Tsunami Hazards in New Zealand Ports

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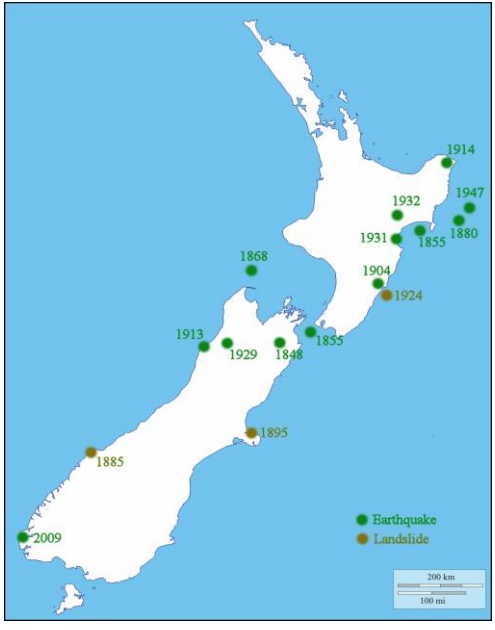
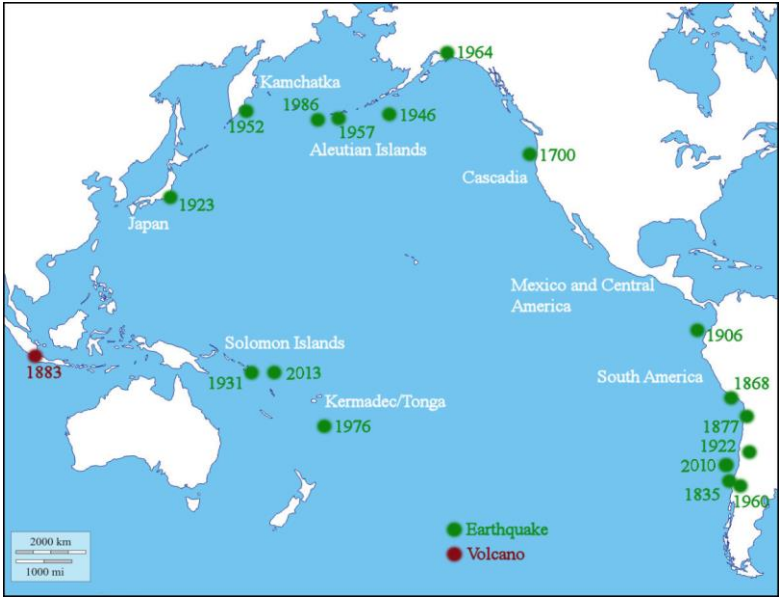
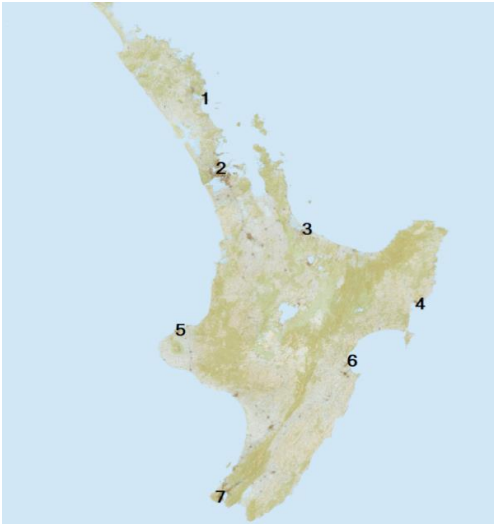
RNC Distributed Infrastructure Group Meeting
8 July 2019

