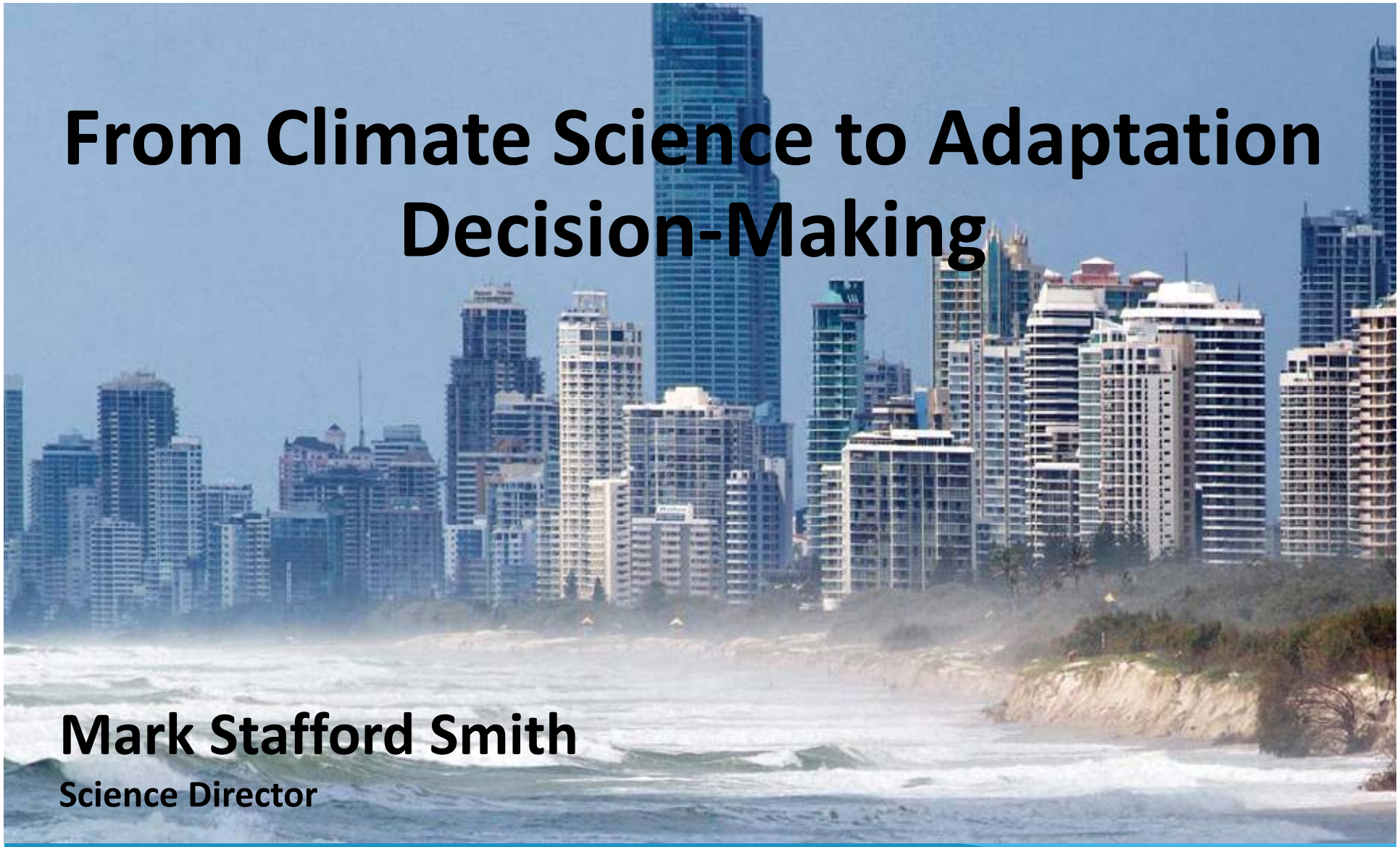
From Climate Science to Adaptation Decision-Making



Mark Stafford Smith

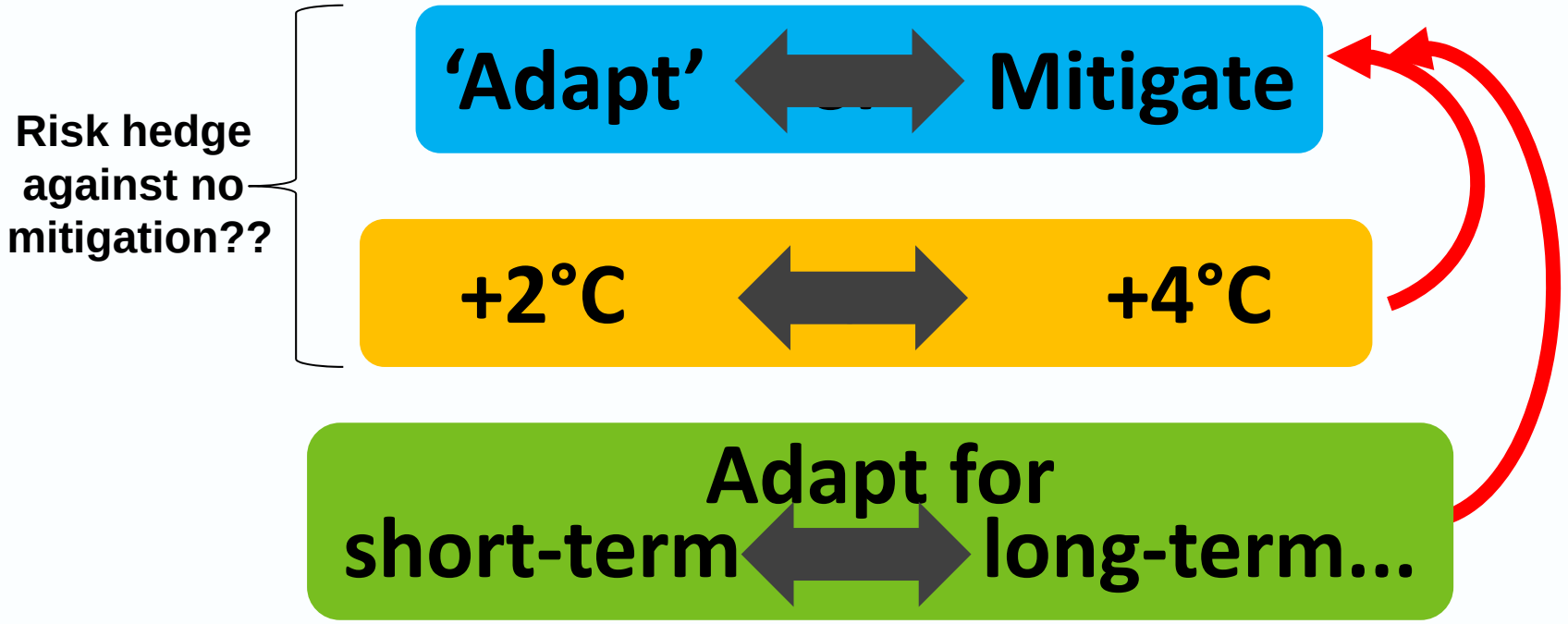
Science Director

CLIMATE ADAPTATION FLAGSHIP

www.csiro.au

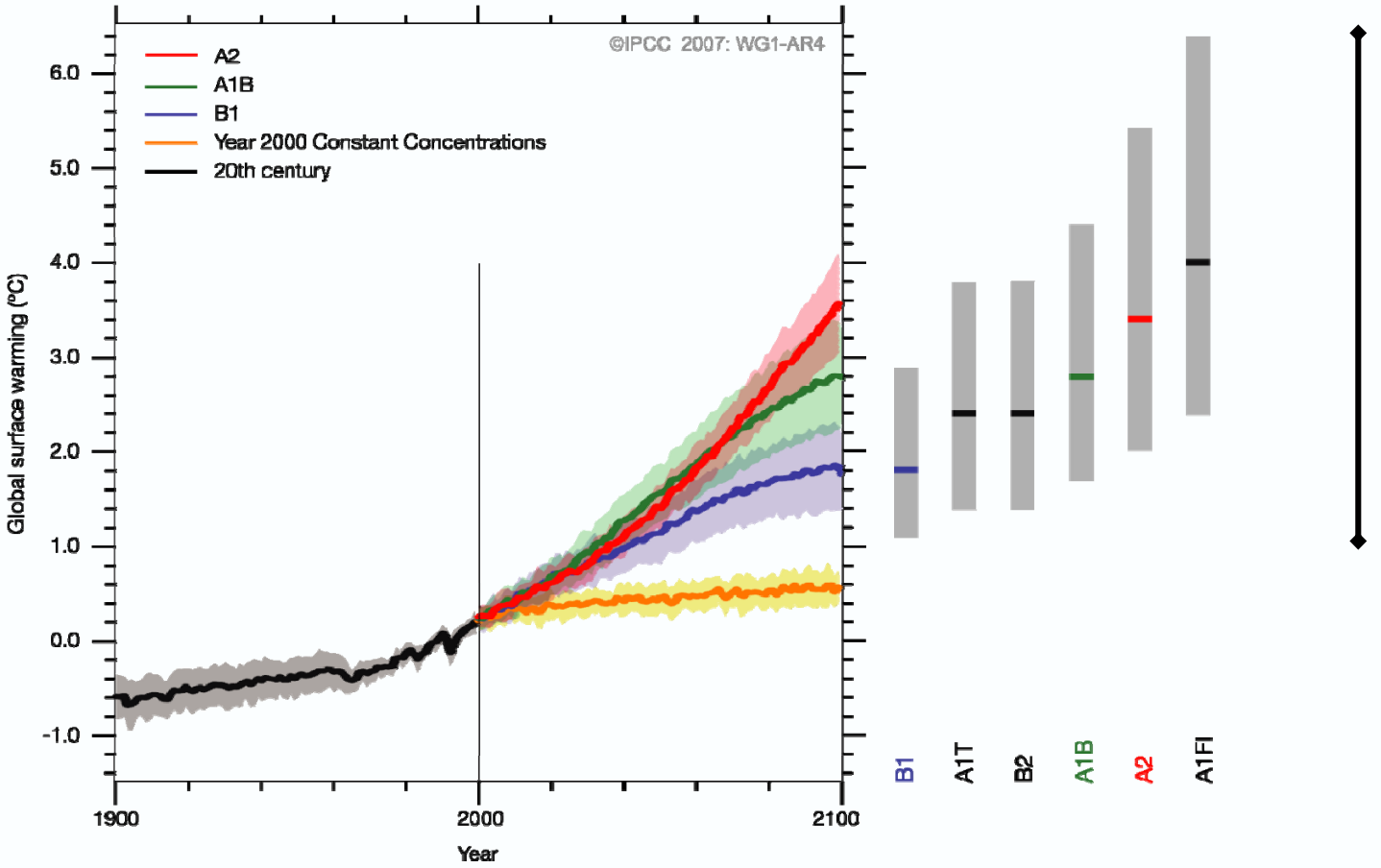
Cape Town Colloquium, 25th November 2013

Adapt, Innovate, Advocate – Business as Usual is not an Option



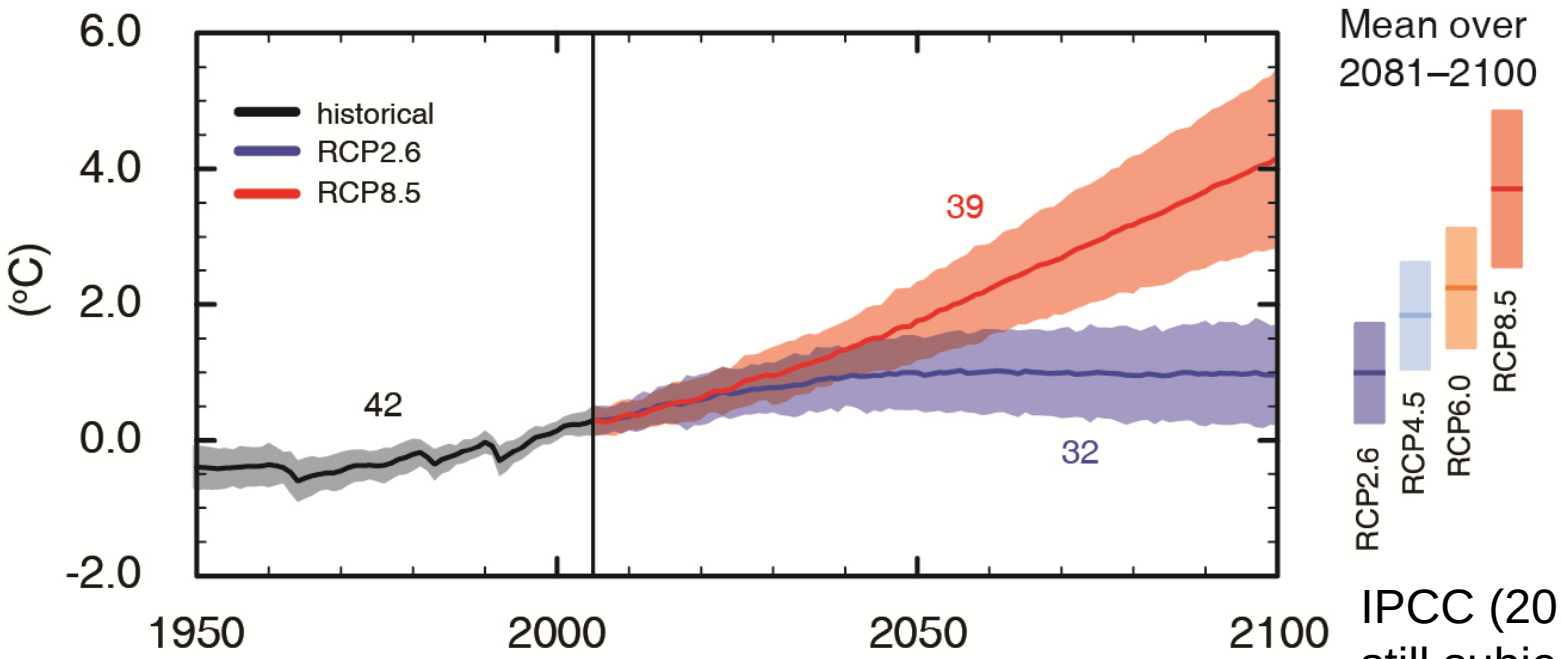
- Australian focus!

