



MERIT

MERIT: Helping Communities Understand Social & Economic Consequences of Disruption Events, and Assess Mitigation Options

Michele Daly, Nicola McDonald, Charlotte Brown



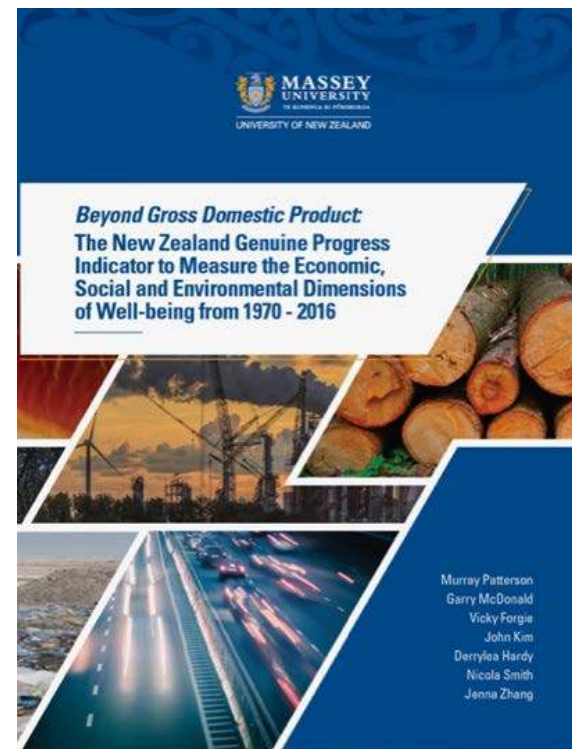


ECONOMICS *of* RESILIENT INFRASTRUCTURE

- Developed 2012-16 Economics of Resilient Infrastructure MBIE-funded research programme
 - Developing an understanding of the economic impacts of infrastructure failure in a disruption context*
- Utilised throughout NZ by infrastructure providers, government, and councils
- Jointly owned and managed by GNS Science, ME Research & Resilient Organisations
- New ideas and development through Resilience NSC, MBIE Endeavours, PhD students etc

What MERIT does that other tools don't

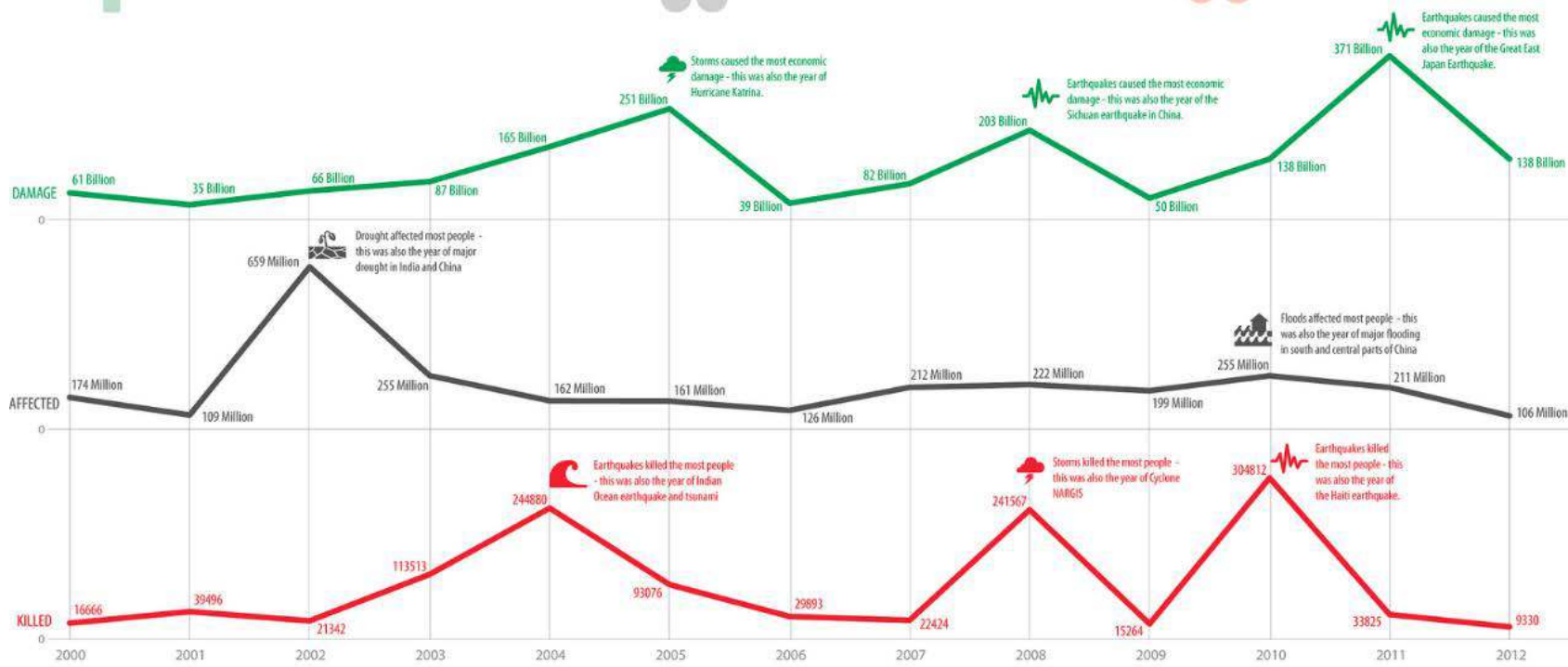
- *Dynamic Through Time* Transition pathways over time (up to 100 years)
 - Evaluate different Futures
 - Conceptualise what the options are
- *Across Space* Impacted area, communities, districts, regions and the nation
- *Multiple Stakeholders*
 - 40-60 industries, infrastructure providers, govt, NGOs
- *Accommodates emergent behaviours*
 - *Felt impact of the end-user vs direct damage*
- *Based on General Equilibrium*
 - *Equilibrium-seeking pricing*
 - Adaptations can be built in



History and Evolution of MERIT Tools

DISASTER IMPACTS / 2000-2012

*Disasters refers to drought, earthquake (seismic activity), epidemic, extreme temperature, flood, insect infestation, mass movement (dry & wet), storm, volcanic, and wildfire / Data source: EM-DAT: The OFDA/CRED International Disaster Database / Data version: 12 March 2013 - v12.07
OCHA Humanitarian Symbol (2012): <http://reliefweb.int/map/world/world-humanitarian-and-country-icons-2012> / Find out more about UNISDR: <http://www.unisdr.org>



