DAMSAFETY intelligence

2016 Kaikoura Earthquake (NZ) Effects & Phenomena

The presenter is grateful for the support and input of Trevor Matushka (Engineering Geology), Kelvin Berryman (GNS Science) and Peter Lilley (Trustpower)

Presenter: Dan Forster dan.forster@damsafety.co.nz

Date: 8 March 2017, CEATI Hydropower Conference

Introduction

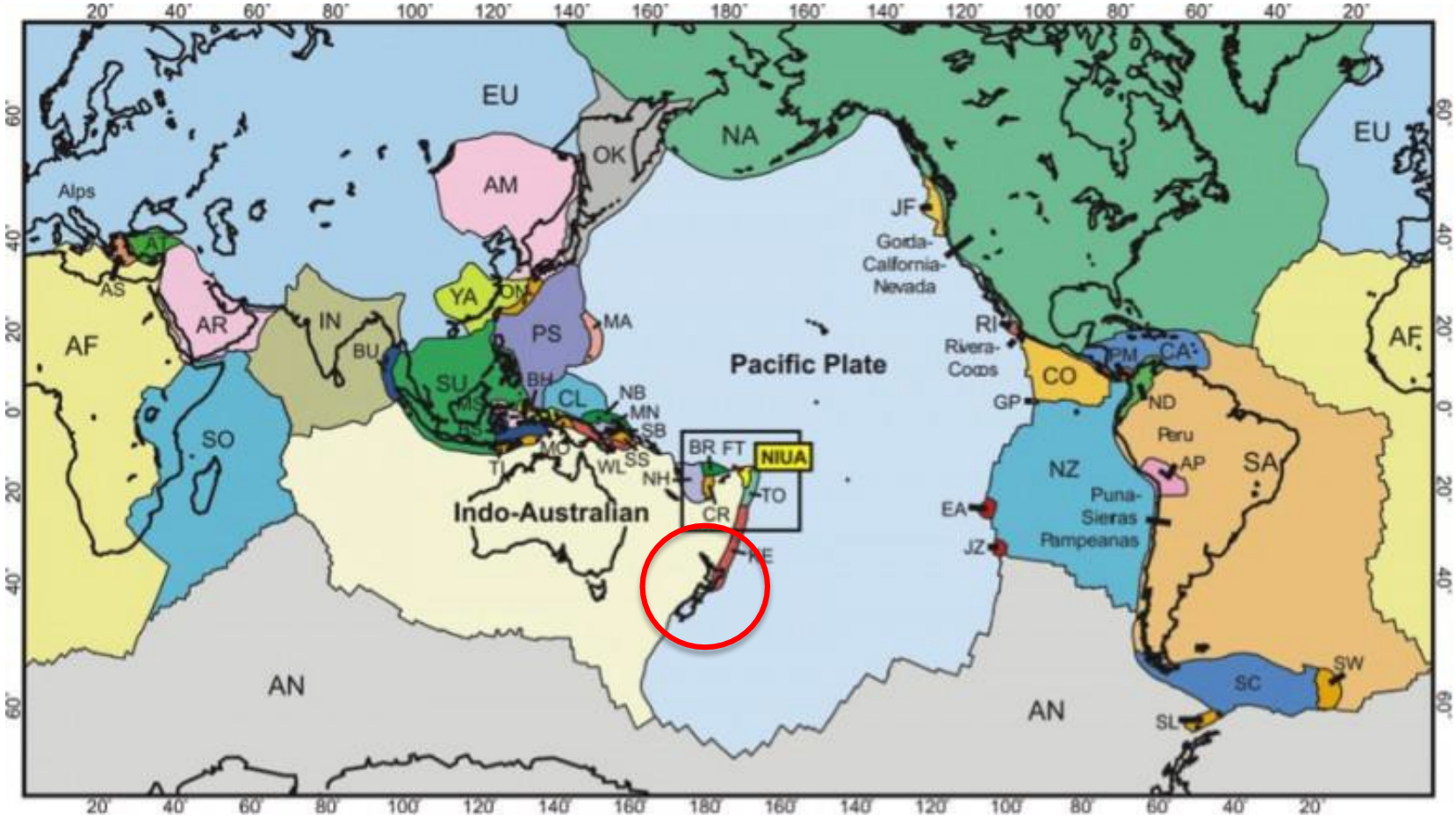
DSI is a newly formed subsidiary of Meridian Energy

meridian

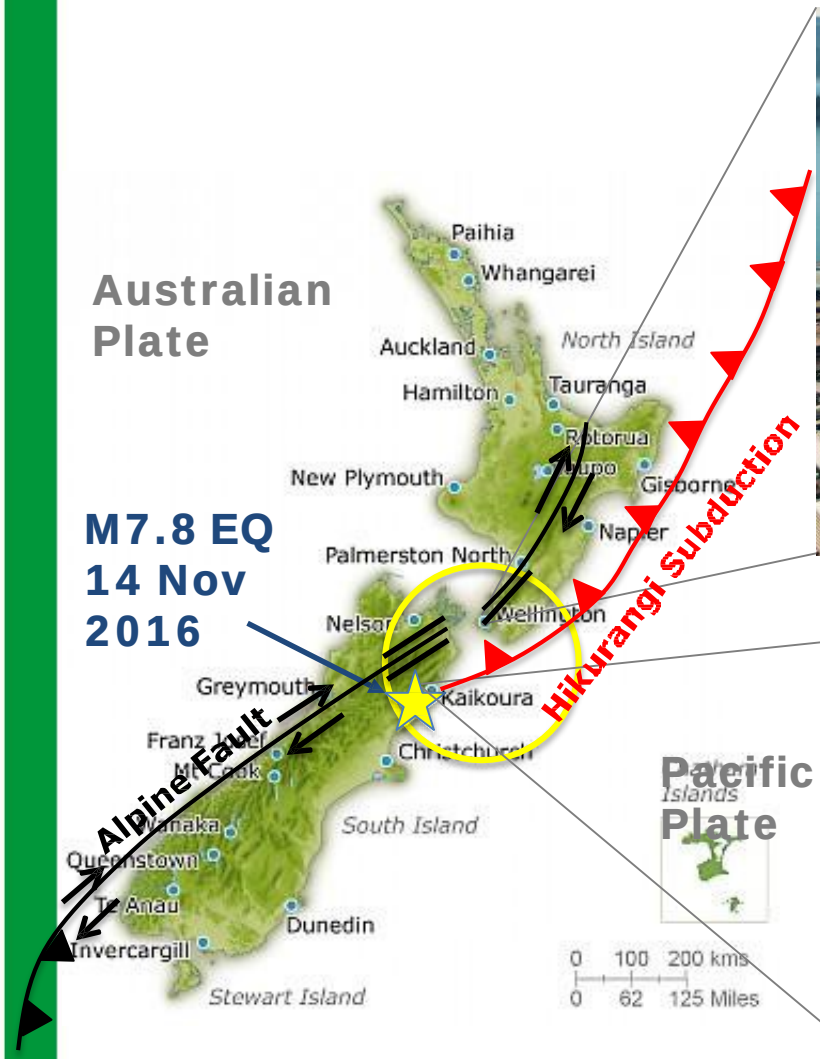
Contents

1. The Kaikoura Earthquake – where and what happened
2. Seismo-geologic effects and phenomena
3. Impacts on infrastructure (general)
4. Impacts on dams
5. Impacts on buildings
6. Concluding remarks on seismic design and readiness

