# Climate prediction: a limit to adaptation?

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**Climate change impacts and adaptation: Dangerous rates of change**
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# Adaptation expert perspective

- "***the level of certainty*** *associated with climate change and impact projections is often* **key** *to determining the extent to which such information can be* **used** *to formulate appropriate adaptation responses*" Gagnon-Lebrun and Agrawala (2006)

- "*The* **effectiveness** *of pro-active adaptation to climate change often* **depends** *on the* **accuracy** *of regional climate and impact projections, which are subject to substantial uncertainty*" Füssel,H-M. (2007)

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# Scientist perspective

- "*It is … **essential** that GCM* [global climate model] *predictions are accompanied by quantitative estimates of the associated uncertainty in order to render them **usable** in planning mitigation and adaptation strategies.*" (Murphy et al. 2004)

- "*It is … vital that **more detailed** regional climate change predictions are made available both in the UK and internationally so that **cost-effective adaptation** and appropriate mitigation action can be planned*" Met Office Hadley Centre 2007

# Science funding agency perspective

*"NERC-funded science must play a leading role in the development of **risk-based predictions** of the future state of the climate – on regional and local scales, spanning days to decades. Advances in climate science … are **necessary** to develop the high-resolution regional predictions **needed** by decision makers. New scientific knowledge will enable policy-makers to develop adaptation and mitigation strategies."* NERC Strategy 2007-2012

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# World Modelling Summit for Climate Prediction
# ECMWF - Reading (UK), May 6-9, 2008

- *"The climate models will, as in the past, play an important, and perhaps **central, role in guiding the trillion dollar decisions** that the peoples, governments and industries of the world will be making to cope with the consequences of changing climate. … adaptation strategies **require more accurate and reliable predictions** of regional weather and climate extreme events than are possible with the current generation of climate models."*

# Are there limits to climate prediction?

- **Uncertainties in climate prediction arise from:**
  - Lack of knowledge (Epistemic uncertainty)
    - Parameter uncertainty
    - Structural uncertainty
  - Randomness (Natural stochastic uncertainty)
    - Initial conditions uncertainty
  - Human actions (Human reflexive uncertainty)
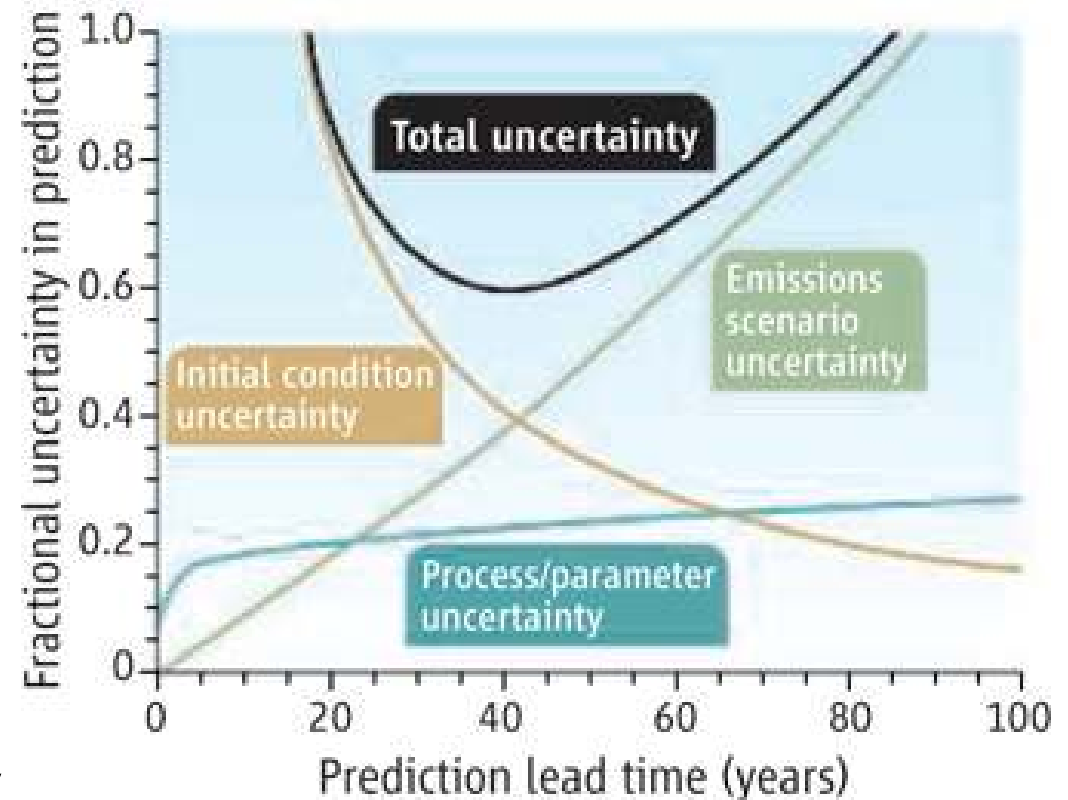