Source: <https://reliefweb.int/map/world/world-disaster-impacts-2000-2012>

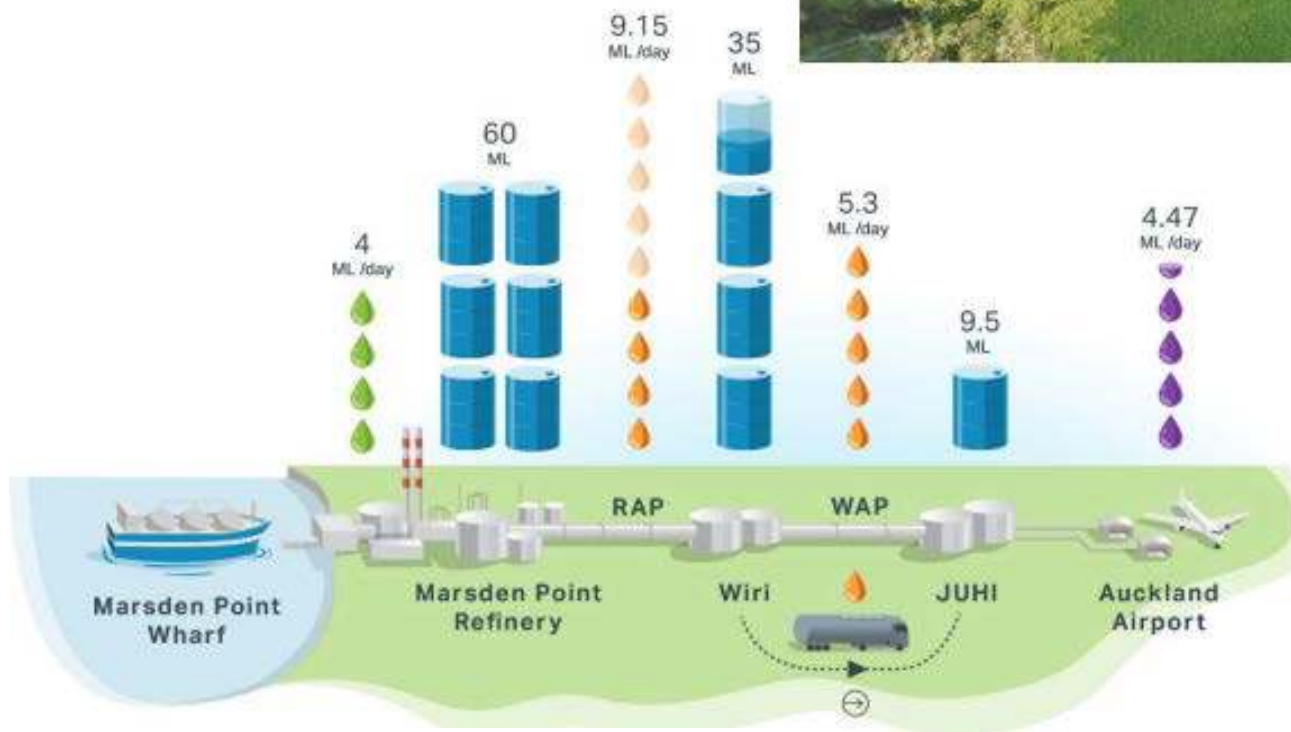


Source: NIWA



Photo of Petroleum Leak

Source: dia/govt/nz

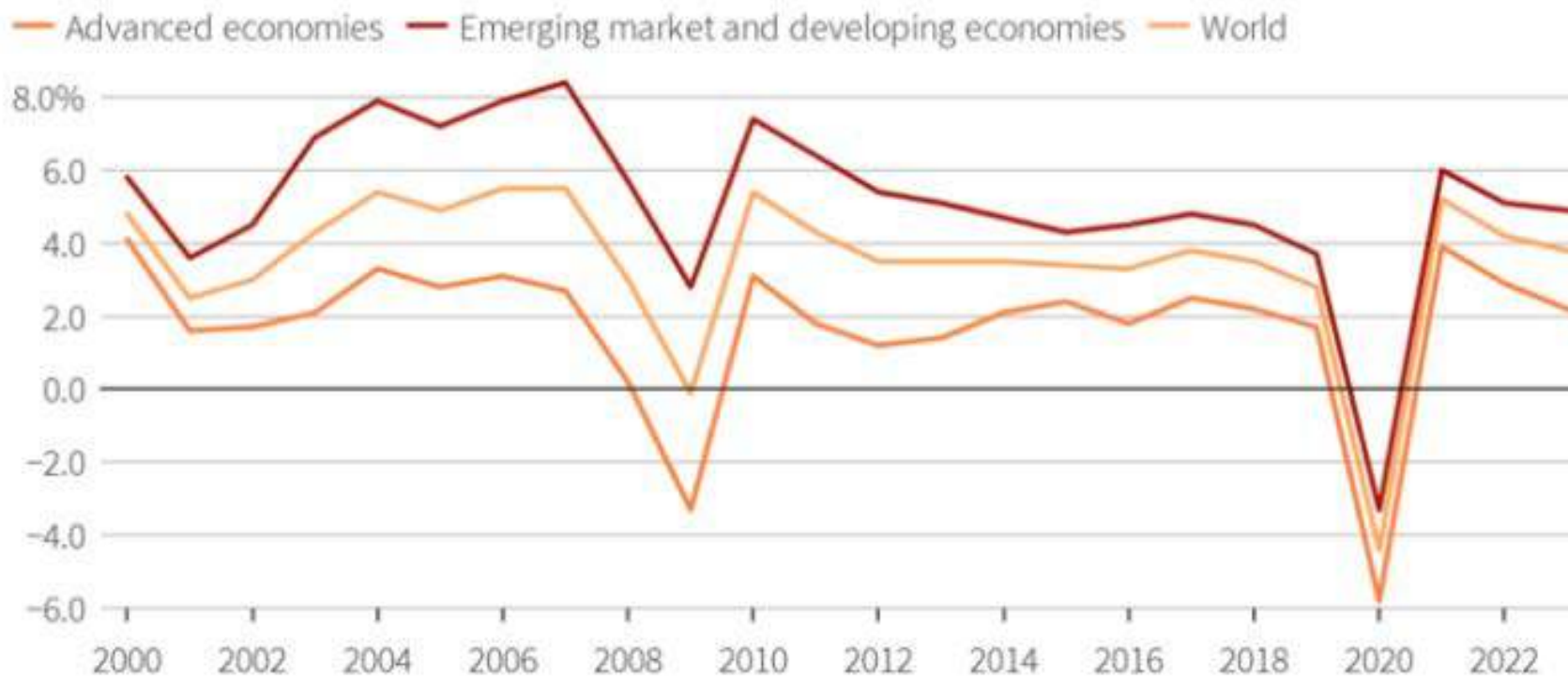


Source: dia/govt/nz



The global coronavirus recession

COVID-19 brought the global economy to a halt in 2020, but the IMF sees a swift rebound



Note: Data for 2020 and beyond are estimates

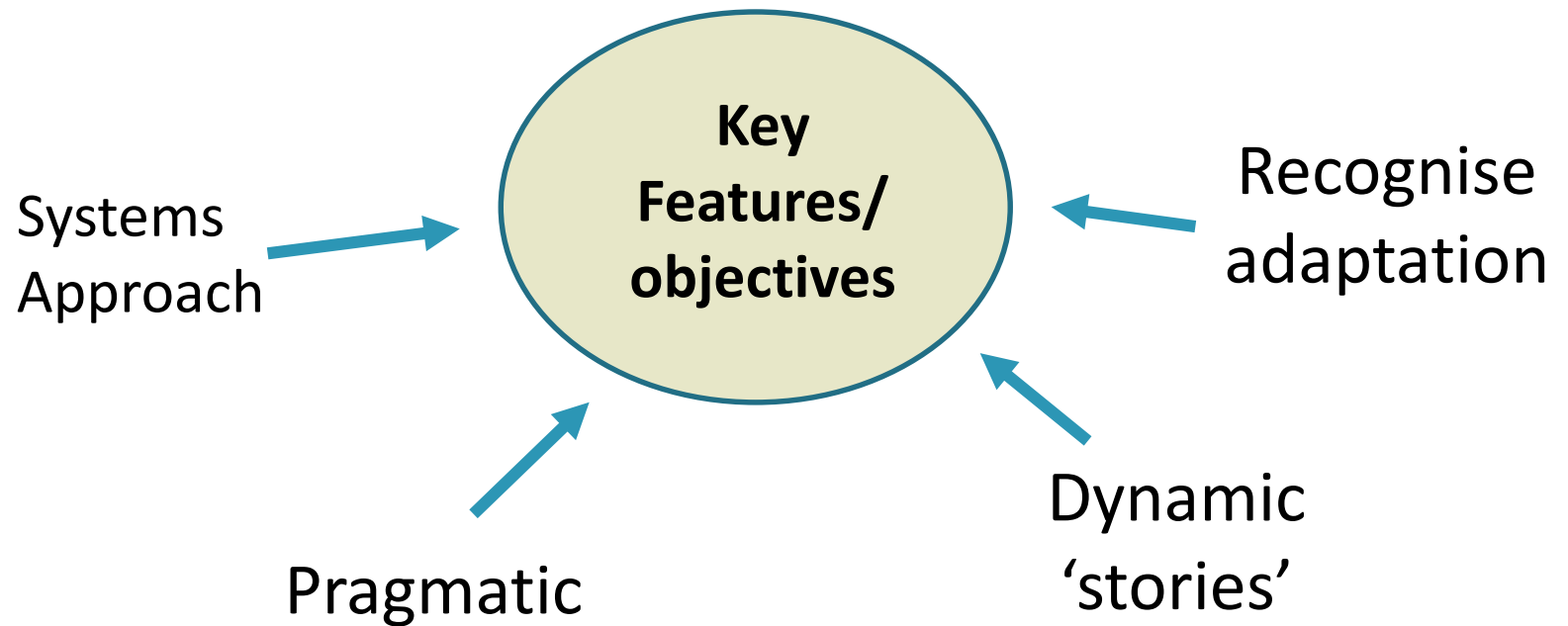
Source: International Monetary Fund World Economic Outlook



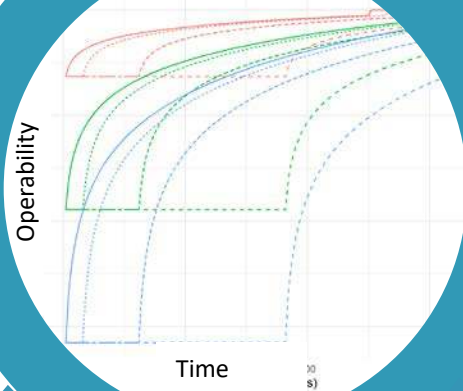
80

Original MERIT objectives

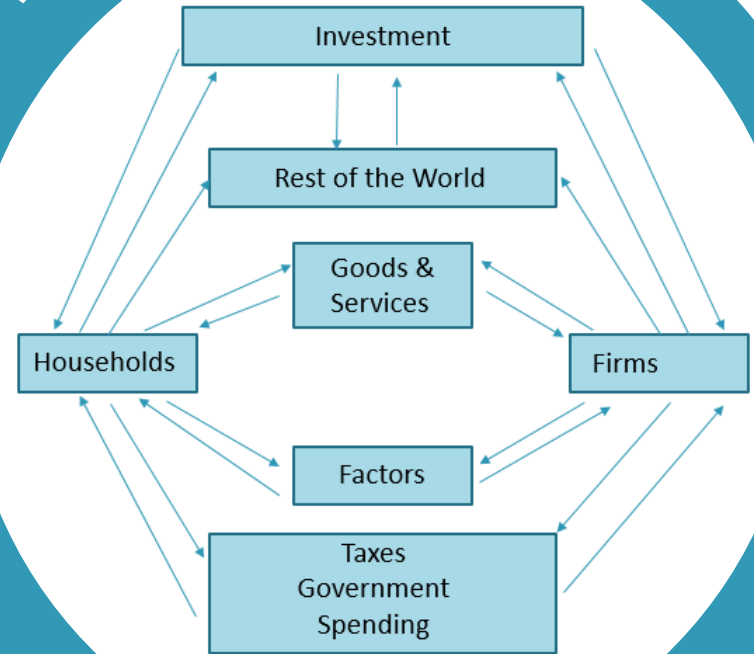
- Economics of Resilient Infrastructure (MBIE programme)