IPCC 2007: 1.1-6.4°C? – probably not any more



IPCC (2007) Summary for Policy Makers (Fig.SPM.5)

Projected global warming (IPCC 2013)

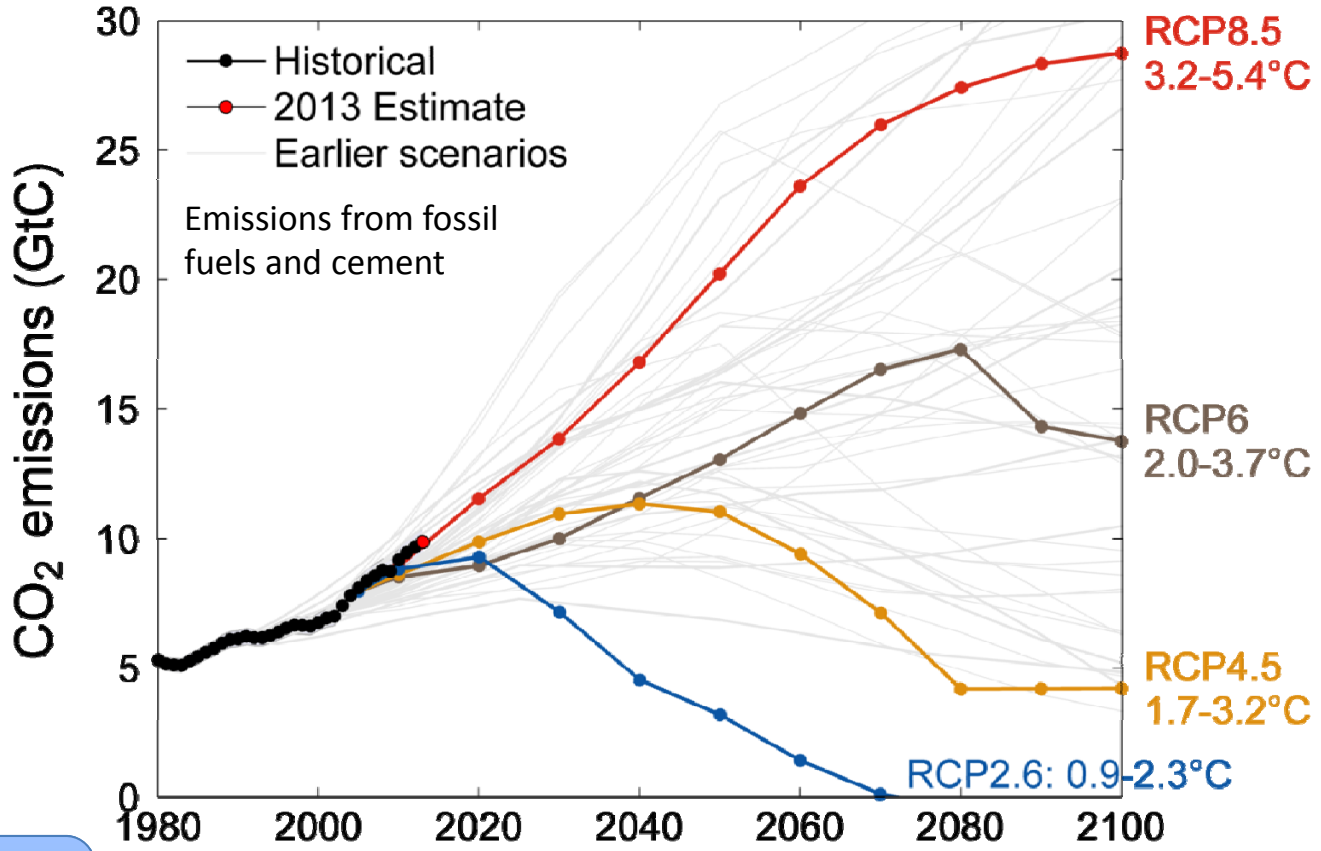


IPCC (2013) – figure still subject to copy edit

"Global surface temperature change for the end of the 21st century is likely to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6. It is likely to exceed 2°C for RCP6.0 and RCP8.5, and more likely than not to exceed 2°C for RCP4.5."

Observed Emissions and Emissions Scenarios

Emissions are on track for 3.2–5.4ºC "likely" increase in temperature above pre-industrial
Large and sustained mitigation is required to keep below 2ºC

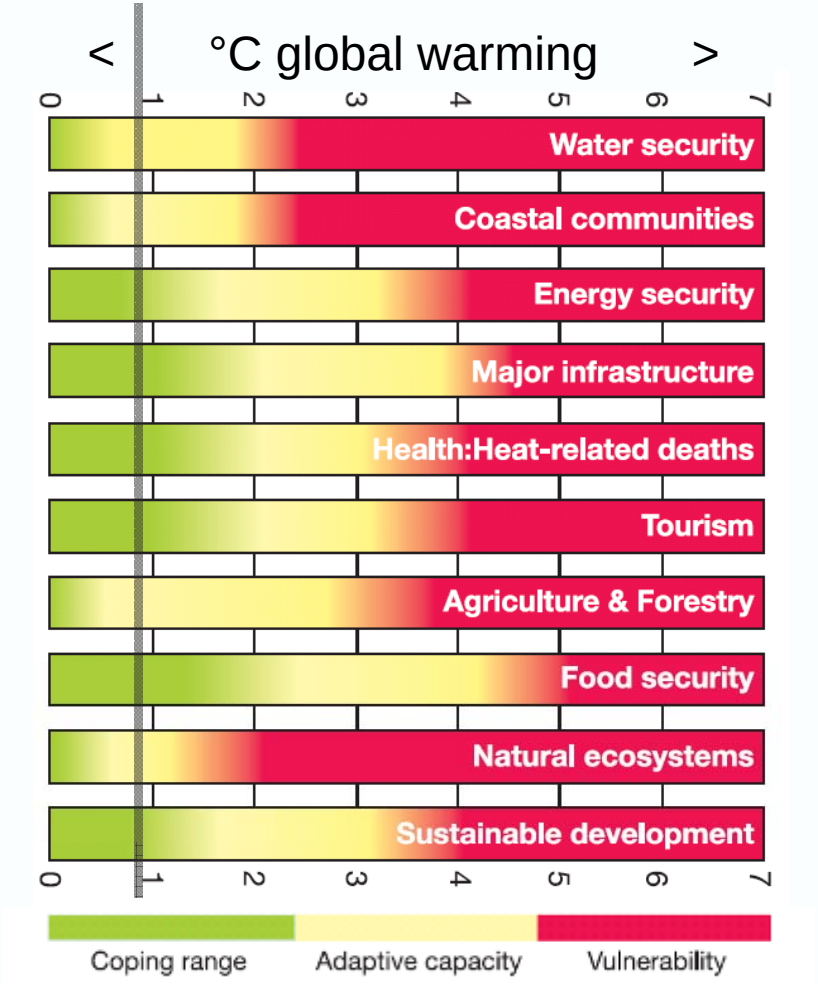


Released last week

Linear interpolation is used between individual data points

Source: Peters et al. 2012a; CDIAC Data; Global Carbon Project 2013

Australia: vulnerable among OECD nations



(a) Qualitatively different levels of impact, vulnerabilities and adaptation needs at 4°C compared to 2°C

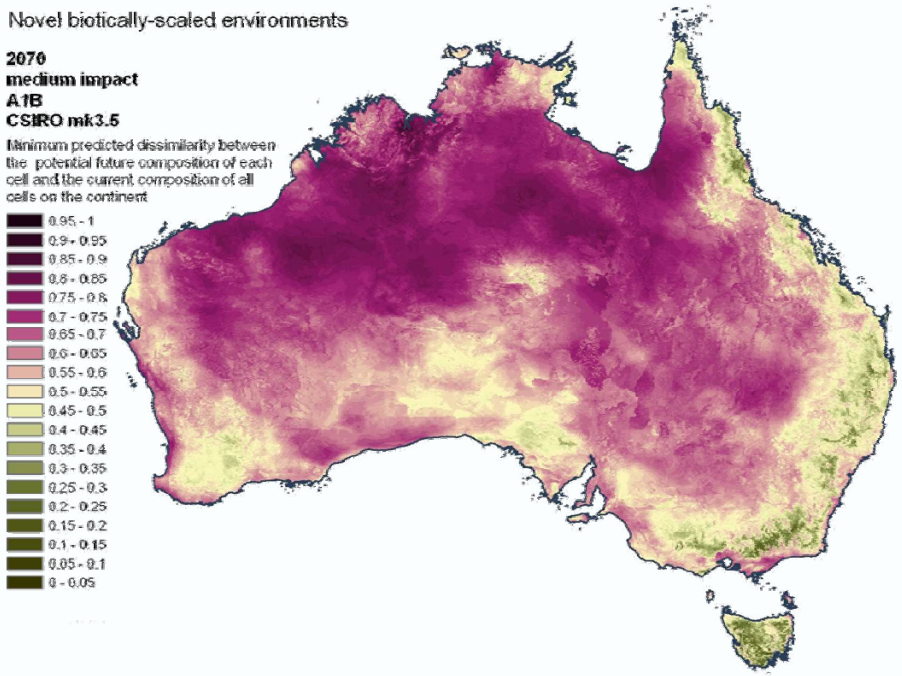
(b) Proactive adaptation needed to plan for stabilising at 2°C are very different to those needed for 2°C heading for 4°C+

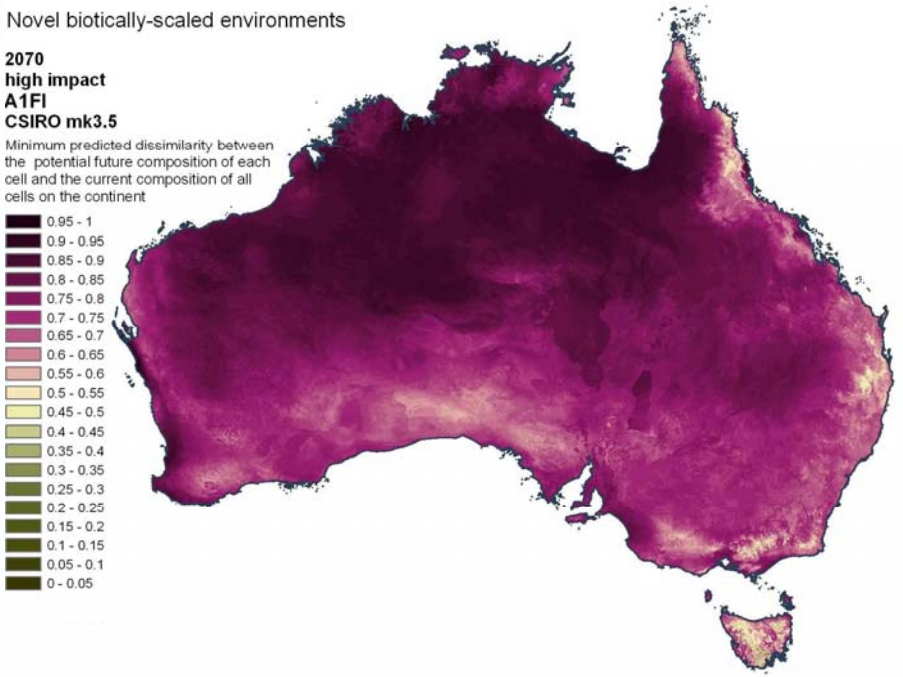
Could be disempowering…

IPCC (2007) (Fig.11.4: Australia)

National environmental change datasets

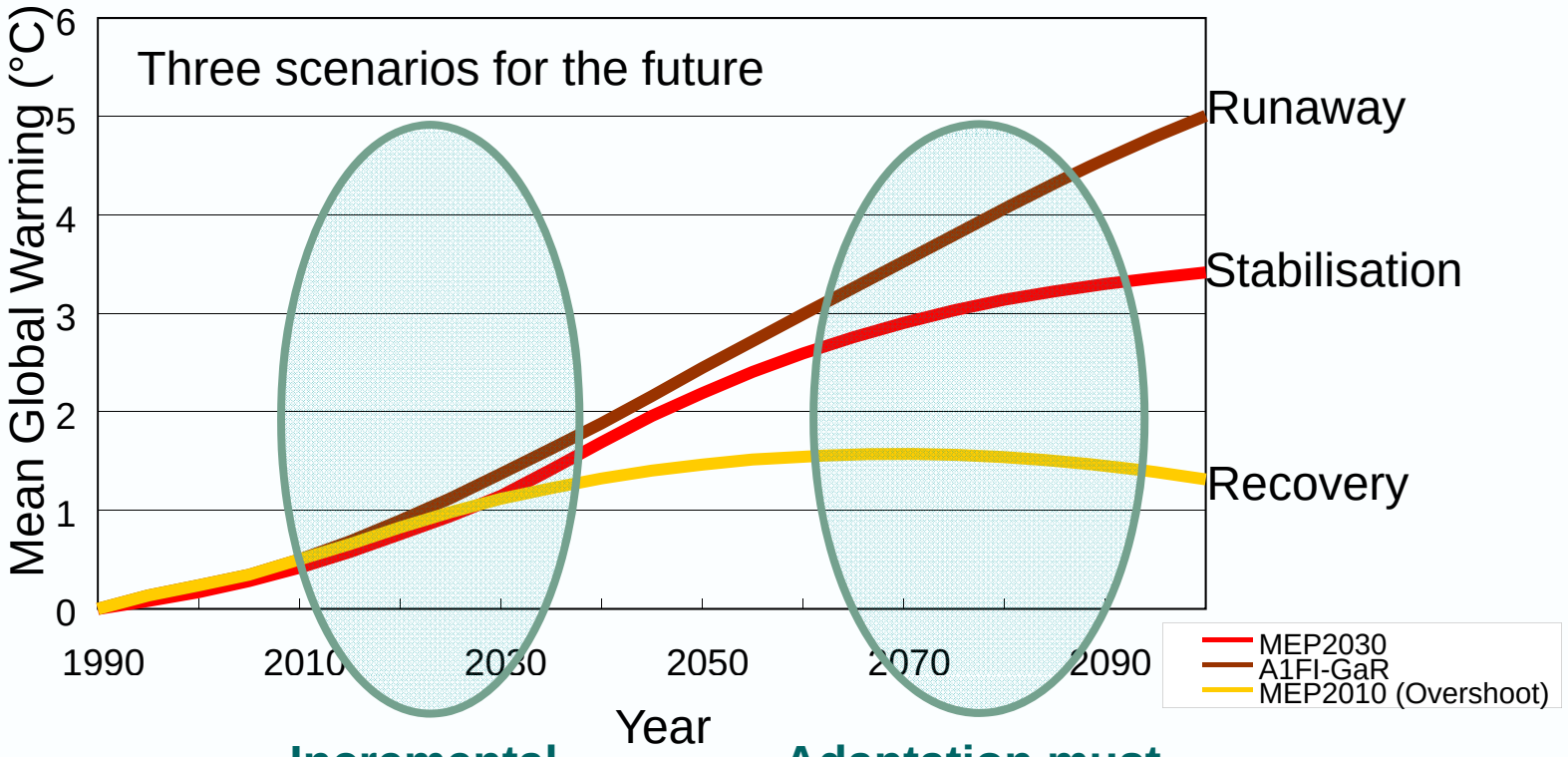
(e.g. GDMs of novel environment projections for 2070)





Ferrier *et al.* 2012

Managing the risk from diverging possible futures



Incremental adaptation to changes of reasonable certainty possible

Adaptation must increasingly manage the risk of divergent possible futures, and need for transformation

Re-framing our adaptation message

From:

- Disempoweringly complex, all-encompassing, problematic, uncertain and distant

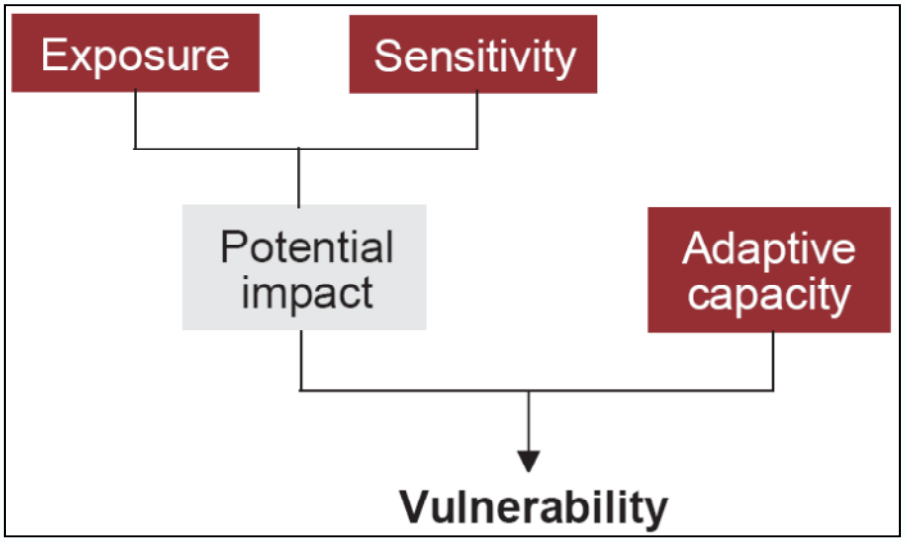
To:

1. **Solutions**, *not problem-oriented*
2. Decisions **today**, *not in 2070*
3. **Risk management**, *not uncertainty*
4. **Social and economic** issue, *not (only) environmental*
5. **Emergent** challenges, *not (only) local responses*

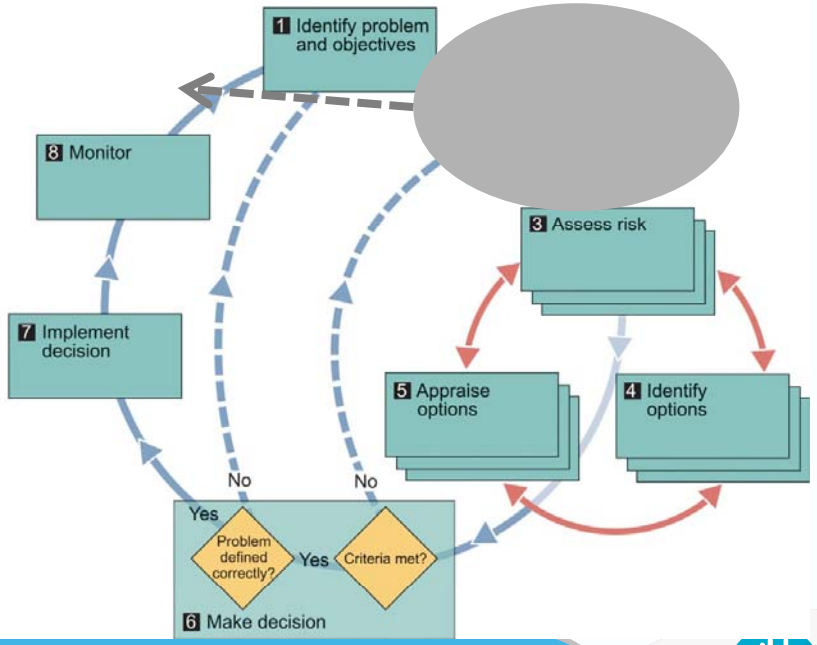
➢ **Systematic planning processes and manageable mental models**

Solutions-oriented

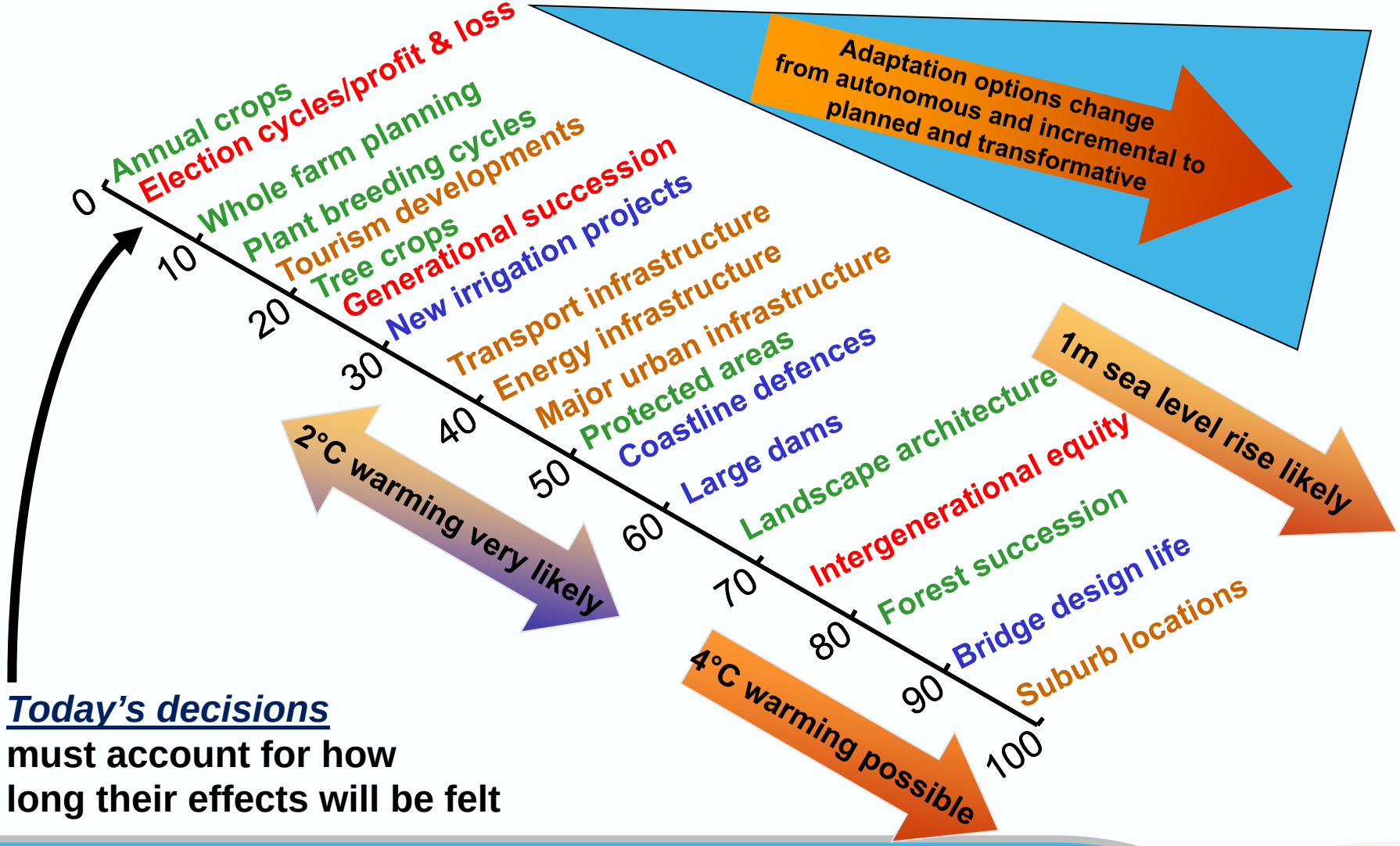
Problem or solution-centred??



Willows & Connell 2003 UKCIP



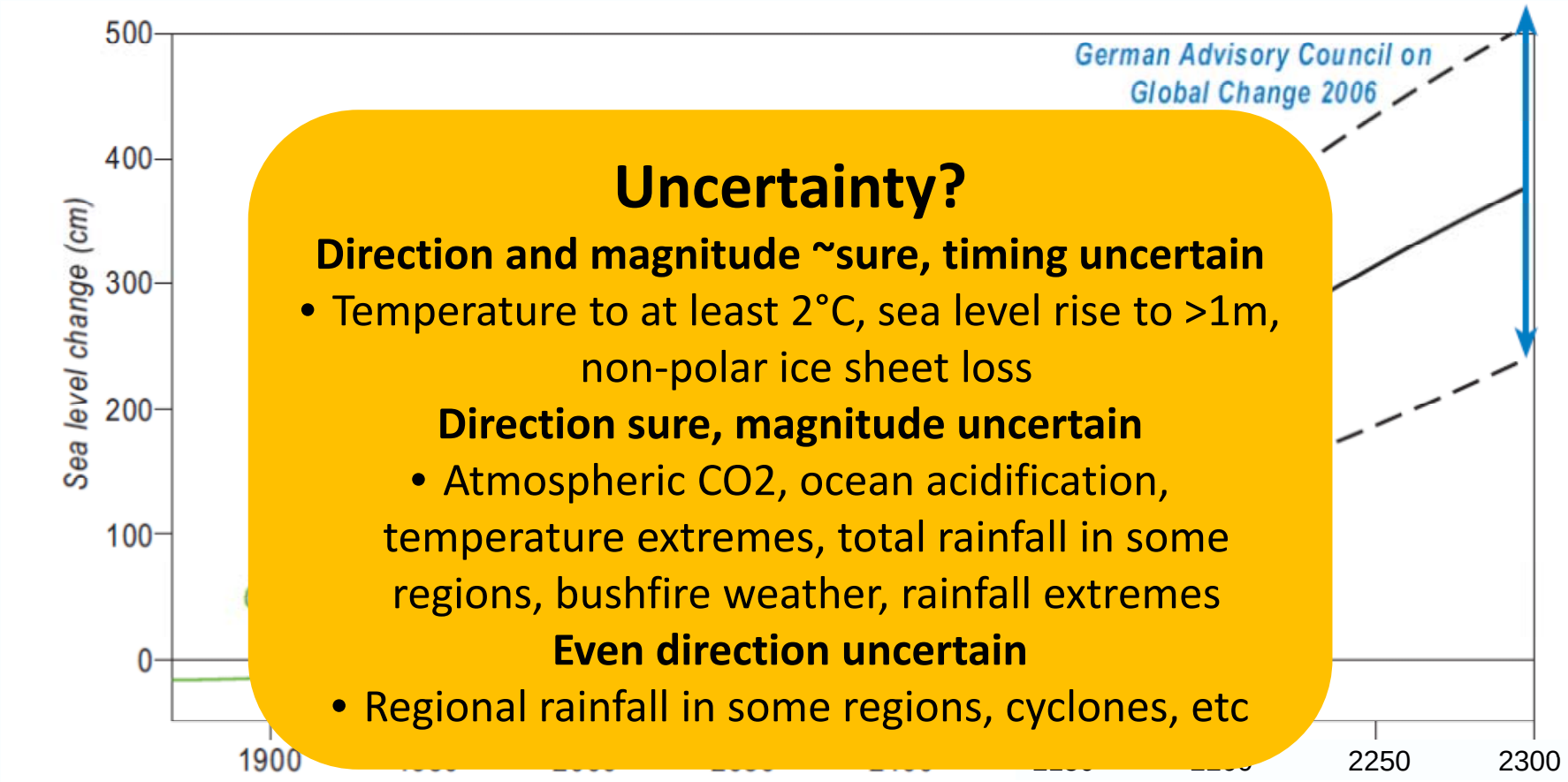
Adaptation timing and priorities



Today's decisions
must account for how long their effects will be felt

Stafford Smith et al, *PhilTransRoySoc* 2011 (after Jones & McInnes 2004)

Sea level rise: 1m within 2080-2170



Uncertainty?

Direction and magnitude ~sure, timing uncertain

- Temperature to at least 2°C, sea level rise to >1m, non-polar ice sheet loss

Direction sure, magnitude uncertain

- Atmospheric CO2, ocean acidification, temperature extremes, total rainfall in some regions, bushfire weather, rainfall extremes

Even direction uncertain

- Regional rainfall in some regions, cyclones, etc

Figure 2.10 Recent estimates of future sea-level rise relative to the 1990s.
Source: German Advisory Council on Global Change 2009[24]

Managing risk

Hallegatte (2009) *Global Environmental Change* **29**: 240-7

(i) selecting 'no-regret' strategies that yield benefits even in absence of climate change (*e.g. better disaster preparedness, 'CAR' principles)*)

(ii) favouring reversible and flexible options (*e.g. real options, delaying development*)

(iii) buying 'safety margins' in new investments (*e.g. heavier dam foundations*)

(iv) promoting soft adaptation strategies, including [a] long-term [perspective] (*e.g. social networks, insurance, water demand reduction*)

(v) reducing decision time horizons (*e.g. shorter lifetime buildings*)

Dessai & van de Sluijs (2007)

- 11 frameworks for decision-making; 12 tools for assessing uncertainty

Ranger *et al*. (2010)

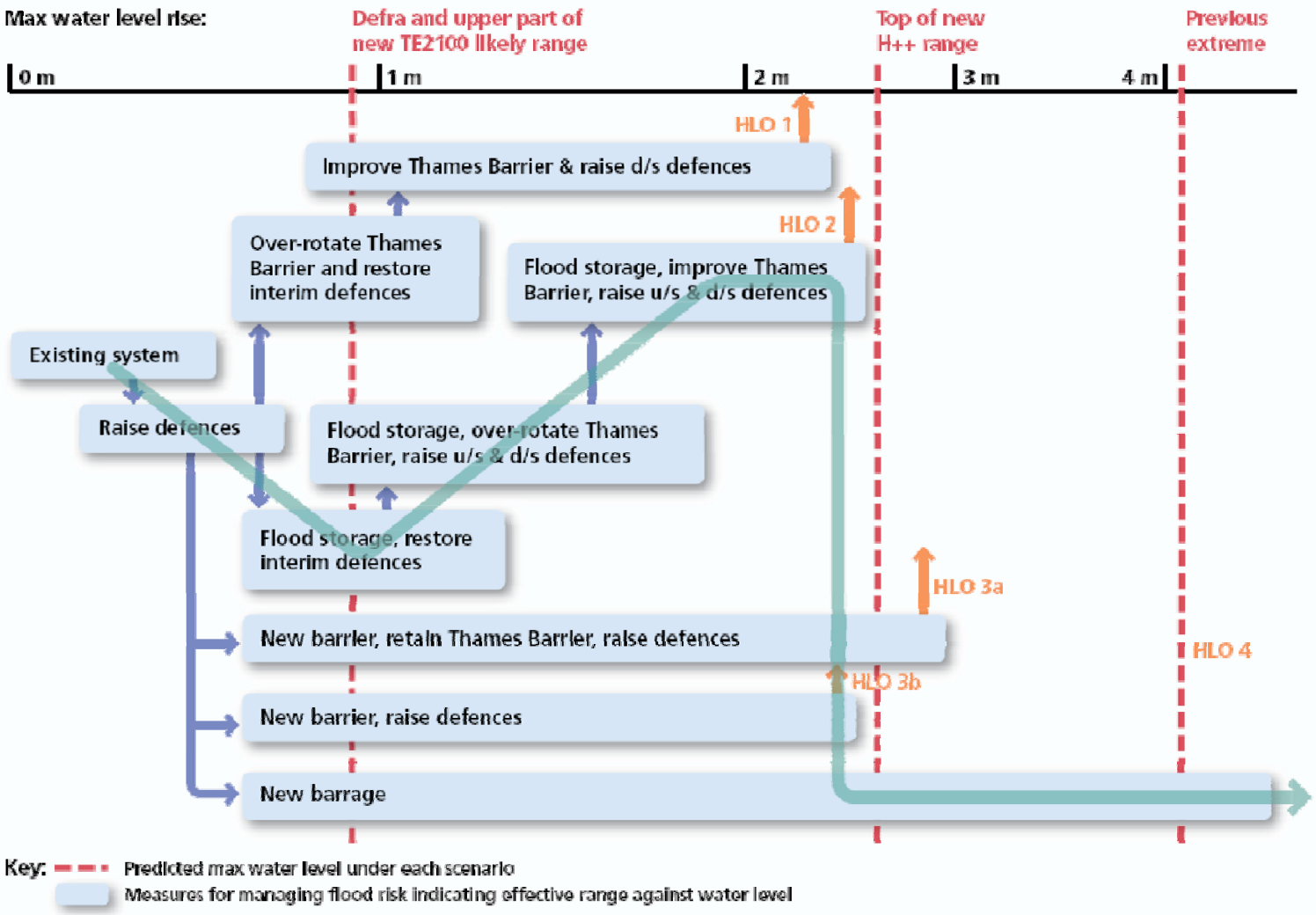
- '*Adaptation in the UK: a decision making process*'

