Flexible decision making for uncertainty and dynamic climate change: A New Zealand/Netherlands decision ‘experiment’

Judy Lawrence
Adjunct Research Fellow
New Zealand Climate Change Research Institute
Victoria University of Wellington

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1. Climate change risks and characteristics
2. The decision-makers challenge
3. The partnership with Deltares, the Netherlands
4. A decision experiment: research as a ‘change agent’
5. Adaptive pathways spawned
1. Climate change risk and characteristics
Key climate change risks for New Zealand

• Impacts amenable to risk reduction by mitigation and adaptation (BUT less mitigation means more transformative adaptation required)
  • increased frequency and intensity of flooding & wild fire

• Impacts subject to large climate uncertainty, with major risk at upper end of changes and with associated adaptation challenges
  • widespread damages from sea-level rise

Changes in extremes as a result of changes in mean climate

- hot days ↑
- cold days/frosts ↓
- heavy rain ↑
- drought ↑
- fire risk ↑
- severe storms ± (↑)

Source: Reisinger, A. (2009) Figure 3.5. Based on IPCC AR4 WGI Box TS.5
Increase in flood risk

• Driven by **warming** (more than changing mean rainfall)

• ‘Adaptation deficit’: events with much less than 100-year return periods cause significant damages

• **Expected widespread increase in flood risk** but amount of possible change spans a wide range

• Flood risk increases even where average rainfall decreases
Implications for risk assessment

*Uncertainty and dynamic change* means risk assessment requires exploration of many alternative climate futures

- by using results from one detailed climate model; scale extreme rainfall to reflect range of different climate models / scenarios and
- using detailed hydrological model to translate rainfall into peak flood flow

*Simplified model study can explore uncertainties*

- high emissions, 440 yr event $\rightarrow$ 30-100 yr
- stringent emissions reductions, $\rightarrow$ 50-300 yr

*Severe end of potential changes* would require transformative adaptation
non-mitigation scenario (A2)

- modelled present climate (1972-2008)
- model median future climate (2090s)

- 90 percentile model range
- full model range

Lawrence et al, 2013, for lower Hutt river at Taita Gorge
Sea level will continue to rise and surprise
What is at stake?

Human settlements, access and mobility, Infrastructure and economic activity
2. The decision makers challenge
Climate change characteristics create a decision challenge

Typology of capacity to address uncertainty and dynamic change (Dovers and Hezri 2010)

• Some climate changes similar to existing variability—existing institutional framework and practice adequate

• Climate variability and consequences greater than the current climate range experienced but not outside historic and institutional experience

• Climate changes and variability beyond living experience and institutional memory and outside current experience with regime shifts and political instability challenging institutions and ability to cope
New Zealand has regulatory consideration of "the effects of climate change"
Adequacy of the institutional framework

Objective of **flexibility** and **robustness** across a range of possible futures

Conceptual approaches that can address uncertainty and dynamic change
- *Precautionary principle* – reflected but little guidance on degree of precaution
- *Risk management* – reflected but generally based on known quantifiable risks
- *Adaptive management* – not reflected but not ruled out
- *Transformational change* – not reflected

State of the framework
- Fragmented institutions across discrete special purpose statutes
- Organisations are discrete autonomous governance units
- Coordination lacking between governance scales and functions
- Disciplinary ‘silos’ operating
Adequacy of the practice and barriers

Practice

• Reactive, ‘event-driven’
• Limited anticipation of risk
• Risk represented as static in time (short-medium), space (fixed) → expectations of continued protection
• Difficulty adapting responses over time and space → lock-in of land use
• Lack of coordination across scales—separated governance
• Practice reflects different and entrenched disciplinary traditions
• Options often closed off early

Barriers

• Missing instruments at national and regional scales
• Legacy effects and existing land uses
• Quasi-legal practice demands ‘certainty’ which reduces flexibility
• Mitigation practice has physical and affordability limits
• Organisational form, disciplinary practices and siloed functions
• Capacity and capability deficits
The decision making challenge requires *fit, interplay and scale* to be addressed (Oran Young, 2002)

**Fit** = understanding and representing uncertainty and dynamic climate change characteristics

**Interplay** = organisations and actors within them and interplay between scales

**Scale** = governance and regulations at multiple levels are **ALL** in place

AND

**Adaptive governance** from the values and preferences of the actors

**BUT**.........
Uncertainty

• People can’t imagine 2100 and beyond…but climate science asks us to

• Difficult for people to accept incurring costs for a future they can’t even imagine

