Risk and Resilience of Community Infrastructure

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NZ infrastructure and its vulnerability

- Infrastructure
  - Critical driver for economic growth of a country
  - Fundamental for community well-being
- Challenging geography
- Varying levels of infrastructure redundancy across the country
- Functionality: intra-dependencies and inter-dependencies

IMPACTS:

- Disruptions to Levels of services (LoS) to businesses and community
- High economic and social risk for cities, councils and the entire country

What are the issues?

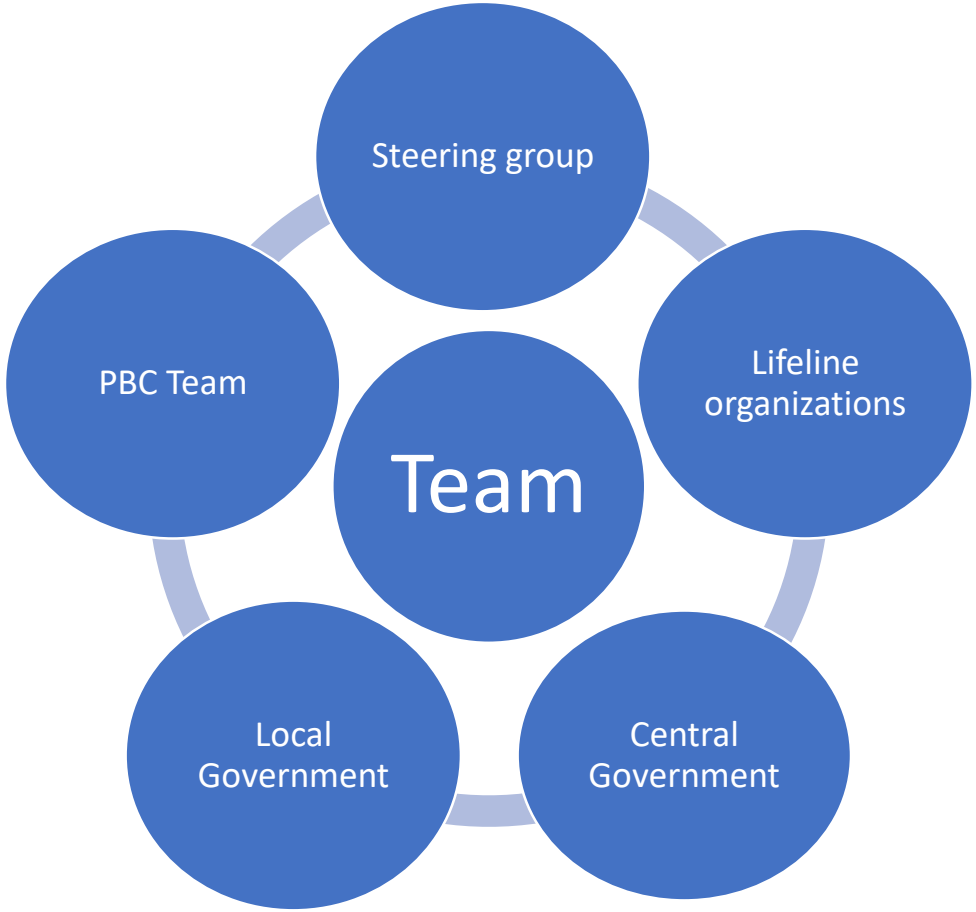
- Priority to household resilience, not necessarily to improving infrastructure resilience
- Lack of interest or capacity for coordinated efforts from various infrastructure providers
- Insufficient evidence on the positives of resilience initiatives

- Risk and resilience assessment of infrastructure demonstrates the benefits of resilience initiatives to wider groups

WELLINGTON LIFELINES
RESILIENCE PROGRAMME BUSINESS CASE

Wellington Infrastructure

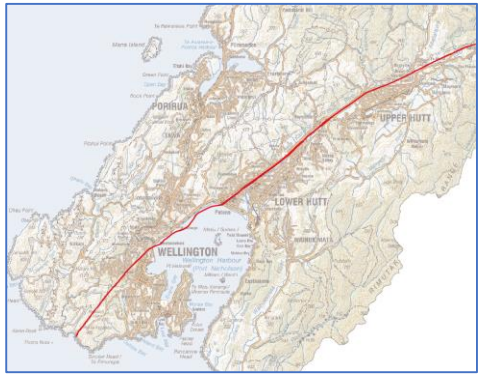
Programme Business Case (PBC)



