



# Exploring NZVD2016

## *NZ's National Vertical Datum*

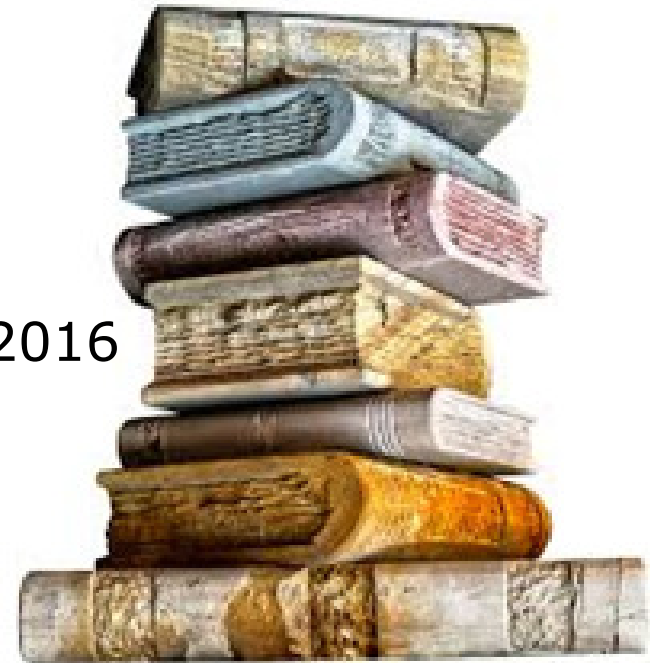
**Rachelle Winefield**

**Senior Geodesist | Location Information**

**Email: [rwinefield@linz.govt.nz](mailto:rwinefield@linz.govt.nz)**

## Overview

1. If it's not broke why fix it?
2. Napier 1962 is not MSL
3. What a is geoid?
4. The difference between NZVD2009 and 2016
5. The magic of NZVD2016 orders
6. How good are the relationship grids?
7. Why must NZVD2016 heights change?
8. Maintenance, resurvey and the future



**Not covering : height theory, or gravity data collection**

# If its not broke...



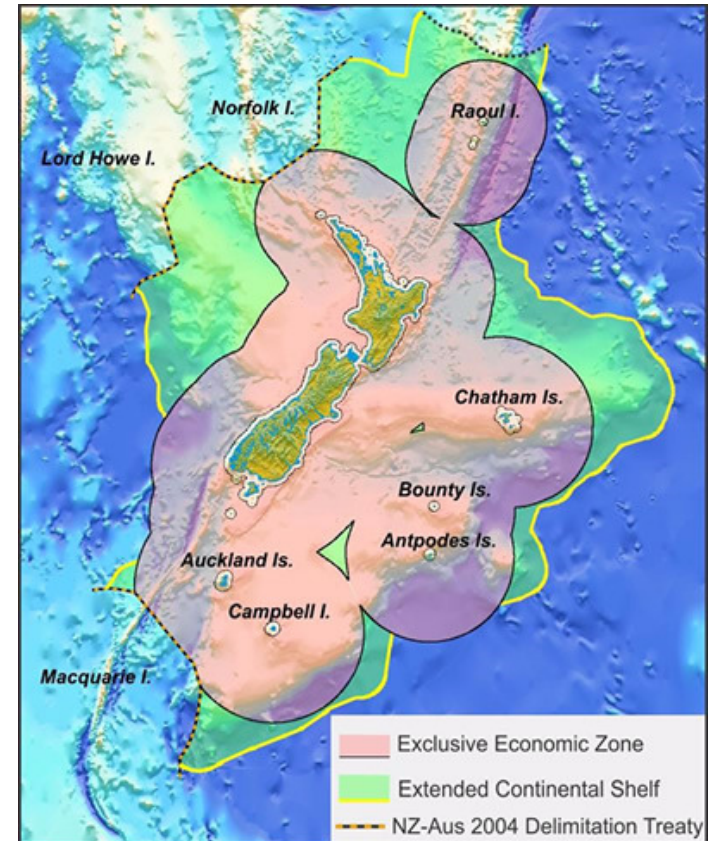
Image courtesy ZNO



## If its not broke...

### Desirable attributes of a national vertical datum:

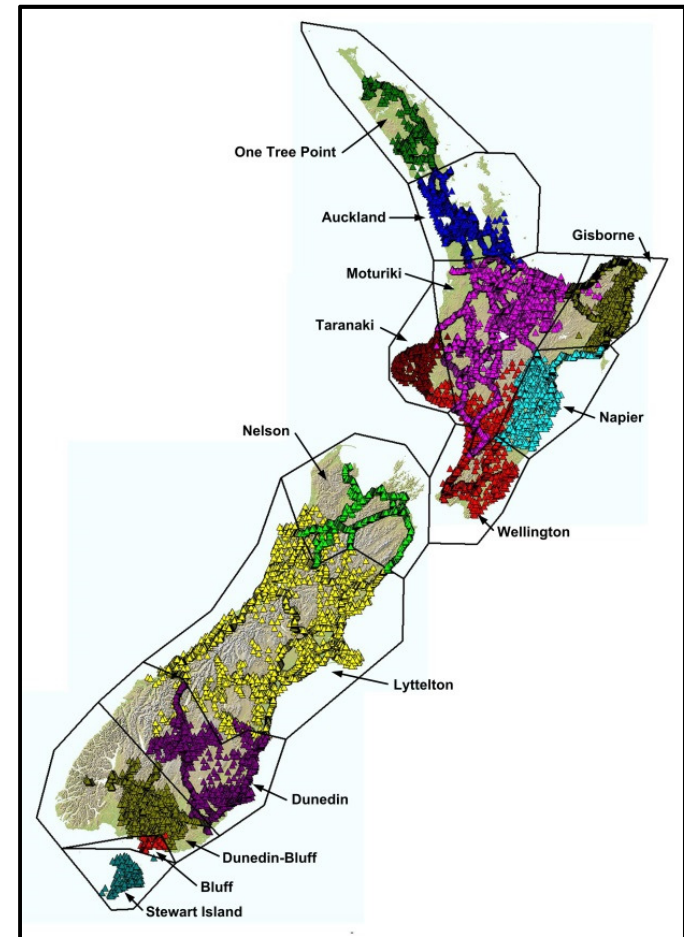
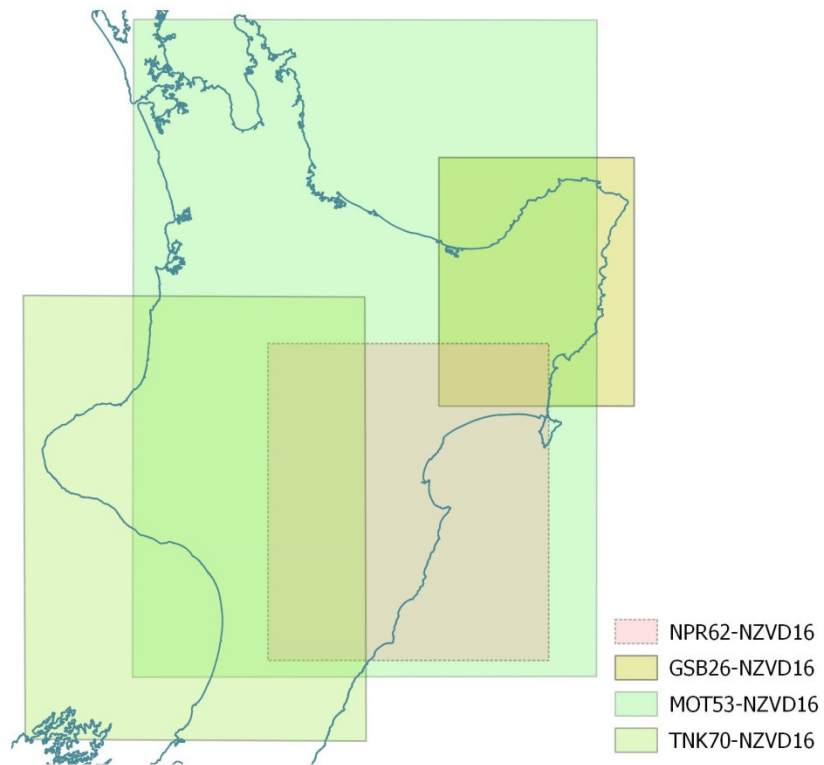
- Accessible - anywhere
- Consistent reference system
- Compatible with technologies
  - GNSS heighting
  - Precise levelling
- Fit for purpose
- Robust
- Maintainable and assessable