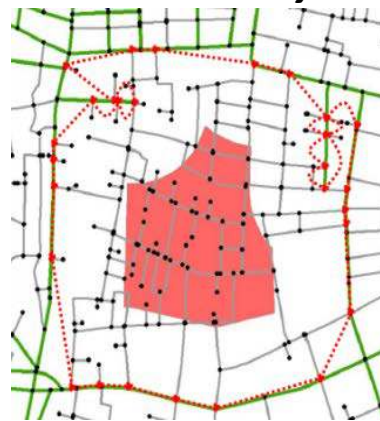
Business Behaviours Model



Dynamic Economic Model



Network Analysis



Run simulation

Restore Run Stop Home

48
Set Outage Duration (Days)

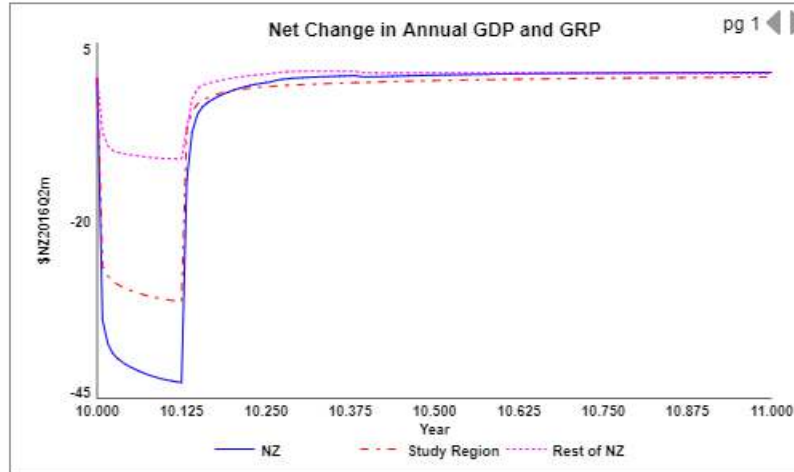
Set Annual Increase in Household Travel Costs (\$NZ2006Q2m/year)

Study Region
160,000
Rest of New Zealand
20,000

Set transport margins for traded commodities

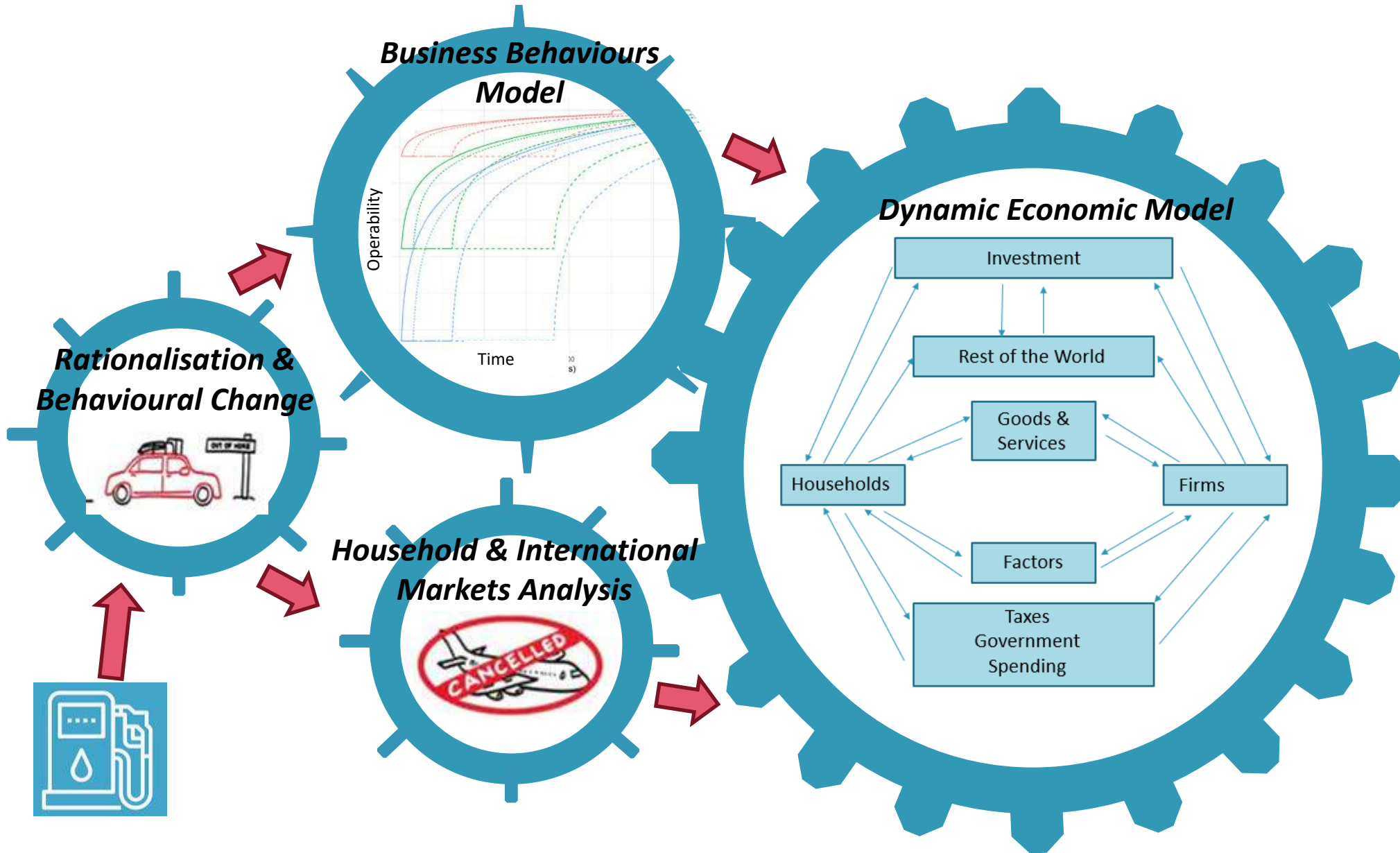
International
Domestic

Model Assumptions Release Notes



Study Region Accumulated Change in Value Added (\$NZ2016Q2m)

	0	1	2	3	4	5	6	7	8	9	10	Final
Sheep, beef & grain farming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dairy cattle farming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Forestry & logging	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Other agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mining	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Food manuf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Wood & paper manuf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemical & mineral manuf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Other manuf	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Utilities & construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Trade & hospitality	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7
Road transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other transport & storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
Other services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.2



