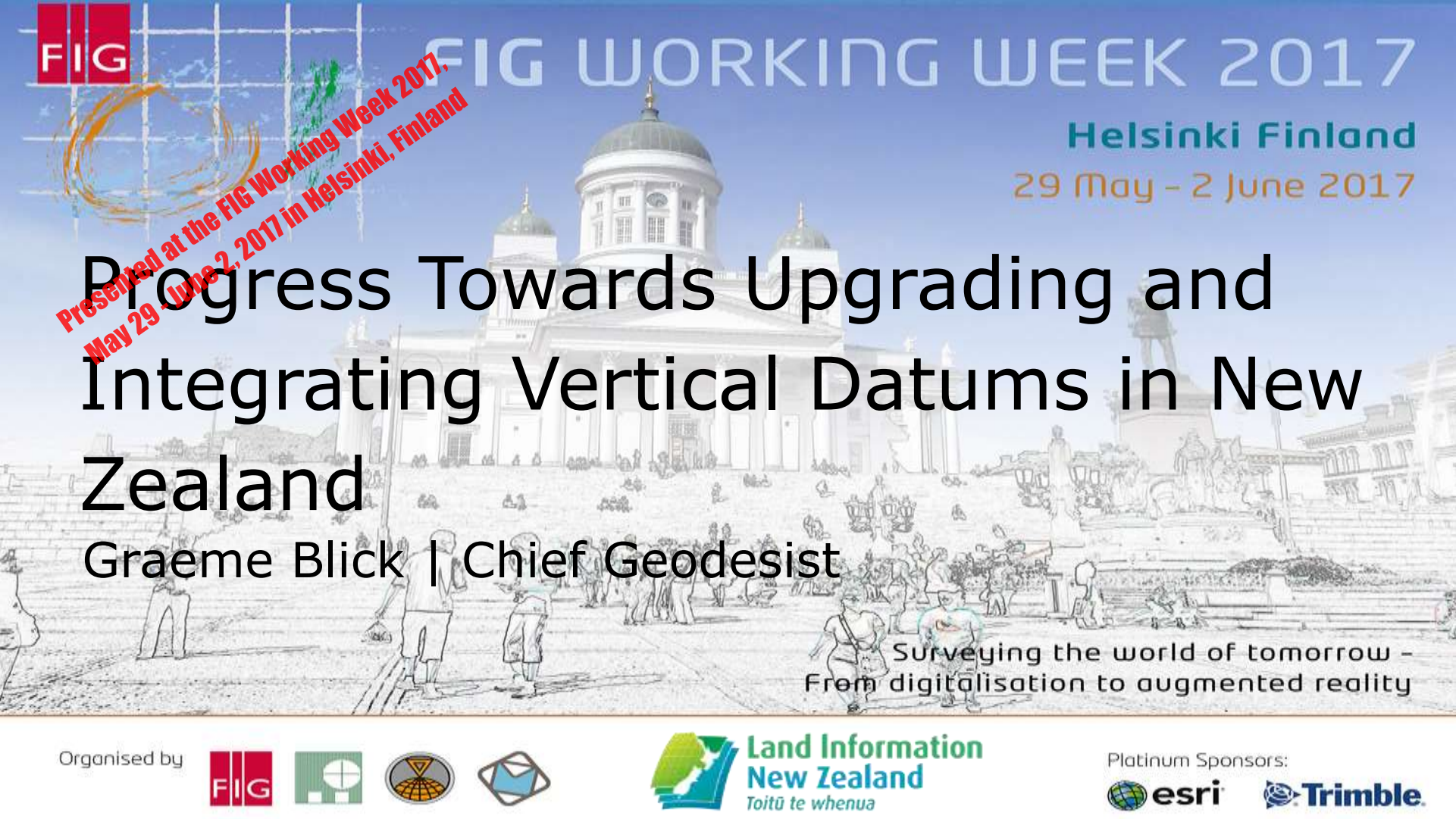


Progress Towards Upgrading and Integrating Vertical Datums in New Zealand

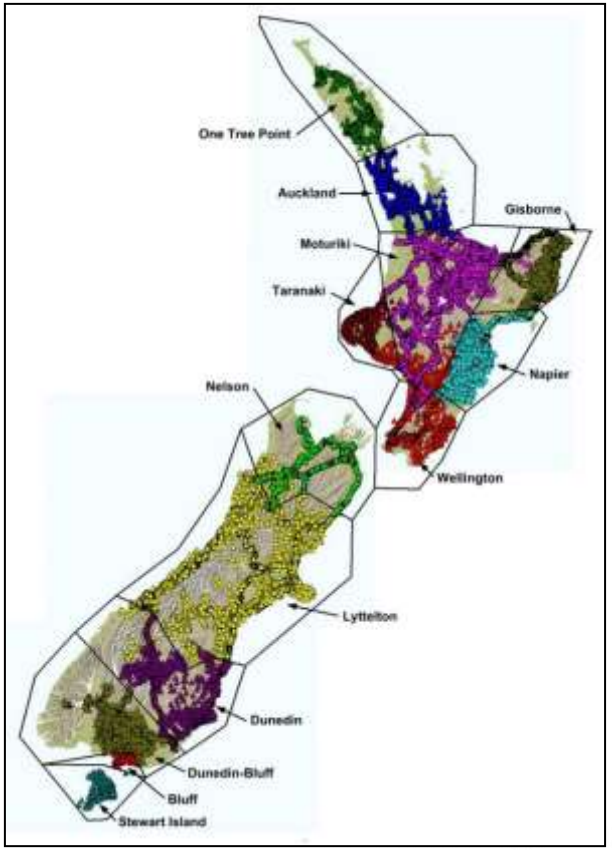
Graeme Blick | Chief Geodesist

What we'll cover

- Levelling based datums
- New Zealand Vertical Datum 2009
- New Zealand Vertical Datum 2016
- Next Step -Joining Land and Sea (JLAS) (transforming between land and sea datums)