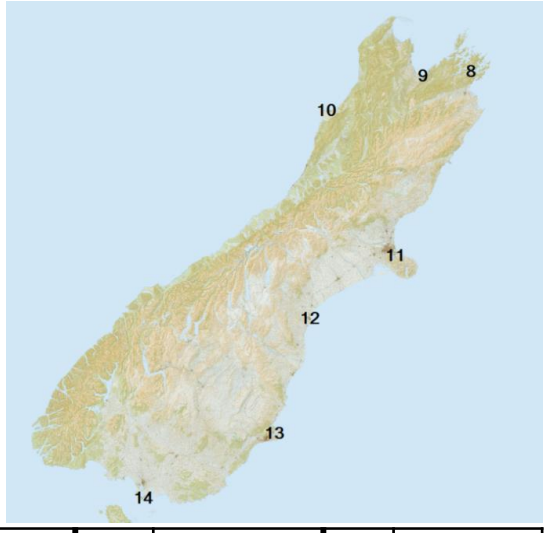
Introduction / Background





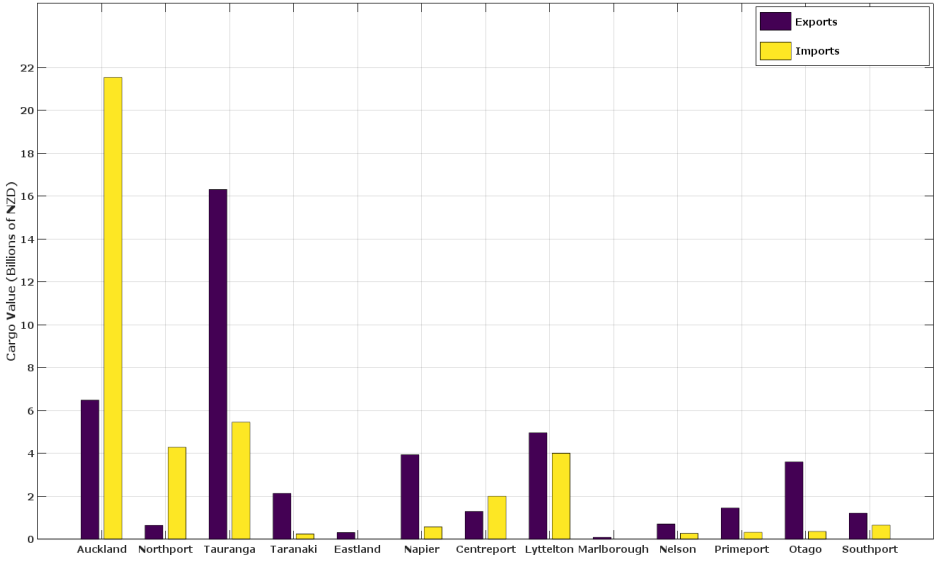
NZ Ports





ID	Port	ID	Port	ID	Port	ID	Port	ID	Port
1	Northport	4	Eastland	7	Centreport	~~10~~	~~Westport~~	13	Primeport
2	Auckland	5	Taranaki	8	Marlborough	11	Lyttelton	14	Southport
3	Tauranga	6	Napier	9	Nelson	12	Primeport		

NZ Ports



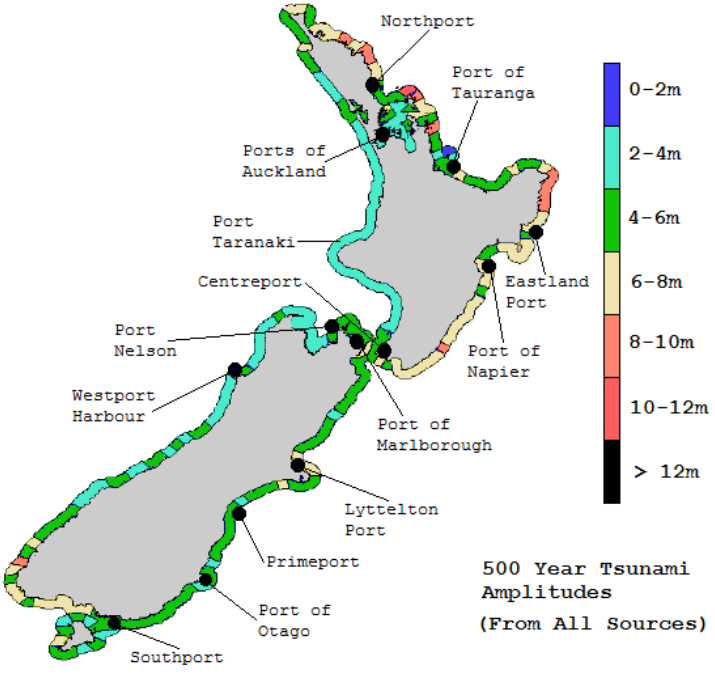
Annual import / export cargo value (billions of NZD)

Key sites include

- Auckland (imports)
- Tauranga (exports)
- Northport (Marsden Refinery)
- Centreport (Key South Island port)

But all service a range of industries and markets

Existing Information



Maximum expected tsunami amplitudes at 20 km intervals

Need more localised results for site-specific analyses

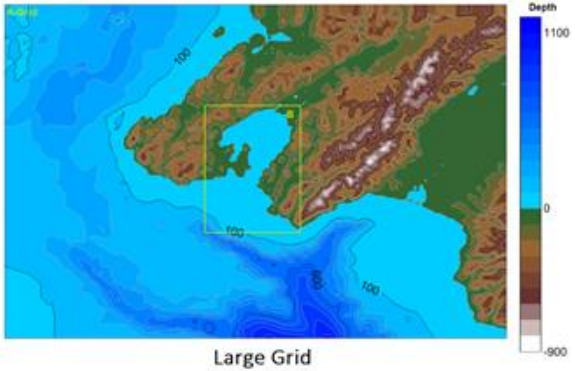
Propagation Models

- Model to predict wave heights and current speeds at location based on seismic source model

