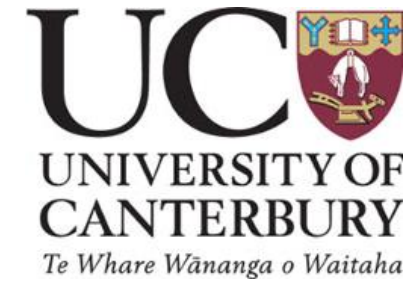# A geospatial assessment of critical infrastructure impacts and adaptations in small rural towns following the 14 November 2016 (Kaikōura) earthquake, New Zealand
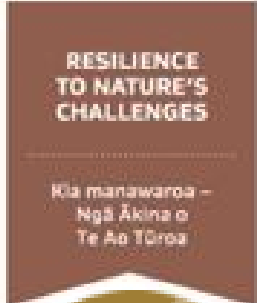
Damon McKibbin, Dr Daniel Blake, Assoc. Prof. Thomas Wilson, Dr Liam Wotherspoon, Dr Matthew Hughes

Tonkin+Taylor, November 2016.

The physical, emotional and economic impacts of disasters in high population areas are widely known. The effects on small, isolated rural communities are not.

Key objectives

Using the 2016 Kaikōura earthquake as an analogue, our project aims to:

- Document the critical infrastructure impacts on small towns in Canterbury & Marlborough.

- Examine anticipated & actual adaptions to lifeline service disruption.

- Document community adaptations.

- Assess the success of these adaptions, and consider the implications of future changes to infrastructure.

Envivo Ltd, undated.

