IT'S OUR FAULT
NŌ MĀTOU TE HAPA

Increasing Our Resilience
TE WHAKAPIKI MANAHAU

WELLINGTON EARTHQUAKE RESEARCH PROGRAMME

Wellington Collab meeting
30 November 2023
Nicola Litchfield (IOF Science Leader)

Toka Tū Ake EQC

CD CIVIL DEFENCE WELLINGTON REGION EMERGENCY MANAGEMENT GROUP

Absolutely Positively Wellington City Council
Me Heke Ki Pōneke

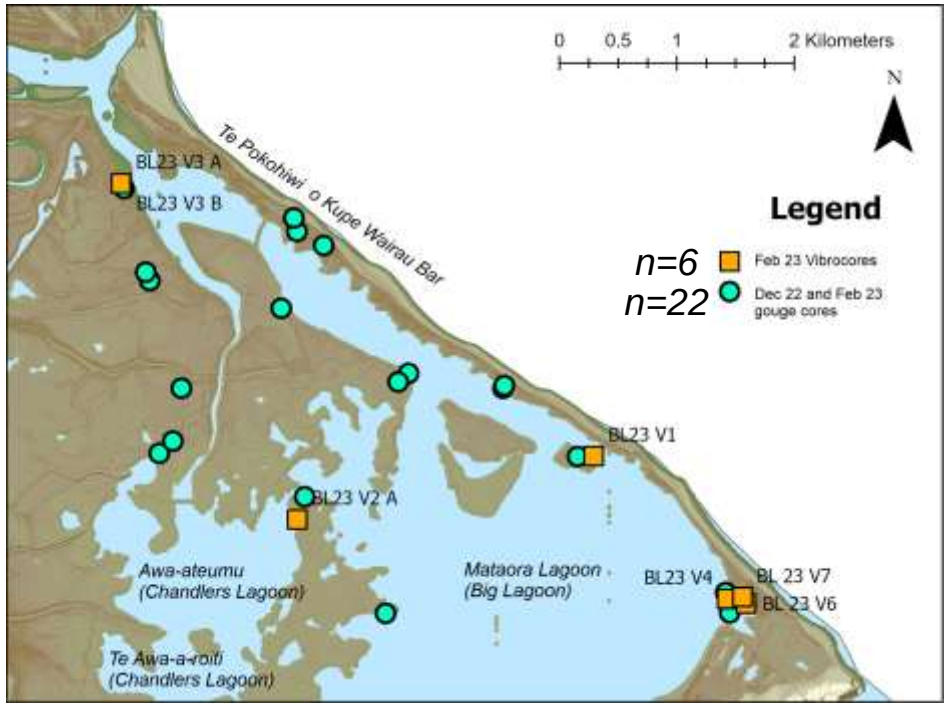
GNS SCIENCE TE PŪ AO

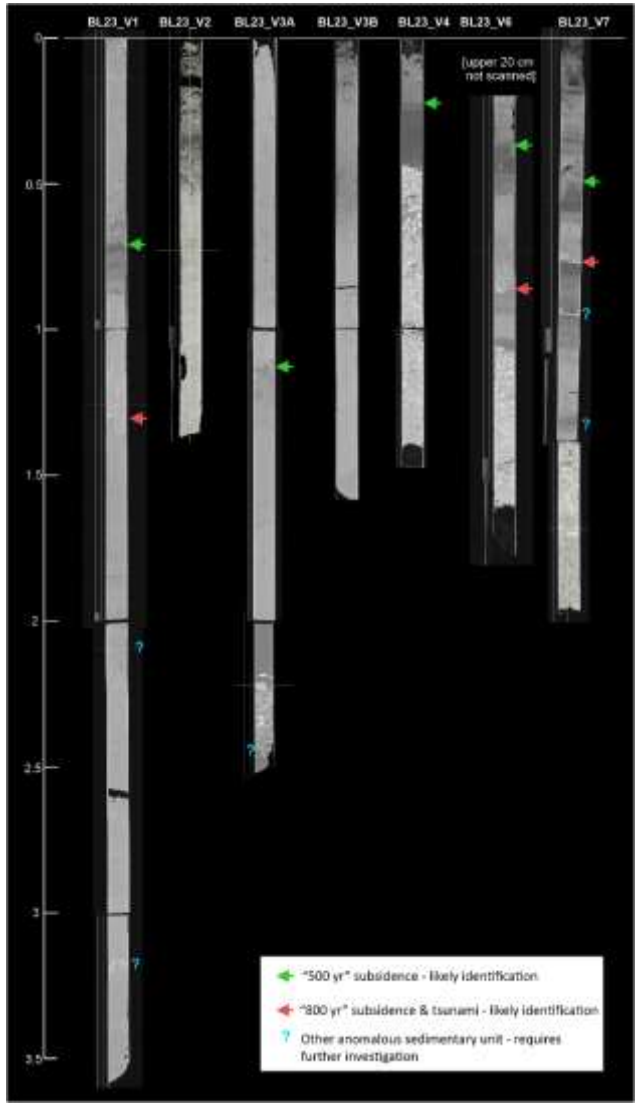
- **2022-23 science projects**
  - **Hikurangi Subduction Zone**
  - **Active Fault Paleoseismology**
  - **Tsunami Hazard and Vulnerability**
  - Ground Deformation
  - Planning and Policy
- **2023-24 science projects**
  - **Hikurangi Subduction Zone**
  - **Tsunami Hazard and Vulnerability (x 2)**
  - **Engineering/Risk**
  - **Planning and Policy**

