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Managing Water Resources under Climate Uncertainty: Challenges & Opportunities

Climate Adaptation National Research Flagship

Bryson C. Bates

Climate Change Adaptation Conference

30th June 2010

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Preliminary comments

- Climate has changed, & will always change
- Uncertainty & surprise are inevitable; risk is certain
- Climate variability will continue at all temporal scales
- Believe/disbelieve – manage the risk
- The science is incomplete
- Cannot wait for full scientific certainty
- Eliciting information about climate vulnerability & coping mechanisms can be illuminating
- Climate is not the only source of water stress – population growth; rising water demand for economic growth; environmental water allocations; agriculture; pollution, …

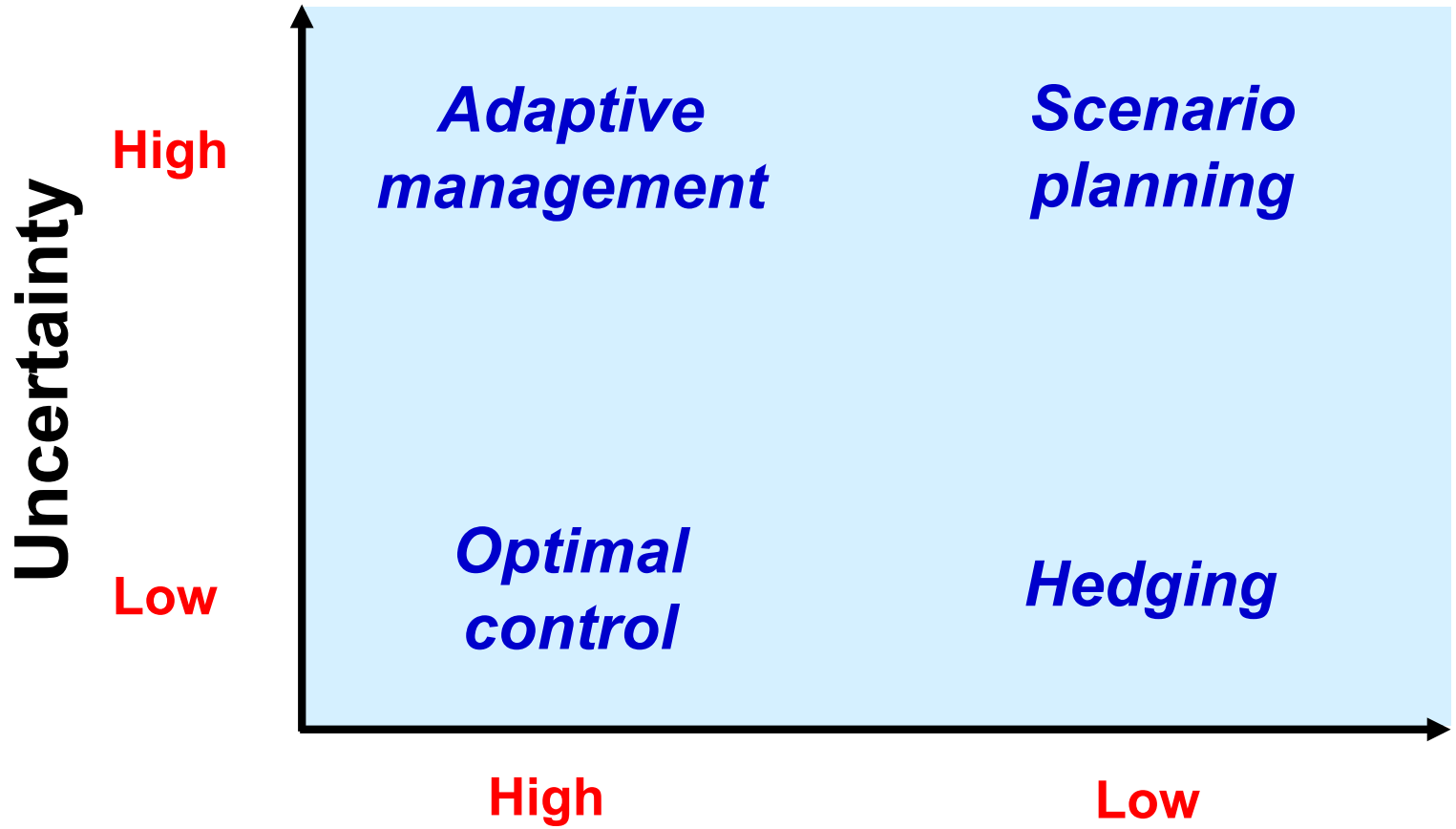
Distinguishing characteristics

Marsden, Jacob & Assoc. (2006)

