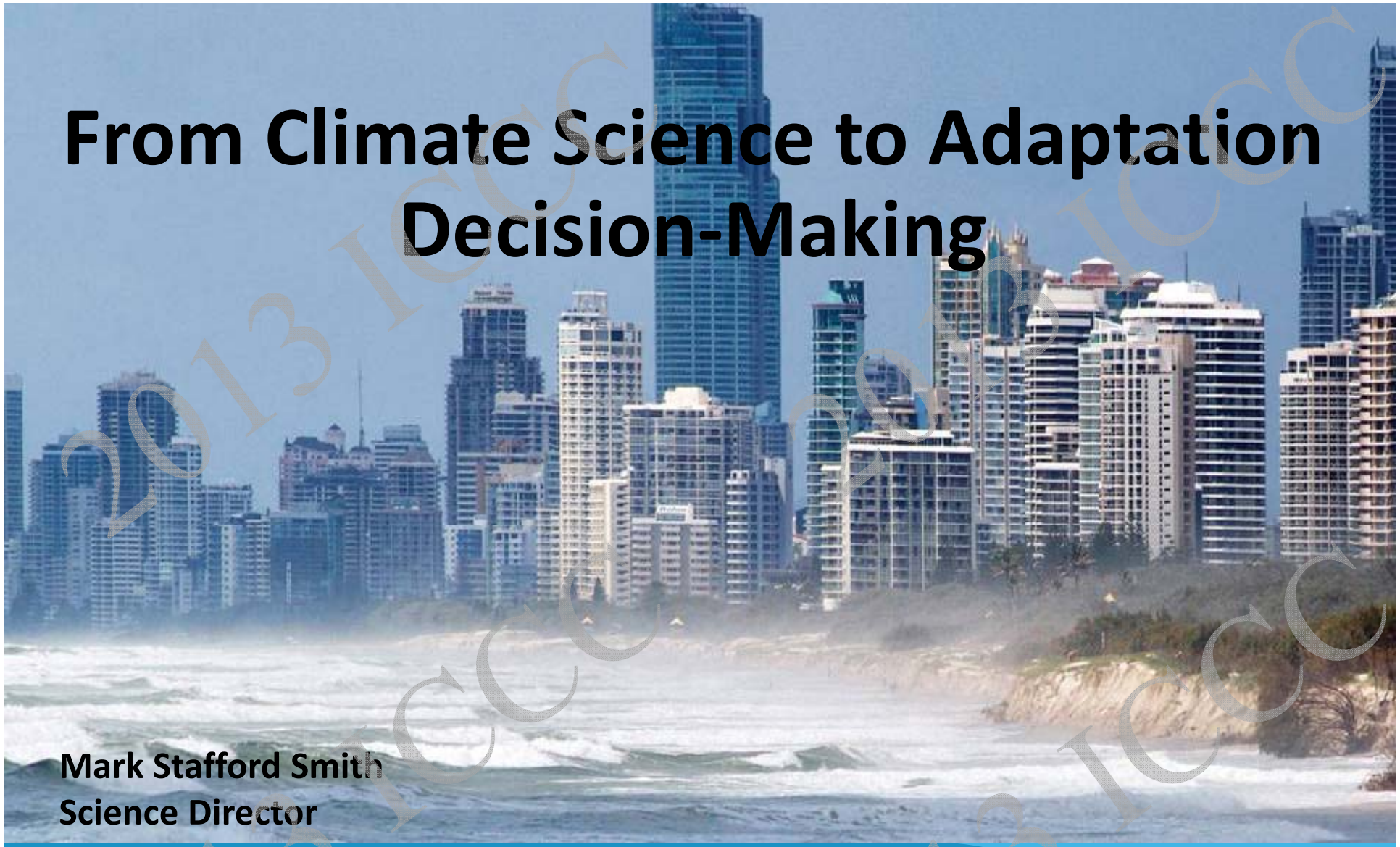
From Climate Science to Adaptation Decision-Making



Mark Stafford Smith
Science Director

CLIMATE ADAPTATION FLAGSHIP
www.csiro.au

International Conference on Climate Change
Taipei, 15 January 2013

Where I'm going

- A little background on Australia, CSIRO and the Climate Adaptation Flagship
  - Our mission: to have our research used!
- Beyond 2°C: from mitigation to adaptation
  - Focusing on adaptation decision-making in response to climate projections
- Some case studies
  - Towards appropriate delivery of climate information

CSIRO National Research Flagships

BIOSECURITY

CLIMATE ADAPTATION

DIGITAL PRODUCTIVITY AND SERVICES

ENERGY TRANSFORMED

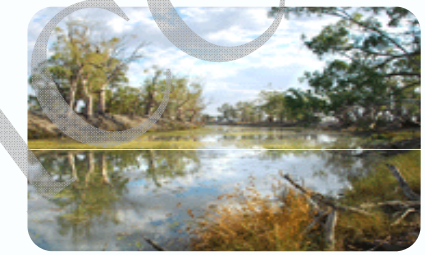
FOOD FUTURES

FUTURE MANUFACTURING

MINERALS DOWN UNDER

PREVENTATIVE HEALTH

SUSTAINABLE AGRICULTURE



WATER FOR A HEALTHY COUNTRY

WEALTH FROM OCEANS

National Research Flagships

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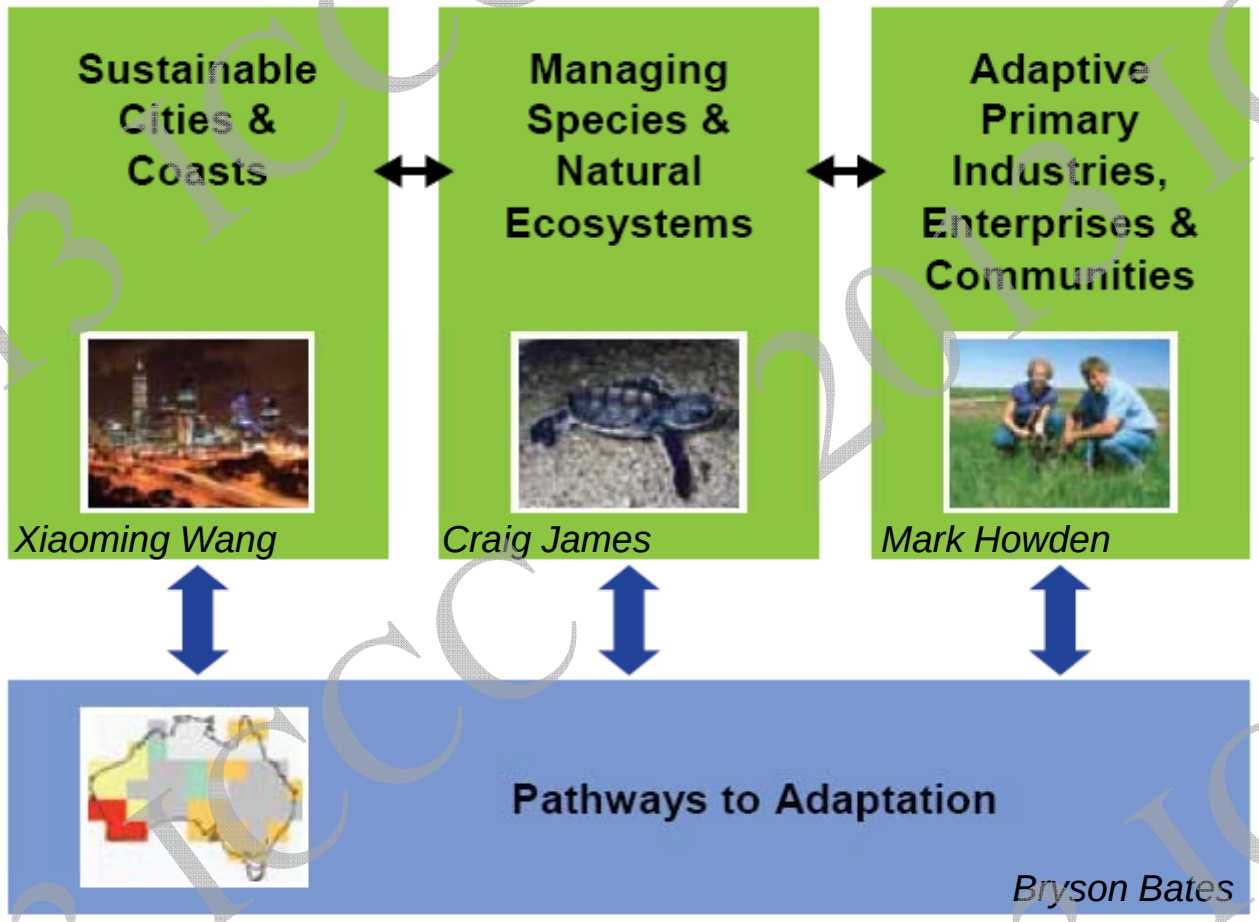
Climate Adaptation Flagship Goal

To equip policy makers, industries and communities with practical and *effective adaptation options* to climate change and *variability* and, in doing so, create in the national interest *$3 billion* per annum in net benefits by 2030.