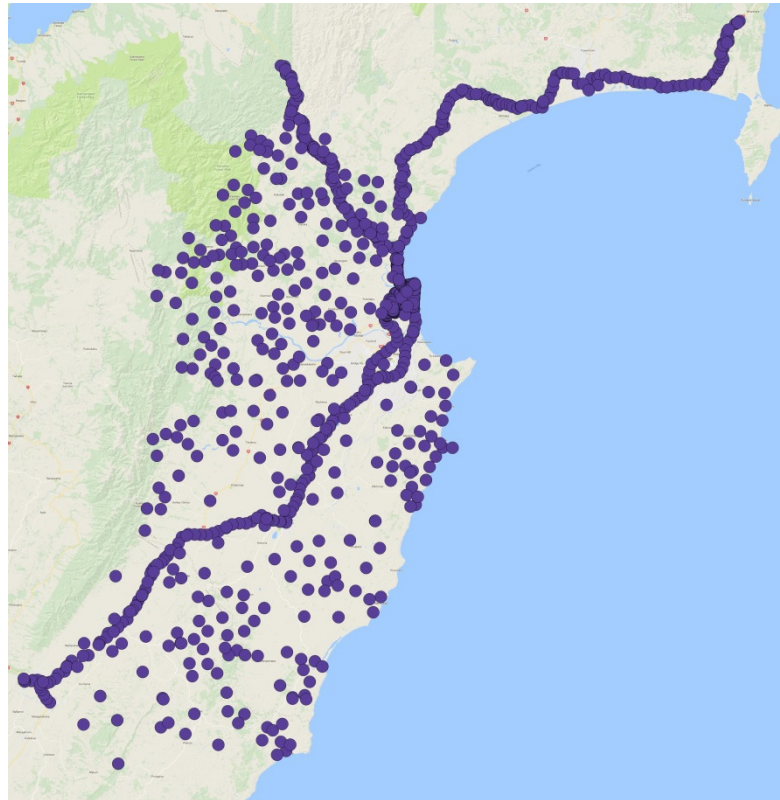
Map of New Zealand Maritime boundaries.  
GNS Science (2013)



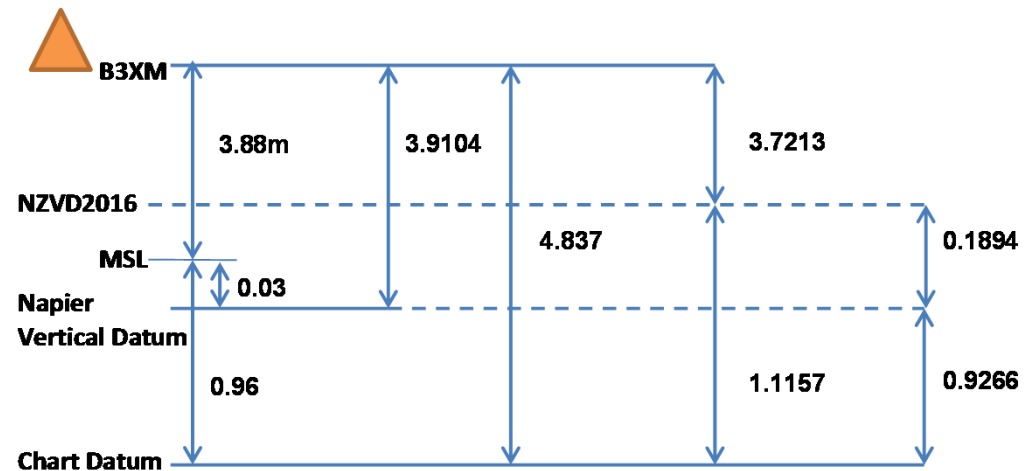
# Local Vertical Datums



# Napier 1962 is not MSL...



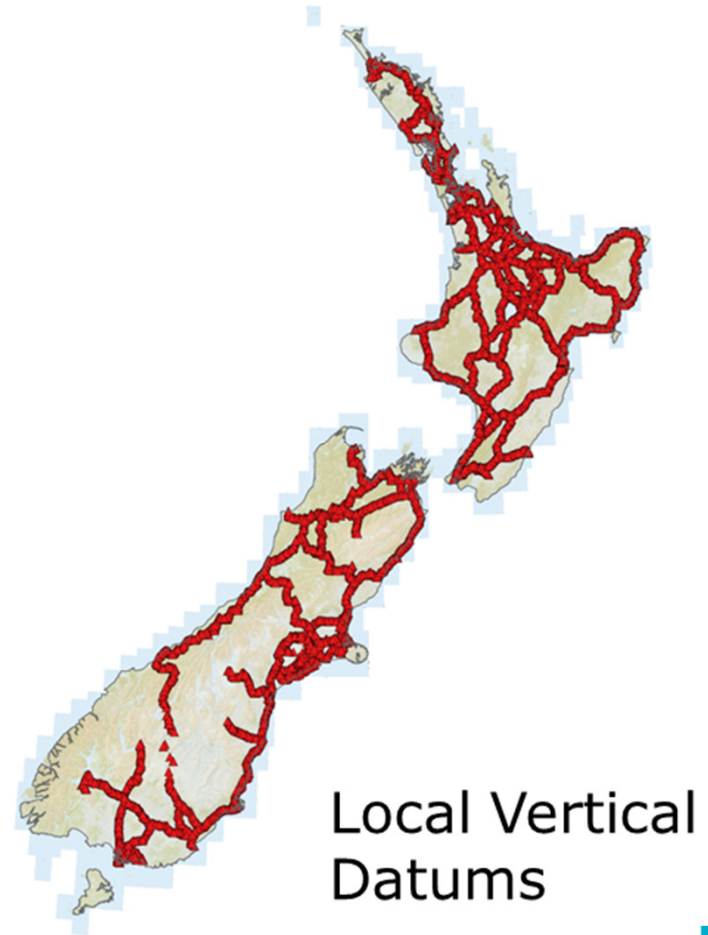
## Predicted MSL for Surveyors: B3XM Napier



Date: September 2017

## Napier 1962 is not MSL...

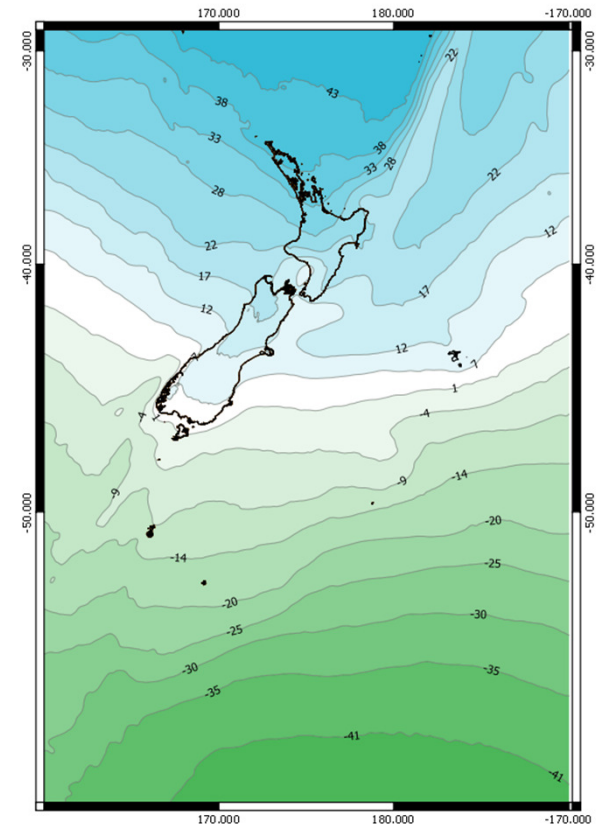
- **Long, liner, poorly constrained networks**
  - Restricted to roads
- **Accuracy assessed on an observation basis**
  - Errors propagate
  - No relative assessment of marks not observed
- **Benchmarks move**
  - Difficult to tell if a benchmark is disturbed
  - Absolute accuracy is unknown