Historic levelling-based datums

- 13 levelling based datums
  - based on “MSL”
- Not nationally consistent
  - offsets of up to 0.5m
- No national adjustment



Height Modernisation

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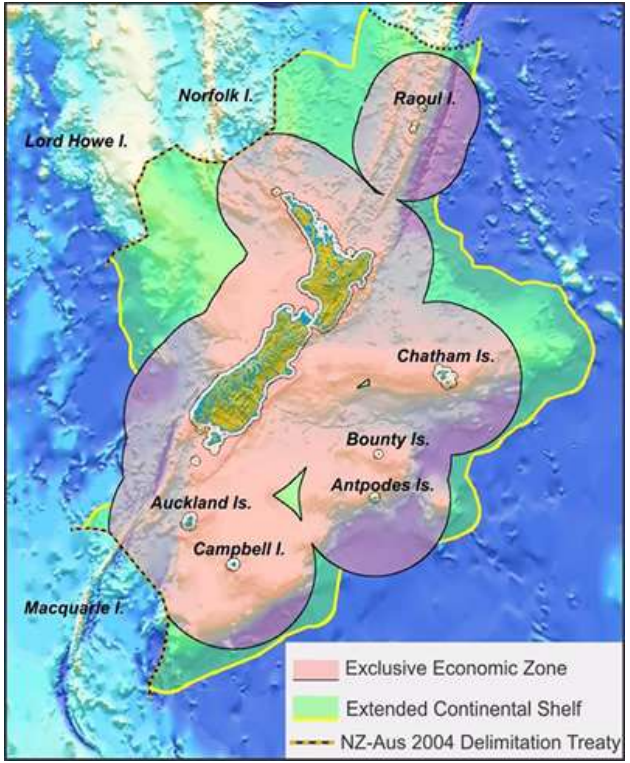
Toitū te whenua

Desirable attributes of a national vertical datum:

- Accessible - anywhere
- Consistent reference system
- Compatible with NZGD2000
  - GNSS heighting
- Fit for purpose
- Robust
- Maintainable and assessable



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

New Zealand Vertical Datum 2009

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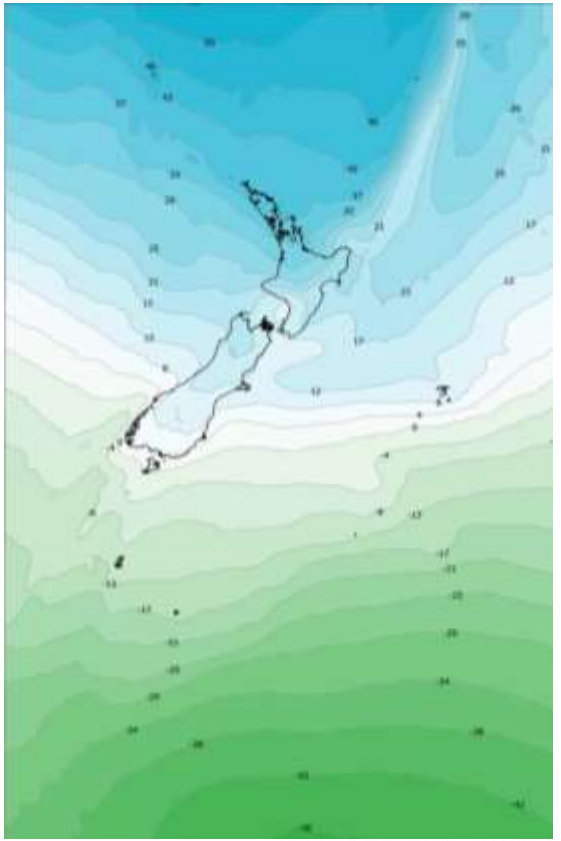
- Based on NZ Geiod 09
- NZ one of the first countries to adopt a geoid based vertical datum
- Provided nationally consistent vertical datum within the NZ continental shelf
- Enabled normal-orthometric heights from GNSS