Multi-Infrastructure Disruptions

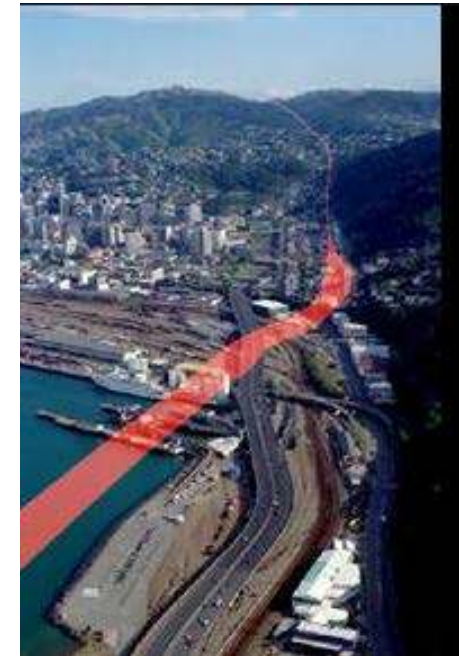
Kaikoura Quake



Alpine Fault Scenario

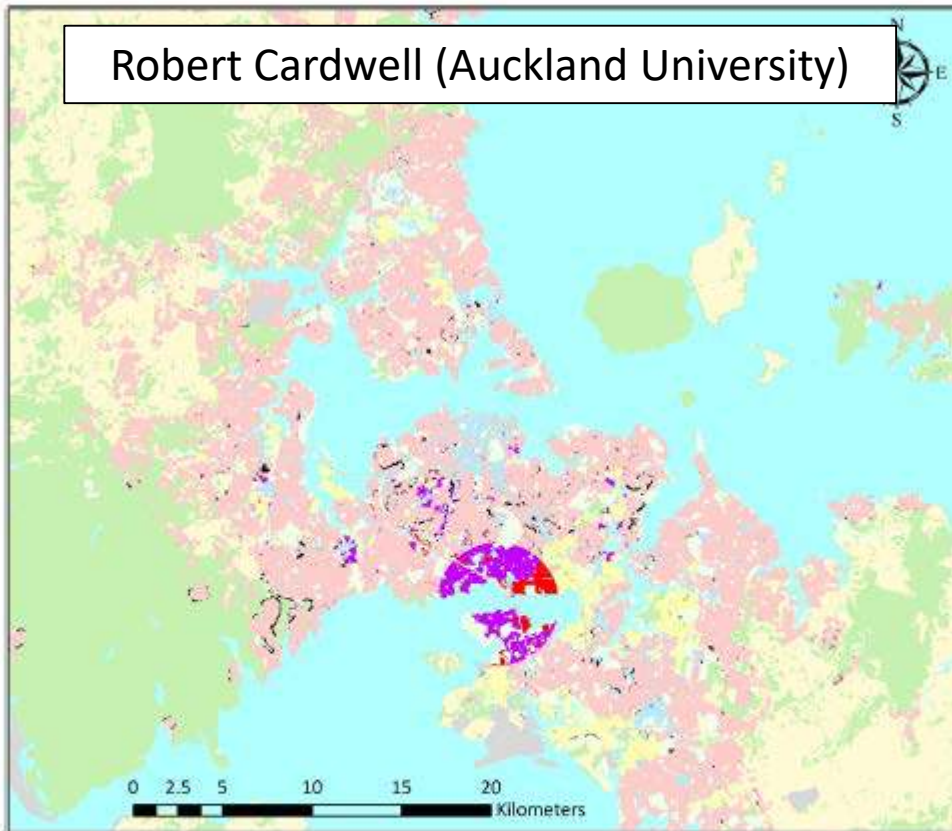


Wellington Resilience Programme Business Case

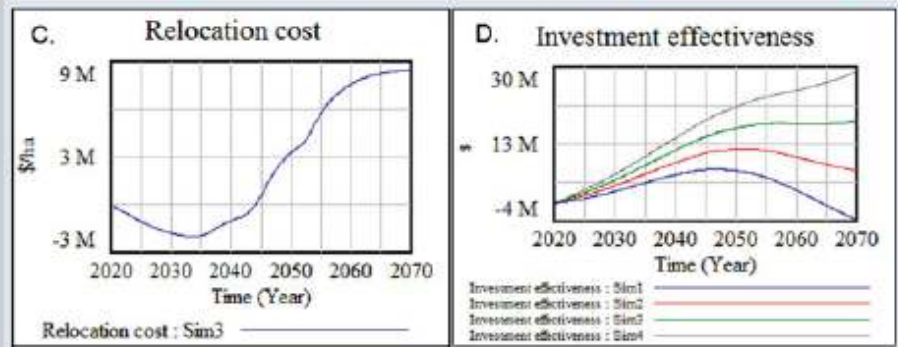
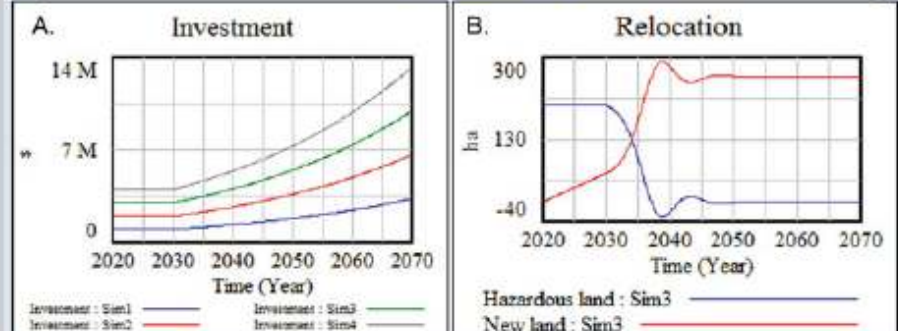
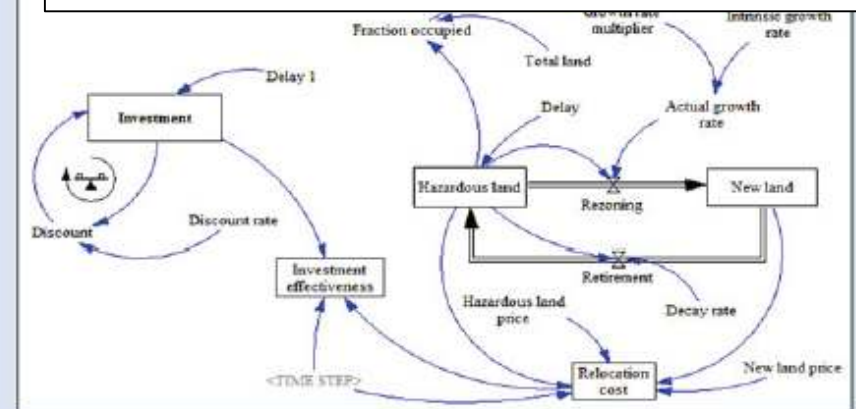


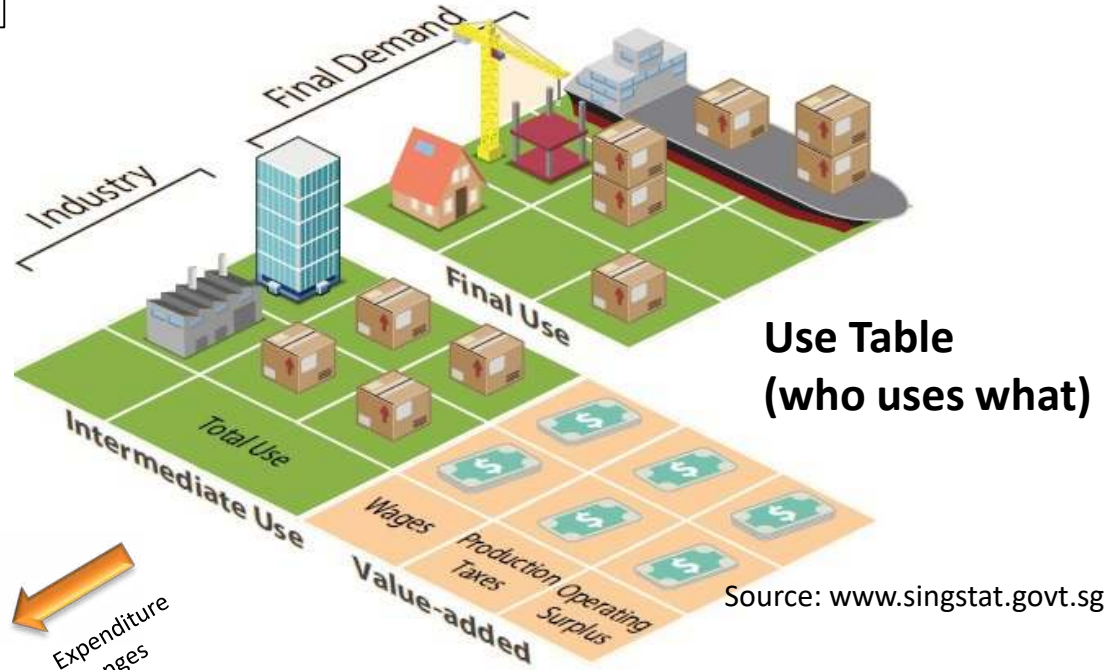
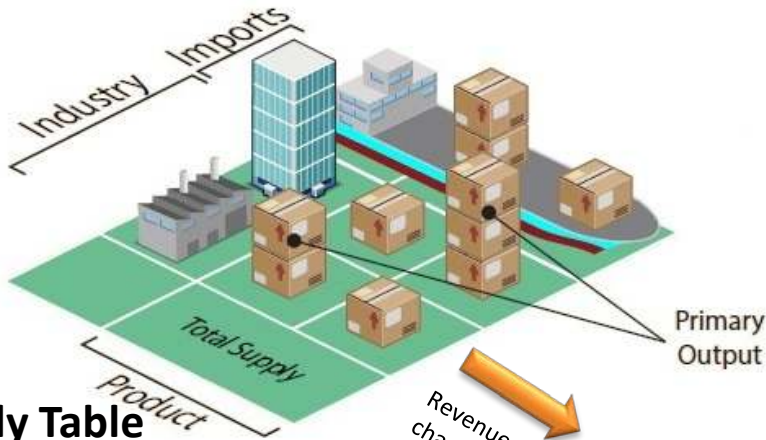
Resilience NSC – PhD Programmes

Robert Cardwell (Auckland University)



Ashton Eaves (Auckland University)





Source: www.singstat.govt.sg

Supply Table
(who produces what)

Interdependencies

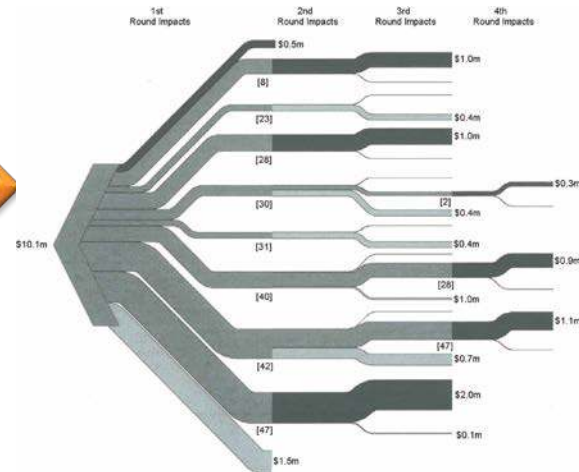
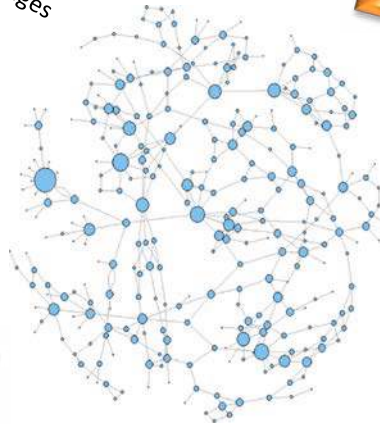
- Direct impacts
- Indirect impacts
 - Backward (supply chain)
 - Forward (processors)
- Induced impacts
 - Household spending