➢ *Classify in terms of decision types and future change risks faced*

Systematising responses

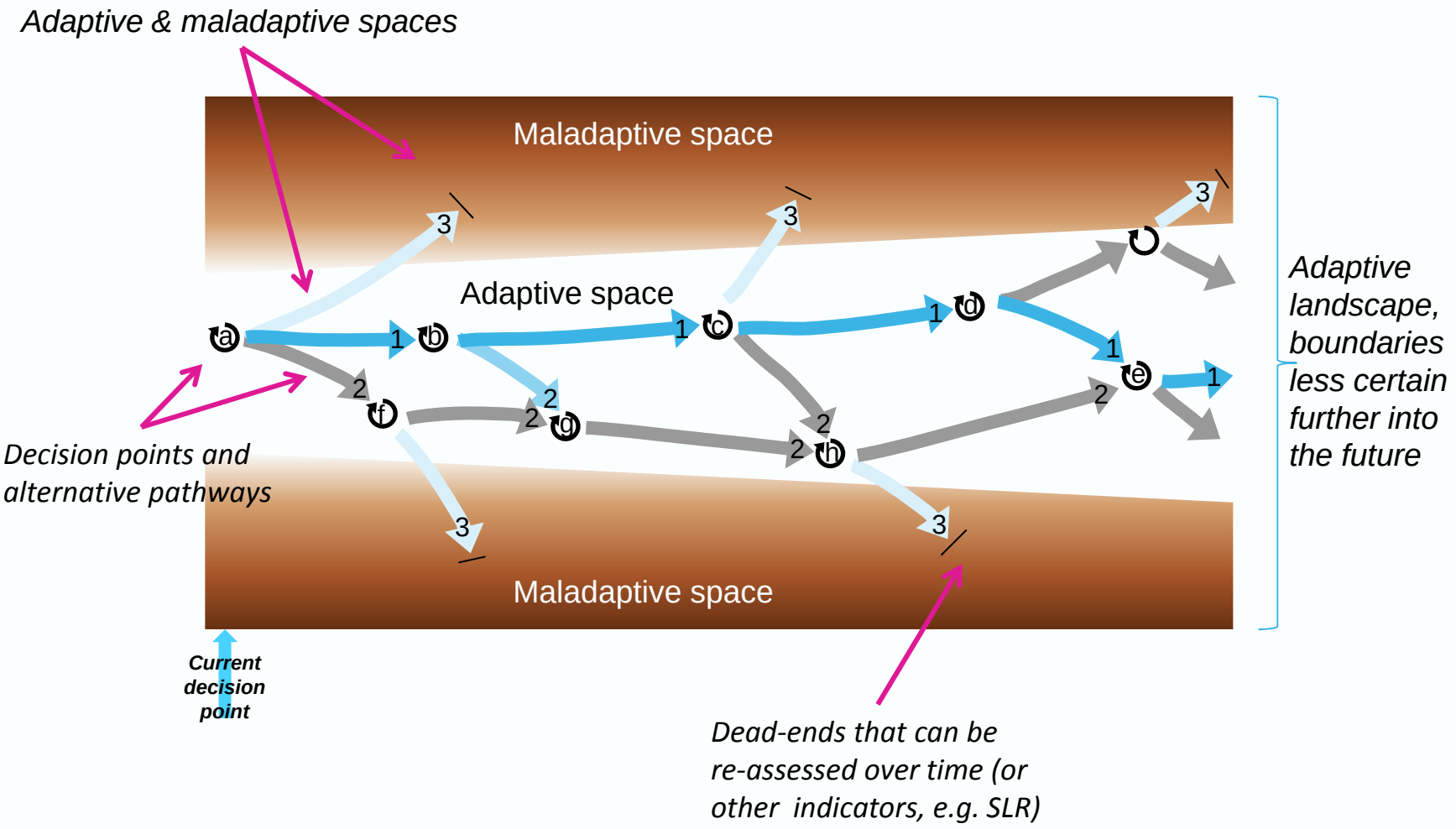
1. Short lifetime decisions
   - Mainly adapt incrementally, watch out for thresholds
2. Long lifetime decisions (where risk often falls to government)
   1. Monotonic, ~certain to occur, timing unsure
   – E.g. 2°C, 1m sea level rise, more hot periods, more extremes, more CO2
      – Plan for these, look for no regrets actions, use precautionary principle
   2. Direction sure but extent unsure
   – E.g. drying SW Australia and reduced water flows, fire risk in many areas
      – Use risk management, 'soft adaptations' to delay expensive decisions (but prepare for these), 'real options' analysis
   3. Even direction of response unsure
      – Robust decision-making, risk hedging against alternative futures, etc
3. And plan adaptation pathways, with critical decision-points
   - May include no action options, but deliberatively!

Flexible decision pathways: Thames Estuary

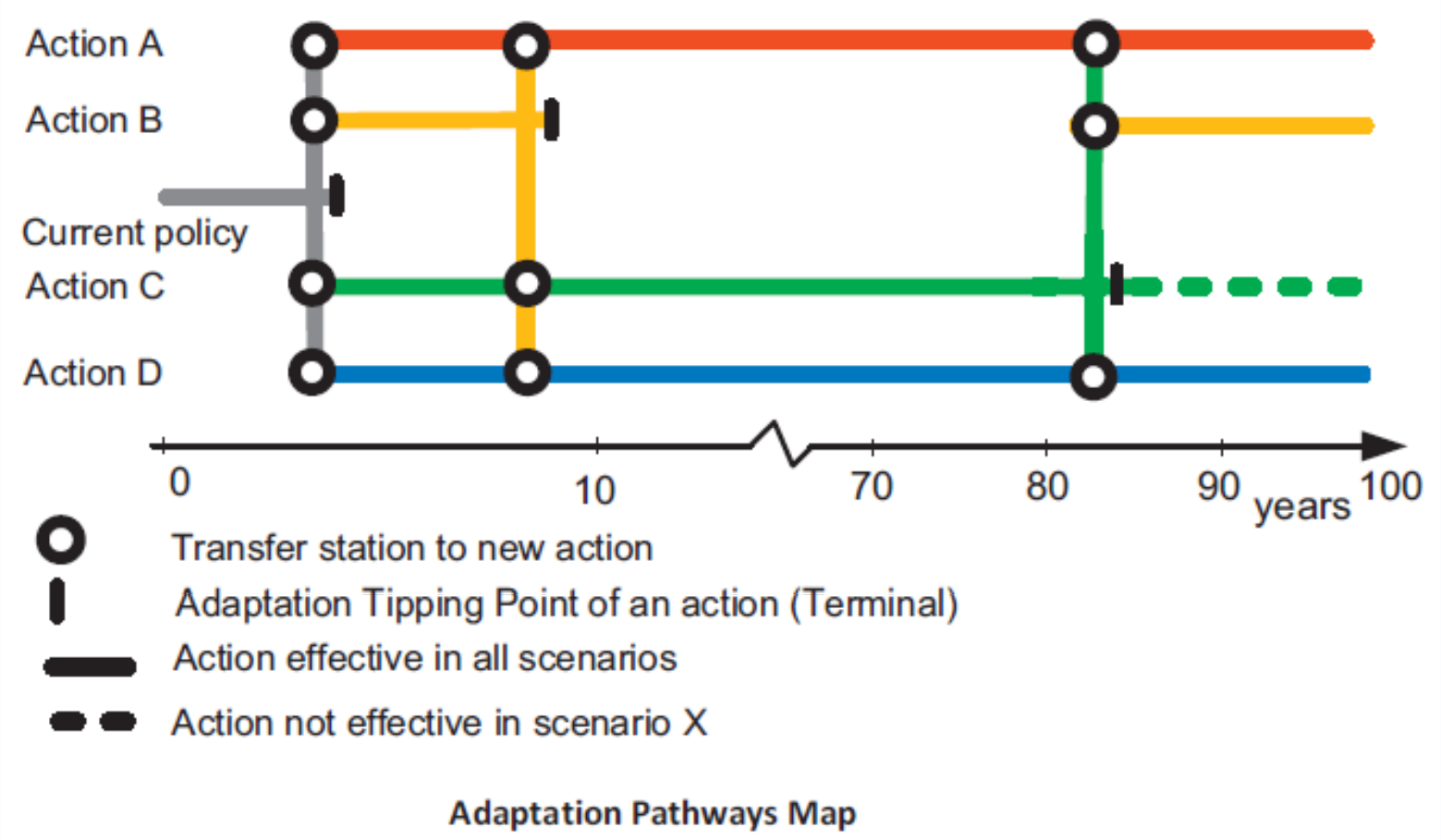


Lowe et al, *UK Met Office* 2009

The ‘classic’ adaptation pathway concept



Recent formalisations of pathways



Haasnoot *et al* – from Dynamic Adaptive Policy Pathways idea

Recent formalisations of pathways

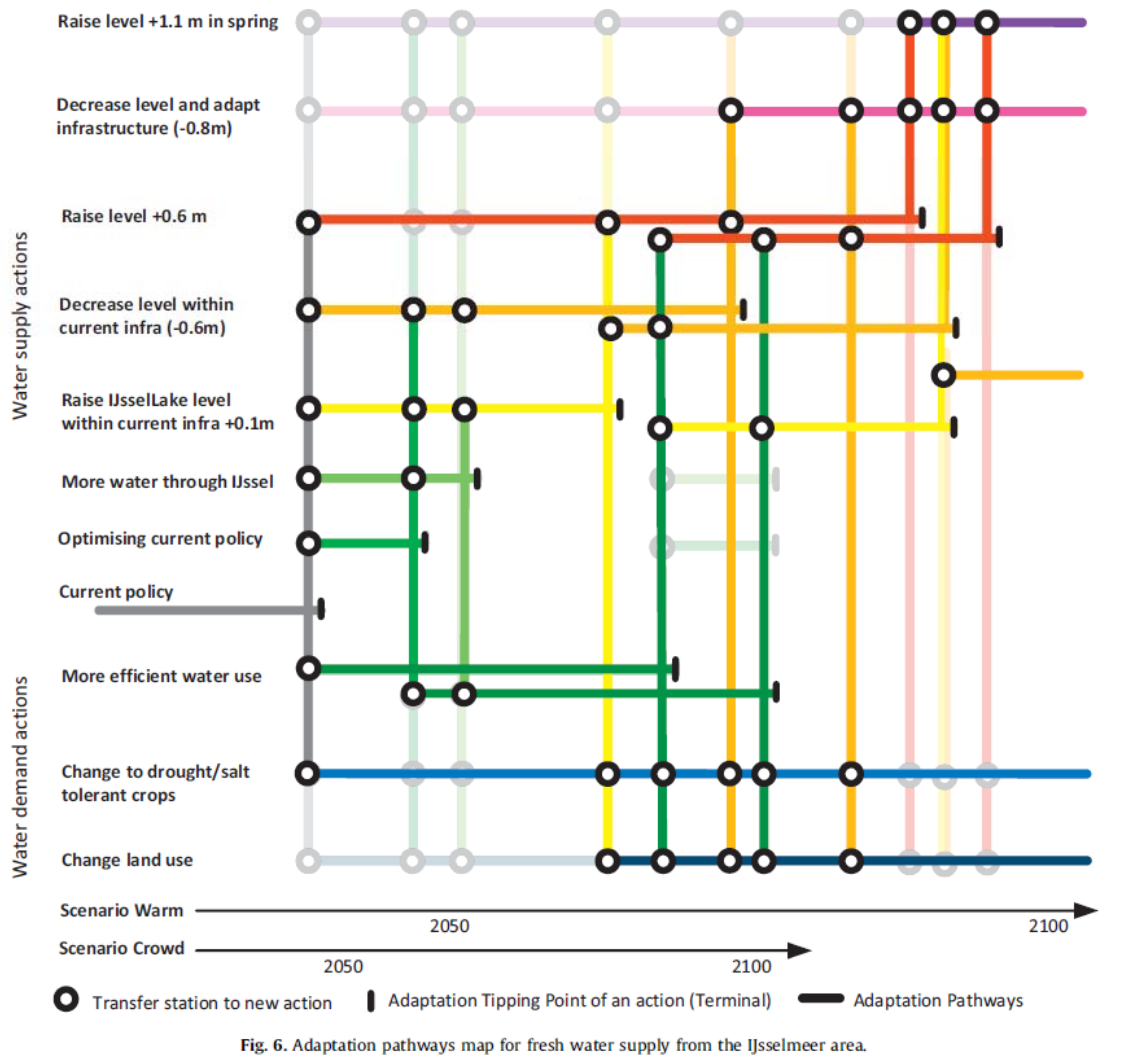


Fig. 6. Adaptation pathways map for fresh water supply from the IJsselmeer area.