NZ – “the Shaky Isles”



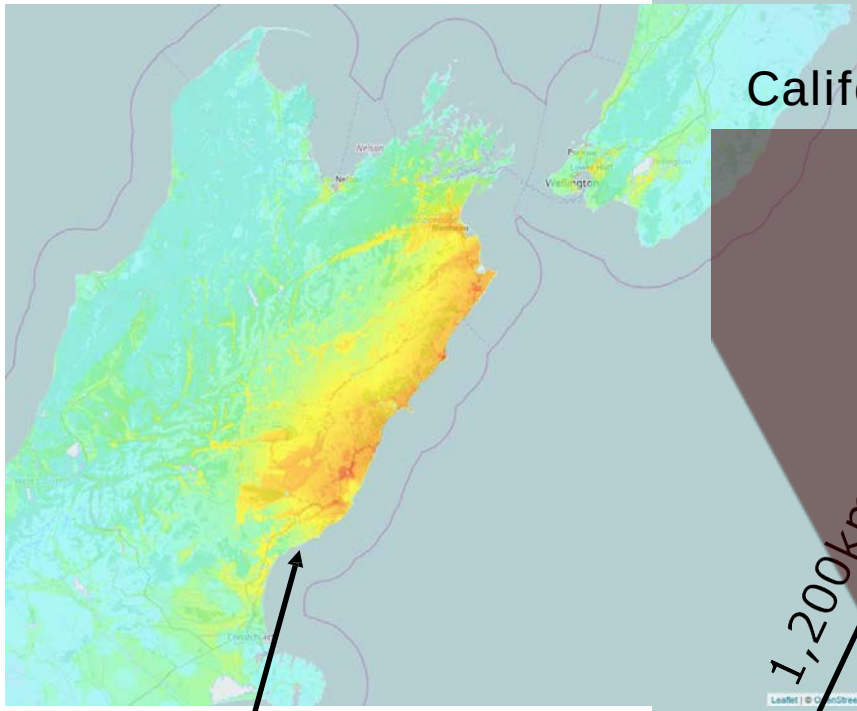
Kaikoura and Wellington City



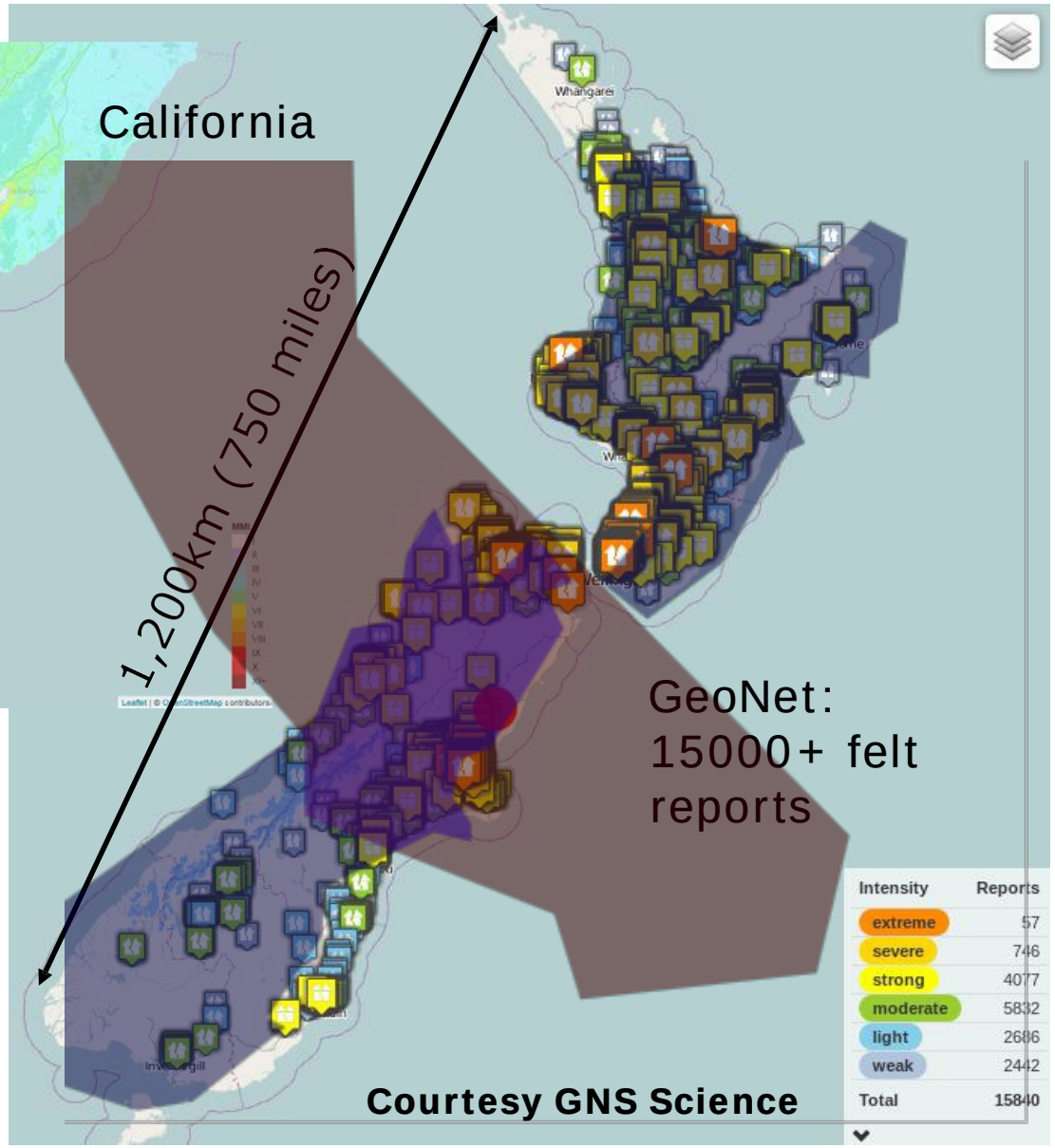
14 November 2016, 12.02am

Play Newshub Breaking News (2:15)