The Kaikōura Earthquake - Background

- 00.02 14th November 2016

- Mw 7.8, 15km deep, Near Kaikōura 95km NE of Christchurch

- Widespread shaking, landslides, surface rupture, liquefaction, tsunami, uplift

- Tourist season heavily impacted

Reef Uplift Research Consortium
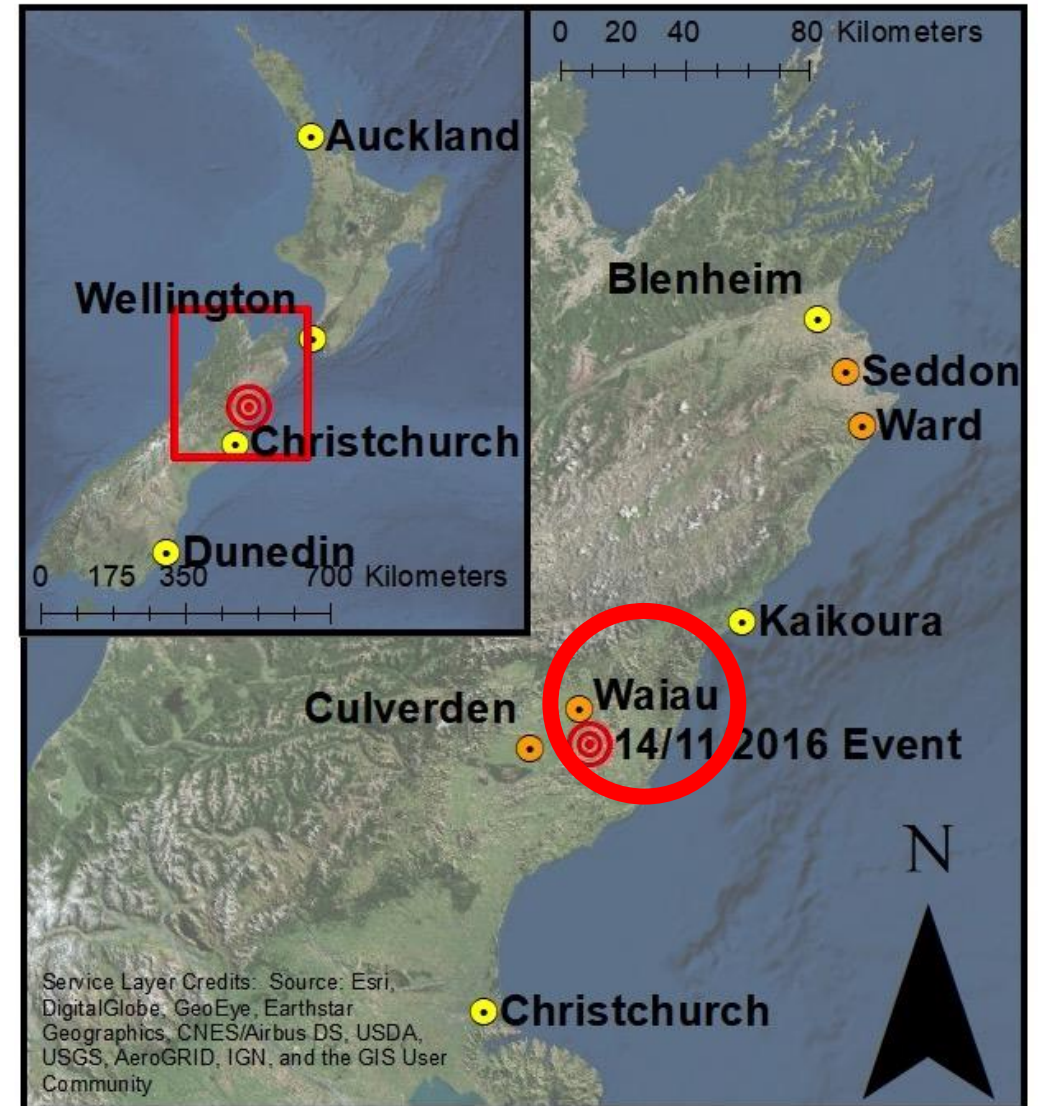
Methods

A robust literature review drawing on:

- Journal literature

- Industry/CDEM reports

- News and social media

- Geospatial data sources

Filter communities through selection matrix. Four for broad analysis and one for in-depth investigation

Interviews as a valuable first-hand source of information

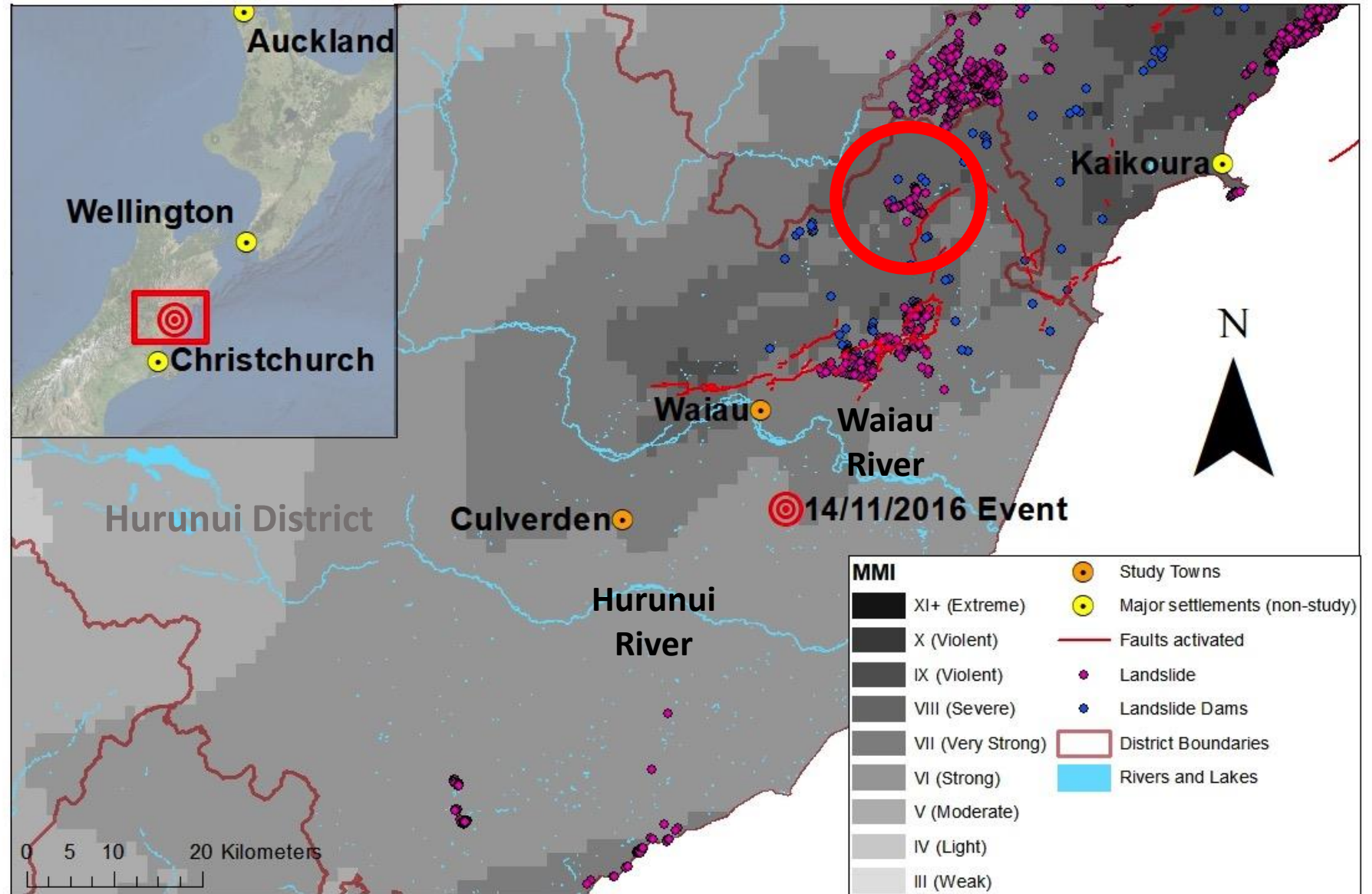Construct hazard maps, infrastructure inventories, interdependency analyses and timelines of LOS

