Economic impact of the 2016 Kaikōura earthquake

GEN and Transport Knowledge Hub Event, March 30, Wellington
Dr Garry McDonald and Dr Nicola Smith
Kaikōura earthquake

- 14 Nov 2012 @ 12.02am
- Magnitude 7.8 @ depth of 15kms
- Multi-fault rupture event
- Tsunami at Goose Bay 6.9m±0.3m
- 2 deaths, by Feb 2017 $900 million of insurance claims
Outline

• Scope of work, timeline
• Measuring the Economics of Resilient Infrastructure Tool (MERIT)
• MERIT modelling and results
  – Transport
  – Business operability
  – Tourism
  – Bringing it all together
  – Rebuild workforce
• Research agenda

Source: dailymail.co.uk
Scope of work

- Rapid assessment of the economic impacts as part of the wider information response to support decision-making
  - Understand the scale and extent of the *Kaikōura event* and impacts of response options
  - Key focus on transport (road, rail, port), business operation (all industries), tourism (domestic, international), wider flow-on impacts
  - Separate analysis of rebuild workforce requirements
Timeline

14 – 16 Nov
• Discussions with government (MoT, MBIE, NZTA)/research community

17 Nov – 7 Dec
• Govt – A3 ‘factsheets’ (People, Networks, Freight, Port, Fiscal etc)
• Research – Info sharing portal (Riskscape, Geotech, Landslides etc)

8 Dec
• Economic impact assessment work begins – 40 hours

12 Dec
• 1st A3 ‘infosheets’: transport, business operability, tourism, wider flow-on impacts, rebuild workforce (update to Ministers)

20 Dec
• 2nd A3 ‘infosheets’ & draft report: transport, business operability, tourism, wider flow-on impacts, rebuild workforce (update to Ministers)

27 Jan
• Final report including options analysis (60pp) (update to Ministers)
What is MERIT?

- Computer simulation model for assessing the economic impacts of disruption events
  - 3 versions: inoperability (<1 wk), two-region (>1 wk), Auckland spatially explicit model
  - Multi-regional covering 16 regions
  - Daily time steps over 20 years
  - Multi-agent including 70+ businesses/industries, households, government, investors, trade by 70+ commodities
  - Reports direct, flow-on/cascading impacts (value added, income, employment and other indicators)
  - Based on general equilibrium theory, adapted for business disruption response and equilibrium-seeking dynamics
Where is MERIT being applied?

• Single infrastructure disruptions
  – Electricity (Vector, Transpower),
  – Port (Lyttelton), Road (MoT, NZTA ‘Transport MERIT Online’)
  – Water (WaterCare, Wellington Water)

• Natural hazard event disruptions
  – Alpine Fault (MCDEM)
  – Auckland Volcanic Field (AC, AELG)
  – Kaikōura (MoT/MBIE/NZTA)
  – Wellington Fault (GW, WELG, etc)

• Currently being developed under the QuakeCoRE, Resilience NSC and through commercial contracts
General modelling process
How does MERIT work?

Direct impacts e.g. operability

Outage maps

MERIT flow-on impacts

Reporting

Impacted business

How does MERIT work?

Direct impacts e.g. operability

Outage maps

MERIT flow-on impacts

Reporting
Kaikōura modelling process

- Direct impacts estimated by MERIT sub-modules
  - transport
  - business behaviours
  - tourism

- These transform event information (e.g. road closures, building closures) into MERIT input parameters

- MERIT then estimates wider flow-on effects for economy

- Reporting is net of established ‘counterfactual’

- Rebuild workforce requirements estimated using MBIE/ME’s National Construction Occupations Model
Transport networks significantly impacted
- SH1 and rail line connecting upper North Island and Chch
- Kaikōura township isolated
- Container shipping from Centreport

Transport analysis concentrated on quantifying the increased freight costs
- Accessibility issues for tourism operators covered by business inoperability and tourism modules

Other potential impacts
- Loss of value of perishable goods due to time delays
- Supply-chain interruptions
### Route Status for Disrupted SH Network, as supplied by NZTA on 23 Jan 17