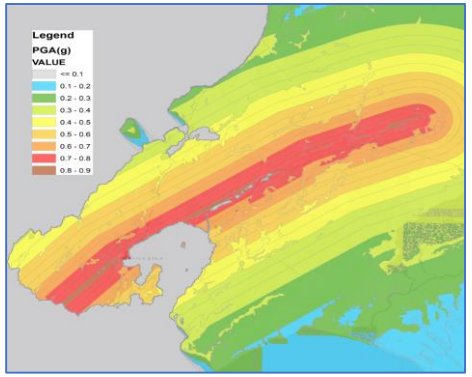
Scenario Event

- M7.5 Earthquake on the Wellington Fault
- ~1 in 1000 annual likelihood

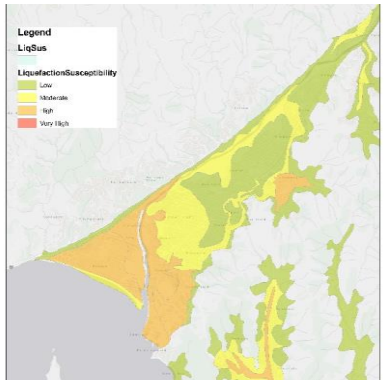
Perils considered



Fault Rupture

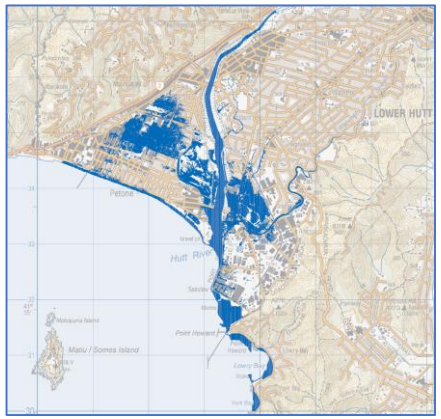


Shaking



Liquefaction

Landslide

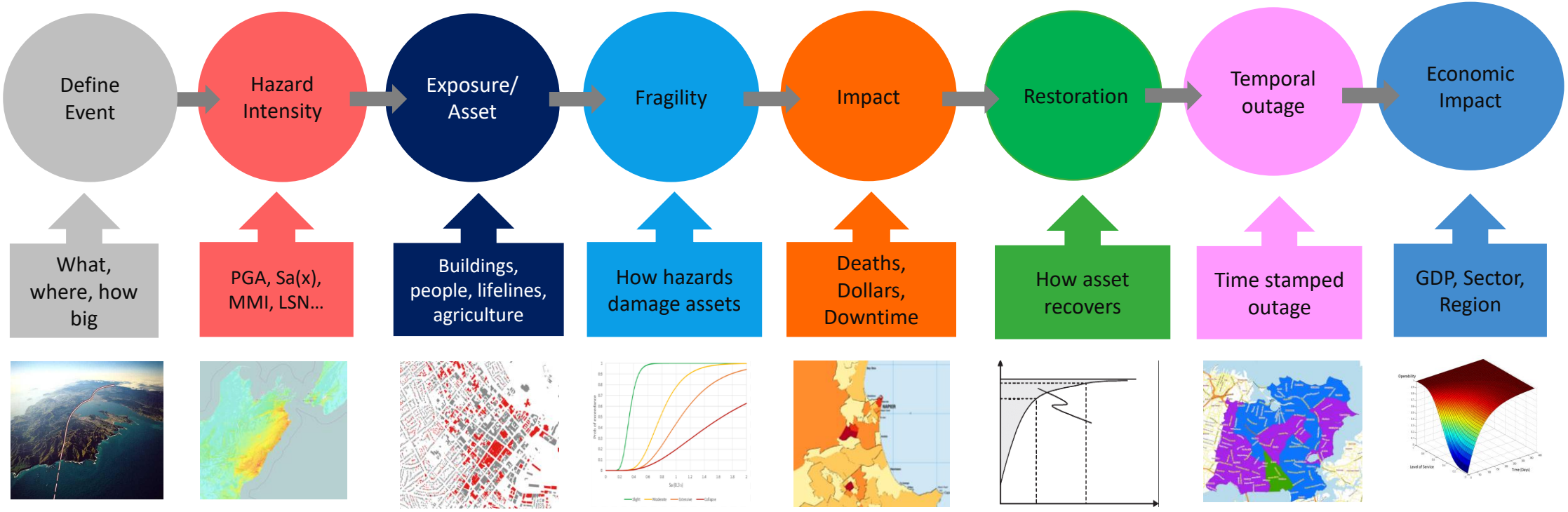


Co-seismic subsidence

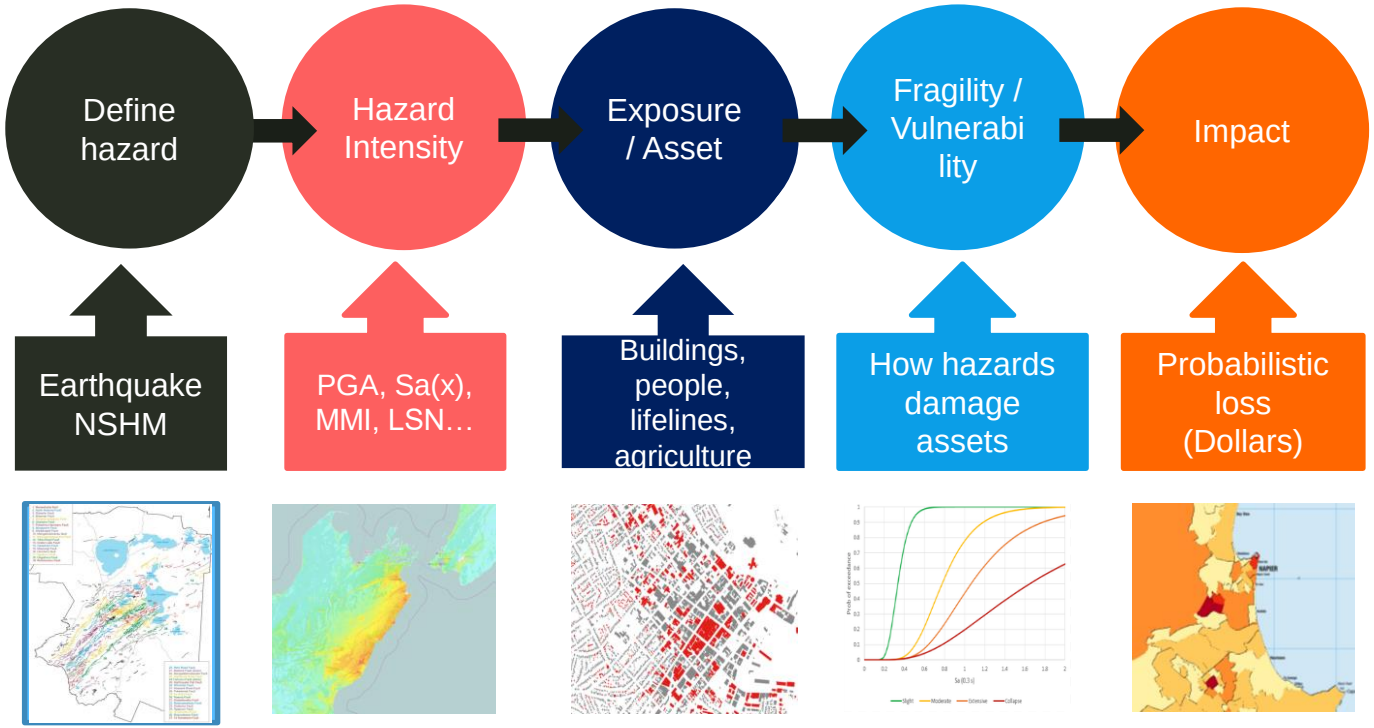
Earthquake Impact Model Framework

WELLINGTON LIFELINES REGIONAL RESILIENCE PROJECT

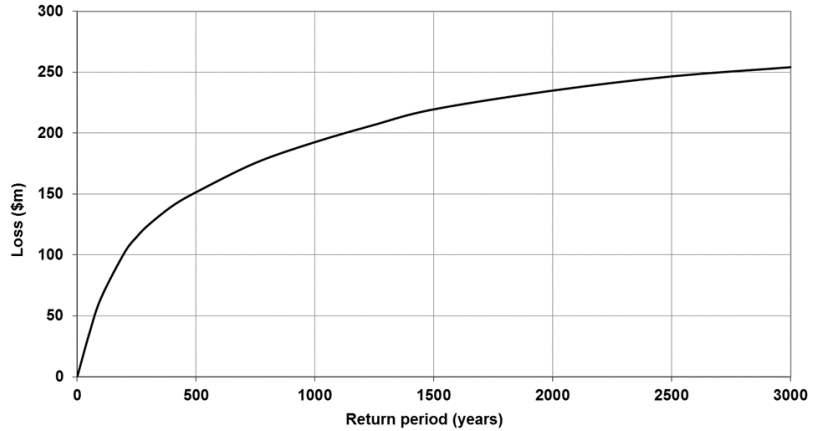
Wellington LIFELINES Group



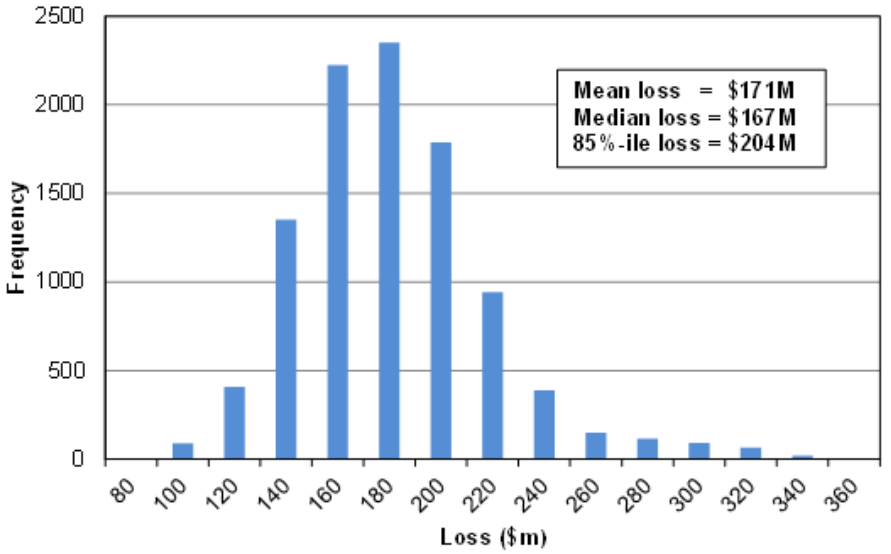
Framework for loss modelling



Probabilistic loss estimates



Scenario loss estimates



Co-creation of Outage Maps with Lifeline Agencies

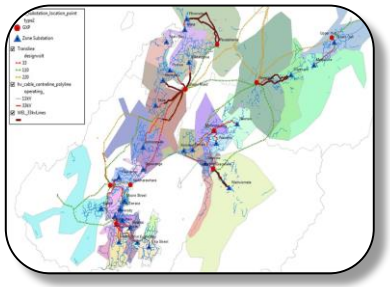
WELLINGTON LIFELINES REGIONAL RESILIENCE PROJECT

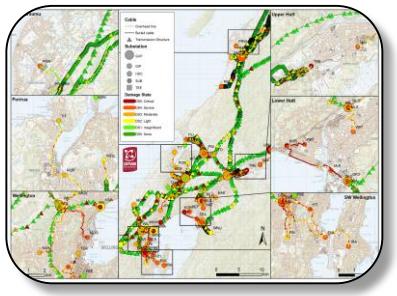
Wellington LIFELINES Group

RiskScape

Hazard/Vulnerability

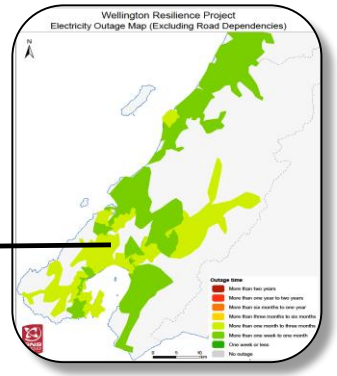
Network Data (providers)





Damage Results

MERIT
(economic impact)
SIH
(social impact)
Res Org
(business)



Outage Maps

Recovery Strategy

Interdependencies

POST DISASTER CITIES PDC ENGINEERING FOR RESILIENCE

Modify Assets/Fragility/Restoration for Intervention Projects and Remodel Outage

WELLINGTON LIFELINES REGIONAL RESILIENCE PROJECT

Wellington LIFELINES Group

Define Event → Hazard Intensity → Exposure/ Asset → Fragility → Impact → Restoration → Temporal outage → Economic Impact

