Tsunami Impacts to Lifelines:

Learning about Tsunami Impacts on Infrastructure from Recent Events

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Project Background

- **Recognising the lack of information on tsunami impacts to lifelines ALG/WeLG commissioned study to summarise the available information**
- **Project Aims:**
  - Document expected damage to the four lifelines sectors from tsunami
  - Draw on experiences and learning's from previous events
  - Develop recommendations for increasing lifelines resilience to tsunami

Information Sources

- **Post-tsunami reconnaissance survey reports**
- **Scientific literature**
- **Reports published by lifeline operators**
- **Damage data from post-tsunami surveys**
- **First hand experience by report team:**
  - 2010 Japan tsunami
  - 2015 Chile tsunami
- **Variable quality of information:**

Lifeline Sector	Damage and Failure Models	Recovery Actions	Increasing Resilience
Water			
Telecommunications			
Transport			
Energy			

Project Outputs

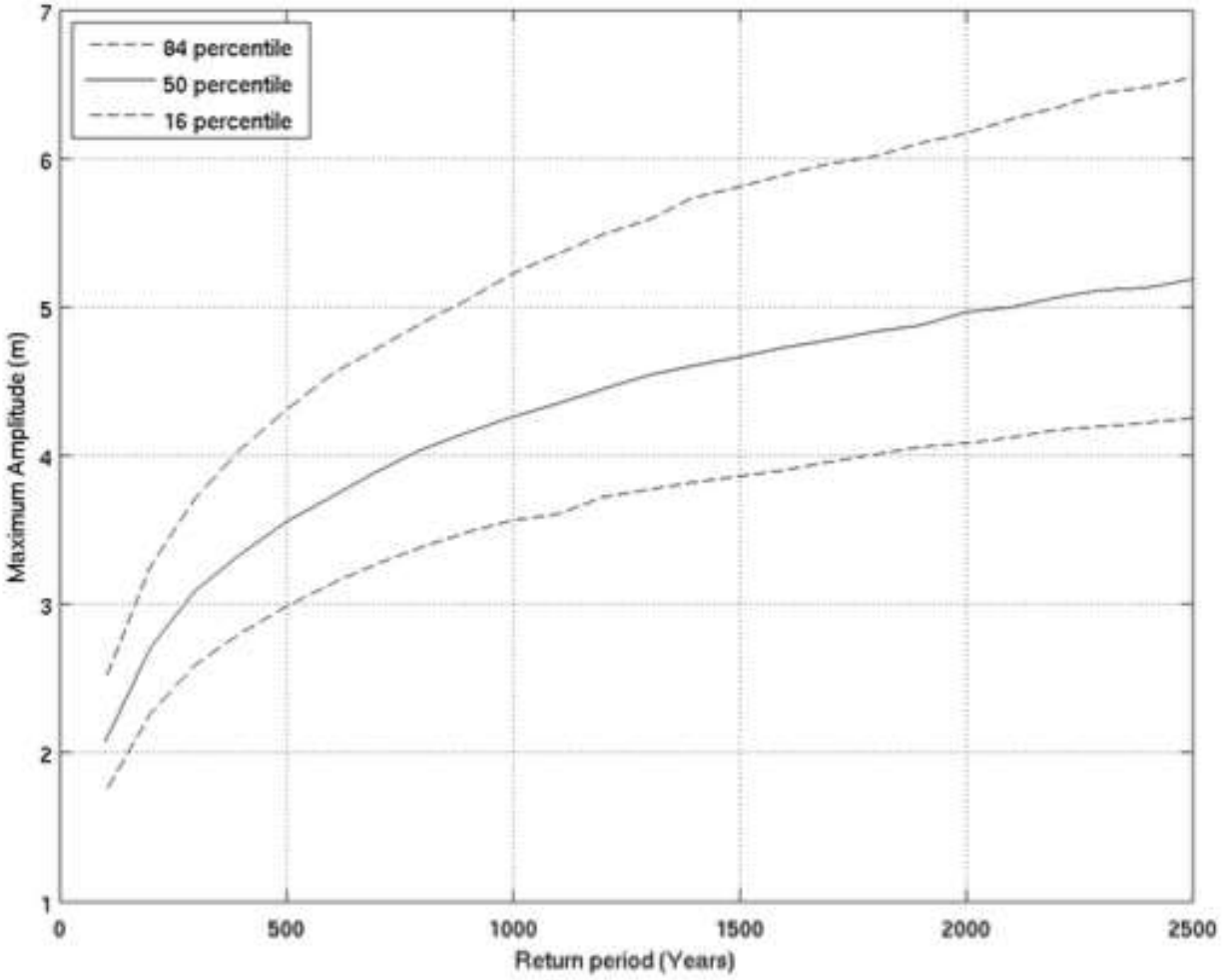
- **Report documenting, sector by sector:**
  - Likely damage and loss of functionality from tsunami
  - Examples of restoration and recovery strategies during previous tsunami events
  - Recommendations for increasing resilience from tsunami
- **Tsunami Damage Look-Up Tables, sector by sector:**
  - Likelihood of damage for different tsunami flow depth ranges (<0.5 m, 0.5 – 2 m, > 2m)
  - Description of damage for each tsunami flow depth range