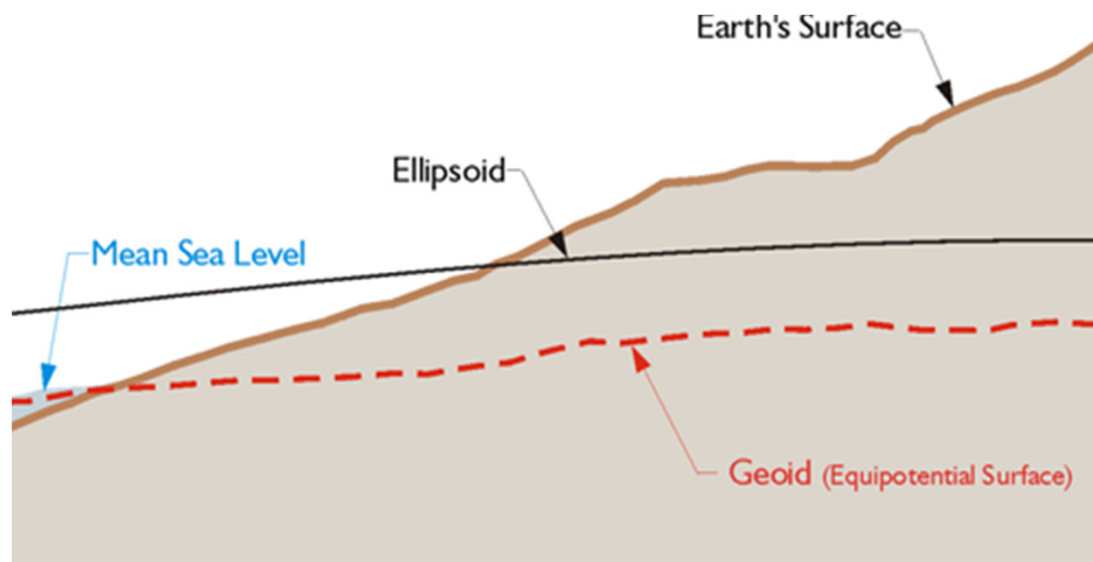
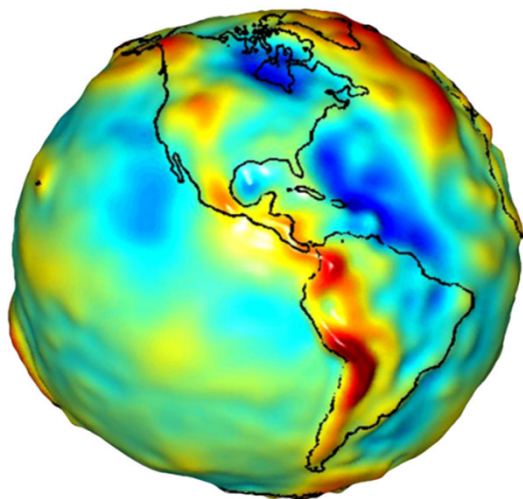


# New Zealand Vertical Datum 2016

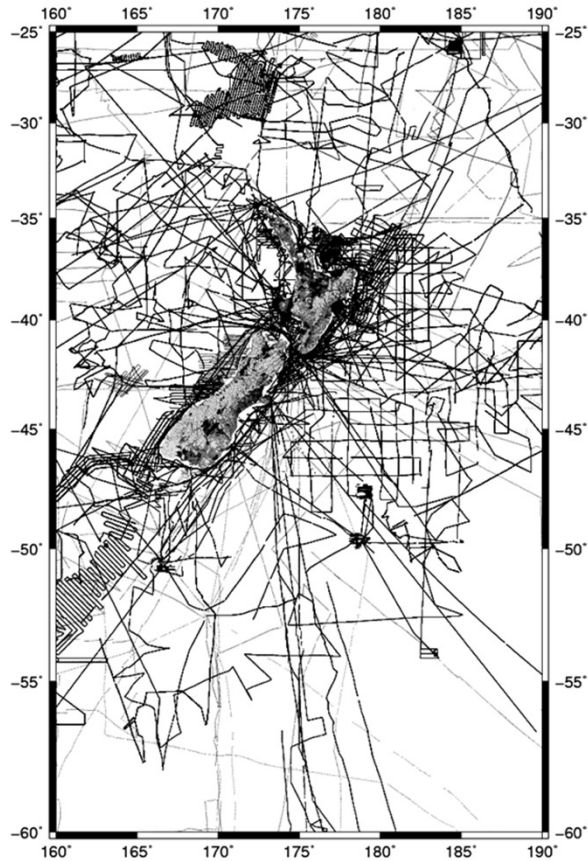
- Well defined “zero” level
  - NZGeoid2016
- Nationally consistent
- Maintained heights
- Accuracy statistically assessed
- Improved density of marks
- Consistent with NZGD2000



# What is a geoid?

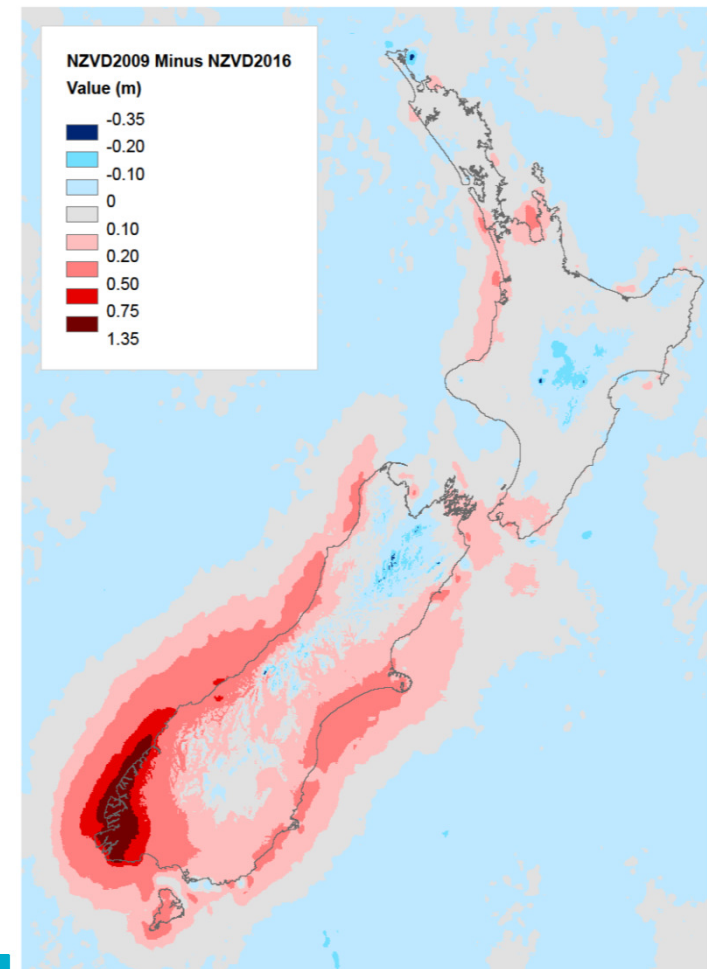
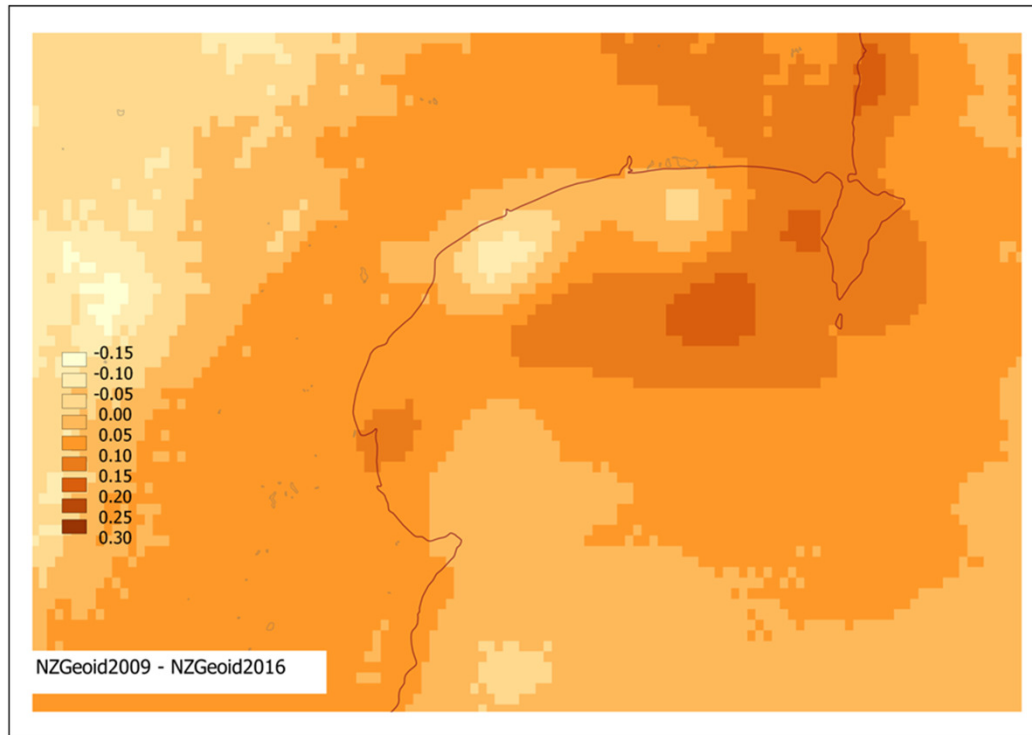


