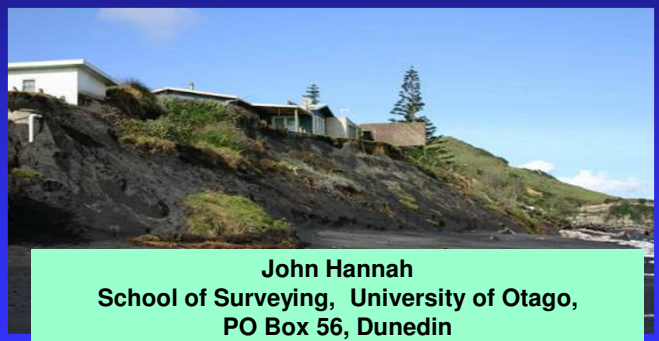
AUCKLAND: A CASE STUDY in the REGIONAL ASSESSMENT of LONG TERM SEA LEVEL CHANGE



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OUTLINE

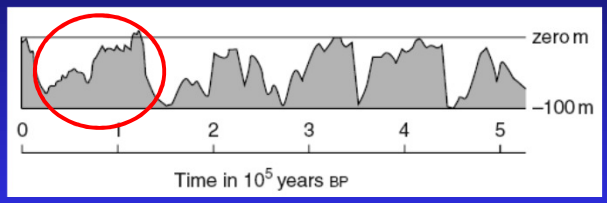
1. Introduction
2. The Past - What do we think we know?
3. The Present – What do we really know?
4. The Future – What we would like to know?
5. Pulling it all together.

INTRODUCTION

- Projected sea level change is a vital issue in assessing the hazards associated with coastal zone management.
- New Zealand has one of the best long term sea level records in the Southern Hemisphere. Auckland's record is the best of all.
- **WHAT CAN WE REASONABLY EXPECT by 2100?**
- Future projections for sea level change are predicated upon many imprecisely known quantities. These include:
  - Our understanding of the past changes in climate.
  - Our projections for future changes in climate.
  - How earth systems will respond to these changes.

THE PAST
What do we think we know – Pt I?

Geologists believe that over the last 1.7 Million Years (ma) there have been several cycles of global sea level fluctuations (each greater than 100 m) caused by cyclic glacial-interglacial periods.



This general pattern is largely inferred from the last glacial-interglacial cycle dated between 20 – 128 ka year before present.

At the last interglacial maximum (~ 120 ka BP) global sea levels appear to have been 2 – 5 m higher than at present.

It is generally thought that sea levels rose from well below present levels at ~20 ka BP to near present levels between 7 to 6 ka BP = ~ 9 mm/yr on average

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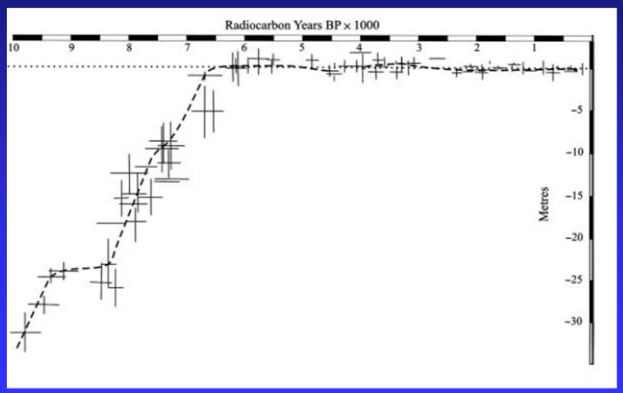
THE PAST
What do we think we know – Pt II?

Holocene sea level changes in the Auckland region (i.e., from 12 ka BP to the present) broadly seem to follow the trends observed globally.



Taken from Gibb, 1986

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THE PAST
What do we think we know – Pt III?