2022-2023 projects – Selected Results

22-23: Hikurangi Subduction Zone

Clark et al. (2023)

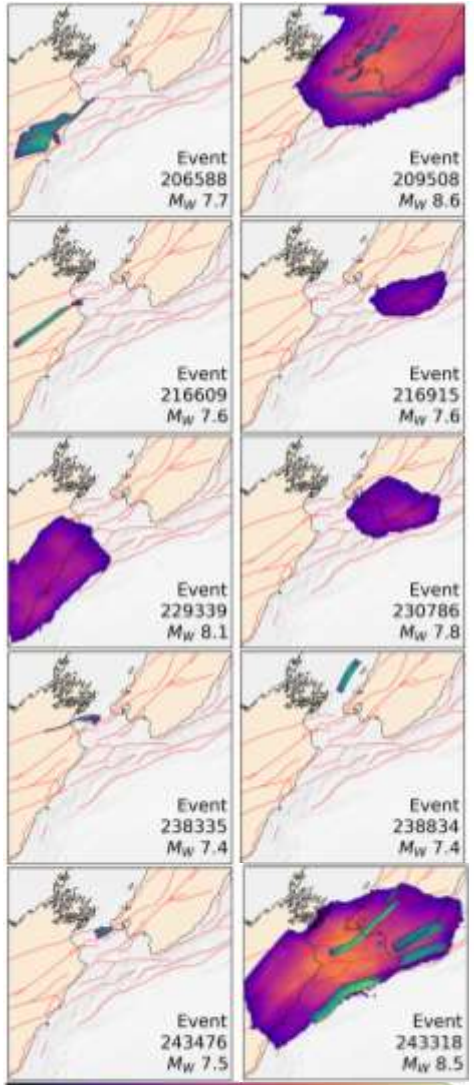


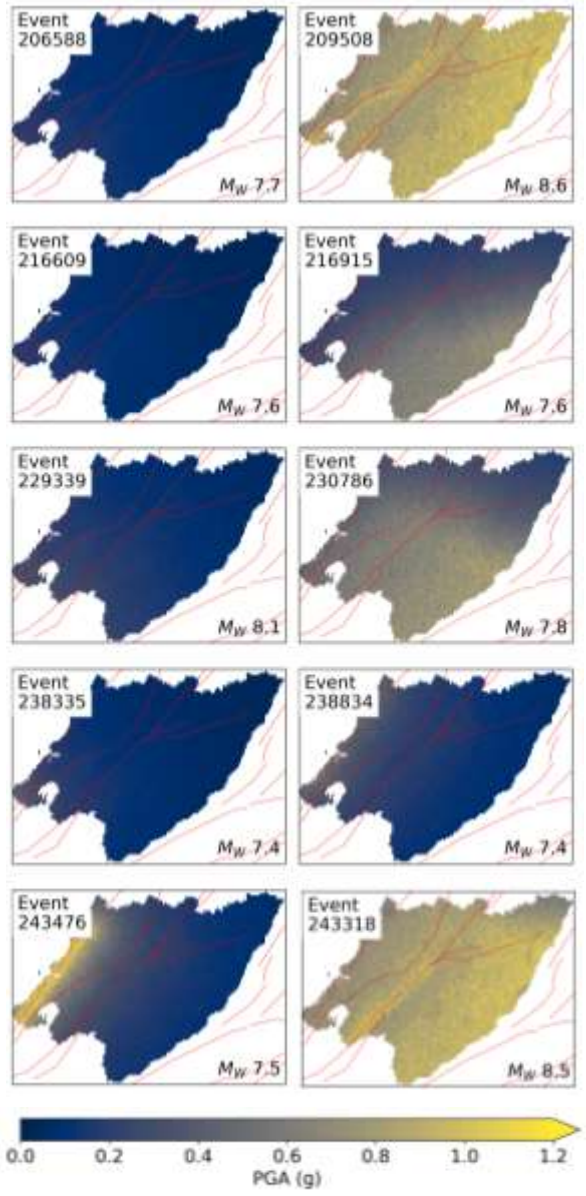


- ~500 years BP earthquake widely observed
- 880-800 years BP earthquake in most cores, revised to 858-811 years BP
- Prior to ~1000 years BP the lagoon was deeper and more connected to the ocean
- Older anomalous deposits may indicate earthquakes or tsunami

22-23: Hikurangi Subduction Zone

Howell et al. (2023)