- **Extent to which past changes in streamflow (&/or groundwater recharge) recognised**
- **Degree of reliance on historical record**
- **Level of service requirements**
- **Degree of reliance on reductions in water demand**
- **Willingness to consider non-traditional sources**
- **Extent to which climate change projections considered**
- **Extent to which contingency plans & triggers identified & articulated**

Approaches to systems planning

(Adapted from *Peterson et al.*, 2003)



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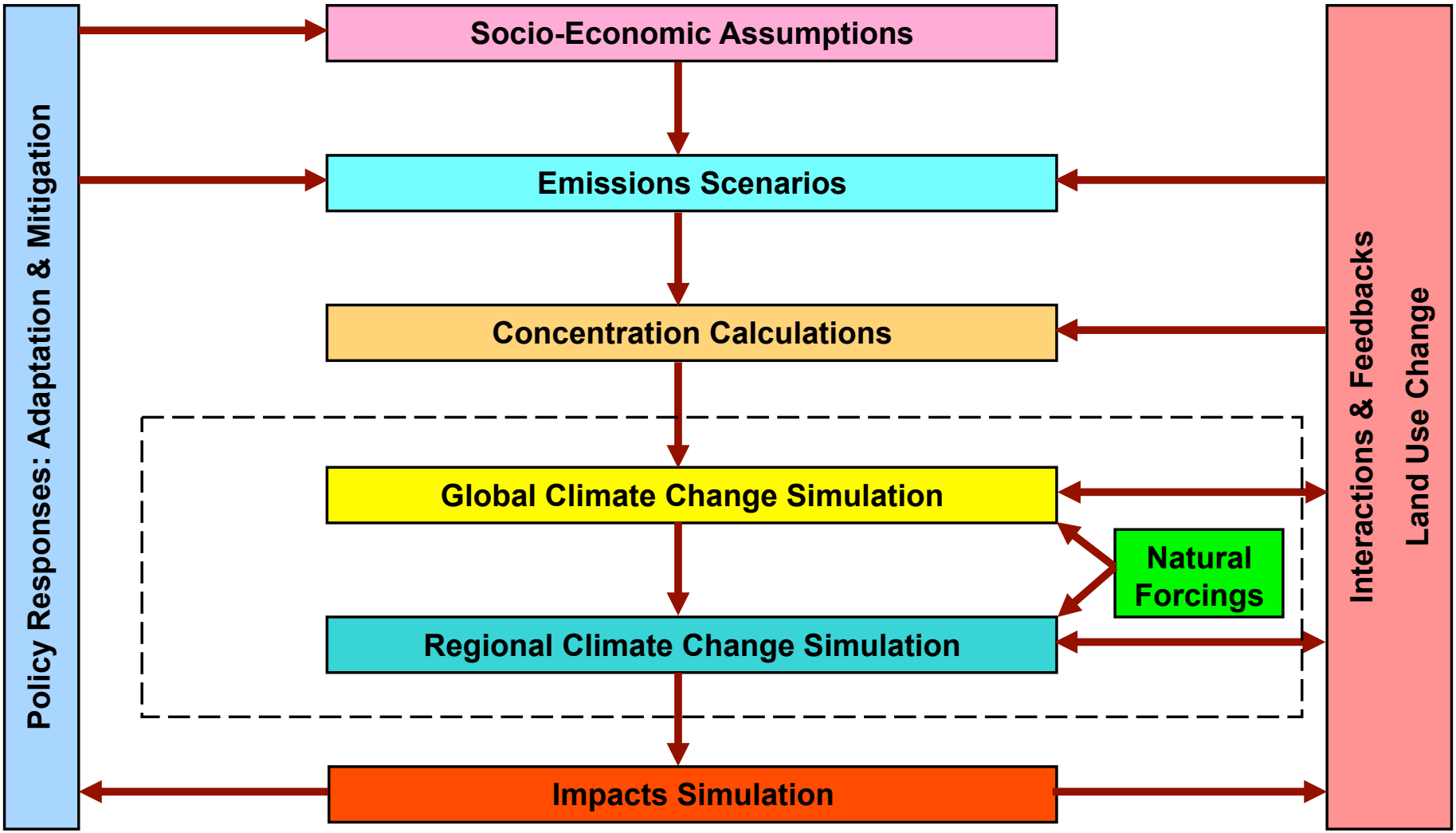
The uncertainty cascade



