

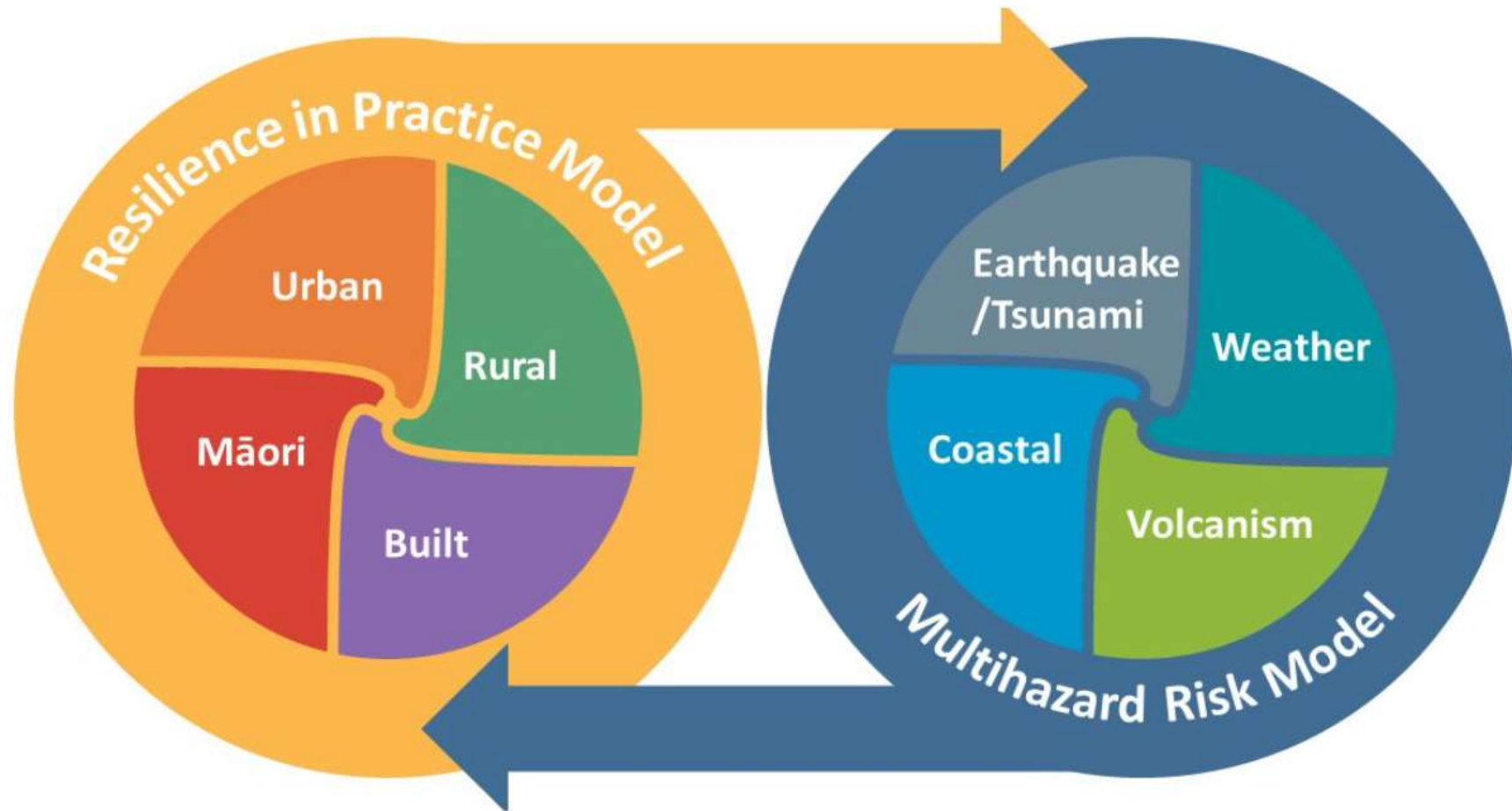
Resilience to Nature's Challenge
Built Environment theme
Coordination meeting for Vertical
Infrastructure workstream

27th Nov 2019

Agenda

- Introduction and overview of RNC2
- Project summaries:
 - Marae engineering resilience interventions and decision making (Fa'au)
 - Tsunami loadings on New Zealand structures (Toma)
 - Benchmarking the risk of code-compliant buildings (Sullivan)
 - Post-Earthquake Decision Criteria for Steel Buildings (MacRae)
 - Rehabilitation of damaged RC structures (Pujol)
 - Development of guidelines to account for soil-structure interaction (Millen/Cubrinovski)
 - Reducing economic losses in NZS3604 light timber framed houses (Li)
 - Reconsidering Design Criteria for the Serviceability Limit State (Sullivan)
 - Wellington building stock seismic modelling with identification of effective retrofit strategies (Elwood/Stephens)
- Reporting and contracting
- Closing discussion and date for next meeting