New Zealand Vertical Datum 2009

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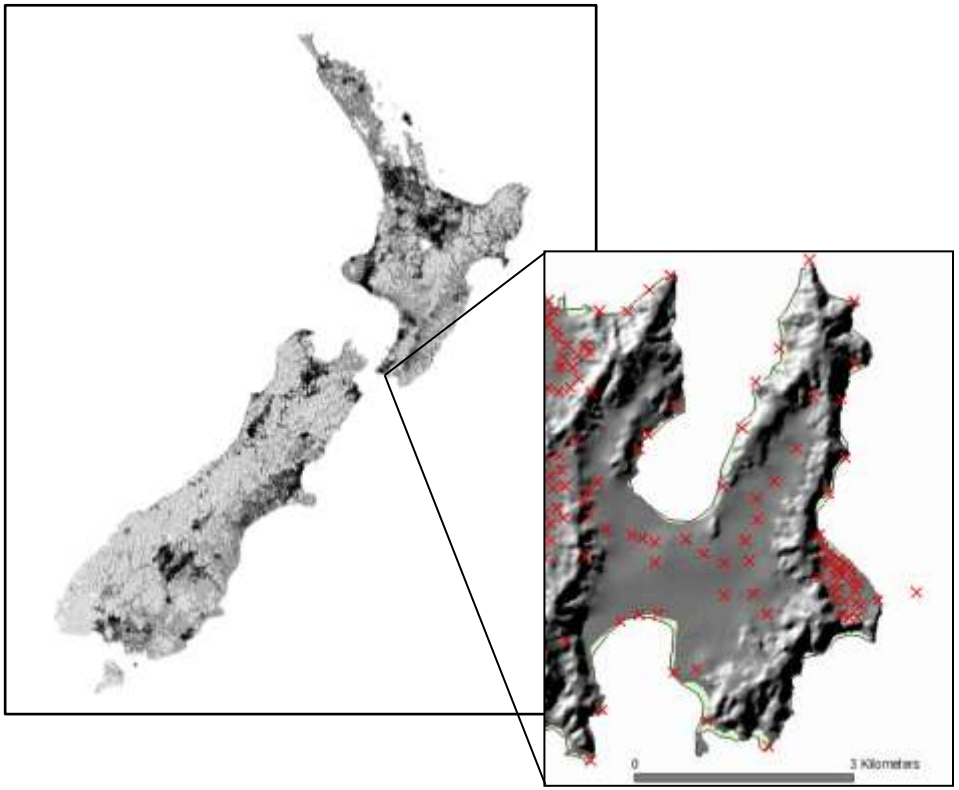
Toitū te whenua

- Includes official offsets to 13 local MSL vertical datums
- Based on a simple offset at the reference tide gauge
- Nominal accuracy ±0.06m

Datum	Offset	Std Dev
One Tree Point 1964	0.06	0.03
Auckland 1946	0.34	0.05
Moturiki 1953	0.24	0.06
Gisborne 1926	0.34	0.02
Napier 1962	0.20	0.05
Taranaki 1970	0.32	0.05
Wellington 1953	0.44	0.04
Nelson 1955	0.29	0.07
Lyttelton 1937	0.47	0.09
Dunedin 1958	0.49	0.07
Dunedin-Bluff 1960	0.38	0.04
Bluff 1955	0.36	0.05
Stewart Island 1977	0.39	0.15

NZVD2009 limitations

- Irregular gravity coverage
- Computed from existing gravity data
- Gravity data not collected for geoid determination
- Simplistic offset modelling to existing MSL datums



Why improve it?

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Toitū te whenua

Cadastral Surveyors

Local Government

Hydrographic Charting

Topographic Mapping

NZVD20??

0.001 | 0.03 | 0.10 | 0.15 | 0.25 | 0.5 | 1.0

NZVD2009

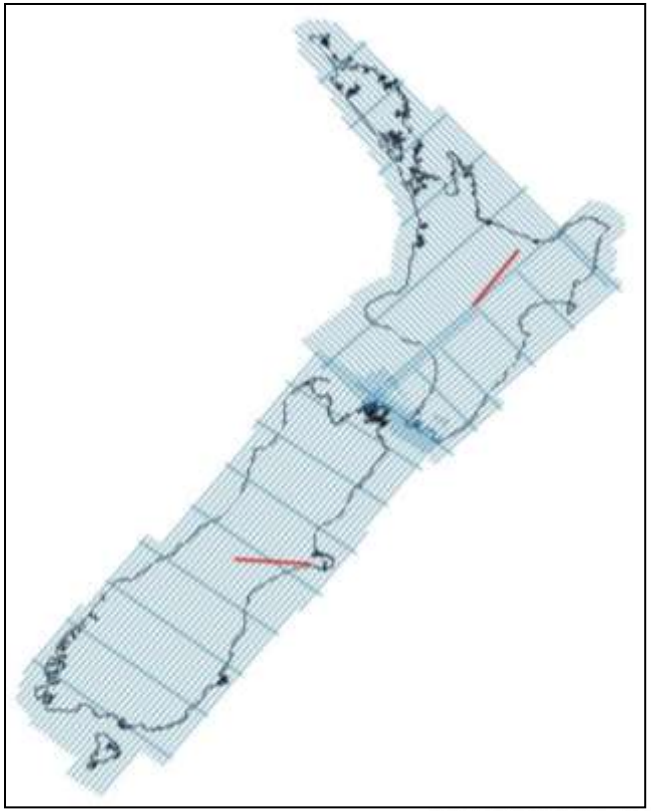
Scientific Monitoring

GIS

Recreational GNSS

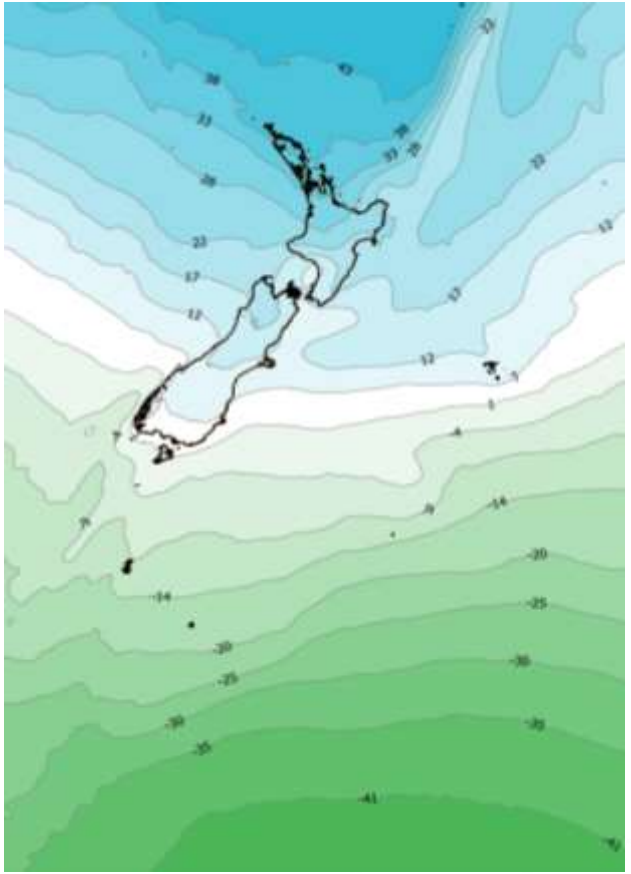
Improvements to NZVD2009

- Inclusion of airborne gravity
- A trended surface model used to better model the offsets to the local vertical datums