What, where, how big

PGA, Sa(x), MMI, LSN…

Buildings, people, lifelines, agriculture

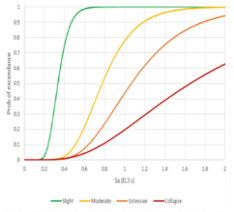
How hazards damage assets

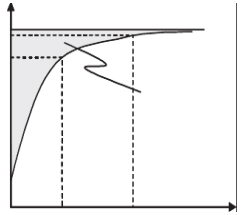
Deaths, Dollars, Downtime

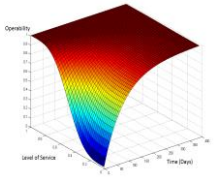
How asset recovers

Time stamped outage

GDP, Sector, Region





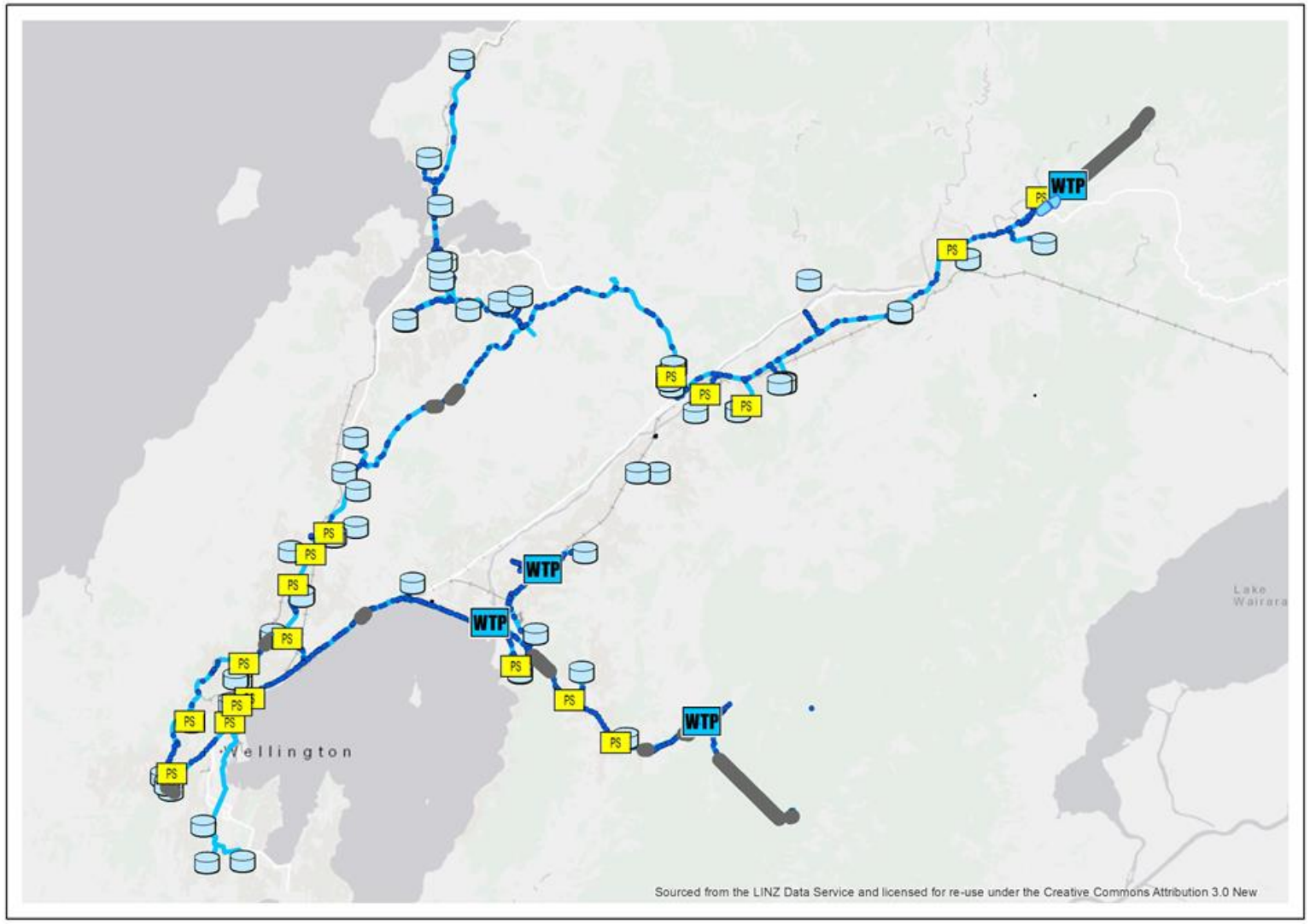


Damage modelling

Outage modelling

Economic modelling

Potable Water

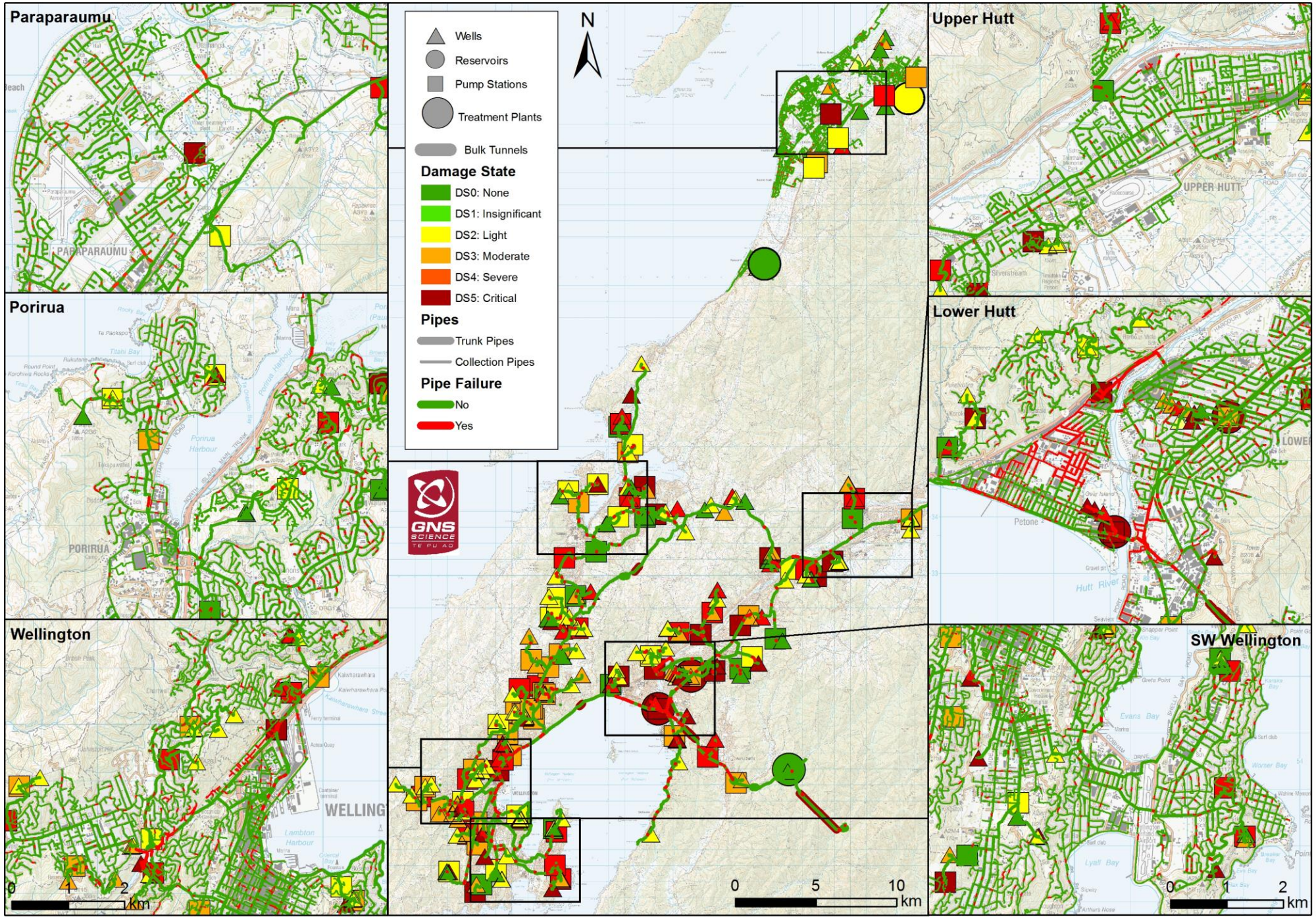


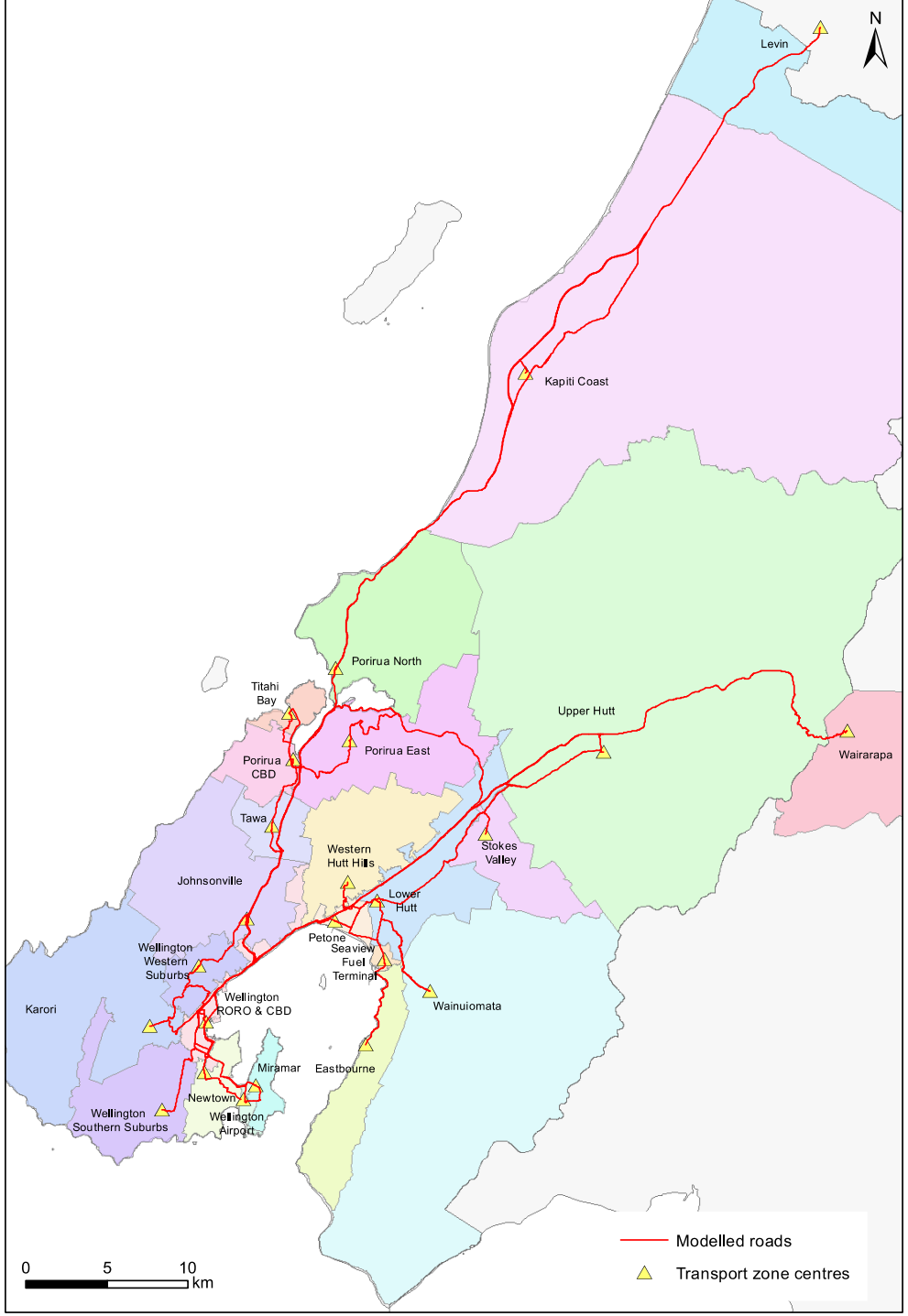
- Water Treatment Plants
- Pumping Stations
- Wells
- Tunnels
- Transmission (Bulk) Pipes
- Distribution Pipes
- Reservoirs (Storage tanks)

GNS SCIENCE TE PŪ AO

Damage Assessment

Damage states defined in collaboration with Council.

