Characterisation and screening of NZ stopbank networks

Phase 1

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Outline

1. Flood protection in NZ
2. Toward an understanding of stopbank failure risks
3. DRAFT NZIS outcomes
4. Conclusions and future work

Flood protection in New Zealand

Protection in extreme events

Protection – personal and societal expectations

- Expectation: protection will withstand predicted loading conditions (i.e. not fail)

- Protective properties = f(
  1. design/construction standard,
  2. current condition)

NZ society and engineering/safety standards

- Seatbelts - AS/NZS 2596:1995
- PPE – e.g. Helmets - AS/NZS 2063

↓

- Building Act 2004
- Regulations under the Building (Earthquake-prone Buildings) Amendment Act 2016
- Large dams – NZSOLD dam safety guidelines (1995, 2001, 2015)
- Bridge manual (SP/M/022)
- Geotechnical - NZGS guidelines
- **Stopbanks (?)**

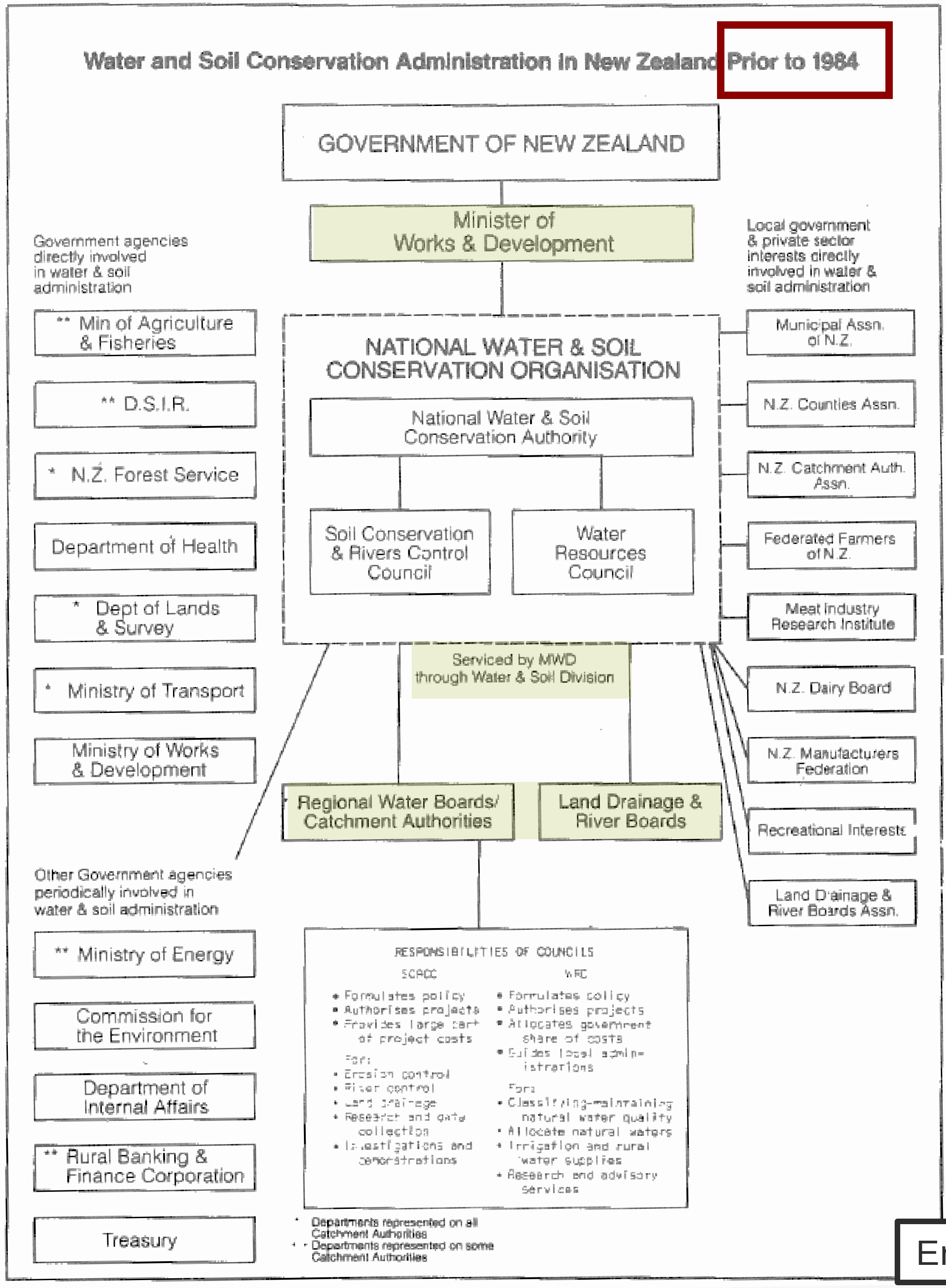
Protective properties = f(

1. **design/construction standard,**
2. **current condition)**

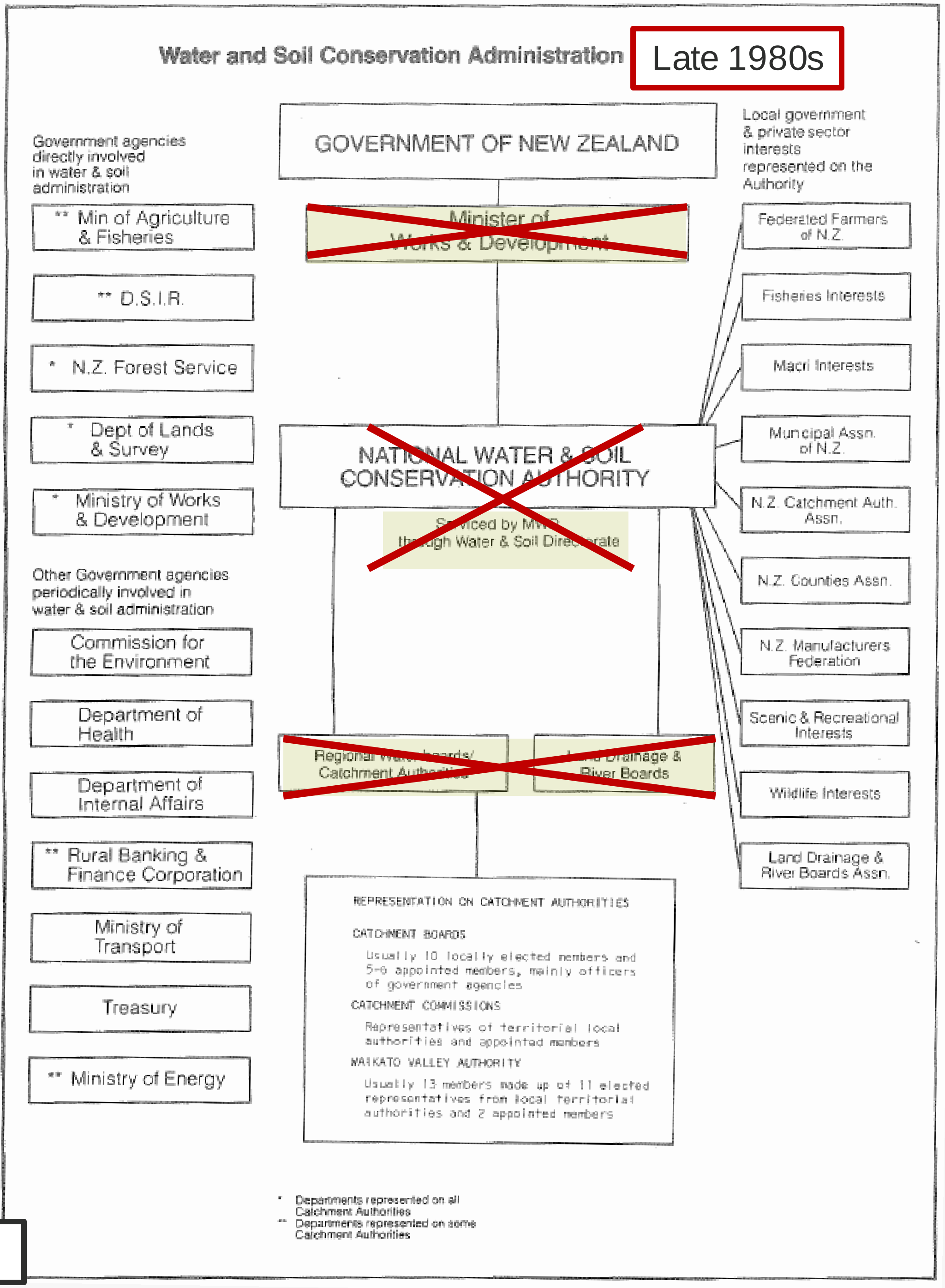
Rangitaiki River stopbank breach, April 2017. Image: Sky View photography

MfE (2008) review of flood risk management

- *The physical and engineering attributes of stopbank assets in New Zealand "**vary across the country depending on past decisions, community expectations and the risk profile of each area**"*
- *"There are no uniform standards for the design, construction and maintenance of (flood protection) assets."*
- *"Central government currently spends most of its investment in flood risk management on the <u>response</u> and <u>recovery</u> phases."*
- ***"… local risks are a local responsibility…"***



Prior to 1984



Late 1980s

Ericksen, 1986

~1990 - today

DPMC

MCDEM

MBIE

Metservice

DIA

EQC

GOVERNMENT OF NEW ZEALAND

Minister for the Environment

Resource Management Act 1991 (RMA)

Regional councils and unitary authorities

Territorial authorities
(other city and district councils)

Council river managers' forum

"local risks are a local responsibility"

Understanding stopbank failure risks

Failure under loading conditions

Since de-centralisation… (30 years)

- *Loss of subsidies (previously up to 1:7 local:government)*