The important takeaways:

- At times in the past sea levels appear to have risen very rapidly (by more than 15 mm/yr).
- Sea levels have fluctuated by about 1.0 m around present levels for the last 6,500 yr.
- A period of higher sea level is recognised in the Pacific and east Australia around 3.4 ka BP, but is more variable in NZ. Best estimates suggest a maximum sea level elevation in NZ at this time of between 0.5 – 1.0 m above present levels. **THIS IS CRUCIAL**
- Global average surface warming of 2.4 – 6.4ºC for 2100 essentially returns the earth to its mid Holocene state. **THIS IS ALSO CRUCIAL**

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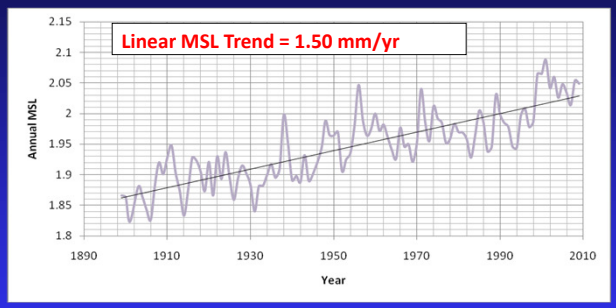
THE PRESENT
What do we really know – Pt I?
Auckland



- Auckland has the most reliable long term sea level record in NZ and is one of the best in the Southern Hemisphere.
- The pattern of sea level rise is similar to results from other NZ gauges, as well as other reliable gauges from around the world. It parallels the results from Freemantle.

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THE PRESENT
What do we really know – Pt II?

Port	Relative sea level change (linear trend) *a*	GIA Correc-tion *b*	GIA corrected sea level trend *a + b*	Local Tectonic Motion from cCPS data *c*	Absolute sea level trend *a + c*
Auckland	+1.50 (0.09)	+0.30	1.80	-0.1	+1.4
Taranaki	+1.24 (0.32)	+0.33	1.57		
Wellington	+2.00 (0.17)	+0.30	2.30	-1.4	+0.6
Lyttelton	+1.90 (0.10)	+0.29	2.19	-0.2	+1.7
Dunedin	+1.28 (0.09)	+0.25	1.53	-0.2	+1.1
Mean	*1.6 mm/yr*		*1.9 mm/yr*		*1.4 mm/yr*

From tide gauge records

From an earth model

From 10 yrs of cGPS obs.

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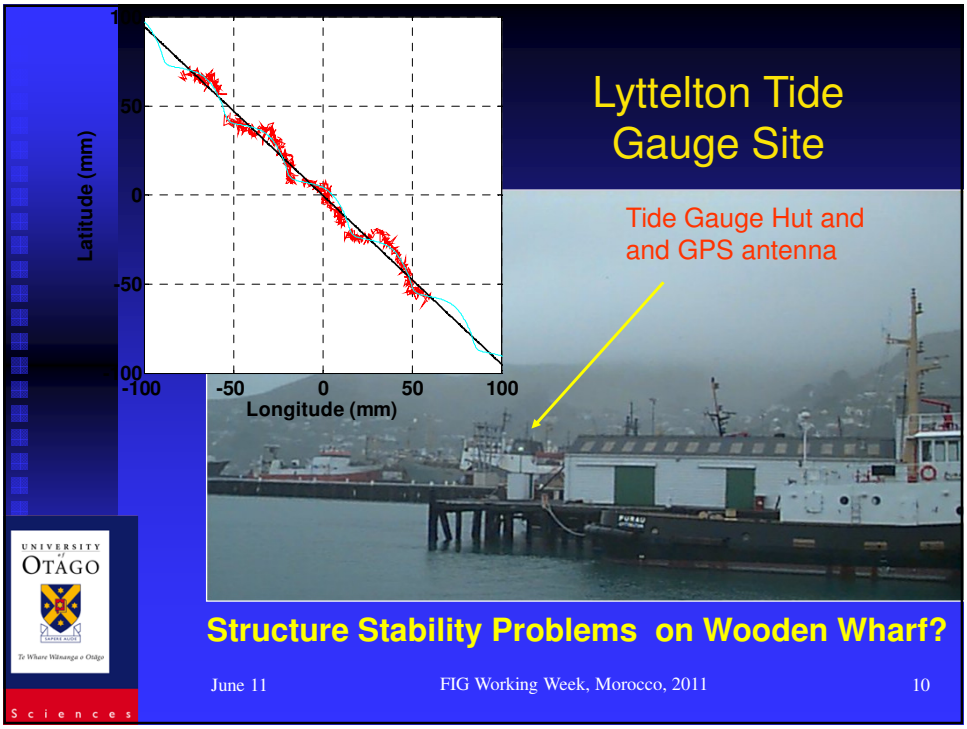
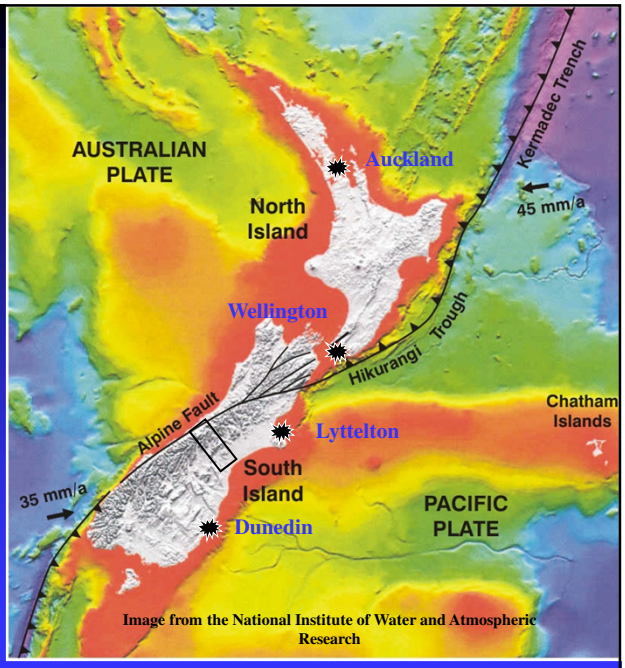