<table>
<thead>
<tr>
<th>State Highway</th>
<th>14-Nov-16</th>
<th>21-Nov-16</th>
<th>19-Dec-16</th>
<th>21-Dec-16</th>
<th>28-Feb-17</th>
<th>30-Apr-17</th>
<th>31-May-17</th>
<th>31-Jul-17</th>
<th>31-Oct-18</th>
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<tbody>
<tr>
<td><strong>Waiau to Kaikoura (Inland Route)</strong></td>
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<tr>
<td>Options 1&amp;2</td>
<td>closed</td>
<td>closed</td>
<td>road open - functional</td>
<td>open</td>
<td>open</td>
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<tr>
<td>Option 3</td>
<td>closed</td>
<td>closed</td>
<td>road open - functional</td>
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<td><strong>SH1 North of Kaikoura</strong></td>
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<tr>
<td>Option 3</td>
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<td>closed</td>
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<td>closed</td>
<td>closed</td>
<td>closed</td>
<td>closed</td>
<td>road open - functional</td>
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<tr>
<td><strong>SH1 South of Kaikoura</strong></td>
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<tr>
<td>Options 1&amp;2</td>
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<td>road open - functional</td>
<td>road open - functional</td>
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<td>road open - functional</td>
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<tr>
<td>Option 3</td>
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<td>road open - functional</td>
</tr>
</tbody>
</table>

**Railways** – Main line north estimated to carry 1.12m tonnes – all assumed to be freighted by road

**Centreport** – Disruption of 9 months (Options 1&2) and 2 years (Option 3) containers re-routed through other ports (mainly Tauranga, Auckland)

**Coastal shipping** – Assumed to be analogous to road, applied road freight margins
Transport (modelling)

- Road Outage Scenario
  - Road network x Level of Service x time (BAU & hazard event scenarios)

- Network Analyser
  - Distance and time to travel between zones (BAU & hazard event scenarios)

- Direct Impact Analyser
  - Net change in transport margins x commodity

- Compile Direct Impacts / MERIT Economic Model

* Refer to NZTA’s Transport-MERIT Online

The economic impacts of road outages in New Zealand
Business operability (background)

- MERIT’s Business Behaviours Model (Brown et al., 2015) calculates business operability
  - “operability” = proportion of as normal production that can be maintained (0-100%)
  - impacted by disruption sources from infrastructure (water, sewage, electricity, gas, phone, fuel) and non-infrastructure (premises, neighbourhood, staff)
  - key theme is that businesses are adaptive, but the more severe the disruption the slower the recovery

- BBM based on data collected from survey of Canterbury businesses following Canterbury quakes
## Business operability (info. & assumptions)

### Infrastructure Outage by Location (excl. road, rail, port)

<table>
<thead>
<tr>
<th>Area</th>
<th>Geospatial definition</th>
<th>Electricity (Days of Outage)</th>
<th>Water (Days of Outage)</th>
<th>Sewerage (Days of Outage)</th>
<th>Stormwater (Days of Outage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaikoura Urban Area</td>
<td>8(^4) 5(^2) 11(^3) 11(^1)</td>
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<tr>
<td>Hanmer Springs Urban Area</td>
<td>1(^5) 0(^5) 0 0</td>
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<tr>
<td>Waiau Area Unit</td>
<td>2(^6) 1(^5) 0 0</td>
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<tr>
<td>Waiau - Rural Area Unit</td>
<td>2(^6) 12(^7) 0 0</td>
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<tr>
<td>Culverden Area Unit</td>
<td>1(^6) 0(^5) 0 0</td>
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<tr>
<td>Cheviot Area Unit</td>
<td>1(^6) 0(^5) 0 0</td>
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<tr>
<td>Ward Area Unit</td>
<td>5(^9),4 14(^8) 14(^8) 14(^1)</td>
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<tr>
<td>Seddon Area Unit</td>
<td>3(^10) 3(^10) 0 0</td>
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<tr>
<td>Blenheim Urban Area</td>
<td>0 0 0 0</td>
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<tr>
<td>Picton Urban Area</td>
<td>0 0 0 0</td>
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<tr>
<td>Nelson Urban Area</td>
<td>0 0 0 0</td>
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<tr>
<td>Wellington Urban Area</td>
<td>0 0 0 0</td>
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<tr>
<td>Lower Hutt Urban Area</td>
<td>1(^11) 0 0 0</td>
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</tbody>
</table>

