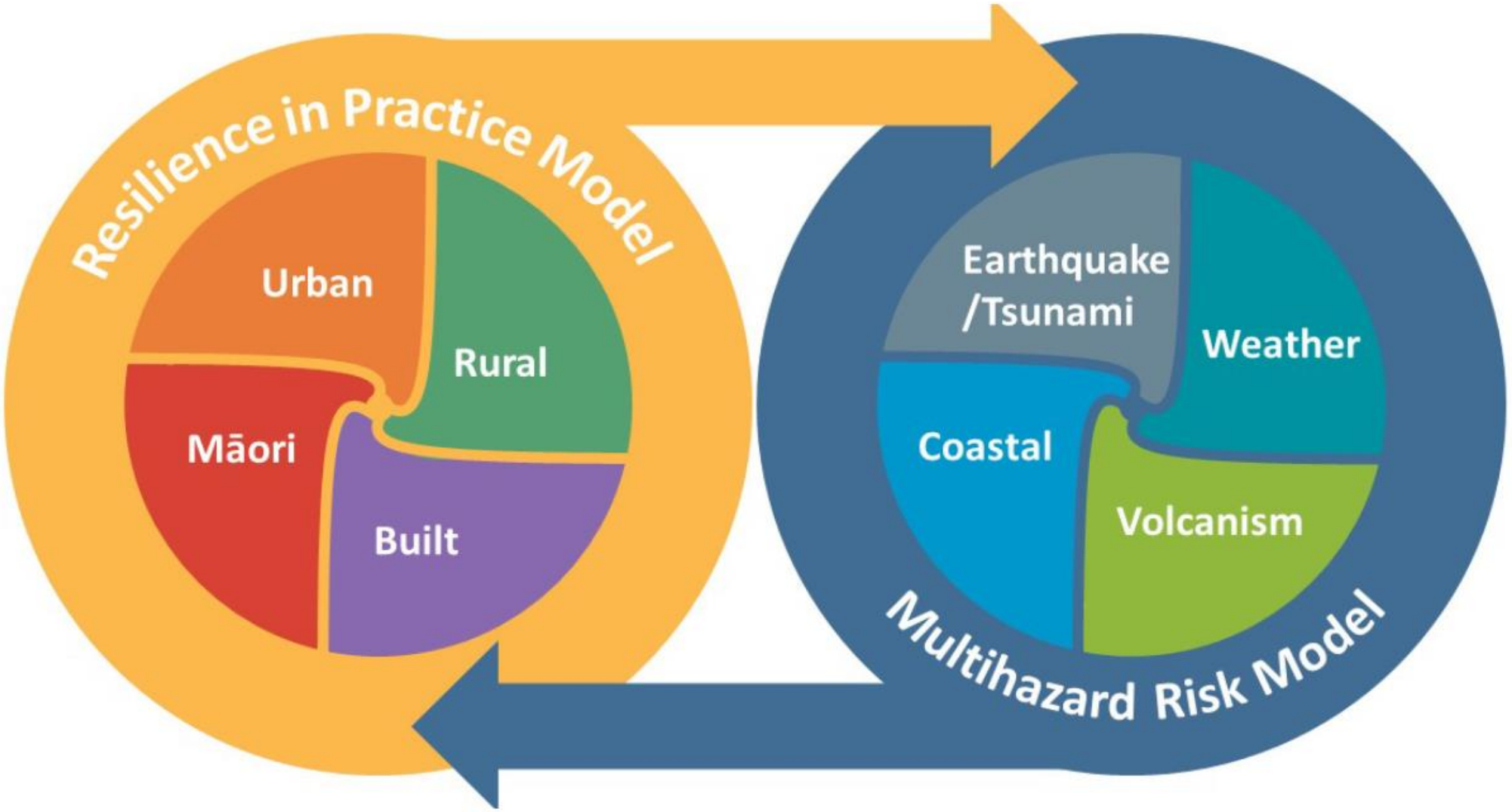
RNC-QuakeCoRE Infrastructure Research

RNC1 Structure



RNC2 Structure – from mid 2019



Overview - Infrastructure

- Move towards a formal linking of hazard and infrastructure models
  - From geospatial hazard assessment to system of systems response
  - Integration of computational tools
  - Needs a highly multi-disciplinary team

- Developments should be incrementally adopted

- Not trying to replace judgement, but provide more data to inform decision making

End-to-end Collaboration

- Over 45 research presentations in monthly meetings over last 2 years

Power systems engineering

Telecommunication engineering

Volcanology

Water resources engineering

Organisational resilience

Hydrology

Seismology

Computer science

Geohazards

Geotechnical engineering

Coastal engineering

Transportation engineering

Risk and resilience

Human behaviour

Geospatial analysis

Natural hazard response

Economics

Engineering Science

Structural engineering

Asset Management

Infrastructure engineering

Statistics

Hydraulic engineering

10 September 2018 (13:00-14:30am NZT)

Purpose: To coordinate and share research activities on 2018 RNC/QuakeCoRE Distributed Infrastructure research.

Agenda:

- Introductions (All)
- Program updates and summaries (All)
- Presentation: "Development and calibration of an urban and rural transportation simulation model to assess resilience." Mujaddad Afzal and Mohammad Aghababaei
- Presentation: "Inferred recovery from the 22 February 2011 Mw6.2 Christchurch earthquake and a recovery optimization tool." Xavier Bellagamba
- Discussion (All)

Participants: *Nirmal Nair, Daniel Blake, Kaley Crawford-Flett, Colin Whittaker, Finn Scheele, James Williams, Mark Bebbington, Mujaddad Afzal, Mohammad Aghababaei, Melanie Liu, Ryan Paulik, Prakash Ranjitkar, Rob Cardwell, Seosamh Costello, Snehalata Thakur, Theuns Henning, SR Uma, Vinod Sadashiva, Xavier Bellagamba, Leo Liu, Duncan Maina, Samad Shirzadi Deh Kohneh, Ebad Rehman, Farrukh Latif, Mostafa Baghersad.*

Apologies: *Roger Fairclough*

13 August 2018 (13:00-14:30am NZT)

Purpose: To coordinate and share research activities on 2018 RNC/QuakeCoRE Distributed Infrastructure research.

Agenda:

- Introductions (All)
- Presentation: "The Resiliency of Communication Infrastructure during Alpine Fault earthquake scenarios in West Coast, New Zealand." Farrukh Latif
- Presentation: "A resilience based assessment method for primary stormwater management system urban flood control." Nariman Valizadeh
- Discussion (All)

Participants: *Nirmal Nair, Roger Fairclough, Kaley Crawford-Flett, Leo Liu, Duncan Maina, Samad Shirzadi Deh Kohneh, Rob Cardwell, Laura Lechine, Mark Bebbington, Prakash Ranjitkar, Ben Popovich, Subeh Chowdhury, SR Uma, Alec Wild, Sophia Tsang, Amelia Lin, Vinod Sadashiva, James Williams, Josh Hayes, Mohammad Aghababaei, Mujaddad Afzal, Jo Stevenson.*

Apologies: *Liam Wotherspoon, Seosamh Costello*

Research-Practice Collaboration

- **Real-world data, real-world complexity, real-world perspective**

Infrastructure Advisory Group

TRANSPOWER

CHORUS

water NEW ZEALAND
The New Zealand Water & Wastes Association Waiora Aotearoa
A consistent approach across the 3 waters sector