- *Population increase of ~43% - 3.3M (1990) to 4.7M (2016)*
- *Loss of institutional knowledge (MWD)*
- *Fragmentation of expertise/resources/knowledge*
- *Climate change: increasing flood loads*

Resulting risk profile?

Risk Matrix		Consequence				
		Trivial	Minor	Moderate	Major	Severe
Likelihood	Almost certain	L	H	H	E	E
	Likely	L	M	H	H	E
	Possible	L	M	M	H	E
	Unlikely	L	M	M	H	H
	Rare	L	L	M	M	H

E - Extreme risk, requiring immediate action.
H - High risk issue requiring additional research or some immediate action
M - Moderate risk issue that are likely to benefit from adaptation measures
L - Low risk issues that can be dealt with as and when they happen or they are considered acceptable should they happen

Source: https://ischool2013.wikispaces.com/file/view/risk-table.jpg/472497818/risk-table.jpg

Probability of stopbank failure		Consequence
Loading	**Resistance (aka protective properties)**	
Flood (AEP)	Design standards	Population at Risk (PAR) Potential Loss of Life (PLL)
Seismic (many mechanisms)	Asset condition	Policy and planning Preparedness
Other		Areas of value (environment /cultural)

≠

"There are presently no uniform standards for the design, construction and maintenance of (flood protection) assets"

Probability of stopbank failure		Consequence
Loading	**Resistance**	
Seismic (many mechanisms) ✓	Design standards	Population at Risk (PAR) Potential Loss of Life (PLL) ✓
Flood (AEP) ✓	Asset condition	Policy and planning Preparedness ✓
Other? ✓	If location known	Areas of value (environment /cultural) ✓

Project objectives

- *Produce a single, standardised, reliable and spatially-referenced inventory in the form of the* ***NZ Inventory of Stopbanks (NZIS)***
- *Characterise the New Zealand stopbank network (e.g. height, type, geometry, location, design and service levels)*
- *Inform a first stage assessment of the hazard exposure of the stopbank network across New Zealand*

Project impacts

- Develop an improved understanding of New Zealand's stopbank infrastructure.
- Enable broad-based performance and consequence assessments across the portfolio.
- Help asset managers, owners and regulators manage risk, prioritise improvement works, and improve inspections following earthquake and flood events.

