FIG WORKING WEEK 2019

22–26 April, Hanoi, Vietnam

"Geospatial Information for a Smarter Life and Environmental Resilience"

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Building a Resilient Geodetic System – A New Zealand Case Study

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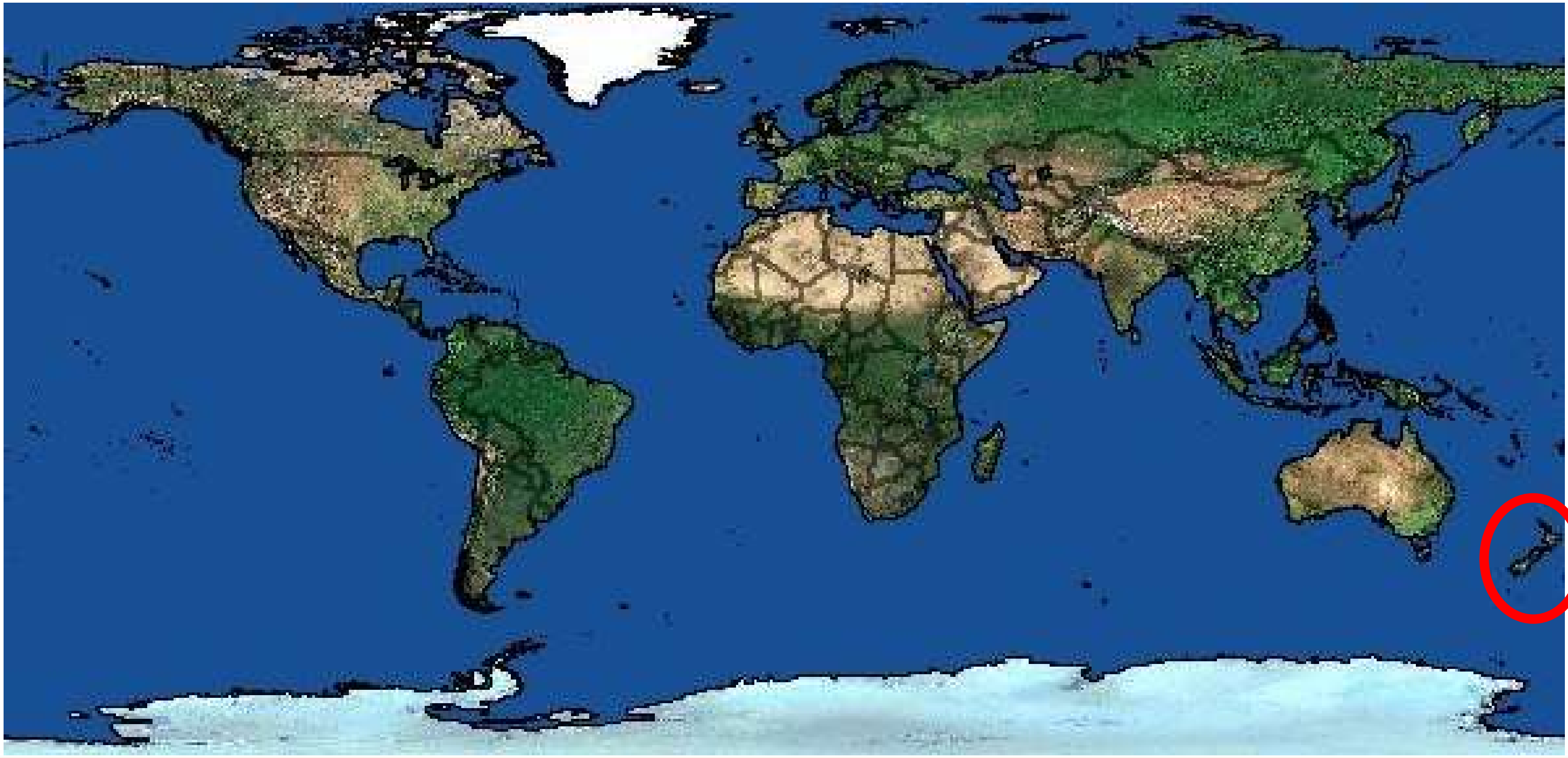
Land Information New Zealand