Felt Intensity (MMI)



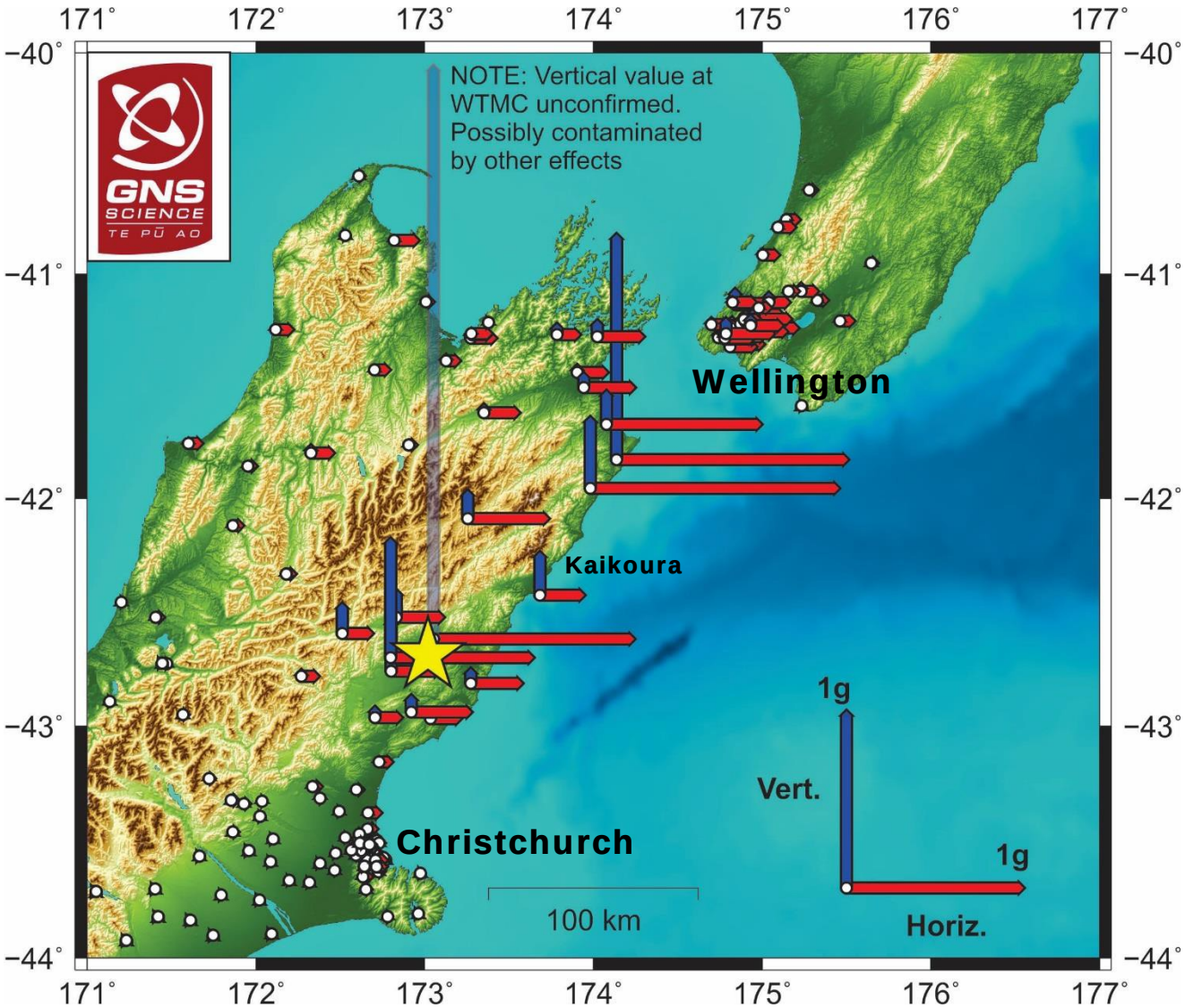
NZ ShakeMap:
MMI VIII, Isolated pockets of MMI IX