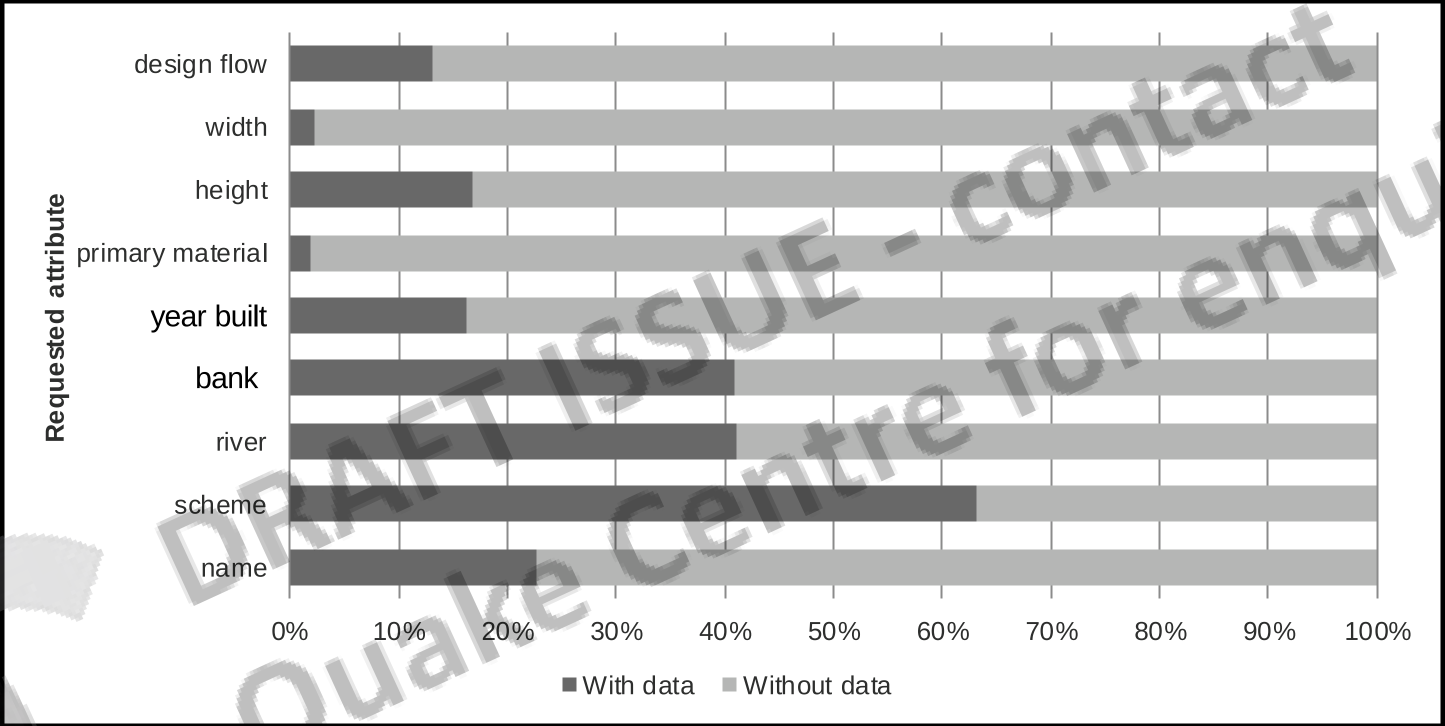
DRAFT Outcomes

Analysis of the NZIS

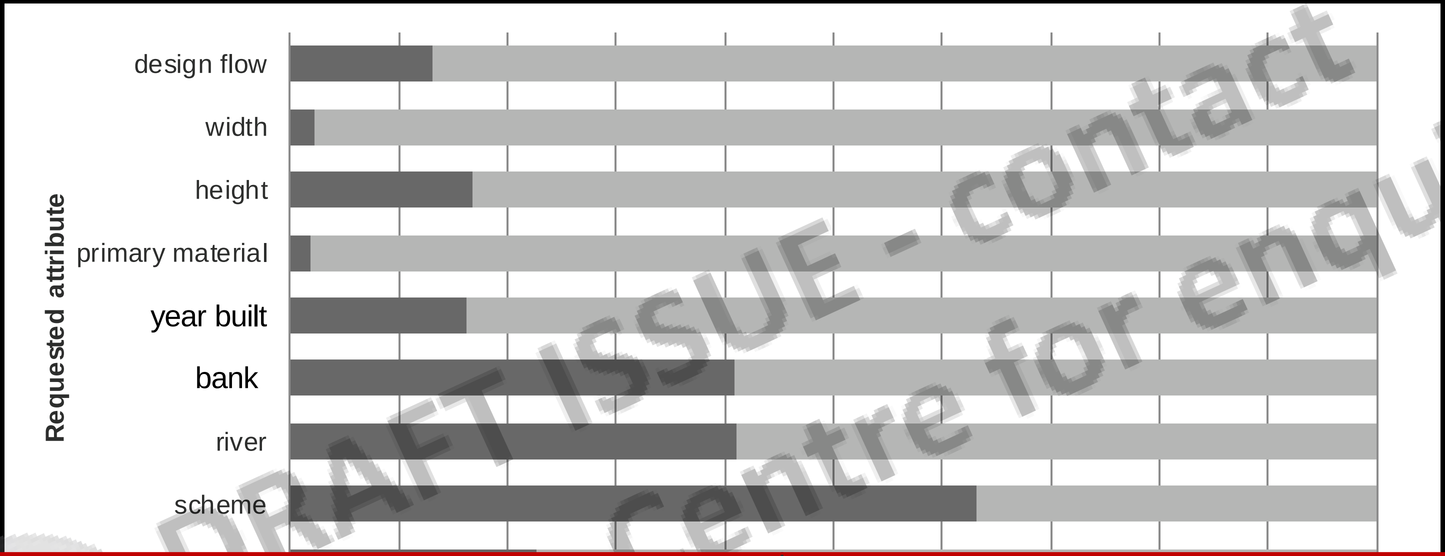
The NZIS

- Made possible by council river managers' forum (13 of 16)
- >4,800 linear km stopbank network
- Data varies by region (significantly!)
- Design and condition attributes generally unknown
- Impacts of non-council (undocumented) stopbanks?

The NZIS (4832 linear km): data completeness



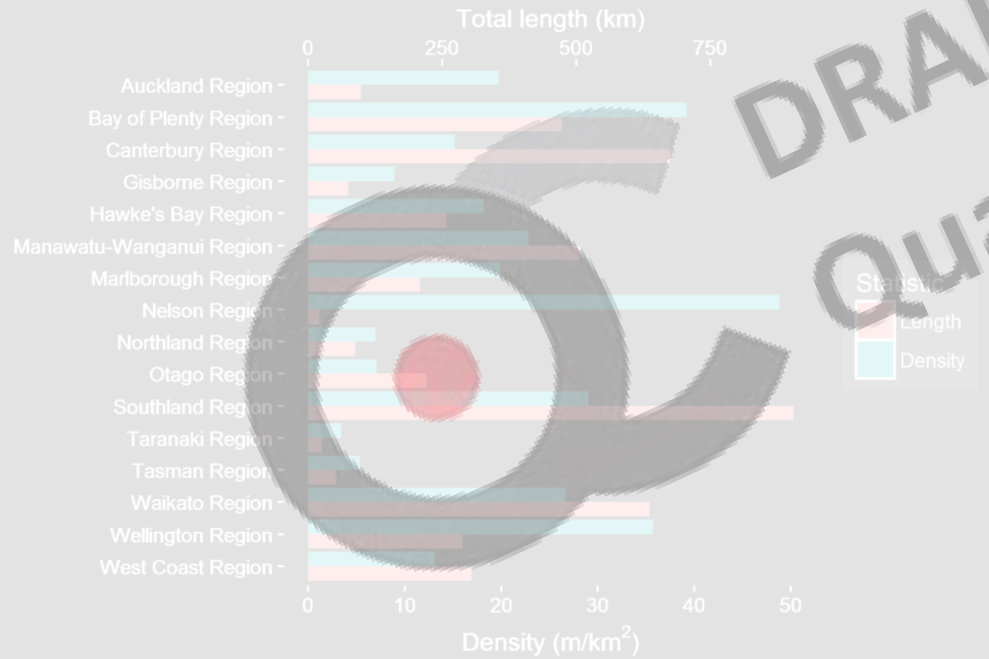
The NZIS (4832 linear km): data completeness