Ministry of Transport
TE MANATŪ WAKA
Enabling New Zealanders to flourish

New Zealand Lifelines Council

Ministry of Civil Defence & Emergency Management
Te Rākau Whakamarumaru

Land Information New Zealand
Toitū te whenua

NZ TRANSPORT AGENCY
WAKA KOTAHI

THE TREASURY
Kaitohutohu Kaupapa Rawa

Orion

Westpower

Christchurch City Council

AT

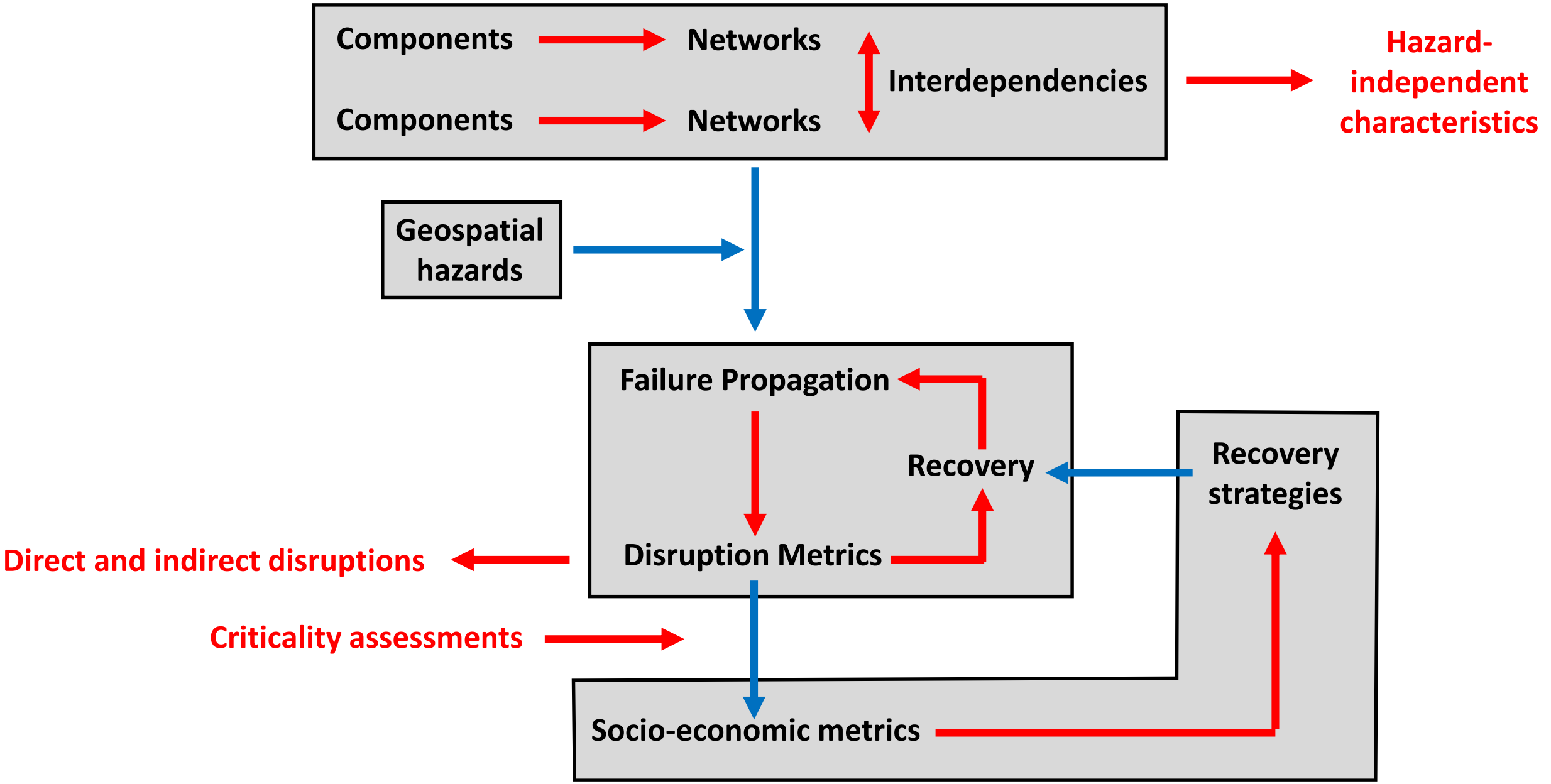
mainpower

Auckland Council
Te Kaunihera o Tāmaki Makaurau

tasman district council

QuakeCoRE
NZ Centre for Earthquake Resilience
Te Hiranga Rū

infrastructure National SCIENCE Challenges
RESILIENCE TO NATURE'S CHALLENGES
Kia manawaroa – Ngā Ākina o Te Ao Tūroa


Components
Networks
Components
Networks
Interdependencies
Hazard-independent characteristics
Geospatial hazards
Failure Propagation
Recovery
Disruption Metrics
Recovery strategies
Direct and indirect disruptions
Criticality assessments
Socio-economic metrics