NZ's tectonic setting

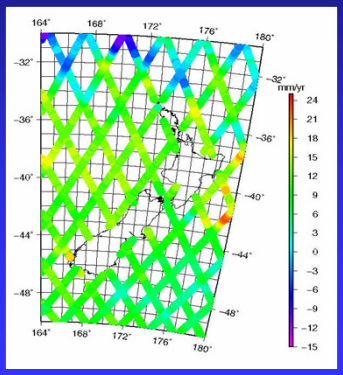
Central South Island experiences oblique continental collision at about 40 mm/yr

Shortening component normal to Alpine fault is about 10 mm/yr



Are There Other, Independent Measurement Techniques?

- Yes! Satellite altimetry data from 1993 – 2010 via the Topex Poseidon and Jason-1 missions.



- Shows a global (open ocean) sea level rise of 3.2 0.2 mm/yr over the last 16 yrs.
- Poor estimates close to the coast.
- Ocean models indicate significant spatial variability.
- Global water budget can account for a rise of 2.8 0.35 mm/yr.

Summary of our Present Knowledge

- Auckland's linear sea level trend = +1.5 mm/yr since 1901. Best GIA corrected **global** estimate = + 1.7 0.3 mm/yr (95% confidence)
- cGPS results suggest little or no vertical tectonic movement of any description at Auckland.
- The tide gauge record shows **NO evidence of any acceleration** in sea level rise. This is consistent with results from the UK and Australia. **Question:** Doesn't the Satellite altimetry data imply an acceleration in sea level rise over the last 17 yrs? Not necessarily:

  (a) Could be due to periodic effects (= time frame problems)

  (b) Could be due to reference frame problems (there are uncertainties at the sub-millimetre level)

  (c) Could be due to spatial variability

THE FUTURE
What would we like to know?

1. **A realistic climate change scenario – hinges around future economic growth, sustainability initiatives and the use of fossil fuels. Current projections suggest temperatures at mid-Holocene high levels (+2 ºC to + 6 ºC).**
2. **The response to Greenland and the Antarctic to this heating. Thermal expansion and mid-latitude glacier contributions are well known.**
3. **A better understanding of sea levels in New Zealand during the Holocene period.**
4. **A better understanding of the errors in our measurement systems (GPS and altimetry).**

PULLING IT ALL TOGETHER

What to expect by 2100

IPCC 2007 report: Allow for a global sea level rise of 18 cm – 59 cm with the possibility of a further 10 – 20 cm.

Min. of Environment: Plan for 50 cm and assess sensitivity of activity to a possible 80 cm by 2090.

BUT pressure is building to increase these numbers!

Given what we know about the mid-Holocene maximum, and present trends, the MoE advice is more than appropriate – even out to 2100. Present knowledge does NOT warrant any change!!

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Thank you

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17