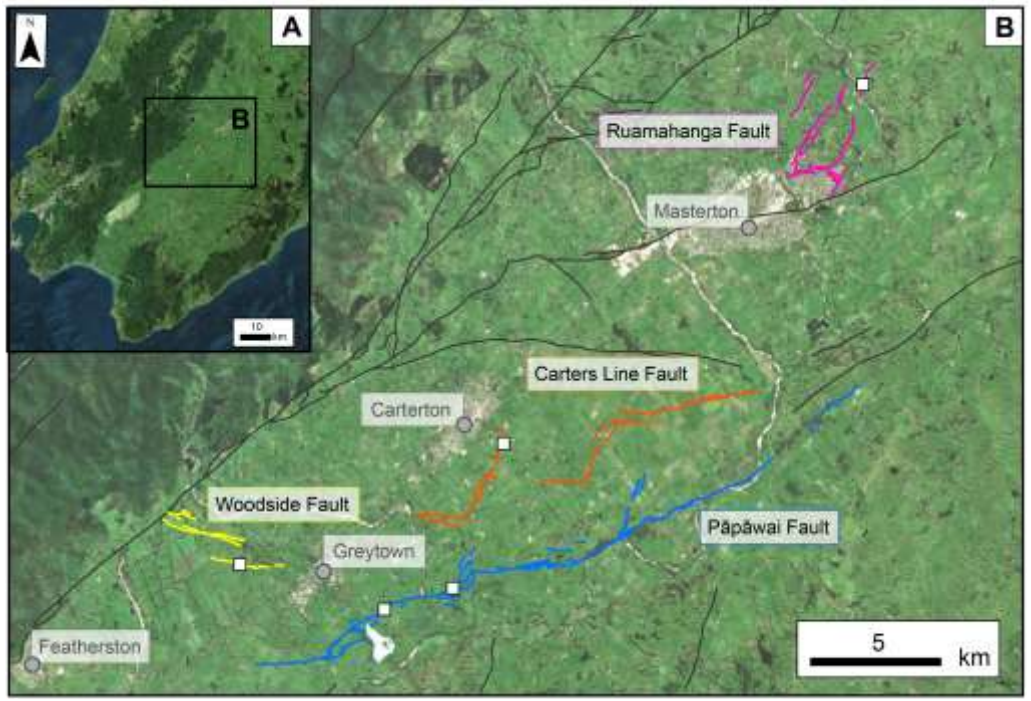




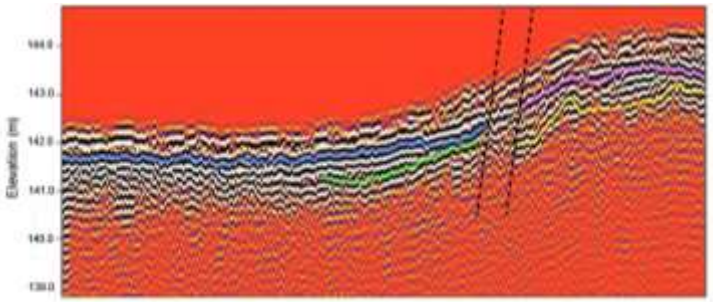
- Used an earthquake simulator (RSQSIM) to model ground shaking from 20 multi-fault earthquakes, including, for the first time, combined fault-Hikurangi Subduction Zone earthquakes
- For combined ruptures, the crustal faults dominate ground shaking in the area immediately adjacent to their surface trace
- Further away, ground motions are dominated by the subduction component
- Can apply even when the subduction component is much greater than the crustal faults
- The range of shaking caused by these scenarios may make it challenging to determine past earthquake sources from ground shaking proxies (e.g., landslides)

22-23: Active Fault Paleoseismology

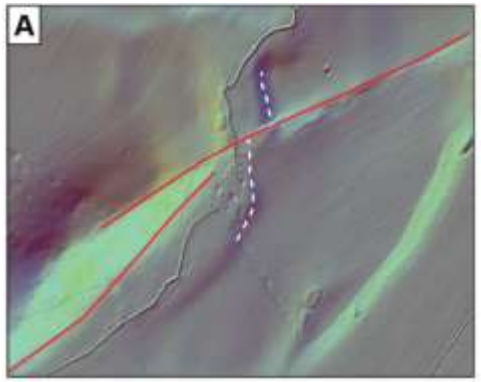
Coffey & Litchfield (2023)



- GPR profiles showed offsets on 3 faults (Ruamahanga, Pāpāwai, Woodside)
- Preliminary slip rates have been calculated and used to check recurrence intervals (RI's)
- RI's consistent with previous estimates except for the Woodside Fault, which changed from RI Class III (3500-5000 years) to I (<2000 years)