New Zealand Vertical Datum 2016

- Lead to the development of NZVD2016

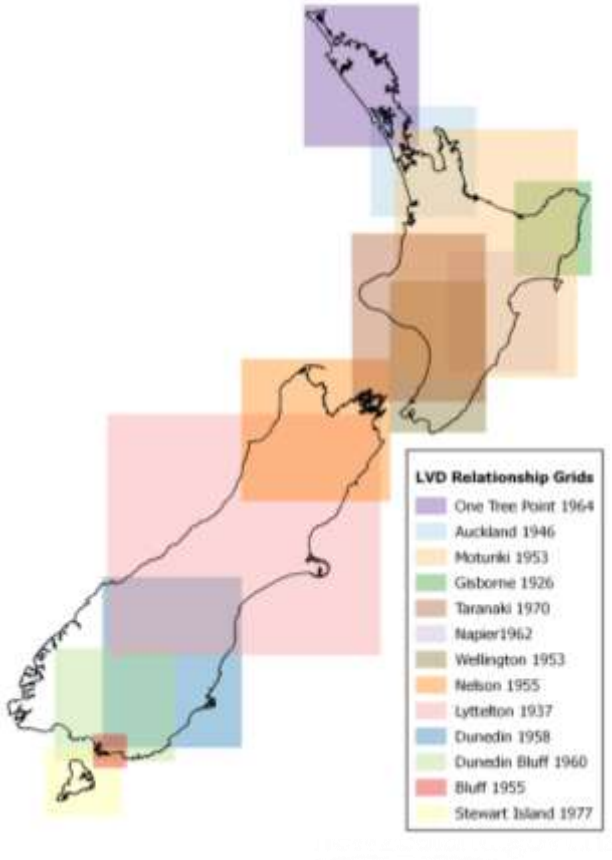


New Zealand Vertical Datum 2016

Land Information New Zealand
Toitū te whenua

- Includes official offsets to 13 local MSL vertical datums
  - based on a a trended surface
- Nominal accuracy ±0.02m

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



Differences between NZGeoid2009 and NZGeoid2016

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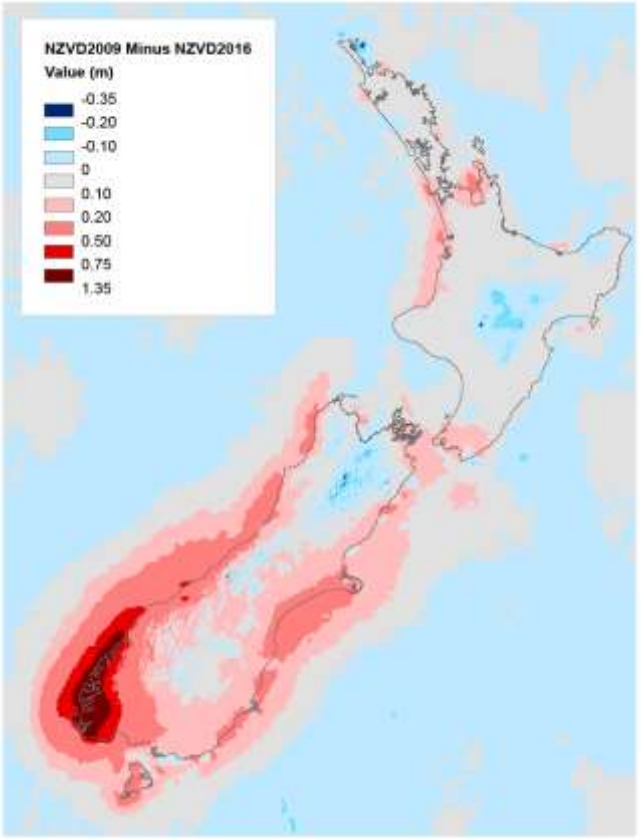
- Most significant changes:
  - Coastal areas
  - Mountainous regions
  - New global gravity model

- GPS/Levelling height changes:
  - Average: 0.10m
  - Range: -0.11m to 0.57m



Next Step - Joining Land and Sea (JLAS project)