Recent formalisations of pathways

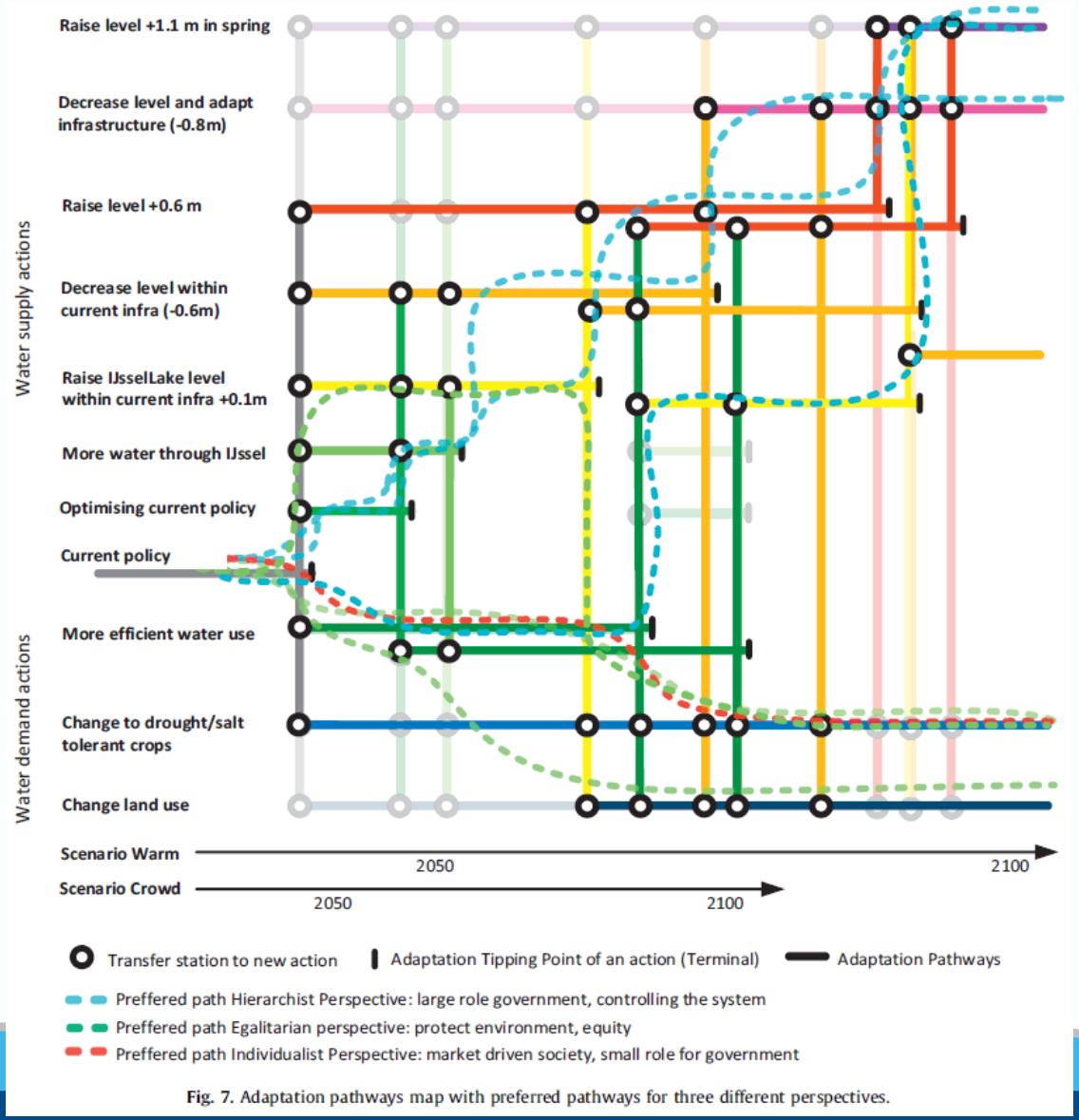
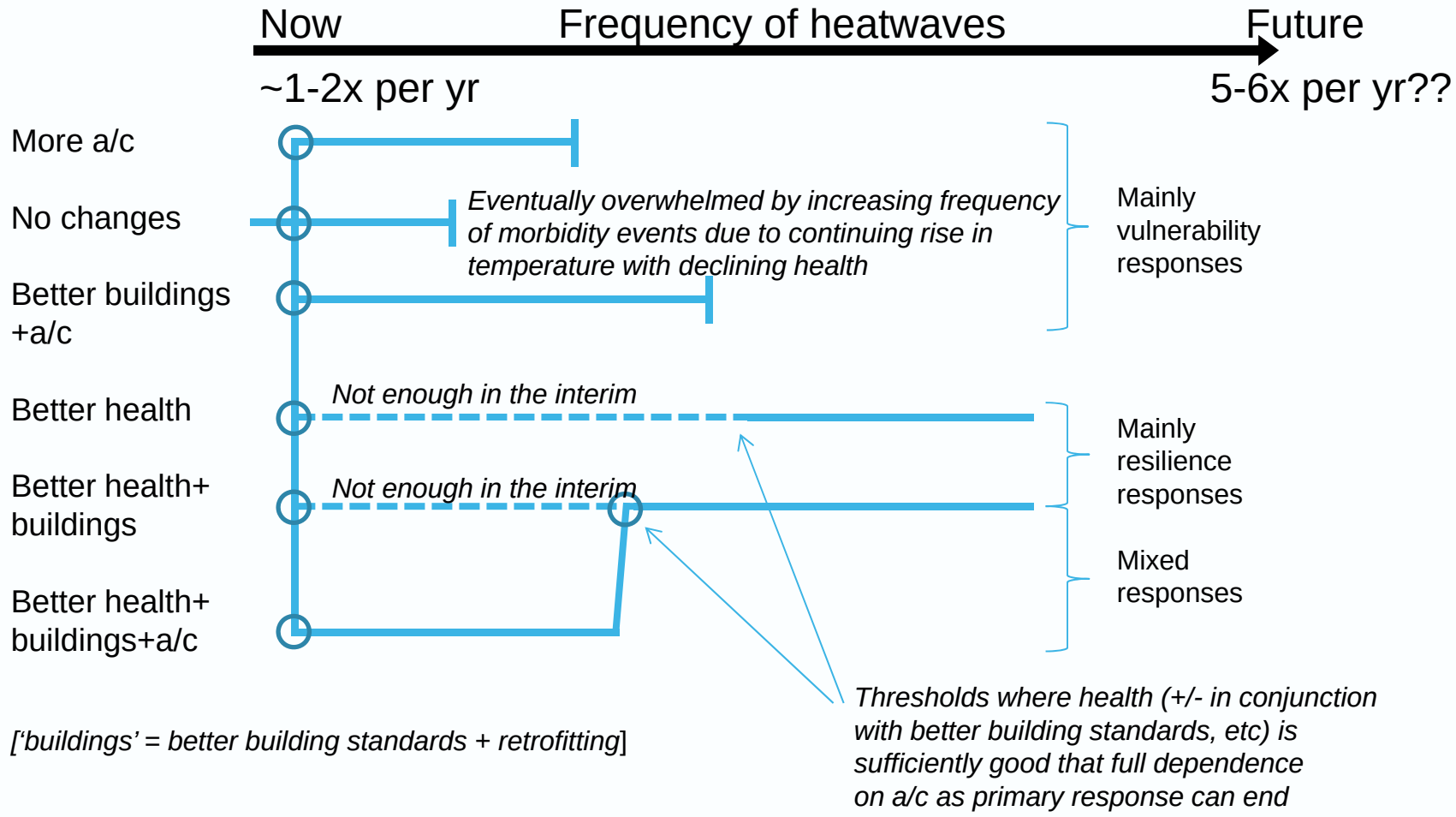


Fig. 7. Adaptation pathways map with preferred pathways for three different perspectives.

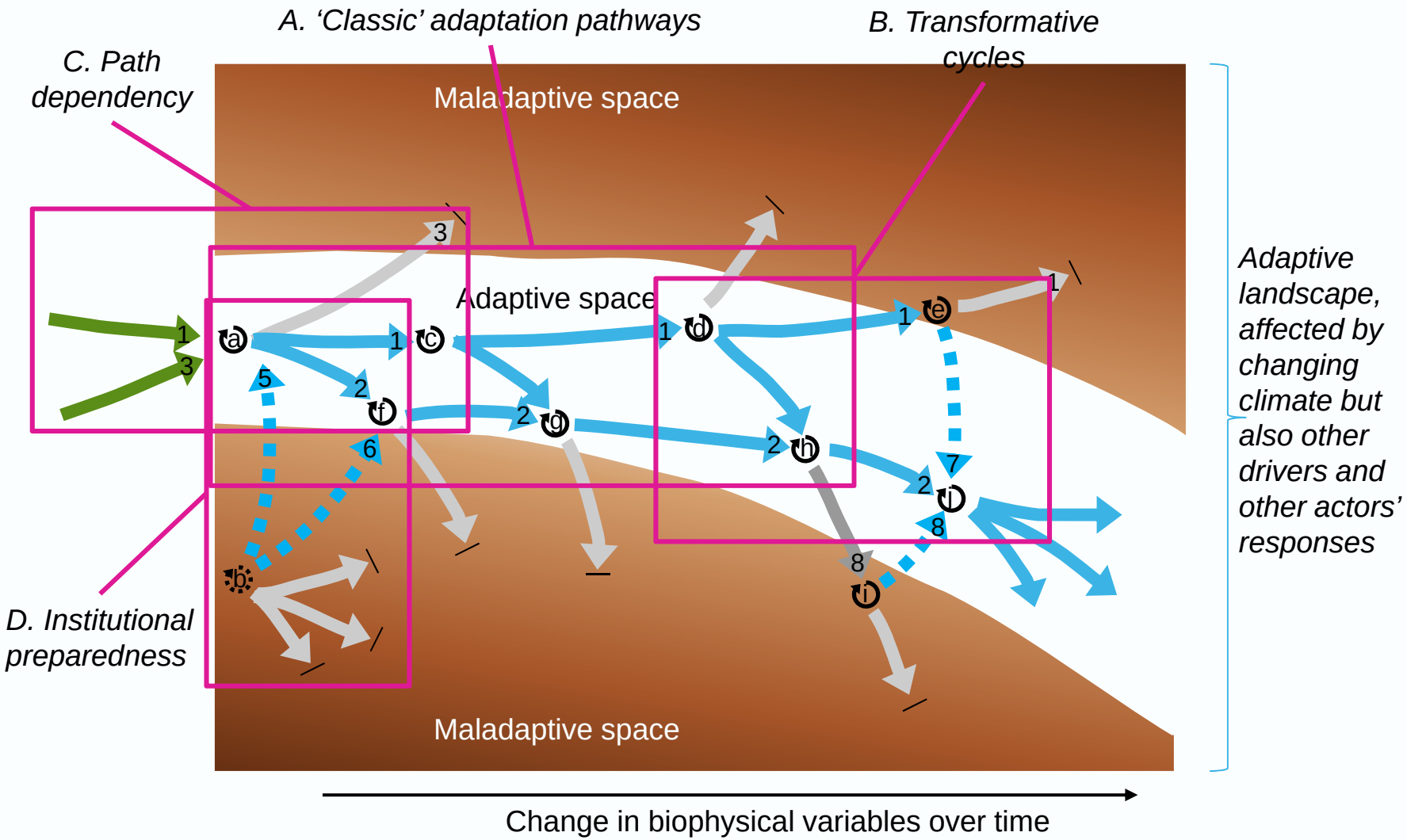
Haasnoot *et al.*, GEC 2013

Resilience and vulnerability responses in remote settlements in Australia



['buildings' = better building standards + retrofitting]

The latest adaptation pathway concept



Re-framing our adaptation message

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To:

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Give me 1 word that characterises what adaptation is tackling?

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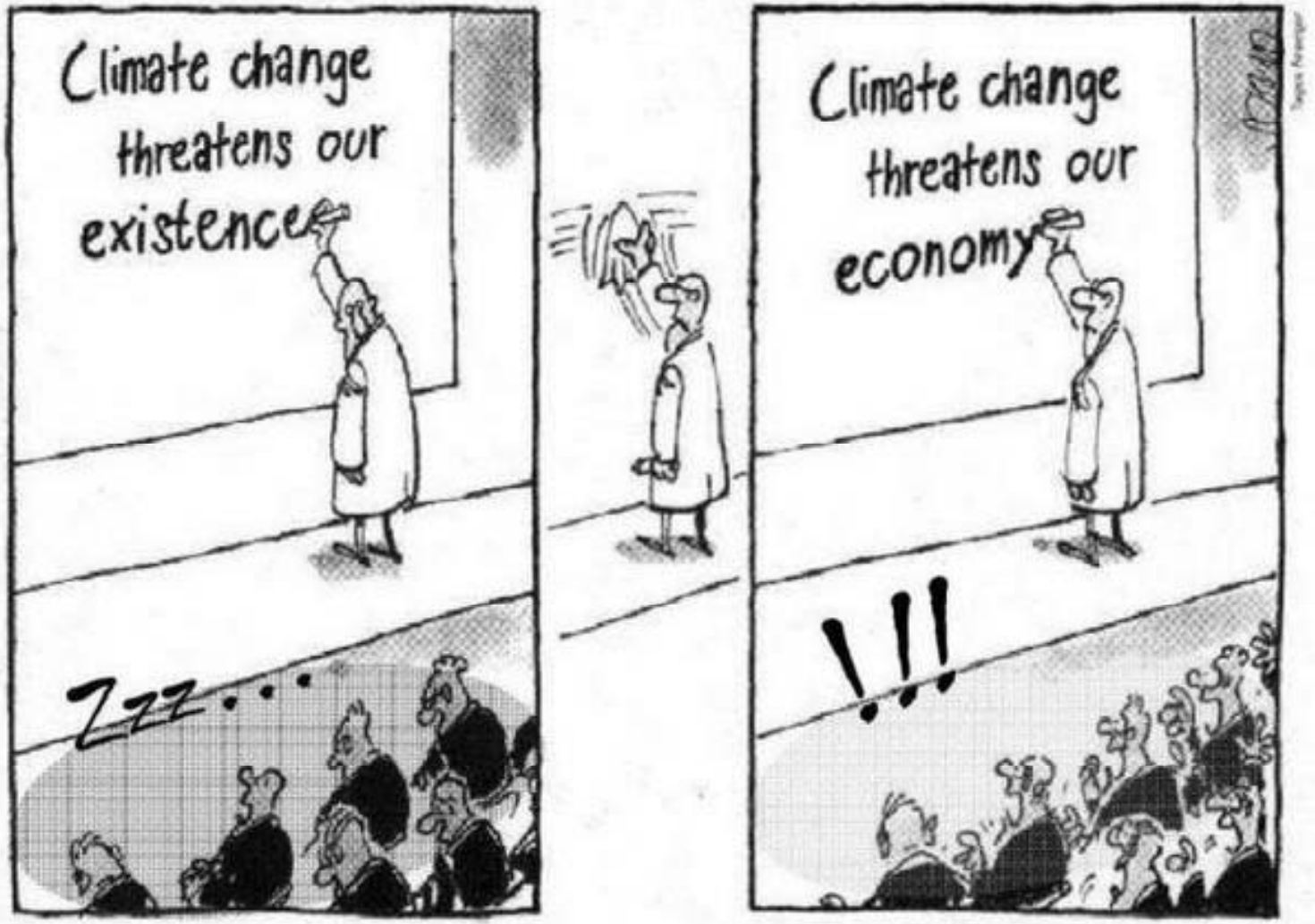
   - *Australia: Dept of Environment → Dept of Climate Change+ → Dept of Environment*
   - *ADB: embedded adaptation in their project assessment process: but in their Environmental Impact Assessment!*

Getting attention....