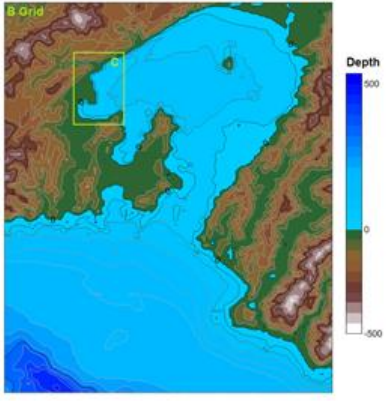
- Requires:
  - Accurate bathymetric map
  - Seismic source model

- Models run with ComMIT (Community Modelling Interface for Tsunami

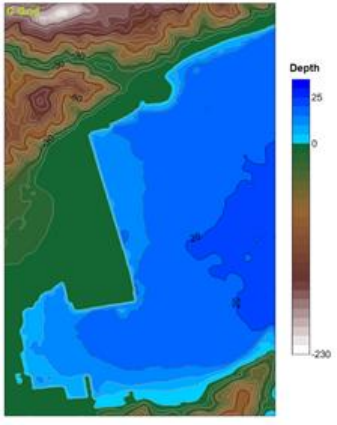
Propagation Models - Bathymetries



Large Grid
(500m)

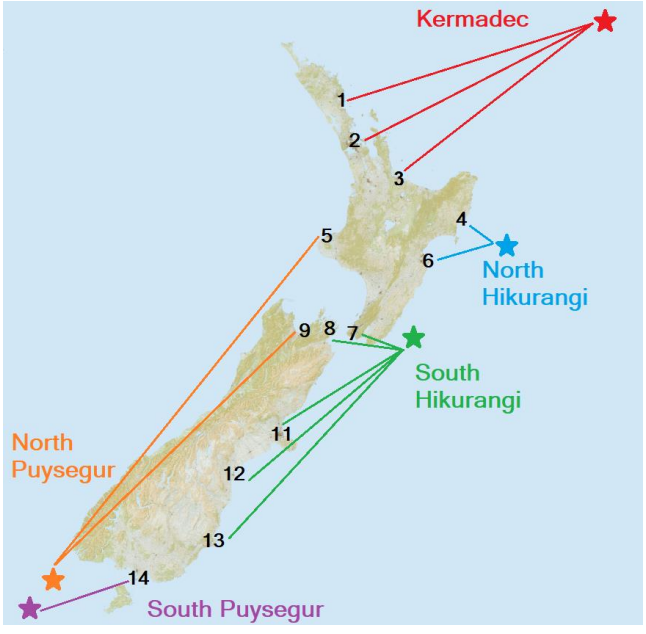


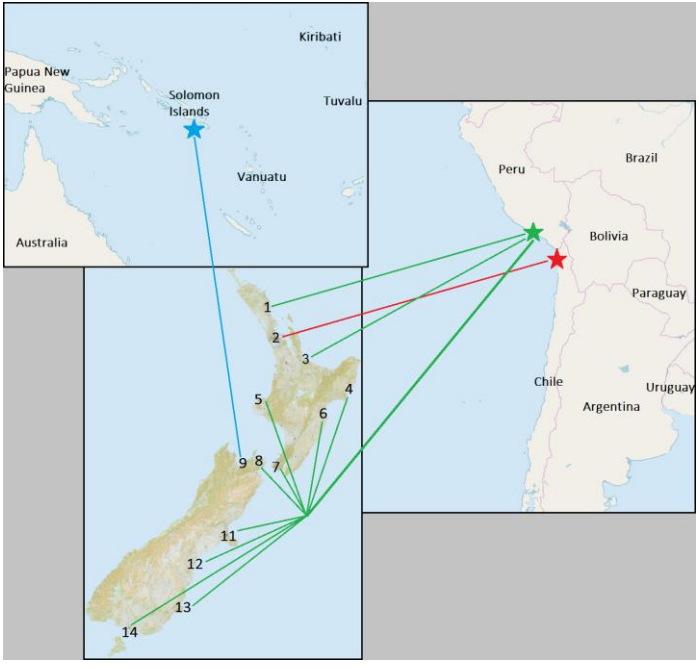
Middle Grid (150m)