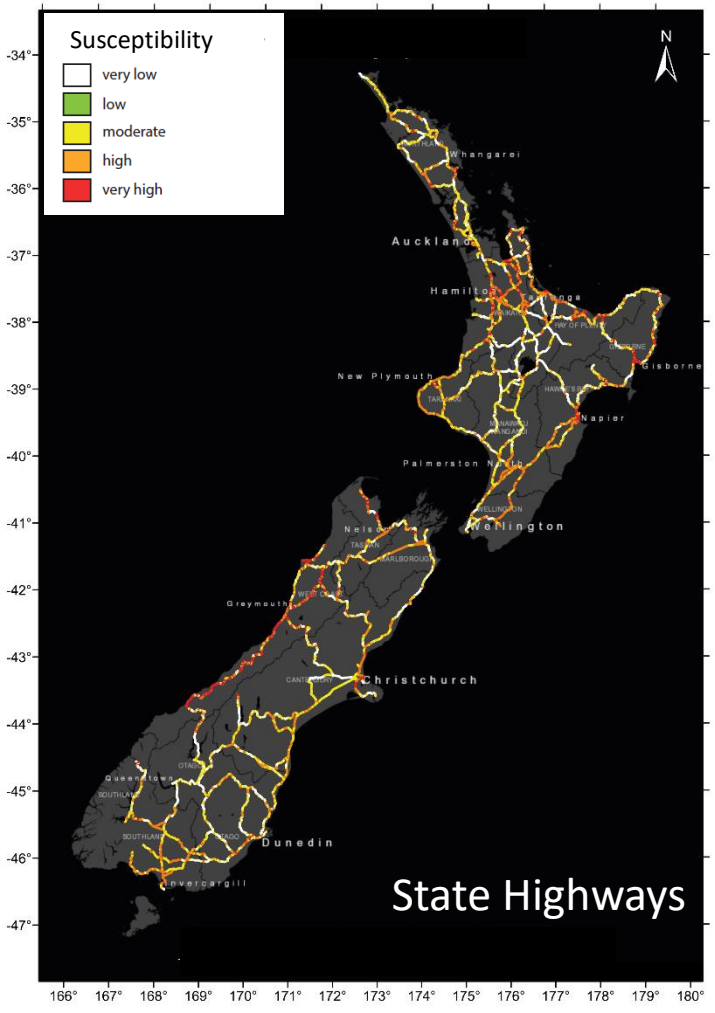
Geospatial Hazards

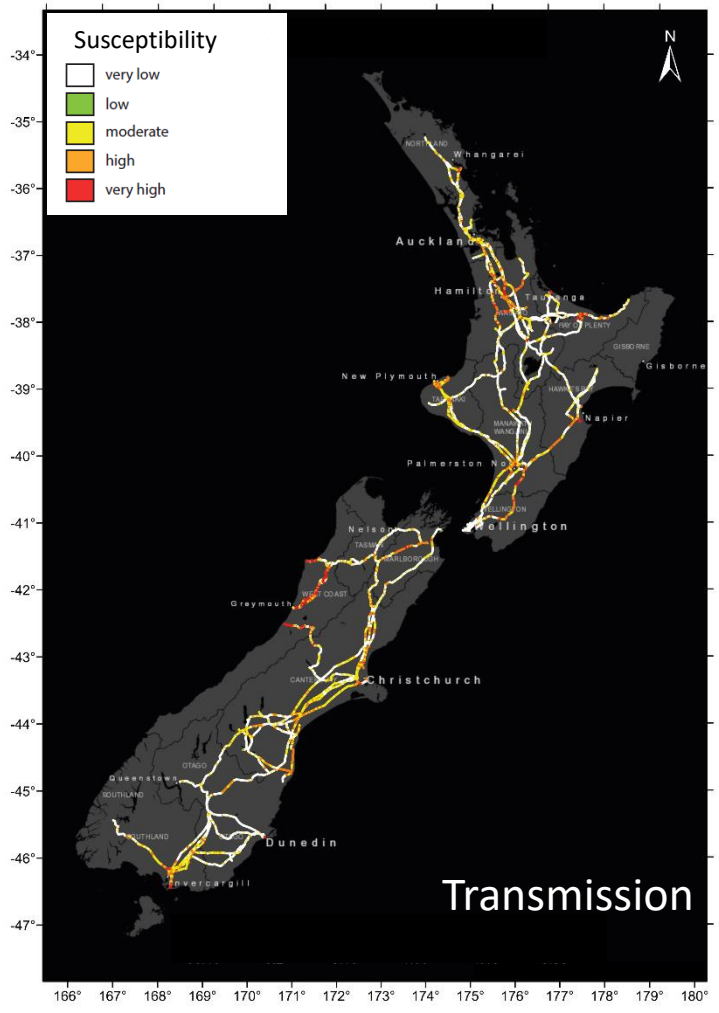
- Balance site specific and broader characterisation of infrastructure networks
  - Seismic hazards
  - Co-seismic hazards

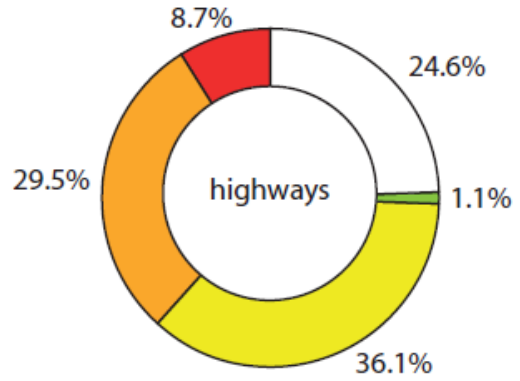
- Highlight exposure hotspots for more detailed assessment

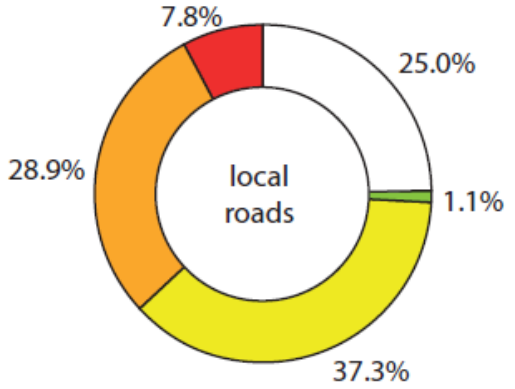
- Integrate site specific outcomes into broader geospatial approaches
  - Update and improve tools

Infrastructure Susceptibility: Liquefaction









Lin et al.