**NB:** Footnotes as per final report

### Adjustments to BBM model required for:

1. Centreport and KiwiRail operations
2. Whale-watching
3. Other Kaikōura tourism businesses
4. Wine manufacturing
5. Wellington building closures
## Impacts of Kaikōura Quake on Business Operability

<table>
<thead>
<tr>
<th>Industry</th>
<th>Kaikoura District</th>
<th>Hurunui District</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>% Loss to Business Operability</td>
<td>% Loss to Business Operability</td>
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<tr>
<td></td>
<td>1 week 7 weeks 3 months 6 months 12 months</td>
<td>1 week 7 weeks 3 months 6 months 12 months</td>
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<tr>
<td></td>
<td>Pre-quake Value A ($2016 mil/yr)</td>
<td>Pre-quake Value A ($2016 mil/yr)</td>
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<tr>
<td>1 Agriculture</td>
<td>0% 0% 0% 0% 0%</td>
<td>0% 0% 0% 0% 0%</td>
</tr>
<tr>
<td>2 Other primary</td>
<td>0% 0% 0% 0% 0%</td>
<td>1% 1% 0% 0% 0%</td>
</tr>
<tr>
<td>3 Food manufacturing</td>
<td>19% 8% 4% 0% 0%</td>
<td>19% 8% 4% 0% 0%</td>
</tr>
<tr>
<td>4 Wood and paper manufacturing</td>
<td>23% 9% 5% 0% 0%</td>
<td>11% 5% 2% 0% 0%</td>
</tr>
<tr>
<td>5 Other manufacturing</td>
<td>19% 8% 4% 0% 0%</td>
<td>15% 6% 3% 0% 0%</td>
</tr>
<tr>
<td>6 Utilities, construction &amp; transport</td>
<td>34% 26% 5% 0% 0%</td>
<td>14% 6% 3% 0% 0%</td>
</tr>
<tr>
<td>7 Trade and hospitality</td>
<td>75% 37% 36% 35% 0%</td>
<td>14% 6% 3% 0% 0%</td>
</tr>
<tr>
<td>8 Finance, insurance, real estate &amp; prof. servs</td>
<td>26% 11% 6% 0% 0%</td>
<td>16% 6% 3% 0% 0%</td>
</tr>
<tr>
<td>9 Government, education &amp; health services</td>
<td>20% 8% 4% 0% 0%</td>
<td>12% 5% 2% 0% 0%</td>
</tr>
<tr>
<td>10 Other services</td>
<td>37% 17% 14% 11% 0%</td>
<td>18% 7% 4% 0% 0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry</th>
<th>Marlborough District</th>
<th>Wellington Region</th>
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<tbody>
<tr>
<td></td>
<td>% Loss to Business Operability</td>
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<tr>
<td></td>
<td>1 week 7 weeks 3 months 6 months 12 months</td>
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<td>1 Agriculture</td>
<td>0% 0% 0% 0% 0%</td>
<td>0% 0% 0% 0% 0%</td>
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<tr>
<td>2 Other primary</td>
<td>3% 1% 1% 0% 0%</td>
<td>0% 0% 0% 0% 0%</td>
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<tr>
<td>3 Food manufacturing</td>
<td>17% 7% 4% 0% 0%</td>
<td>0% 0% 0% 0% 0%</td>
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<td>4 Wood and paper manufacturing</td>
<td>16% 6% 3% 0% 0%</td>
<td>0% 0% 0% 0% 0%</td>
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<tr>
<td>5 Other manufacturing</td>
<td>10% 4% 2% 0% 0%</td>
<td>0% 0% 0% 0% 0%</td>
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<tr>
<td>6 Utilities, construction &amp; transport</td>
<td>11% 5% 3% 1% 1%</td>
<td>1% 0% 0% 0% 0%</td>
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<tr>
<td>7 Trade and hospitality</td>
<td>10% 4% 2% 0% 0%</td>
<td>0% 0% 0% 0% 0%</td>
</tr>
<tr>
<td>8 Finance, insurance, real estate &amp; prof. servs</td>
<td>8% 3% 1% 0% 0%</td>
<td>1% 0% 0% 0% 0%</td>
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<tr>
<td>9 Government, education &amp; health services</td>
<td>9% 3% 2% 0% 0%</td>
<td>1% 1% 0% 0% 0%</td>
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<tr>
<td>10 Other services</td>
<td>9% 3% 2% 0% 0%</td>
<td>1% 0% 0% 0% 0%</td>
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</table>
Tourism (background)