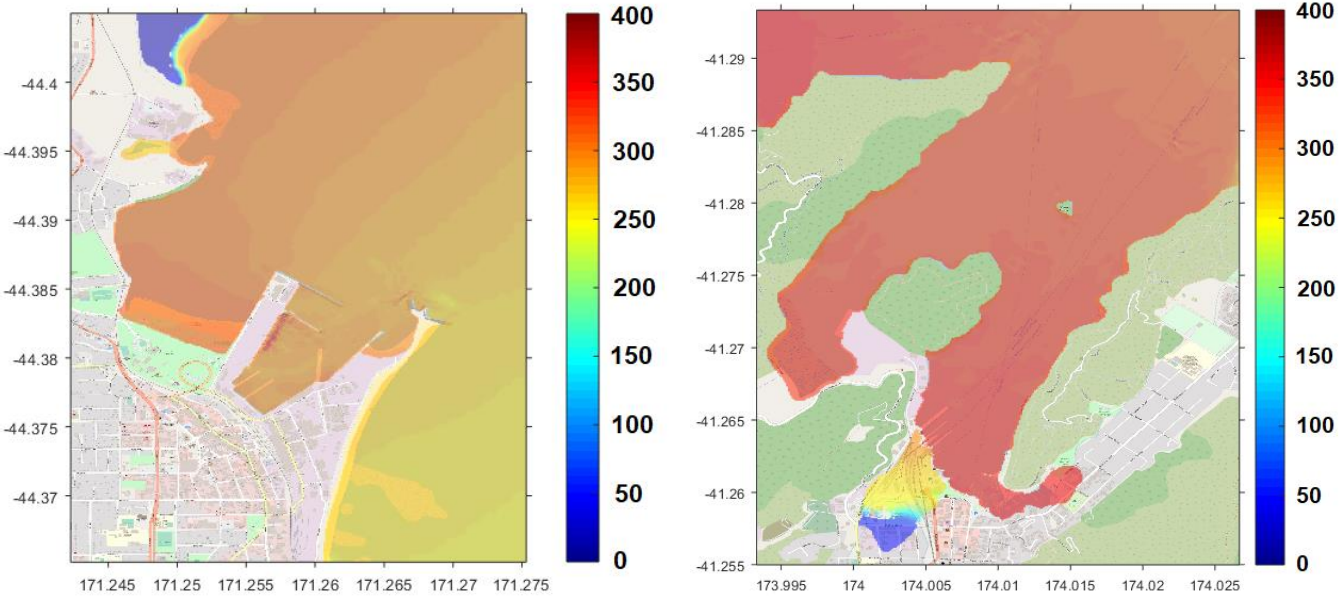
Small Grid (10m)