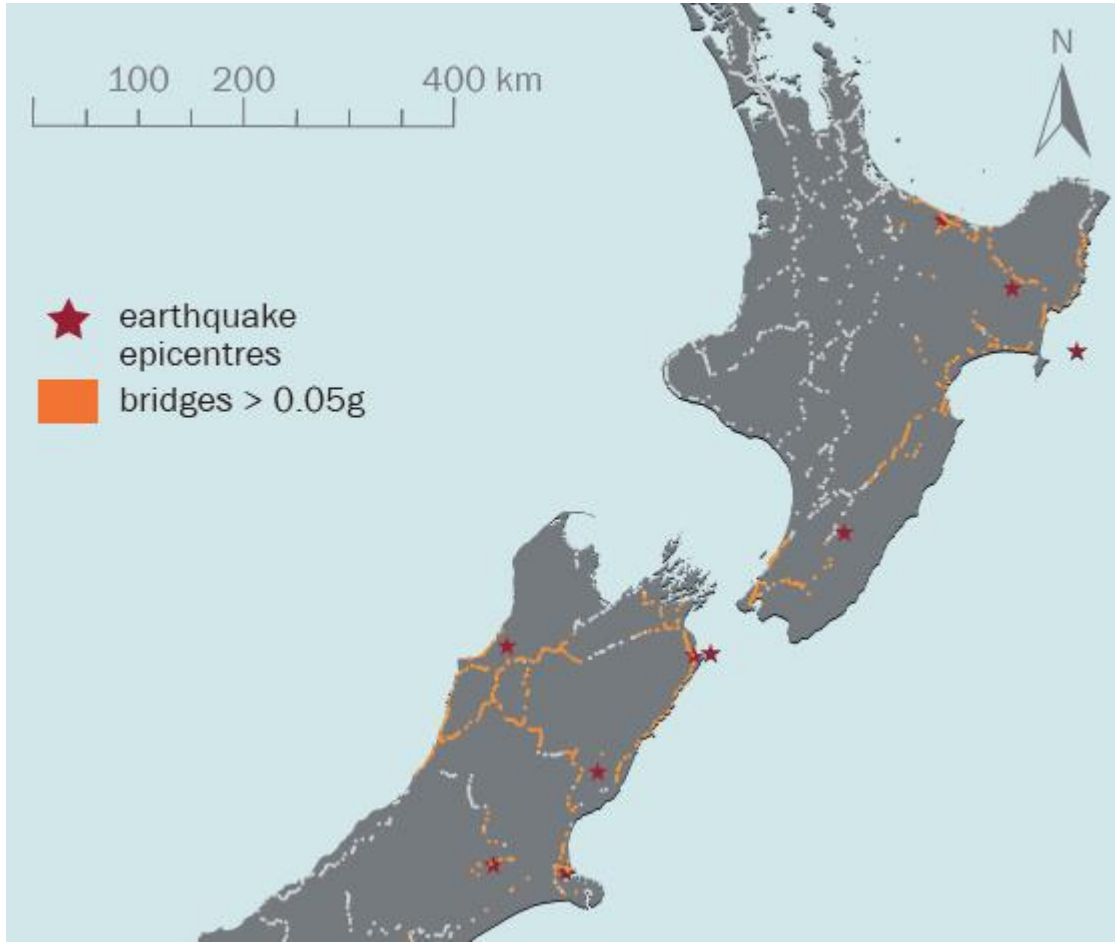
very low low moderate high very high

Infrastructure Components

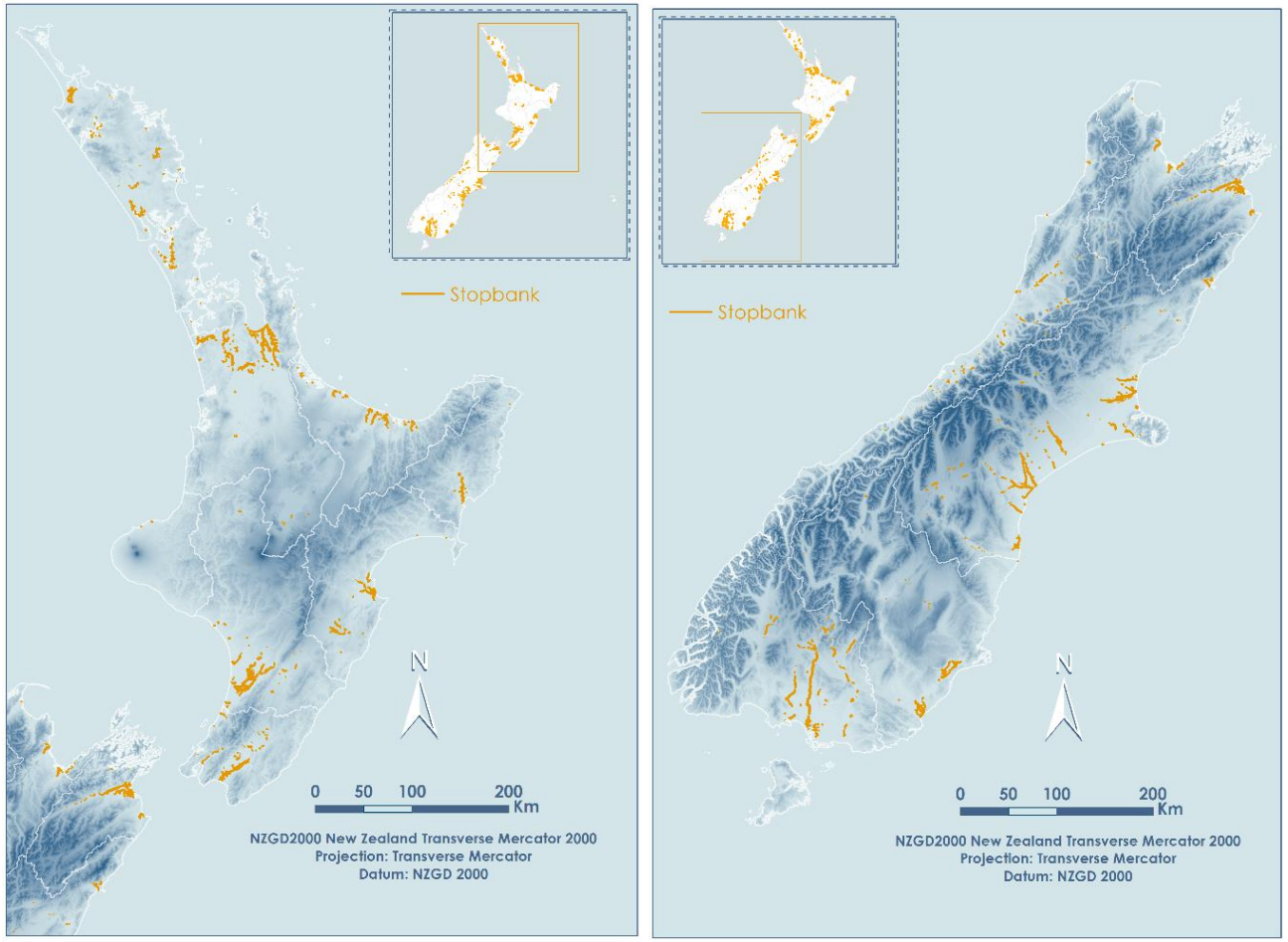
- Like all parts of the built environment, we learn more about physical performance following each EQ
  - Strong stakeholder support in NZ enables this
  - Learn from case history datasets
  - Improve component models (fragility, vulnerability, etc)
  - Look back to look forward – technological changes and retrofit
- Range of hazards and cascading hazards

Infrastructure Components

Bridges



NZIS



Lew et al. Blake et al.

Infrastructure Networks

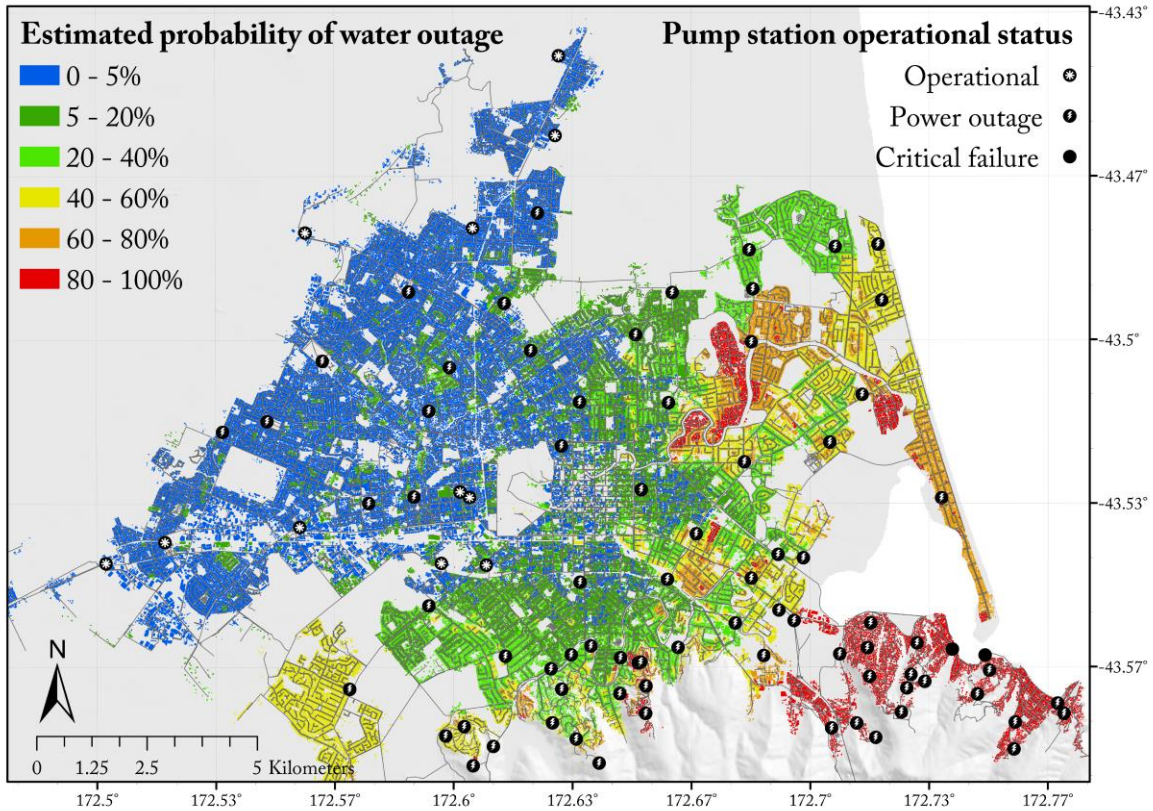
- Focus has traditionally been physical component damage

- Network process models rather than physical damage models
  - Represent the flow of the network
  - Enables assessment of network management strategies
  - Immediately post event: Functionality controls
  - During recovery: Damage controls