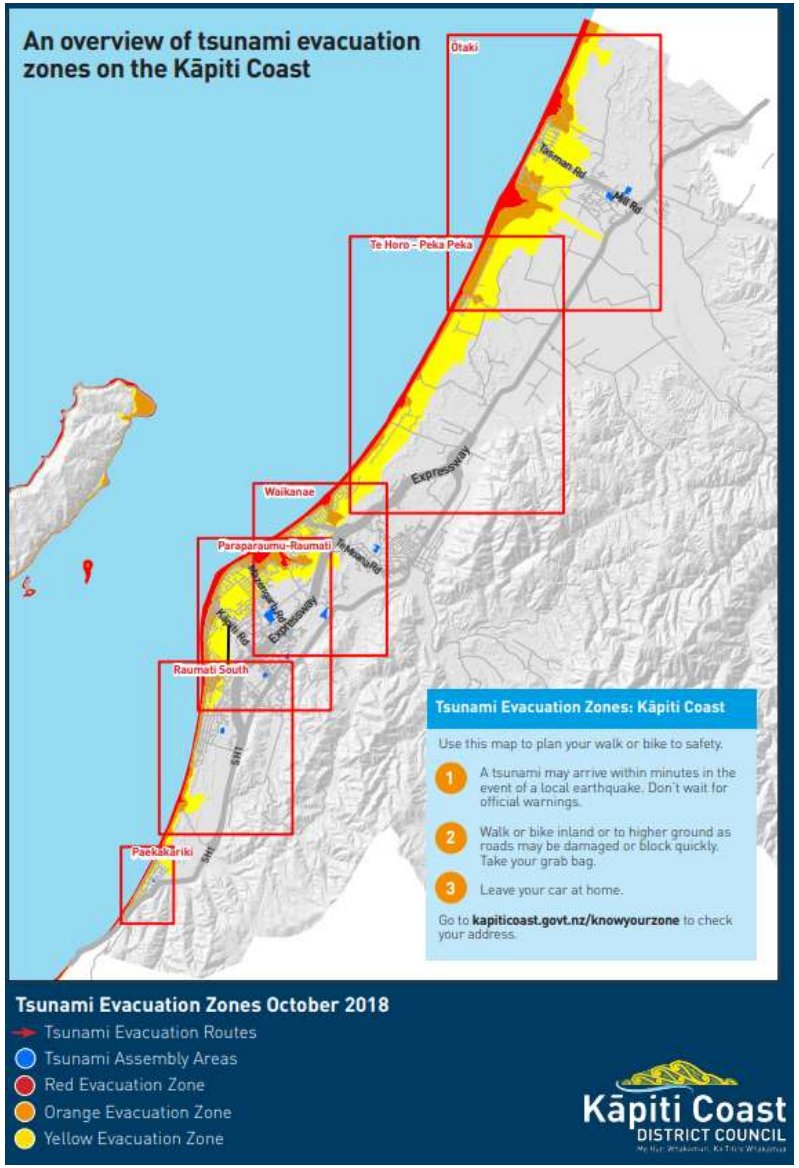
GPR

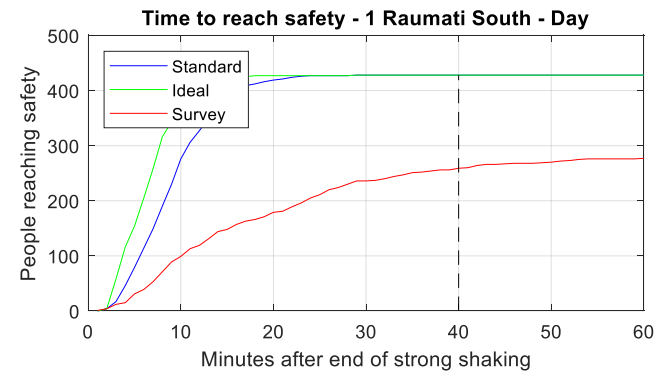


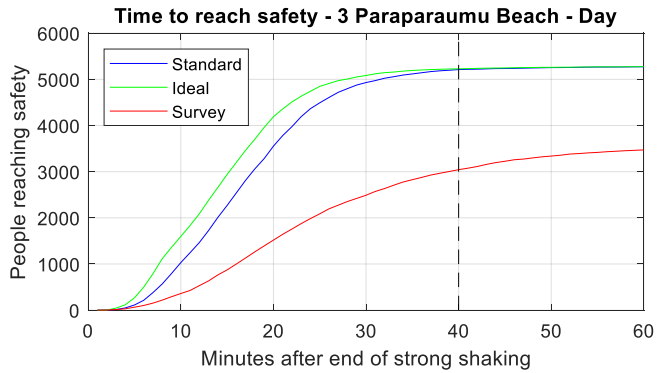
Fault	Net SR (mm/yr)	Length (km)	RI (years)
Ruamahanga	>0.2	6	<4600
Carters Line	>0.1	6*	<16,000
Pāpāwai	0.7–0.9	26	2200–2900
Woodside	0.7–1.5	5	200–520

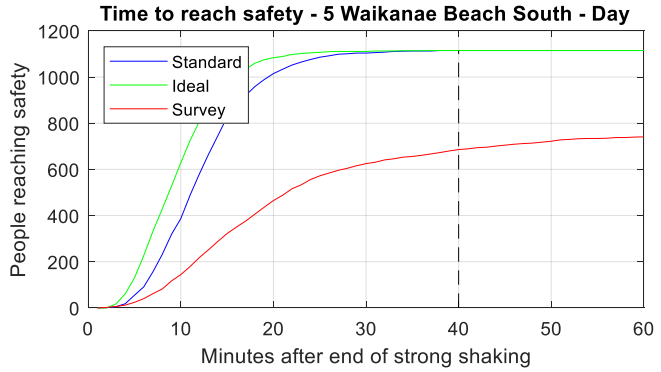
22-23: Tsunami Hazard and Vulnerability

Power et al. (2023)