Built Environment



- Resilience to Nature's Challenges 2019-2024

Summary

- *“To improve the hazard response of the built environment and infrastructure that supports New Zealand.”*
- Budget - \$4.25 million over 5 years

Research Objectives

1. Understand natural hazard-induced demands on vertical and horizontal infrastructure.
2. Advance methods of natural hazard design and assessment.
3. Design analytical methods for quantifying performance of new and retrofit structures.
4. Quantification of infrastructure component and structural system fragility and vulnerability from case history observations and modelling.
5. Develop methods to quantify system-level performance of infrastructure networks and interdependencies.
6. Development of decision-making frameworks to inform resilience investments.
7. Examine the resilience of future alternate realisations of the built environment.

BE Streams

1 Horizontal Infrastructure

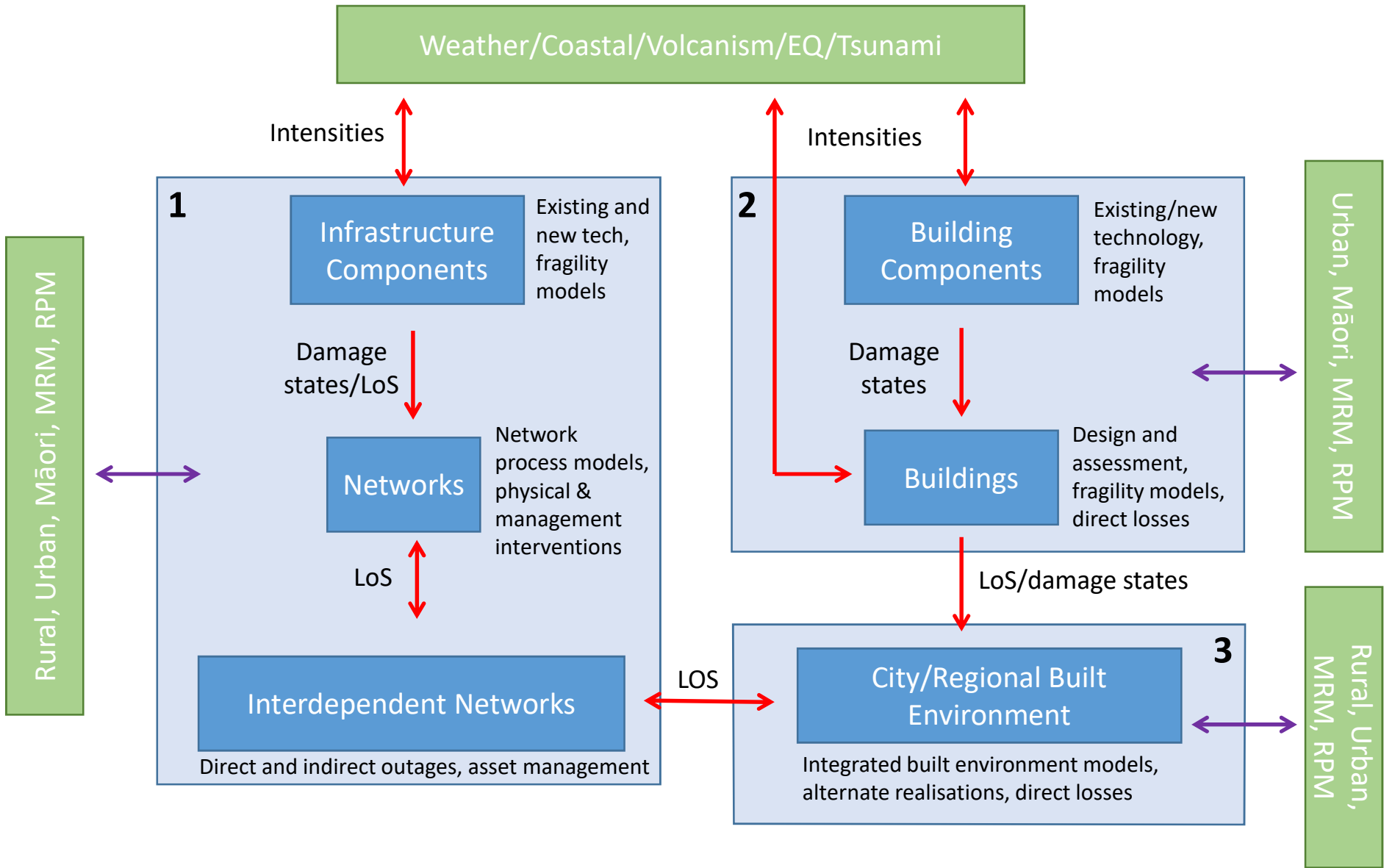
- Builds on RNC1 and QC

2 Vertical Infrastructure

- Builds on NHRP and QC

3 Integrated Scenarios

- Case study scenario (EQ & Tsunami)



BE- Vertical

Overall objective:

This workstream will seek to identify effective means of reducing the damage and disruption caused by future earthquakes.