Introduction

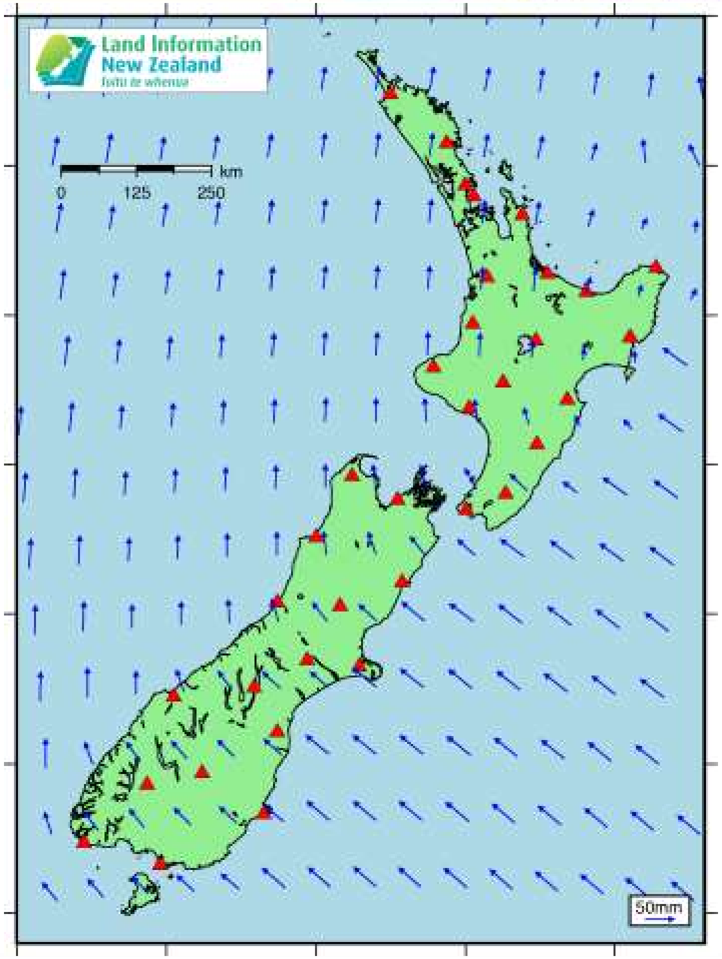
- New Zealand's geometric and vertical datums
- Improving geodetic resilience to earthquakes: 2010-2016
- Current work to improve resilience of New Zealand's geodetic system

