Scenarios for transformational adaptation
(in a ‘4+°C world’)

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CSIRO Climate Adaptation Flagship

With input from Andy Challinor, Phil Thornton, Penny Whetton, Collette Thomas, Richard Moss and Tim Carter

Adaptation Conference, Gold Coast, Jun 2010 on Kombumerri country
Where I’m going

• **Adaptation, transformation and scenarios**
  • Lessons for transformative thinking

• **Why lessons from these matter for the global scenarios**
  • Uses in IPCC AR4
  • Observations from economics
  • The new global scenarios for AR5

• **Towards the future – scenarios that help transformative adaptation**
  • Delivering climate information in the right form

• **A ‘4+°C world’**
  • One where we have to take the prospect of global mean temperature rises of 4+°C very seriously in adaptation planning
Incremental and transformational adaptation

- **Incremental** = maintaining existing activities and building on existing technologies
  - reactive and proactive
  - local scale
  - maintain existing objectives

- **Transformational** = major changes in enterprises, land use and human and social capital
  - mostly proactive and strategic
  - cross-scale
  - fundamentally re-assess objectives

- Strong relation to scale – to maintain functioning at one scale (e.g. farm sector or coastal community) may require transformation at the next scale down (e.g. move farms or shoreline buildings)
Transformational adaptation and scenarios

• Transformation often requires envisioning the implications of futures which are outside current experiences or comfort zones…
  • …in which (some) scenario processes are a key tool

• Determinants of transformation (Folke et al, 2010)
  • Preparedness to change
  • Options for change
  • Capacity for change

• Scenarios are:
  “coherent, internally consistent and plausible descriptions of possible future states of the world” (IPCC 1994)
Scenarios

- Diverse scenarios
  - Illustrated in Tues sessions
- Typology
  1. Problem-focused scenarios
     - e.g. IPCC SRES globally, many examples more locally/sectorally
     - “accurate maps of the future for crews to use”
  2. Actor-focused scenarios
     - e.g. World Bus Council for Sust Dev water scenarios; Shell scenarios
     - “engaging the crew in drawing the map they need”
  3. ‘Reflexive interventionist/multi-agent-based’ (RIMA) scenarios
     - A developing style that mimics how groups of people try to create shared futures, allowing the scenario framing itself to be up for debate
     - “the scenario process helps shape the map, the crew and even the mode of transport”

<table>
<thead>
<tr>
<th>Output orientation</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>SRES</td>
</tr>
<tr>
<td></td>
<td>MA global</td>
</tr>
<tr>
<td>Regional</td>
<td>Finnegan</td>
</tr>
<tr>
<td></td>
<td>MA regional</td>
</tr>
<tr>
<td>Local</td>
<td>Brunckhorst</td>
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<tr>
<td></td>
<td>GBR/Butler</td>
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<td>Badjeck</td>
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<td></td>
<td>Soste Welsh</td>
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</tbody>
</table>
What transformation demands

• To promote thinking about transformational change at local and regional levels
  • Simple but provocative alternative futures, to help people think about what they really want

• Lessons from scenario uses
  • Future pathways and their implications must be clear and distinct
  • Mostly, actor engagement is needed
  • Multi-scale scenarios (with consistency between scales) needed
Did the AR4 promote transformative thinking?

- Did this use the lessons?
  - Lack of clarity of futures that are social choices, and confounding of scientific and social uncertainty (political reasons for this, but…)

Many models x many futures
Learning from economists

• Do not knock the economists!
  • They are successfully delivering information for decision-making
  • Uncertainties, sensitivity analysis, assumptions are mostly in the appendices, not in the main iconic graphs

• How do we differentiate futures clearly to help discuss transformation, whilst retaining the connections to detail??
AR5: Four Representative Concentration Pathways

- **RCP8.5 (IIASA/MESSAGE)**
  - >8.5 W/m² in 2100,
  - Rising

- **RCP6.0 (NIES/AIM)**
  - ~6 W/m² at stabilization after 2100
  - Stabilization without exceeding target

- **RCP4.5 (PNNL/MiniCAM)**
  - ~4.5 W/m² at stabilization after 2100
  - Stabilization without exceeding target

- **RCP2.6 (PBL/IMAGE)**
  - <3 W/m² in 2100
  - Peak & decline stabilization
  - Net negative CO₂ after ~2070

From Richard Moss et al.

http://www.iiasa.ac.at/web-apps/tnt/RcpDb/
AR5: Possible Framework for ‘Representative Socioeconomic Pathways’ - RSPs

- Level 1: RCPs (Radiative forcing levels)
- Level 2: Global or large-region RSPs (set of ~2-3 socioeconomic narratives and quantitative pathways for a few key variables, for each RCP, exploring different levels of vulnerability)
- Level 3: RSPs including additional variables, possibly at finer spatial resolution
- Level 4: Detailed sectoral and regional-to-local narratives and quantitative pathways
New scenarios for adaptation: what is needed?