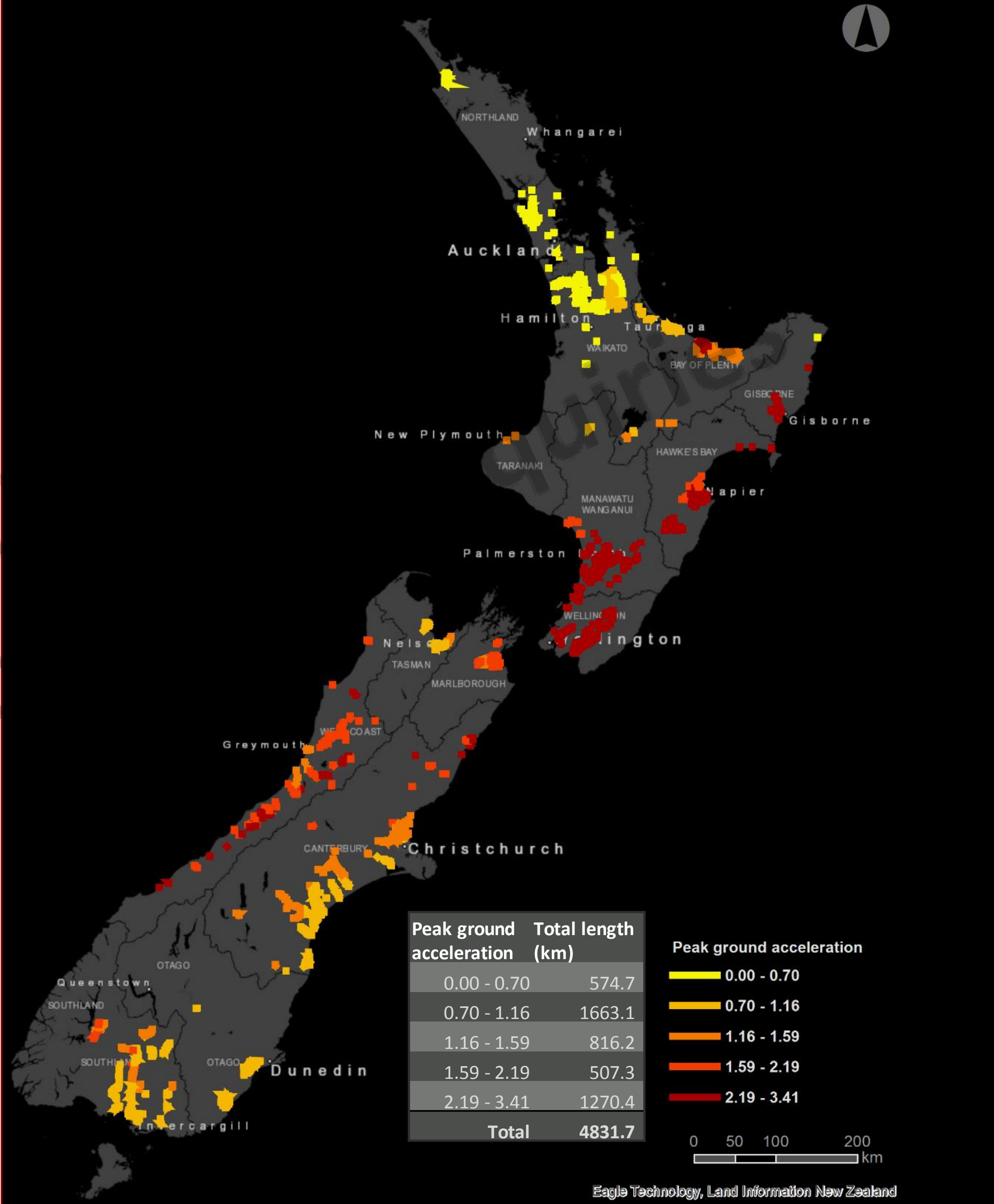


Probability of failure		Consequence
Loading	**Resistance**	
Seismic ✓ (many mechanisms)	Design standards	Population at Risk (PAR) Potential Loss of Life (PLL) ✓
Flood ✓ (AEP)	Asset condition	Policy and planning Preparedness ✓
Other? ✓		Areas of value (environment /cultural) ✓