Research strategy delivers to sectoral clients

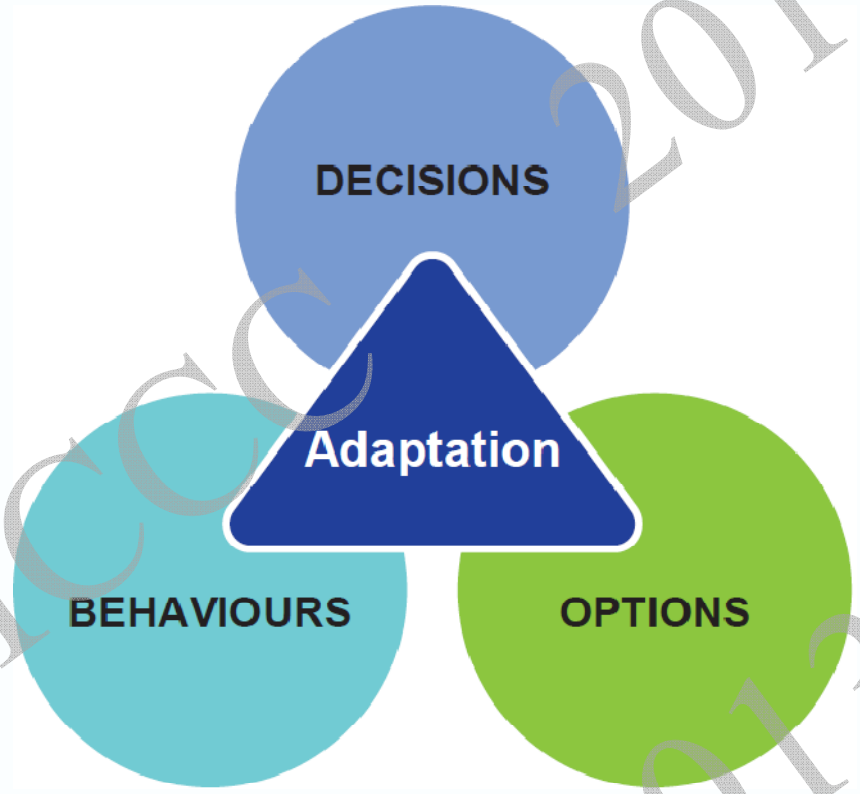


~150 full time equivalents across ~300 staff members
Operating since 2008, now ~$40m/y budget, ~35% external
(Water issues in *Water for Healthy Country Flagship*)

Adaptation science: 3 perspectives, all needed

Adaptation information and decision-making

Evaluation, adaptation pathways, future scenarios, risk management modes, etc



Adaptive behaviours and institutions

Behaviours, incentives, barriers, adaptive capacity, vulnerabilities, etc

Adaptation options and technologies

Cultivars, materials, farming systems, urban planning, etc

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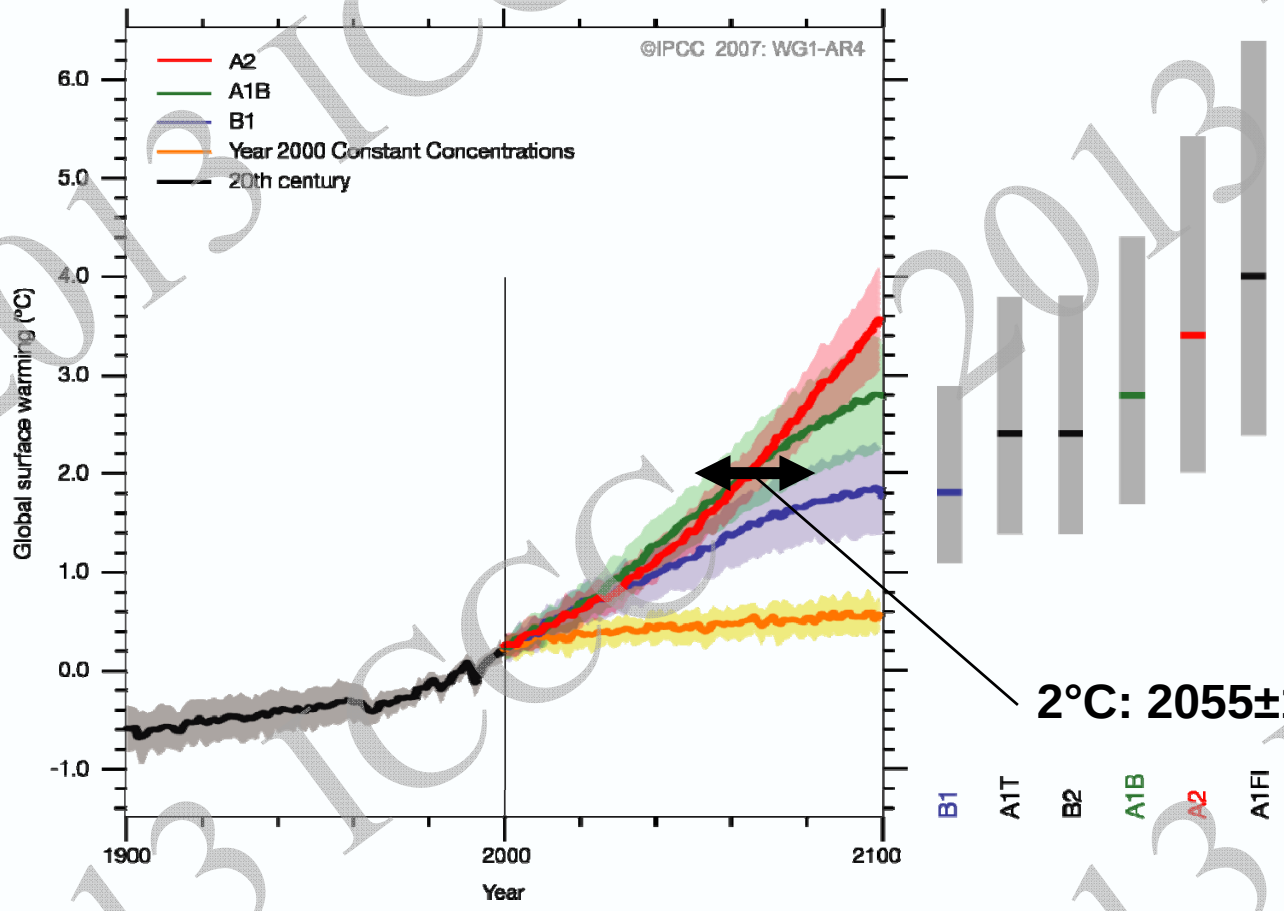
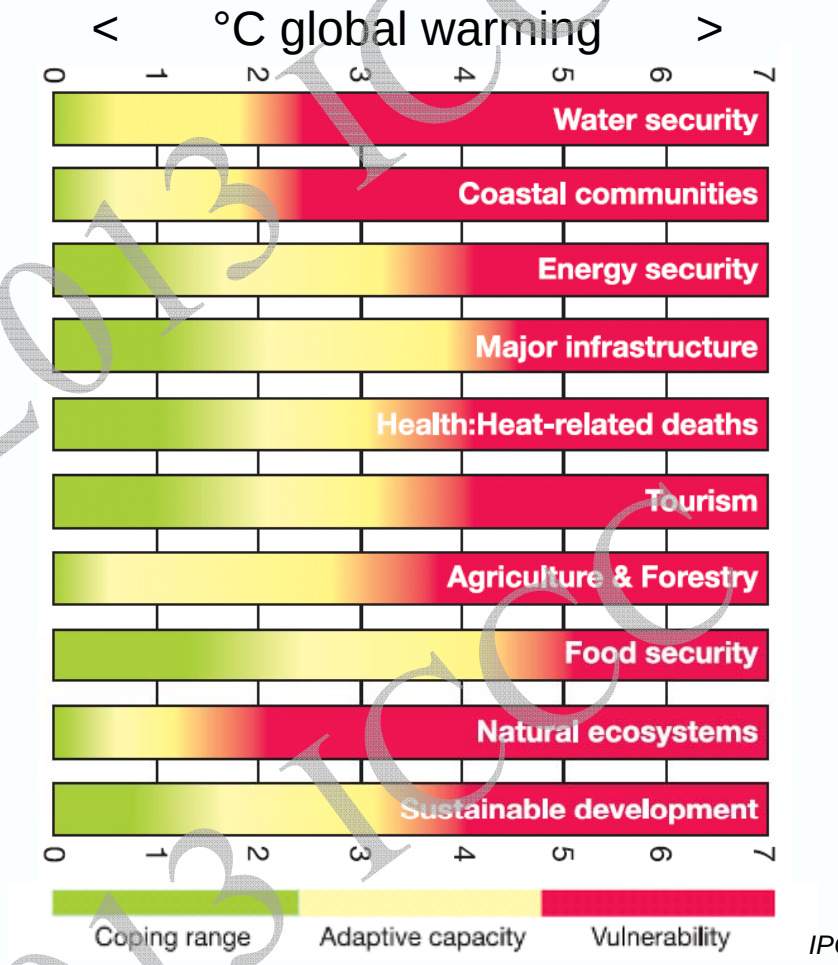
IPCC 2007: 1.1-6.4°C – surely we'll keep to 2°C?



2°C: 2055±10y??