Please let us know your views

1. What approaches, if any, do you favour for characterising the future?

2. General scenario needs: What kinds of global futures could be used to address key research questions relating to adaptation?

3. Specific scenario needs: What are some of the critical scenario needs you have identified in your research?

4. What time horizon into the future is important?

5. What is the maximum number of framing global storylines that would be manageable by adaptation researchers?

6. If new scenarios can be made available in time, would you be interested, willing and able to perform rapid analyses that could feed into the IPCC AR5 process?

➢ Please see Richard Moss or Tim Carter to have input
For presentation of scenario implications in AR5…

1. Let’s insist on naming the scenarios comprehensibly
   • Ideally something which at least hints at human agency
     • Low, Medium-, Medium+ and High?

2. Let’s keep the information aimed at supporting transformational thinking clear
   • Comparisons of scenarios should only show the central tendency
     – comparisons are there to map the general different futures
     • Uncertainties in the detail/text, not the iconic graphs
     • If uncertainties and other complexities are to be shown on graphs, these should rigorously show only one scenario at a time
   • Recognise that the presentation and mode of engagement with decision-makers is as important as the information itself

• Important for both mitigation and adaptation…
For climate data aimed at adaptation decision-making

- Recognise different decision-making uses
  - Some short term and incremental
  - Some long term, risk managing and/or transformative
- Supply simple, differentiated scenarios for supporting transformational adaptation
  - But seamlessly nest more complexity within them
    - Across levels of detail and scales in space
- ‘Representative Future Regional Climates’ or ‘Storylines’
  - Select a (small) set of future climates, not models.
  - High level descriptions of the set of future climates (the ‘storylines’) anchor discussion between climate projection providers and users.
    - Detailed data sets then developed to populate selected scenarios
- This process has in effective operated in many impacts projects

Penny Whetton
National Research Flagships
CSIRO
Climate Adaptation
In Australian work we have mostly used Temperature and Precipitation as the two dimensions.
## Getting to storylines: *Climate futures web tool*

Matrix based on changes in temperature and rainfall

<table>
<thead>
<tr>
<th>Rainfall - Annual (% change)</th>
<th>Surface Temperature - Annual (°C)</th>
<th>2055 A2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slightly Warmer &lt; 0.50</td>
<td>Warmer 0.50 to 1.50</td>
</tr>
<tr>
<td>Much Drier &lt; -15.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drier -15.00 to -5.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little Change -5.00 to 5.00</td>
<td>Likelihood: 4.2% 1 model</td>
<td>Likelihood: 29.2% 7 models</td>
</tr>
<tr>
<td>Wetter 5.00 to 15.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Much Wetter &gt; 15.00</td>
<td>Likelihood: 8.3% 2 models</td>
<td></td>
</tr>
</tbody>
</table>

*Export to Word...*

- Can select seasonal, other variables, other years and other emission scenarios
- Detailed results for individual models or downscaled data nested behind this, providing internal consistency across many variables
- Storylines need not be superseded as new model results become available

*Penny Whetton*
Nesting local applicability

Climate Futures
Climate change options for tourism operators

Australia’s climate is changing, and this change is expected to increase and continue well into the future. The precise type and degree of these climate changes cannot be known with absolute certainty, so we must prepare for a range of challenges and opportunities that this change may bring.

We can achieve this by identifying and applying adaptation actions. These are actions that reduce the impacts and make the most of the opportunities that climate change has on coastal tourism businesses. Such adaptation actions are different to mitigation strategies. Mitigation strategies aim to reduce the size of changes to climate by reducing the amount of greenhouse gases. Adaptation strategies, on the other hand, aim to develop ways to buffer businesses against unavoidable change.

In order to adapt to our changing climate, we first need to understand what the impacts and opportunities might be. In this exercise we will present you with three future climate storylines. These storylines have been developed to highlight potential climate changes relevant to coastal tourism and help you to identify a range of adaptation actions. This Climate Futures resource has been developed to help you think about climate adaptation actions, not mitigation strategies.

Collette Thomas & co.
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Supporting the coastal Queensland tourism industry in preparing the for potential impacts of our changing climate by better understanding the choices available.
2030 Warmer & wetter

Air temperatures increase by 1.0–1.5 degrees above baseline

+1.0°–1.5°
Sea surface temperatures will be warmer, leading to localised coral bleaching in the Great Barrier Reef.