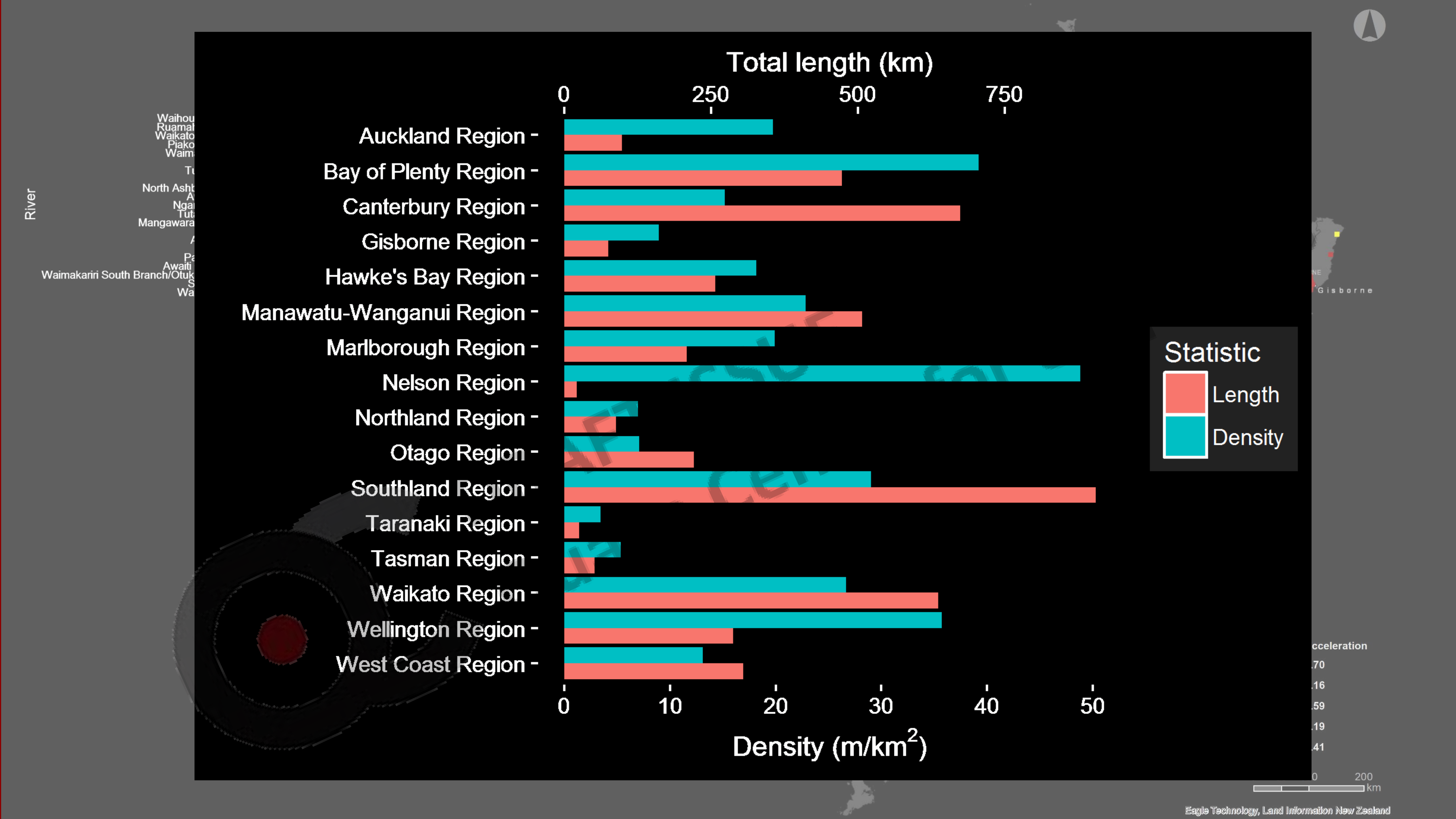
The NZIS (4832 linear km)

Symbology based on nationwide PGA model for 1/100 year event (QuakeCoRE)



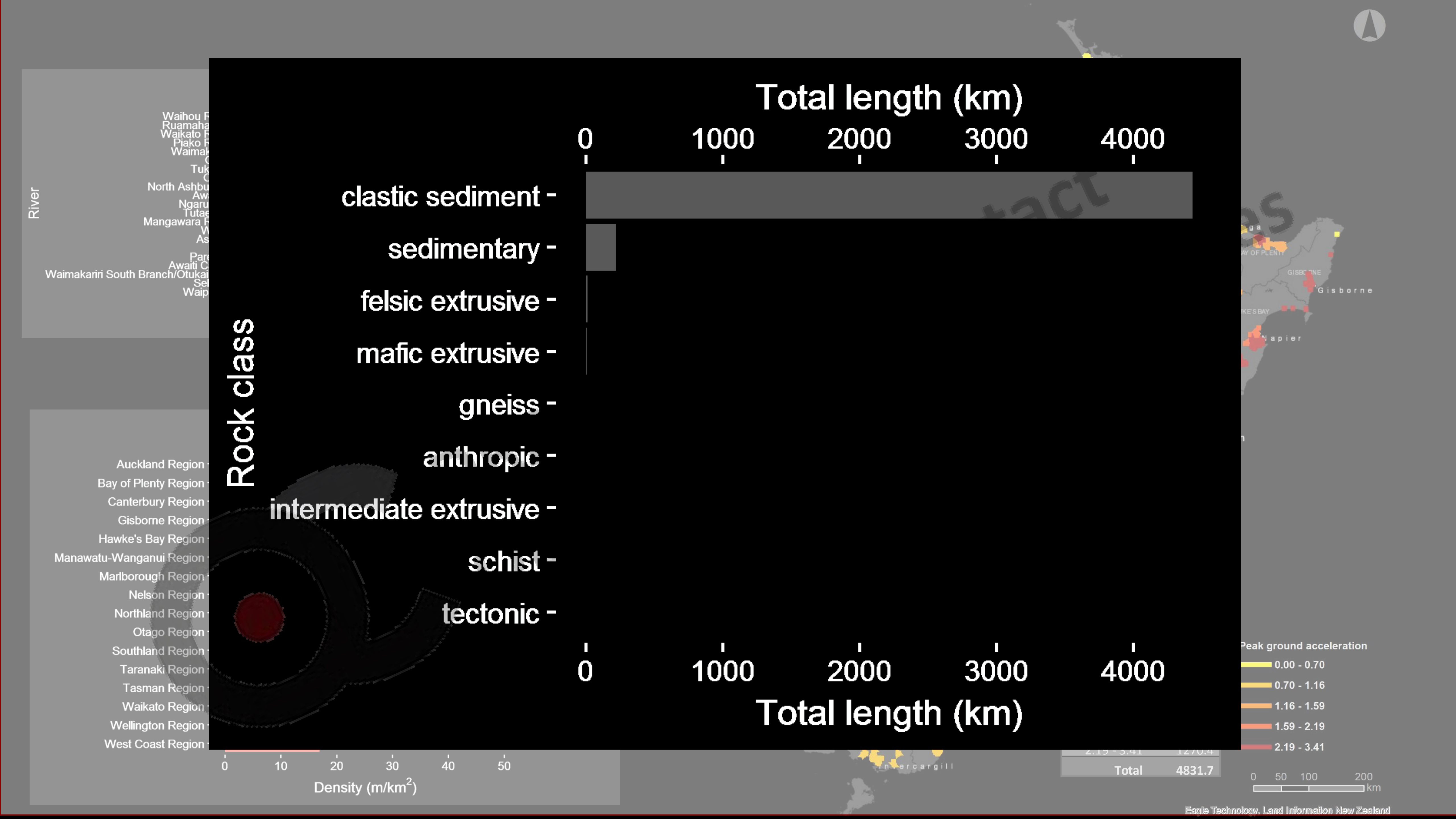


Peak ground acceleration	Total length (km)
0.00 - 0.70	574.7
0.70 - 1.16	1663.1
1.16 - 1.59	816.2
1.59 - 2.19	507.3
2.19 - 3.41	1270.4
Total	4831.7