• Communities prefer small, incremental change that doesn’t threaten our way of life and sense and value of place

There is a way through this...

the dynamic adaptive policy pathways approach (DAPP) Haasnoot et al 2013 ...
Adaptive pathways planning

- **Adaptive planning** supports decision making under uncertain change “*invest not too little nor too much, and not too early nor too late*”

- **Adaptation PATHWAYS** provide insights into options, lock-in possibilities, and path dependencies to identify **short-term actions** to mitigate adverse impacts and seize opportunities and **keep options open** to adaptations later.

- **Adaptation TIPPING POINTS** *(policy use-by date)* help in identifying if and **when** to take actions at earliest or at latest.

- **MONITORING** plan and **CONTINGENCY** actions help **to stay on track**. Autonomous adaptation of stakeholders can be important.
Approach for generating pathways

Ensemble transient scenarios

Set of actions
- Action A
- Action B
- Action C
- Action D

Model-based development

Adaptation pathways

Participatory/qualitative Workshop & storylines
Adaptation Tipping Point & Use by date of policy action

A stress test: **How much** (climate) change can we cope with?  
**When** do we start to miss our objectives?

Decision moment = f (time A, time B, lead time action)

Adapted from: Kwadijk, J.C.J. et al 2010 WIREs Climate Change DOI: 10.1002/wcc.64; Haasnoot et al 2012 Climatic Change
Adaptive pathways approach

- Assumes dynamic climate
- Proactive
- Decision-focused
- Considers lifetime of decisions
- Considers lead-time for implementation
- Flexible and robust over time
Determines **CONTINGENCY** actions to stay on track

- Land use planning rules
- Drought tolerant crops
- Mainstreaming
The essentials of DAPP

- Preparation
- Exploration of what could happen
- Familiarity with different scenarios
- Can switch between options depending on what evolves
- Not prediction; it is preparation and knowing what to expect
- Knowing what the next step could be gives decision makers confidence under conditions of uncertainty and change
- Leads to flexible and adaptable implementation
3. The partnership with Deltares, the Netherlands
The partnership

Project partners

• Deltares
• Carthago Consultancy
• NZ CCRI, Victoria University of Wellington
• Greater Wellington Regional Council
• Wellington City Council
• Tasman District Council
• Ministry for the Environment
Purpose

Tailor and test the Sustainable Delta Game in New Zealand decision settings
Use the DAPP approach in real-life NZ decision-making settings
Design a pathways generator to interface with the Game for making adaptive plans (Deltares)
Flooding, drought and sea-level rise

Develop DAPP in different institutional settings (policy advice; local spatial planning; regulatory)
Use with different climate and socio-economic scenarios
Develop and test economic costing of pathways (Real Options Analysis)
Use to understand how decision makers shift from short- to long-term decision making
4. A decision experiment: research as a ‘change agent’
Objectives of the simulation game

• Experience the future and its uncertainties

• Raise awareness about adaptive management

• Raise awareness about the role of negotiation and collaboration

• Reflect on policy decisions

• Discussion on robust and flexible policy actions
Develop a sustainable plan for the next 100 years

• Address flood risk
• Pay attention to water uses
• Consider environmental issues
• Consider social and economic changes
• Acknowledge uncertainties

Past river discharges

Yearly maximum discharge Waas

m³/sec

1900 1920 1940 1960 1980
Game round

- Determine team’s point of view and strategy
- Choose maximum two actions (the cards)
- Take into account society’s point of view (local communities and ngo’s)
- Negotiate between groups and decide two actions to simulate
Debrief: evaluation after simulating 100 years

• Did you behave in a more reactive or proactive way?

• (When) did you experience change in strategy or vision?

• What arguments did you use to change?

• What was the role of negotiation?

• In hindsight, would you have played the game differently?
Transient scenarios
The Game: Round 1

1st round: BAU options, short term, evacuation, more development, education for population

Simulation: high damage costs and loss of life

Context: higher frequency high rainfall events, disruption of transport networks and more droughts
The Game Round 2

Round 2: Precautionary- large scale upstream cooperation and room for the river

Simulation: reduced damage costs dramatically

Context changed: improved economy, recreation space demanded, climate change everyone’s business
The Game: Round 3

3rd round: Built on 2nd round results, large scale dredging and levee protection from increasing wave overtopping

Simulation: benefits became greater than costs!
What we learned

We make short-term decisions.