Tsunami Damage Look-Up Tables – Potable Water

Lifeline Component	Flow Depth < 0.5m		Flow Depth 0.5m – 2m		Flow Depth >2m		Information Quality	Sources
Drinking Water								
Pipes	Low	Minor siltation	Low	Scouring, exposure and floatation, debris strikes, damage at bridges	Medium	Scouring, exposure and floatation, debris strikes, damage at bridges	Medium	(American Society of Civil Engineers, 2005; Auckland Engineering Lifelines, 2014; Edwards, 2006; Eguchi et al., 2013; Francis, 2006; Ghobarah et al., 2006; Horspool & Fraser, 2015; Horspool et al., 2016; Kazama & Noda, 2012; Lekkas, 2011; Miyajima, 2014; Scawthorn et al., 2006; Tang & Edwards, 2012; Villholth & Neupane, 2011)
Wells	Medium	Salt water contamination of shallow wells	High	Salt water & sewage contamination, groundwater contamination, debris strikes to components	High	Salt water & sewage contamination, ground water & aquifer contamination, scour, debris strikes, components exposed & washed away	Low	(American Society of Civil Engineers, 2005; Robert; Bell et al., 2005; Chandrasekar & Ramesh, 2007; Edwards, 2006; Horspool & Fraser, 2015; Kim et al., 2014; Villholth & Neupane, 2011)
Storage	Low	Salt water contamination	Low-Medium	Salt water and sewage contamination, siltation, debris strikes to tanks & reservoir embankments, low volume polyurethane tanks floated, scour of foundations, tilting of water towers	High	Salt water and sewage contamination, siltation, debris strikes to tanks & reservoir embankments, low volume polyurethane tanks floated, scour of foundations, tilting of water towers, floating of low volume concrete reservoirs, washout	Low	(American Society of Civil Engineers, 2005; Robert; Bell et al., 2005; Edwards, 2006; Francis, 2006; Horspool & Fraser, 2015; Villholth & Neupane, 2011)
Treatment & Pump Facilities	Low	Water damage to electrical & mechanical equipment	Medium-High	Water damage to structure interiors, salt & sewage contamination, equipment & machinery washed away, damage to electrical equipment	High	Water damage to interiors, salt & sewage contamination, collapse of structures, equipment & machinery washed away, damage to electrical equipment	Medium	(American Society of Civil Engineers, 2005; Robert; Bell et al., 2005; Edwards, 2006; Eguchi et al., 2013; Horspool et al., 2016; Scawthorn et al., 2006; Villholth & Neupane, 2011)

Auckland's Tsunami Hazard

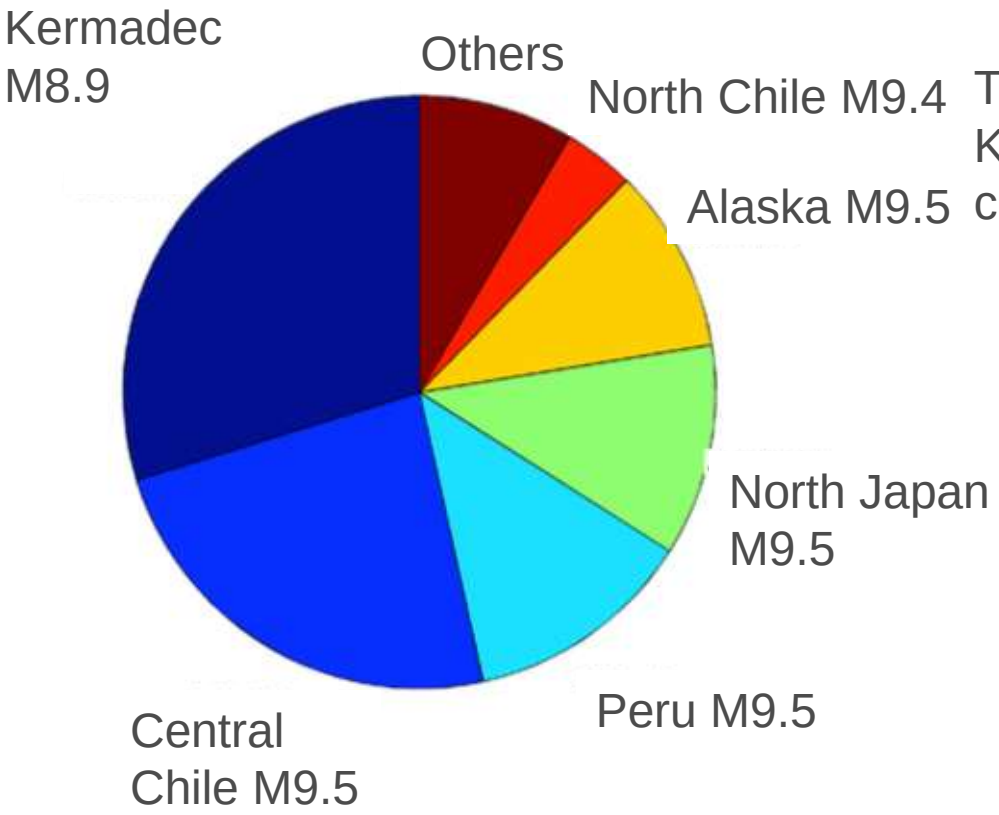
- **Maximum offshore tsunami height (above still water)**