Some sensitive reefs may become barren rubble fields and/or switch from coral-dominated to more seaweed like algal-dominated area.
### Climate change scenarios

<table>
<thead>
<tr>
<th>Variable</th>
<th>2030 Warmer and drier</th>
<th>2030 Warmer and wetter</th>
<th>2050 Hotter and much wetter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual air temperature</td>
<td>No Change</td>
<td>Warmer</td>
<td>Hotter</td>
</tr>
<tr>
<td>Average annual rainfall</td>
<td>Drier</td>
<td>Much wetter in winter, wetter in summer</td>
<td>Much wetter in winter, wetter to much wetter in summer</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>Less humid</td>
<td>More humid</td>
<td>More humid</td>
</tr>
<tr>
<td>Solar radiation</td>
<td>Duller</td>
<td>Brighter</td>
<td>Brighter</td>
</tr>
<tr>
<td>Sea surface temperature</td>
<td>No change</td>
<td>Warmer</td>
<td>Hotter</td>
</tr>
<tr>
<td>Wind speed</td>
<td>No change to lighter</td>
<td>Stronger</td>
<td>Stronger in winter, much stronger in summer</td>
</tr>
</tbody>
</table>
**Categories of change and 1990 baselines for climate variables for Cairns and Airlie Beach**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Season</th>
<th>Categories</th>
<th>Cairns Baseline</th>
<th>Airlie Beach Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature °C</td>
<td>Summer</td>
<td>No change</td>
<td>18 - 21</td>
<td>18 - 21</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>&lt;0.5</td>
<td>24 - 27</td>
<td>24 - 27</td>
</tr>
<tr>
<td>Rainfall mm</td>
<td>Summer</td>
<td>Much drier</td>
<td>400 - 600</td>
<td>200 - 300</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>&lt;-15%</td>
<td>1600</td>
<td>1600 - 1800</td>
</tr>
<tr>
<td>Relative humidity %</td>
<td>Summer</td>
<td>Much less humid</td>
<td>70 - 80</td>
<td>60 - 70</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>&gt;-10%</td>
<td>60 - 70</td>
<td>60 - 70</td>
</tr>
<tr>
<td>Solar radiation MJ/m²</td>
<td>Summer</td>
<td>Much duller</td>
<td>15 - 18</td>
<td>15 - 18</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>&gt;-15%</td>
<td>24 - 27</td>
<td>24 - 27</td>
</tr>
<tr>
<td>SST °C</td>
<td>Summer</td>
<td>No change</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>&lt;0.5</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Wind speed km/h</td>
<td>Summer</td>
<td>Much lighter</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>&lt;-15%</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

**Notes:**
Projected changes for Townsville are midway between those for Cairns and Airlie Beach.

The megajoule (MJ) is equal to one million joules, which is approximately the same amount of energy of a one-ton vehicle moving at 160 km/h. Source: [http://en.wikipedia.org/wiki/Joule](http://en.wikipedia.org/wiki/Joule)
Information sources used to develop categories of change and baselines

Variable

Temperature - estimated from:
http://www.climatechangeinaustralia.gov.au

Rainfall - estimated from:
http://www.climatechangeinaustralia.gov.au

Relative humidity - estimated from:
http://www.climatechangeinaustralia.gov.au
For a 5% increase in relative humidity, apparent temperature will increase by 0.5 to 10 °C; the recommended level of indoor humidity is in the range of 40-60% (Wolkoff & Kjærgaard 2007).

Solar radiation - estimated from:
http://www.climatechangeinaustralia.gov.au
Change categories derived with assistance from David Turnbull at the University of Southern Queensland

Sea surface temperature - estimated from:
http://www.climatechangeinaustralia.gov.au

Wind speed & cyclone intensity - estimated from:
http://www.climatechangeinaustralia.gov.au
using 3pm monthly means

Download PDF: [Climate Adaptation Flagship](http://www.climatechangeinaustralia.gov.au)
Conclusions: scenarios for transformation….

- **Scenarios are particularly important for transformational thinking (in adaptation and mitigation)**
  - Clarity of scenario differentiation, engagement of users, and cross-scale consistency important

- **New scenarios**
  - Let’s present them better for transforming our society in IPCC AR5
  - Develop multi-scaled representative socioeconomic pathways, with increasing user engagement more locally

- **Deliver climate (and other information) in forms to support this**
  - Framed simply, but with scaleable (in space and in detail) data behind them, backed with good science, uncertainties, etc, etc
The most important transformation to avoid…

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