

Climate prediction: a limit to adaptation?

Suraje Dessai^{1,2}, Mike Hulme^{2,3}, Robert Lempert⁴ and Roger Pielke, Jr.⁵

1 – Department of Geography, University of Exeter, Exeter, UK

2 – Tyndall Centre for Climate Change Research, UK

3 – School of Environmental Sciences, University of East Anglia, Norwich, UK

4 – RAND Corporation, Santa Monica, California, USA

5 - Center for Science and Technology Policy Research, University of Colorado, USA

Tyndall^oCentre
for Climate Change Research



Climate change impacts and adaptation: Dangerous rates of change

22-24 September 2008, University of Exeter, Exeter

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)

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

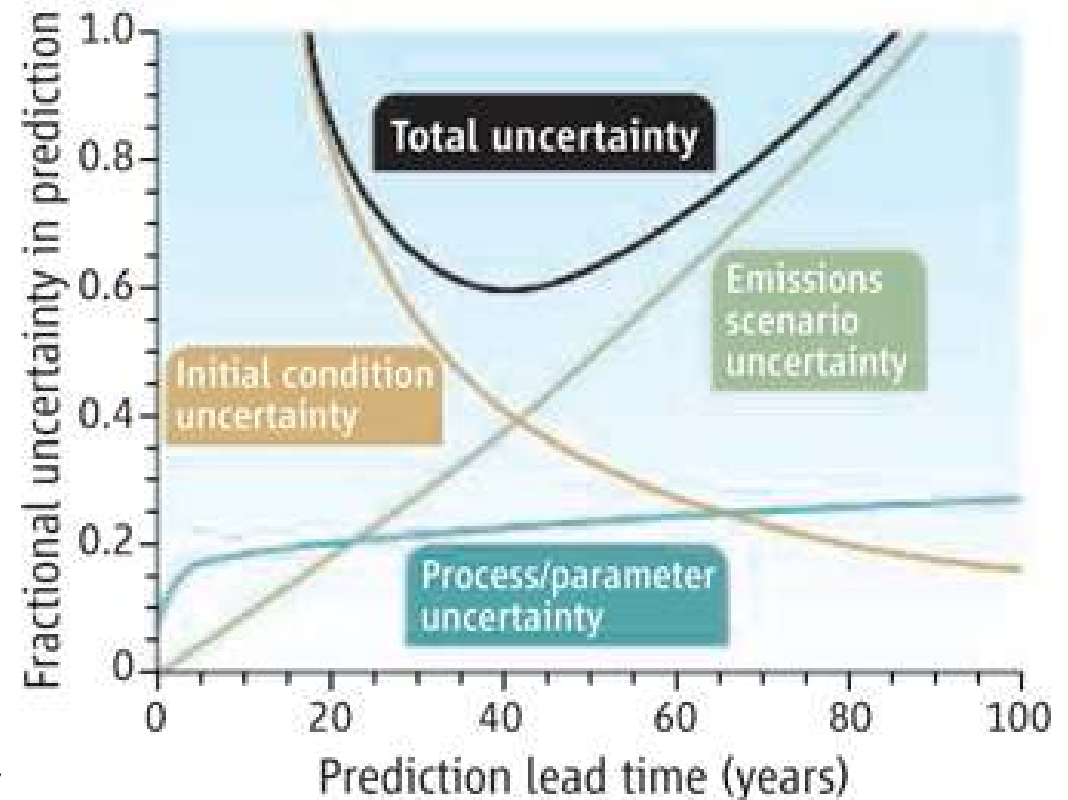


World Modelling Summit for Climate Prediction ECMWF - Reading (UK), May 6-9, 2008