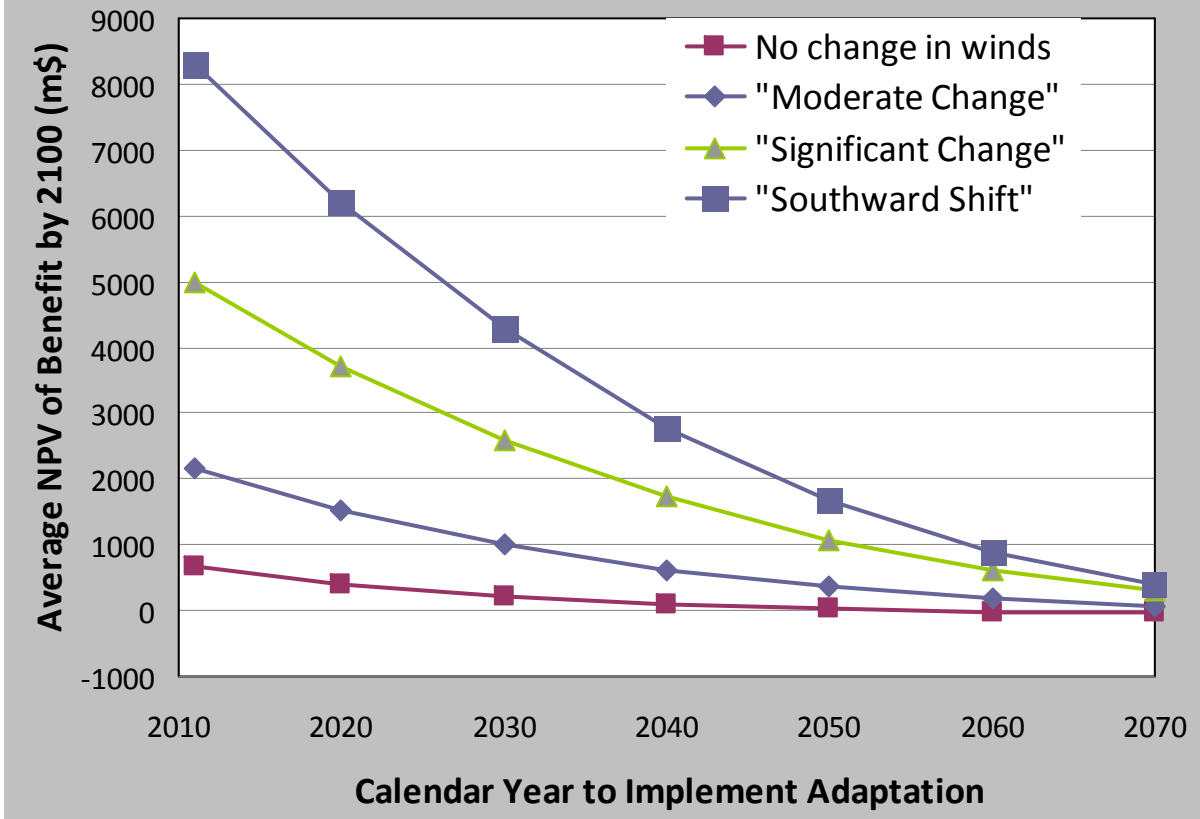
Economic issue: eff
extreme winds in C

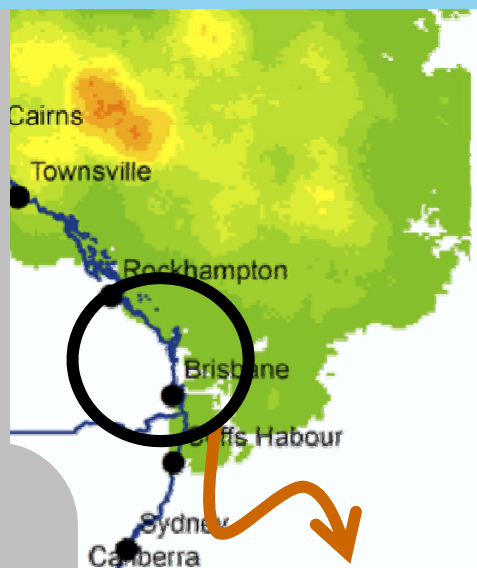
Key attributes

- No regrets (value even if no climate change)
- Robust (value for all scenarios)
- Act early (rapid decline in value over time)
- Proactive collective action (else delay)

Occurrences of TC,

Adaptation Timing and Bene





Vulnerable to extreme wind hazard, especially *if* cyclones move south

Stewart & Wang, *Climate Adaptation Flagship*, 2011

Social issue: impact of temperature on years of life lost in Brisbane

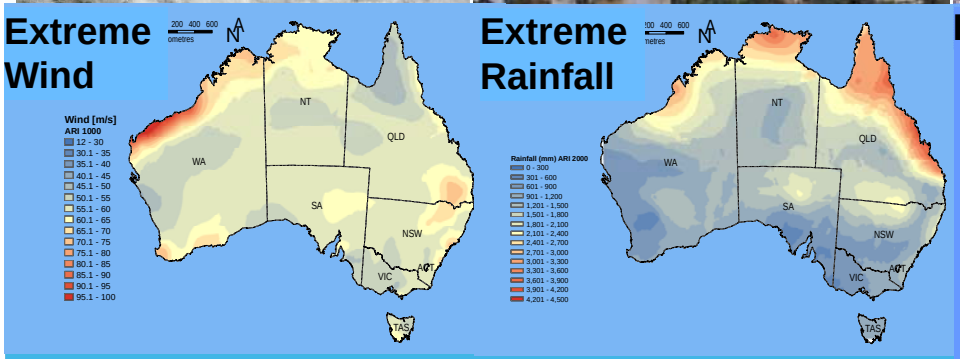
	Baseline	Climate change scenario							
		1 °C increase		2 °C increase		3 °C increase		4 °C increase	
		Projection	Change	Projection	Change	Projection	Change	Projection	Change
Hot days	1,519	2,533	1,014	3,969	2,450	5,879	4,360	8,301	6,782
	(1,214-1,821)	(2,079-2,978)	(840-1,178)	(3,272-4,610)	(2,049-2,845)	(4,892-6,827)	(3,656-5,062)	(6,956-9,622)	(5,675-7,893)
Cold days	5,053	3,941	−1,112	2,984	−2,069	2,177	−2,876	1,513	−3,540
	(3,759-6,313)	(2,851-4,996)	(−1,337-−871)	(2,082-3,842)	(−2,484-−1,624)	(1,453-2,871)	(−3,462-−2,255)	(952-2,067)	(−4,286-−2,753)
Whole year	6,572	6,474	−98	6,953	381	8,056	1,484	9,814	3,242
	(5,297-7,809)	(5,315-7,590)	(−372-199)	(5,801-8,056)	(−156-980)	(6,804-9,346)	(633-2,425)	(8,302-11,392)	(2,011-4,596)

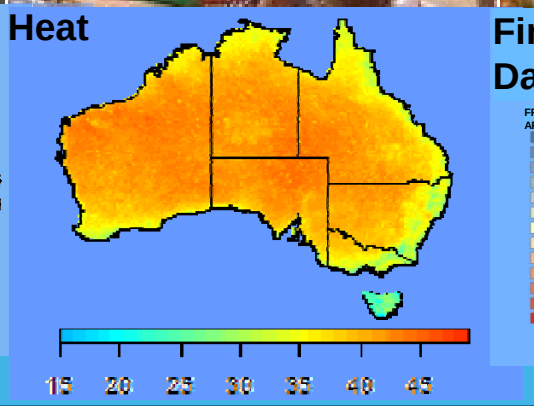
Total loss reduces

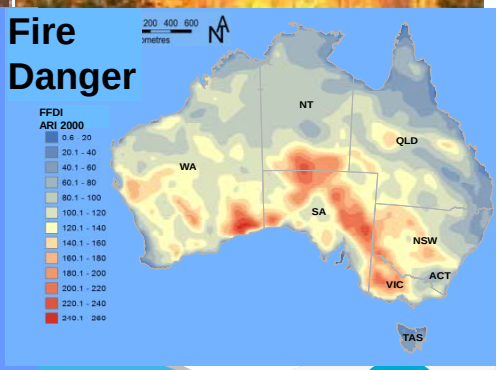
Total loss increases

Huang *et al.* (2012), *Nature Climate Change*, 2: 265-270.

Taking a national, all-hazards view

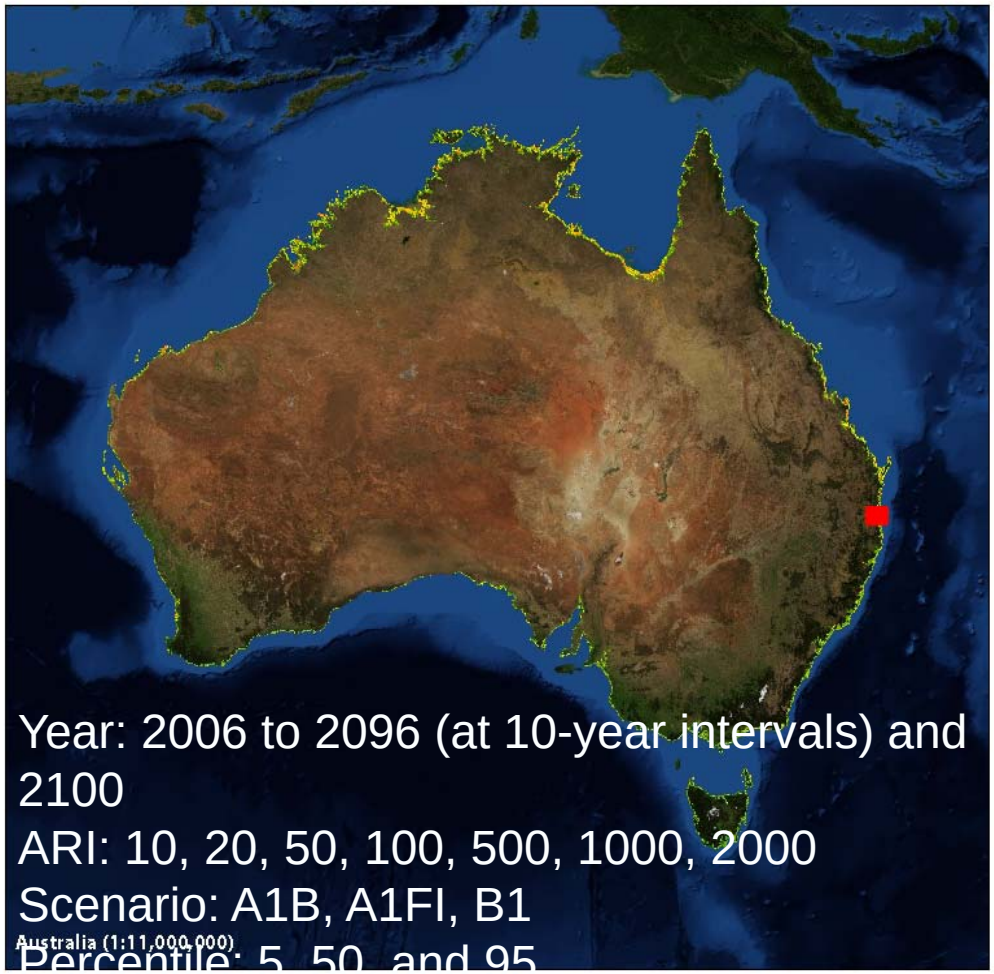


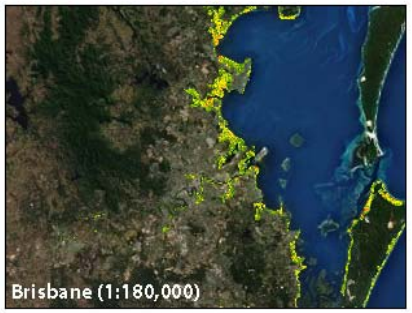


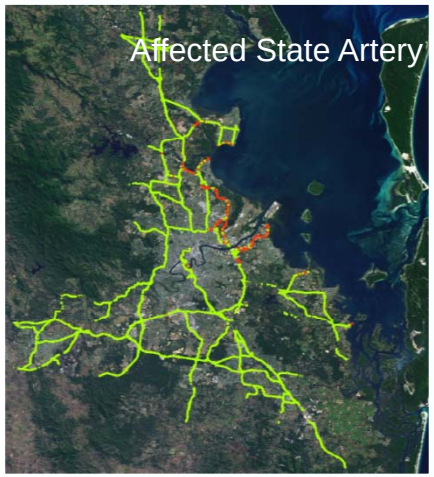


Baynes et al, *Climate Adaptation Flagship*, 2012

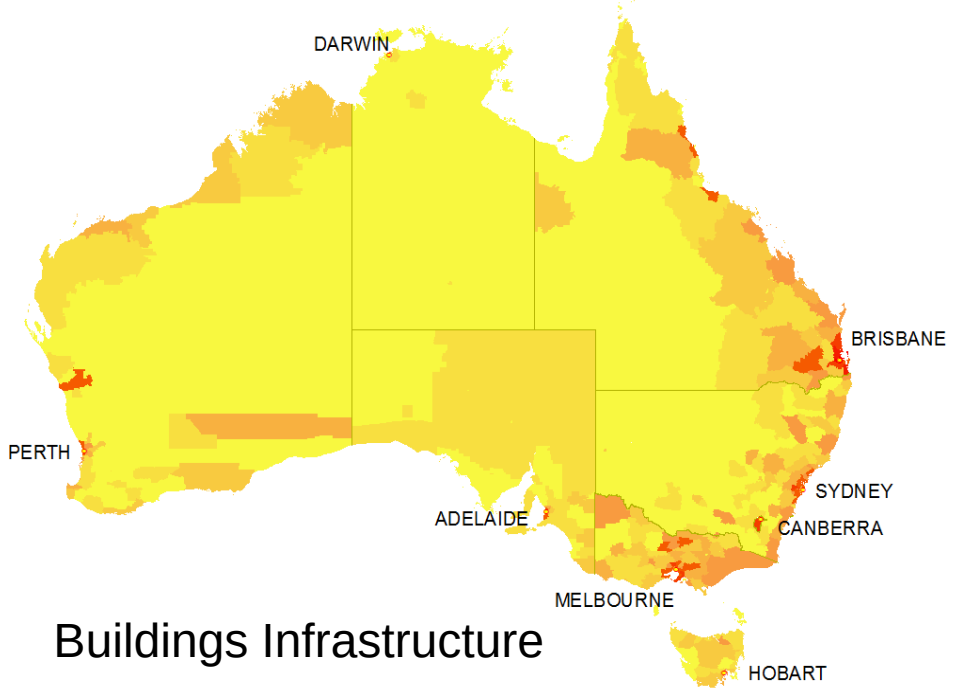
Coastal Inundation: current to future risks