• Growth in both domestic and international tourism markets has been strong (up 15% and 6% for year ending Oct 2016)

• For last weeks of November and December, we estimated changes in tourism expenditure
  – Required comparing actual spend with predicted spend
  – Key data are EFTPOS and credit card transactions & MBIE Monthly Regional Tourism Expenditure

• Also needed to develop assumptions of tourism expenditure impacts into the future for MERIT
### Estimated Impacts of Quake on Tourism Expenditure by Selected Regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Month (2016)</th>
<th>Domestic</th>
<th>Impact</th>
<th>Impact (%)</th>
<th>Domestic</th>
<th>Impact</th>
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<tbody>
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<td></td>
<td></td>
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<td>(£2016 NZ million)</td>
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<td>(£2016 NZ million)</td>
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<td><strong>Total New Zealand</strong></td>
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<tr>
<td>November</td>
<td>-73 (-30,-117.6)</td>
<td>-6%</td>
<td>62 (117.9,4.1)</td>
<td>6%</td>
<td></td>
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<tr>
<td>December</td>
<td>-129 (-78.5,-180.2)</td>
<td>-8%</td>
<td>51 (131.7,-34.4)</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-202 (-108.5,-297.7)</td>
<td>-7%</td>
<td>113 (249.6,-30.2)</td>
<td>5%</td>
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<tr>
<td><strong>Wellington RTO</strong></td>
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<tr>
<td>November</td>
<td>-23 (-16.5,-29.1)</td>
<td>-19%</td>
<td>3 (-1.78)</td>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>-14 (-7.2,-19.9)</td>
<td>-11%</td>
<td>1 (-4.2,-6.9)</td>
<td>-2%</td>
<td></td>
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<tr>
<td>Total</td>
<td>-36 (-23.8,-49)</td>
<td>-15%</td>
<td>5 (-5.2,-14.7)</td>
<td>-3%</td>
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<tr>
<td><strong>Rest of North Island</strong></td>
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<tr>
<td>November</td>
<td>-31 (-9.6,-52.6)</td>
<td>-4%</td>
<td>51 (80.2,20.5)</td>
<td>10%</td>
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<tr>
<td>December</td>
<td>-70 (-44.5,-95.5)</td>
<td>-7%</td>
<td>66 (106.9,23.7)</td>
<td>10%</td>
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<tr>
<td>Total</td>
<td>-101 (-54.1,-148.1)</td>
<td>-6%</td>
<td>117 (187.1,44.2)</td>
<td>10%</td>
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<tr>
<td><strong>Rest of South Island</strong></td>
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<tr>
<td>November</td>
<td>-5 (-0.4,-10.3)</td>
<td>-4%</td>
<td>17 (29.4)</td>
<td>8%</td>
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<tr>
<td>December</td>
<td>-16 (-10.2,-22.3)</td>
<td>-9%</td>
<td>2 (22.4,-19.5)</td>
<td>1%</td>
<td></td>
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<tr>
<td>Total</td>
<td>-22 (-10.6,-32.6)</td>
<td>-7%</td>
<td>19 (51.4,-15.5)</td>
<td>4%</td>
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<td><strong>West Coast RTO</strong></td>
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<tr>
<td>November</td>
<td>-1 (0.3,-2.7)</td>
<td>-8%</td>
<td>1 (1.3,-2.5)</td>
<td>-2%</td>
<td></td>
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<tr>
<td>December</td>
<td>-1 (1.1,-2.6)</td>
<td>-3%</td>
<td>4 (-1.3,-6.1)</td>
<td>9%</td>
<td></td>
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</tr>
<tr>
<td>Total</td>
<td>-2 (1.3,-5.3)</td>
<td>-5%</td>
<td>4 (0,-8.6)</td>
<td>6%</td>
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<tr>
<td><strong>Nelson Tasman RTO</strong></td>
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<tr>
<td>November</td>
<td>-2 (-0.2,-4.7)</td>
<td>-8%</td>
<td>4 (5.6,2.9)</td>
<td>21%</td>
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</tr>
<tr>
<td>December</td>
<td>-6 (-3.9,-9)</td>
<td>-13%</td>
<td>4 (6.4,2.1)</td>
<td>13%</td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td>-9 (-4.1,-13.7)</td>
<td>-11%</td>
<td>9 (11.9,5)</td>
<td>16%</td>
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<td><strong>Marlborough RTO</strong></td>
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<tr>
<td>November</td>
<td>-2 (-0.9,-3.3)</td>
<td>-11%</td>
<td>1 (0.1,-1.9)</td>
<td>-6%</td>
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<tr>
<td>December</td>
<td>-4 (-2.9,-5.9)</td>
<td>-16%</td>
<td>2 (-1,-3.5)</td>
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<tr>
<td>Total</td>
<td>-6 (-3.8,-9.2)</td>
<td>-14%</td>
<td>3 (-1,-5.4)</td>
<td>-9%</td>
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<tr>
<td><strong>North Canterbury</strong></td>
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<tr>
<td>November</td>
<td>-3 (-2.1,-4.3)</td>
<td>-18%</td>
<td>5 (-4.6,-5.9)</td>
<td>-40%</td>
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<td></td>
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<tr>
<td>December</td>
<td>-8 (-6.6,-9.1)</td>
<td>-35%</td>
<td>12 (-11.4,-13.3)</td>
<td>-63%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-11 (-8.7,-13.4)</td>
<td>-28%</td>
<td>18 (-16,-19.2)</td>
<td>-54%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Impact values are in millions of New Zealand dollars.
Tourism (info. & assumptions)