Comprehensive investigation of results

Thesis was submitted Feb 2019. Research papers currently under development.
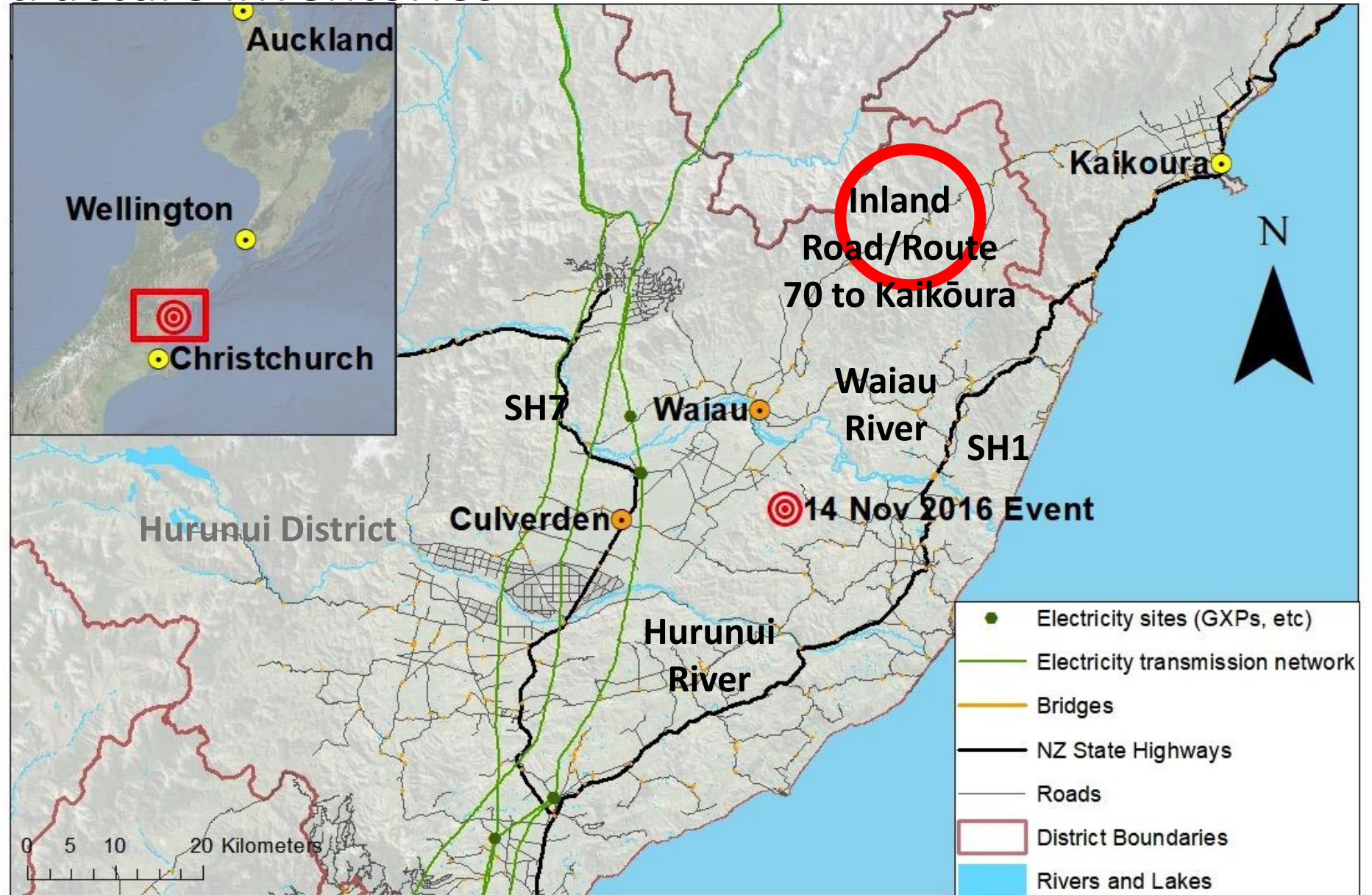