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

Australia: vulnerable among OECD nations



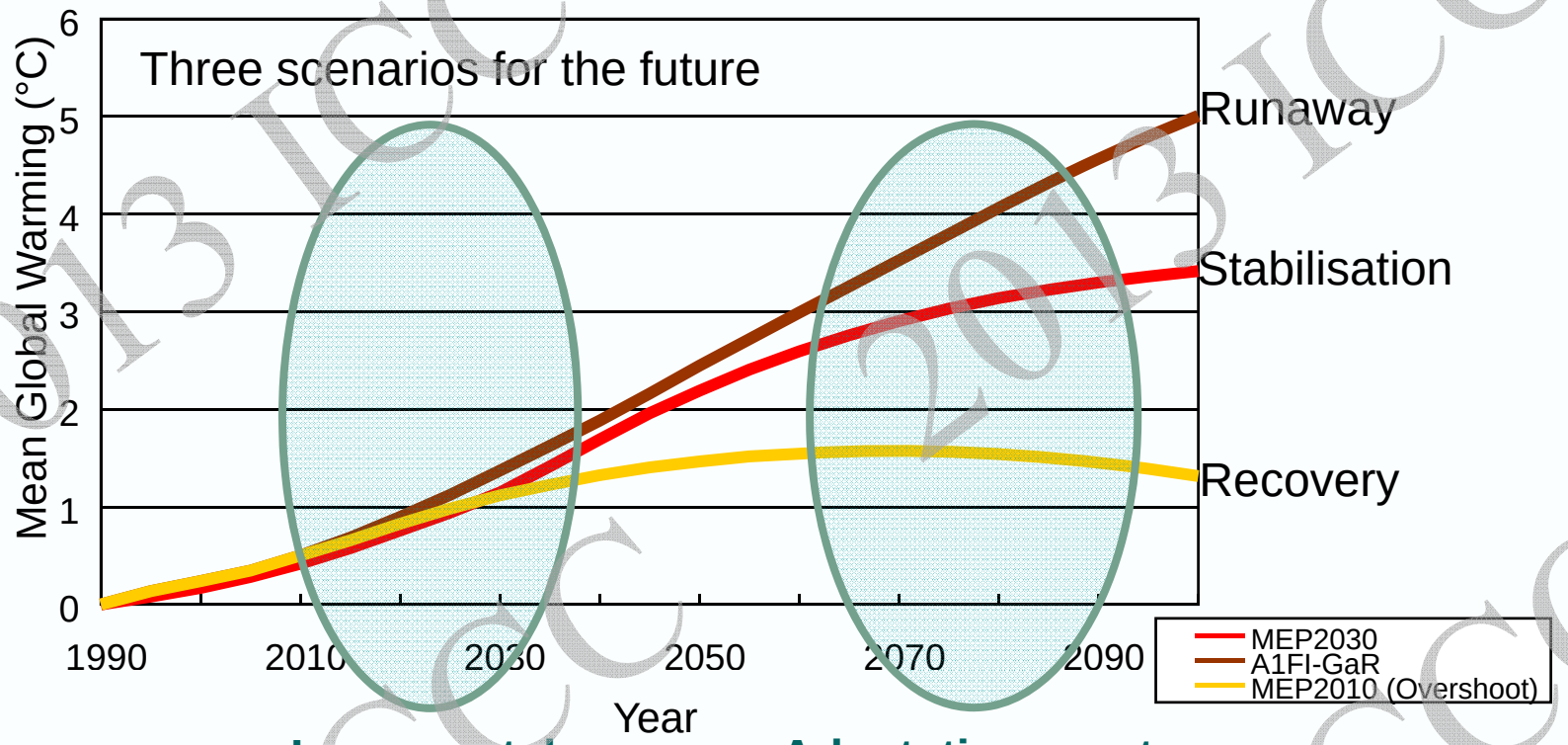
IPCC (2007)
(Fig.11.4: Australia)

(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…

Managing the risk from diverging possible futures

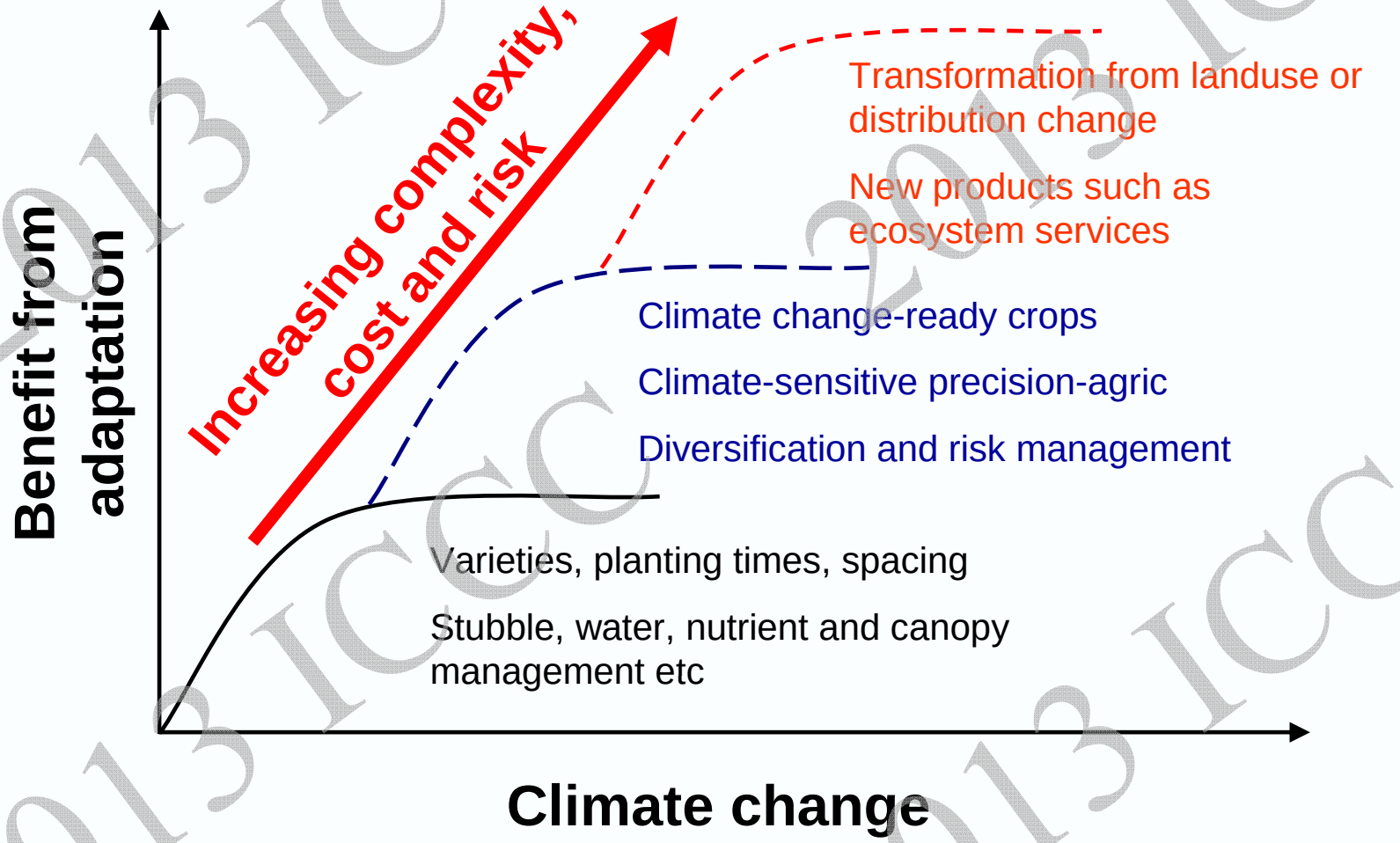


Incremental adaptation to changes of reasonable certainty possible

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

Stafford Smith et al 2011, Phil.Trans.Roy.Soc. 369

Transformational adaptation



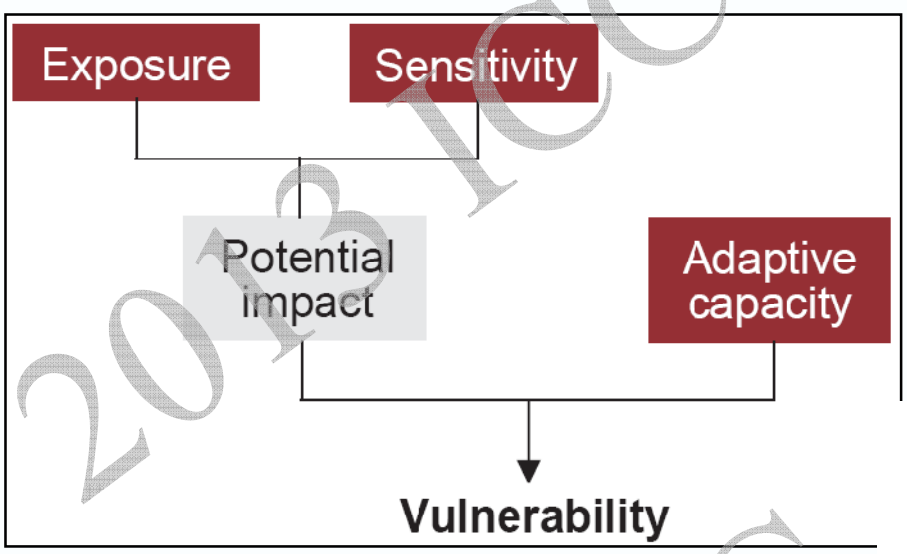
Howden et al, *Greenhouse 2010,* 2010

Working towards *adaptation* planning

Getting past impacts, vulnerability and adaptive capacity assessments to adaptation decision pathways