Courtesy GNS Science

Ground motions

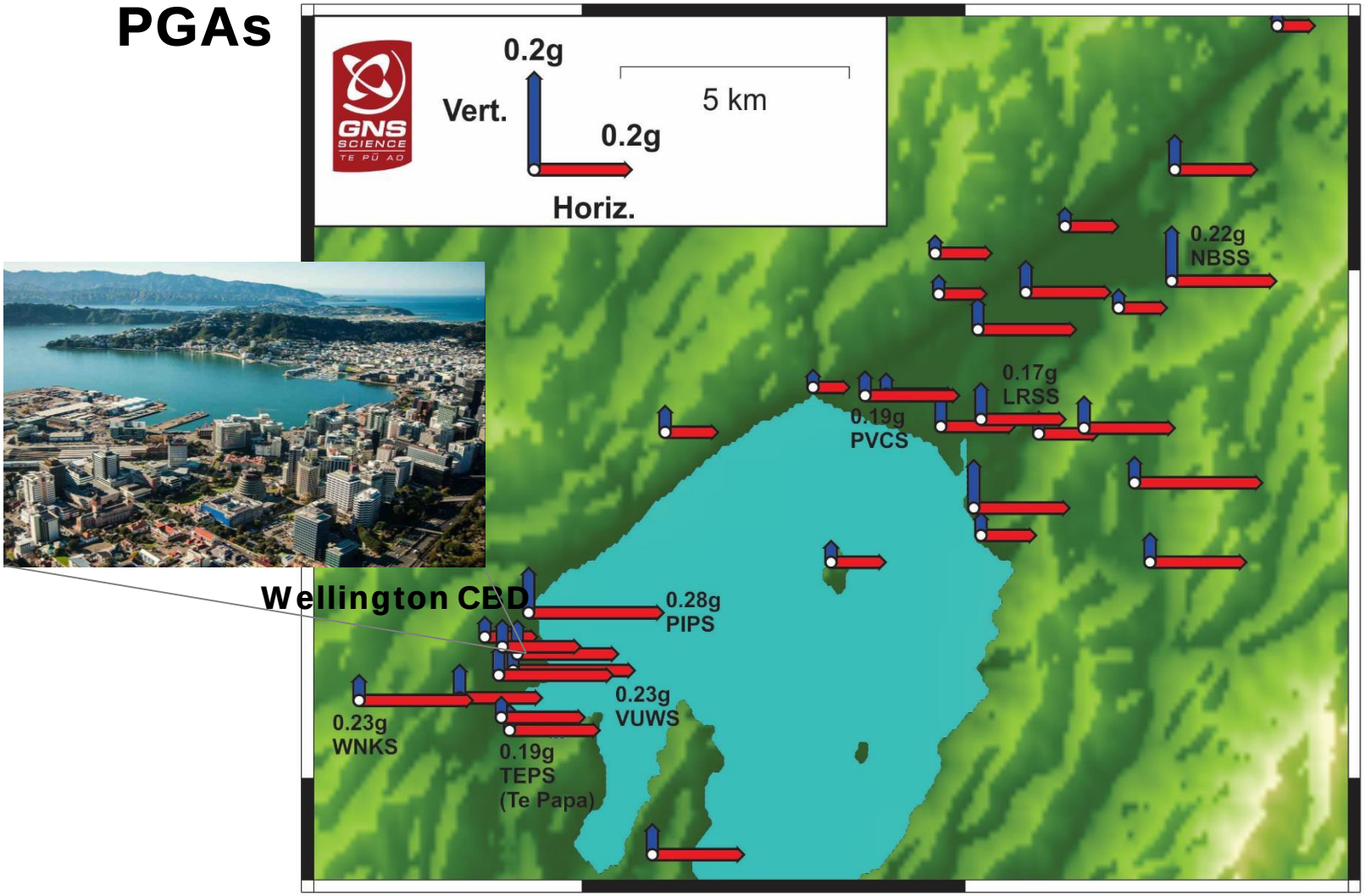
PGAs



Courtesy GNS Science

Ground motions – Wellington

PGAs

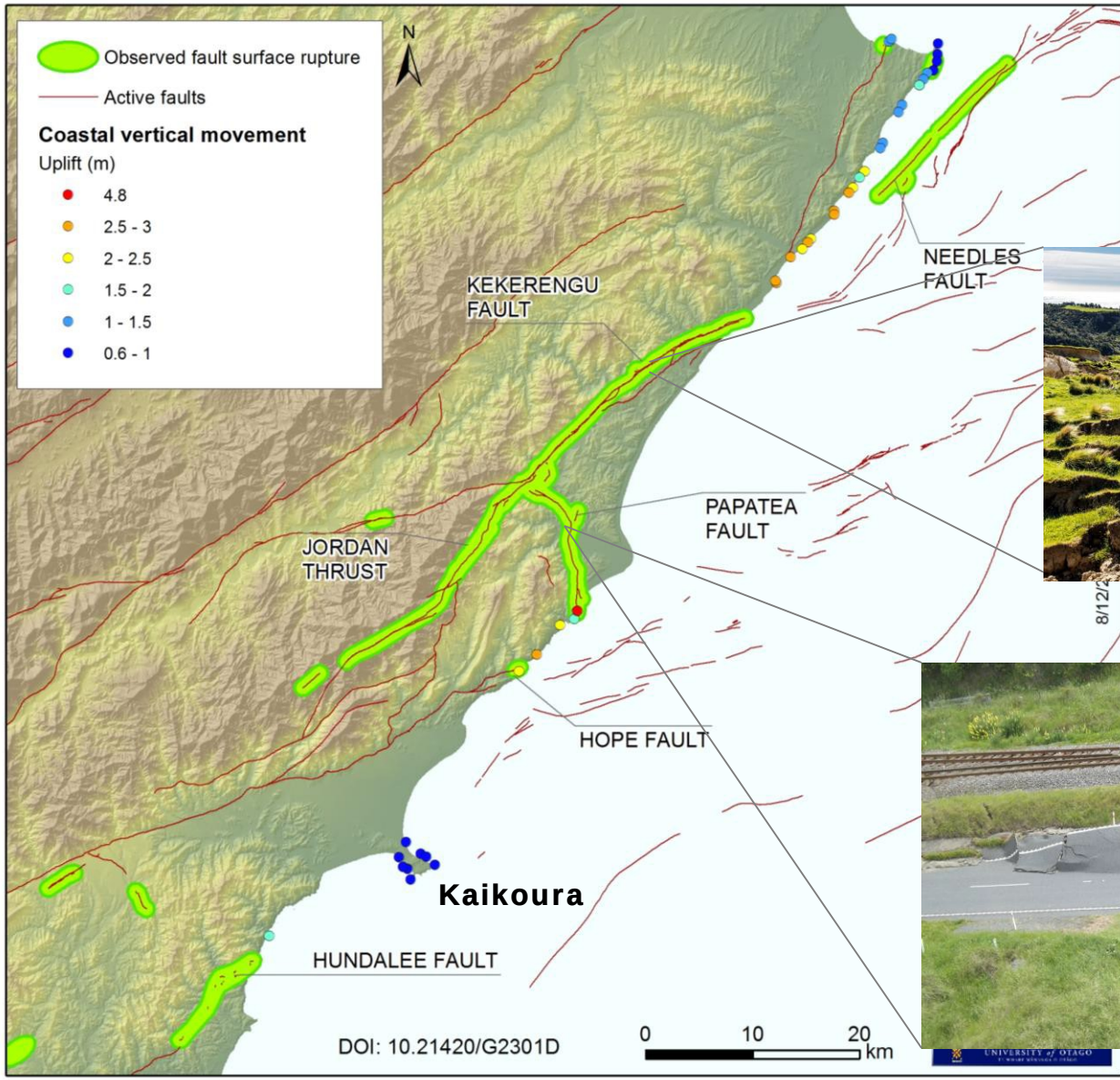


Courtesy GNS Science

Earthquake Propagation

Play UCQC animation (1:00)