# NZVD2009 vs NZVD2016

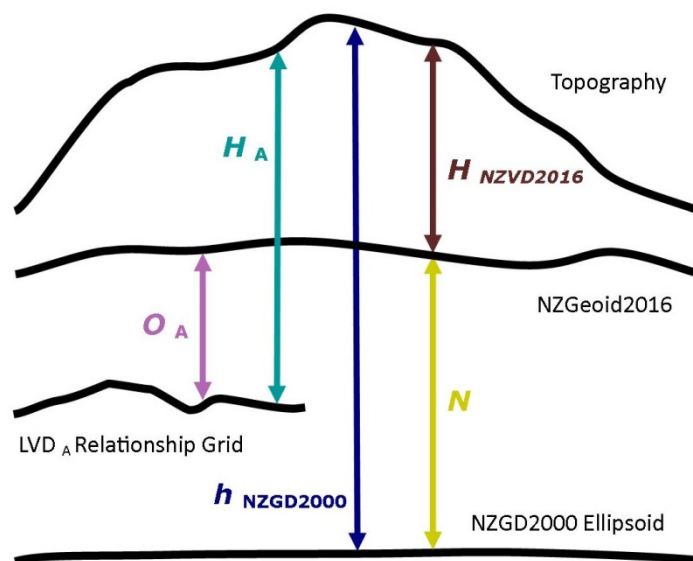




# NZVD2009 vs NZVD2016



## NZVD2016 transformations



NZVD2016 heights (**H**) can be determined by subtracting a NZGeoid2016 height (**N**) from an ellipsoid/GNSS height (**h**)

$$H = h - N$$

The LVD Relationship Grids (**O<sub>A</sub>**) transform NZVD2016 heights (**H**) from LVD heights (**H<sub>A</sub>**)

$$H_A = H + O_A$$

## Case Study: Nelson City and Tasman District

- Tasman District and Nelson City Councils used to use independent height datums: Nelson 1955 and Nelson City Datum
  - With a difference of  $\sim 12\text{m}$ .

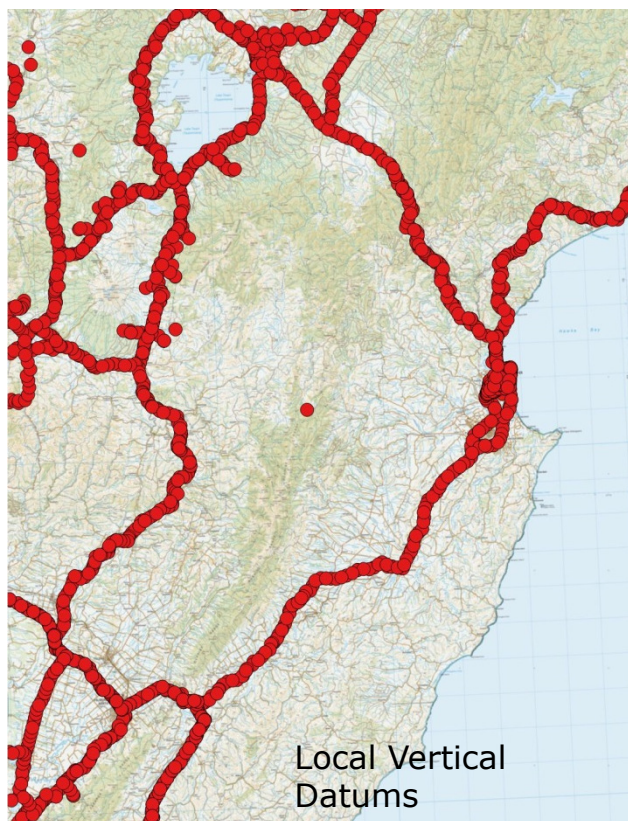


- One building site within the Nelson City boundary, had services supplied via Tasman District...
  - Two sets of plans with two different heights had to be prepared.
- In July 2017, both councils successfully adopted NZVD2016

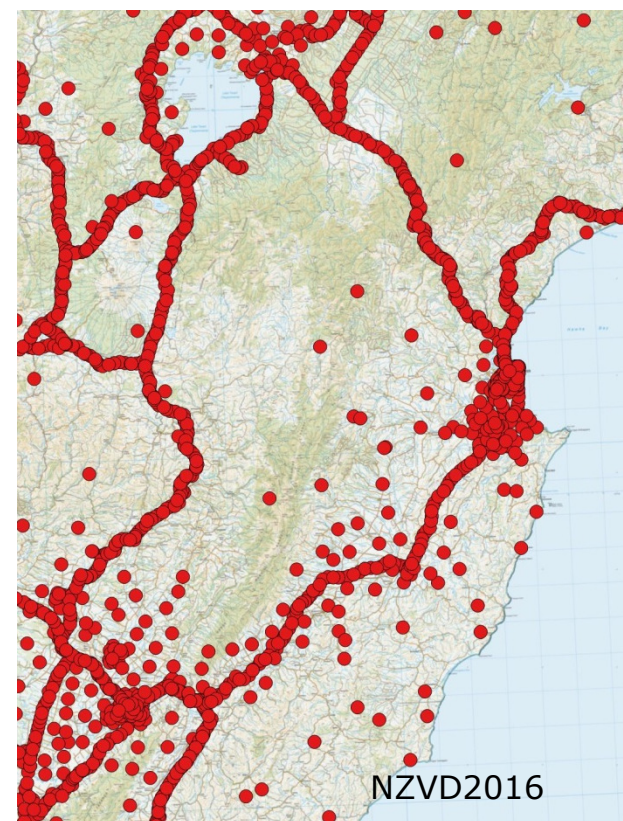
g 13 October 2018 NZVD2016 is now the standard for



## NZVD2016 Benefits

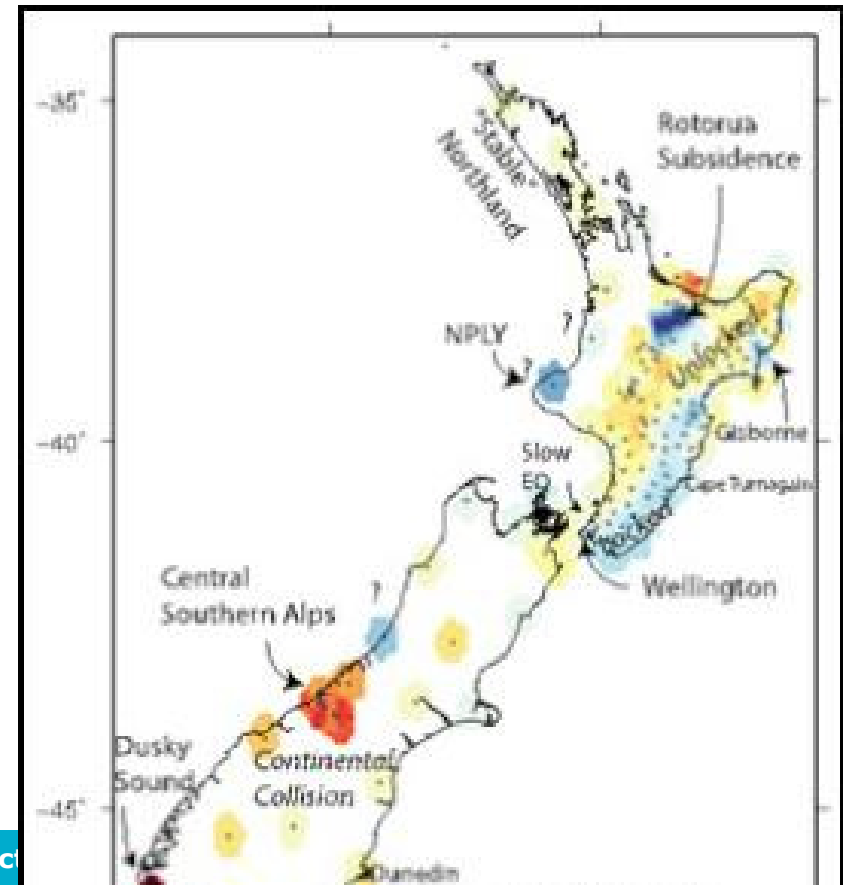


- Consistent heights
- Recoverable
- Readily accessible
- Easier to analyse multiple datasets



## Living on a Dynamic Country - vertical deformation

- New Zealand is constantly moving
- Vertical deformation is not always obvious
- NZVD2016 heights move with the land