Total length (km)
0
250
500
750
Auckland Region
Bay of Plenty Region
Canterbury Region
Gisborne Region
Hawke's Bay Region
Manawatu-Wanganui Region
Marlborough Region
Nelson Region
Northland Region
Otago Region
Southland Region
Taranaki Region
Tasman Region
Waikato Region
Wellington Region
West Coast Region
0
10
20
30
40
50
Density (m/km^2)
Statistic
Length
Density
River
Waimakariri South Branch/Otuk
Gisborne
200
km
Eagle Technology, Land Information New Zealand


Total length (km)
0
25
50
75
100
River
Waihou River
Ruamahanga
Waikato River
Piako River
Waimakariri
Orari
Tukituki
Opihi
North Ashburton
Awanui
Ngaruroro
Tutaekuri
Mangawara River
Waihi
Ashley
Hutt
Pareora
Awaiti Canal
Waimakariri South Branch/Otukaikino
Selwyn
Waipawa
Total length (km)
Auckland Reg
Bay of Plenty Reg
Canterbury Reg
Gisborne Reg
Hawke's Bay Reg
Manawatu-Wanganui Reg
Marlborough Reg
Nelson Reg
Northland Reg
Otago Reg
Southland Reg
Taranaki Reg
Tasman Reg
Waikato Reg
Wellington Reg
West Coast Reg
0
10
20
30
40
50
Density (m/km^2)
Gisborne
Napier
Peak ground acceleration
0.00 - 0.70
0.70 - 1.16
1.16 - 1.59
1.59 - 2.19
2.19 - 3.41
Total
4831.7
0
50
100
200
km
Eagle Technology, Land Information New Zealand


Total length (km)
0
1000
2000
3000
4000
Rock class
clastic sediment
sedimentary
felsic extrusive
mafic extrusive
gneiss
anthropic
intermediate extrusive
schist
tectonic
Total length (km)
River
Waimakariri South Branch/Otukai
Auckland Region
Bay of Plenty Region
Canterbury Region
Gisborne Region
Hawke's Bay Region
Manawatu-Wanganui Region
Marlborough Region
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Northland Region
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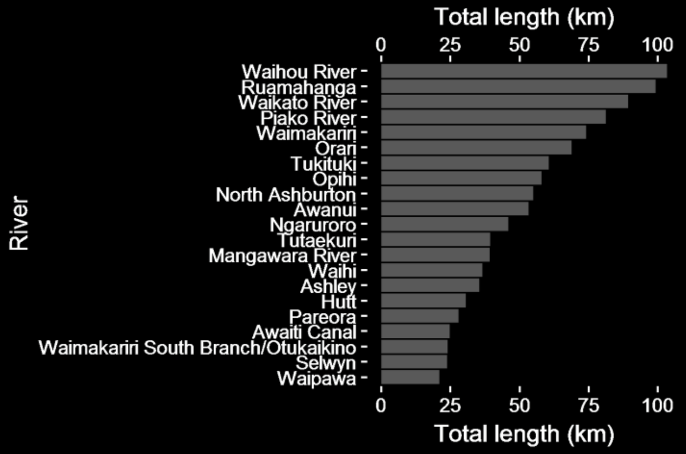