6+ Fault Ruptures



Courtesy NZ Geographic

Courtesy GNS Science

Kekerengu Fault

Courtesy GNS Science

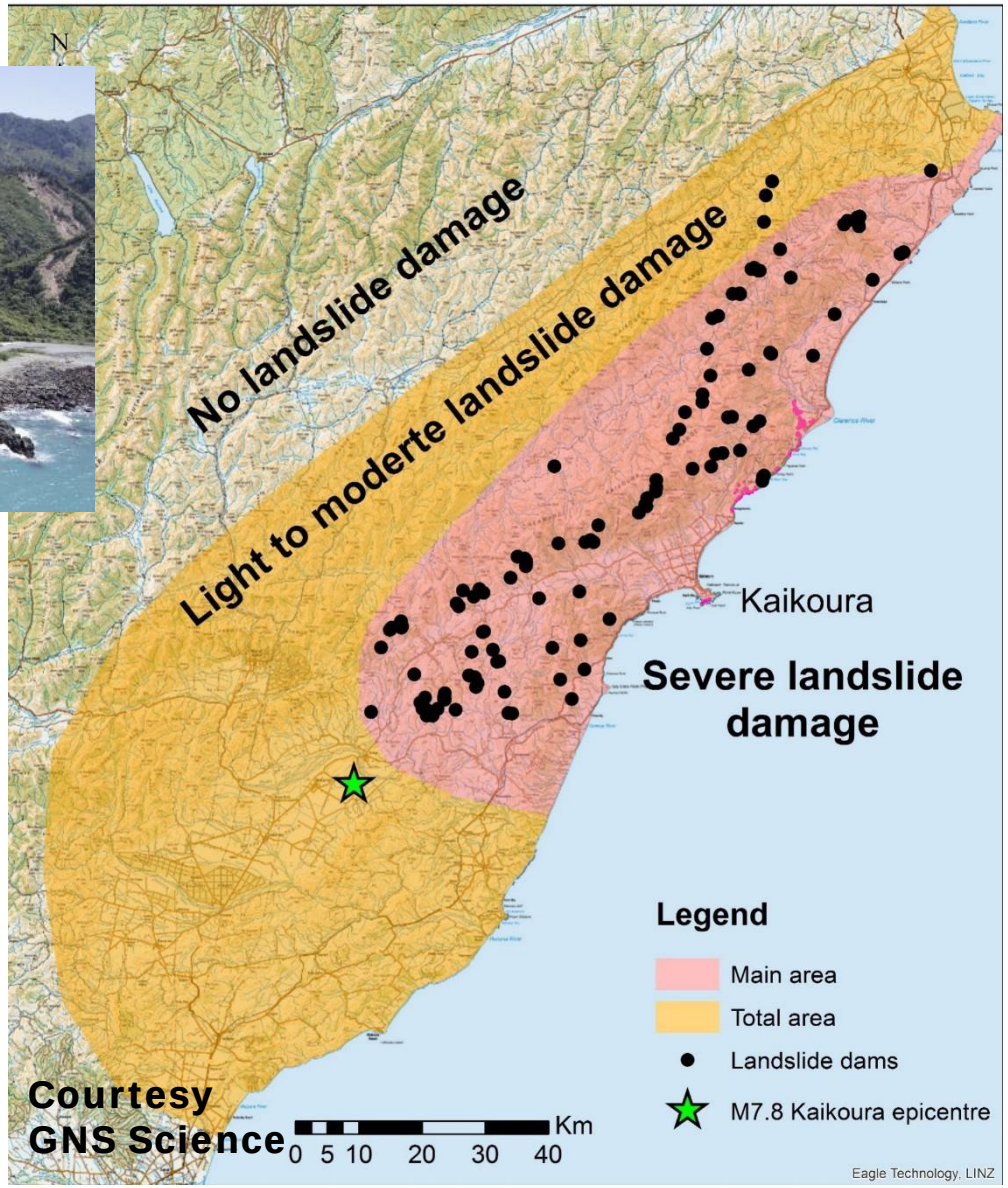
Papatea Fault Coastal Uplift

Courtesy GNS Science

Papatea Fault

Play GNS video (1:31)

Landslides



Courtesy GNS Science

Closed: State Highway 1, Main Trunk Railway

Road and rail tunnels

Train stranded in tunnel

Fibre-optic Link Repair

84 km of treetop fibre!

Broken fibre under main trunk rail

Cow Island

Stranded cows rescued from quake island near Kaikoura

15/11/2016 | By Simon Wong

Like 0

Seaward Landslide

Landslide Dams

BREAKING NEWS Spectator involved in Kiwi Hayden Paddon's rally crash in Mc

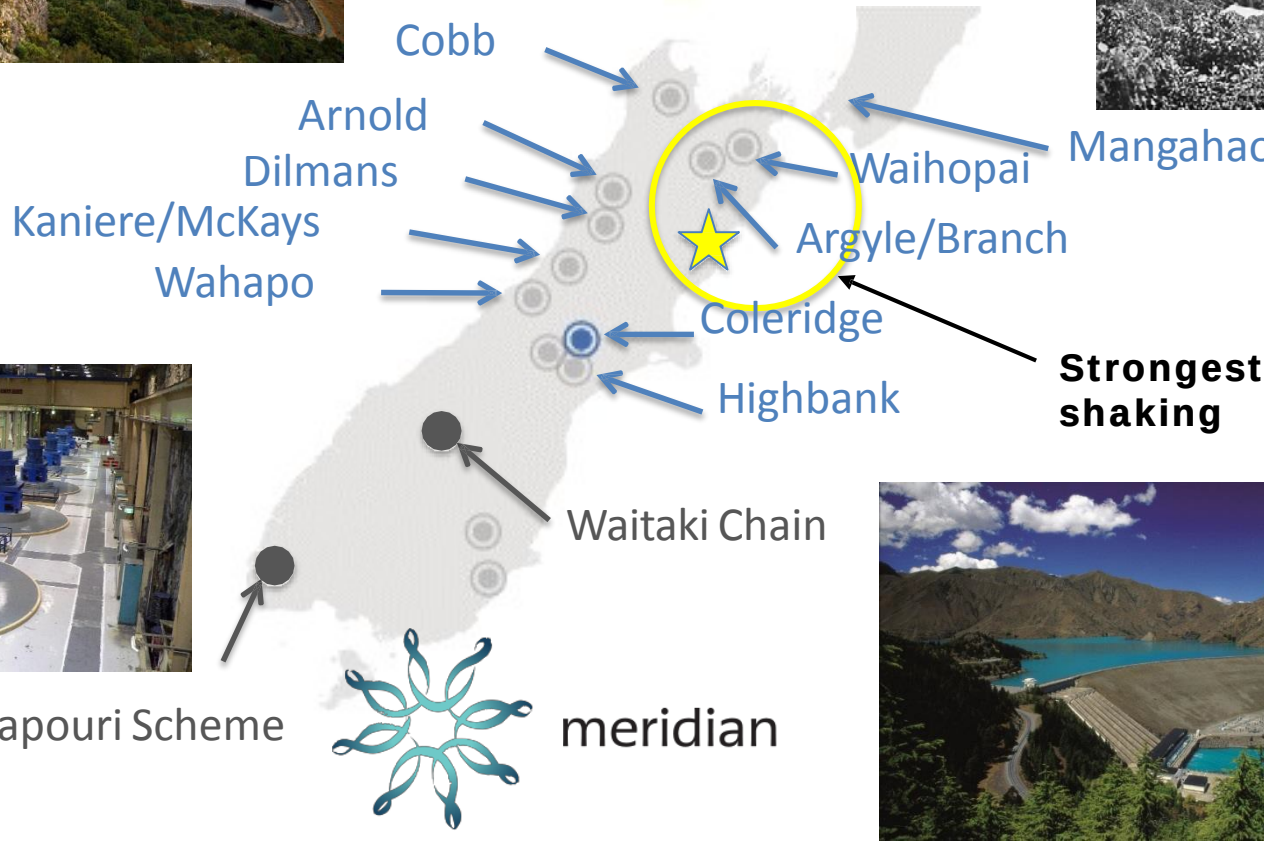
Clarence River: Slip causes breach after earthquake damage