Two main research areas;

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

BE- Vertical

Current project list:

1. Marae engineering resilience interventions and decision making
2. Tsunami loadings on New Zealand structures
3. Benchmarking the risk of code-compliant buildings.
4. Post-Earthquake Decision Criteria for Steel Buildings
5. Rehabilitation of damaged RC structures
6. Development of guidelines to account for soil-structure interaction (SSI)
7. Reducing economic losses in NZS3604 light timber framed houses.
8. Reconsidering Design Criteria for the Serviceability Limit State
9. Wellington building stock seismic modelling with identification of effective retrofit strategies

BE- Horizontal

- Multi-Hazard Assessment of Operational Impacts on the Transportation Network (links with Urban)
 - Builds on transport models developed in RNC1
 - Auckland focus

Costello et al.
- Telecommunication-electricity system resilience
 - Focus on telecommunications post-event
 - Build on current industry led projects
 - Resilience interventions and post-event strategies

Nair et al.
- Resilience through an Asset Management Long-term Planning Process (links with RPM)
 - holistic investment logic decision approach to guide infrastructure investments
 - wellbeing perspective

Henning et al.

BE- Horizontal

- Marae-based adaptations following infrastructure outages due to natural hazard events (links with Māori)
 - Building on scoping study – geospatial analysis and surveys
 - Iwi wide assessment
- Tsunami infrastructure vulnerability & fragility of infrastructure components (links with Rural/Urban)
 - Expand current suite for analysis
 - Loading characteristics to component performance
 - Assessment of mitigation measures

Fa'au'i et al.

Higuera et al.

BE- Horizontal

- Geospatial seismic and co-seismic assessment tools for infrastructure networks
 - tools for application to infrastructure networks
 - developed for NZ conditions
 - **Applicability within Vertical Infrastructure**
- Infrastructure-building interdependencies and recovery (links with Urban)
 - process-based modelling of networks and building exposure
 - current risk, future risk
 - mitigation/adaptation strategies and network recovery priorities

Orense et al.

Zorn et al.

BE - Horizontal

- Ground motion simulation of subduction zone earthquakes in NZ
 - Simulation to inform design and assessment
 - Seismic hazard and GM suites
 - **Applicability within Vertical Infrastructure**

Bradley et al.

BE– Integrated Scenario

- Range of projects listed previously within this scenario
- Wellington – EQ and Tsunami:
 - Geohazard and tsunami modelling
- Vertical Infrastructure projects:
 - Building stock seismic modelling
 - Loss modelling and decision making
 - Tsunami impacts
- Horizontal Infrastructure projects:
 - Infrastructure-building interdependencies
 - Telco-electricity
 - Tsunami impacts
- Resilience of current and future networks (ageing and investment)

Also co-funded projects in other themes:

- Volcanic/Rural
- High-impact weather
- Coastal
- Multi-Hazard Risk

Reporting

- Annual reporting to be detailed.
- Quarterly reporting
 - Flagging any major issues that have arisen or risks to project. Early notification key.
 - Collection of data to inform more detailed reporting

Example RNC1

▲ Infrastructure: Infrastructure Highlights Report for period Q4 ending 30/06/2019

Advanced Understandings

Drag coefficients for power poles under tsunami impact, contributing to general expressions for tsunami loading and fragility curves for slender structures impacted upon by tsunami bores.

Comprehensive understanding, modelling, simulation and case studies for the Westcoast electricity network restoration following large-scale natural disturbances. This is being socialized with energy stakeholders alongside their annual industry meetings.

Methods of characterizing and analysing communication infrastructure impacts following large-scale earthquakes using Alpine Fault potential trajectories (identified by energy stakeholders Westpower) and Westcoast network completed. This has been socialized with MBIE and has been identified to be more detailed and useful than existing methods used by consultants.