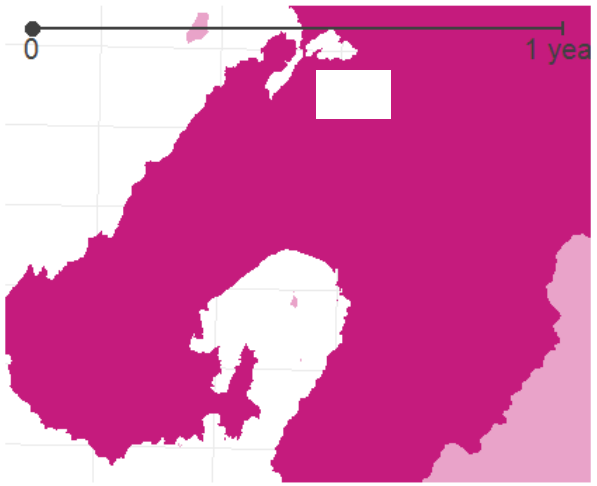




WELLINGTON LIFELINES
REGIONAL RESILIENCE PROJECT

Wellington LIFELINES Group

Days since event = 0



Level of road accessibility (taking fuel into account)

- No Access
- Access to local CBD only
- Access to local and Wellington CBD
- Access to local CBD and out of region
- Full Access

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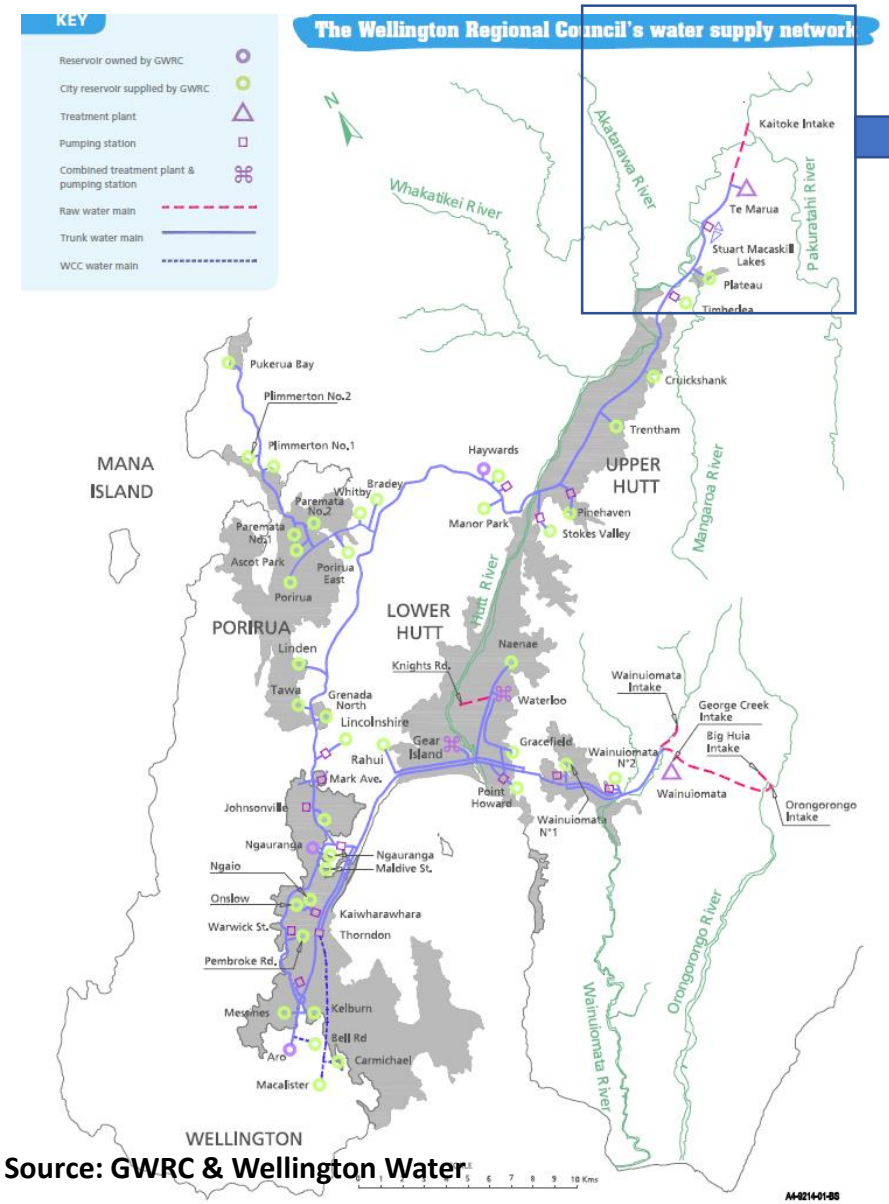
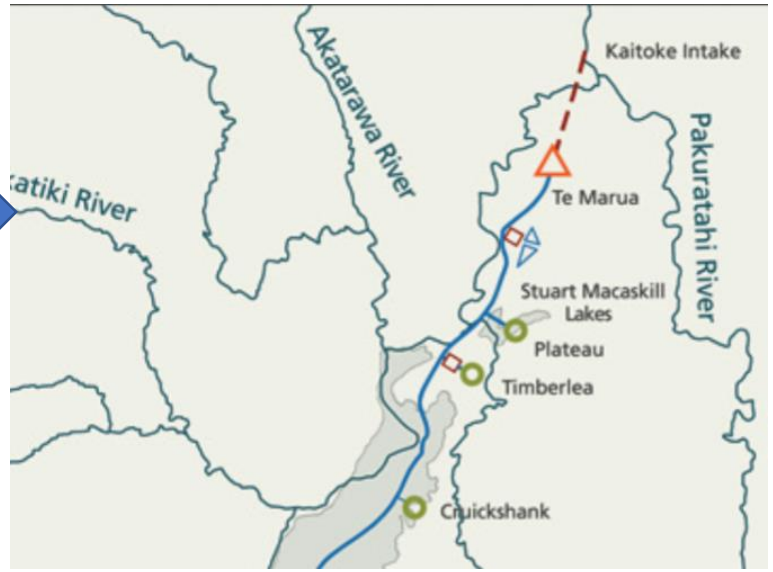