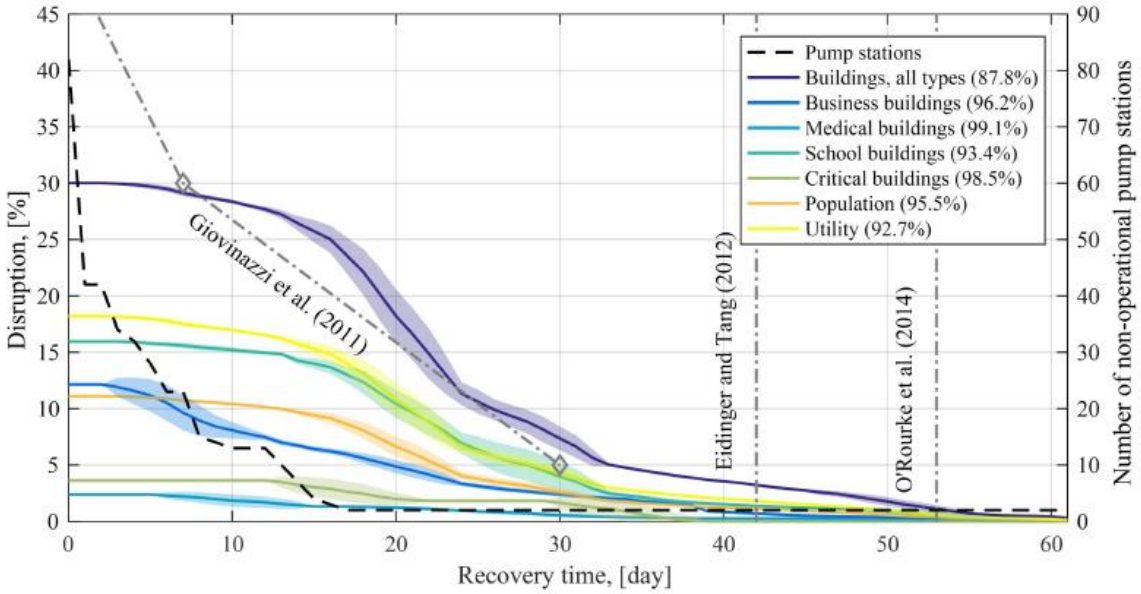
- Collaboration with network-specific experts

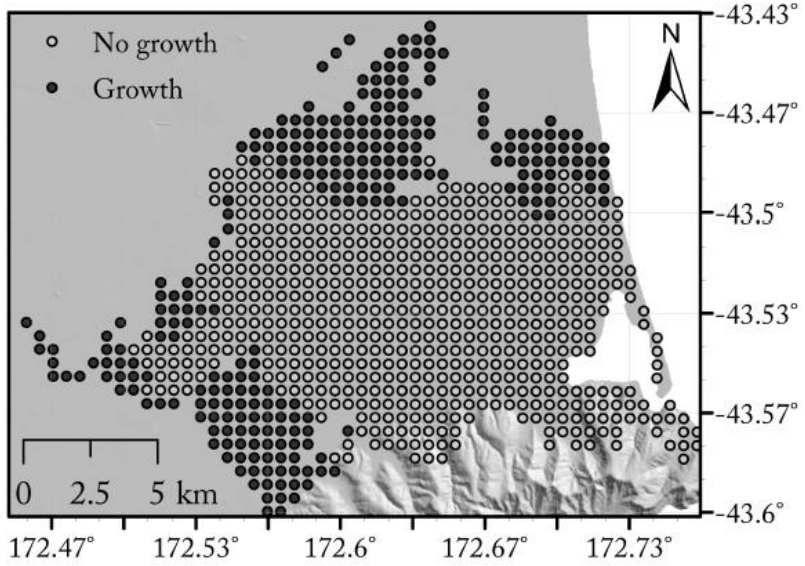
Potable Water

Outage estimation



Recovery modelling





Natural hazard impacts within asset management strategy

QuakeCoRE
NZ Centre for Earthquake Resilience
Te Hiranga Rū

infrastructure
National Science Challenges
RESILIENCE TO NATURE'S CHALLENGES
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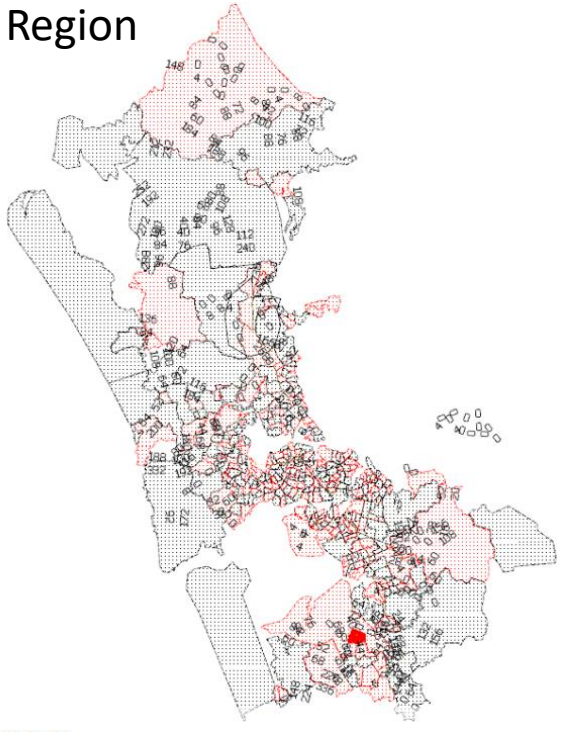
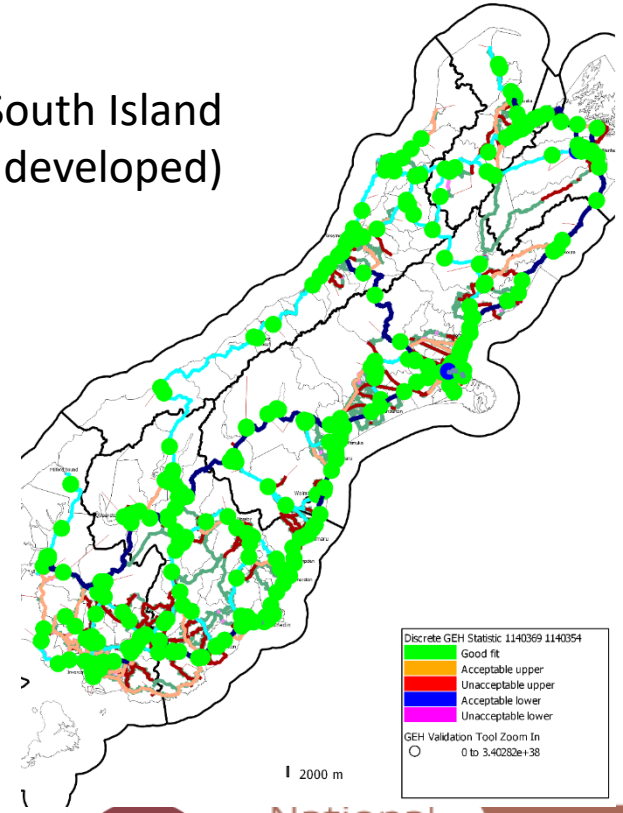
Transportation

- Newly developed road transport network models
- High-resolution transport network models, provides basis for assessment across hazards