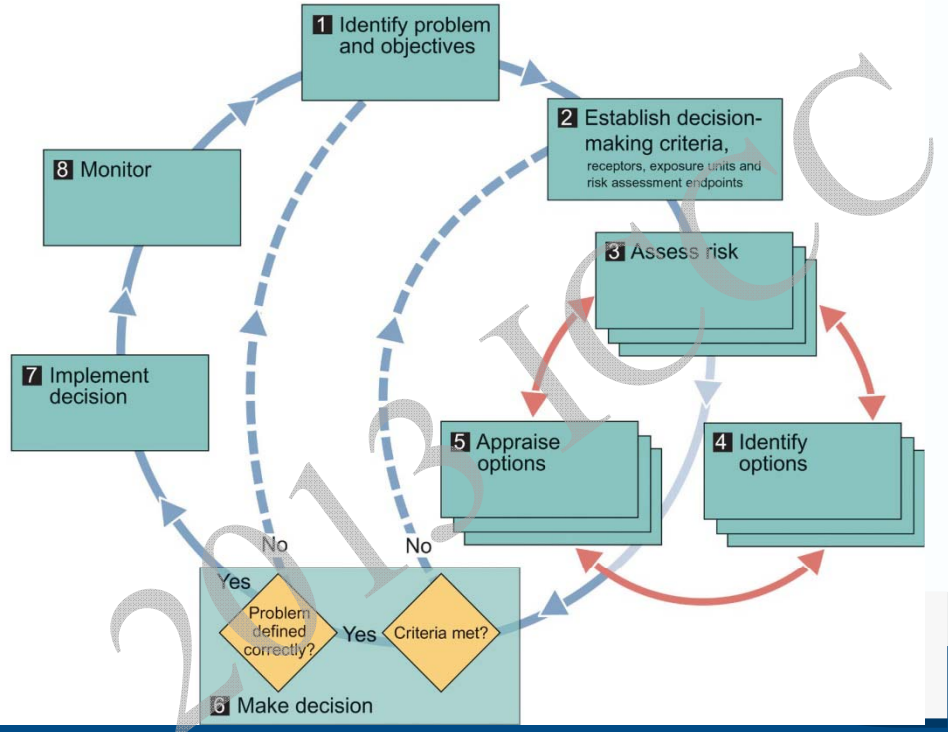
- Not all decisions are the same
- Not all aspects of the future are equally uncertain
- How do we generalise?
- How do we evaluate?

Climate or decision-centred??

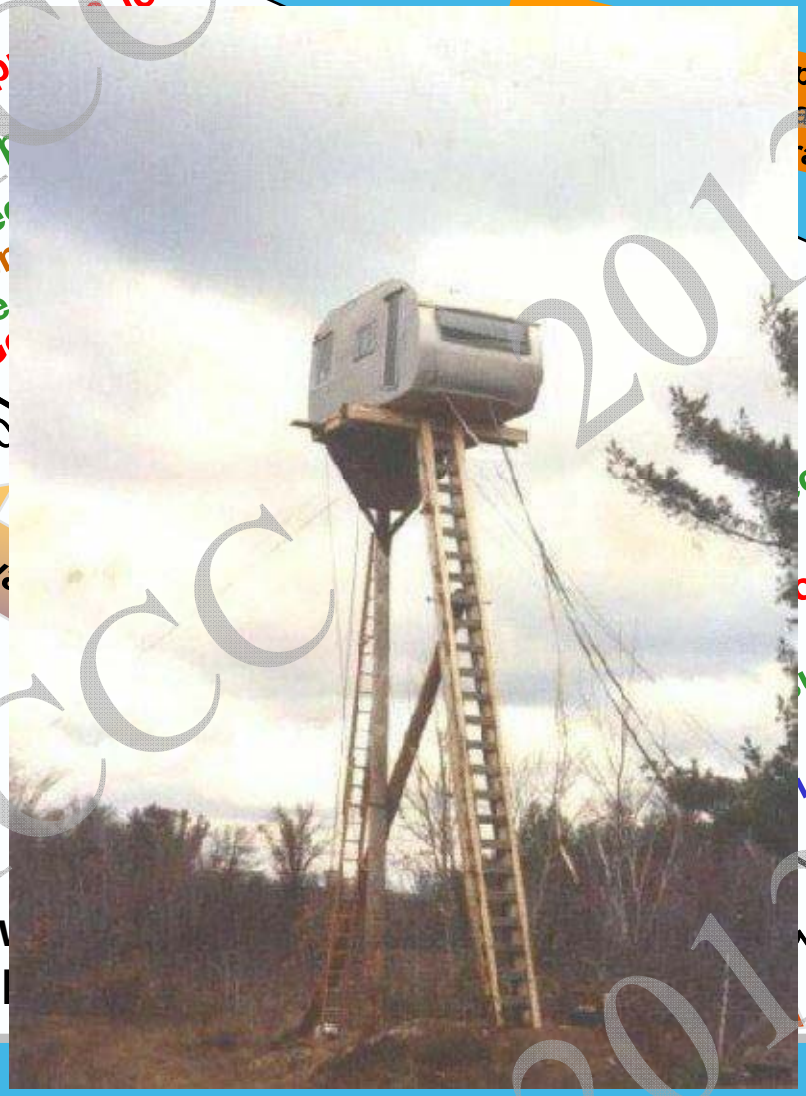


IPCC

Willows & Connell 2003 UKCIP



Adaptation timing and priorities



Annual crops
Election cycles/p
Whole farm
Plant bre
Tourism
Tree
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2°C w
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and incremental to
ransformative
1m sea level rise likely
cture
onal equity
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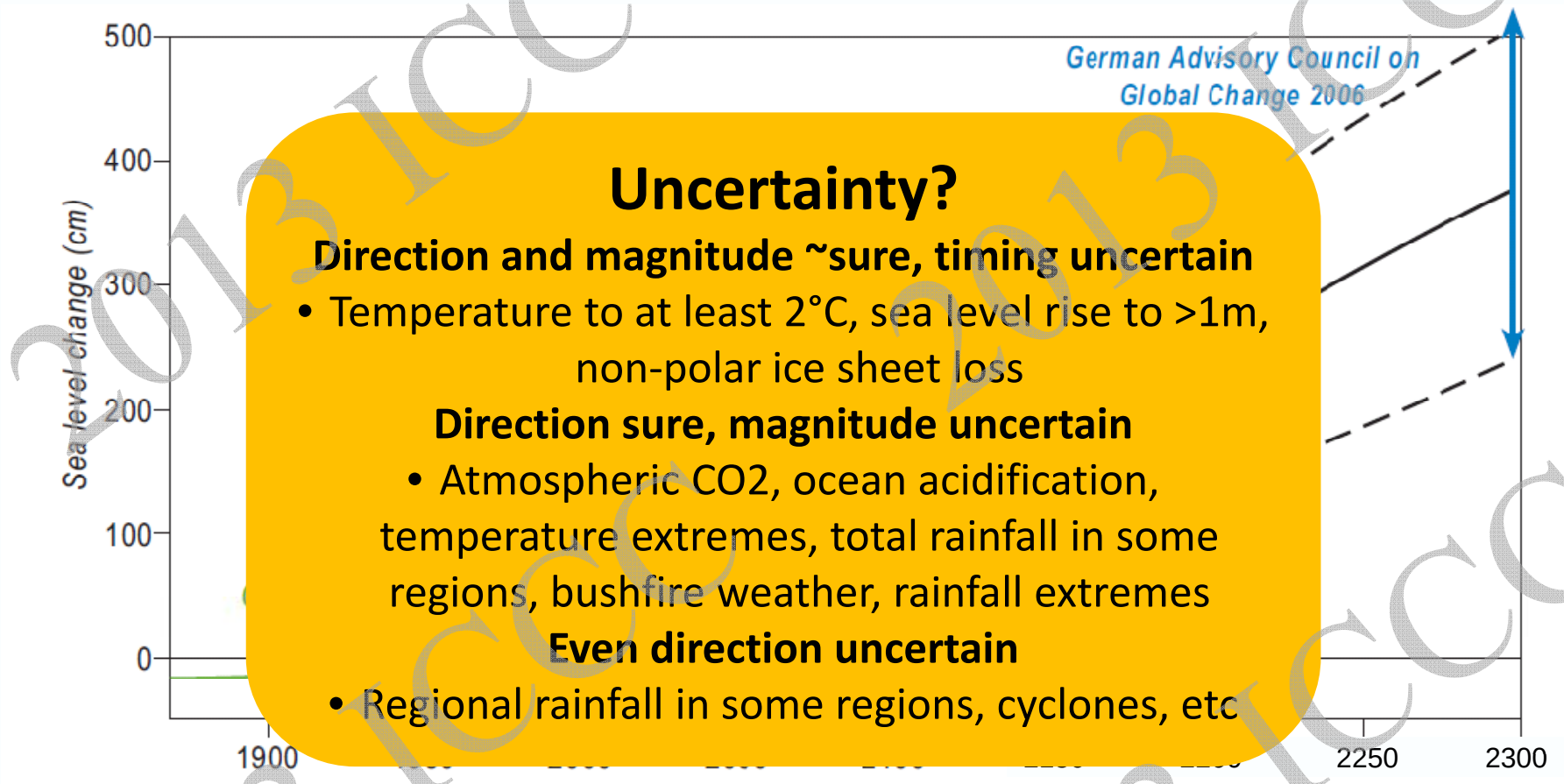
dge design life
Suburb locations
100

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

Stafford Smith et al, *PhilTransRoySoc* 2011

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)