## Resilience

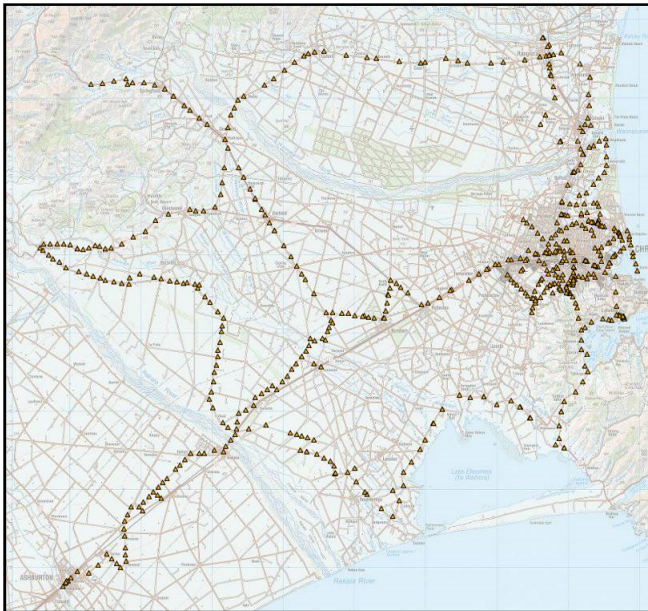
### - Kaikōura Recovery

- The coastline lifted approximately 1.0 metre around Kaikōura,
  - exposing kelp and paua.

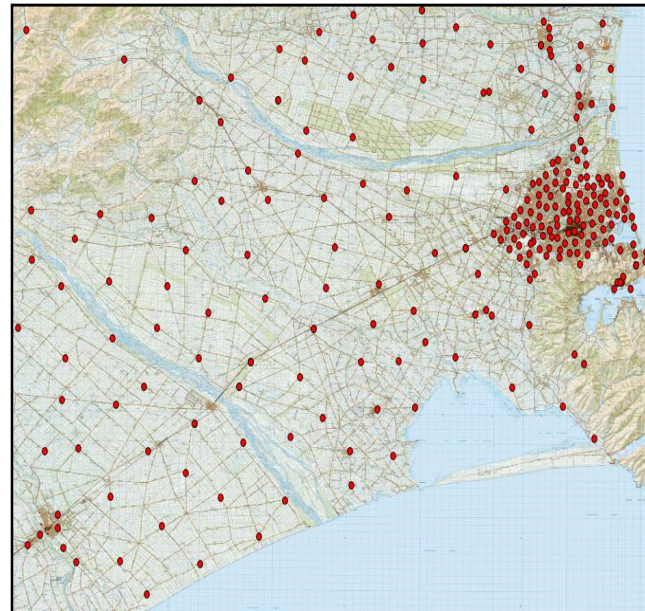




## Example – Disaster recovery



- Heights re-established by levelling
- 400 marks, 500 km



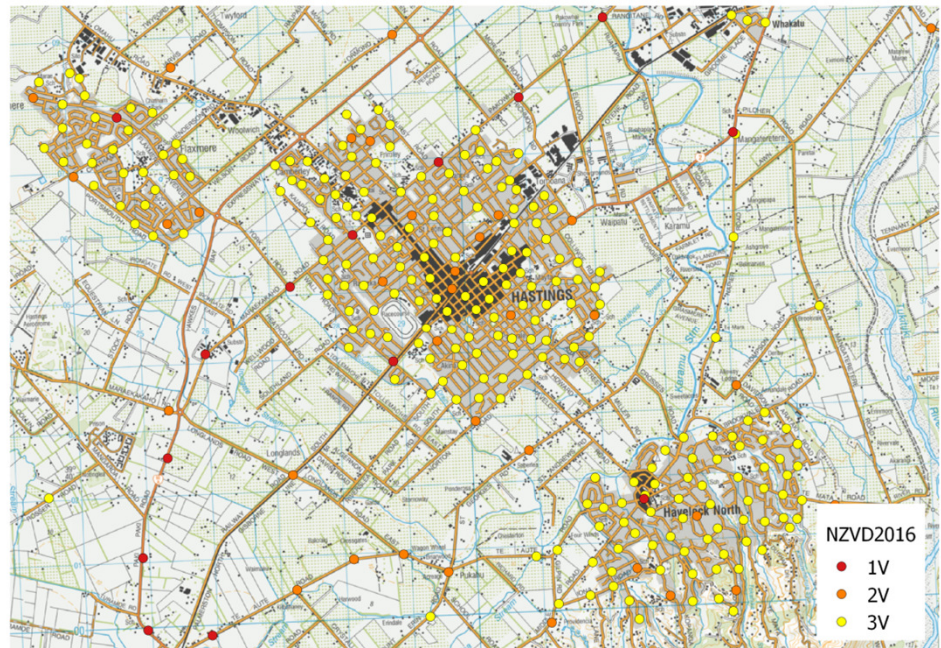
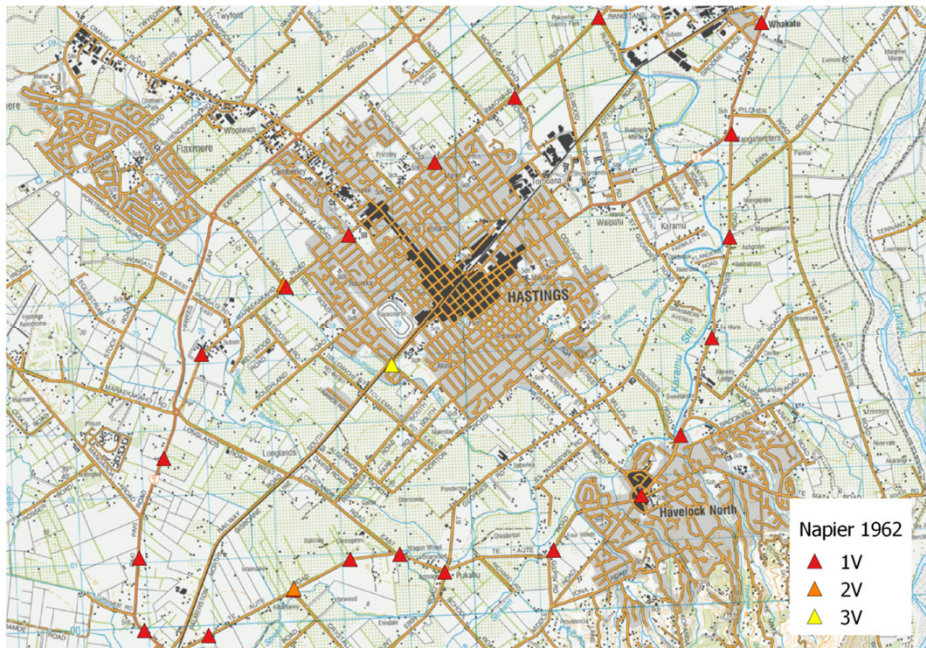
- NZGD2000 control re-established by GNSS Survey
- 250 marks

**Current heights above the geoid can be observed using GNSS**

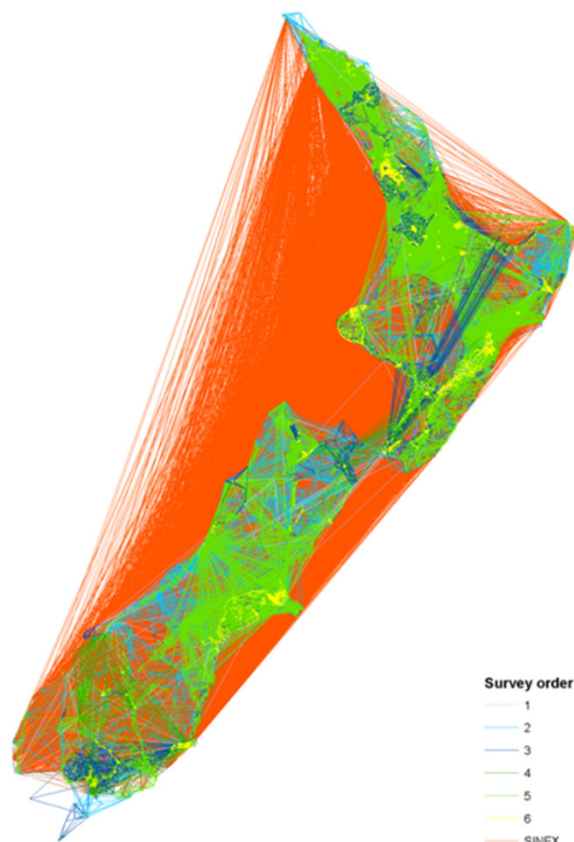
**An accurate geoid would have reduced the need for extensive levelling**