Resilience options

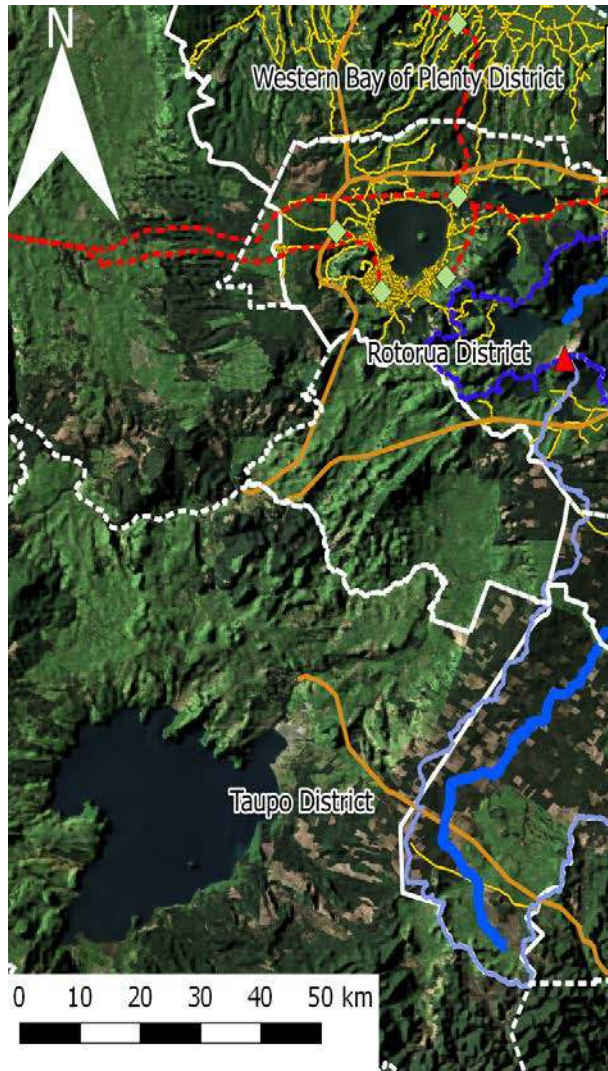
- Expenditure
- Rebalanced budget

Revenue changes

Expenditure changes

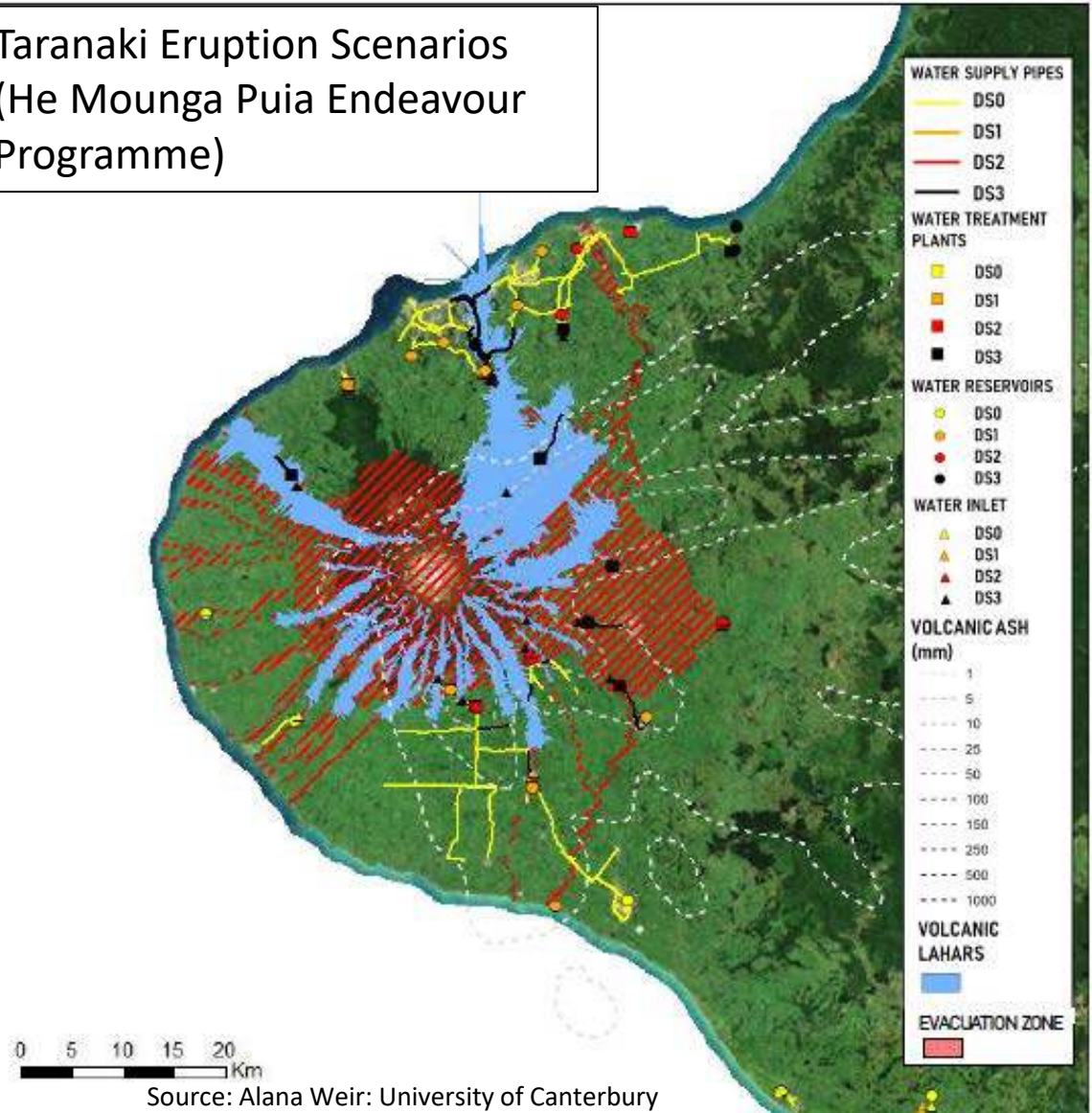


Current MERIT-Involved Programmes



Source: Tim Davies, University of Canterbury

Taranaki Eruption Scenarios
(He Mouna Puia Endeavour Programme)



Source: Alana Weir: University of Canterbury

New Extensions (1)

Probabilistic Assessment

Scenarios Exploration System

Multi-hazard

Uncertainty Quantification

Robust Decision Making

Model Emulation

New Extensions (2)

Wellbeing

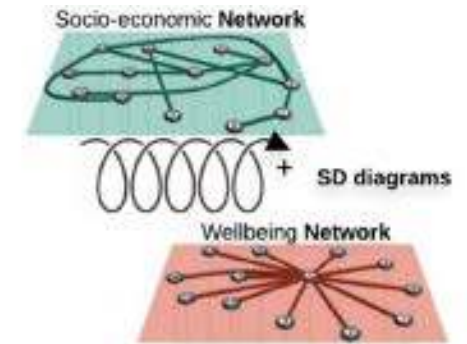
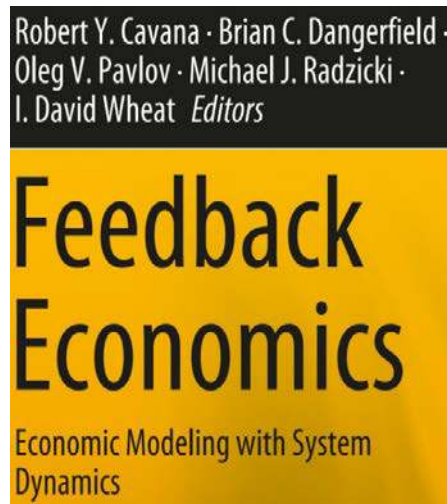
Multi-Capital

Household Disaggregation

Distributional Impacts

Multi-indicators

Risk Preferences



19 **Extending the Boundaries of Economics to Well-Being:
An Interlinked Thinking Approach** 521
Vicky E. Forgie, Marjan van den Belt, and Garry W. McDonald