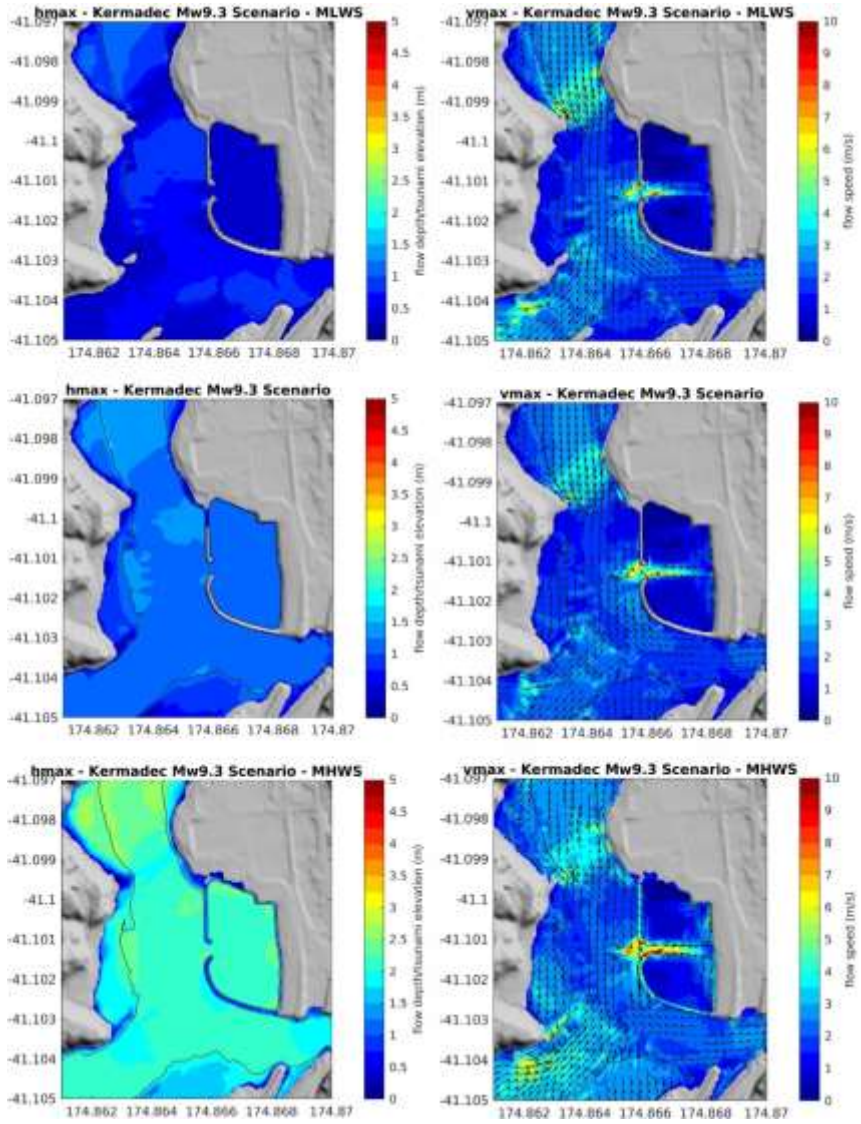




- Agent-based modelling (individual pedestrians) for crustal and Hikurangi Subduction Zone earthquakes
- Modelled 3 scenarios for different ‘start-delay’ times and day versus night
- Population densities generally low enough that most people are evacuated within 40 minutes
- But surveys elsewhere show that 30% do not identify ‘long or strong get gone’ as a reason to evacuate, which is a big risk

22-23: Tsunami Hazard and Vulnerability

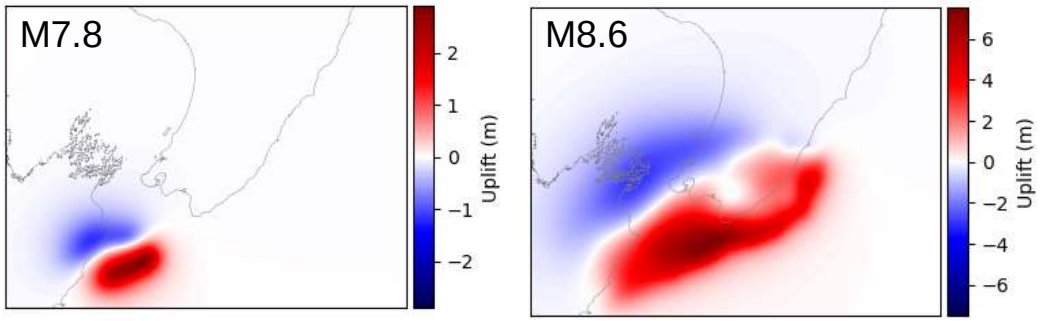
Roger and Wang (2023)