Landslide Dams

Landslide Dams

Play Landslide video (1:52)

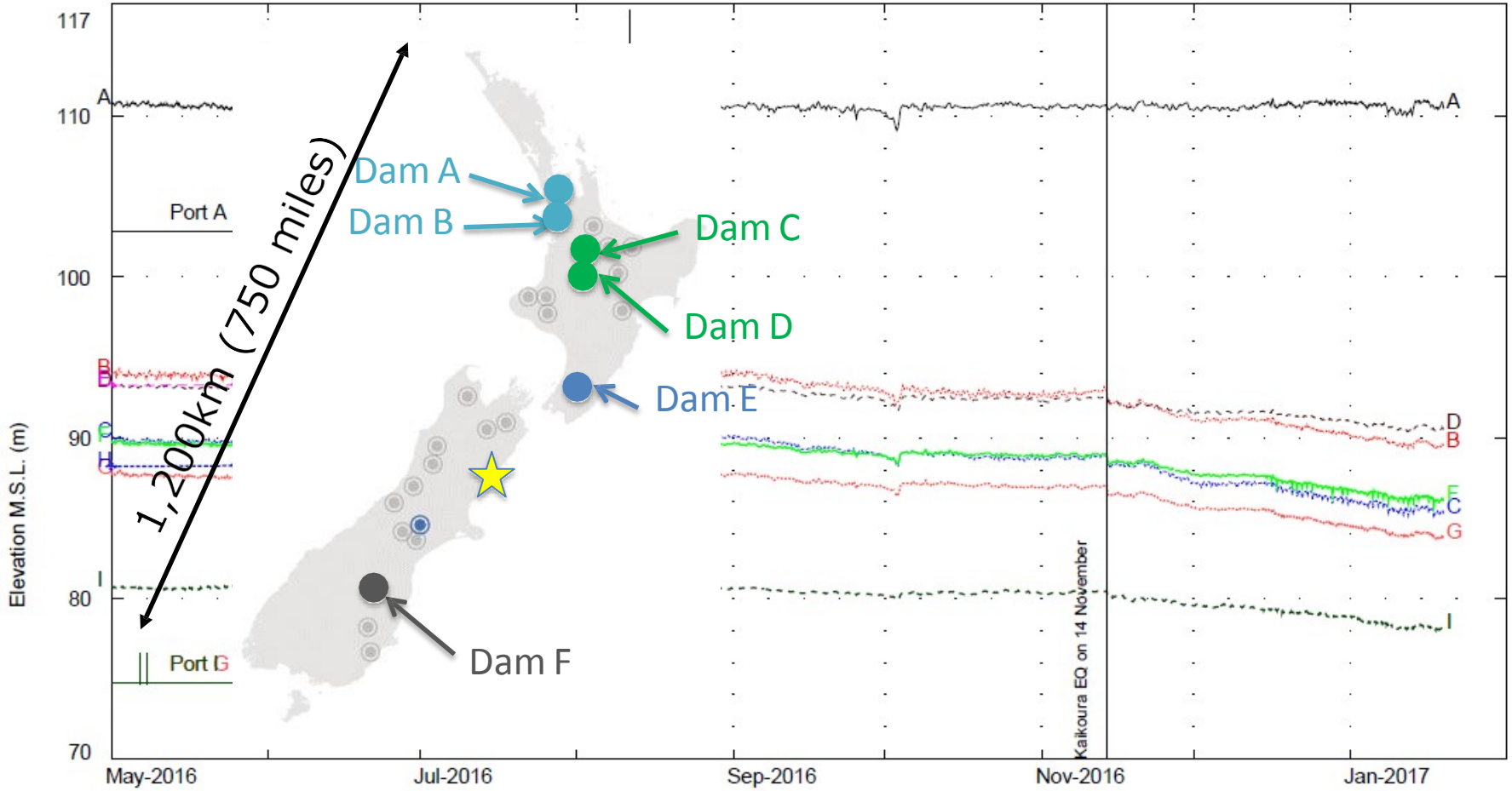
Hydro Dams


Cobb
Arnold
Dilmans
Kaniere/McKays
Wahapo
Mangahao
Waihopai
Argyle/Branch
Coleridge
Highbank
Strongest shaking
Waitaki Chain
Manapouri Scheme