## Local example:



# NZVD2016 Order *Magic*



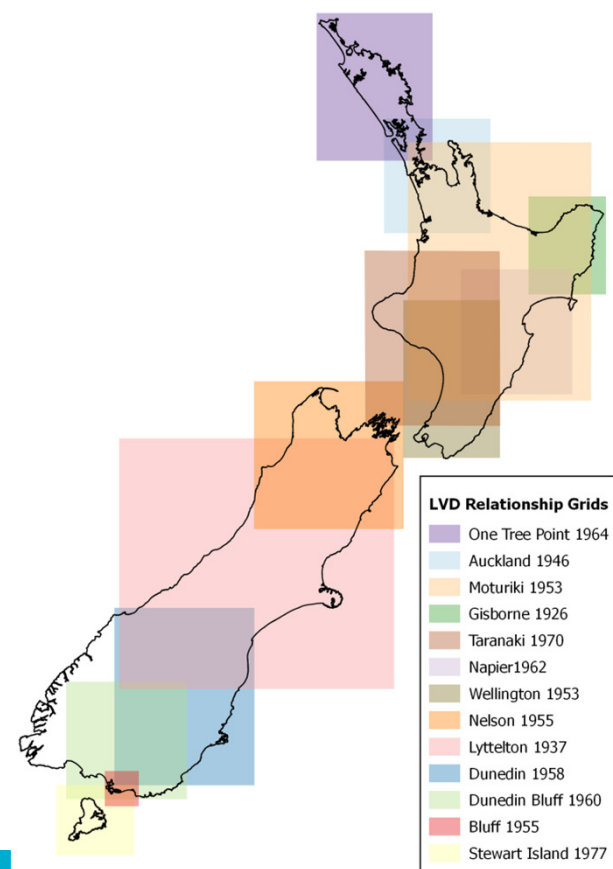
- Determined by observation
  - GNSS
  - Terrestrial observations
  - Order 1-2V levelling
- Relatively consistent
- Tested against accuracy standards

Order	Purpose	Tier (95% CI, m)	Class (95% CI) Constant (m)	Class (95% CI) Proportional (m/m)
1V	National height network	0.25	0.01	0.000 003
2V	-	0.35	0.01	0.000 01
3V	Cadastral vertical control	0.35	0.02	0.000 1
4V	-	0.5	0.03	0.000 15
5V	-	1	0.3	0.000 6
6V	-	-	-	-

Order 6V has no accuracy upper accuracy limit, it contains all coordinates with an accuracy less than Order 5V.

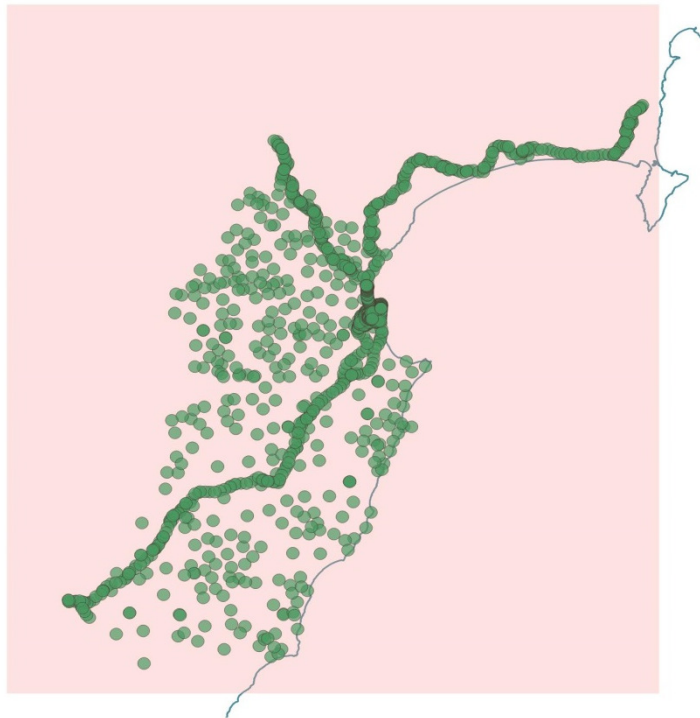
## Relationship grids

Datum	Range	STD
Auckland	0.23 - 0.35	0.02
Bluff	0.22 - 0.34	0.02
Dunedin-Bluff	0.17 - 0.33	0.02
Dunedin	0.19 - 0.44	0.02
Gisborne	0.27 - 0.39	0.02
Lyttelton	0.22 - 0.47	0.01
Moturiki	0.17 - 0.49	0.02
Napier	0.14 - 0.29	0.02
Nelson	0.23 - 0.43	0.02
One Tree Point	-0.01 - 0.15	0.01
Taranaki	0.23 - 0.34	0.02
Wellington	0.34 - 0.50	0.02
Stewart Island	0.30	0.18