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Sea level datums

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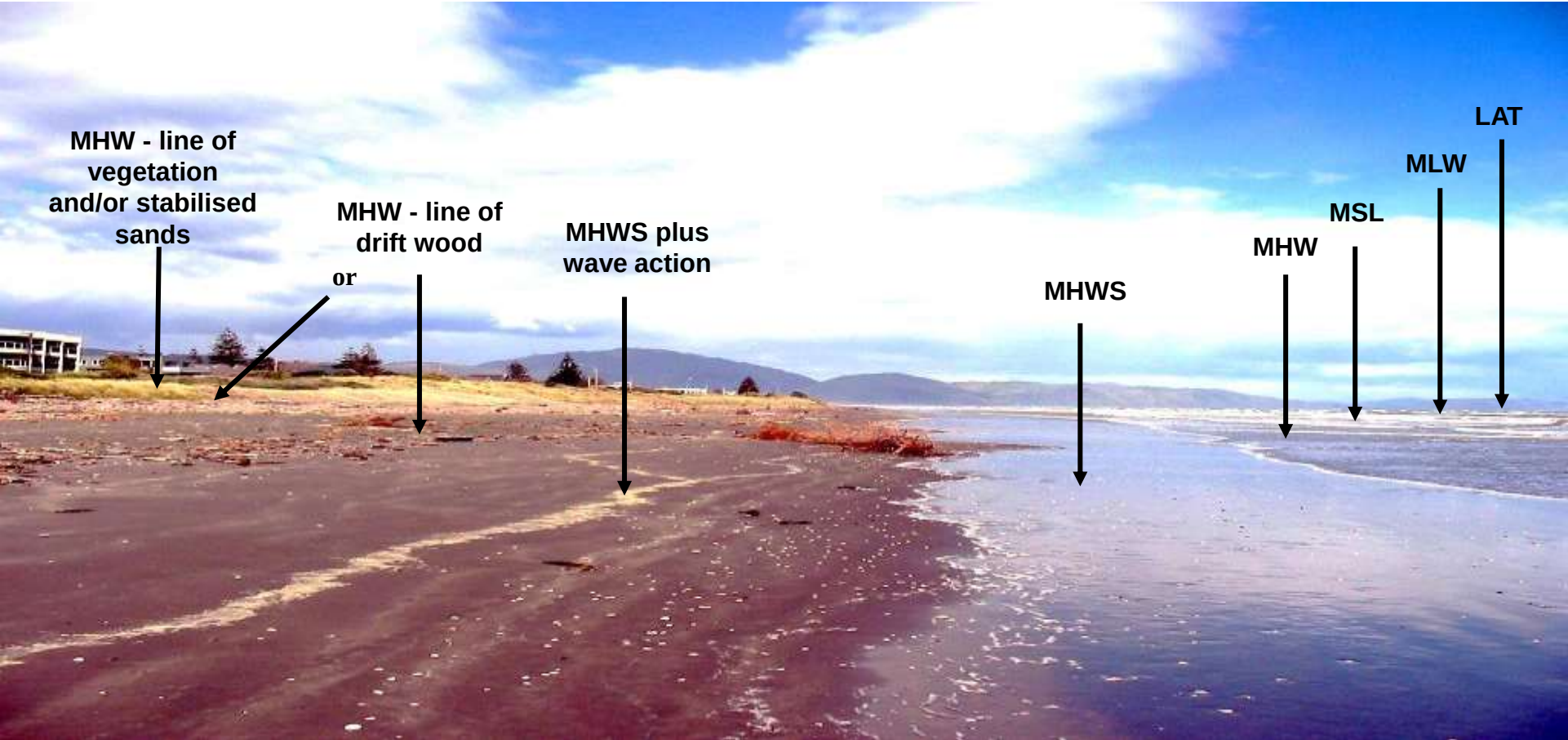