Wellington Resilience Programme Business Case

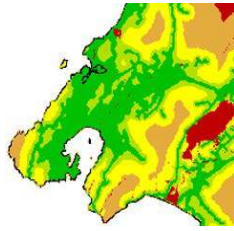
Case Study: Wellington Resilience



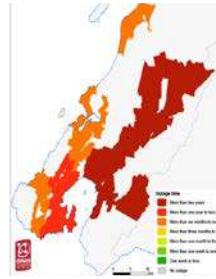
**WELLINGTON LIFELINES
REGIONAL
RESILIENCE
PROJECT**



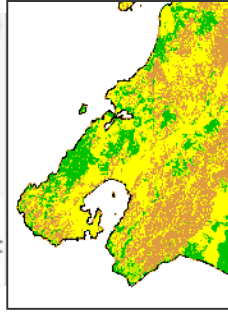
Direct Impact Maps (including interdependencies)



**Transport –
Fuel, Road, Rail,
Air, Ports**



**Non-transport
Infrastructure,
Water,
Electricity etc.**



Buildings

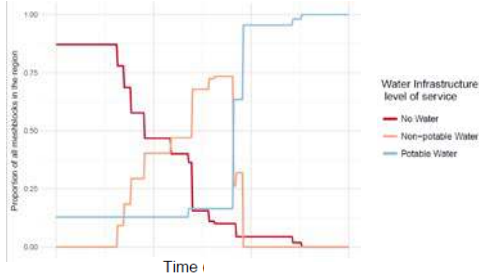


**Event Occurs - Building and
Infrastructure Damage**

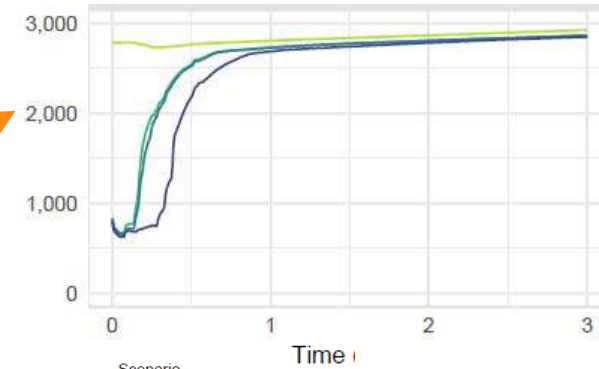


**Direct Tourism
impacts**

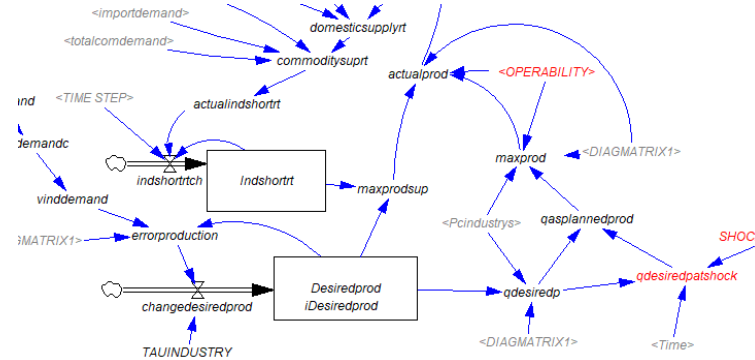
Infrastructure Recovery through time



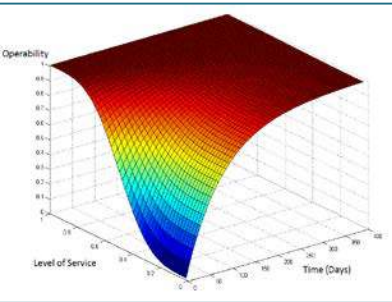
Results through time for Region, NZ – GRP, Income etc by industry



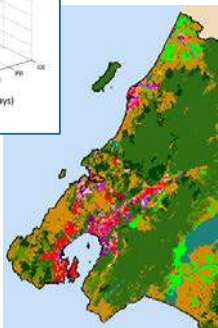
Flow on Wider Economic Impacts using the Dynamic Economic Model