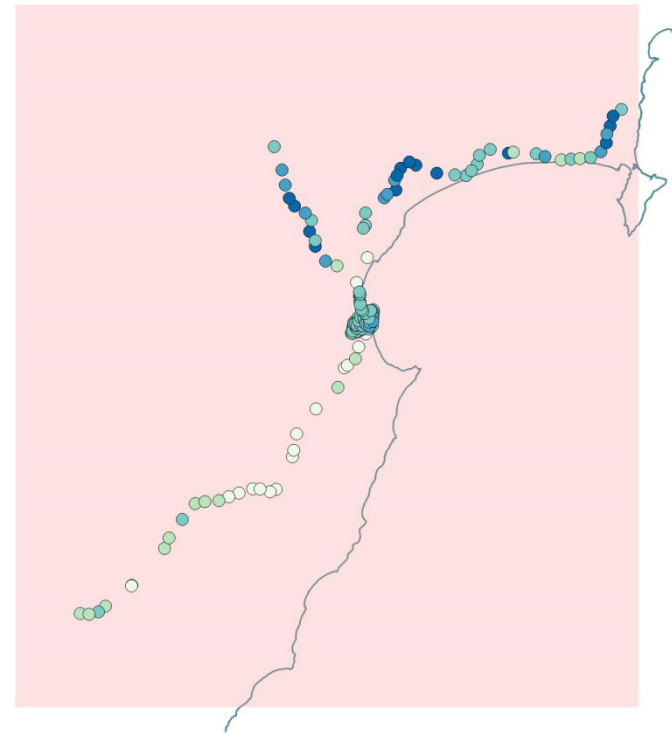


# Relationship grid control marks

**Heighted Marks**

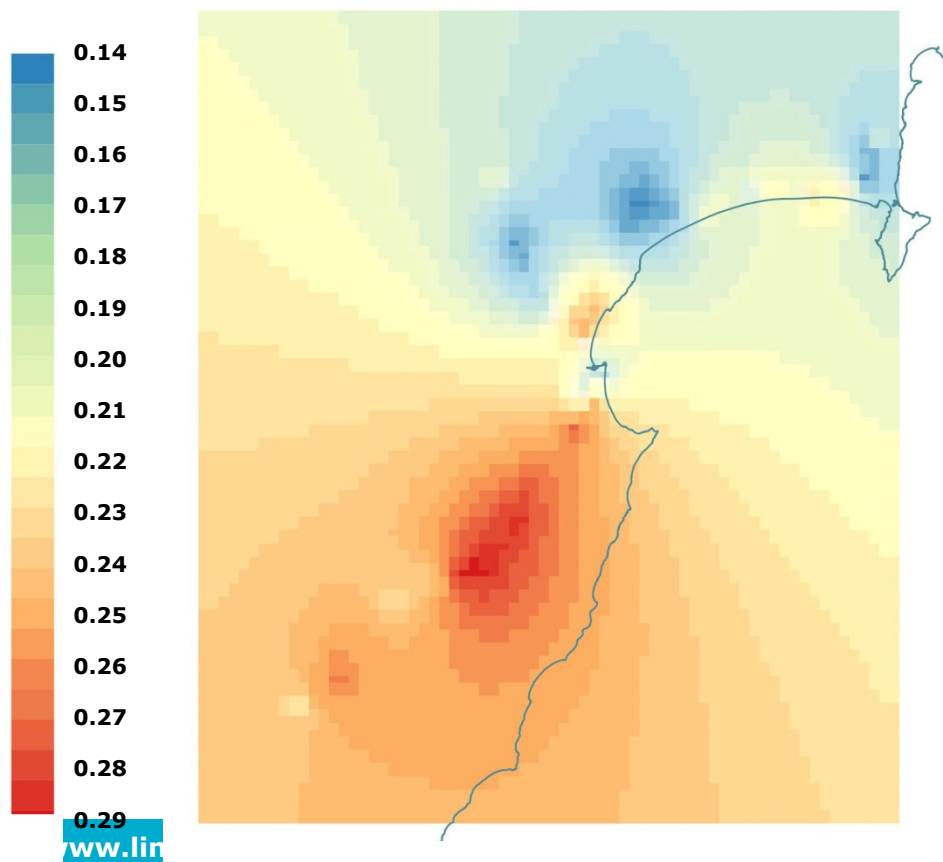


**GPS/Levelling Control**





## Relationship grid example

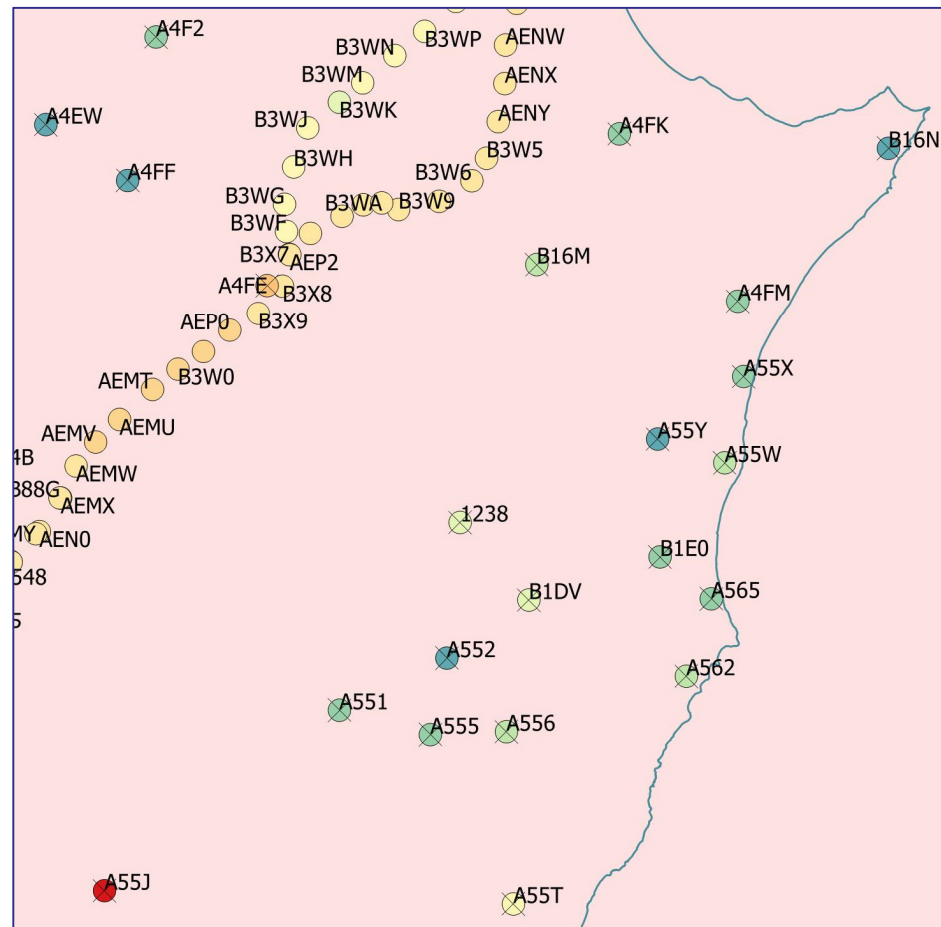
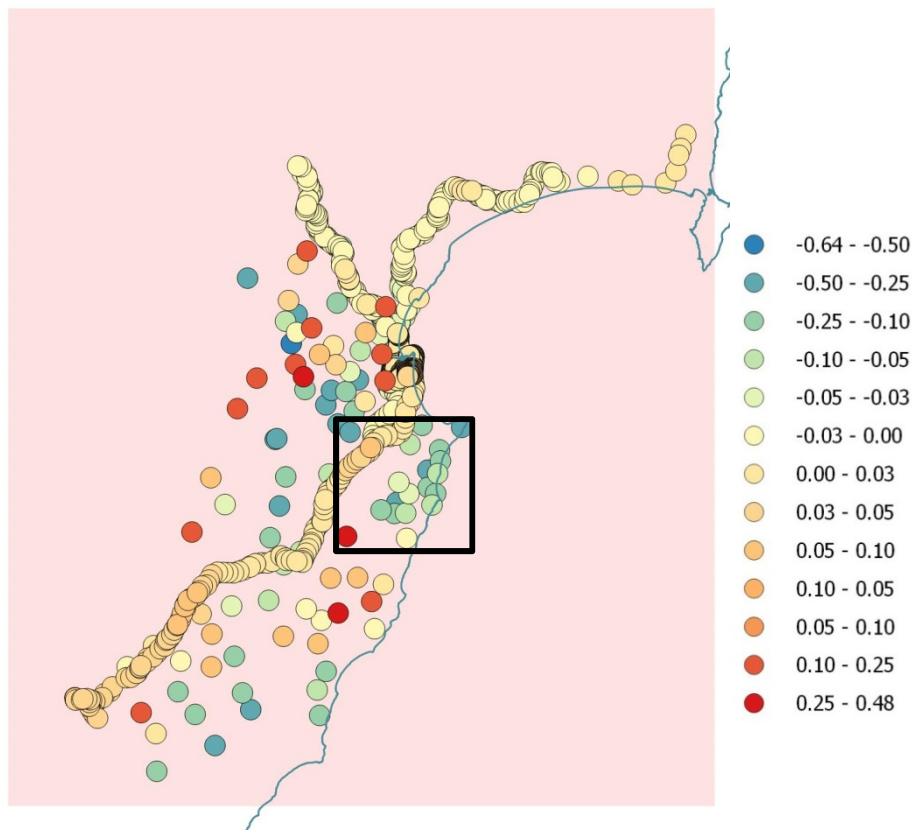


**Created using:** *datumgrid*

### Parameters

- Grid Spacing: 2'
- Zero height: LVD mean (0.20)
- Point error: 1mm
- Distortion error: 0.5 ppm

<b>Mean</b> (m)	<b>0.20</b>
<b>Range</b> (m)	<b>0.14- 0.29</b>
<b>SD</b> (m)	<b>0.02</b>



# Geodetic Database

## A4EX: Mark details

### MARK IDENTIFICATION

Code:	<b>A4EX</b>	Country:	<b>New Zealand</b>
Name:	<b>U FERNHILL</b>	Land District:	<b>Hawkes Bay</b>
Alternatives:	<b>FERNHILL</b>	Topo50 sheet:	<b>BK38</b>
		NZTM:	<b>5610701.310</b> <b>1923030.880</b>

### NZGD 2000 COORDINATES

Latitude:	<b>39° 35' 33.16190" S</b>	Order:	<b>3</b>
Longitude:	<b>176° 45' 41.65893" E</b>	Authorised:	<b>30-Jun-2016</b>
Ellipsoidal height (m):	<b>94.502</b>	Reference:	<b>National Geodetic Adjustment 2016-07-16</b>

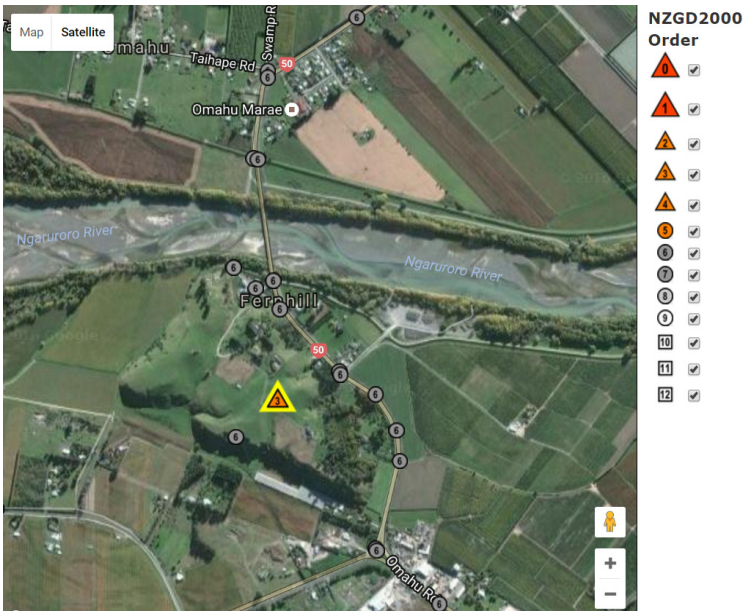
[Historical values](#)

Circuit	Northing (m)	Easting (m)	Scale Factor	Convergence
<b>Hawkes Bay Circuit 2000</b>	<b>806467.907</b>	<b>407555.768</b>	<b>1.0000007</b>	<b>+0° 03' 21"</b>

