Adapting to changing climate risk

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Vulnerability, resilience and adaptation to climate change research programme

**Purpose**—to develop a consistent **framework** for considering vulnerability, resilience and adaptation to climate change in NZ to enable decision-makers to build resilience to the adverse effects

**Local Government case studies**
- Flooding—Hutt Valley
  - modelled climate change effects
  - household survey
  - workshop
- Sea level rise—Auckland
  - interviews
- Water security—Wellington
  - workshops
- Envirolink workshops
  - Tasman/Nelson council staff and politicians
- Interviews with council practitioners
  - Auckland
  - Dunedin
  - Wellington

Changing climate

1. Our climate is changing .... and expected to go on doing so

2. More frequent extreme events changing more rapidly than reproduced by models

3. Sea level is rising at an increasing rate of change over this century
We plan for a range of circumstances

1% likely

Probability

1% likely

Shaded areas are high & low 1% probability ranges
Damages tend to be worse for rare events.
and $\text{Risk} = \text{probability} \times \text{damage}$

Risks reduce for the very extreme events because they are very rare.
But probabilities are changing

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 11-year periods.

The shift now occurring in the ranges is becoming more important than the shift in the average.

Submitted for publication in Proceedings of the National Academy of Sciences
Changes in rainfall

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

Days with no rain MORE often
Days with light rain LESS often
Days with heavy rain MORE often

Amount of rain rate mm / day

Shifting probability = Increasing risk

In this example ...
What was only 1% likely is now about 6% likely
... 0.5% ... 4% ... etc.

As the range of weather continues to shift this way, risk management requires repeated reductions in the magnitude of the damages that are caused by what used to be rare events, but are becoming more frequent.
The practice

1. BUT Flood risk uses historical analyses, measurable data and not changing risk—future unlikely to be like the past
2. AND Sea level rise and storm surge from extreme events not currently factored into planning
3. AND practice based on fixed lines and static structures is entrenching risk—creating locked-in and is hard to change
4. Planning based on single numbers is likely to under-estimate risks
5. We have a resulting legacy effect
## Response options—implications for risk management

<table>
<thead>
<tr>
<th>Type of response</th>
<th>Description</th>
<th>Implications</th>
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<tbody>
<tr>
<td><strong>Protect</strong></td>
<td>Hard structures e.g. stopbanks and sea walls</td>
<td>Locks in developments, false sense of security, costly to maintain and change</td>
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<tr>
<td><strong>Accommodate</strong></td>
<td>Development controls e.g. mitigation of risk through consent conditions, raised floor levels above defined flood, ‘flood proofing’ of services, hazard lines</td>
<td>Time limited, false sense of security</td>
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<tr>
<td><strong>Retreat</strong></td>
<td>Planning rules to control existing development, hazard zones as a transition with change triggered by change of ownership or withdrawal of protection</td>
<td>Long lead time, ongoing deliberation, possible legal challenges and funding and alternative land required</td>
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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.
1. Risk management needs to deal with both the future change and uncertainties in the amount.

2. Anticipatory planning needed before thresholds reached – lifetime of assets and lead time for adjustment.

3. Adaptation will need to be ongoing and flexible.

4. BUT do we know what is exposed and sensitive to changing climate and where it is located?

5. How can our planning systems be more flexible to changing climate impacts?
A new approach for decision makers - Netherlands

- Transition from high levels of protection to risk management

- An adaptation tipping points approach is used to ask
  
  - “what are the first issues that we will face as a result of climate change and when can we expect this?”

  - How long will current strategies be effective and when will alternative strategies be needed?

Responses under diverging climate futures and different timelines

Because ice loss is becoming the dominant factor in SLR it is the RATE that increases with the temperature, not just the amount. Uncertainty in future estimates also expected to remain significant.

- Incremental adaptation only over timeframes that are reasonably certain and where flexibility is possible
- **BUT** also plan for divergent possible futures and transformative adaptation

**THIS MEANS** that the *lifetime* of the adaptation decision relative to *the rate of change* is **KEY** in determining the type of response
Identify the threshold and work backwards

Based on:
Identify the threshold and work backwards

Based on:
Identify the threshold and work backwards

Based on:

1 - Threshold when intervention is required
2 - Updated SLR estimates and uncertainties
3 - Lead time for implementation/construction & establishment of responses
4 - Deadline for the decision, taking account of uncertainty
5 - And careful analysis of options has to start first.
Ability to adapt, cope and recover from flooding

- Understanding of flood risk clouded by legacy of structural protection and hazard zones e.g. understanding low in Hutt Valley

- How risk is communicated affects understanding of the likelihood and severity of flood risk e.g. ARI, AEP versus chance and visual images

- A perception that e.g. 1:100 or 1:440 flood design level means that those protected by stopbanks will be safe!

- Past experience
  - increases household preparedness but only for the easy to do things
  - increases willingness for flood risk reduction
  - increases preference for land use planning to avoid future risk

- Households prefer a region-wide integrated flood risk management regime that includes stormwater flooding and land use planning
Barriers

1. **Statutory framework** - misalignment between statutes and some provisions RMA, BA & code and SC&RC Act

2. **The practice** - evidence-based leads to single numbers and static responses

3. **The timeframes** - electoral and many plans

4. **Capability and resources** - scale issues, legacy effects, efficiency and consistency

5. **Role of central government** - national tools, consistent information & repository, monitoring, adaptation research strategy, alignment across functions, strategic leadership, identify adaptation hotspots

6. **Roles of regional and local government** - greater strategic direction, subdivision and building consent stage too late, feedback from emergency response and lifelines groups to planning
Barriers to adaptive capacity
Workshop and interviews

- Non-structural measures are weakly developed or static
- Current planning does not account for changing climate risk
- Lack of integration and strategic oversight within and between levels of government
- Leadership at all levels of government needed to improve long-term risk management
- How risk is communicated can reduce perception of risk and thus risk management options
- Different risk assessment approaches across NZ
- Mismatch of timeframes across council functions
- Dominant focus on costs rather than who pays, when and how
Some adaptive responses options

- A suite of integrated options that can be progressively implemented
  - Brownfields—reduce infill and intensification in hazard risk areas, combine —protect, accommodate and retreat
  - Greenfields—avoid hazard risk areas
  - Provision of secondary flow paths as contingency

- Monitor BAU with triggers for review e.g. rate of change accelerates; increased frequency of hazard events

- Reversible and less risky options e.g. reserves and parks

- Risk hedge e.g. stronger/wider foundations to roads and stop-banks

- Extra safety margins where cost-effective and lock-in of assets avoided

- Shorter life of infrastructure so change can be made in future at lower cost

- Retreat from hazard—staged over time and alternative land identified
A strategic approach

Scan exposure and sensitivity across nation and regions

Stage actions for different consequences

What is at risk and when over lifetime

Options over a range of scenarios

Implications of BAU - different timeframes under a range of scenarios

Undertaken in a deliberative manner continuously
Key issues

- Current decision frameworks and practice are entrenching risk, constraining future flexibility and limiting adaptation to climate change increasing damages and costs over time
- Communication that climate risks are changing
- Decisions will need lead time and before thresholds are reached
- Transitions will take place over decades
- Unbundling different types of decisions by different timeframes
- A clear strategic planning framework needed at all levels of government