Business Operation

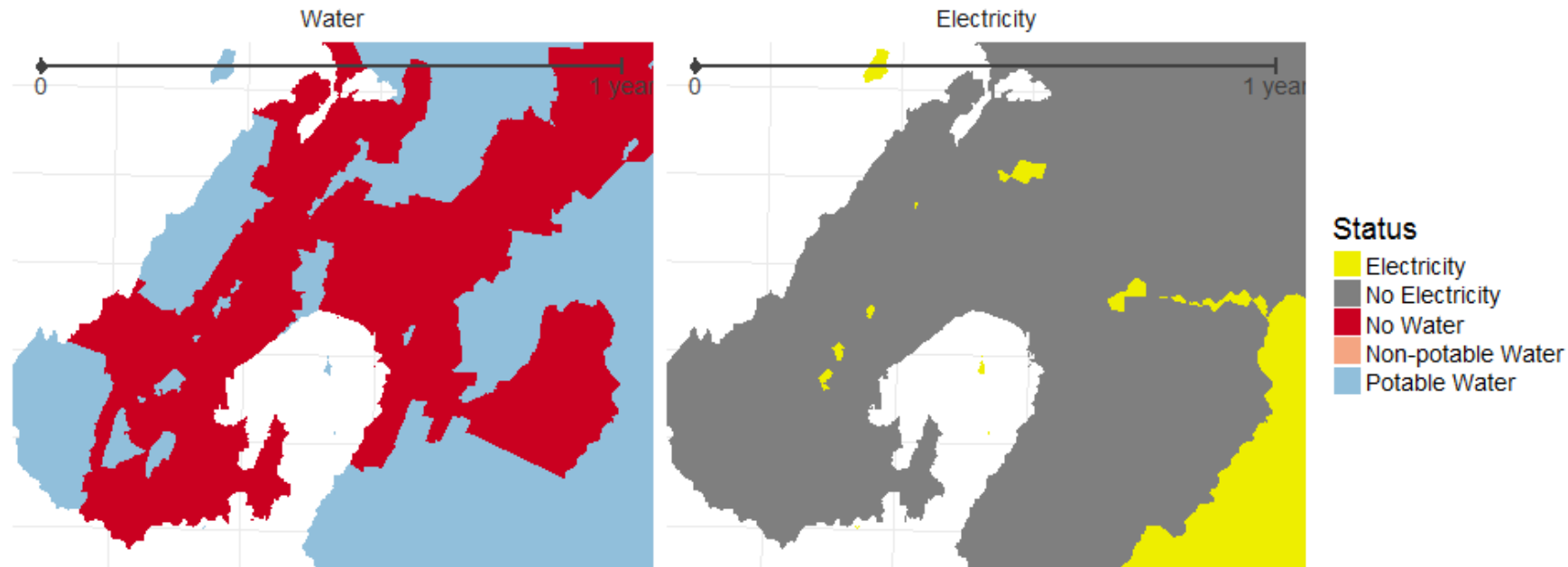


People & Business Relocation



Direct impacts and recovery over time

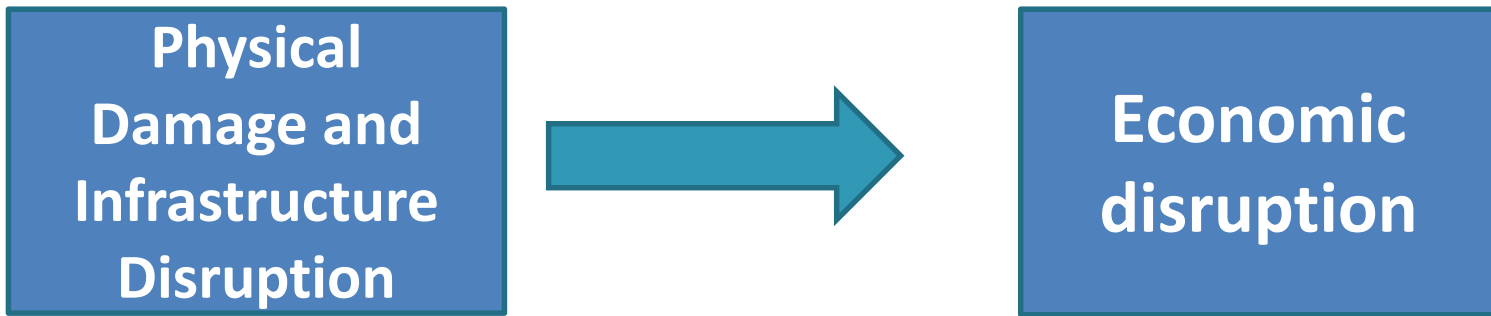
Days since event = 0



Water Supply

Electricity

Loss Modelling + Workshops with lifeline utilities



Habitability

Liveability

Business Operability

Business Viability

Market Inaccessibility

Tourism Attractability

**Transport provision/
substitutability**



People relocations



Supply of goods and services



Business relocations



Altered supply/demand relationships



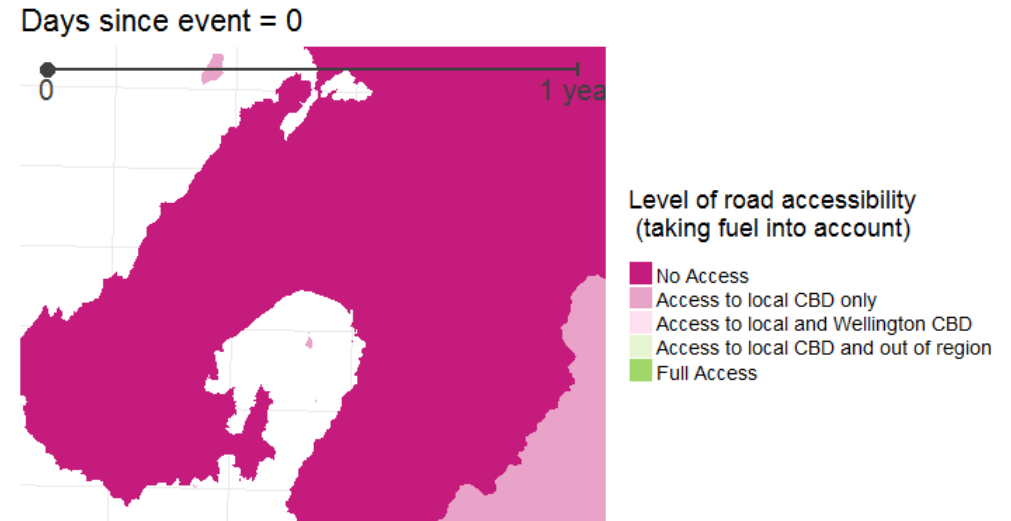
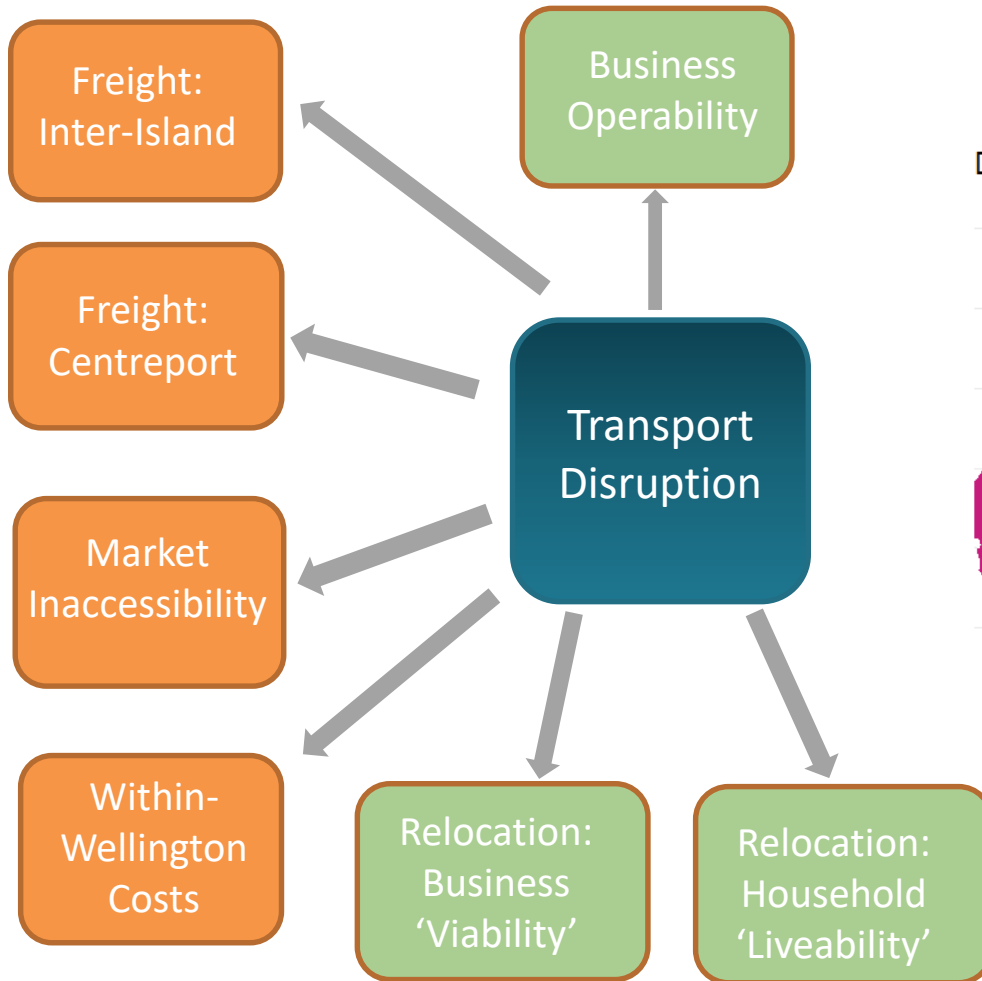
Altered tourism demands



Altered mode/service providers and transportation costs

Transport impacts

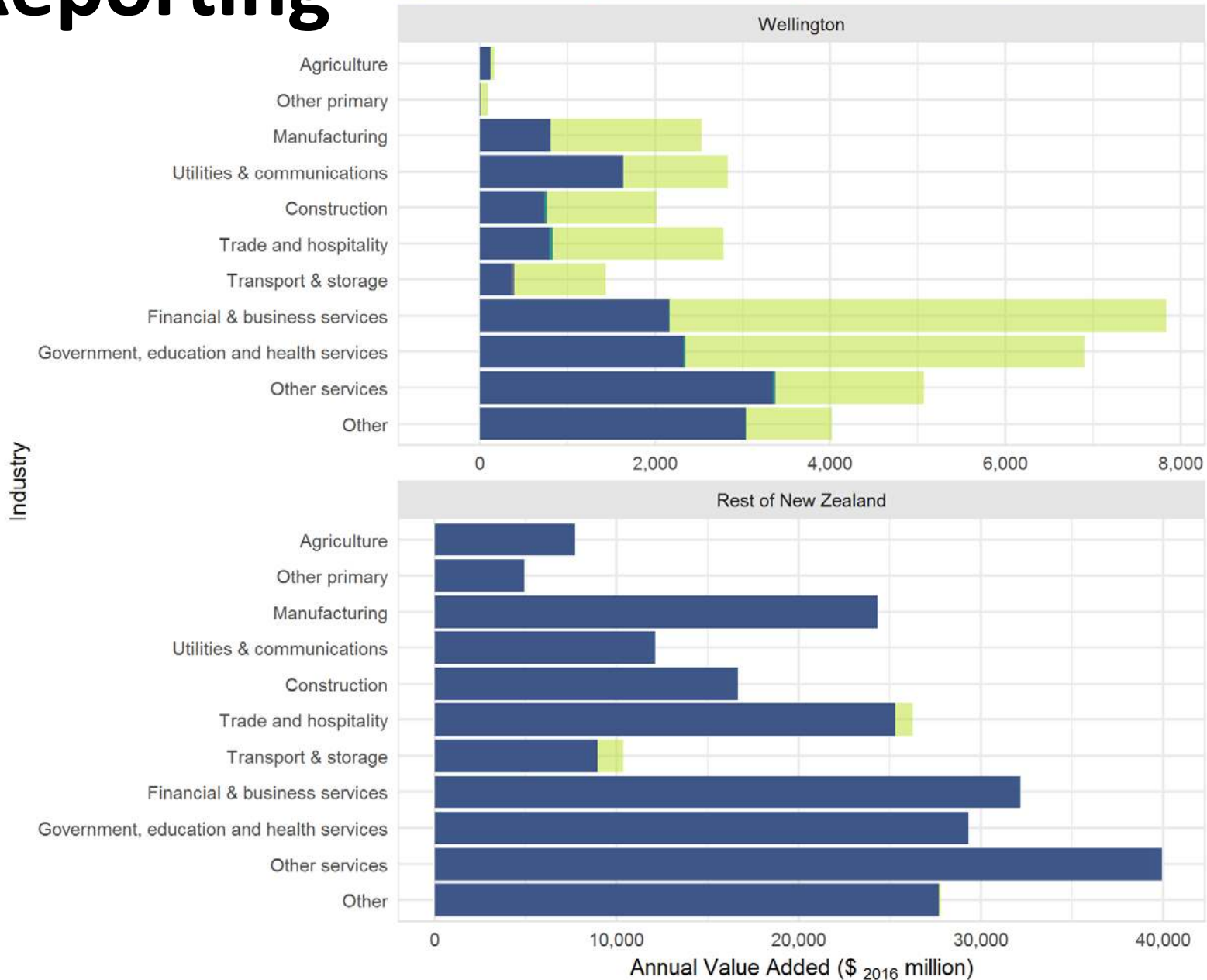
Fuel, Road, Rail, Air, Ports



Reporting

Days since event = 0

■ No Quake Base Run ■ Quake High Investments ■ Quake Low Investments ■ Quake No Investments