• Based on Tourism analysis we assumed for MERIT:
  – *International Tourism Expenditure (Canterbury)*
    • 11.5-12.7% loss to end of December
    • 1.5% loss until road fully opens
  – *International Tourism Expenditure (Rest of NZ)*
    • 9% gain for first 1-2 weeks
    • 3% gain December
    • Rest of period, losses in Canterbury are gains for rest of NZ

• No attempt to change domestic tourism expenditures in MERIT (further development of tourism module required)
Bringing it all together in MERIT

**MERIT**

**Dynamic Economic Model**

- Industries
- Labour
- Capital
- Commodities
- Households
  - Enterprise
  - Factors
  - Rest of world
  - Investment & savings
  - Government
  - Reporting

**Transport Analysis**

- Network Analyser (M.E.)
  - Road outages and alternative routes
  - Change in transport time & distance
- Direct Transport Cost Analyser (M.E.)
  - Net additional domestic/export/import transport margins per unit of commodity
  - % change in international tourist export demand

**MERIT Components**

- Media/Civil Defence reports
  - Non-transport infrastructure outages
  - MMI maps and list of closed buildings in Wellington
- GNS
- NZTA
- MarketView data
- Tourism Direct impacts
## Impacts on Gross Domestic Product/Value Added

<table>
<thead>
<tr>
<th></th>
<th>Baseline GDP ($\text{2016 m}$)</th>
<th>OPTIONS 1&amp;2</th>
<th></th>
<th>OPTION 3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Time Period After Event</td>
<td>Estimated change in GDP ($\text{2016 m}$)</td>
<td>% change from YE March 2016</td>
<td>Time Period After Event</td>
</tr>
<tr>
<td><strong>Regional Results</strong></td>
<td></td>
<td>0-12 months</td>
<td>12-24 months</td>
<td>Total (0-24 months)</td>
<td>Total (0-24 months)</td>
</tr>
<tr>
<td>Total New Zealand</td>
<td>241,200</td>
<td>-402</td>
<td>-62</td>
<td>-465</td>
<td>-0.1%</td>
</tr>
<tr>
<td>Canterbury</td>
<td>32,900</td>
<td>-107</td>
<td>-10</td>
<td>-117</td>
<td>-0.2%</td>
</tr>
<tr>
<td>Rest of New Zealand</td>
<td>208,300</td>
<td>-295</td>
<td>-53</td>
<td>-348</td>
<td>-0.1%</td>
</tr>
<tr>
<td><strong>Industry Results</strong></td>
<td></td>
<td>Estimated change in Value Added ($\text{2016 m}$)</td>
<td>% contribution to GDP loss</td>