- Modelled tsunami impacts on **Mana Marina** from local faults and subduction zone - validated through comparison with 6 past events (2016 Kaikōura and 5 global)
- A M_w 9.3 Kermadec earthquake could cause a 2-3 m high tsunami and current speeds ≤10m/s
- Even for small tsunami, strong currents of >1.5 m/s could be of concern
- Strong unidirectionality flow directions

2023-2024 projects – Plans and Progress to Date

23-24: Hikurangi Subduction Zone Hazard



Dislocation models of VLMs for Hikurangi subduction earthquakes

Paleoearthquake records

- Detailed analysis of Wairau Lagoons cores – cores have been scanned, split and preliminary sedimentary analyses undertaken
- Exploratory coring at south Wgtn/Wairarapa coast lakes – applying for permits
- Led by *Kate Clark*

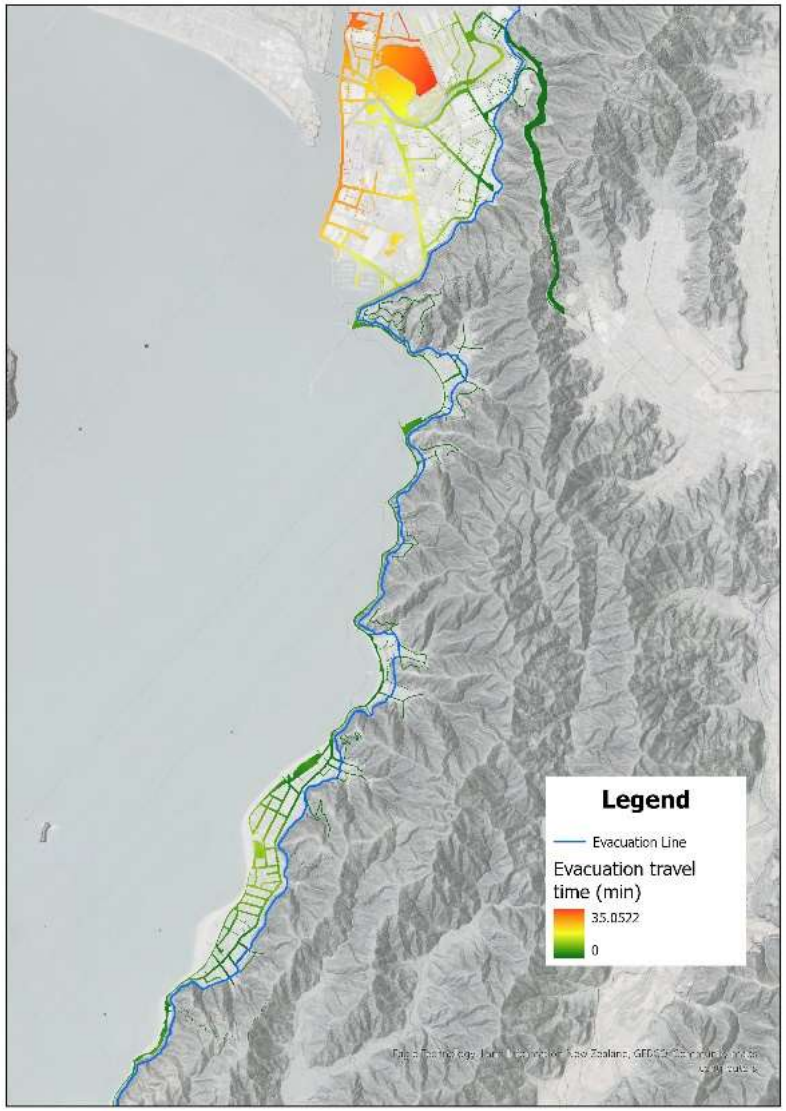
Probabilistic modelling of coseismic vertical land movements (VLMs) for the Wellington Region

- Model VLMs for all earthquake scenarios in the 2022 NSHM
- Establish a methodology to estimate probabilities and coseismic coastal deformation
- Modelling essentially complete and looking into how best to communicate the results
- Led by *Andy Howell, Jaime Delano*