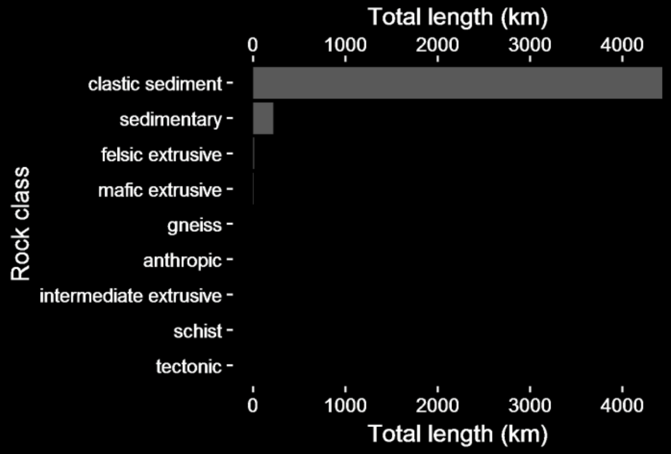

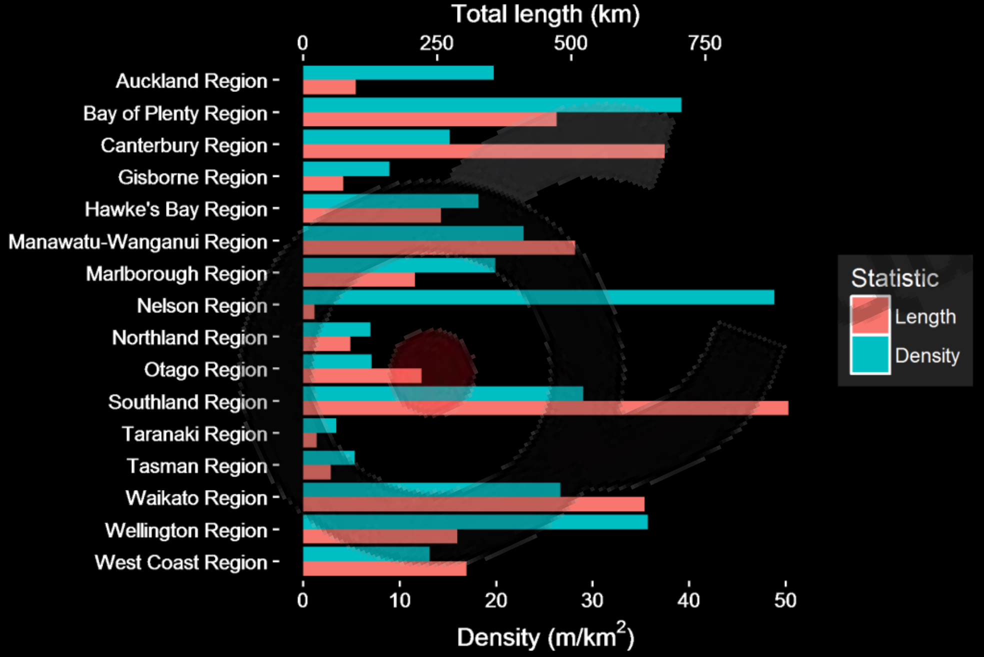

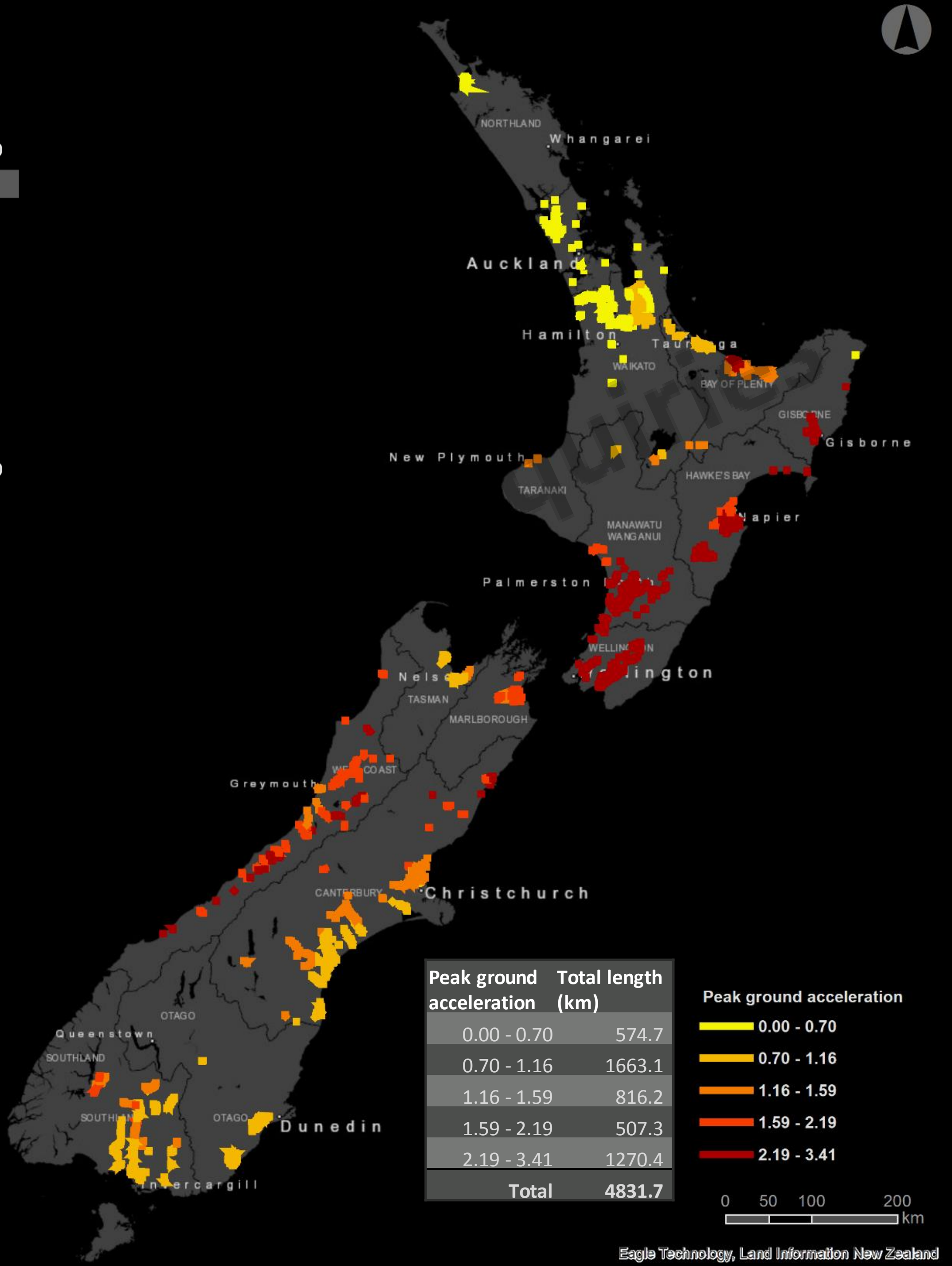

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Ongoing

- QA/verification
- Spatial hazard analysis (huge potential)
  - *Geotechnical/coastal hazards*
  - *Cascading hazards*