[Historical values](#)

### ORTHOMETRIC HEIGHTS

Height datum	Height (m)	Order	Calculation Date	Reference
<b>New Zealand Vertical Datum</b>	<b>76.280</b>	<b>1V</b>	<b>18-Nov-2016</b>	<b>NZVD2016 heights from National Geodetic Adjustment 9-11-2016</b>
<b>Napier Vertical Datum 1962</b>	<b>76.50</b>	<b>4V</b>	<b>8-Aug-1984</b>	<b>HB 2/115</b>

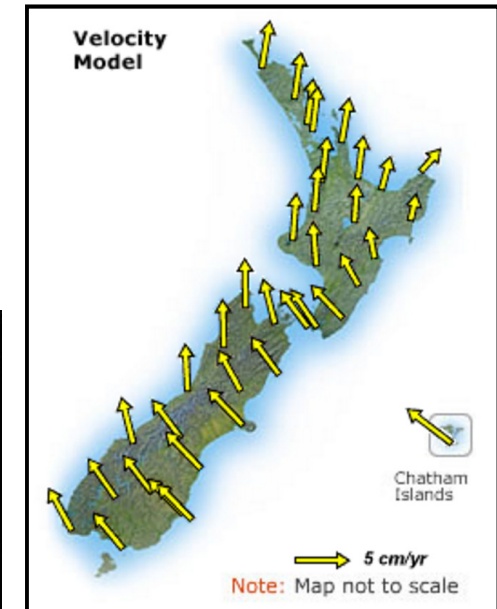
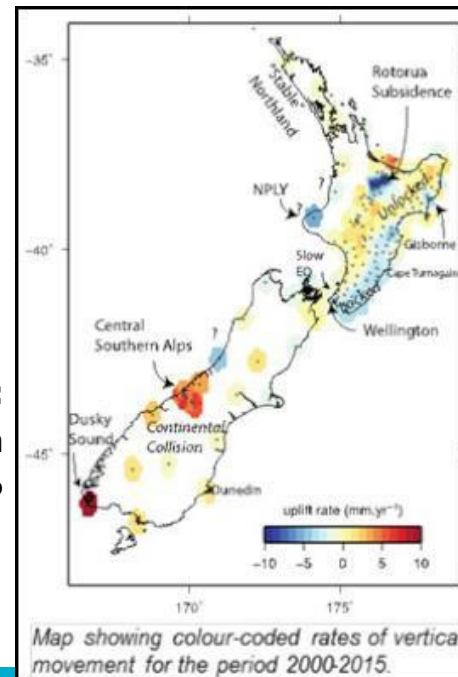


## Living on a Dynamic Country

- New Zealand is constantly moving
- Vertical deformation is not always obvious

### Press Release:

Victoria University of Wellington  
23 November 2016



# LINZ Tools

[About LINZ](#)[Contact us](#)[Back to main site](#) ↑

## Online Conversions - vertical datums

The coordinate converter has been upgraded to account for the tectonic movement of New Zealand. This means that converting coordinates from global systems (WGS84 and ITRF) realisations to New Zealand coordinate systems requires a transformation date, and that the resulting coordinates are different to those from the less accurate version of the coordinate converter.

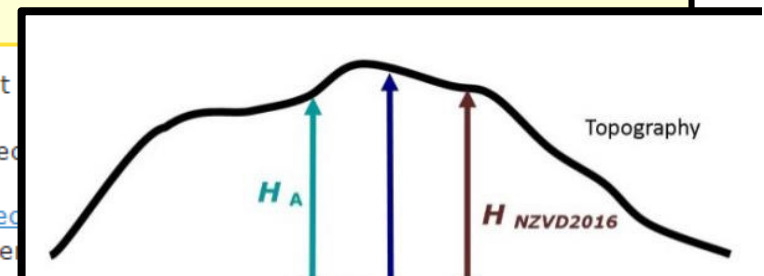
The LINZ website has [more information on the changes](#)

The [previous version of the converter](#) will be available until the end of 2016.

Convert between pre-selected [geodetic datums](#) and [projections](#) using default input

Use the [basic online conversion](#) to choose between pre-selected datums and projections

Use the [detailed online conversion](#) to choose from a wider range of [datums](#), [projections](#), and [output formats](#) (including bulk options) that are more suited to users with an understanding of





# Geoid maintenance



## Next Steps

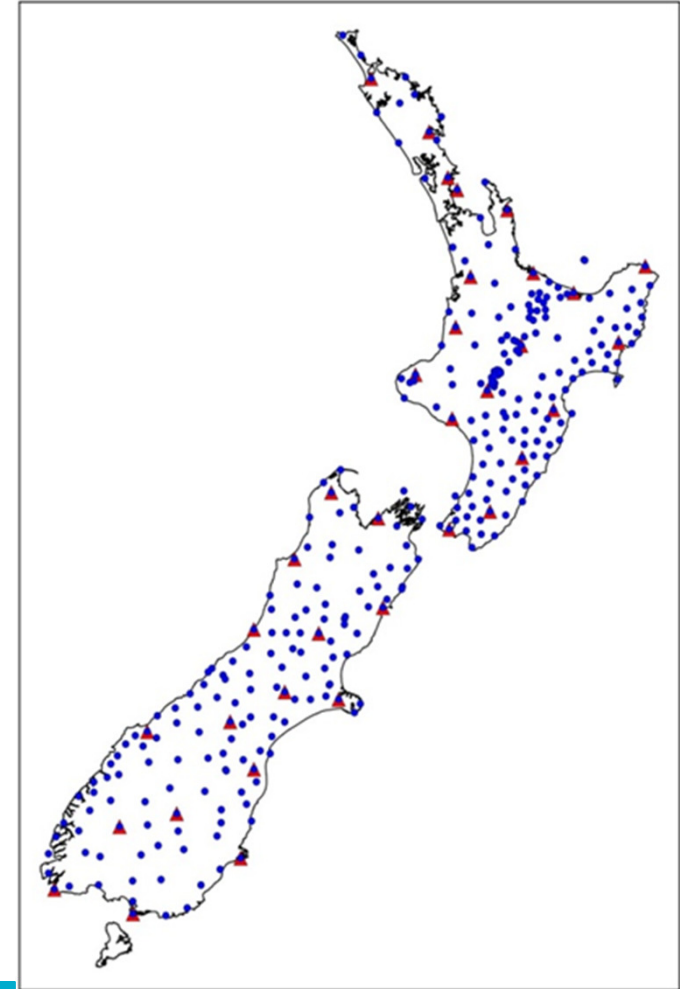
- Datasets usually defined in terms of different vertical datums and reference surfaces
  - Topography – MSL
  - Hydro – LAT/CD
  - Cadastral – MHWS
  - Geodesy – MSL & ellipsoid
- Challenge is to combine different datasets



Photo: 14/09/12 Stuff: Snells Beach

## Maintenance of control points

- Regional Deformation Monitoring Networks
  - 8 years
- Local Deformation Monitoring Networks
  - Being established



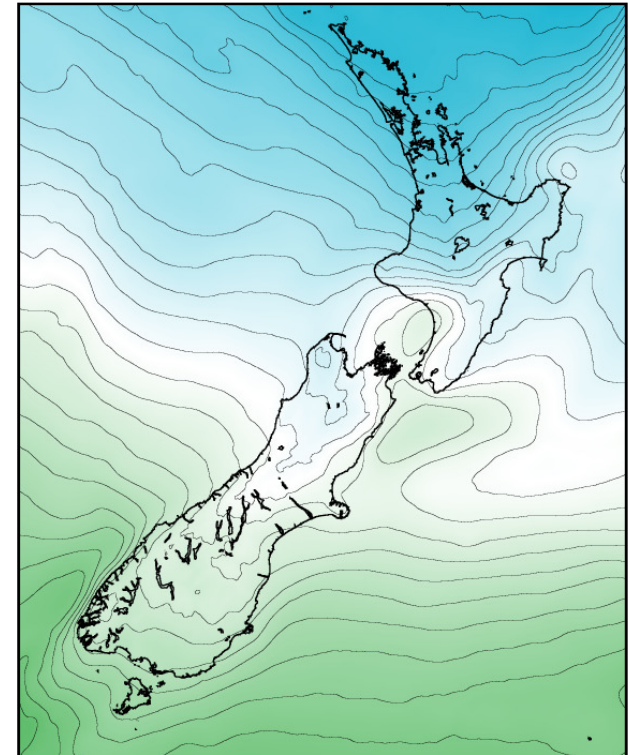




**MSL Based Datums**



**NZ Vertical Datum 2009**



New Zealand's vertical  
datums

# Questions?