Source: GWRC & Wellington Water



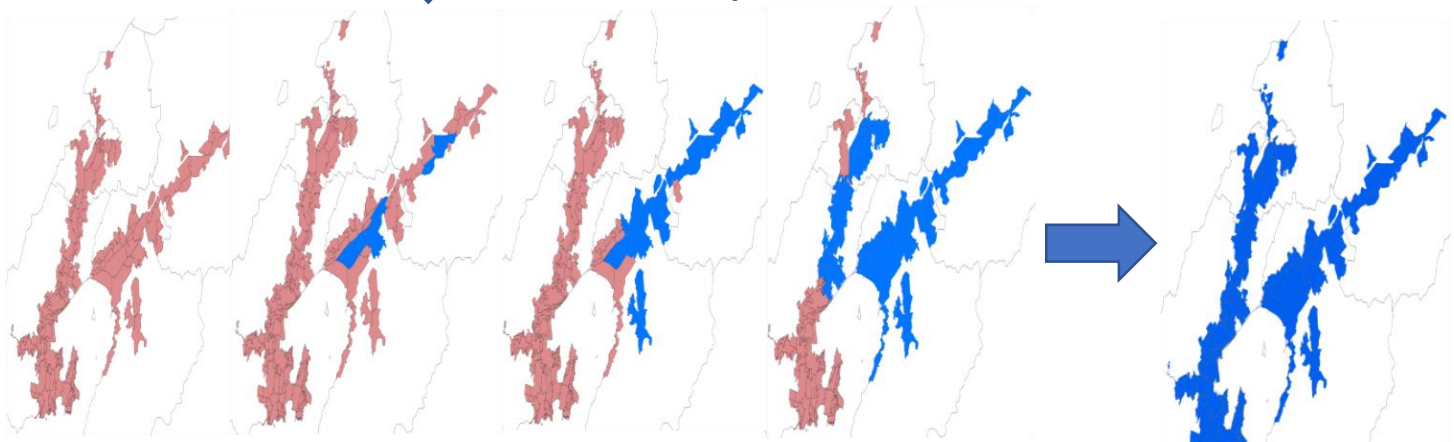
1) Network components Connectivity

2) Intra-dependent Restoration Times

3) Inter-dependent Restoration Times

→ Road access

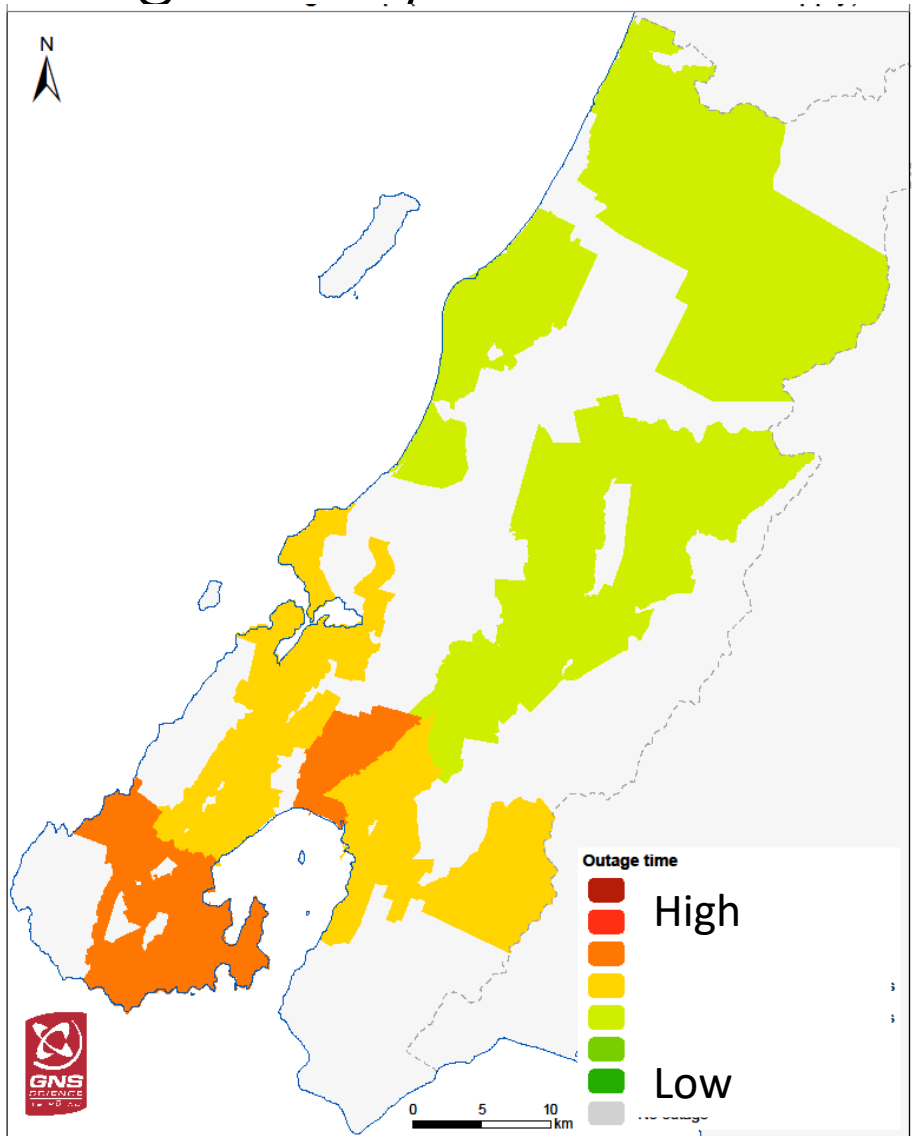
- Restoration of services (LoS)
- Interdependencies



Day 0-7 Day 14 Day 30 Day 40

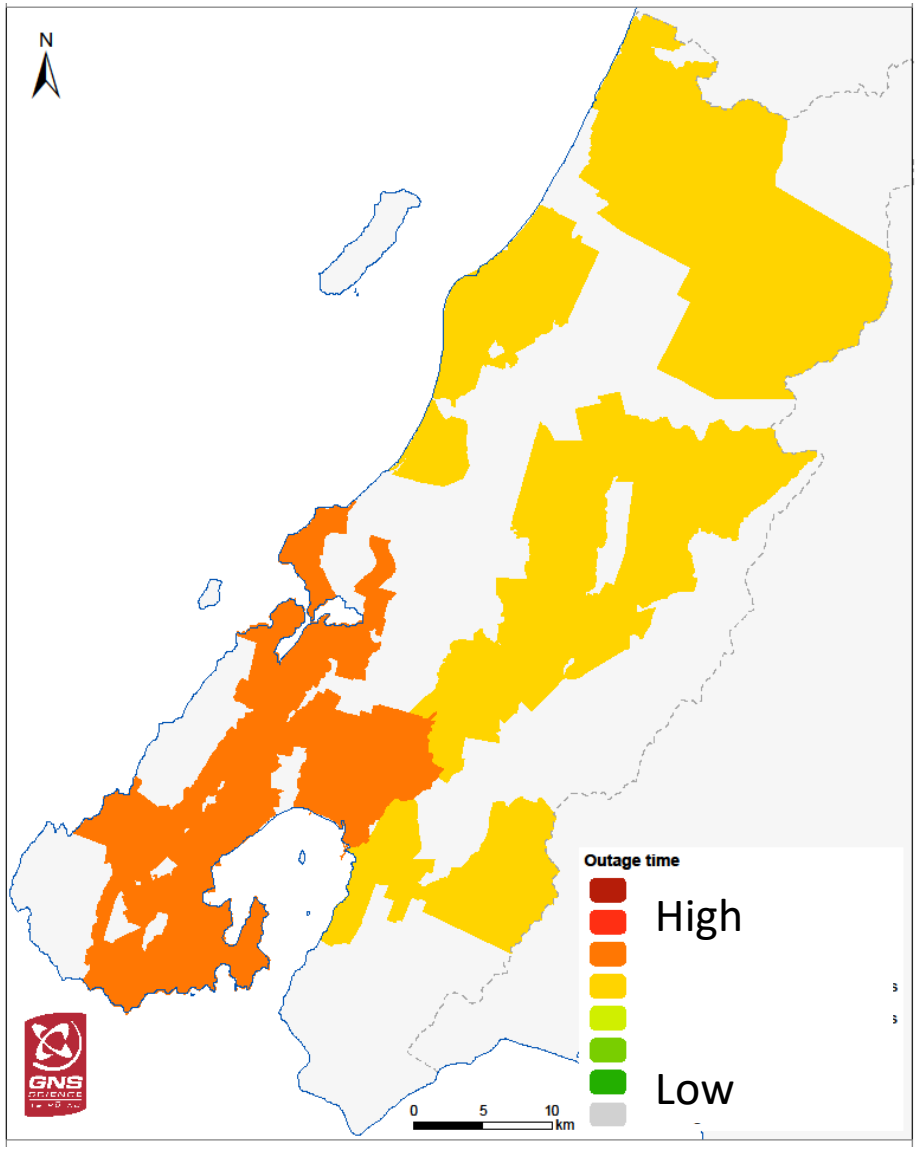
Outage

Potable Water (Boiling Notice)



Outage

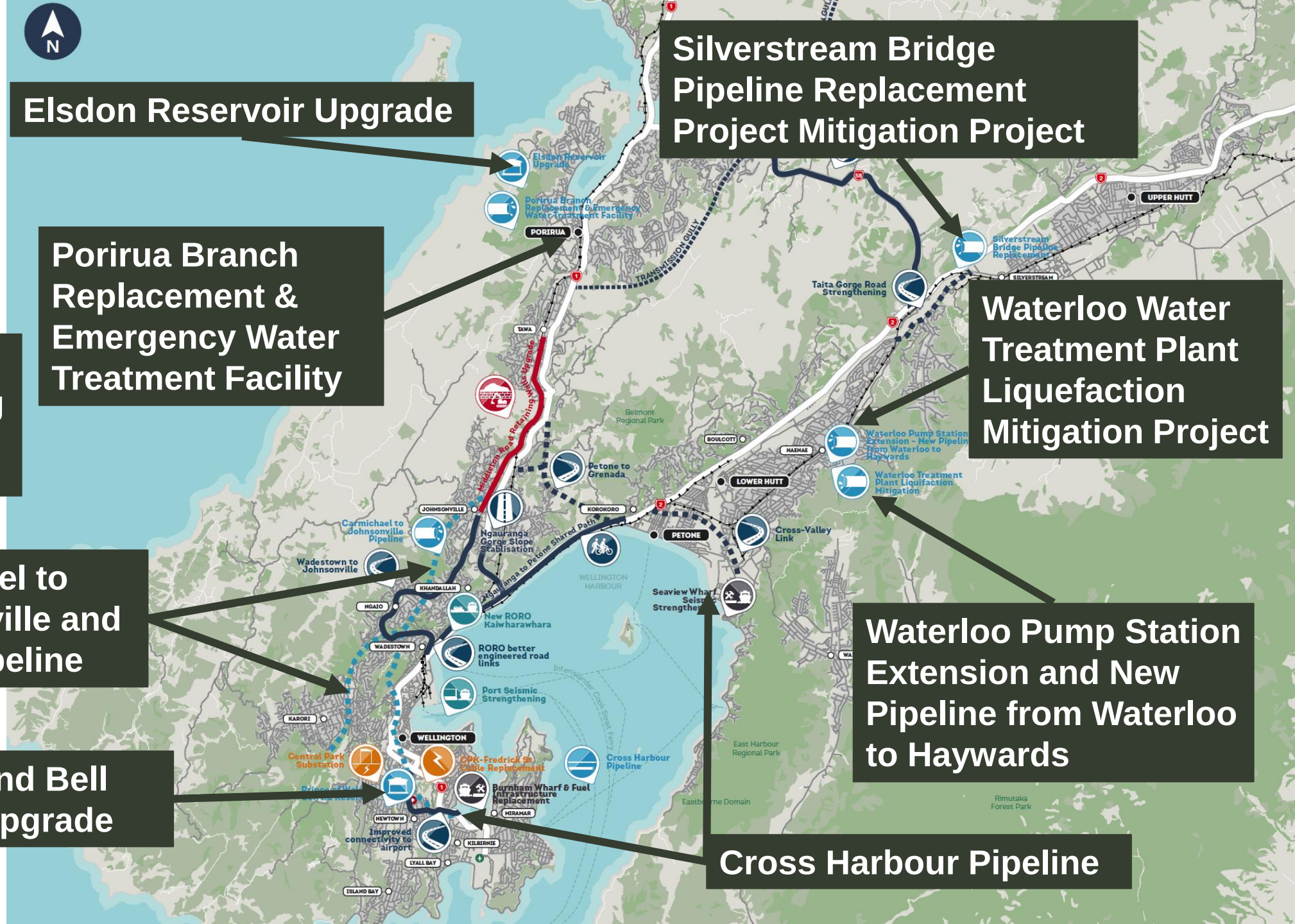
Potable Water (Treated)