New Zealand



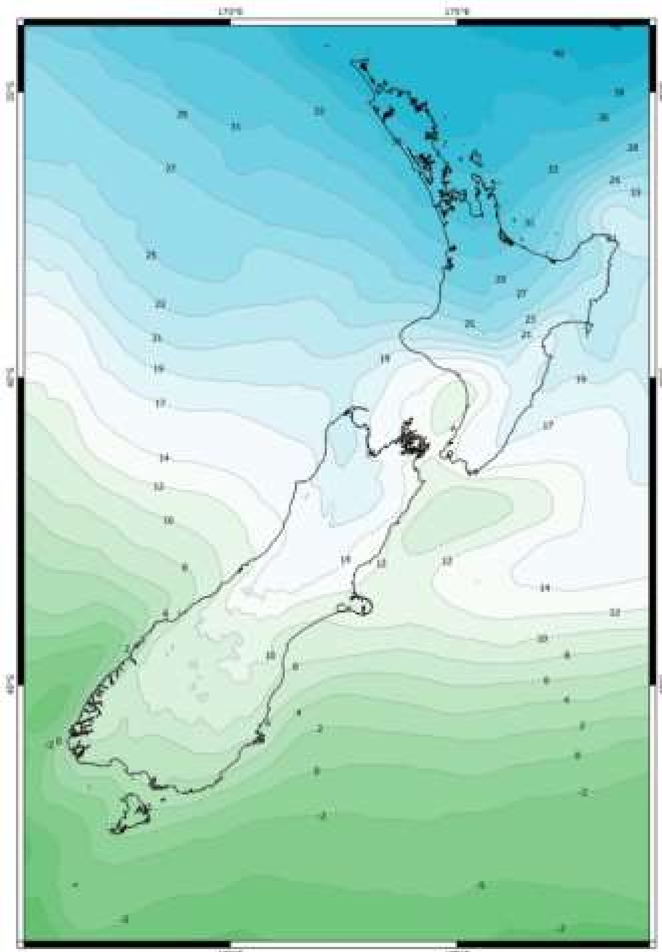
New Zealand Geodetic Datum 2000

- NZGD2000 describes an ensemble of datums, each related to a different version of the deformation model (eg NZGD2000v20180701)
- Deformation model accounts for deformation in a way that meets the majority of user requirements – see it (reverse patch) or hide it (forward patch)

