Dealing with changes in our climate

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Three Points

1. Our climate is definitely changing

2. That means we have to start dealing with more frequent extreme events

3. Sea level rise requires planning for an increasing rate of change on our coastline
New Zealand is warming

For more than 100 years, NZ has been warming by about 20% more than the global average rate. Climate models suggest NZ’s future warming will be less than the global average – but there are still significant uncertainties in the details for changes over areas the size of NZ.

http://ftpmedia.niwa.co.nz/Seven_Station_Series/
New analyses suggest “Step changes”

Shifts in ocean circulation patterns and other changes can happen in steps rather than gradually each year. New analyses for S E Australia show evidence for step changes in temperature, and that is now being investigated for NZ.

We don’t know the amount of greenhouse gases that will go into the atmosphere this century. But, for a wide range of different scenarios, temperatures will become warmer than at any time over the last 100,000 years.

Different Northern Hemisphere temperature records for the last 1300 years

High, medium and low greenhouse gas scenarios for the future

Degrees °C

Thermometer measurements
Changes in extremes becoming evident

“New Zealand national climate summary 2011: A year of extremes“

- **February**: scorching heat waves, extremely dry over most of the North Island
- **April**: extreme rain State of Emergency in Hawkes Bay
- **May**: warmest May on record
- **June**: third warmest June on record
- **July**: polar blast with heavy snow July 24 – 26
- **August**: record breaking cold temperatures
- **November**: extremely dry north of Taupo
- **December**: State of Emergency in Nelson after record breaking rainfall

Civil Defence controller, Te Aroha Cook, told *Morning Report* on Friday the storm was similar to Cyclone Bola in 1988, though the damage has been greater for some communities.

http://www.radionz.co.nz/news/regional/73986/hawke%27s-bay-storm-clean-up-will-take-weeks

Aerial photographs are from Peter Scott, Napier City Council, taken on April 30 and May 9.
New Zealand weather

The Hawkes Bay region, April 2011

“Civil Defence controller, Te Aroha Cook, told Morning Report on Friday the storm was similar to Cyclone Bola in 1988, though the damage has been greater for some communities.


And this time the storm does not even get a name

Aerial photographs are from Peter Scott, Napier City Council, taken on April 30 and May 9.
We plan for a range of circumstances

Shaded areas are high & low 1% probability ranges
Damages tend to be worse for rare events

A potential damage range

Probability

1% likely

Damages can escalate for very rare events
Risk = probability × damage

But “risks” reduce because these are very rare
This shows the changing distribution of June-July-August temperatures averaged globally by decade for the last 60 years.

This statistical analysis is based on temperatures from meteorological records, averaged over 250 km wide spatial areas, normalised to the historical records for that area, and then combined to show a distribution that summarises the values globally and for an 11-year period.

Changes in rainfall

Trends in rainfall are more complex. But an increasing amount of data show a common pattern over wide areas …

Days with no rain more often
Days with light rain less often
Days with heavy rain more often

Predictability of extremes is a challenge

In several parts of the Hutt River, the TopNet model reproduced annual maximum flow quite well, but more recent years clearly require some re-calibration of the model. So there is a change going on!

This probability shift increases Risk by ~60% for low damage and ~100% for high damage case.
Shifting probability = Increasing risk

This probability shift increases Risk by ~60% for low damage and ~100% for high damage case.

The red dashed line shows what is now 1% likely, and initially it was only 0.05% likely!
Future change is even more of a challenge

This shows flood frequencies for the Hutt River at Taita Gorge under current (1972-2008) and modelled future climate (SRES A2 emissions scenario for the 2090s) and corrected for differences between modelled and observed flood volumes under current climate conditions.

Observed trends in the maximum amount of rainfall that occurs over a 5-day period in each year, for the period 1951 – 1999 ... ... and what was expected from climate models.

Extreme rainfall is coming sooner than we thought.
It’s worth watching other countries

A new report on climate risk by the UK Department of Environment, Food and Rural Affairs (DEFRA) was released in early 2012.

This covers 100 impacts of climate change in the UK and considers the magnitude of impact and confidence in the evidence base for these.

It lists vulnerability to flooding and heatwaves as the major issues for the UK.

The annual damages caused by flooding in England and Wales are expected to rise by somewhere between 60% and 800% during this century unless adaptive action is taken.

In the IPCC 2007 assessment of climate science we had climate models estimating sea level rise of up to 0.6 m by 2100.