(Adapted from *Mearns et al.*, 2001)

Sources of uncertainty

- ***Ignorance***: lack of complete knowledge about processes, 'natural' variability
- ***Randomness***: stochastic or chaotic nature of natural forcing, errors in observational data, independence/interdependence
- ***Structural uncertainty***: simplification, choice of model configuration, internal physics, spatial & temporal averaging
- ***Parameter uncertainty***: 'tuneable' parameters in model schemes & numerical algorithms
- ***Initial & boundary conditions***

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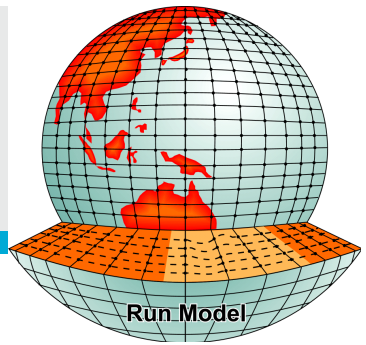
Selection of AR4 GCMs



Climate Model	van Oldenborgh (realistic ENSO)	Perkins (Aust)	CMAR (Aust)	Maxino (MDB)	Charles (SE MDB MSLP)
GFDL2.0	Yes	Yes	Yes	No	Yes
GFDL2.1	Yes	Yes	Yes	No	Yes
ECHAM5	Yes	Yes	Yes	No	No
GISS-ER	No	Yes	Yes	No	No
CSIRO Mk3	No	Yes	No	Yes	No
MRI-CGCM	No	No	No	Yes	Yes
CGCM3.1	No	No	No	Yes	No
IPSL-CM4	No	No	No	Yes	_

Probabilistic scenarios: limitations

- **Propagation of uncertainty through nonlinear models amplifies uncertainty**
- **Rigorous exploration of entire uncertainty space would be labour intensive & computationally expensive**
  - **models & ensembles samples drawn from populations**
  - **statistical independence questionable**
  - **estimates of pdfs highly conditioned on models & methods used**
  - **therefore, can only represent fraction of total uncertainty**
- **Prudent policy action could be deferred if levels of uncertainty prove to be irreducible or increase**
- **Current projections could be biased & level of uncertainty understated**
- **Maladaptation could occur if projections are accepted without question, misinterpreted or used incorrectly**

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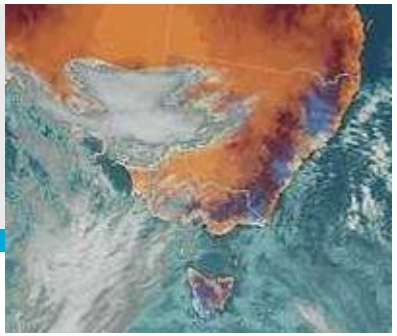
Storylines – SE Australia



2050 A1FI

Temp/ rainfall*	Slightly warmer	Warmer	Hotter	Much hotter
Much drier	No evidence	No evidence	Very unlikely 1 model IPSL-CM4	Very unlikely 1 model CSIRO-Mk3.5
Drier	No evidence	Very unlikely 2 models GISS-AOM PCM	As likely as not 11 models	Very unlikely 2 models CGCM3.1(T63) MIROC3.2(hires)
Little change	No evidence	No evidence	Unlikely 4 models	No evidence
Wetter	No evidence	No evidence	Unlikely 3 models	No evidence
Much wetter	No evidence	No evidence	No evidence	No evidence

