Climate change risk assessment: Missing the wood for the trees?

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The climate science “uncertainty narrative”

The cascade of uncertainty

Future society
GHG emissions
Climate model
Regional scenario
Impact model
Local impacts
Adaptation responses

Envelope of uncertainty

Source: Wilby and Dessai (2010)
A proto quantification of uncertainty elements

Conditional probabilities of lower summer flows in the River Thames by the 2020s, 2050s and 2080s. Source: Wilby and Harris (2006)
Typical outcome: “the uncertain outlook”…

Model simulations of future annual energy production at Kairakkum, Tajikistan. Source: EBRD (2011)
...not always due to climate models...

...but typically leads to ‘low-regret’ recommendations

<table>
<thead>
<tr>
<th>Climate scenario method</th>
<th>Adaptation options analysis</th>
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<tbody>
<tr>
<td></td>
<td>Not done</td>
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<tr>
<td>Qualitative</td>
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<td>Sensitivity test</td>
<td>2</td>
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<td>Scenario-led</td>
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CCRA methodology

- Risk Screening
  - Literature review
  - Tier 1 list (~700)
  - Systematic mapping

- Risk Selection
  - Scoring
  - Tier 2 list (~100)
  - Risk metrics

- Assess vulnerability
  - Social vulnerability
  - Adaptive capacity
    - Economics of Climate Resilience

- Current risks
  - Data collection

- Future risks
  - Response functions
  - Climate change & variability
  - Socio-economic change
  - Monetisation

* Ongoing studies to inform the National Adaptation Plan
Consequences and confidences (from UKCP09)

Source:
Part of a much larger climate risk domain…

**International**
Other international effects of concern

**UK (imported)**
Impacts in the UK from international effects

**UK (domestic)**
Impacts arising directly in the UK

- Loss of small island states
- Security & Conflict
- Large scale global tipping points
- Tourism revenue
- Price effects e.g. agriculture
- Migration
- Major sea level rise, H++ scenario

CCRA focus

Cross-sectoral, wider economic

Source: Paul Watkiss Associates for ASC (2012)
…amidst other major uncertainties

**Global drivers of food security**
- Population
- **Climate impacts on agriculture**
  - Patterns of consumption/behaviour
  - Energy prices
  - New crops/livestock
  - Ecosystem services
  - Competition for land
  - Agricultural investment
  - Globalisation and trade
  - Competition for water
  - Urbanisation
  - Production to plate
- Security
- Income distribution
- Waste
- Human health
- Technology
What happens when uncertainty is a given?
Hot spot analysis of existing risk

Estimated annual maximum daily rainfall totals with return period of 10 years. 
Risk reduction options (Yemen flash floods)

- Clearing and maintaining drainage systems
- Retrofitting and upgrading water channels
- Relocating key infrastructure such as hospitals from flood prone areas
- Raising awareness of hazards and responses
- **Developing and improving early warning systems**
- Identifying evacuation routes
- Preparing an emergency response (shelter, resources needed for rescue)
- Financing the response (reconstruction, insurance, micro-insurance).

World Bank (2012)
As a community, where can we add greatest value to climate risk assessment and adaptation planning?
Adding value 1: Model credibility

‘Ghost’ moisture sources: Global annual mean residual of the atmospheric water balance \((E - P - \text{dw/dt})\) for CMIP3 climate models. One Sverdrup (Sv) is \(10^6 \text{ m}^3\text{s}^{-1}\) or \(31,600 \text{ km}^3 \text{ yr}^{-1}\). Note that four climate models have residuals > 0.1 Sv. For comparison, observed atmospheric moisture transport from ocean to land is estimated to be 1.2 Sv. Data from Liepert and Previdi (2012).
Adding value 2: Process understanding

The 900 hPa specific humidity fields at 0600 UTC for the top 10 winter flood events on the River Eden at Temple Sowerby. Source: Lavers et al. (2011)

Damage caused by Nov 2009 Cockermouth Flood. Photo: O’Neill

Flood damage estimation. Source: O’Neill et al. (2012)
Adding value 3: Hazard forecasting
A climate response function for water supply reliability (contours) as a function of changes in annual mean (x-axis) and annual standard deviation (y-axis) of net basin supply (NBS; inflows net evaporation) based on the water supply system serving a metropolitan area in Massachusetts. Circles represent GCM simulations of the historical period; grey boxes indicate the historical range of variability generated by resampling observed data. Source: Brown and Wilby (2012)
Adding value 5: Decision timing

Schematic of the thresholds, lead times and decision points approach of TE2100. Source: Reeder and Ranger (2011).
Adding value 6: Options appraisal

Mean annual frequency of ecologically harmful flows (<224 Ml/d) in the River Itchen under various abstraction license conditions, climate variability and change. Source: Wilby et al. (2011)
Concluding remarks

• Uncertainty quantification is a legitimate subject for research;
• A danger of over-looking gross uncertainties;
• Acknowledge there may be opportunity costs;
• The conceptual frame really matters.

Photo: reefbuilders.com
Any questions?

Loughborough University campus flash flood 28 June 2012