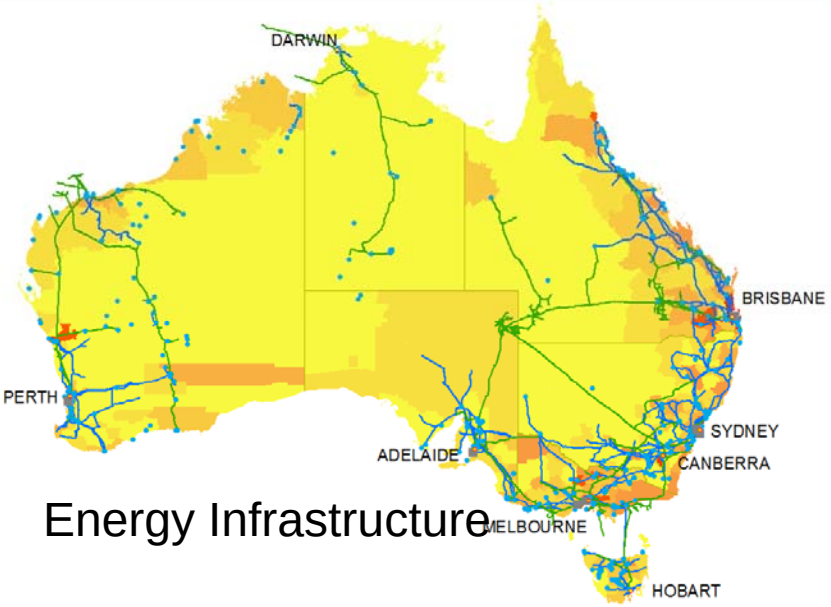




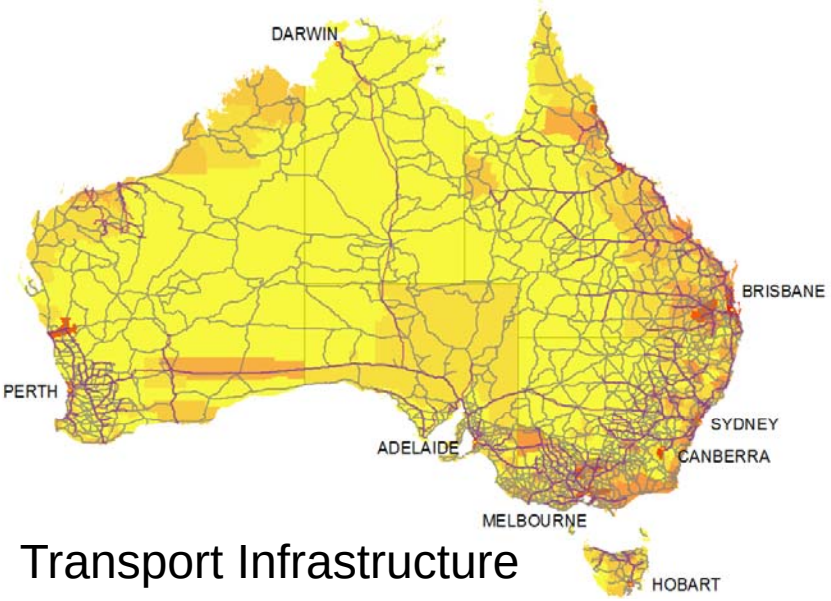
Infrastructure



Buildings Infrastructure



Energy Infrastructure



Transport Infrastructure

Transport Infrastructure

- Major Roads
- Railways

Energy Infrastructure

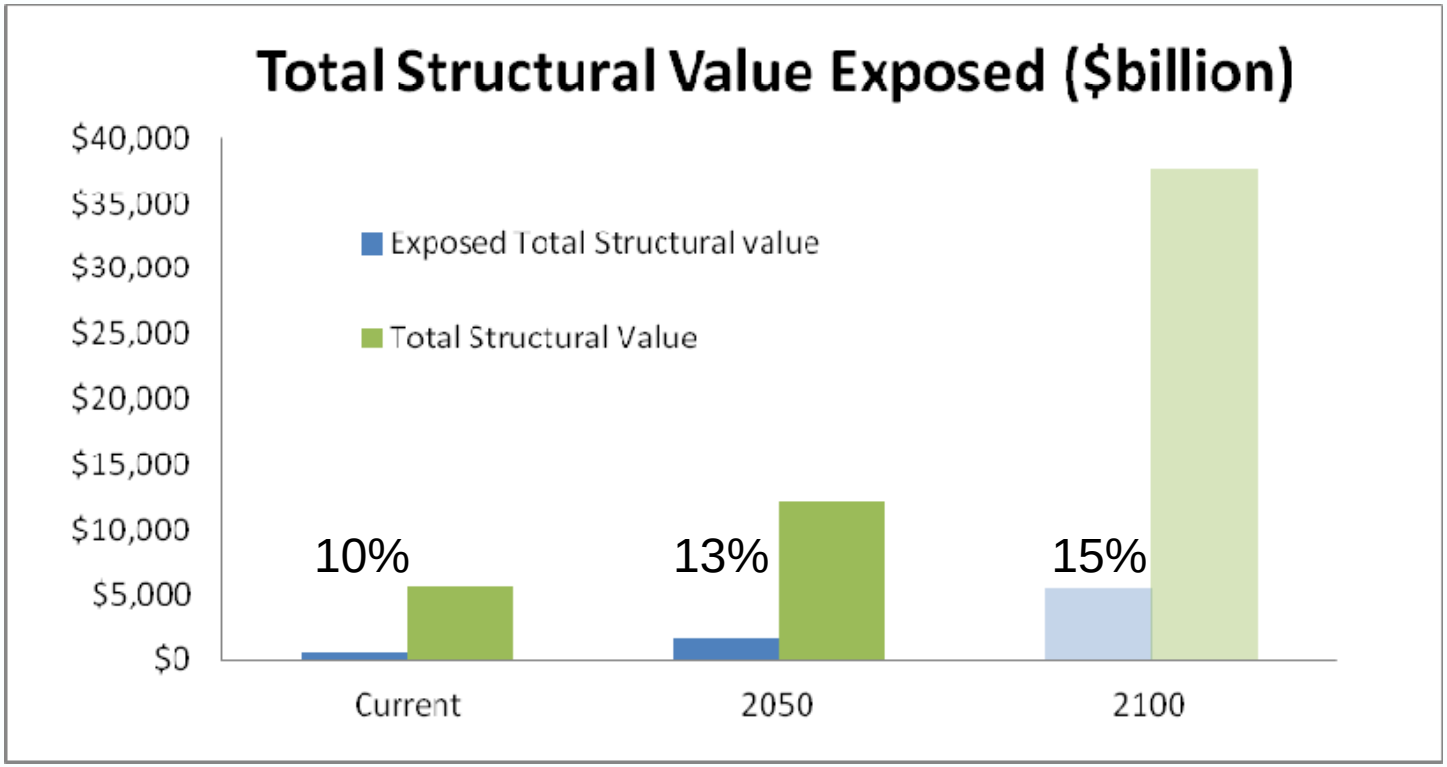
- Refineries
- Power Stations
- Gas Pipeline
- TransmissionLines

National building exposure replacement cost (Residential, Commercial & Industrial Buildings) NEXIS 2012 LGA aggregated.

- < 2 billion
- 2 - 5 billion
- 5 - 10 billion
- 10 - 15 billion
- 15 - 25 billion
- 25 - 50- billion
- 50 - 75 billion
- 75 - 1 trillion
- 1 - 2.25 trillion

Geoscience Australia: NEXIS LGA 2012, Geodata Infrastructure datasets

Key results – total structural value exposed



(Residential, commercial and industrial buildings, scaled for growth in population and real GDP: per IGR 2010. 2010$. Exposure to fire + inland flooding + coastal inundation)

React or anticipate? Adapting our infrastructure

National impacts of *coastal inundation* on *residential* buildings

Direct impact costs of adaptation, Present Value (2010$)

	2050	2099
Repair to 2010 standards	**$3bn (±1bn)**	**$9bn (±2bn)**
React to current hazard	**$2bn**	**$4-6bn**
Anticipate future hazard	**$1-2bn**	**$2-4bn**

Payoffs:

Accommodate: ~$20 NPV benefit for every $1 spent

Protect: $6-$42 NPV benefit for every $1 spent

+ Other hazards, other buildings/infrastructure, indirect costs?

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Questions that policy-makers should ask

1. Is there an impact worth worrying about?
2. Are there adaptation options available?
3. Is it worth implementing an adaptation option?
   - If so, *when*?
4. Who should worry about adapting?
   - Is it the role of government?

Queensland floods and cyclones 2010-11

Extreme events, value chains & productivity

Unexpected high-intensity rain and other weather affects transport, energy and mining infrastructure

Intensities expected to increase in many areas

Ensham Mine, Queensland, 2008
• Production stopped for over a year
• $mil

Yallourn, Victoria, 2007:
• Excessive rainfall caused a

Pilbara, WA, 2006, 2009:
• Cyclones in 2006 and

ed

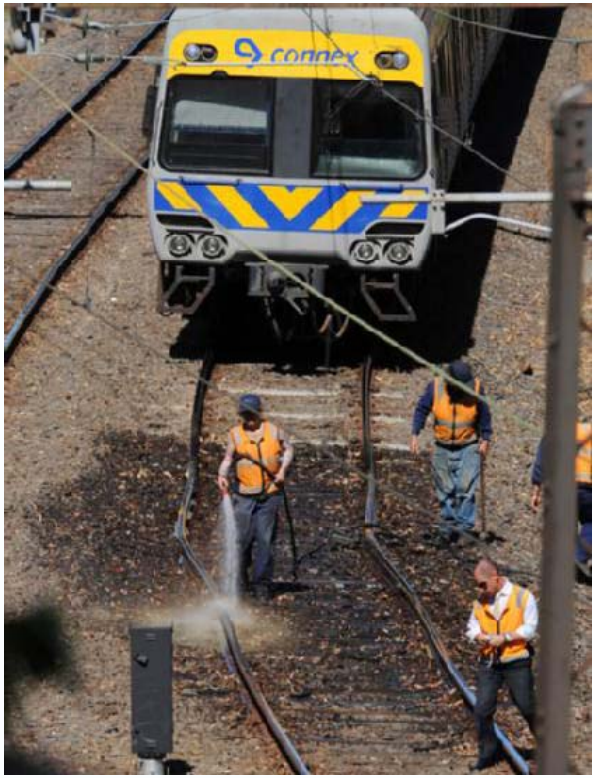
Despite major disruptions, evidence from surveys (2010) that mining industry in Australia is lagging behind

- **'climate adaptation action' - 40% (Canada) vs. 10% (Australia), vs. 45% LGAs (Australia)**

Systemic impacts of extreme events

Heatwaves

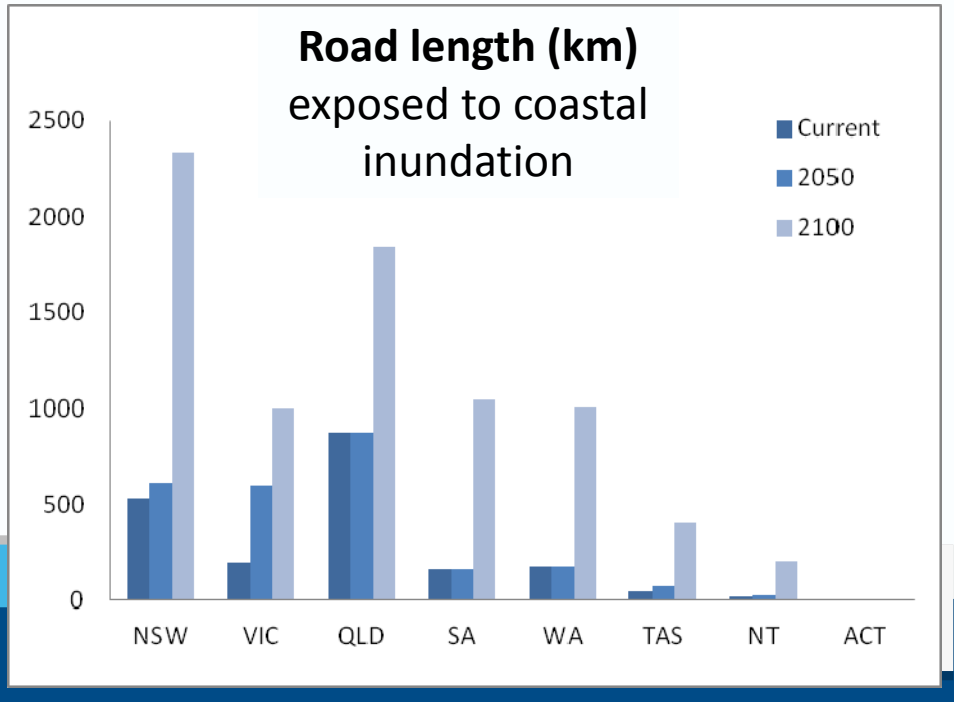
- Heatwaves in our southern cities are becoming more common and more intense events, with both chronic and acute impacts.
- Eg. SE Australia heatwave, 28-30th Jan 2009
  - 374 premature deaths in SE Australia + morbidity
  - Power blackouts to >500k buildings – one outage caused $70M load shed in 5h; Basslink overheated
  - Transport disruptions (24% of Melbourne trains cancelled; $5M in fines)
  - Damage to transport infrastructure
  - Damage to fruit and vegetable growers; est. $10M's
  - Loss of economic activity: >$800M



- The frequency of such events is likely to at least triple in southern Australia by 2070

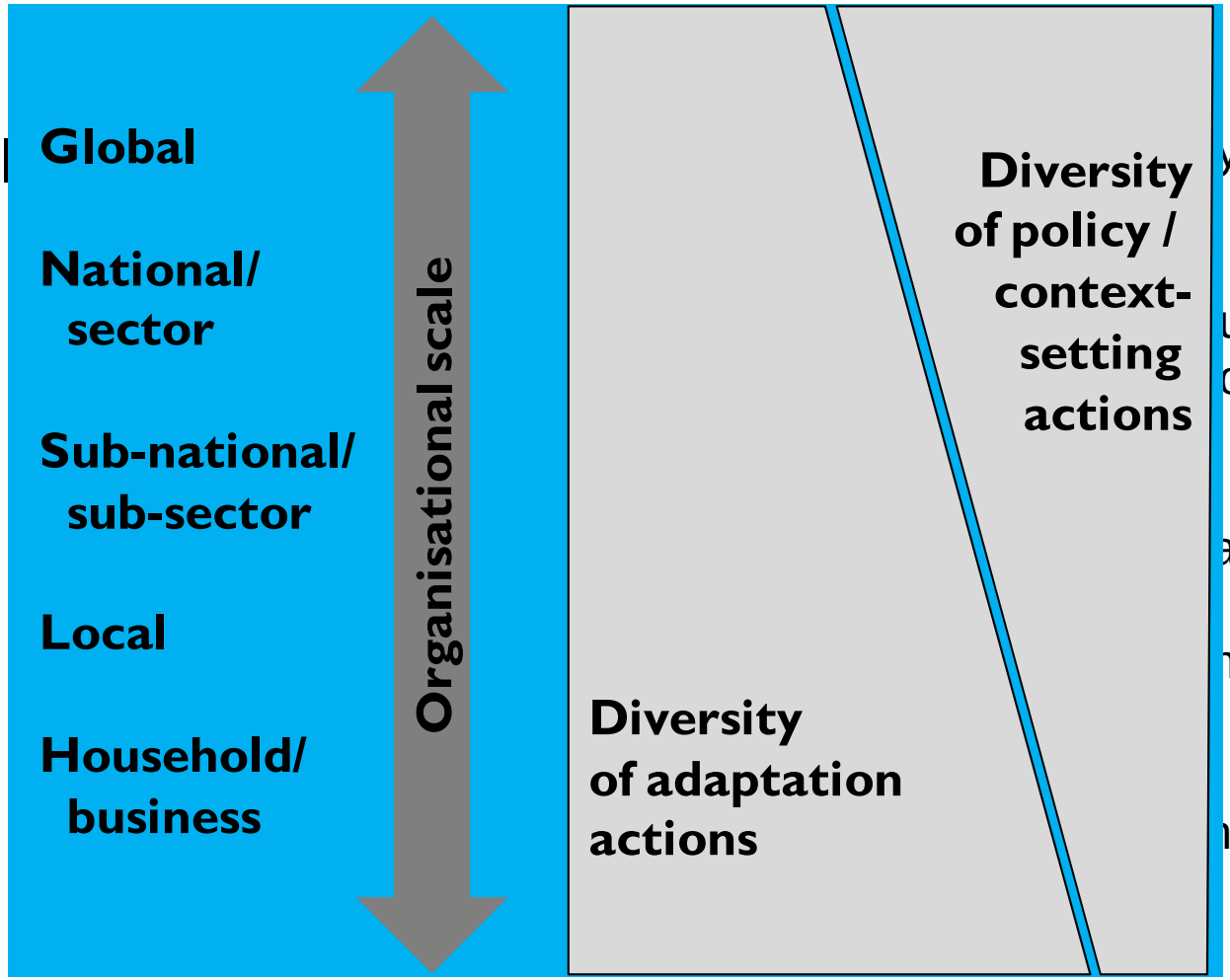
Is anyone managing the emergent risks?