Data, Tools & Processes

Geospatial data for FirstGas network obtained through formal Data Use Agreements with University of Canterbury and University of Auckland (Blake, Wotherspoon). Flood reports and associated flood incident data from Environment Canterbury, Environment Southland, Gisborne, Greater Wellington, Hawkes Bay Regional Council, Horizons, Marlborough, Nelson, Northland, Otago, Taranaki, Tasman and Waikato for use in stopbank incident inventory (Blake, Crawford-Flett, Singh, Wotherspoon, Shamseldin).

Peer Reviewed Publications

McKibben, D., Blake, D., Wilson, T. M., Wotherspoon, L. M., & Hughes, M. W. (2019). A geospatial assessment of critical infrastructure impacts and adaptations in small rural towns following the 14 November 2016 (Kaikōura) earthquake, New Zealand, Japanese Geotechnical Society Special Publication, 6(2): 19-29. <https://doi.org/10.3208/jgssp.v06.GIZ04>

Maina DK, Sanjari, MJ, Nair N-KC. (2019) DFIG-based Windfarm Starting Connected to A Weak Power Grid 2019 IEEE PES GTD Grand International Conference and Exposition Asia, GTD Asia 2019), Bangkok, Thailand 20-23 March 2019.

Maina DK, Sanjari, MJ, Nair N-KC. (2019) Blackstart of DFIG-based Windfarm 2019 IEEE PES General Meeting, PES GM 2019, Atlanta, USA 4-8 August 2019.

Maina DK, Nair N-KC. (2019) Network Component Modelling for Blackstart Planned Islanding 2019 Electricity Engineers' Association Annual Conference & Exposition, EEA 2019, Auckland, New Zealand, 25-27 June 2019.

Shirzadi S, Nair N-KC. (2019) Efficient Distribution Network Recovery following Natural Disasters: New Zealand Case Studies 2019 Electricity Engineers' Association Annual Conference & Exposition, EEA 2019, Auckland, New Zealand, 25-27 June 2019.

Lin A, Wotherspoon L, Blake D, Bradley B & Motha J. (2019) Liquefaction assessment of highway networks using geospatial models, 7th International Conference on Earthquake Geotechnical Engineering, Rome, Italy, 16-19th June 2019.

Conferences

Safa-Al-Sachit, Protection Scheme Performance in an Islanded Distribution Grid, CIGRE 2019 Forum, Auckland, 24 June 2019.

Samad Shirzadi, Islanded Grid Control at Distribution Level in New Zealand, CIGRE 2019 Forum, Auckland, 24 June 2019.

Duncan Maina, New Zealand Grid Black Start CIGRE 2019 Forum, Auckland, 24 June 2019. Farrukh Latif, Communication System Resilience' CIGRE 2019 Forum, Auckland, 24 June 2019.

Ebad Rehman, Resilience of Underground Cable Systems in New Zealand CIGRE 2019 Forum, Auckland, 24 June 2019.

Liam Wotherspoon, Simulation of direct and indirect infrastructure failure and recovery strategies for an Alpine Fault earthquake scenario, ICONHIC 2019, Chania, Greece, 26 June 2019, Invited Presentation.

Xavier Bellagamba, Enhancing the full cycle of distributed infrastructure seismic resilience assessments: A New Zealand perspective, ICONHIC 2019, Chania, Greece, 26 June 2019, Invited Presentation.

Stakeholder Engagement & Workshops

Collaborative meetings/workshops with River Managers at offices of Environment Canterbury, Environment Southland, Gisborne (on Kapiti Coast), Greater Wellington, Horizons, Marlborough, Nelson, Otago, Tasman and Waikato by Blake in May-June 2019 to discuss recent stopbank work and stopbank incidents (data obtained).

Multiple research meetings with Westpower/Electronet, Chorus and Orion as part of completion of multiple projects and the development of new projects moving into RNC2. Invited presentation to World Bank event by L Wotherspoon: South Asia Regional South-to-South Learning workshop on strengthening geohazard risk management in transport, 1 May 2019. Focus on the Transportation related research in RNC and QuakeCoRE.

Public Participation & Outreach

C Whittaker assisted with the design of tsunami tank for new 'Te Taiao Nature' exhibition at Museum of New Zealand Te Papa Tongarewa.

AF8 presentation by Blake on A Future Alpine Fault Earthquake and Expected Impacts (11 April 2019) and following discussion. Canterbury Civil Defence Emergency Management Group Controllers' Forum, Christchurch, New Zealand.

Maori Involvement & Matauranga

Contracting

- Auckland contract signed
- Sub-contract with UC being finalised (expect to be signed prior to Christmas).

Meetings/collaboration

- Regular meetings encouraged between projects and across themes.
- Monthly group coordination meetings to briefly update on progress and coordinate work.