The contribution from glacier and ice sheet loss was thought to reach about 25% by 2100.

That was at odds with a growing amount of direct observations. So it was also said that we could not put an upper bound on what would happen this century.

Then in 2008 we found that, over the last 50 years, glacier and ice loss was already causing ~60% of the current sea level rise – and it is accelerating.

Most of sea level rise is now due to loss of glaciers and ice sheets. So as the temperature rises, the \textbf{rate} of sea level rise increases.

Sea level rise at an increasing rate

Is expected to continue for more than another 100 years.

Vermeer & Rahmstorf. PNAS 2009;106:21527-21532
1. Estimates of SLR by 2100 taken from 13 science papers and 7 review papers or reports for governments published in the last 4 years.

2. This is a probability distribution based on the estimates shown below. The most likely value is 0.85 m, but it is a flat topped distribution to reflect the significant uncertainties.

Risk management means plan for the high side

This shows the range of risks, in 2100, for a wide range of potential damages.

The low- and high- risk situations shown here have their maximum risk values for SLR ~45% and ~65% higher than the most likely value.

Coastal Hazards and Climate Change – MfE, 2008

“For planning and decision timeframes out to the 2090s... where impacts are likely to have high consequence or where additional future adaptation options are limited ... all assessments should consider the consequences of a mean sea-level rise of at least 0.8 m relative to the 1980–1999 average.

“For planning and decision timeframes beyond 2100 where, as a result of the particular decision, future adaptation options will be limited, an allowance for sea-level rise of 10 mm per year beyond 2100 is recommended (in addition to the above recommendation).

Planning now needs to take account of a continually changing environment.

Using 0.8 m as THE upper limit for SLR can be very misleading.
The probability and risk are now shown for about 2112 – the dashed lines show where 2100 was.

The peak in the SLR probability curve has moved by 0.1 m, but the peak for high risks has moved up by 0.2 m.

Future rates of change in risk in the more vulnerable coastal regions require the development of a capacity to adapt and to anticipate structural changes before they occur rapidly and so restrict the number of adaptation options.
Example from Miami Beach area.

Rise of 300 mm by 2040?

Example from Miami Beach area.

Rise of 600 mm by 2065?
Example from Miami Beach area.

Rise of 900 mm

by 2080?

Rise of 1200 mm by 2100?

Example from Miami Beach area.

Use of low lying coastal land should plan for a major transition occurring over a period of about 30 years.

Anticipating the change is necessary for planning and implementing effective response options.

How do we plan for sea level rise uncertainty

This shows an uncertainty range for sea level rise over the next 100 years.

How do we plan for it?
Identify the threshold and work backwards

This is based on:
Identify the threshold and work backwards

4 - Time for the decision, taking account of uncertainty
3 - Lead time for the planning & construction of responses
2 - Updated SLR estimates and uncertainties
1 - Threshold when intervention is required

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Identify the threshold and work backwards

1 - Threshold when intervention is required
2 - Updated SLR estimates and uncertainties
3 - Lead time for planning and construction of responses
4 - Time for the decision, taking account of uncertainty
5 - And careful analysis of options has to start first.

This is based on:
Identify the threshold and work backwards

1 - Threshold when intervention is required
2 - Updated SLR estimates and uncertainties
3 - Lead time for planning and construction of responses
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5 - And careful analysis of options has to start first.

An increasing rate of change means that decisions for major adaptation strategies will have to be made when observed sea level rise is still significantly smaller than the threshold beyond which current structures become unsustainable.

This is based on:
In The Netherlands people have been building houses on raised land for over 2000 years and stopbanks by their rivers for over 1000 years.

They have government reports analysing how to deal with potential future sea level rise of 3 meters by 2200. They also know that SLR is a threat to their freshwater supply and can lead to worse flooding.

But they do not rely on projections of future climate change. Instead they have adaptation strategies that recognise “tipping points” where a current approach to risk management has to change.

“Expressing uncertainty in terms of the period that the existing strategy is effective (when will a critical point be reached) was found to be useful for the policy makers.”

Planning for more extreme weather events is becoming increasingly important, with floods and land slips probably becoming major areas for concern in NZ.

Planning for sea level rise needs to start now and while there will be different response options, none of them may be “best”.

Recognition of critical points, when it is necessary to adopt a new adaptation strategy, requires dealing with the uncertainties by management of changing risks.

The challenge is to avoid delays in planning for change.
Thank you

A copy of these slides is available on request to: martin.manning@vuw.ac.nz