Ulrich Lange, February 2017.
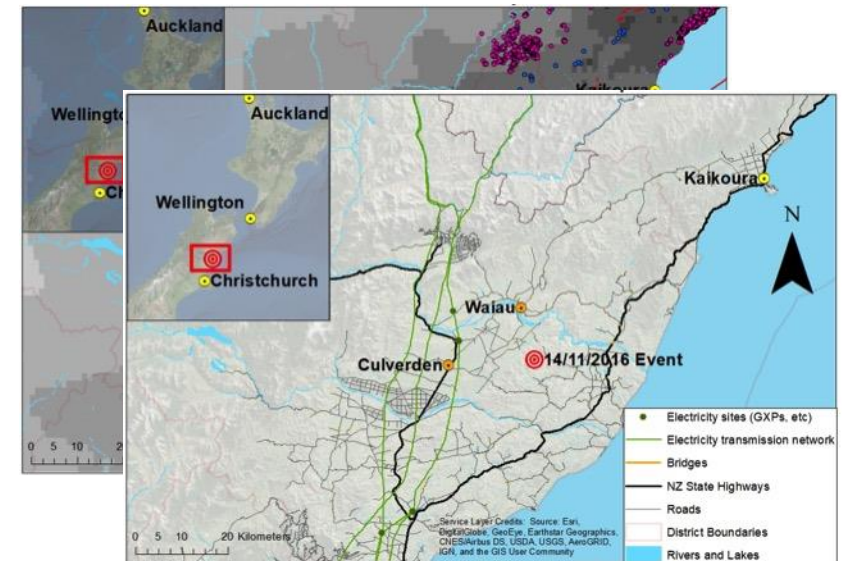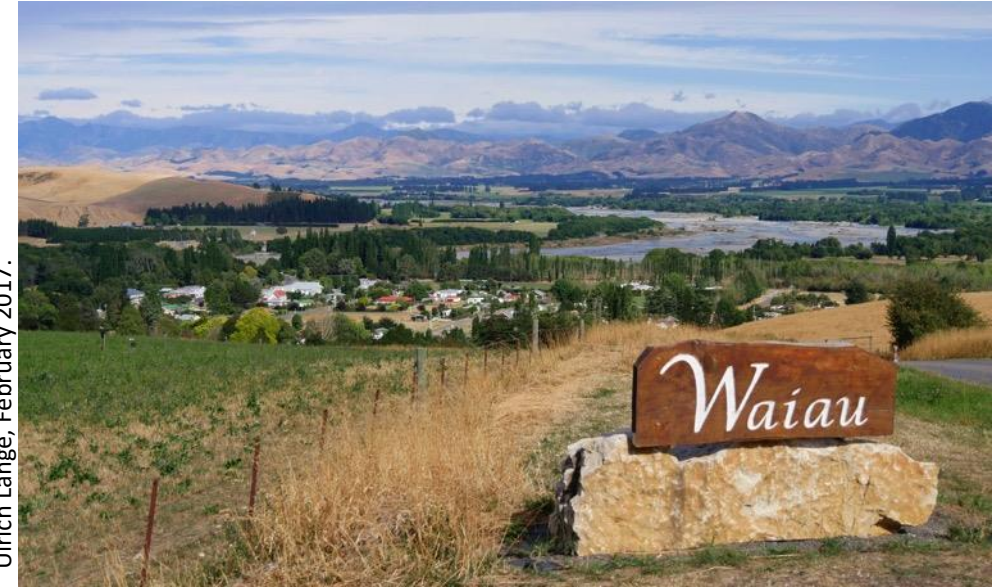
Methods – Hazard Maps