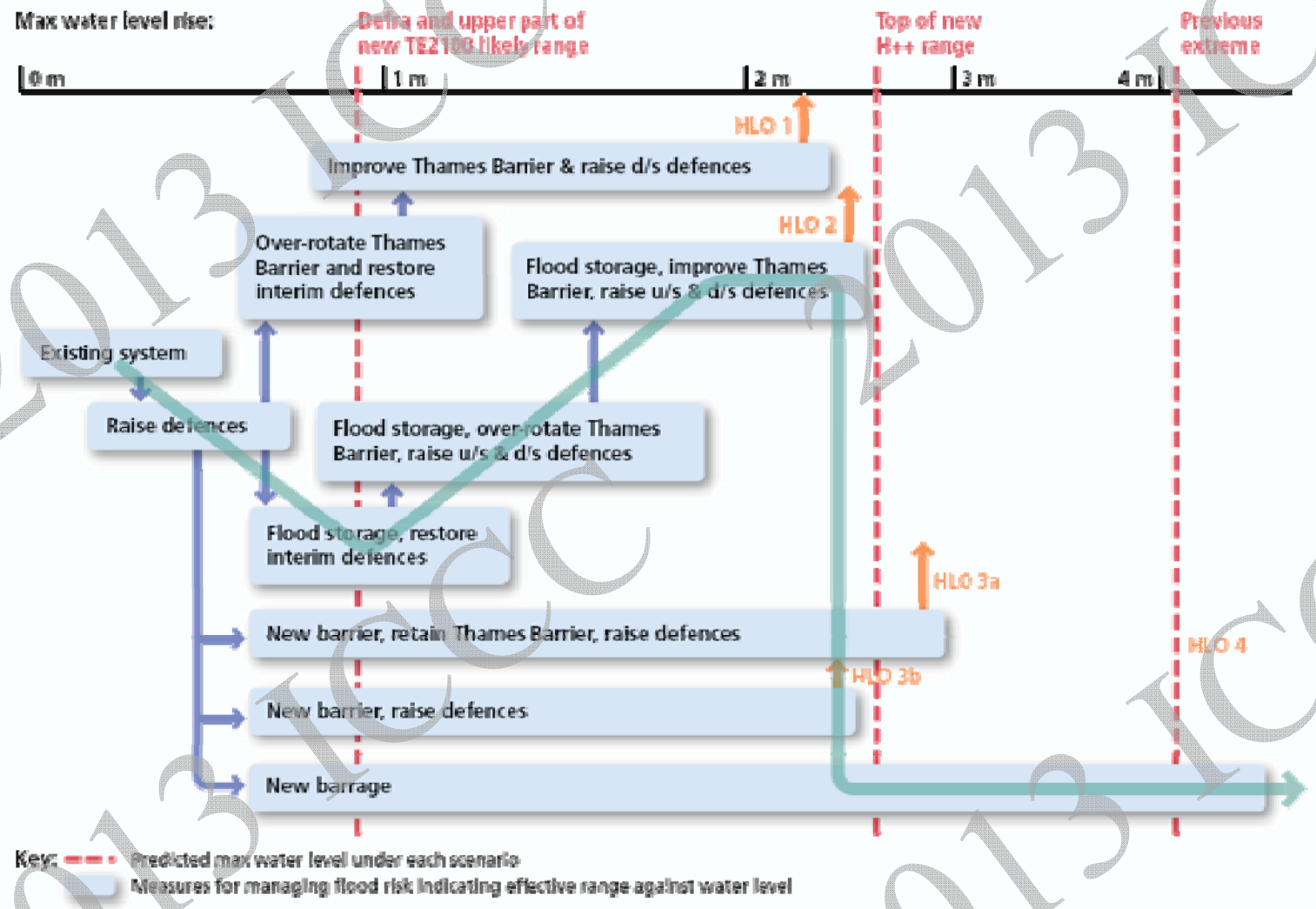
- '*Adaptation in the UK: a decision making process*'

➢ *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 most risk 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

Towards adaptation planning decisions

1. Existing plans / goals + key planning decisions

2. Brainstorm decision areas *outside* existing plans [especially *longer-term,* and include *review of goals*]

General scenarios of future change (climate +)

3. Narrow to *existing* or *new* decisions that could interact with change over time

4. Identify climate-related factors for these decisions, and how these may change*

Key impacts information

5. Prioritise on basis of impacts studies

6. Identify **adaptation options** for each decision
– omit [or upscale] those with no feasible options

Use more detailed climate (etc) info if necessary

7. Analyse preferred adaptation options/pathways, with appropriate approaches to risk mitigation and stakeholder engagement

8. Adaptive learning cycle over time

**only do new climate scenarios work if there is a substantial & critical gap!*

Systematising a *decision*-centred approach…

Not all decisions are equal

- Decision lifetimes really matter, for how decisions intersect with climate change

Not all threats are equal, nor equally uncertain

- Some aspects of climate change are far more certain than others

There are many approaches to managing risk

- Use what's appropriate to the form of climate and other uncertainty

Adaptation will not be a once-off action

- Adaptation pathways, with review points, related to climate and other updates

Not all adaptations are worth doing

- Need to value them – many values, sometimes contested…
- Many methods for choosing adaptation actions but need to suit the decision

➢ ***Don't just assess impacts and vulnerability more precisely!!***

Some case studies...

1. **Extreme winds and building standards**
2. **Coastal inundation and sea level rise**
3. Conservation planning and species movements
4. **National infrastructure impacts and adaptation**
5. Adaptive capacity at all scales

1. Extreme winds

If extreme winds increase in eastern Australia...

- Currently projections are very uncertain
  - No change, increase in intensity, move further south??
- Does this make decision-making impossible?

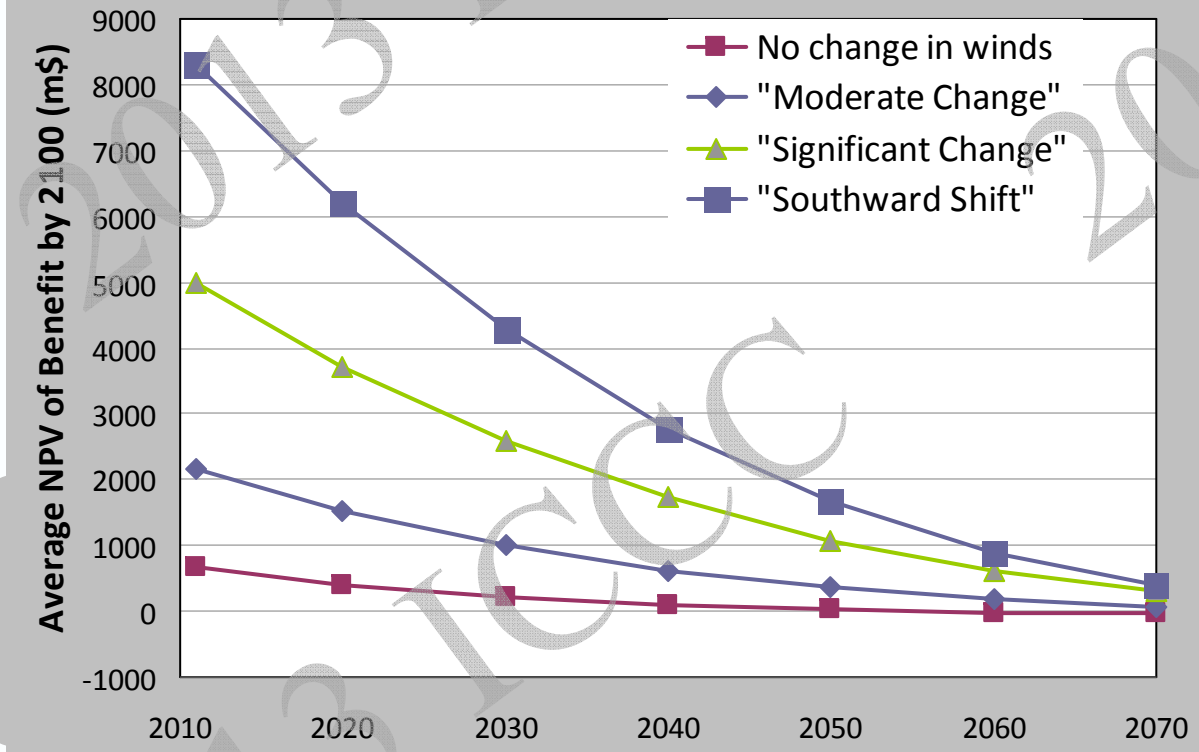
- Collaboration with federal Department of Climate Change
  - (but not enough with the construction industry)

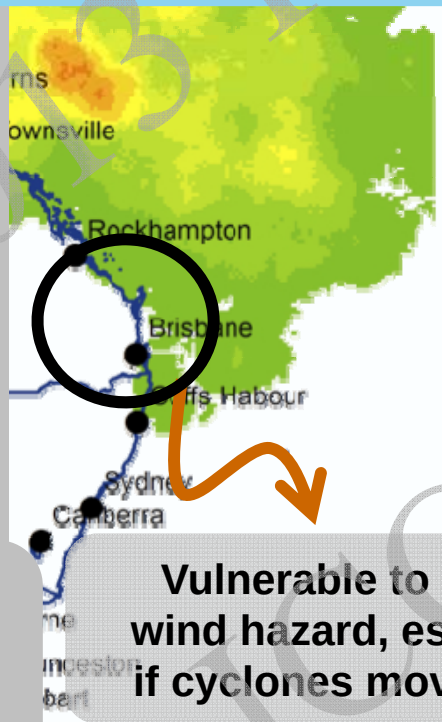
Areas Prone to Extre

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)