Original Propagation Models - Sources



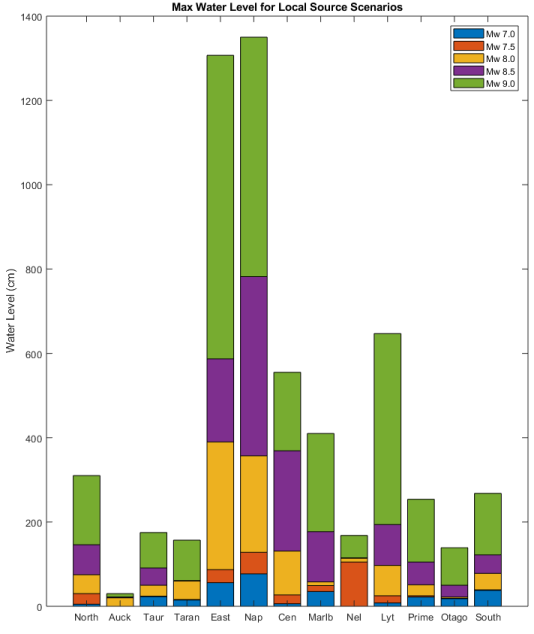


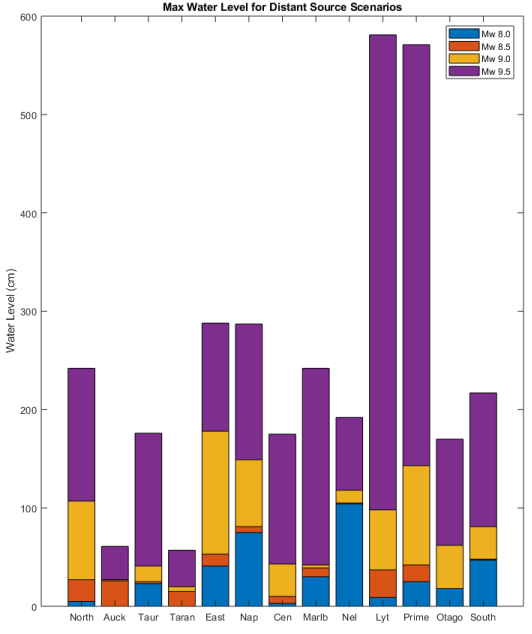
Water Level



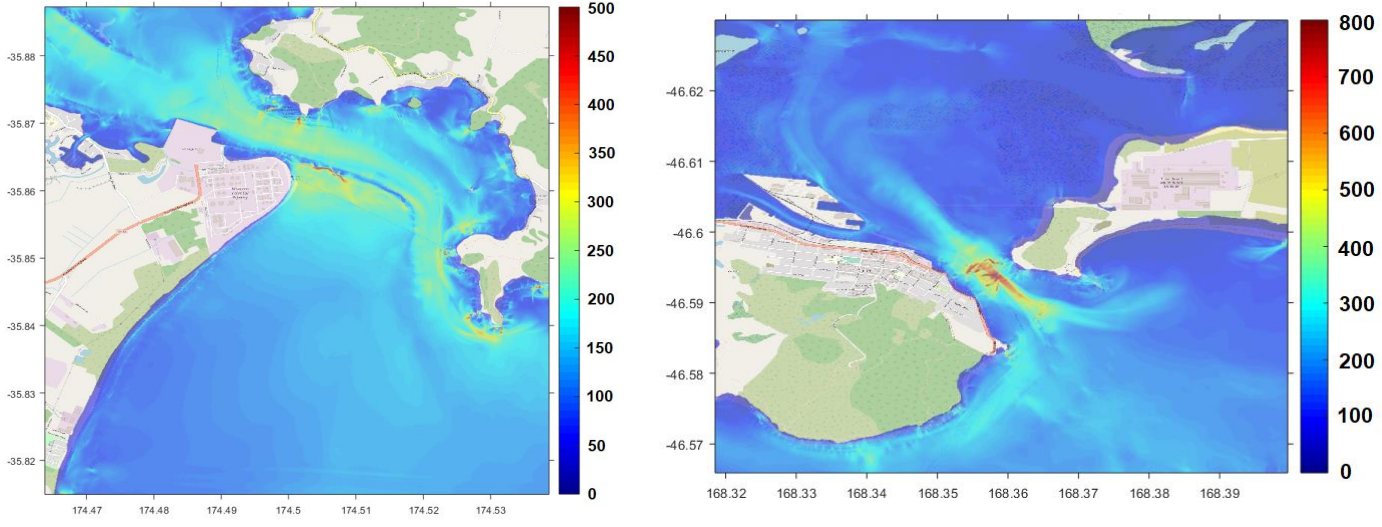
Water Levels in cm

Water Level


Max Water Level for Local Source Scenarios
Water Level (cm)
0
200
400
600
800
1000
1200
1400
Mw 7.0
Mw 7.5
Mw 8.0
Mw 8.5
Mw 9.0
North
Auck
Taur
Taran
East
Nap
Cen
Marlb
Nel
Lyt
Prime
Otago
South

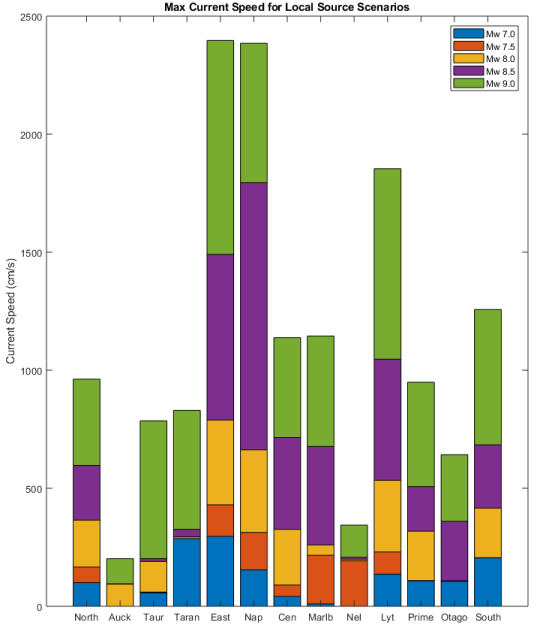

Max Water Level for Distant Source Scenarios
Water Level (cm)
0
100
200
300
400
500
600
Mw 8.0
Mw 8.5
Mw 9.0
Mw 9.5
North
Auck
Taur
Taran
East
Nap
Cen
Marlb
Nel
Lyt
Prime
Otago
South