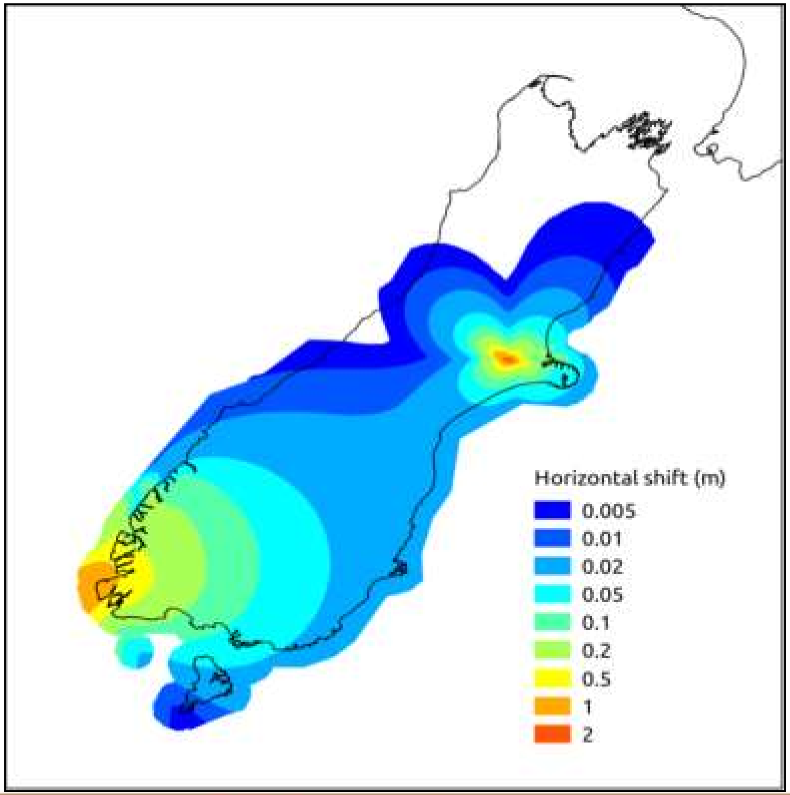


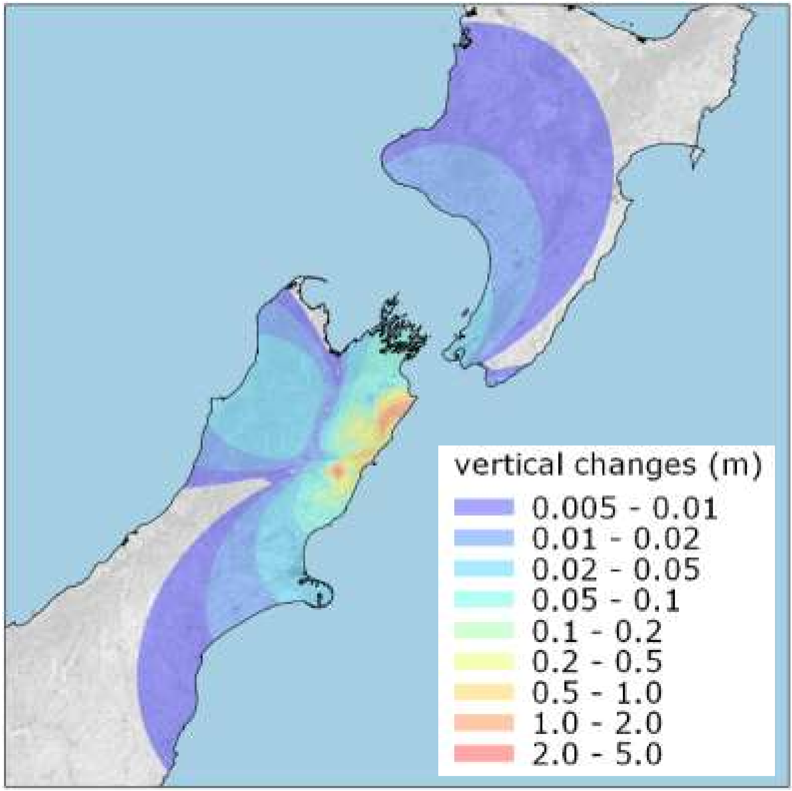
New Zealand Vertical Datum 2016

- Quasigeoid reference surface calculated from national airborne gravity campaign (and other data)
- Heights typically derived from NZGD2000 ellipsoidal height
- Quasigeoid does not change after an earthquake
- Impact of deformation model on ellipsoidal heights is reflected in normal-orthometric height



Datum-Disrupting Earthquakes 2009-2016





A Tale of Two Earthquakes

2010-11 Darfield and Christchurch	2016 Kaikoura
Heights re-established using precise levelling (slow and expensive)	Heights re-established using GNSS and a geoid model (faster and cheaper)
Surveyors could not easily generate their own control	Control easily generated using online processing service
Post-earthquake coordinates distributed using a spreadsheet (poor traceability and version control)	Post-earthquake coordinates published via an online data portal (full version control)
Passive control resurveyed throughout affected region, including rural areas (expensive)	Passive control only resurveyed in urban areas (as at 2019)

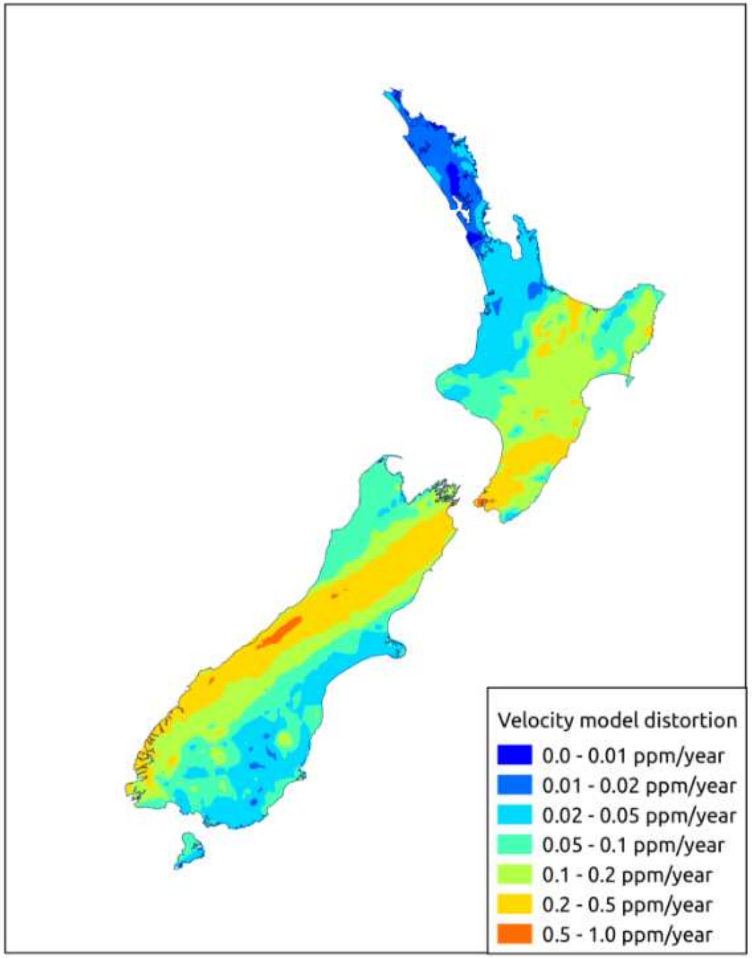
Resilience of geodetic system was greatly improved