Geometric and sea level datums

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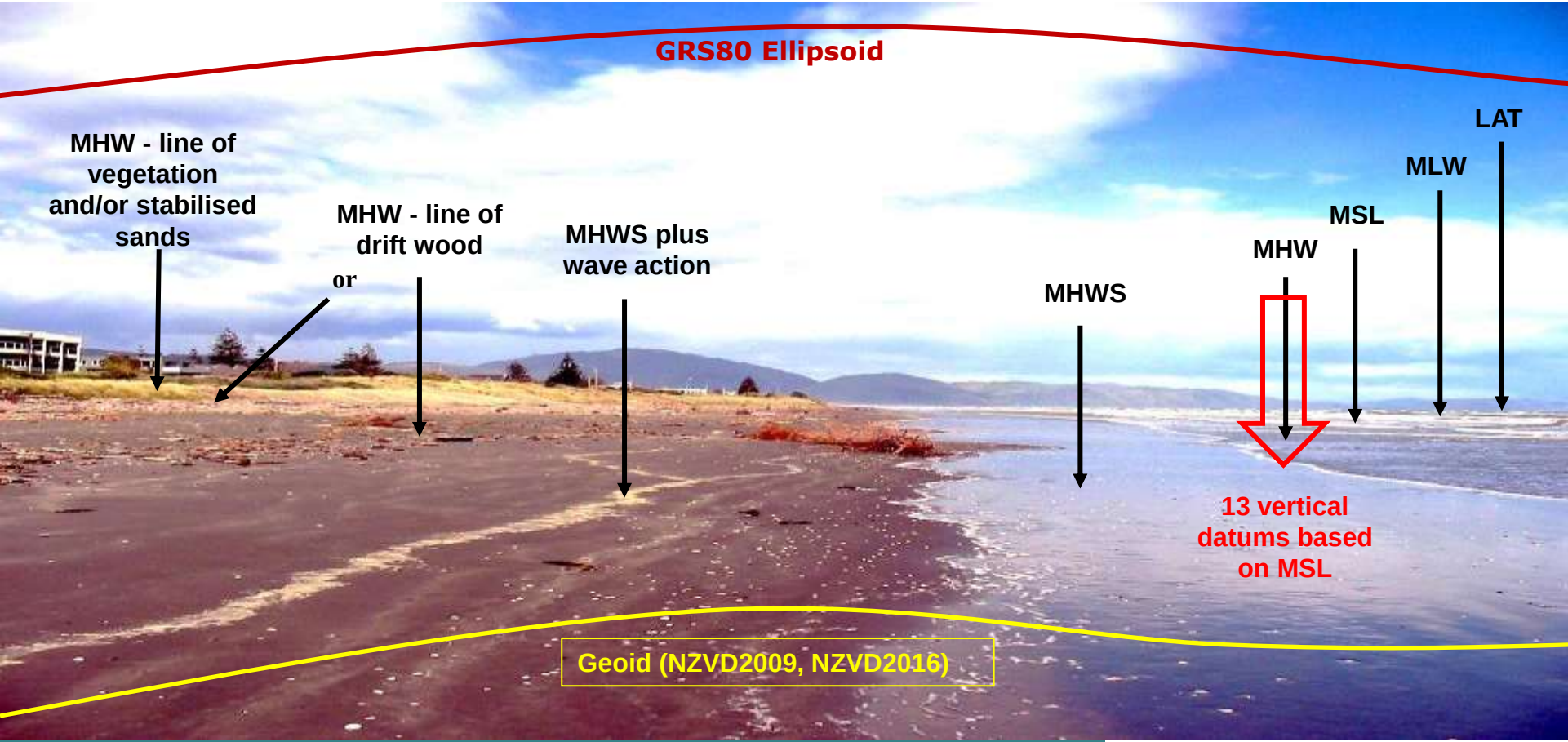
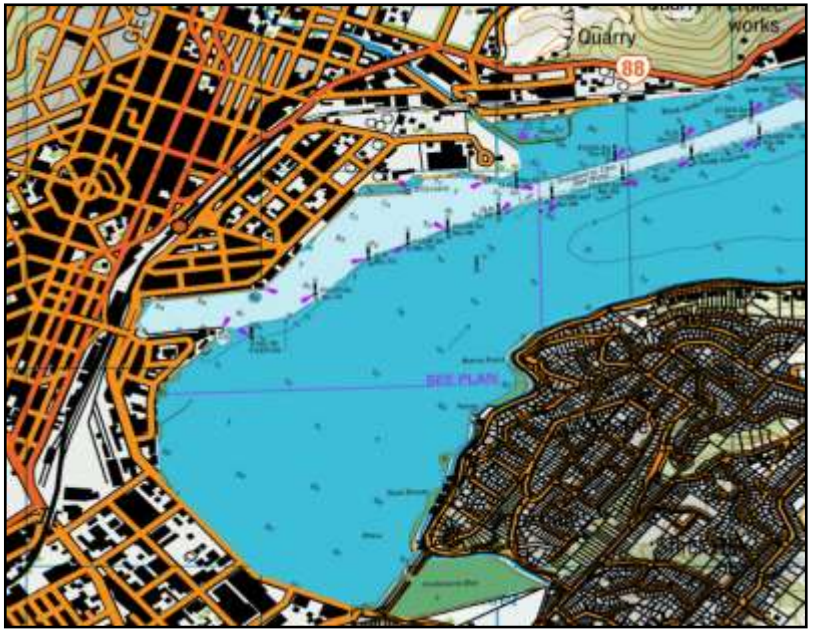


Joining land and sea

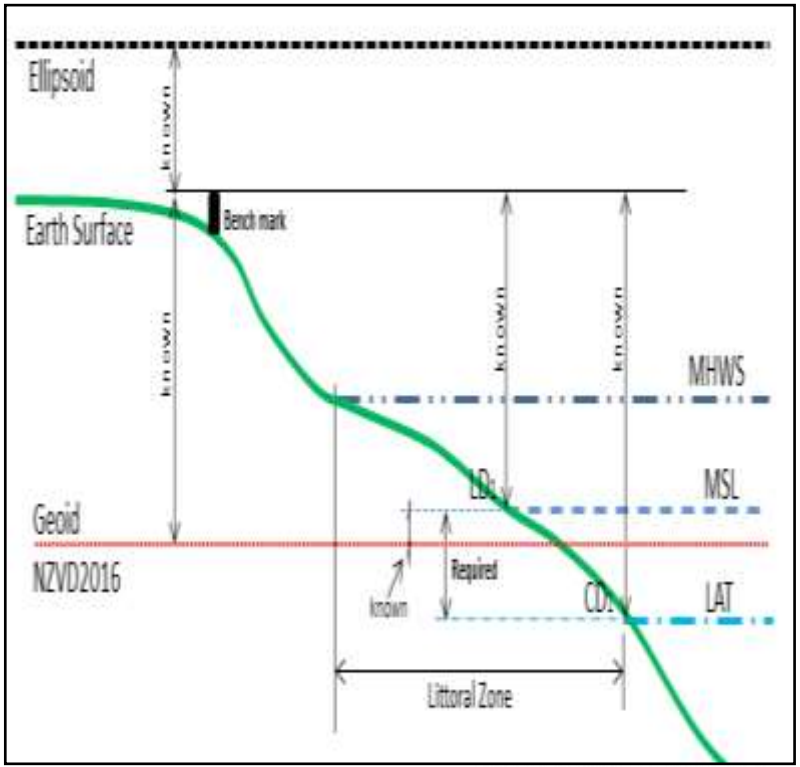
- Existing datasets defined in terms of different vertical datums and reference surfaces
  - Topography – MSL
  - Hydro – LAT/CD
  - Cadastral – MHWS
  - Geodesy – MSL & ellipsoid
  - GIS - ellipsoid
- Challenge is to combine different datasets



Seamless mapping of the land and sea

Relating vertical datums

- For elevation datasets to be blended together, they must be able to be referenced to a common vertical datum/surface
- Joining datasets:
  - Land data surveyed on different datums
  - Depth data from different charts
  - Depth data and height data