Adaptation Timing and Be





Vulnerable to extreme wind hazard, especially if cyclones move south

Stewart & Wang, *Climate Adaptation Flagship*, 2011

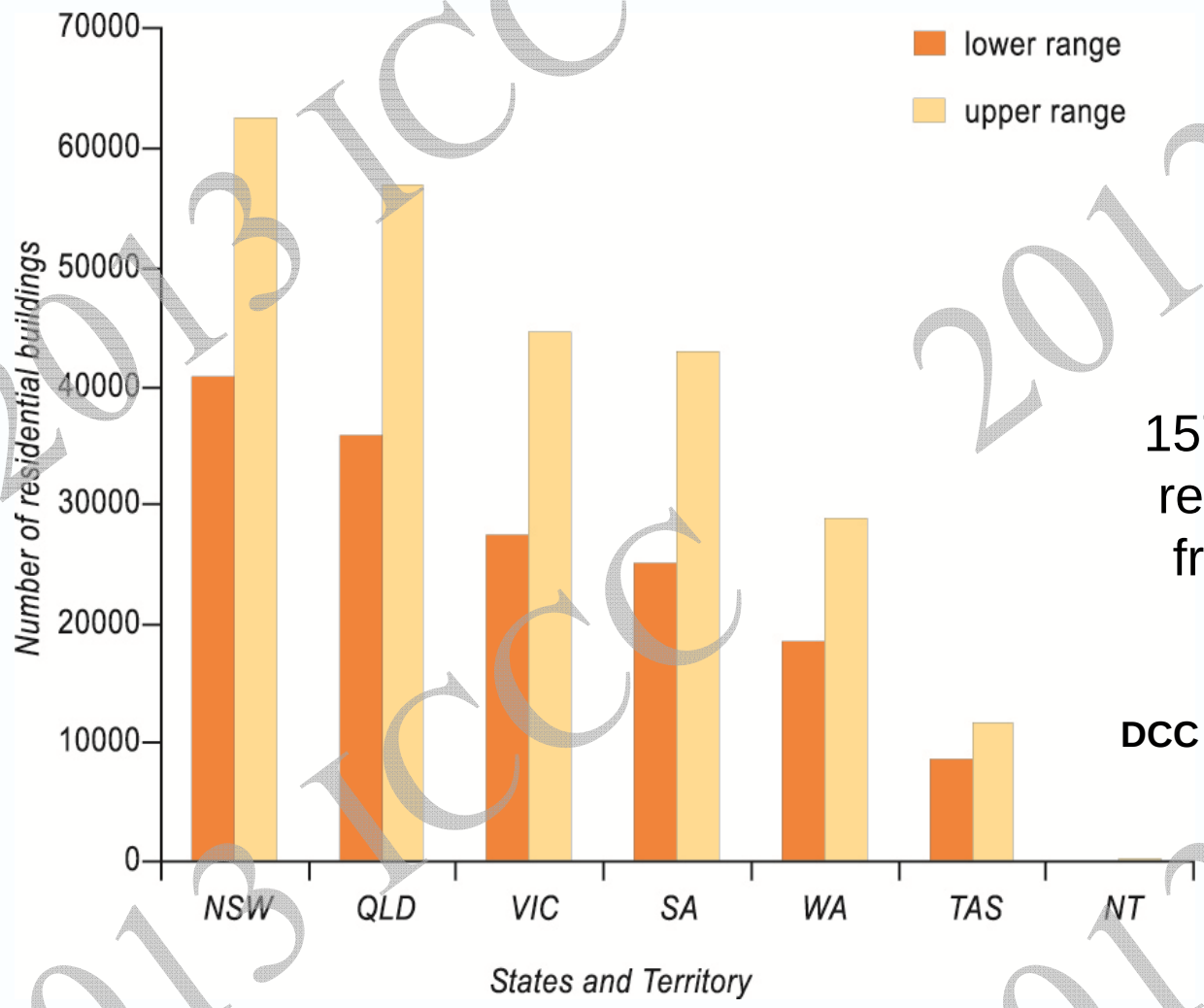
2. Coastal inundation / sea level rise

As sea-level rise increases…

- What are potential impacts?
- Should building be prevented near the sea?
  - Given short term benefits from living near sea, and diverse values in the community

- Collaboration with local governments in SEQ and NSW, and federal Department of Climate Change

Implications for infrastructure and settlements



157,000 – 248,000 residences at risk from a 1.1m sea level rise

DCC (2009)

Storm surges in South-east Queensland

1:100y storm surge event in SEQ

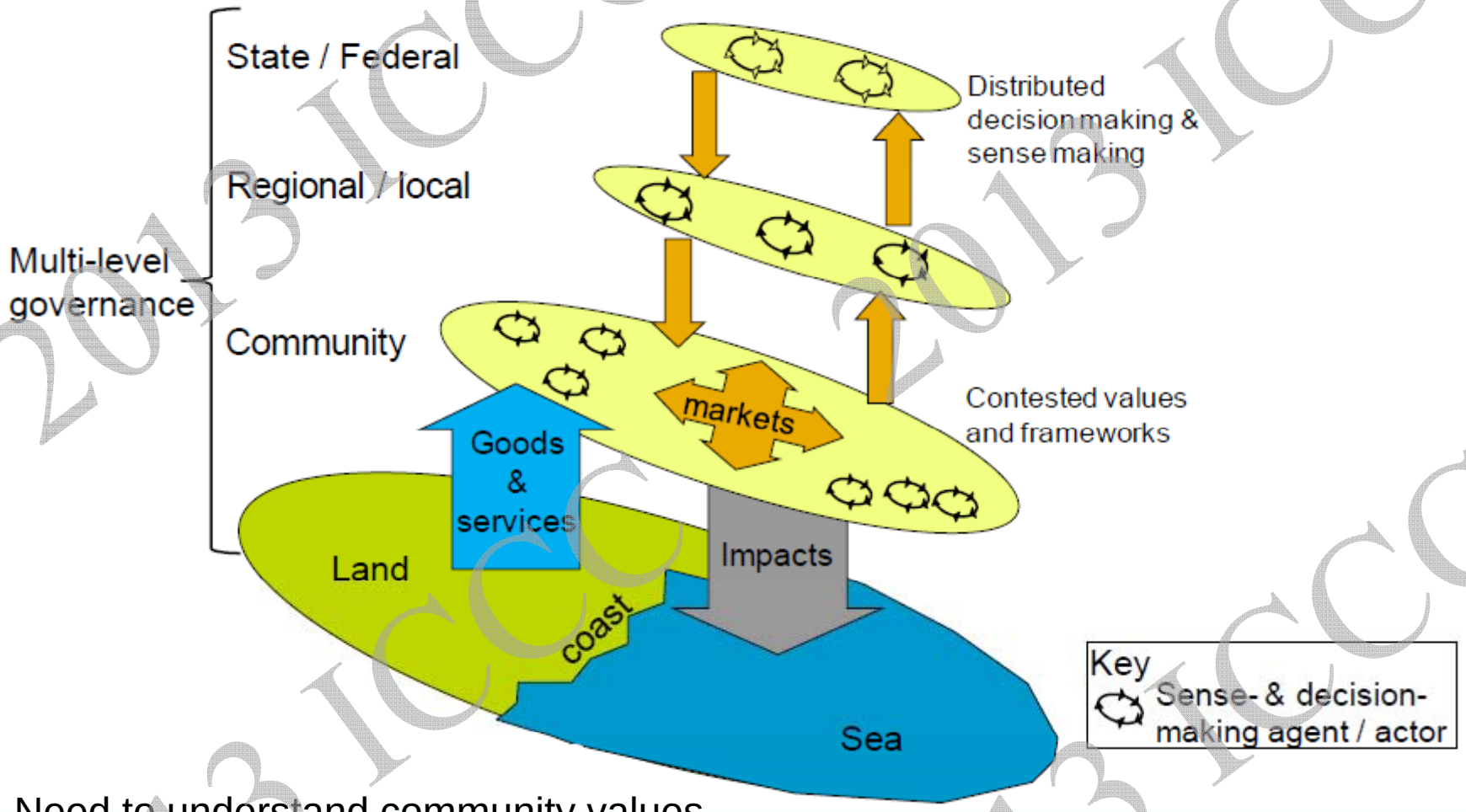
- Damage costs: now ~$1.1bn
  - 226k people, 35k houses affected
- With population growth, sea level rise, current planning: by 2030 expect >$2bn
  - 399k people, 62k houses affected
- ($3.9bn by 2070)

Adaptation

- Banning new risky developments could cheaply save $0.7bn/event; potential to adapt to save more

Importance of acting *now*

Coastal adaptation decision-making systems



- Need to understand community values, and the trade-offs between different types of values