BUT

More can be done

Improved Continuity Planning

- Almost all geodetic staff are in Wellington, an area of high seismic risk
- May not be available to respond in first few days
- Response plan developed to be implemented by staff in another office in the event of a Wellington-based earthquake
- There is much that can be done, even without specialist earthquake expertise



Updated Localised Deformation Monitoring Networks

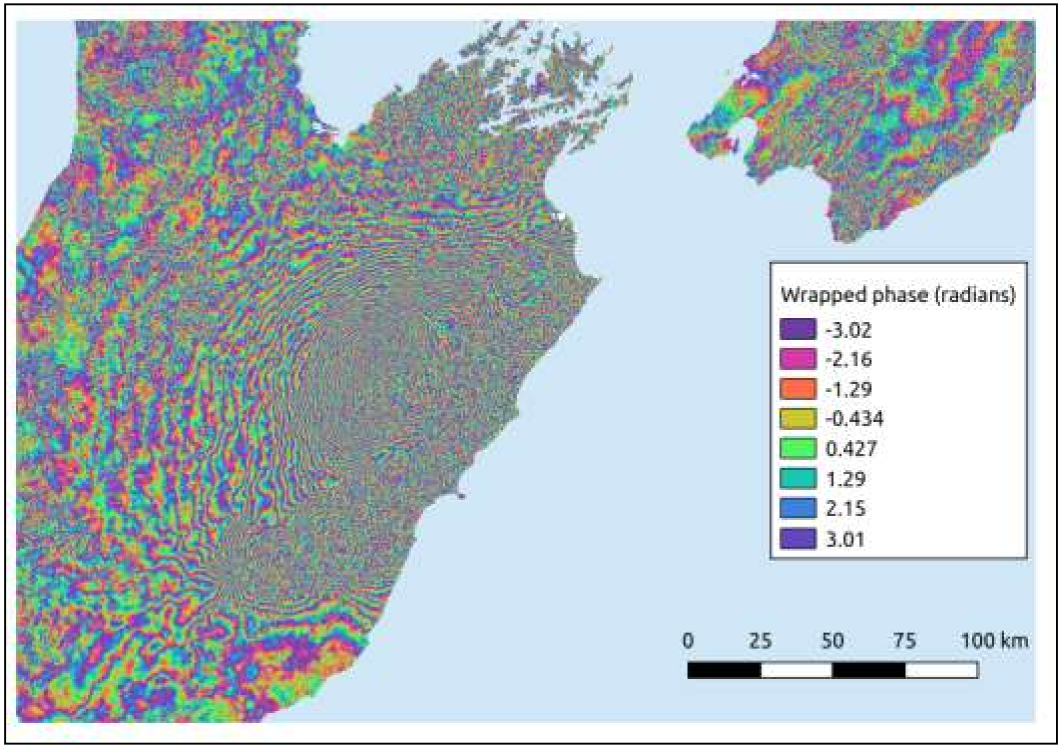
- New Zealand CORS spacing (~100km) is too sparse for full earthquake recovery
- Christchurch experience was that a passive mark every 1-2km is ideal
- Many historic control marks no longer exist, or are in unsuitable locations (poor sky visibility, in roads etc)
- Can be used for many other purposes as well (engineering surveys, cadastral)