Irrigation Dams

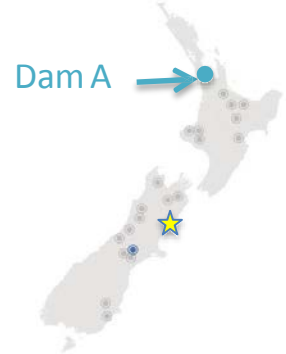
Irrigation Dams

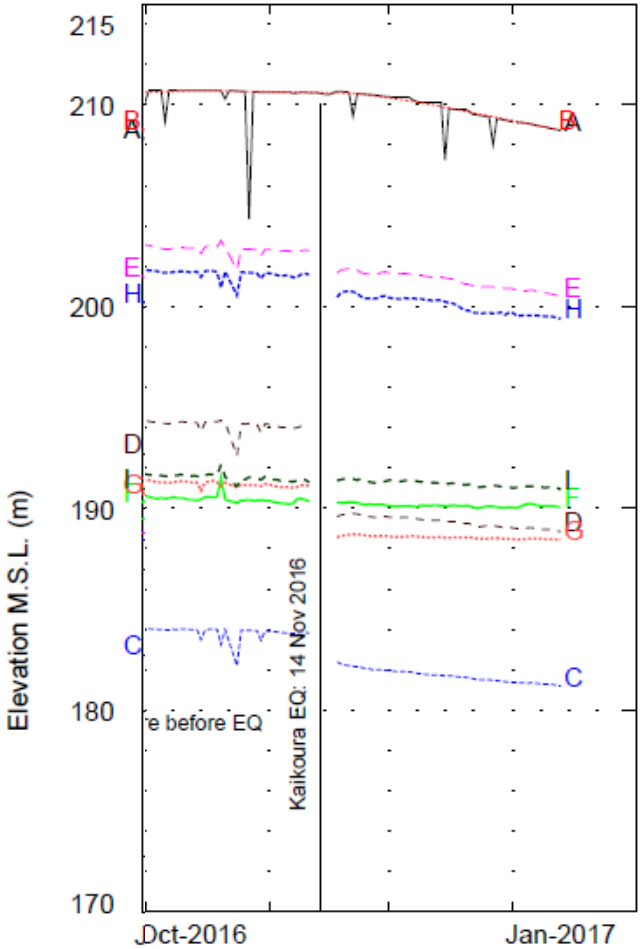
Dam Foundation Responses



Dam Foundation Response

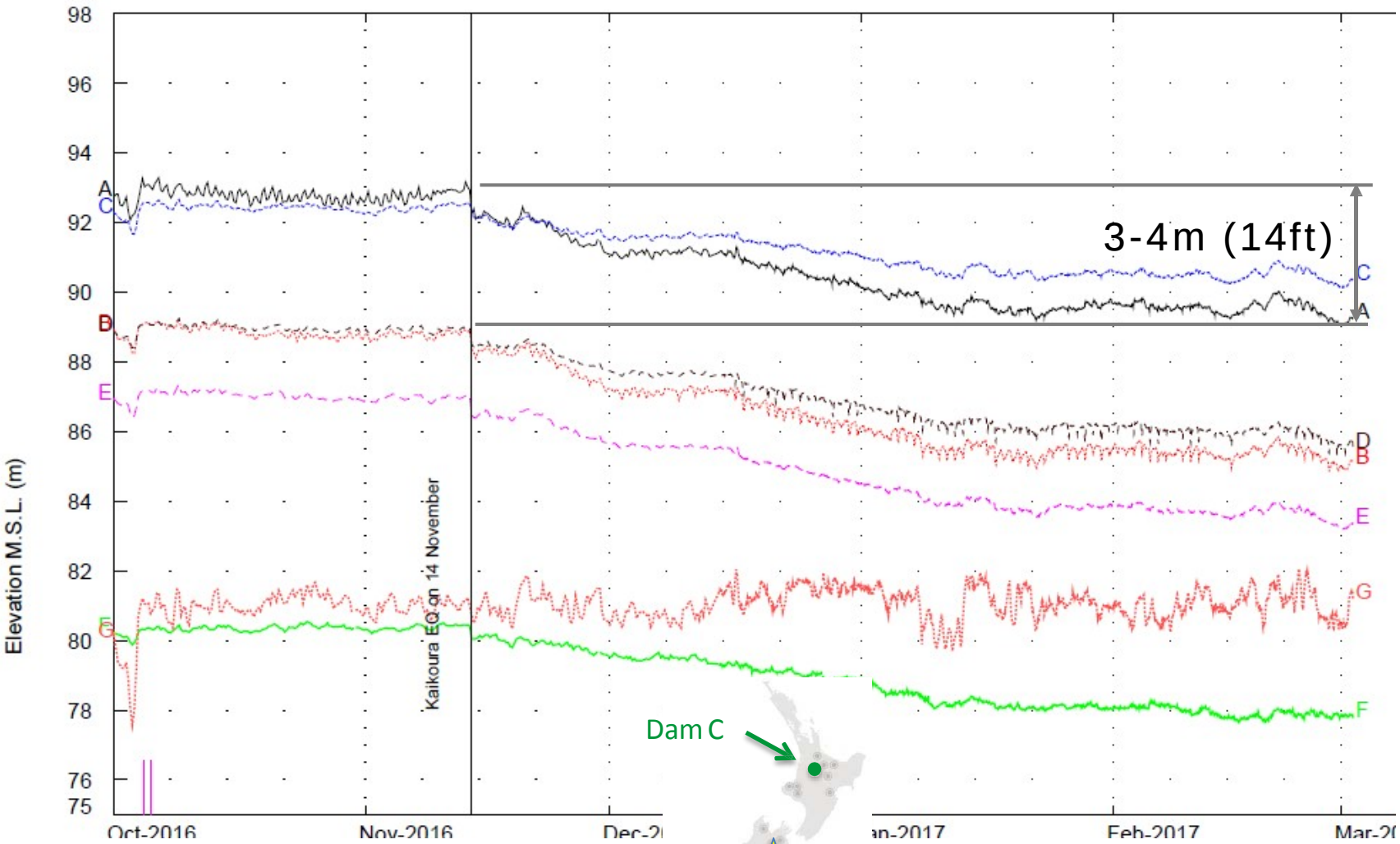
600km away!
(375 miles)





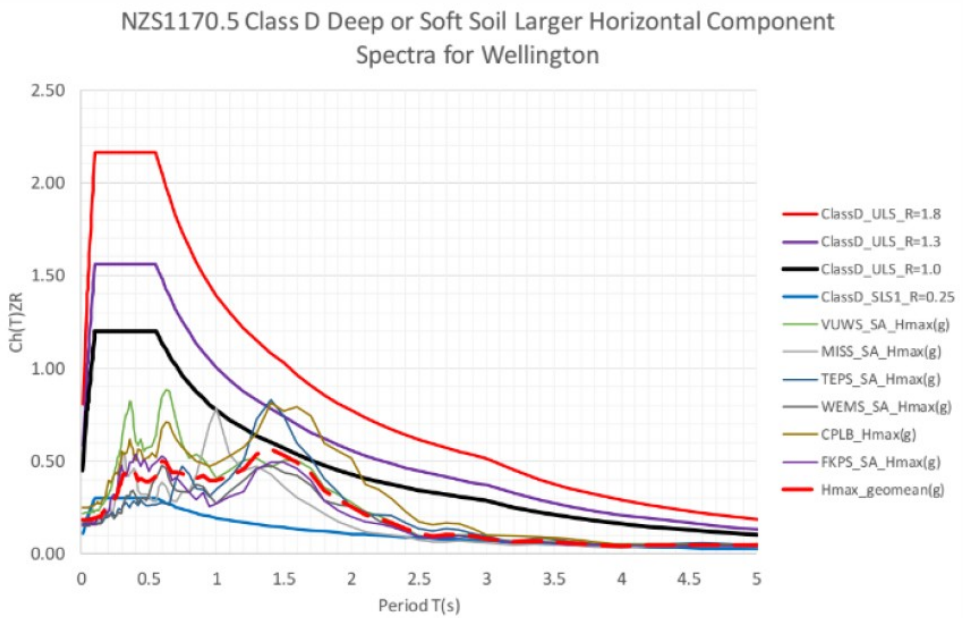
Main Dam VW Piezometers
Foundation, 10m left of spillway