<td>Estimated change in Value Added ($\text{2016 m}$)</td>
<td>% contribution to GDP loss</td>
</tr>
<tr>
<td>All industries</td>
<td></td>
<td>-382</td>
<td>-57</td>
<td>-439</td>
<td>94%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>10,500</td>
<td>-21</td>
<td>-9</td>
<td>-31</td>
<td>7%</td>
</tr>
<tr>
<td>Other primary</td>
<td>5,200</td>
<td>-36</td>
<td>-7</td>
<td>-43</td>
<td>9%</td>
</tr>
<tr>
<td>Food manufacturing</td>
<td>9,500</td>
<td>-115</td>
<td>-4</td>
<td>-119</td>
<td>26%</td>
</tr>
<tr>
<td>Wood and paper manufacturing</td>
<td>2,100</td>
<td>-37</td>
<td>-2</td>
<td>-39</td>
<td>8%</td>
</tr>
<tr>
<td>Other manufacturing</td>
<td>14,400</td>
<td>-86</td>
<td>2</td>
<td>-84</td>
<td>18%</td>
</tr>
<tr>
<td>Utilities, construction &amp; transport</td>
<td>31,900</td>
<td>174</td>
<td>-75</td>
<td>98</td>
<td>-21%</td>
</tr>
<tr>
<td>Trade and hospitality</td>
<td>27,300</td>
<td>-36</td>
<td>4</td>
<td>-32</td>
<td>7%</td>
</tr>
<tr>
<td>Government, education &amp; health services</td>
<td>35,000</td>
<td>-87</td>
<td>22</td>
<td>-65</td>
<td>14%</td>
</tr>
<tr>
<td>Other services</td>
<td>87,600</td>
<td>-140</td>
<td>13</td>
<td>-126</td>
<td>27%</td>
</tr>
</tbody>
</table>
## Estimated Contributions of Transport, Business Operability and Tourism to Total Impacts

<table>
<thead>
<tr>
<th>GDP impacts by component</th>
<th>OPTIONS 1&amp;2</th>
<th>OPTION 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time Period After Event</td>
<td>Estimated GDP impacts ($_{2016}m$)</td>
</tr>
<tr>
<td></td>
<td>0-12 months</td>
<td>12-24 months</td>
</tr>
<tr>
<td>Transport - all New Zealand</td>
<td>-151</td>
<td>-58</td>
</tr>
<tr>
<td>Canterbury</td>
<td>-39</td>
<td>-11</td>
</tr>
<tr>
<td>Rest of New Zealand</td>
<td>-112</td>
<td>-47</td>
</tr>
<tr>
<td>Business operability¹ - all NZ</td>
<td>-274</td>
<td>-3</td>
</tr>
<tr>
<td>Canterbury</td>
<td>-52</td>
<td>1</td>
</tr>
<tr>
<td>Rest of New Zealand</td>
<td>-222</td>
<td>-4</td>
</tr>
<tr>
<td>Tourism - all New Zealand</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>Canterbury</td>
<td>-17</td>
<td>1</td>
</tr>
<tr>
<td>Rest of New Zealand</td>
<td>36</td>
<td>-1</td>
</tr>
</tbody>
</table>