Cox and Stephenson, 2007

# … the story so far

- End-to-end analysis have found large uncertainties in climate impacts

- The search for 'objective' constraints remains elusive

- Verification and validation of numerical models in the earth sciences is impossible

- Models are heuristic tools and not 'truth machines'

- Climate is only part of the story when considering adaptation – multiple drivers and stressors
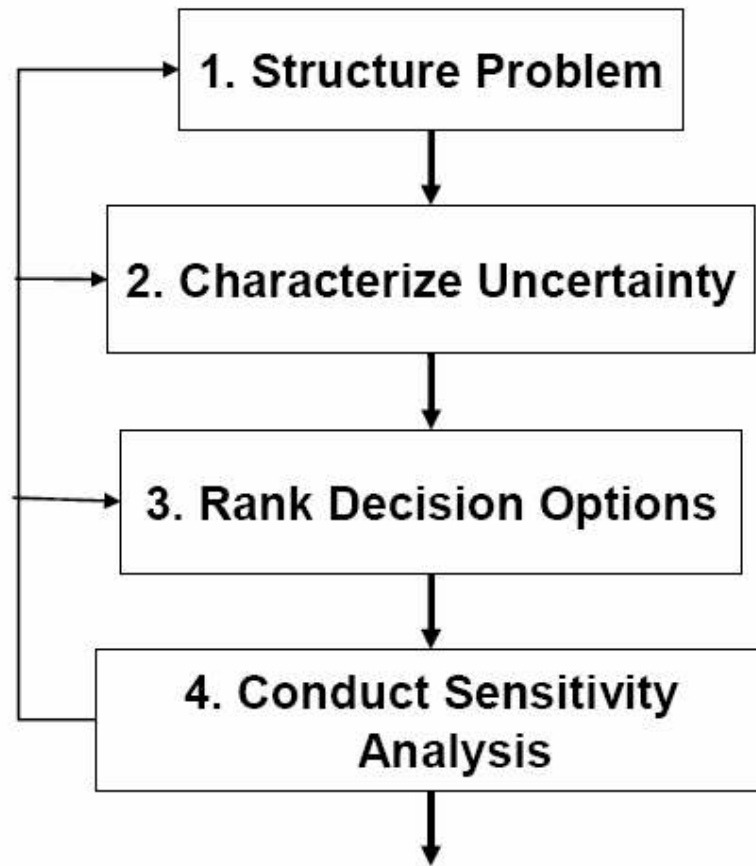
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# Conditions that are needed for prediction to be useful for decision-making