Updated Localised Deformation Monitoring Networks

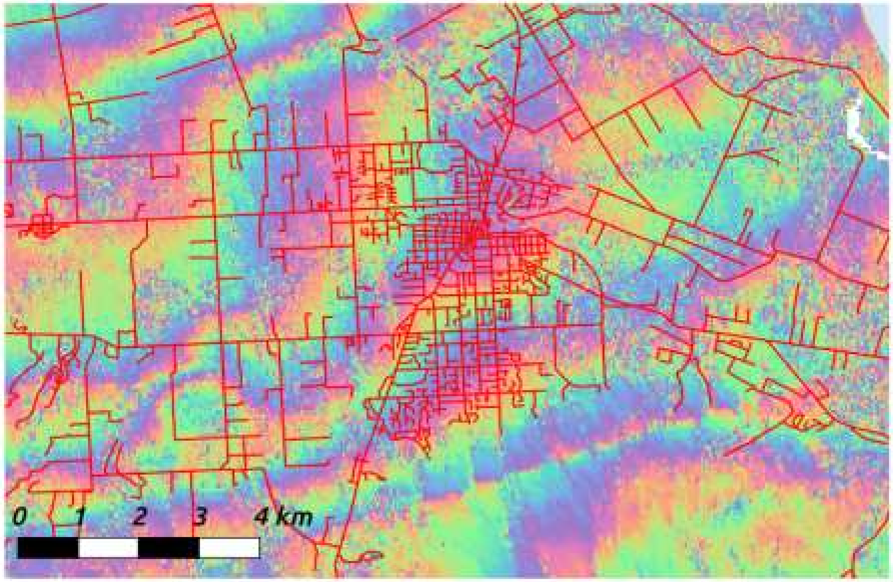
- Ongoing programme to establish these throughout the country
- Focus is on urban areas, where infrastructure recovery requirements are greatest
- Prioritised based on seismic risk
- Typically two 30-minute GNSS occupations, connected directly or indirectly to CORS

Deformation Modelling using InSAR

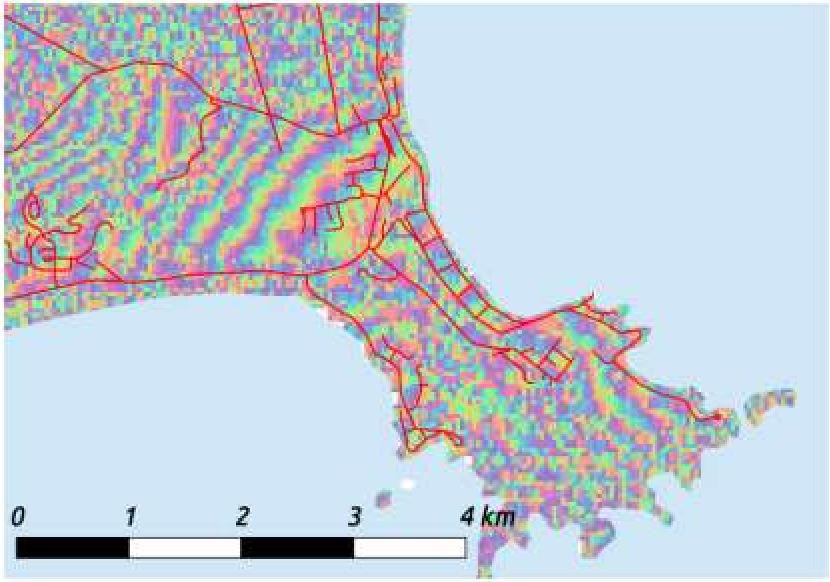
- InSAR already used to compute geophysical models
- Can also be used as a geodetic observation of surface deformation
- Identify areas using InSAR to focus GNSS surveys in the immediate post-earthquake period



Deformation Modelling using InSAR



Blenheim



Kaikoura

Summary

- Geometric and vertical datums can be designed to be resilient to land movements
- CORS are ideal but passive control can provide higher densities
- Remote sensing (InSAR) currently underutilised