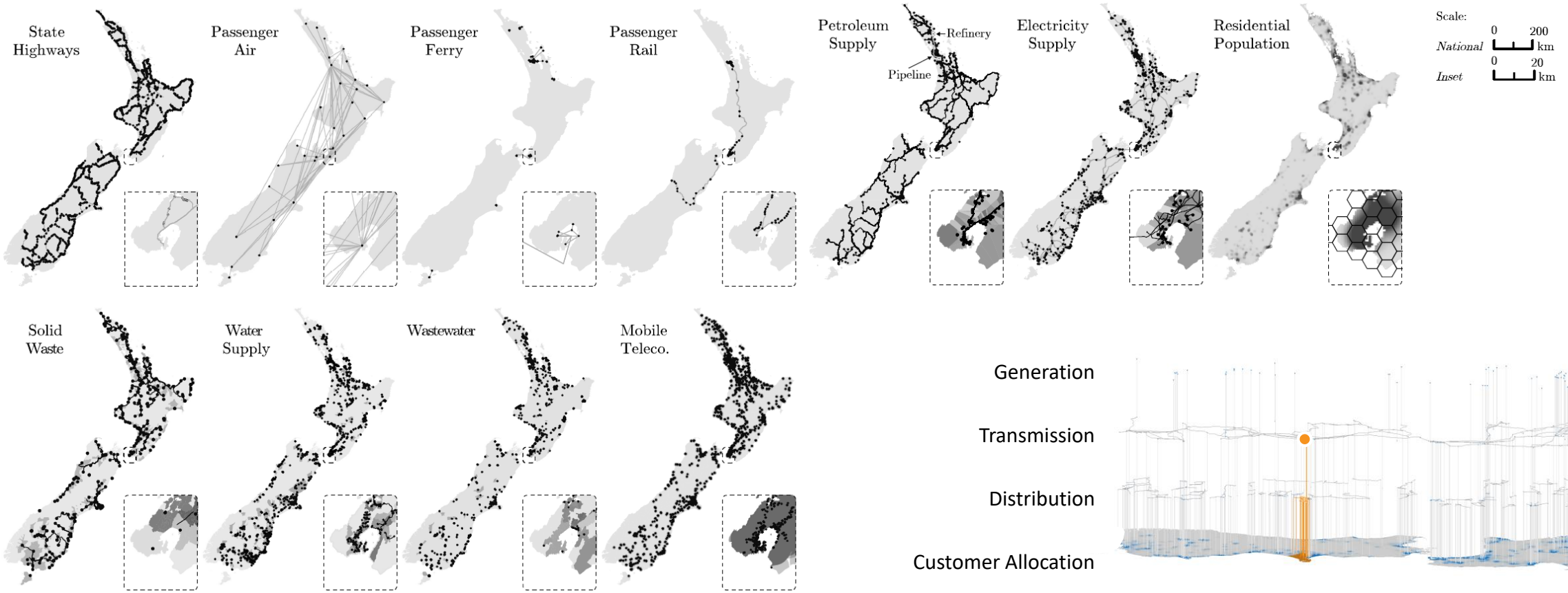
Auckland Region



South Island
(first to be developed)

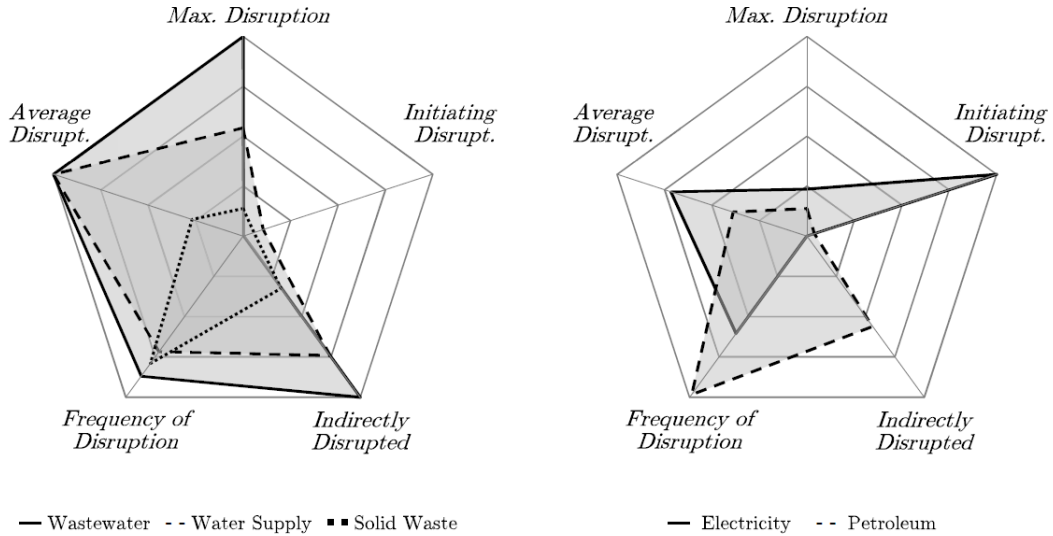


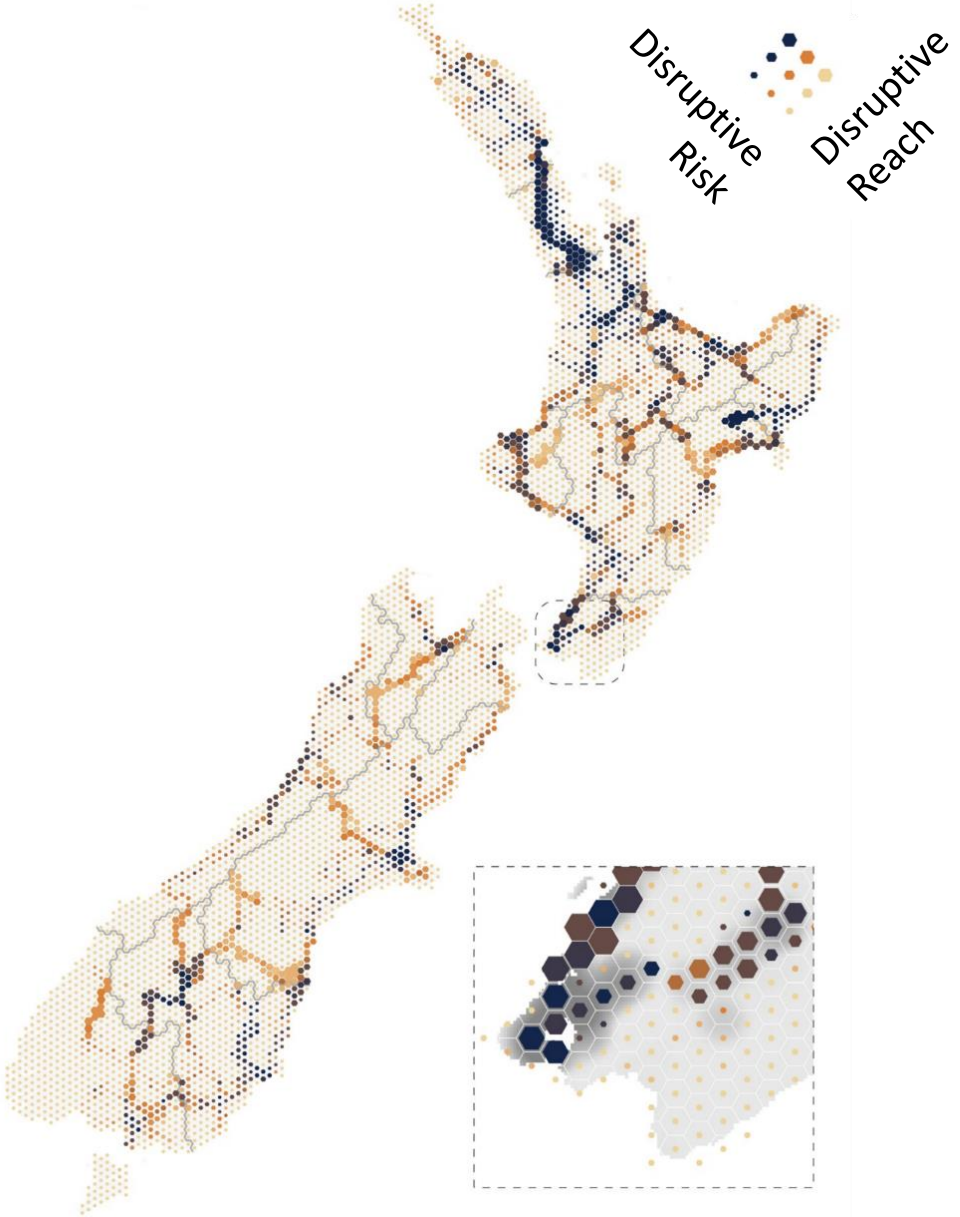
Interdependencies



Zorn et al.