Potable Water

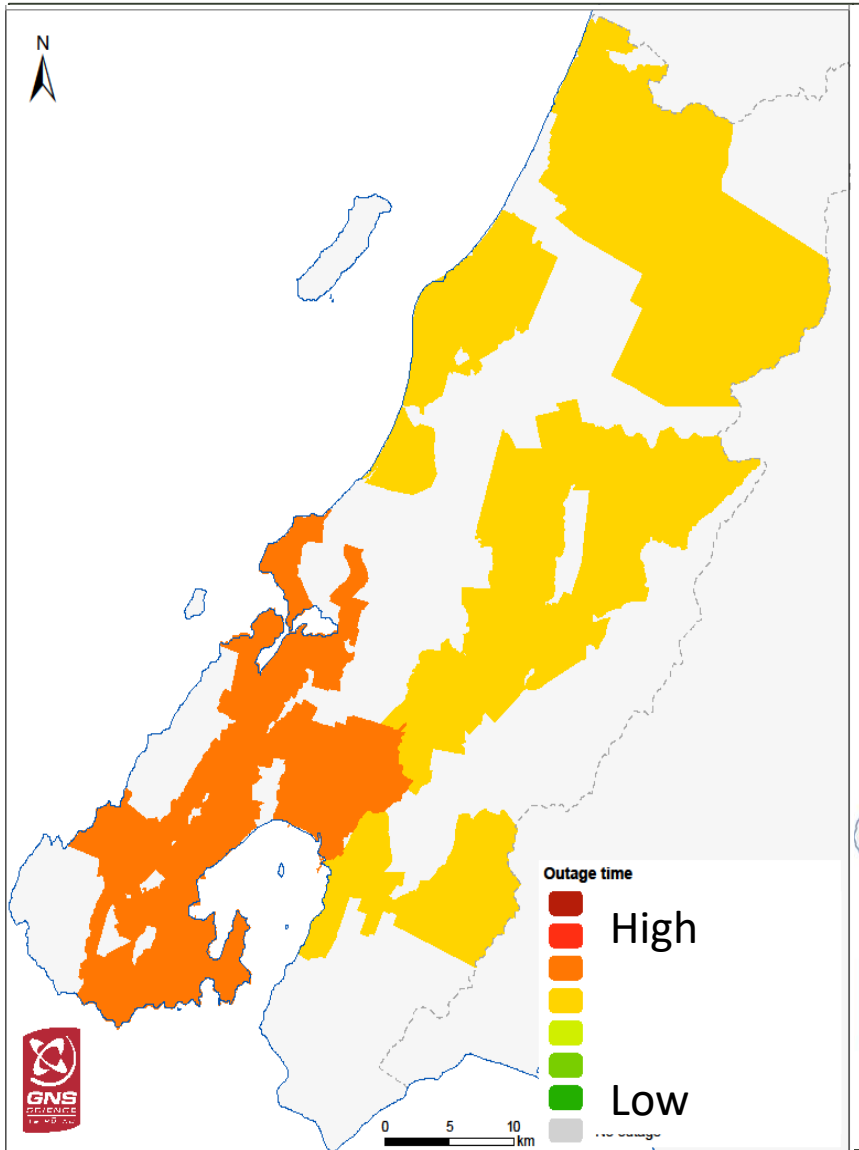
Intervention Projects

General Water Supply Toughening
Already committed but could be accelerated

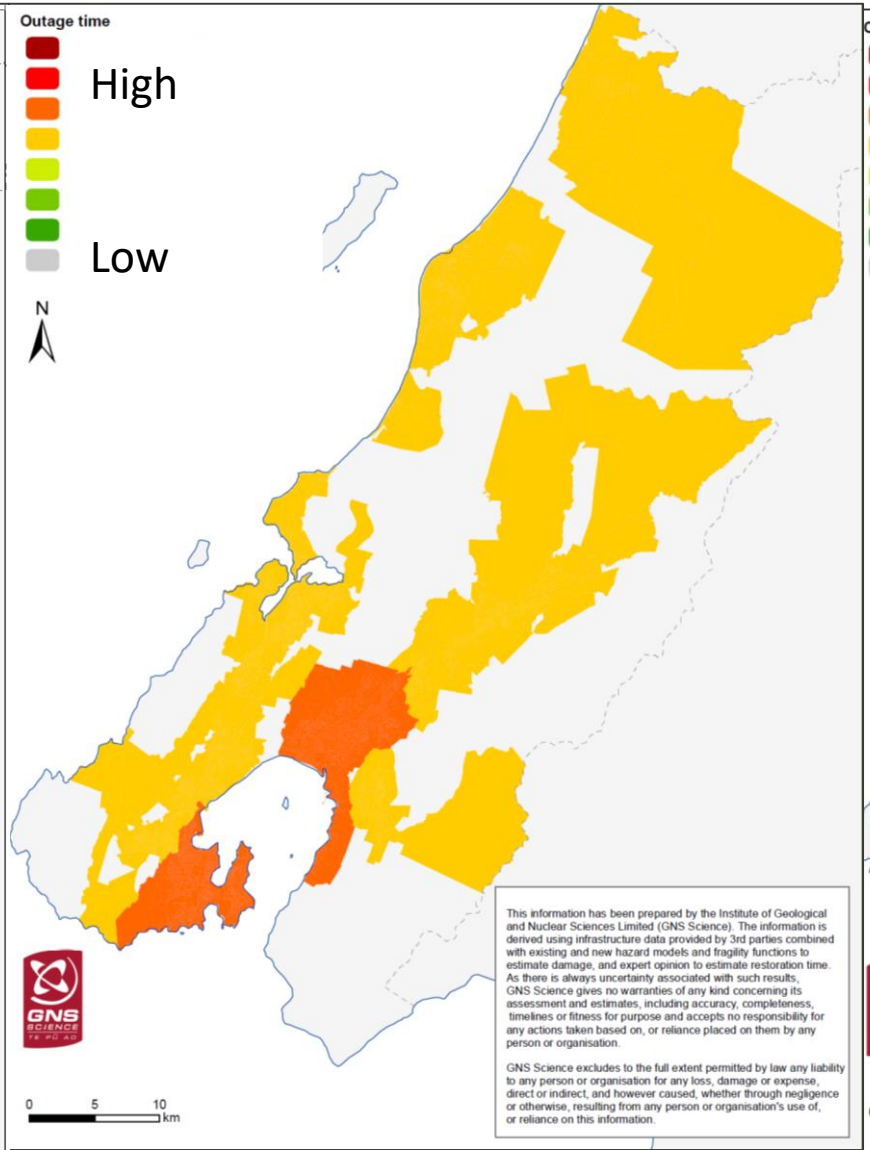


Water Outage - Potable

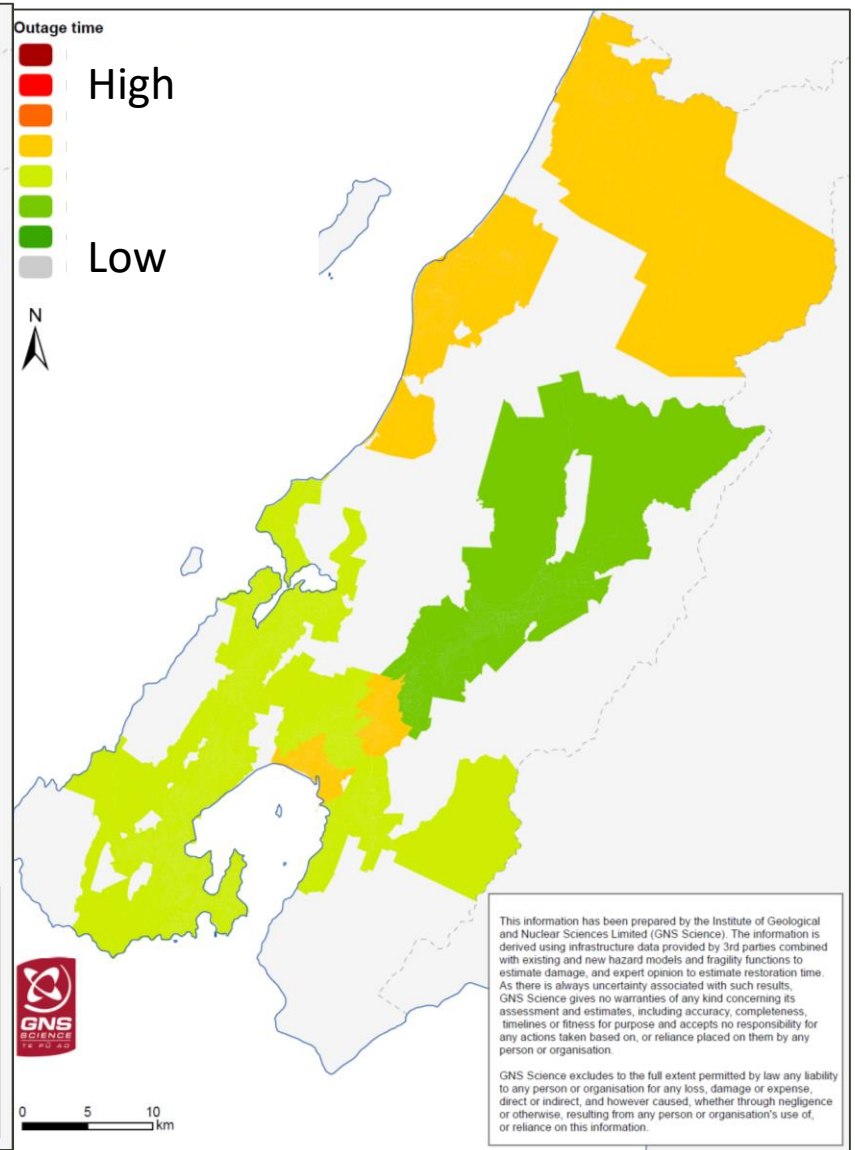
Base Case



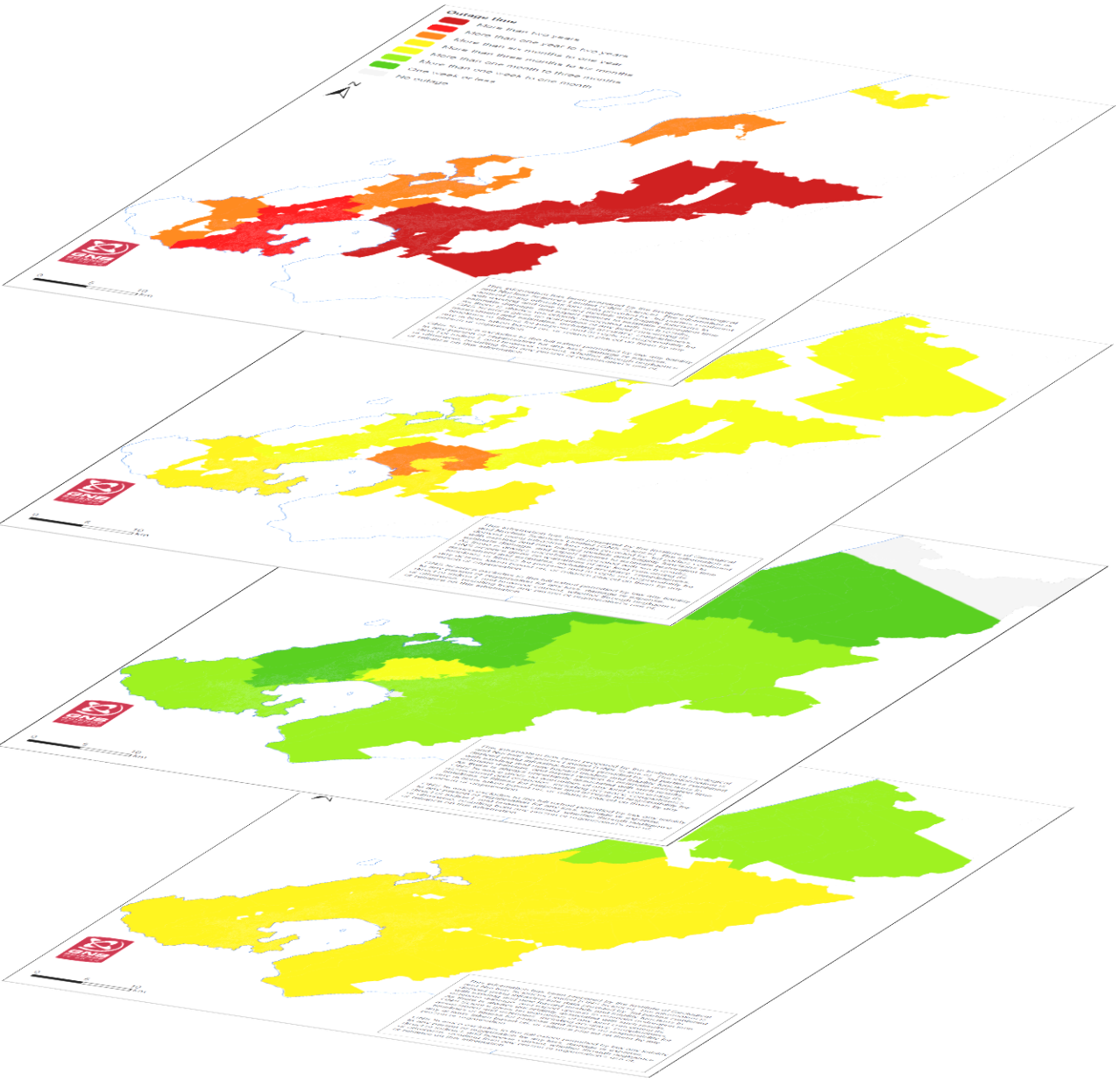
Lower Investment



Higher Investment

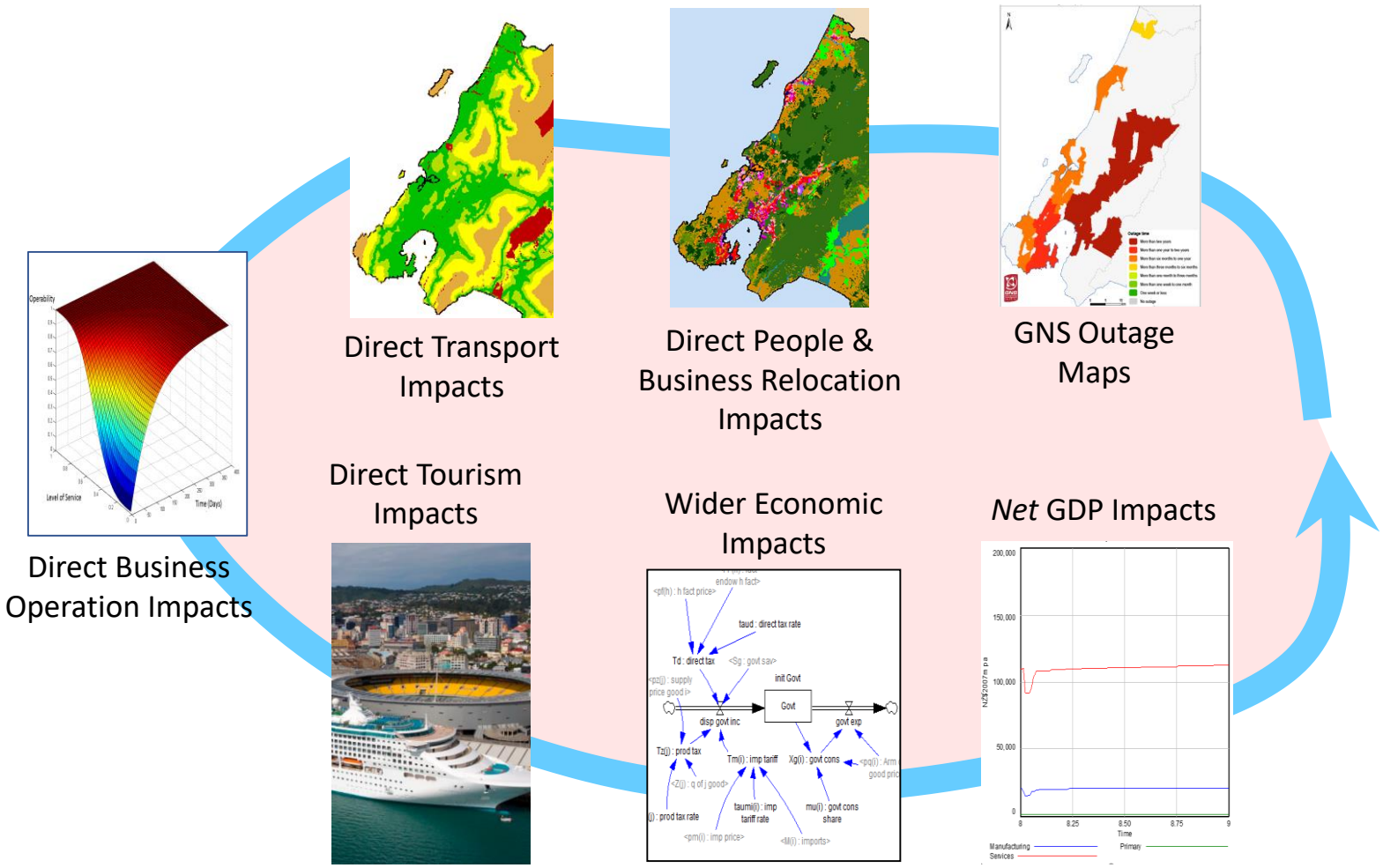


Outage Maps for All Sectors

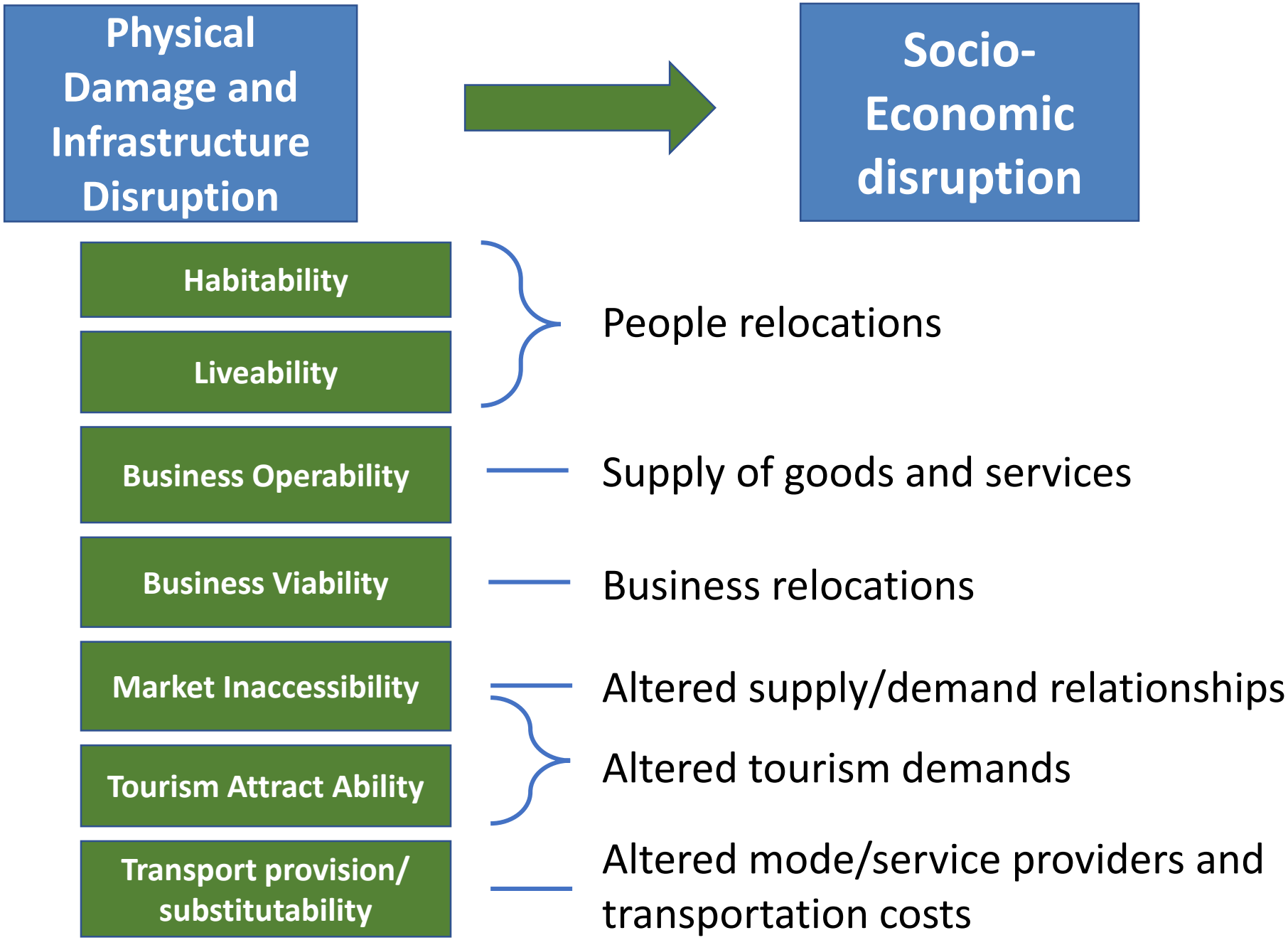


MERIT ECONOMIC MODELLING

The MERIT Modelling Process

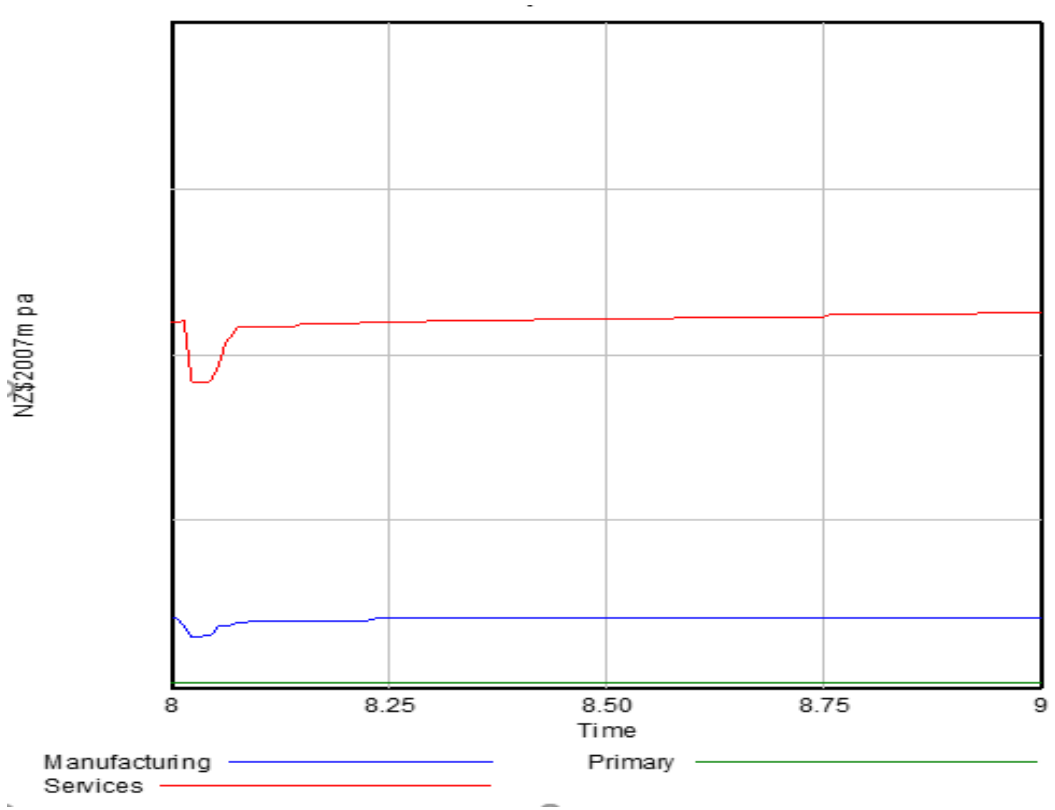


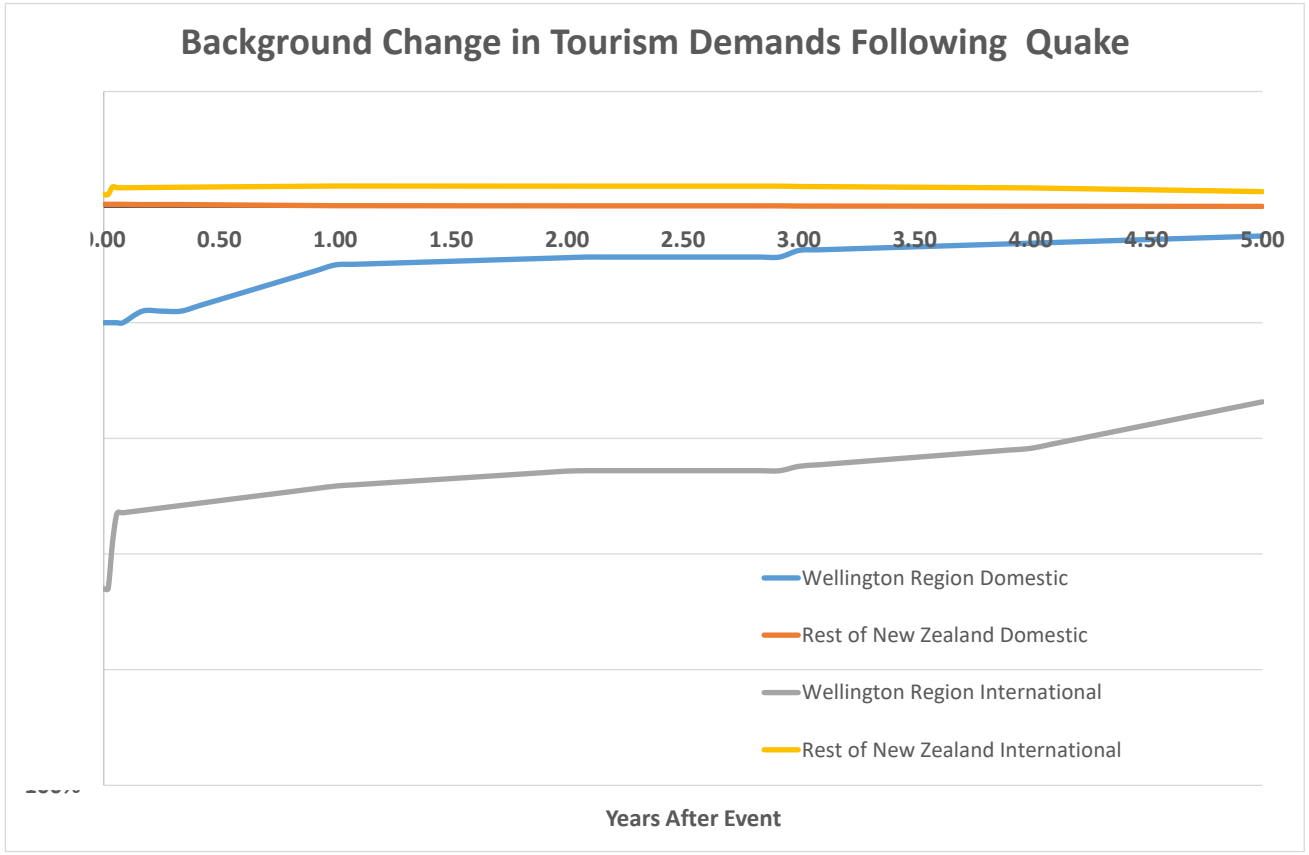
- Economic impacts of distributed infrastructure through time and space
- Key economic indicators – GDP, income, trade, prices
- Unique to account for adaptations people and businesses