- MMI data (Bradley et al. 2017)

- Reported damage matches MMI

- Landslide data (Massey et al. 2018)

- Coseismic landslides cluster in >strong MMI

Methods – Infrastructure inventories

- Inland Route blocked by landslides

Auckland

Wellington

Christchurch

Kaikōura

Inland Road/Route 70 to Kaikōura

Waiau River

SH1

SH7   Waiau

Hurunui District

Culverden

◎ 14 Nov 2016 Event

Hurunui River

N

●	Electricity sites (GXPs, etc)
—	Electricity transmission network
—	Bridges
—	NZ State Highways
—	Roads
▭	District Boundaries
	Rivers and Lakes

0   5   10   20 Kilometers
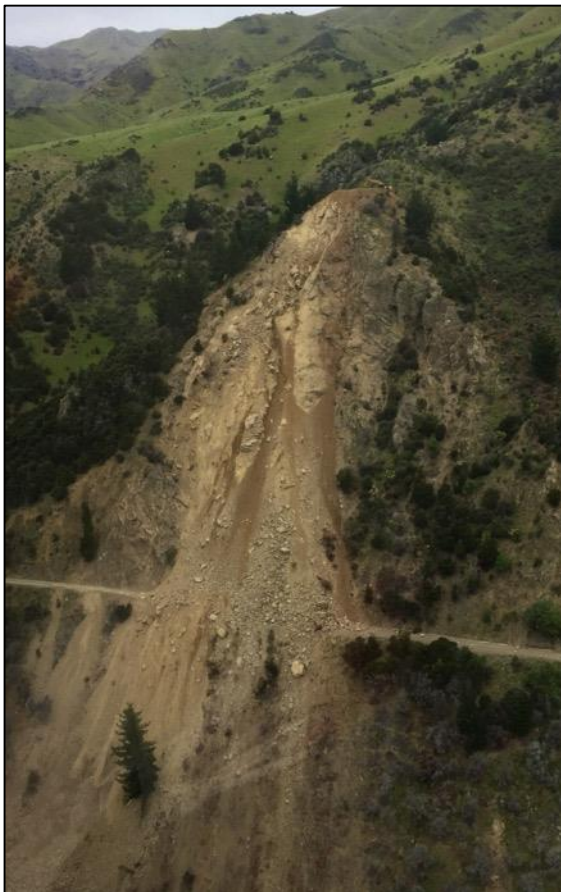
Results - Key impacts

- Branching networks general in rural areas with few redundancies. Bridges are pinchpoints for such networks and large swathes of network were cut off by bridges shaken off foundations

- Roads blocked by slumping, surface rupture and landslides

- Fibreoptic cables stretched

- Three Waters damage most prominent at fixtures and junctions

- Powerpoles tilted, electrical conductors drooping over roads

- Significant structural damage to dwellings

Palermo et al., 2017.