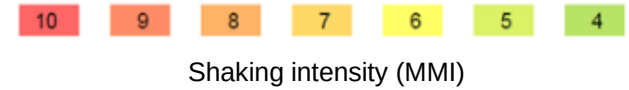
Interdependencies



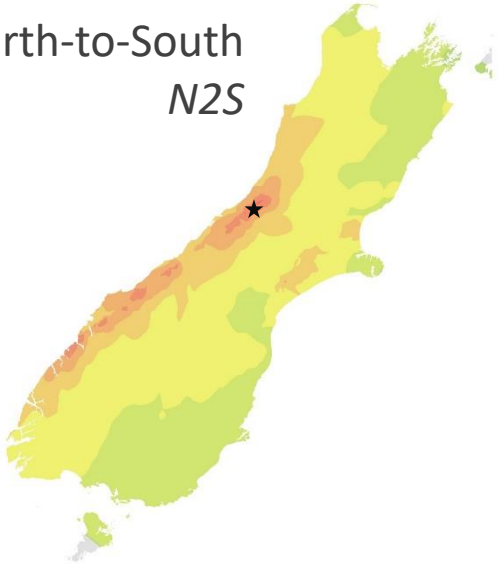


Zorn et al.

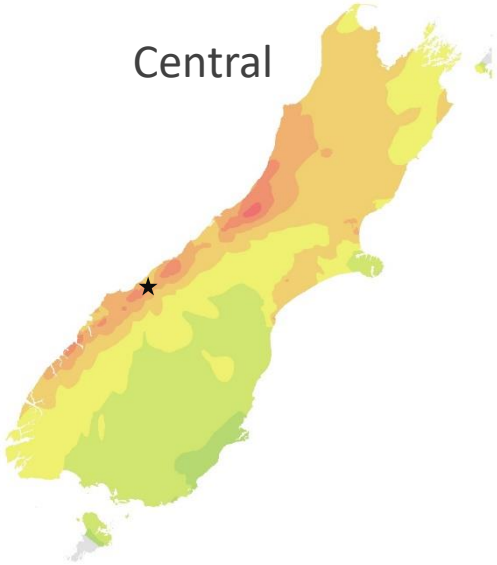
Interdependencies – Fuel Supply



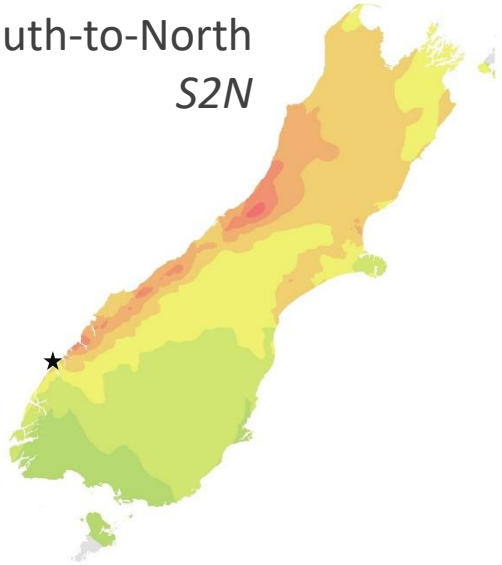
North-to-South
N2S



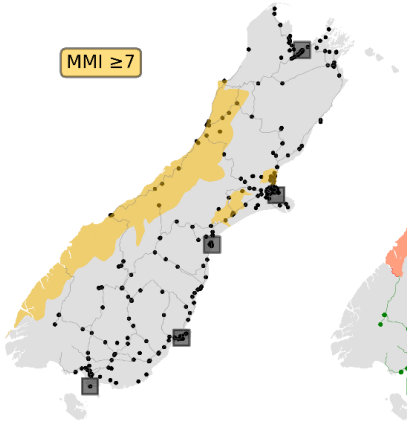
Central



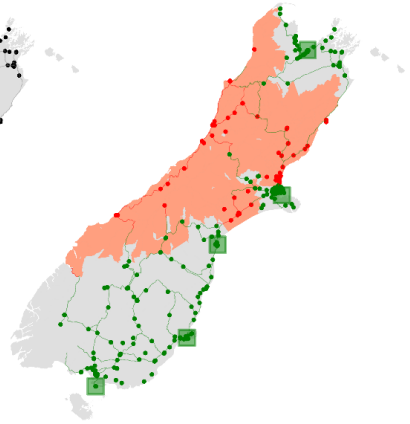
South-to-North
S2N



Asset Exposure



Extent of Disruption



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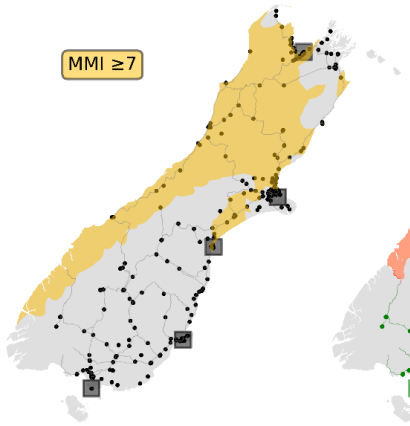
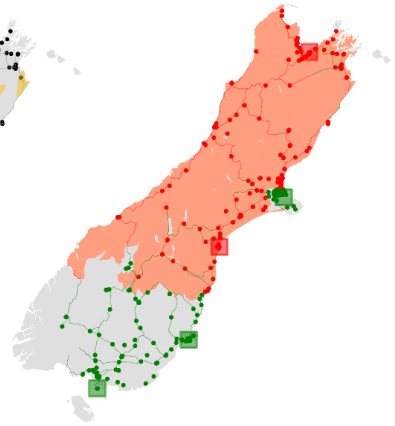
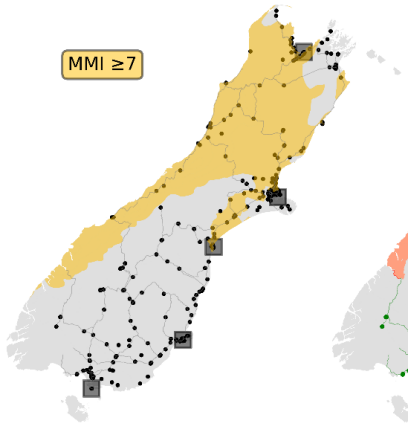