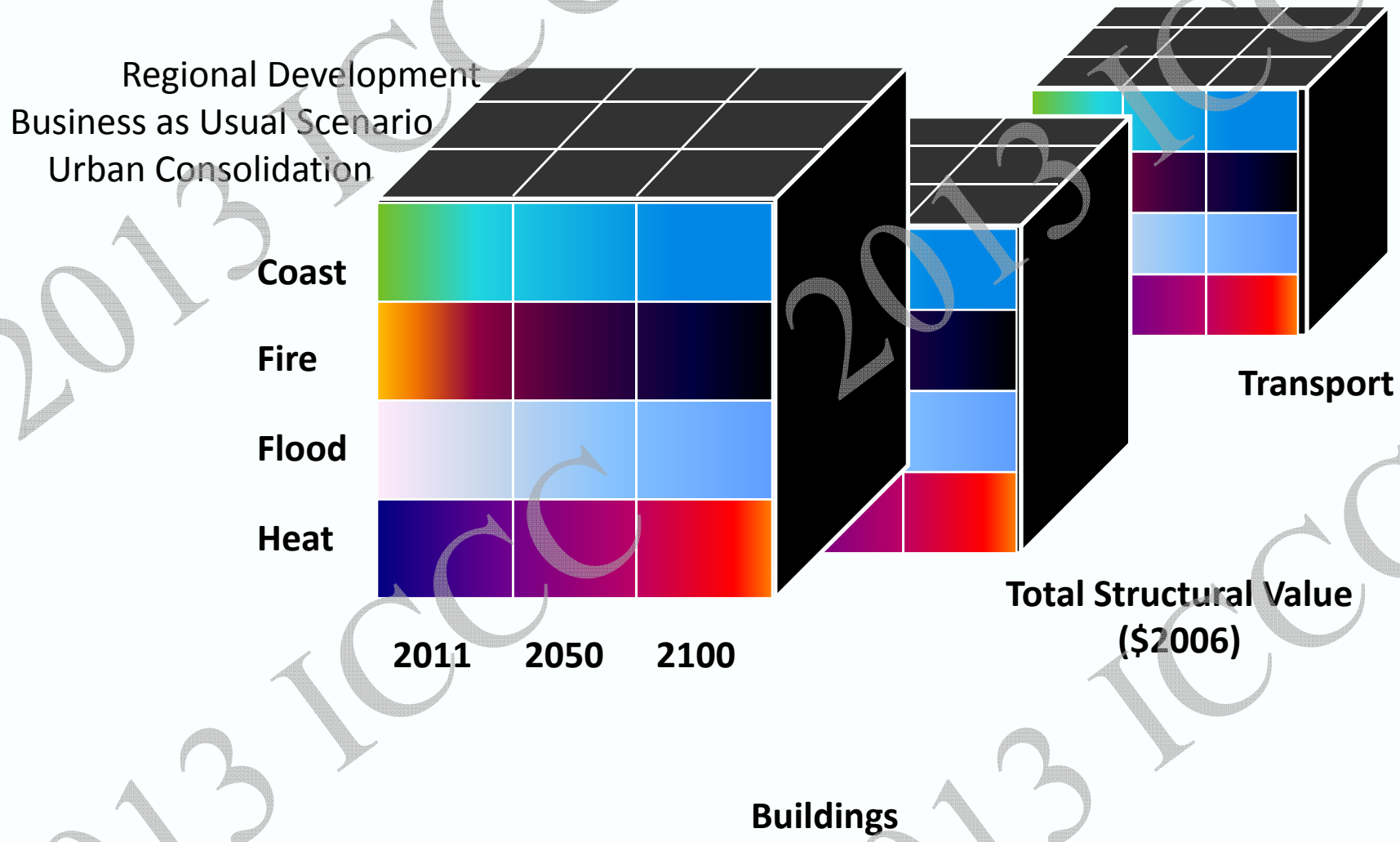
4. National infrastructure assessment

Studies underway:

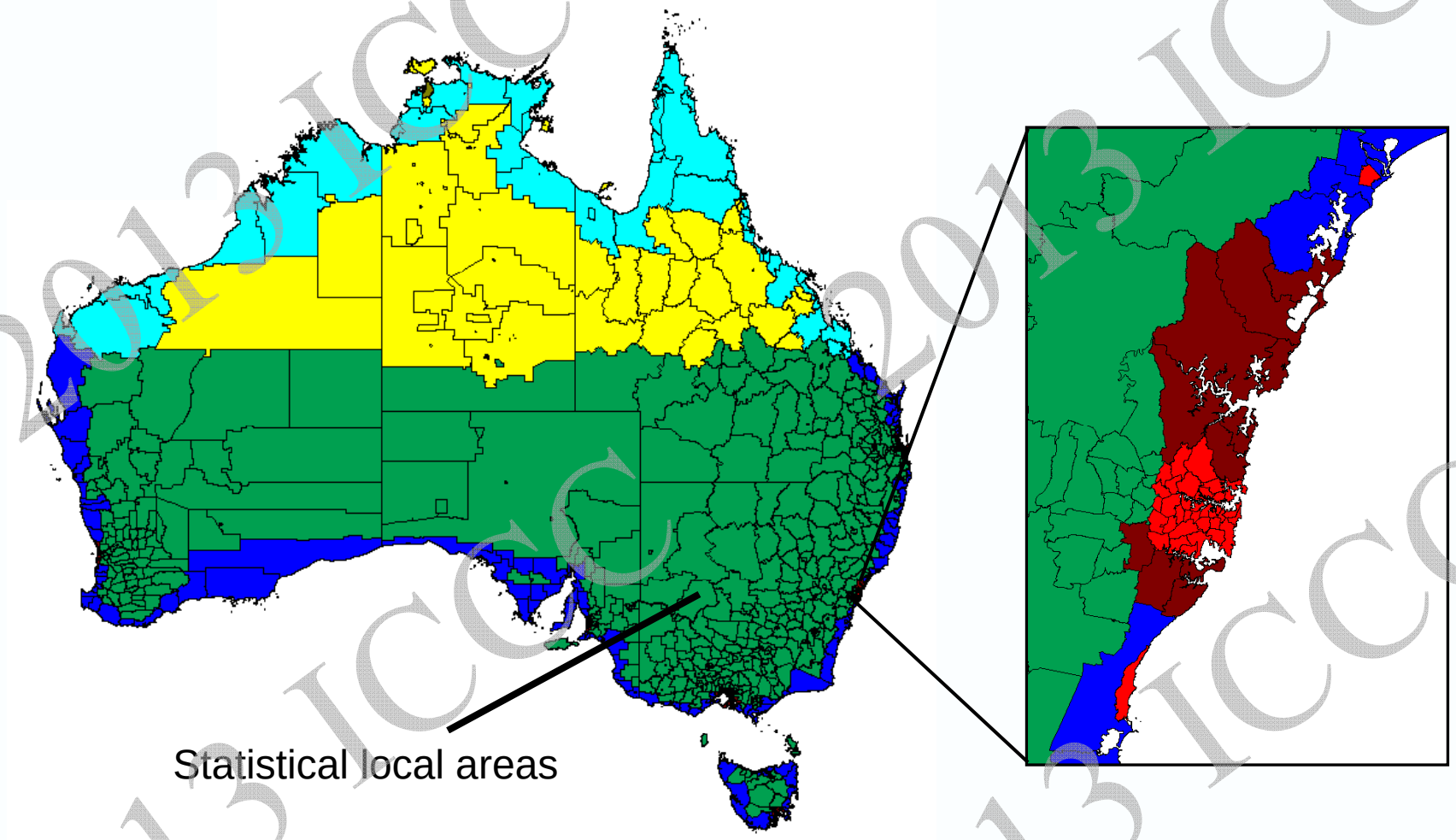
- What will be the **exposure** to future effects of fire, inland flooding, coastal inundation (and heatwaves and high winds) on infrastructure, given different future population distributions in Australia?
- What **impacts** may result and what **adaptation responses** are worth taking?

- Collaboration with federal Department of Climate Change, and Attorney General's Department (includes emergency management)