Notes: 1. This includes supply-side impacts on tourism businesses
Rebuild workforce

• Workforce estimates based on National Construction Occupations Model
  – Uses input data of construction investment (residential, non-residential, civil engineering)
  – Applies a multi-regional input-output model to estimate direct, indirect and induced labour force requirements
  – Model outputs are employment by 1022 occupation groupings

• Direct reinstatement costs were extracted from RiskScape model
  – Estimates scaled upwards to match rebuild cost estimates provided by Reserve Bank
### Construction Workforce Requirements (All Occupations, MEC years) by region

<table>
<thead>
<tr>
<th></th>
<th>Canterbury Region</th>
<th>Rest of New Zealand</th>
<th>Total New Zealand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1</td>
<td>Year 2</td>
<td>Year 3</td>
</tr>
<tr>
<td><strong>Option 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>200</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>Non-residential</td>
<td>300</td>
<td>300</td>
<td>3,500</td>
</tr>
<tr>
<td>Heavy and civil engineering</td>
<td>16,300</td>
<td>0</td>
<td>1,400</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16,800</td>
<td>500</td>
<td>5,400</td>
</tr>
<tr>
<td><strong>Option 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>1,200</td>
<td>1,200</td>
<td>2,800</td>
</tr>
<tr>
<td>Non-residential</td>
<td>1,300</td>
<td>1,300</td>
<td>17,500</td>
</tr>
<tr>
<td>Heavy and civil engineering</td>
<td>24,500</td>
<td>0</td>
<td>2,100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27,000</td>
<td>2,500</td>
<td>22,300</td>
</tr>
<tr>
<td><strong>Option 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>400</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Non-residential</td>
<td>400</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Heavy and civil engineering</td>
<td>12,300</td>
<td>12,200</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>13,100</td>
<td>13,900</td>
<td>1,600</td>
</tr>
</tbody>
</table>

MEC = Modified Employee Counts
Research agenda

• Displacement of Wellington workers
  – Govt provisioning of services (SNZ, Archives, NZDF, GW), loss of productivity
  – Business vulnerability aligned with government activities
    • Particularly primary sector – industry associations, head/national offices

• Coastal shipping dynamics
  – Temporary re-emergence of coastal shipping; NZ Connect (KiwiRail, PoA, LPC & ANL Shipping), Mainfreight
  – Port alternatives (eg. for RORO ferries), re-routing, freight handling, no. of berths, storage
  – Just-in-time practices vs pricing – what are the pinch-points?
  – Role in rebuild and recovery
Research agenda

• Freight price dynamics
  – Uncertainty lead to significant fluctuations in freight pricing over first month
  – Speculation/opportunism vs realistic operational cost increases?
  – What are the decision-making dynamics for freight pricing?

• Stockpiled and perishable goods
  – Built structure failure and road disruption placed perishable stockpiled goods (wine, raw milk) at risk
  – Need for primary sector resilience/disruption planning
Research agenda

• Economic of ‘fear’
  – Prof Adam Rose on 9-11, up to half of economic impacts caused by fear
  – Media, portrayal of impacts domestically, internationally (eg. Australian tourism market post Canterbury quakes)

• Information provisioning
  – Openness and sharing of data between government and research community, different processes adopted – possibly a ‘richer’ picture with more collaboration
  – IRD data protocols need to be established prior to an event for information release enabling risk identification, modelling calibration, learning on business adaptation and response
More information

Economics of Resilient Infrastructure:-

Resilience National Science Challenge:-
https://resiliencechallenge.nz/
(Annual forum tomorrow at Te Papa!)

Transport-MERIT Online:-

YouTube clip on Transport-MERIT:-
https://youtu.be/IRVD3PvZHHY
Questions