*Classes are changes per degree of global warming

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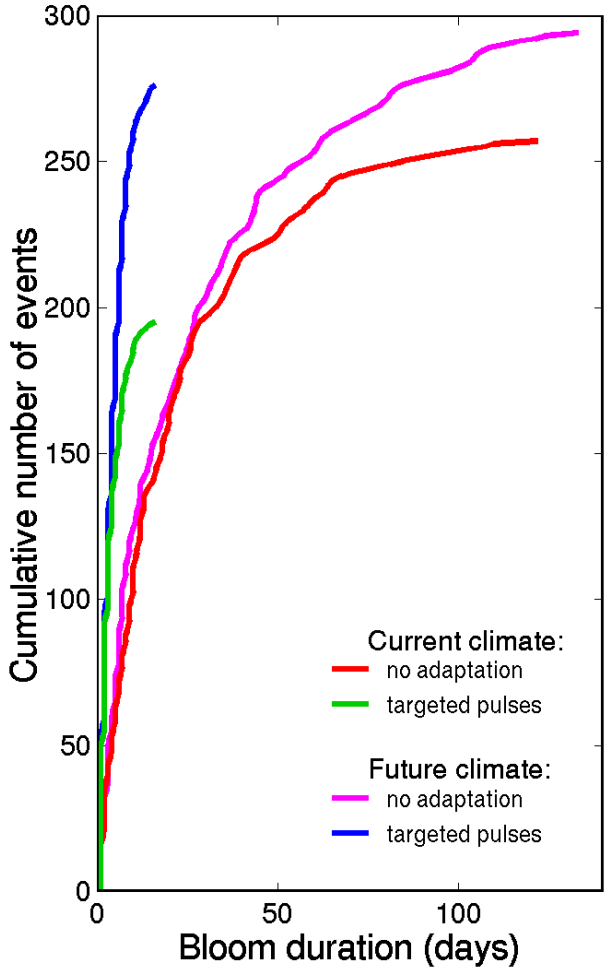
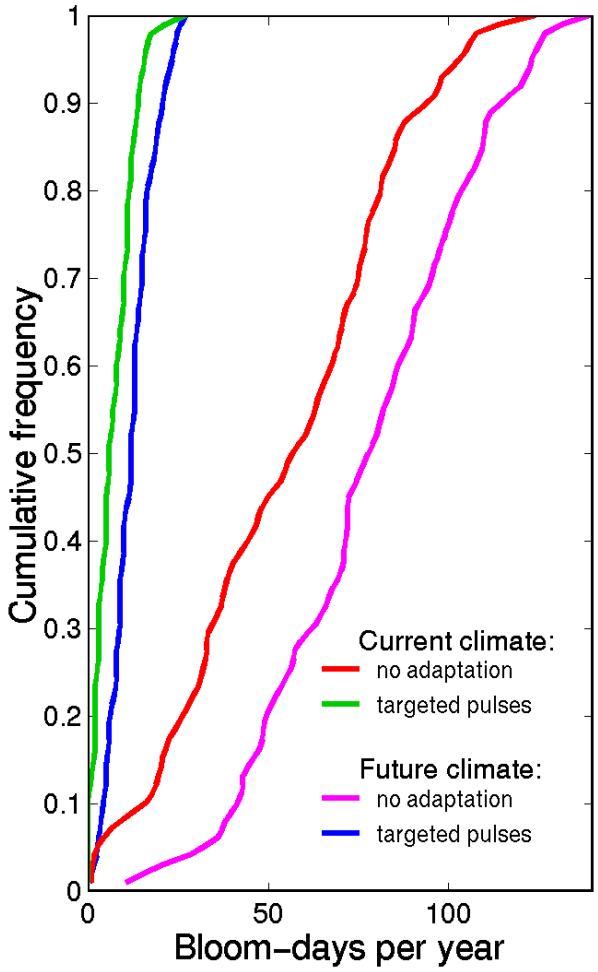
Robust adaptation strategies