Integration of Tidal Data

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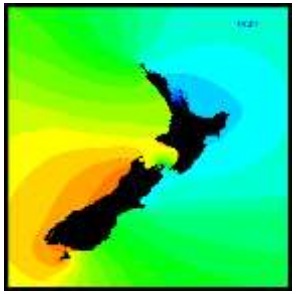
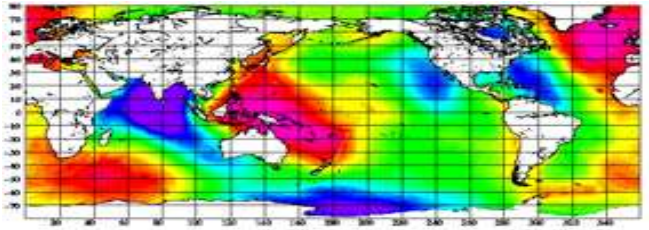
Toitū te whenua

- Tidal records > 1 month duration
- Tidal model
- Ellipsoidal heights at the gauge locations
- Satellite altimetry





Development of a transformation tool

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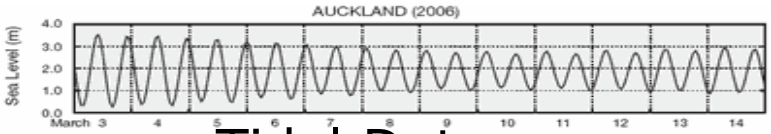
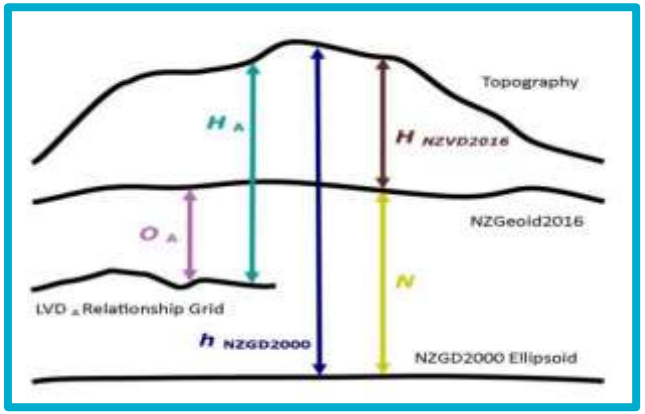
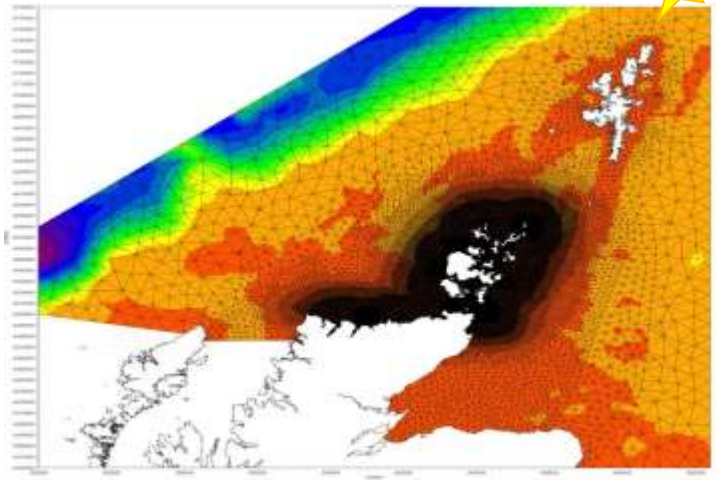
Toitū te whenua