- *“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

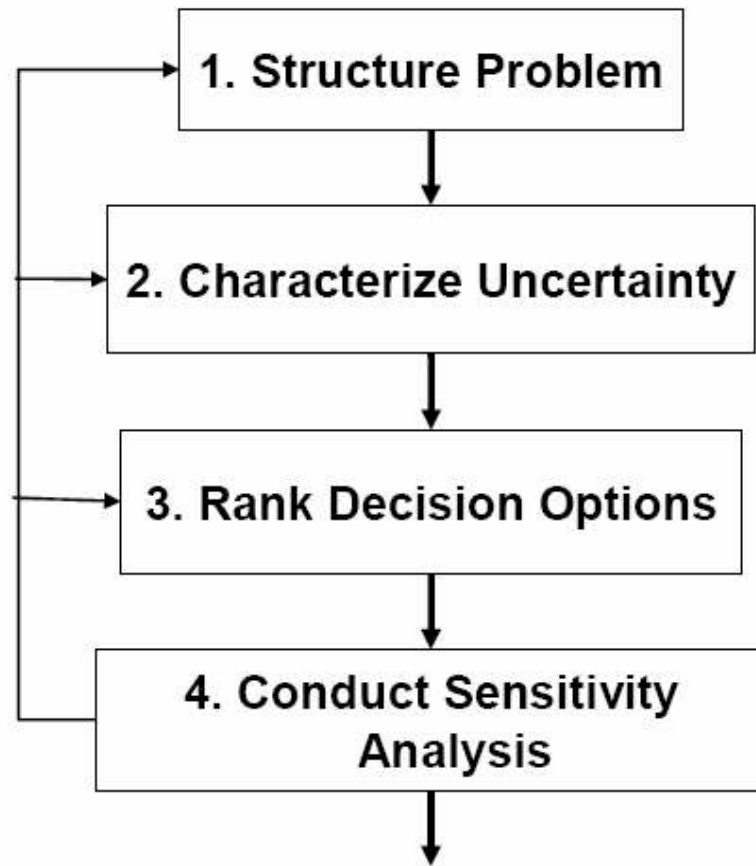
Conditions that are needed for prediction to be useful for decision-making

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

(Pielke Jr. et al. 2000)

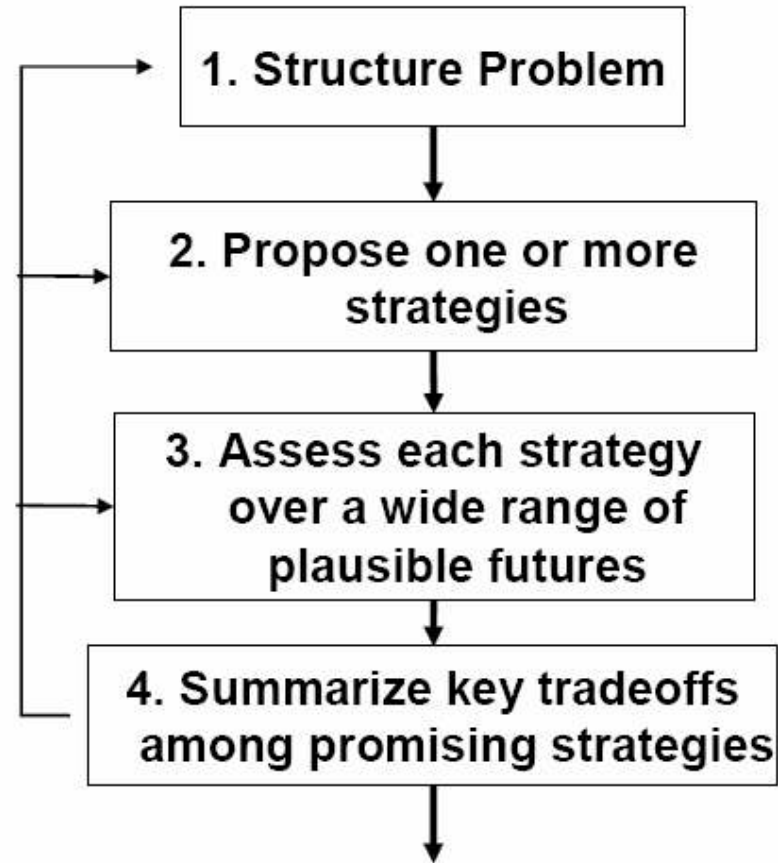
Are there alternatives to prediction?

Predict-then-act approach



Suggests Optimum Alternative

Assess-risk-of-policy framework



Suggests Robust Alternative

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

Thank you

s.dessai@exeter.ac.uk

- 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).