- **Work well under present conditions & wide range of plausible climate futures**
- **Insensitive to resolution of uncertainties**
- **Reduced sensitivity to violated assumptions (possibly at expense of optimal performance)**
- **More likely to succeed than 'optimal' decision/ policy making based on predictive accuracy of climate models**
- **Must be efficient economically & socially acceptable**

(*Lempert & Schlesinger*, 2000; *Pittock et al*., 2001; *Dessai et al*., 2009)

Algal bloom manipulation





- Murrumbidgee River at Maude Weir
- 'Downscaled' CSIRO Mk 3 GCM run
- 30-yr time slices of SRES A2 scenario
- Present versus 2050 (1 x versus 1.7 x CO_2)
- ~ 8% rainfall decrease
- 0.9 ºC increase in max temperature
- 45% reduction for highest 50% of flows

(*Viney et al.*, 2007)

Prudent action under uncertainty

- **Preparedness rather than the prediction paradigm**
- **Uncertainty is an essential source of opportunity, discovery & creativity – knowledge, data & models will remain imperfect**
- **Use scenarios/storylines as well as the historical record**
- **Develop robust planning paths/trajectories well in advance**
- **Manage climatic risk – continuous risk planning & evaluation**
  - **maintain/enhance observational networks**
  - **build capability & synthesis in climate risk assessment**
  - **look for low probability, high impact events (not the most likely)**
  - **identify triggers for action (vulnerability assessment)**
  - **develop contingency plans: paths & trajectories; not just the 'next source'**
  - **quantify lead-time; identify means of cutting construction times**
- **Assess socio-political acceptability well in advance**
- **Adaptive governance arrangements & markets (pricing)**

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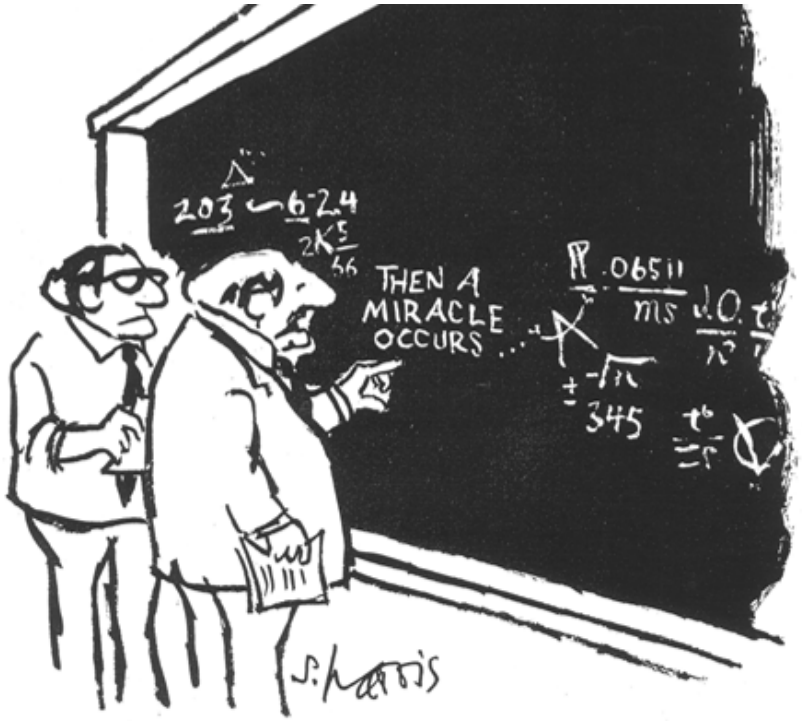
Thank you



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Planning without action is a daydream

Action without planning is a nightmare

Japanese Proverb

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Definitions

Increasing uncertainty; decreasing control

- ***Optimal control***: planning strategies that attain a desired aim by optimising a defined criterion (e.g. minimum cost)
- ***Hedging***: planning strategies designed to eliminate or minimise exposure to risk
- ***Adaptive management***: structured, iterative decision-making process in the presence of uncertainty
- ***Scenario planning***: testing the viability of alternative strategies by exploring the implications of what is possible

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