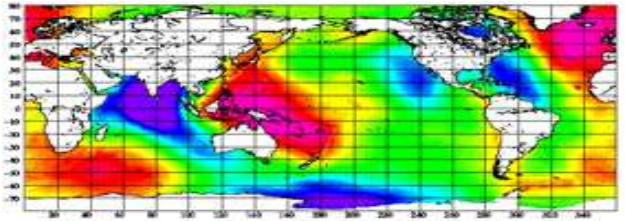
Tidal Data

interpolation



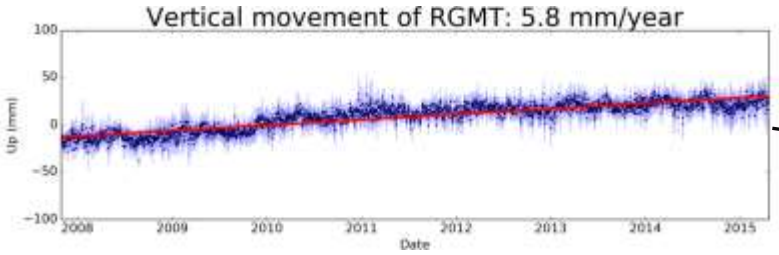


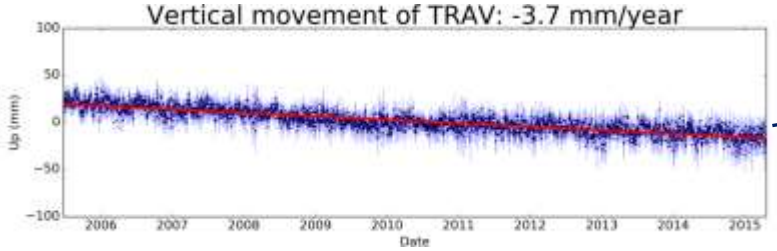
Hydrodynamic Model

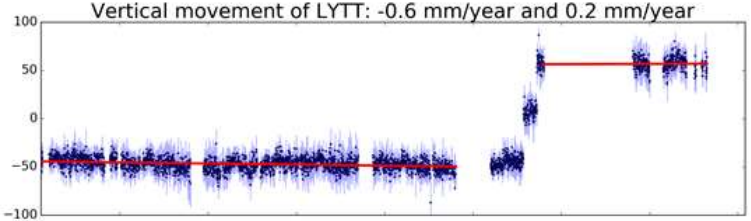


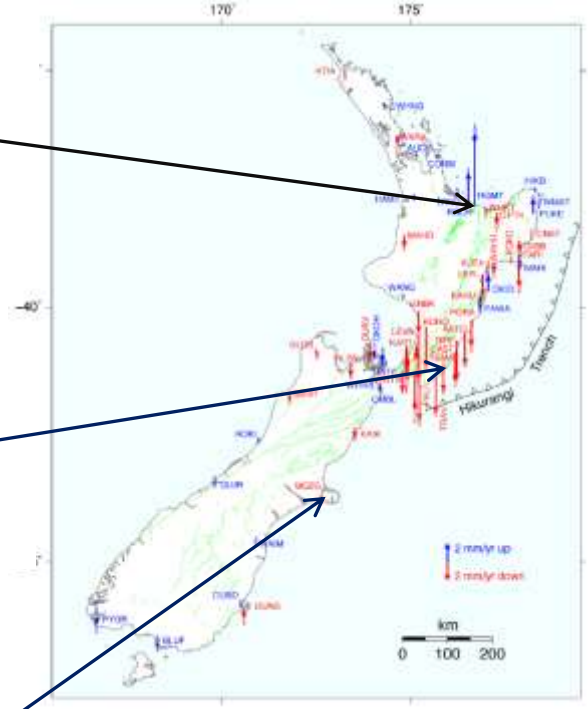
Satellite Altimetry

Present-day vertical rates









Beavan, R.J.; Litchfield, N.J. 2012. Vertical land movement around the New Zealand coastline: implications for sea-level rise, *GNS Science Report* 2012/29

Long term sea level change

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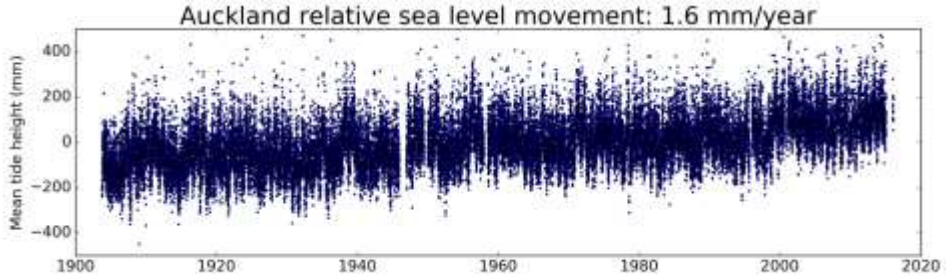

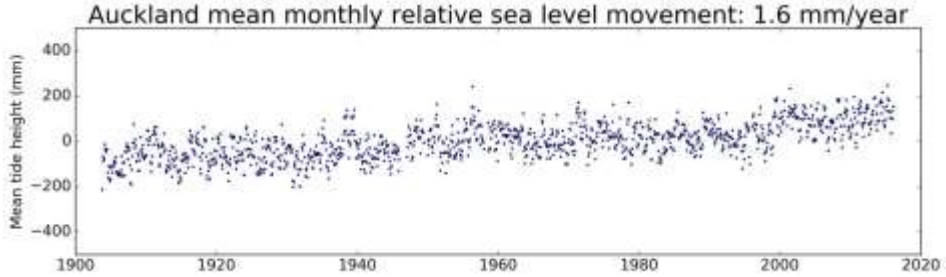

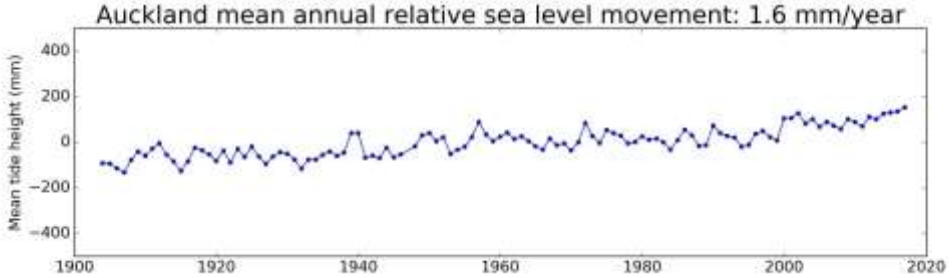

Benefits and Applications

- Provision of a tool to enable the transformation to and from all sea level and geometric vertical datums – time dependent
- Enable the determination of sea level surfaces away from tide gauges using GNSS
- Improved modelling:
  - Sea level rise
  - Flooding
  - Tsunami
  - Uplift/subsidence due to earthquakes
- Integrated ocean and coastal mapping
  - Shoreline studies
- Hydrographic surveying:
  - Integrating bathymetric datasets
  - Surveying on the ellipsoid

Improve resilience to natural events

Presentation Summary

Land Information New Zealand
Toitū te whenua

- NZ has a programme for vertical datum improvement and integration
- There is a need for a tool that easily transforms between sea level and geometric vertical datums
- LINZ's JLAS project is developing such a tool
- The benefits to NZ include improved modelling for resiliency, combining sea and land data and gaining efficiencies in hydrographic surveying

Questions

Acknowledgements

The New Zealand Vertical Datum Improvement Team:

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Euan Smith | Victoria University of Wellington
Fabio Caratori Tontini | GNS Science