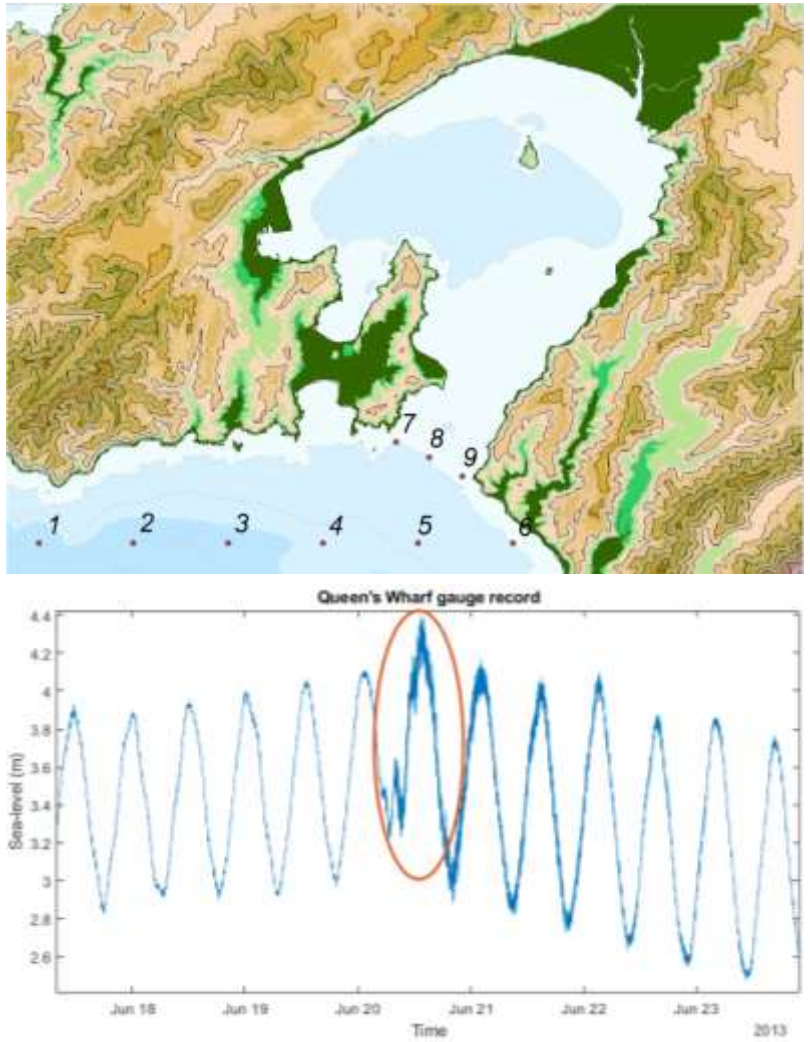
23-24: Tsunami Hazard and Vulnerability – Project 1

Agent-based evacuation modelling from Seaview to Eastbourne

- Combine agent-based evacuation modelling with highly-detailed tsunami evacuation time estimates (which are highly variable)
- Elevation and land-cover data collected and night-time population data processed
- Led by *William Power*



23-24: Tsunami Hazard and Vulnerability – Project 2



Tide and storm surge data from NIWA

Combined impact of tsunami, storm surge, and tides in Wellington Harbour

- Evaluate impacts under the co-occurrence of storm surge, tsunami and high tides
- Tide, surge and combined signals data obtained from NIWA
- Modelling currently under way
- Led by *Jean Roger*

23-24: Engineering and Risk

Natural hazards impacts on key Māori facilities

- **Takapūwāhia Marae** (Porirua) with Ngāti Toa Rangatira
- Exposure analysis to provide qualitative impact to the marae and community from multiple hazards (earthquake shaking, tsunami, liquefaction and landslide)
- Two hui held with the Marae Planning Committee
- Study area agreed and finalized, hazard datasets compiled, currently obtaining exposure data (key sites, population)
- Led by *Shen-Lin Lin*

23-24: Planning and Policy

Science to Practice Workshop

- 1 day workshop held at GNS Science on 8 November 2023
- Aimed at planners and attended by 18 staff from 5 Councils and 4 from MfE
- Covered: tsunami, landslides, sea level rise, liquefaction, Hikurangi Subduction Zone and active faults, as well as an overview of risk-based planning, new legislation and mitigation
- Led by *Edith Bretherton* with assistance from *James Beban* (Urban Edge Planning)

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