Started like real life. Perceived as too expensive and uncertain.

We took the low cost options to see what happened.

It took feedback to hone the choices from reactive to proactive.

This game showed we can make long-term decisions by anticipating and adjusting.

We got better results through negotiation with the other groups.

We experienced uncertainty and could chart a pathway.
Learnings from using the ‘Game’

- Experiencing ‘real life’ events lead to wider range of options being considered

- Demonstrated the important role of consistent leadership in negotiations

- Able to adjust options giving multiple benefits while protection and flexibility for uncertain future events is achieved

- Helped perception of decision making over a 100 year timeframe

- ‘Experienced’ damage costs and demonstrated path-dependency became triggers for changed decisions

- Highlighted that lead-time for decision-making is necessary

- Having players from different disciplines and council functions ‘opened eyes’ to wider connections and deepened the quality of decision making
What changed?

• Raised awareness of the benefits of adaptability

• Moved thinking from reactive to proactive and anticipatory

• New knowledge that the future course could be corrected with fewer consequences and lower cost

• More confidence to manage uncertainty (pathways now being developed)

• Triggered a desire to work together across multi-levels of government using the game and a DAPP approach and in different types of decision contexts

• Decision makers experienced the change and started using a pathways approach for decision making
The Game lead to adaptive pathways planning
A current 500 year ARI event can change to 300 yr - 30 yr ARI over the next 100 years.
Hutt River: Melling to Ewen Improvements

- Hutt CBD and Central residential area protected by stopbanks
- Existing stopbanks—flood capacity 1 in 100 year event
- Melling Bridge –flood capacity 1 in 50 year event
- Hutt Valley community agreed to upgrade the flood protection system to a 1 in 500 year event
- Four basic options were investigated
Hutt CBD pathways and economic analysis

- Committed flood risk managers who experienced the Game
- Options were developed as pathways
- Decision makers experienced the Game
- Asked for options with the effects of climate change included
- Options developed as pathways using 3 scenarios—low Emissions/median, High Emissions/median, High/90th percentile emissions
- Range of options presented to decision makers
- Economic analysis of pathways
- Public consultation
- Decisions later this year
Economic evaluation and adaptation pathways

• A Real Options Analysis—investment costs and damage costs

• A Multi-criteria Analysis—benefits

• Value for Money measure used by dividing the benefit score by the investment cost

• Value for Money rankings compared with the ROA results – each is a check on the other

• The MCA scores are more subjective, the ROA is more reliant on cost estimates

• The results are very similar and both sets support the case for a pathway approach
Next steps could be:

- Make a scorecard. Most actions are needed in the end. The choice is mainly: build now all at once or build in different phases. The scorecard can support decision making on this.

- Consider other policy actions such as flood paths for residual risk/flood-proof building/planning controls/managed retreat.

Side effects get a + if it includes the new bridge that gives opportunities for socio-economic development.

Not so much differences in moment of ATP (use by date) between the considered scenarios.
Investment Pathways

Adaptation Pathways Map (draft)

Action

Melling Bridge replacement
Melling Intersection (interim works)
FP Option 1 + New Bridge
FP Option 2 + New Bridge
FP Option 3 + New Bridge
FP Option 4 + New Bridge
FP Option 5 + new bridge (SA)
Existing

Assumed Climate Change scenarios

High Emissions (A2) Median

2015 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100 2105 2110 2115

High Emissions (A2) 90th percentile

2060
2085

Low Emissions (2 deg) Median

2080
>2115

Adaptation Pathways Map (draft)

"Use by Date" = Review Date every 30 years (approx.)

The "Use by Dates" shown on the map have been assessed on the basis of three potential climate change scenarios. The scale below the map shows the 'review dates' and 'use by dates' for each scenario.

Pathways (examples)
Adaptive pathways

Hutt River City Centre Upgrade Project - Adaptation Pathways Map

Hutt River City Centre Upgrade Project - Adaptation Pathways Map (draft)

Use by Date: Review Date approx. 10 years before the 'Use by Date' The 'Use by Dates' shown on the map have been assessed on the basis of three potential climate change scenarios. The scale below the map shows the 'review dates' and 'use by dates' for each scenario.
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