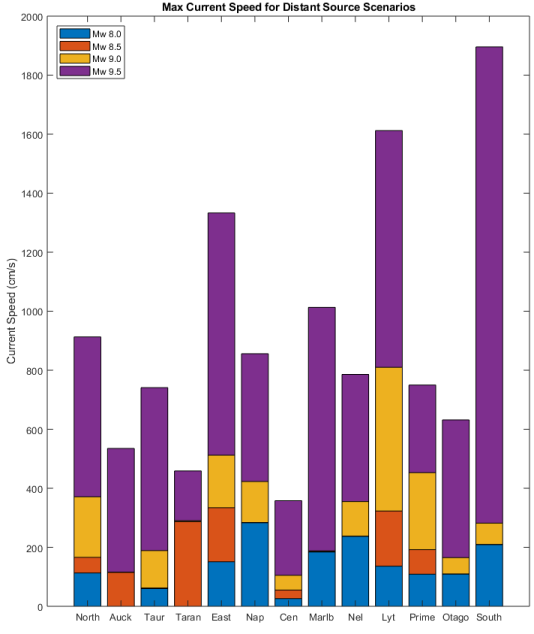
Current Speeds



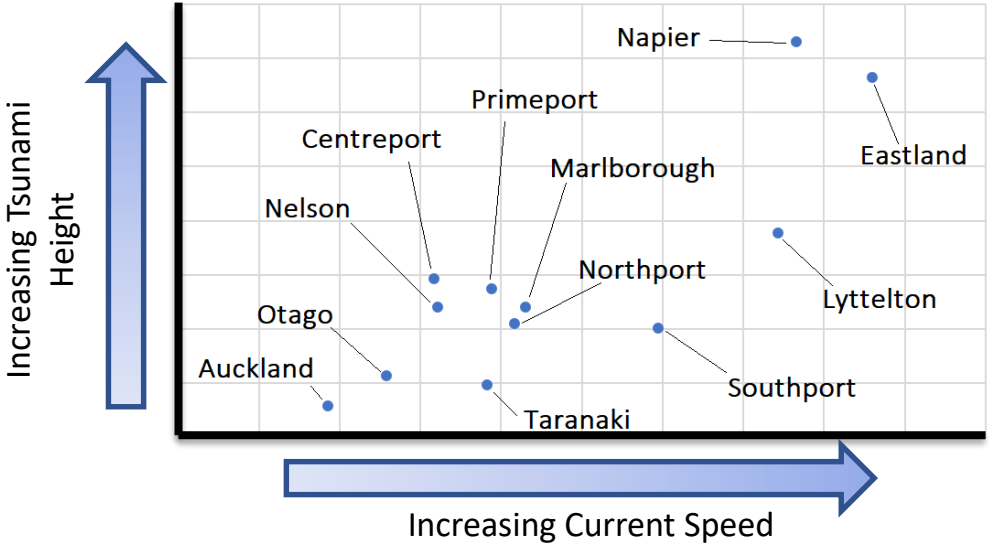
Current Speeds in cm/s

Current Speeds





Result Summary

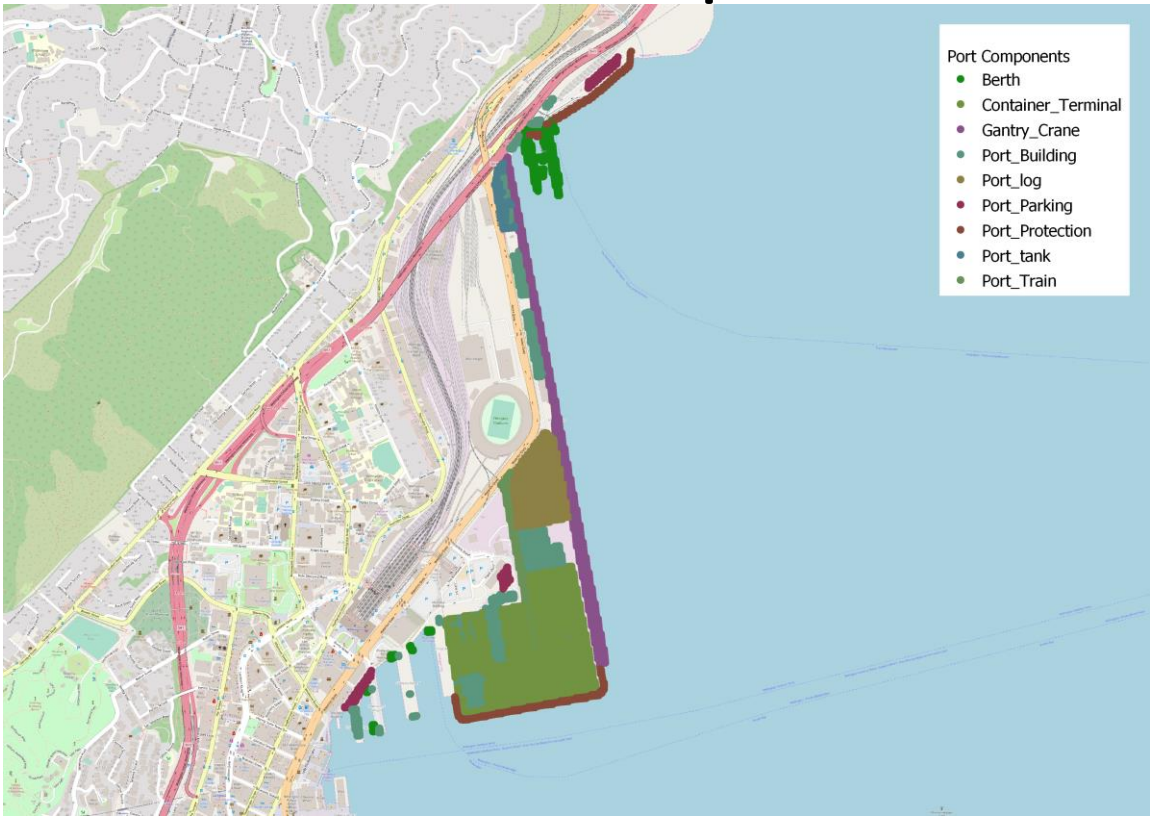


Ongoing Propagation Modeling

Expansion of Sources for All Port Sites

Local	Distant
Tonga/Kermadec	Japan
North Hikurangi	Kamchatka
South Hikurangi	Aleutians
North Puysegur	Peru
South Puysegur	Chile
	Solomon Islands

Digitization of Port Components

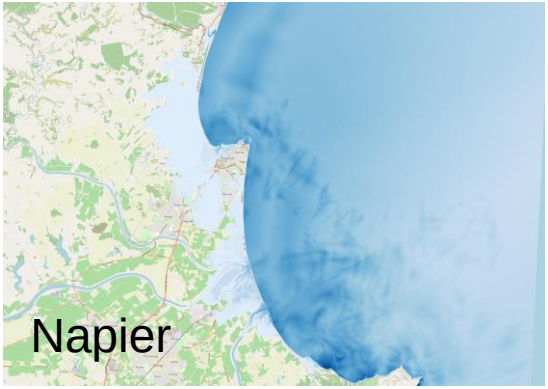


Port Component Applications

Geospatial Analyses:

- Exposure Modeling
- Impact / Vulnerability / Fragility Modeling

Hikurangi Response Plan



Hikurangi Response Plan - Ports

Exposed Area in ha

Category	Wellington	HB	Gisborne	BOP
Wharf	0.77102	0	0	0.034015
Container_Terminal	12.4155	15.5635	0	44.858
Gantry_Crane	2.8852	3.5513	0	3.5878
Port_Building	6.713	5.2792	2.1908	26.1328
Port_Parking	0.53226	0.43384	0.7665	2.8045
Port_Protection	0.27908	3.698	0.73163	0.097533
Port_Train	0.81561	1.3207	0.69994	5.5181
Port_log	4.1693	10.4271	6.434	34.168
Tank_Farm	0.43458	6.3987	0	13.2297
Marina	0	0	0.010697	0

Impact / Vulnerability Data

- Existing literature and vulnerability functions
- Tsunami field surveys
- Modelling of infrastructure response

Wave Height Damage

Table 3 (continued)