Physical Damage and Infrastructure Disruption
Socio-Economic disruption
Habitability
Liveability
People relocations
Business Operability
Supply of goods and services
Business Viability
Business relocations
Market Inaccessibility
Altered supply/demand relationships
Tourism Attract Ability
Altered tourism demands
Transport provision/ substitutability
Altered mode/service providers and transportation costs

Economic impacts

Net GDP Impacts





Key Changes with Investment

- Improved capacity for businesses to adapt
  - The process of recovery commences earlier, faster return to normal levels of productivity
- Improved ‘liveability’
  - Number of people temporarily relocated still high, but number of permanent relocations almost halved
- Improved business ‘viability’
  - Less likely for businesses to choose to relocate; relocation is costly
- Reduced isolation
  - Less disruption to tourism

A key aspect of our ‘value added’

- Resilience is ‘socially defined, but technically delivered’ through good policy, best practice investment planning/prioritisation and effective collaboration.
- Need to understand the make up and expectations of the community with regard to better delivering on resilience outcomes.

We offer..

People

NZ Inc

Government & Lifelines Organisations

WRAP UP AND QUESTIONS

Painting by Charles Gold of the 30,000 cubic metre landslide on the Hutt Road caused by the **1855 earthquake**. The scar of the landslide is still visible today.

Image courtesy of the Alexander Turnbull Library, National Library of New Zealand.

Slip 1A Kaikoura Earthquake November 2016 ~ 30,000 cubic metres