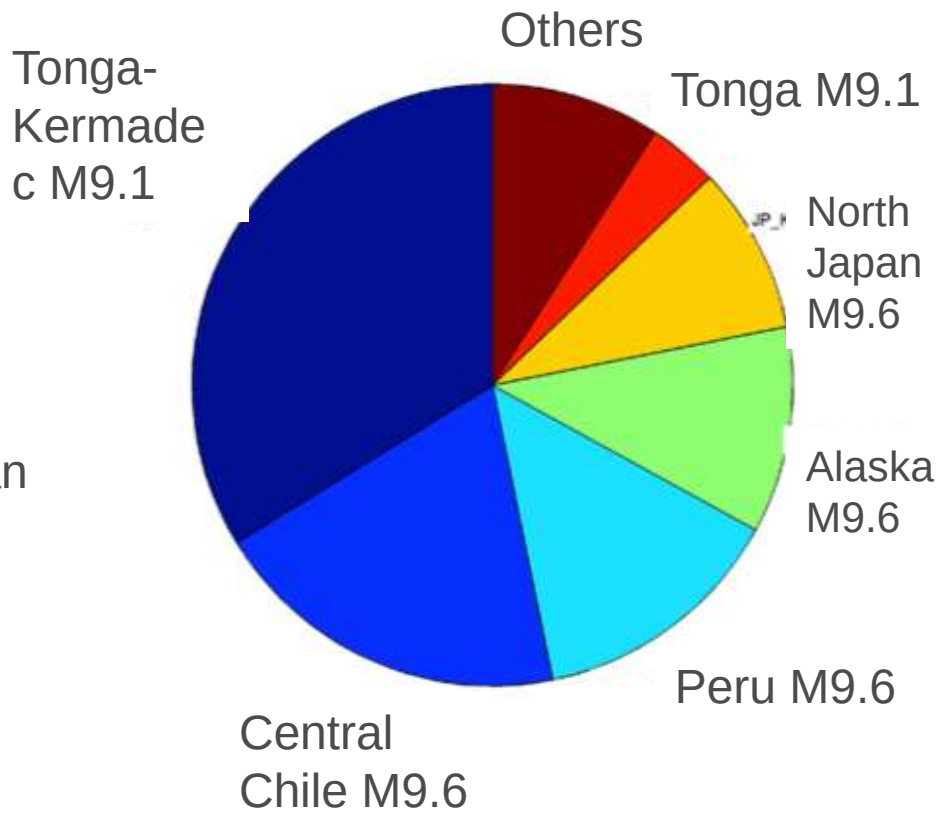
National Tsunami Review (Power, 2013)

Auckland's Tsunami Hazard – Where Does it Come From?