Steve Murrin/Marlborough NZTA 2016

Results – Key Interdependencies (Matrix)

Interdependency matrix adapted from the New Zealand Lifelines Council (2017), tailored for Waiau and the 2016 Kaikōura earthquake:

a) Business as usual, b) post-event

a

| Degree to what this > Is dependent on this v	Electricity	Roads	Fuel	Wired Telecomms.	Water Supply	Stormwater Drainage	Aviation	Broadcast Telecomms.	Total
Electricity		1	3	3	3	1	1	3	15
Broadcast Telecomms.	2	2	2	2	2	2	3		15
Roads	2		3	2	2	2	1	2	14
Fuel	2	2		2	2	2	1	2	13
Wired Telecomms.	2	1	2		2	1	1	2	11
Stormwater and Drainage	1	2	1	1	2		1	1	9
Water Supply	1	1	1	1		1	1	1	7
Aviation	1	1	1	1	1	1		1	7
Total	11	10	13	12	14	10	9	12	91

b

Degree to what this > Is dependent on this v	Electricity	Roads	Fuel	Wired Telecomms.	Water Supply	Stormwater Drainage	Aviation	Broadcast Telecomms.	Total
Broadcast Telecomms.	3	3	3	3	3	3	3		21
Roads	3		3	3	3	3	1	3	19
Fuel	3	3		3	3	3	1	3	19
Electricity		1	3	3	3	1	1	3	15
Aviation	2	2	1	2	2	2		2	13
Wired Telecomms.	2	1	2		2	1	1	2	11
Stormwater and Drainage	1	2	1	1	2		1	1	9
Water Supply	1	1	1	1		1	1	1	7
Total	15	13	14	16	18	14	9	15	114

Results – Key Interdependencies

- Under business as usual conditions in Waiau, the lifeline service most depended on by other lifelines is electricity, followed by broadcasted telecommunications and roads. Post-earthquake, broadcasted telecommunications becomes the most depended on followed by roads and fuel

- Broadcast telecommunications are required for the coordination and monitoring of every sector in recovery

- Roads important for transport of supplies, infrastructure repair crews

- Majority of critical infrastructure nodes are equipped with some form of backup power source

- Reliance on aviation was considerably lower in Hurunui than in Kaikōura and Marlborough

Results – Key Adaptations

Damon McKibbin, 2018
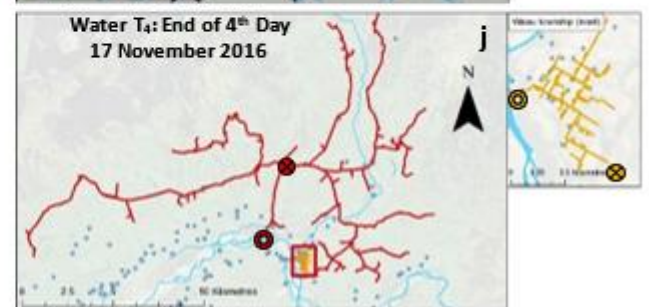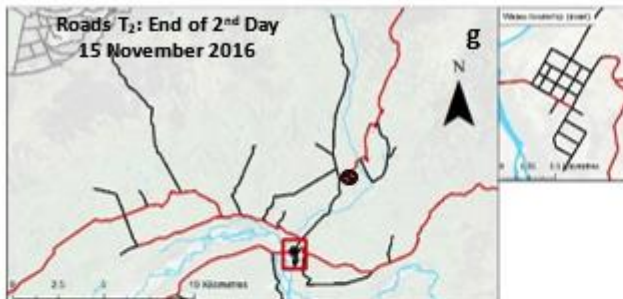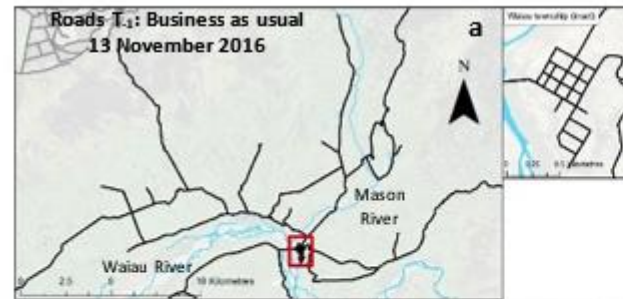
- Transport
  - Inland Road detour

- Water
  - Stock allowed to drink from waterways
  - Water boil notices
  - Production of water pipes for Waiau rural scheme rushed to meet demand

- Electricity and fuel
  - Diesel generators were the preferred backup option, some distributed by the HDC
  - Farmers with power shared rotating milk shed with farmers without power