Critical infrastructure component	Flow depth < 0.5 m		Flow depth 0.5–2 m		Flow depth > 2 m		Information quality	Sources
	Damage potential	Damage type	Damage potential	Damage type	Damage potential	Damage type		
Transportation								
Trains	Negligible	Negligible	Low–High	Derailment, debris strikes, floating, impact damage	High	Derailment, debris strikes, floating, impact damage	Low	Goff et al. (2006), Horspool and Fraser (2016), Impact Forecasting LLC, (2011), Kazama and Noda (2012), Strand and Masek (2007)
Ports								
Wharves and piers	Negligible–Low	Debris strikes, scour of foundations	Medium	Sediment and debris deposition, debris strikes, scour of seabed, debris in waterways, scour of foundations	High	Aggradation/erosion of sea bed, separation of deck slabs from footings, removal of concrete blocks, subsidence, collapse, complete washout, debris in waterways	Low	Auckland Engineering Lifelines Group (2014), Bell et al. (2005), Borrero et al. (2015), Borrero and Goring (2015), Edwards et al. (2012), Evans and McGhie (2011), Francis (2006), Horspool and Fraser (2016), Kazama and Noda (2012), Lekkas et al. (2011), Lynett et al. (2014), MARCOM Working Group 53 (2009), Saatcioglu (2007), Sagara and Ishiwatari (2012), Scawthorn et al. (2006), Strand and Masek (2007), Tomita et al. (2011)

From Williams, J. et al. (2019)

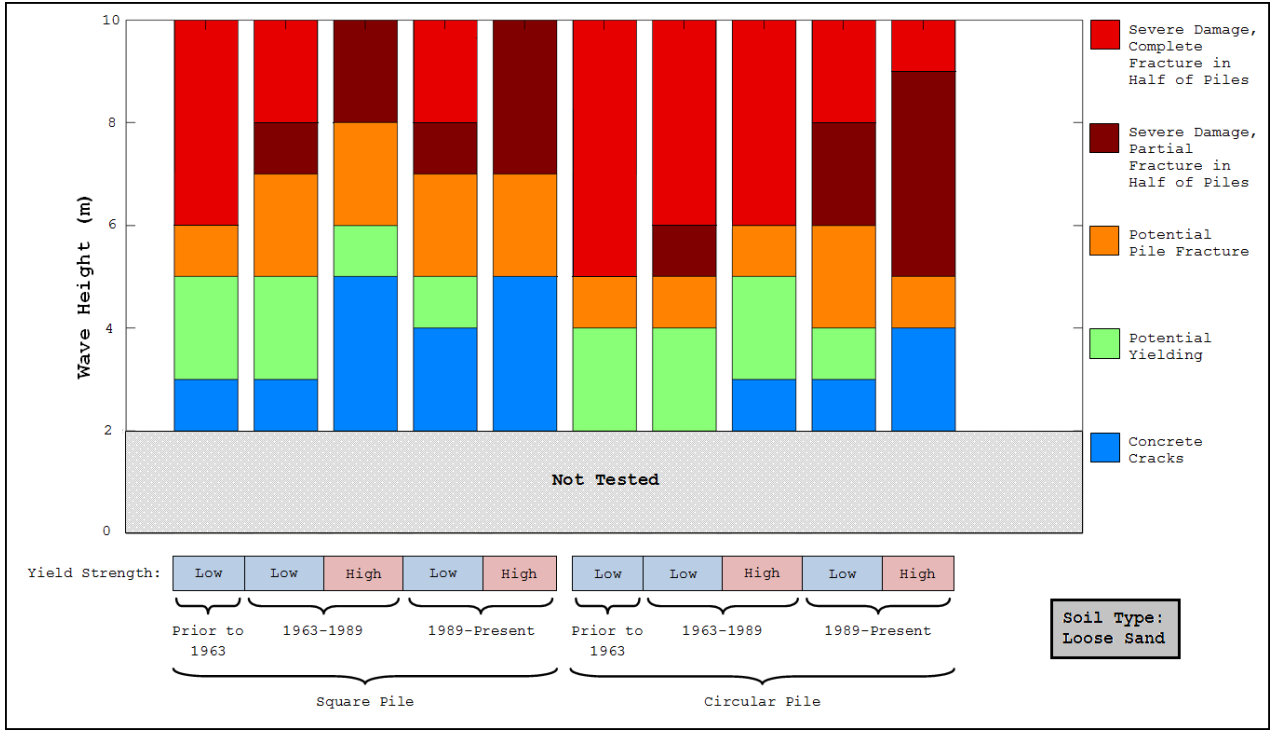
Current Speed Damage

Damage	Range of Current Speeds
No damage expected	< 150 cm/s
Minor/moderate damage possible	Between 150 and 300 cm/s
Major damage possible	Between 300 and 450 cm/s
Extreme damage possible	> 450 cm/s

From Lynnet et al. (2014)

Examination of Field Survey Reports

Ongoing Structural Modelling



Questions


ARE THERE ANY QUESTIONS? FEEL FREE TO ASK ANY—THING AT ALL.
WHY DO GHOSTS HAVE CLOTHES?
IF SOMEONE GIVES YOU A WEDGIE AT THE MOMENT YOU DIE, WILL YOU HAVE IT FOR ETERNITY?
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