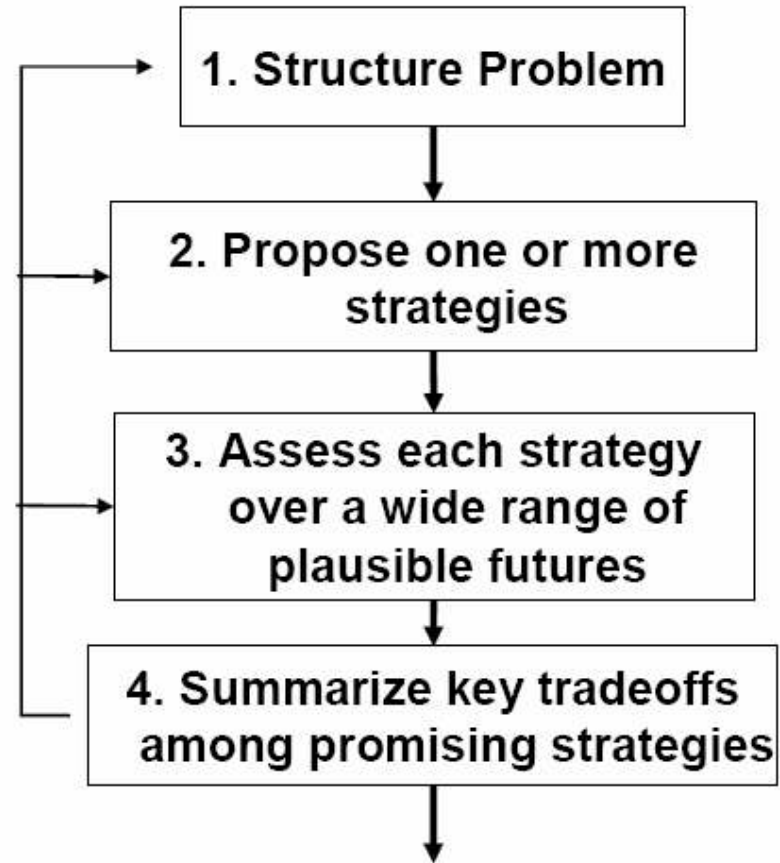| | |
|---|---|
| Predictive skill is known | ✘ |
| Decision makers have experience with understanding and using predictions | ✘ |
| The characteristic time of the predicted event is short | ✘ |
| There are limited alternatives | ✘ |
| The outcomes of various courses of action are understood in terms of well-constrained uncertainties | ✘ |

(Pielke Jr. et al. 2000)

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# Are there alternatives to prediction?

Predict-then-act approach

Assess-risk-of-policy framework



Predict-then-act approach:
1. Structure Problem
2. Characterize Uncertainty
3. Rank Decision Options
4. Conduct Sensitivity Analysis

**Suggests Optimum Alternative**

Assess-risk-of-policy framework:
1. Structure Problem
2. Propose one or more strategies
3. Assess each strategy over a wide range of plausible futures
4. Summarize key tradeoffs among promising strategies

**Suggests Robust Alternative**

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# Robust decision-making

- Does not require accurate and precise predictions of the future state of the climate
- Instead focuses on exploring how well strategies perform across wide ranges of assumptions and uncertainties
- Other techniques: information-gap decision theory (Ben-Haim 2006), resilience

| | East of England's Anglian Water | Southern California's Inland Empire Utilities Agency |
|---|---|---|
| Climate information used | Simple climate model combined with 9 Global and 11 Regional Climate Models | Statistical downscaling using 21 Global Climate Models |
| Risks to current water resource plans | Large precipitation decreases; large increases in demand | Large precipitation decreases; impacts on imports and declines in percolation |
| Measures available | Aquifer storage recovery; desalination plant | Local resource development |

# Conclusions

- 'Predict and provide' approach to science in support of climate change adaptation is significantly flawed

- Adaptation efforts should not be limited by the lack of reliable foresight about future climate conditions

- There are methods and tools that allow the planning of adaptation to climate change despite deep uncertainties

# Science policy implications

- Governments expect decisions to be based on the best possible science (evidence based policy-making)

- The science of climate prediction is unlikely to fulfil the expectations of decision-makers and potentially lead to maldaptation if misinterpreted or used incorrectly

- Society will benefit much more from a greater understanding of the vulnerability of climate-influenced decisions to large irreducible uncertainties than an increase in the accuracy and precision of the next generation of climate models

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# Thank you

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Dessai, S., M. Hulme, R. Lempert and R. Pielke, Jr. (2008) Climate prediction: a limit to adaptation? In W.N Adger, I. Lorenzoni and K. O'Brien (eds.) *Adapting to climate change: thresholds, values, governance* Cambridge University Press, Cambridge (in press).

Dessai, S., M. Hulme, R. Lempert and R. Pielke, Jr. (2008) Do we need more precise and accurate predictions in order to adapt to a changing climate? *EOS Transactions of the American Geophysical Union* (under revision).

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