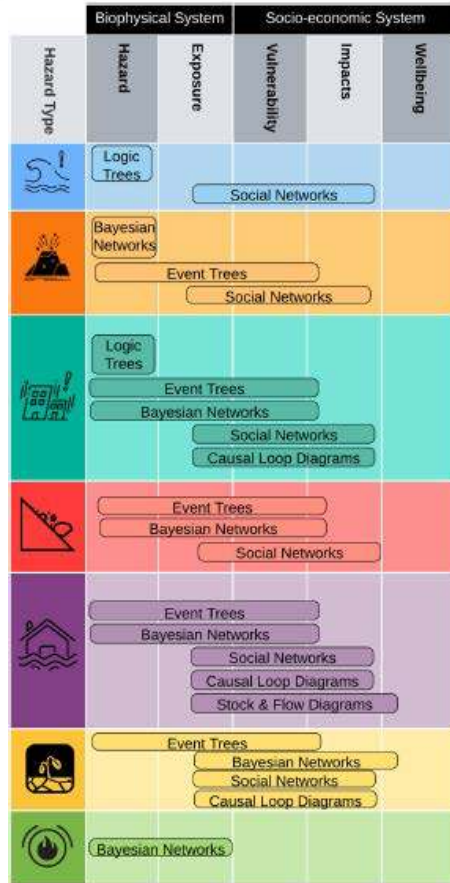


Investment benefits

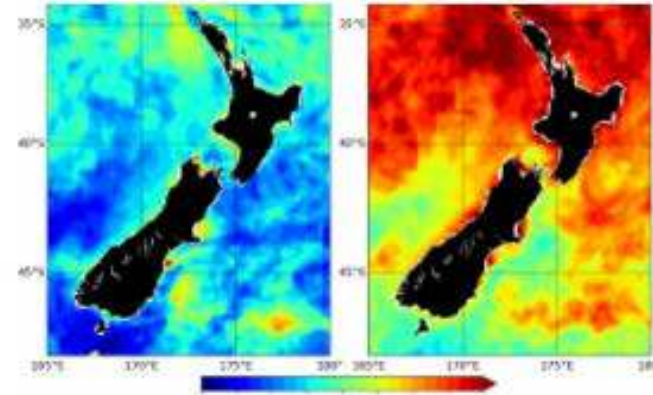
- Improved capacity for businesses to adapt
 - The process of recovery commences earlier, faster return to normal levels of productivity
- Reduced balance-of-trade implications
 - Relatively less disruption to domestic transportation coupled with higher levels of domestic production/exports
- Improved '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

Future Directions

Integration across the Hazard-Wellbeing Assessment Chain



Climate Change (Adaptation and Mitigation)



Source: NIWA

Delivery Mechanisms

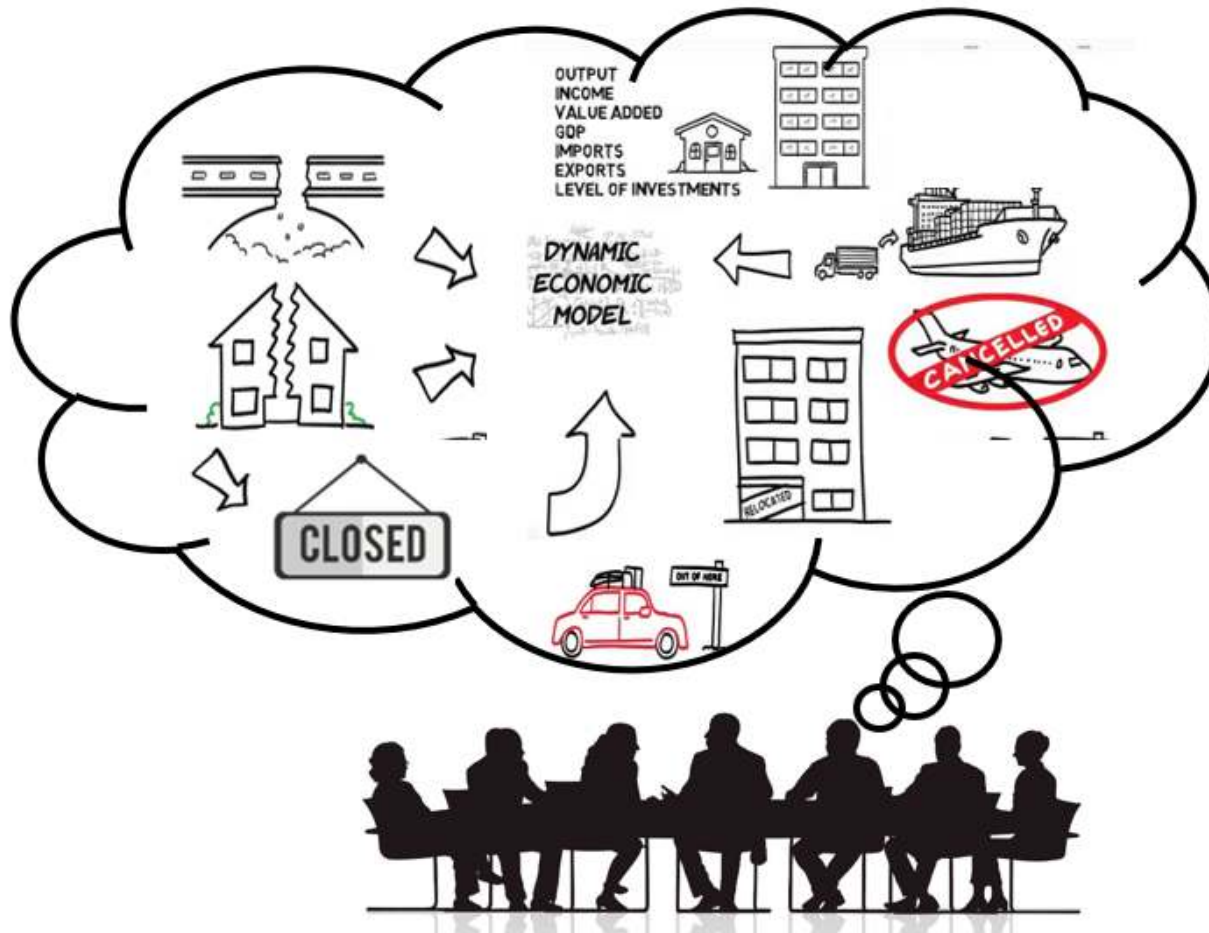
Run simulation

Net Change in Annual GDP and GRP

Study Region Accumulated Change in Value Added (\$NZ2019Q2m)

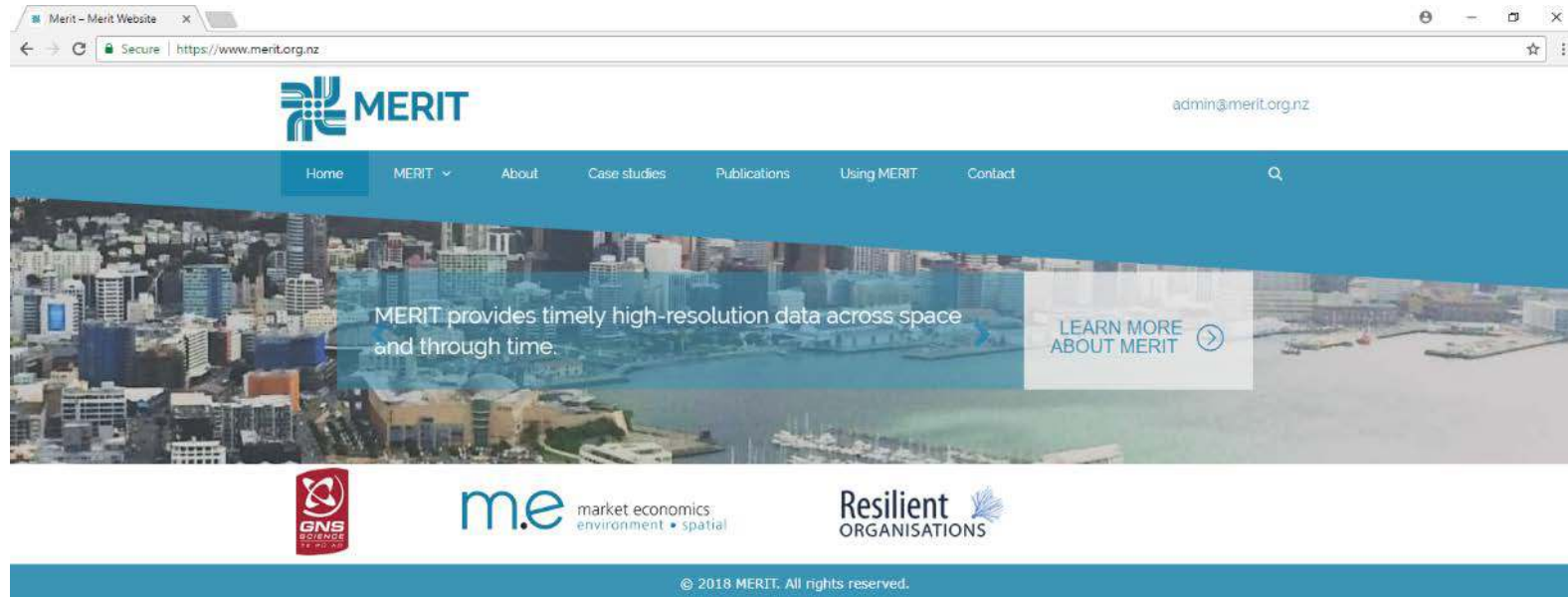
	0	1	2	3	4	5	6	7	8	9	10	Final
Sheep, beef & grain farms	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dairy cattle farming	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Forestry & logging	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Other agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mining	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Food manufact	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wood & paper manufact	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemical & mineral manufact	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Other manufact	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1
Utilities & construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Trade & hospitality	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7
Road transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other transport & storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Other services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2

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MERIT as a process
(for decision making)

For more information ...



<https://www.merit.org.nz/>

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