1 in 500 Year: 3.5 m



1 in 2500 Year: 5.2 m



Tsunami evacuation zones
CBD, Map 149

Civil Defence and Emergency Management
Te Rōnaki Whakamarumaru

Auckland Council

GNS Science

Transportation:

Roads and Bridges




Rail

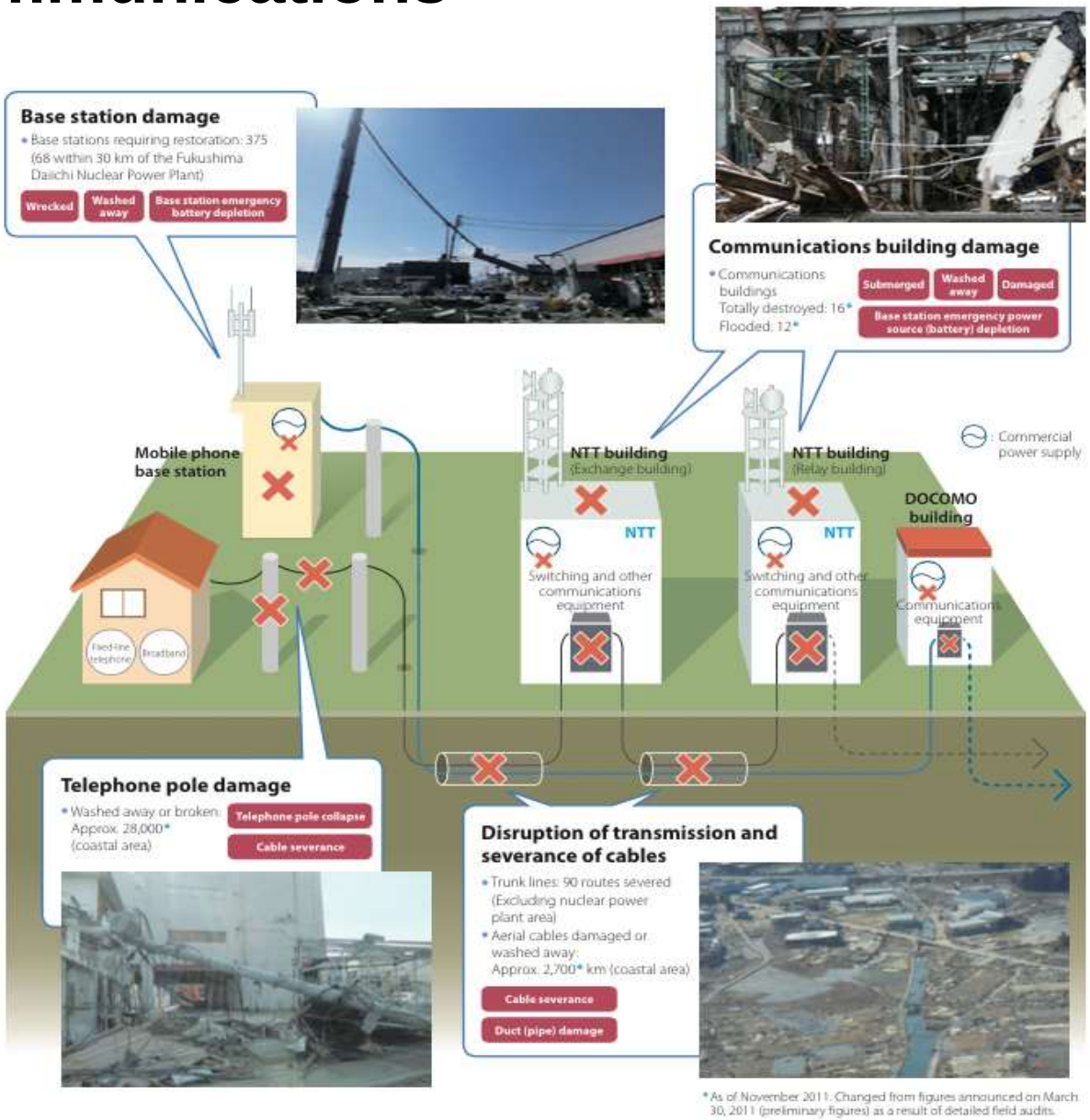

Airport

Port

Three Waters

Energy

Telecommunications



Key Findings Across Lifeline Sectors

- Relocation of assets outside of inundation zone if possible is the best mitigation option
- Electrical equipment is vulnerable and located near ground
- Back-up generators are often located on ground floors and also damaged
- Availability of spares critical to fast restoration of services
- Develop contingency plans for specific tsunami response
- Tsunami ‘hotspots’ for lifelines:
  - Coastal outflow sites and culverts → scour of coastal roads and loss of all below and above ground services
  - Bridges → scouring or washout causes loss of all co-located services on bridge
  - Coastal sites with multiple co-located lifelines (coastal road/rail/buried services or ports with fuel depots)

Now what?

- **Learn and understand the potential impacts to your lifelines**
  - Recovery planning
  - Strengthening network
- **Undertake scenario impact modelling (RiskScape)**
  - Damage state → functionality/levels of service
  - Economic losses → insurance
- **Use as basis for more detailed work on impacts to specific lifelines**

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