1. Supply chains
   - ~13% primary energy used in water supply system [US figures]
     - major concern for water utilities
   - Mining – despite major disruptions, evidence our industry is lagging behind
     - 'climate adaptation action' - 40% (Canada) vs. 10% (Australia) vs. 45% LGAs (Australia)
2. Scheduling issues in mobilising capital investment
   - Sydney Water's $30bn assets
   - E.g. roads
3. Coincident events
   - Same place, multiple times; same time, multiple places; same budget cycle
4. At international scale....?



Baynes et al, *Climate Adaptation Flagship*, 2012

Adaptation options at different institutional scales



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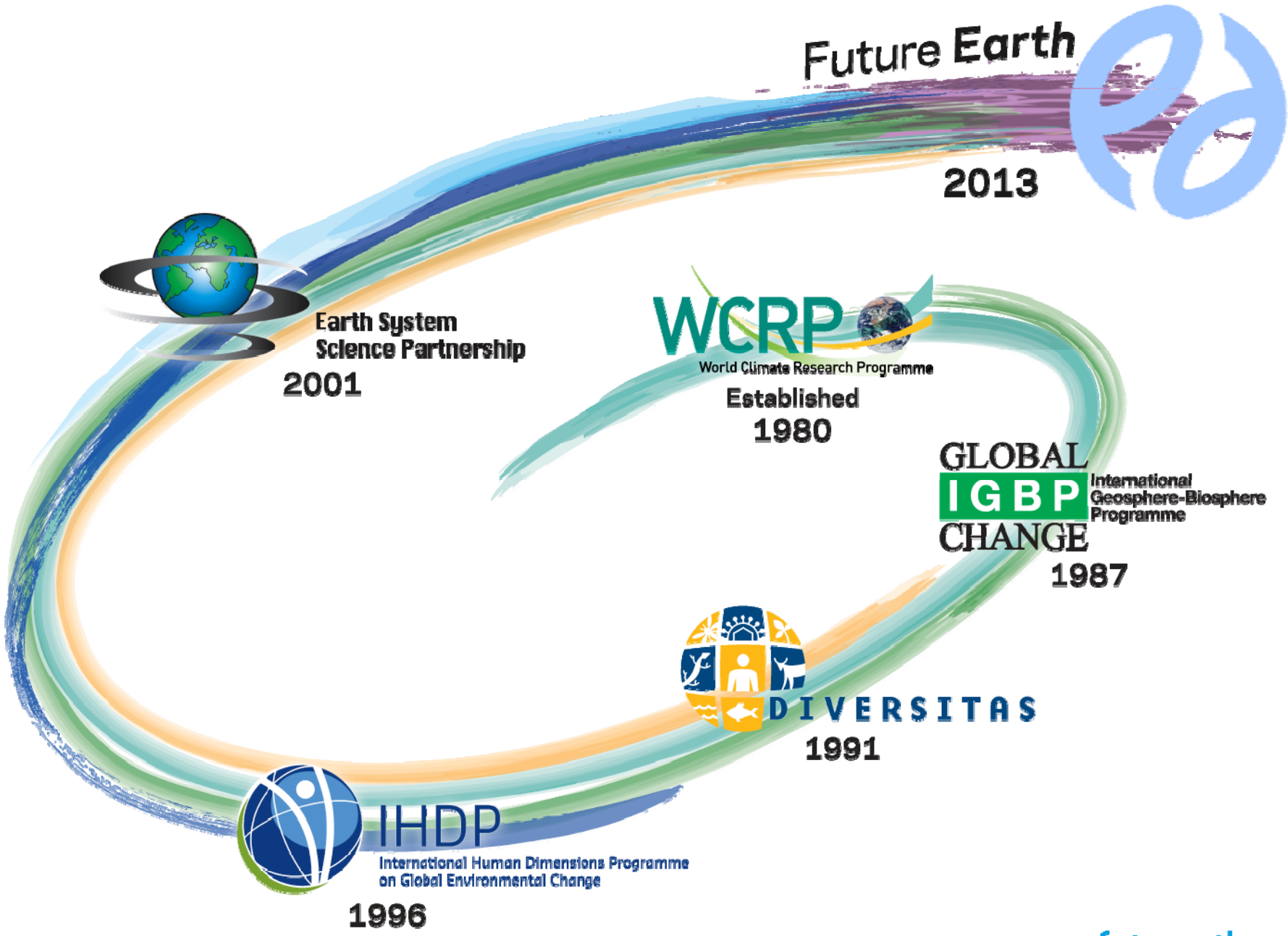
4. **Social and economic** issue, *not (only) environmental*
5. **Emergent** challenges, *not (only) local responses*

➢ **Systematic planning processes, manageable mental models and clearer responsibilities (+implications for Adaptation Challenge)**

A Changing Global Environment for Science

- The grand challenge:
  - Planetary stewardship
  - Social equity
  - Human wellbeing and security

- A new sense of urgency and unprecedented pressure to contribute to real-world problem solving
  - interdisciplinary, solutions-oriented, user-engaged



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photos: www.dawide.com

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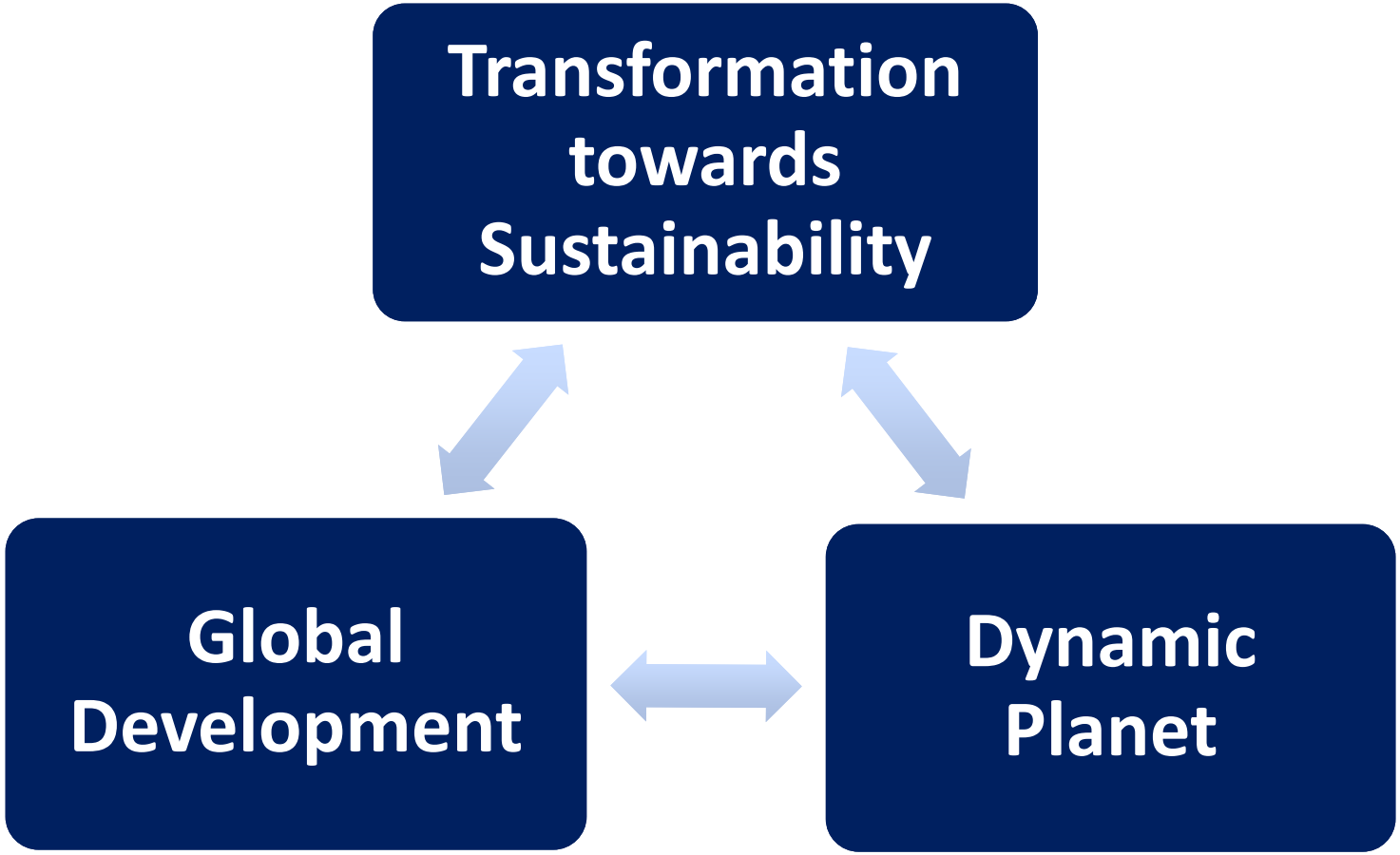
research for global sustainability

To provide the **knowledge** required for societies in the world to **face risks** posed by global environmental change and to seize **opportunities** in a **transition** to global sustainability

Future Earth Research Themes



And cross-cutting issues: Observing systems, models, theory development, data management, research infrastructures

Criteria for Future Earth Research

- From fundamental to use-inspired Earth system research for global sustainability
- Co-design and co-production of knowledge
- Answer complex questions that require international collaboration
- Regional to global scale
- Integrates natural, economic, engineering, arts, humanities and social sciences

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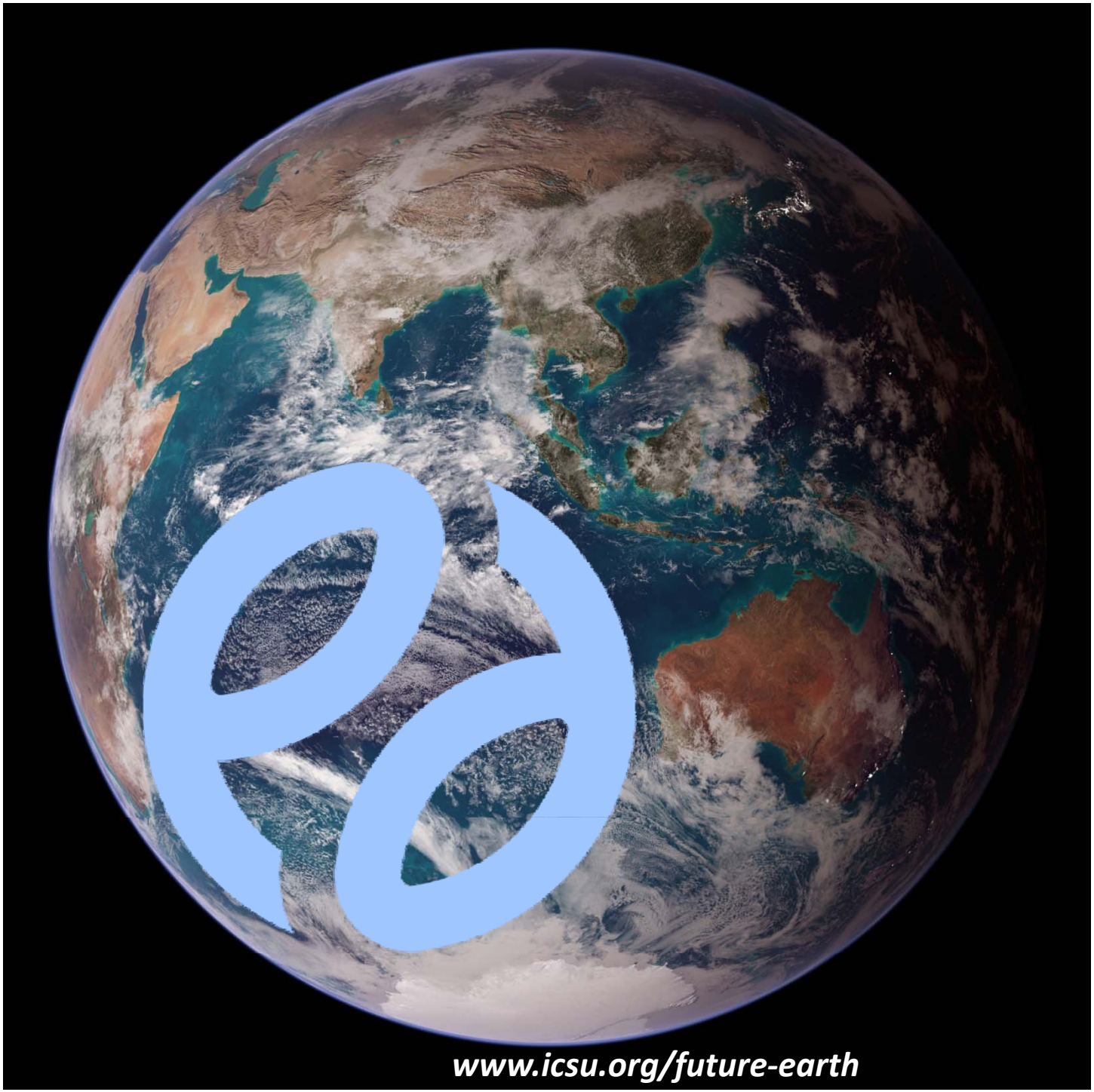

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