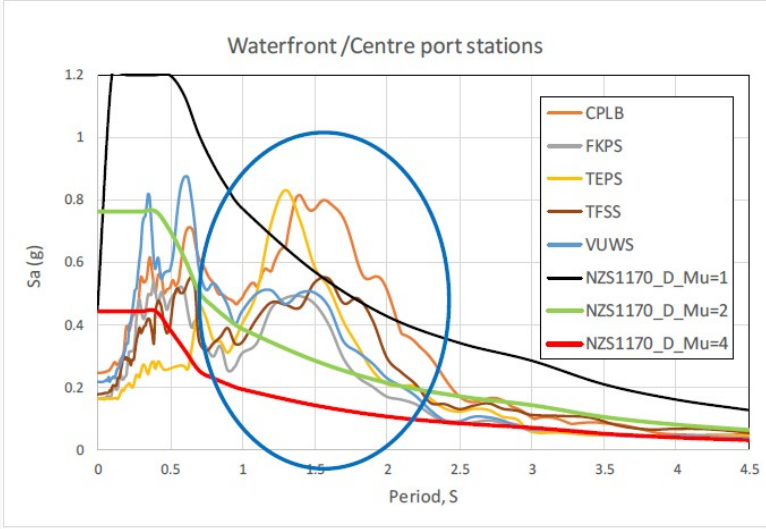
Dam Foundation Response



500km (310 miles)

Wellington Buildings

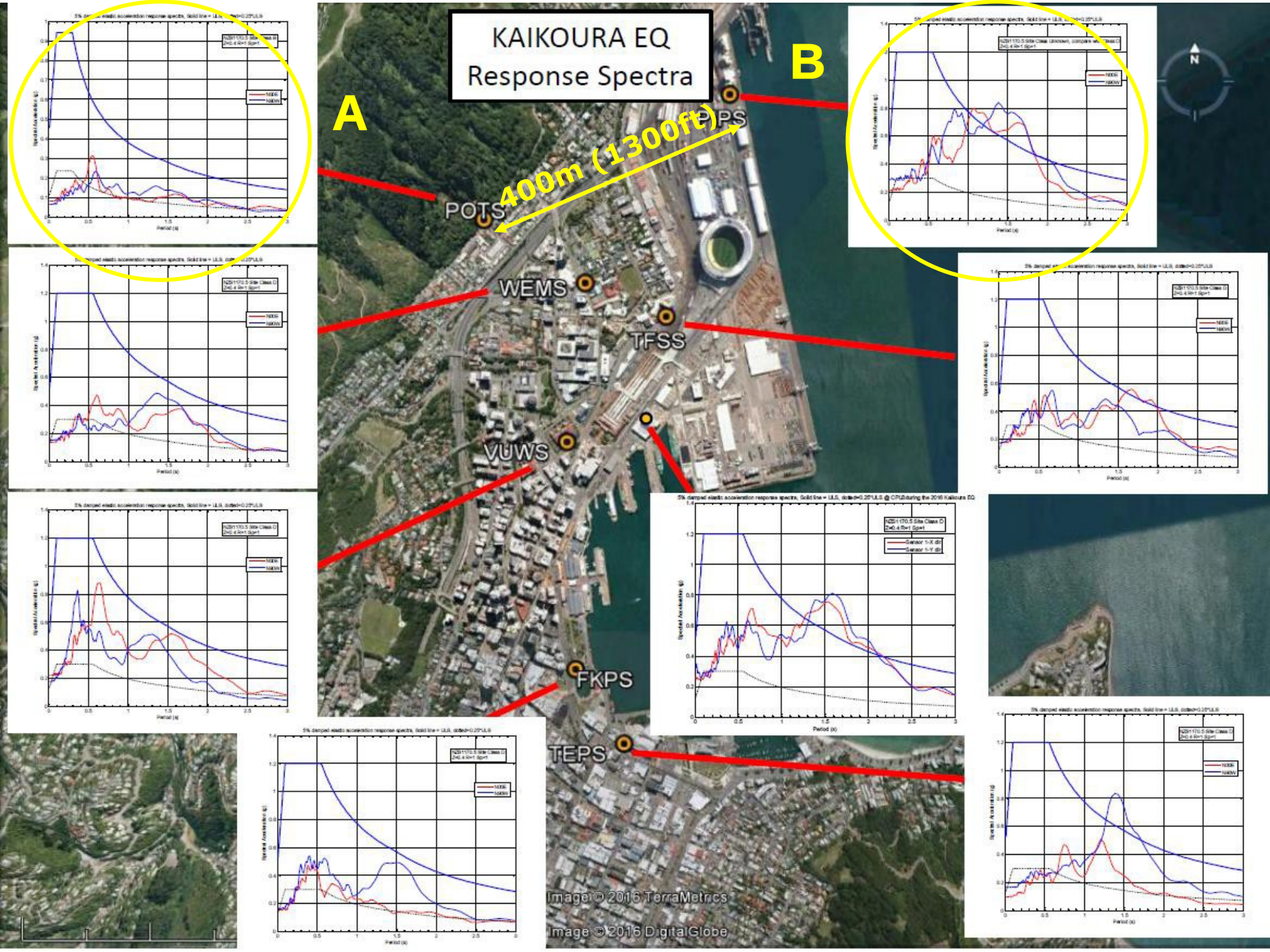




Response spectra of Kaikoura Earthquake

(McVerry et al. 2016)

KAIKOURA EQ
Response Spectra



Wellington Buildings

NEW ZEALAND / KAIKŌURA EARTHQUAKE

New round of earthquake checks ordered for 80 Wellington buildings

8:10 am on 20 December 2016

Share this

18 November 2016

Media release: Engineers says Wellington's mid-height buildings worst affected

Reclaimed Land

Ok

Not Ok

Adequate Seismic Design?

“What Kaikoura taught us about Wellington: Seismic engineering is failing to anticipate the complexity of earthquakes”

“There is a major disconnect between building codes and earthquakes. An earthquake can behave in a way that is difficult for a building code to anticipate – such as the long-duration shaking at a particular frequency seen in Wellington”

Concluding Remarks

- Seismic hazard is real and every earthquake brings new learnings
- Huge financial loss and life loss (would have been worse in Wellington during work hours)
- There is increasing scrutiny on seismic design of infrastructure but earthquakes are more complex than are being captured in our building code
- Dams performed well and design loads are higher (than for buildings)
- Resilient design not minimum design
- Plan and prepare – when, not if!