- Accommodation
  - Emergency accommodation provided
  - Some residents moved in with neighbours or relatives
  - Some flexibility in Hurunui with allowing farmers to inhabit safe farm buildings when their primary dwelling was red-placarded

Results – Key Adaptations (continued)

- Social
  - BBQ gatherings, schools and pubs became important meeting places for community planning, reassurance and information dissemination when more official buildings were damaged
  - Navigator program assisted members of the community in accessing resources, as well as feeding back information used by emergency management to manage priorities

Damon McKibbin, 2018

Results – General Findings

- Wealthier farming families vs lower-socioeconomic townships dichotomy
- Naming of the "Kaikōura" earthquake had negative social consequences
- Four phases of psychosocial recovery model
  - Altruism Phase (positive)
  - Honeymoon Phase (positive)
  - Realism Phase (negative)
  - The 'New Normal' (sustainable)
- Increased building survival in Seddon and Ward related to previous earthquake exposure

Low Incomes

↓

Low Investment/Insurance

↓

Poor Resilience
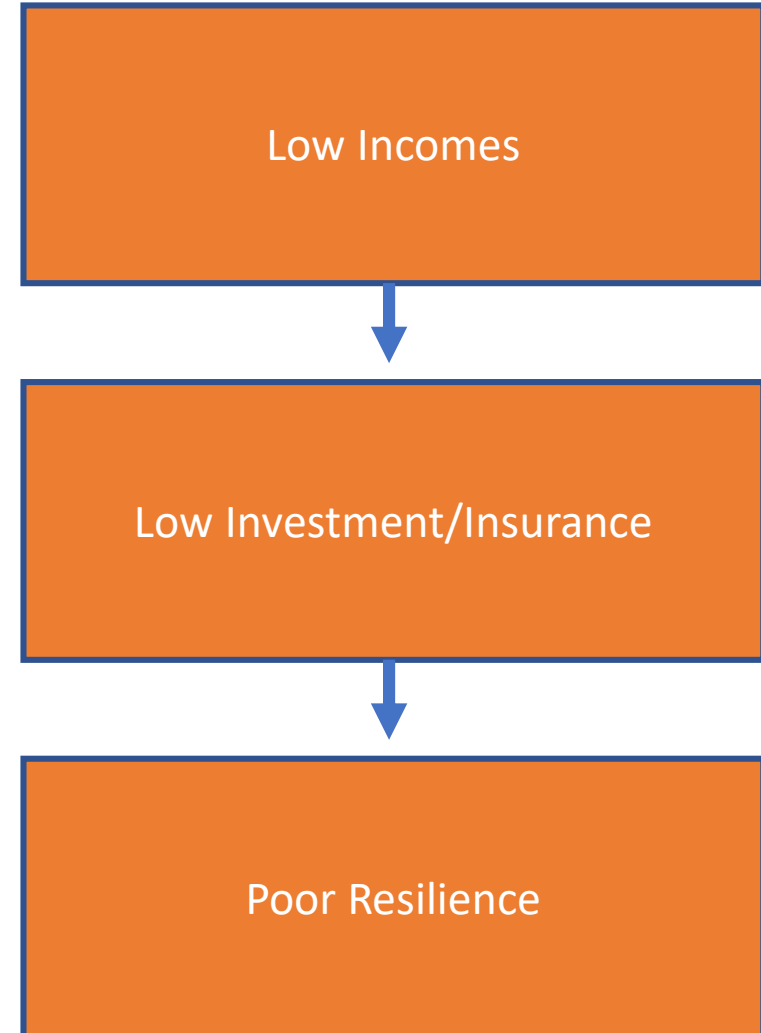
Conclusions

- Impacts concentrated geographically

- Several adaptations found at different levels of management (government, industry, family)

- Interdependence levels between critical lifeline services in small towns differ from large population centres and even between small towns

- Important psychosocial challenges to consider during response and recovery

- Socioeconomic barriers to recovery and building in resilience

- Room for future research both expanding the scope or taking a narrower focus

We invite anyone interested in my work to contact me to receive a summary of findings or further discussion:
damon.mckibbin@pg.canterbury.ac.nz