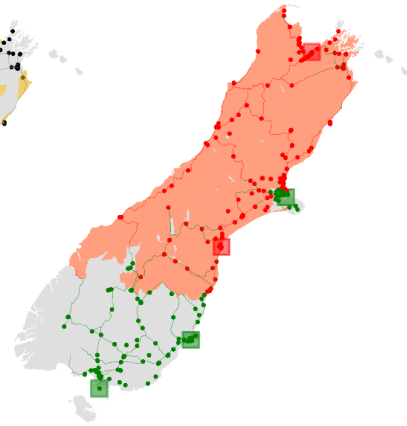
Extent of Disruption



Asset Exposure



Extent of Disruption

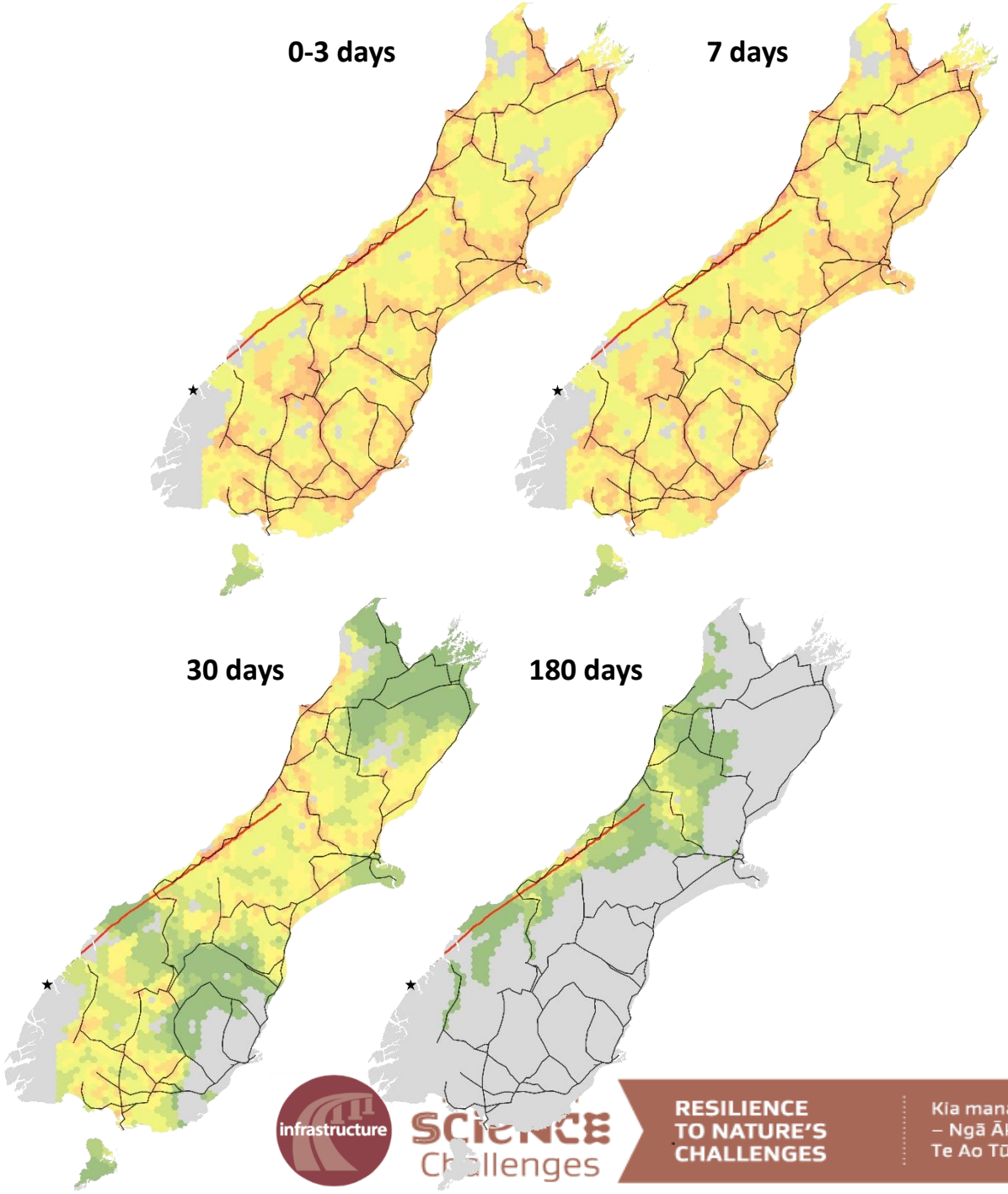


Recovery

- Immediate response strategies
  - Rapid network management decision making
- Assess potential recovery strategies + timing of interventions
  - Informed by direct and indirect socio-economic metrics
- Integrate with building damage and habitability/usability
  - Change in pre- and post-event demand levels

Recovery: Scenarios

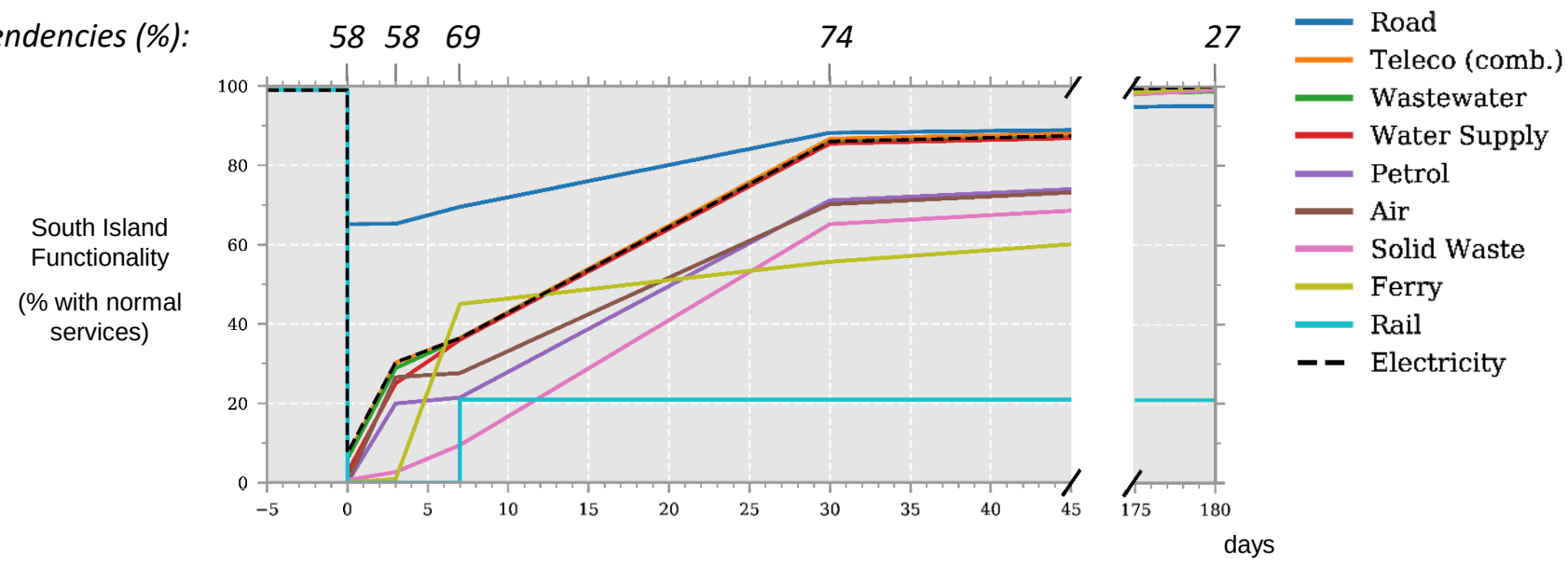
- Key collaboration with stakeholders
- Co-created workshop-based estimates of level of service
- Run through multiple scenarios to guide potential modelled recovery paths
- Type and timing of interventions plays a key role



Recovery

Directly caused disruptions (%): 42 42 31 26 73

Indirectly caused via dependencies (%): 58 58 69 74 27



Summary

- Formal linking of end-to-end models
  - Further insight into system-of-systems response
  - Incremental improvement in each part of the model
  - Dynamic dependencies through recovery stages
- Does not replace judgement, provides more data to inform process
- Assess impacts of:
  - Resilience investments
  - Response strategies
  - Growth and asset management strategies (linked to potential hazard impacts)
  - Technology advances
- Integrate with socio-economic models and decision making