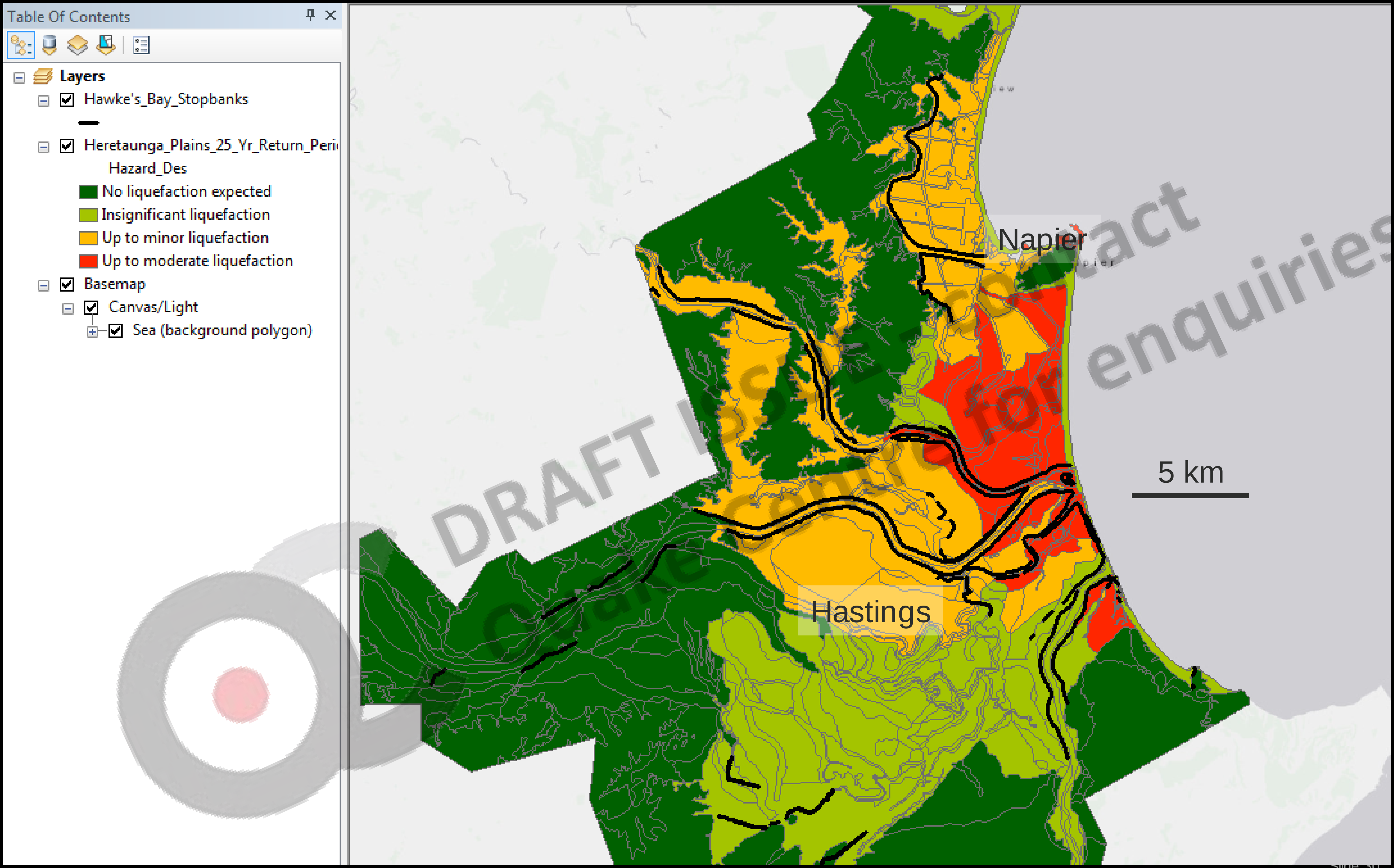


Table Of Contents
Layers
Hawke's_Bay_Stopbanks
Heretaunga_Plains_25_Yr_Return_Peri
Hazard_Des
No liquefaction expected
Insignificant liquefaction
Up to minor liquefaction
Up to moderate liquefaction
Basemap
Canvas/Light
Sea (background polygon)
Napier
5 km
Hastings
DRAFT ISSUE

Conclusions and future work

Future of the NZIS

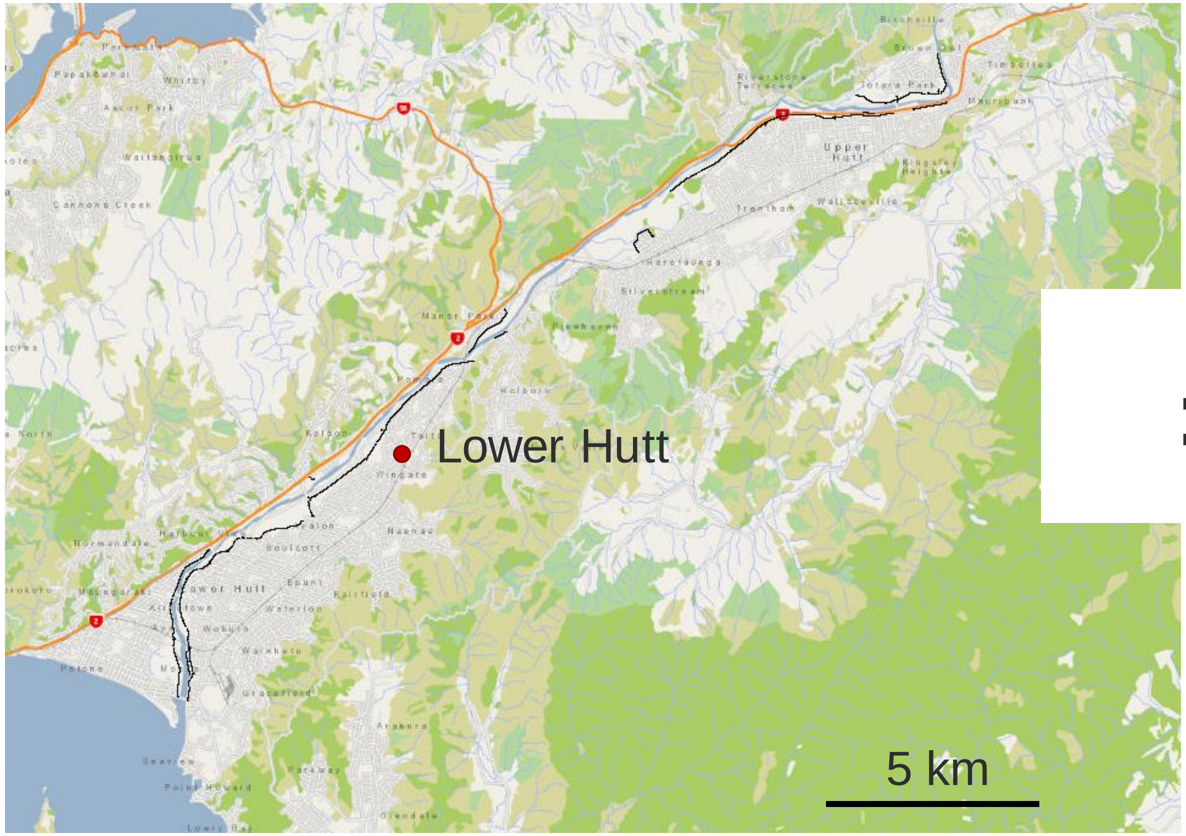
Protection - personal and societal

Expectation: our chosen method of protection will withstand predicted loading conditions to protect us (i.e. not fail)

- Probability of failure governed by
  1. loading conditions ✓
  2. protective properties (resistance)

- Protective properties = f(
  1. design/construction standard,
  2. current condition)

Spatial data informs consequence



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Probability of stopbank failure			Consequence	
Loading		**Resistance**		
Seismic (many mechanisms)	✓	Design standards	Population at Risk (PAR) Potential Loss of Life (PLL)	✓
Flood (AEP)	✓	Asset condition	Policy and planning Preparedness	✓
Other?	✓	If location known	Areas of value (environment /cultural)	✓

The NZIS

- 30 years after de-centralization of flood protection management, project aims to provide national perspective
- First standardized national dataset of stopbanks
- Made possible by council river managers' forum
- >4,800 linear km of stopbanks
- Few engineering properties known

Next steps

- Nationwide hazard screening outputs (QCoRE/RNC collab)
- Marcus Rodger MSc thesis (expected June? 2018)
- Reporting back to council river managers' forum
- Pilot: assessing impacts of undocumented stopbanks (Tasman case-study, 2018 ME project)

Questions?