Scope



How we did it – inputs & outputs by geography

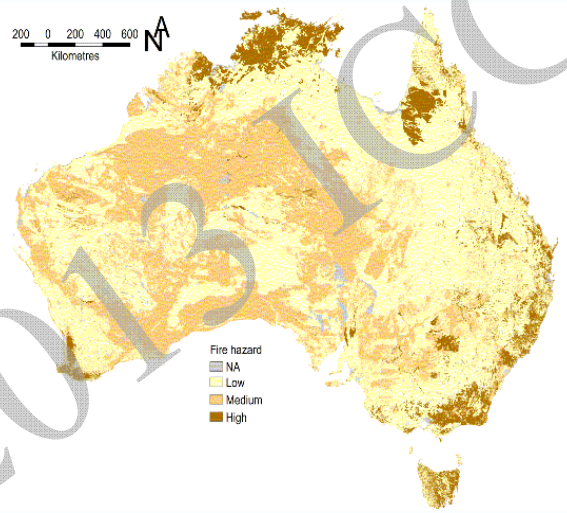


How we did it – exposure maps from projections

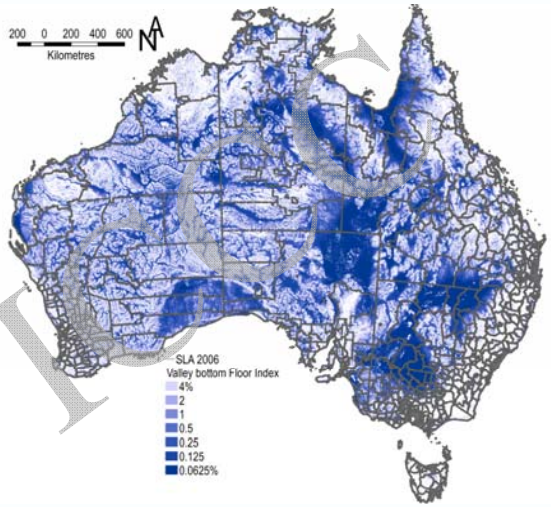
Exposure maps

Coastal Inundation

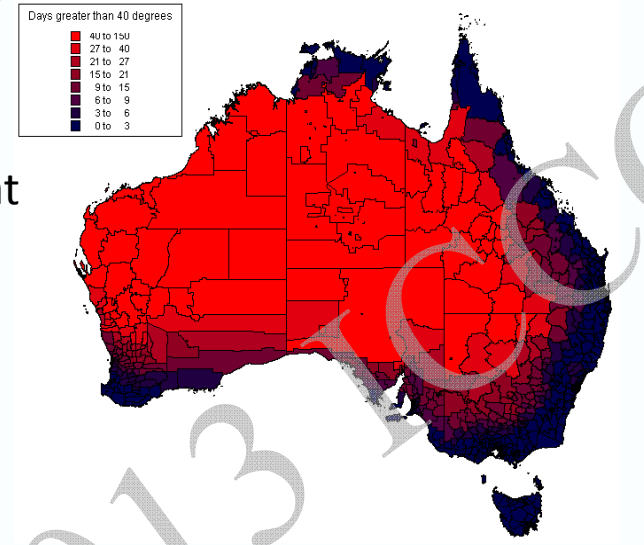
Fire



Inland Flood

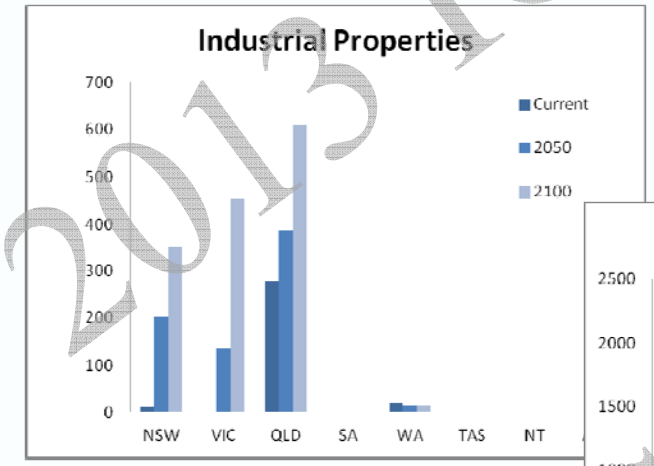


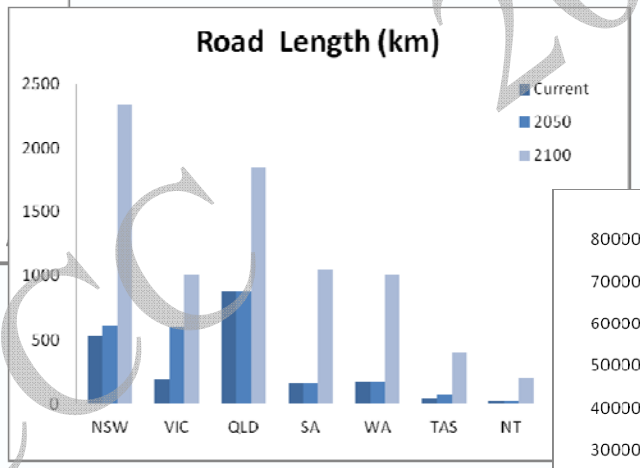
Heat

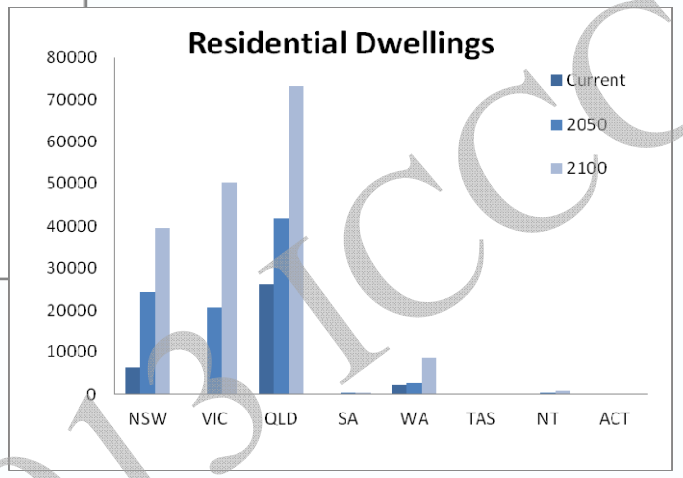


Key results – coastal inundation

Currently < 0.5% of building stock is *exposed* to coastal inundation but this will increase 5 fold





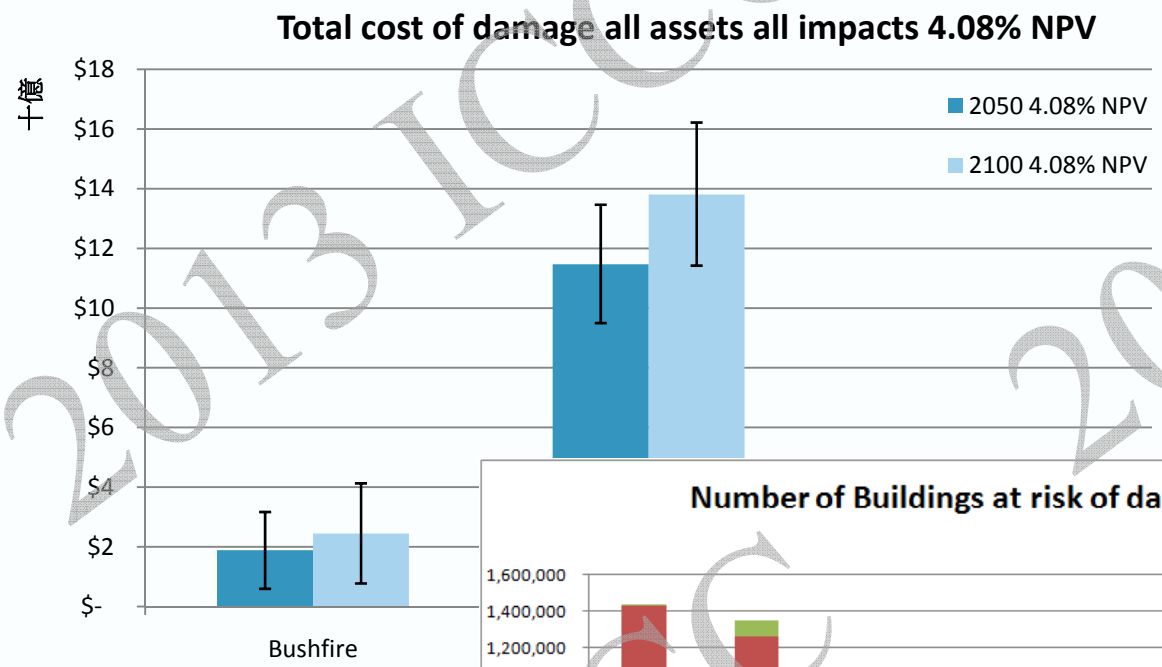


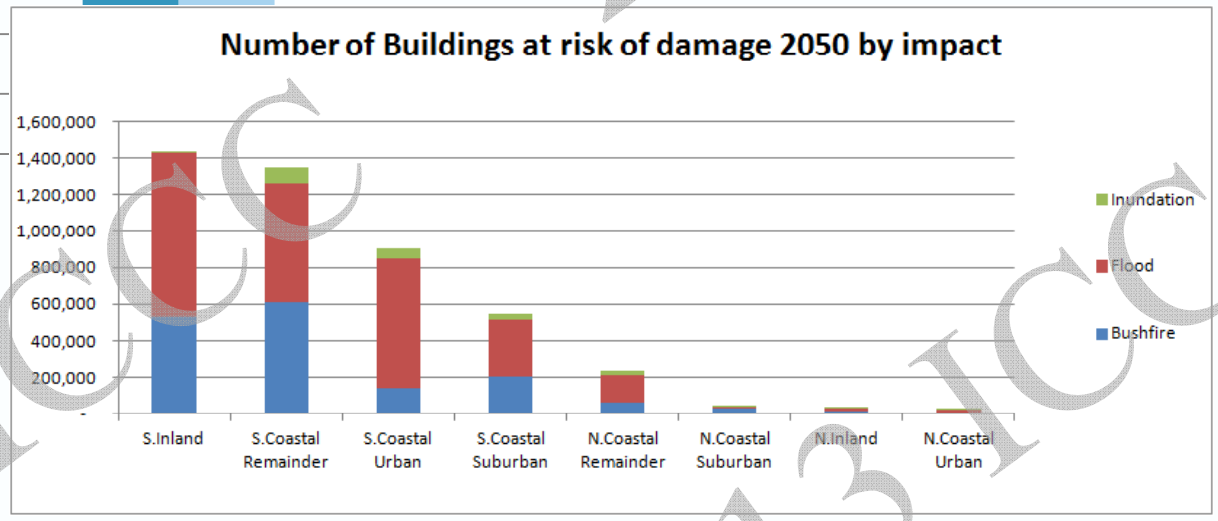
Key results: total national impacts - 1

Fire + inland flood + coastal inundation

	Accumulated damage cost by 2050 (4% NPV) $billion	Accumulated damage cost by 2100 (4% NPV) $billion
Residential buildings	11.0 (8.8-13.2)	14.6 (11.3-18.0)
Commercial and industrial buildings	1.25 (0.29 – 2.2)	1.55 (0.67 – 2.5)
Road	2.1 (1.8 – 2.4)	2.5 (2.1 – 2.8)
Rail	0.03 (0.025 – 0.035)	0.035 (0.036 – 0.046)
Total buildings and transport infrastructure	**14.4 (10.9 – 17.9)**	**18.8 (14.3 – 23.2)**

Key results: total national impacts - 2





Framing policy stances for adaptation responses

Anticipate: act on best estimate of future risks, or "what might happen" (more-or-less precautionary).

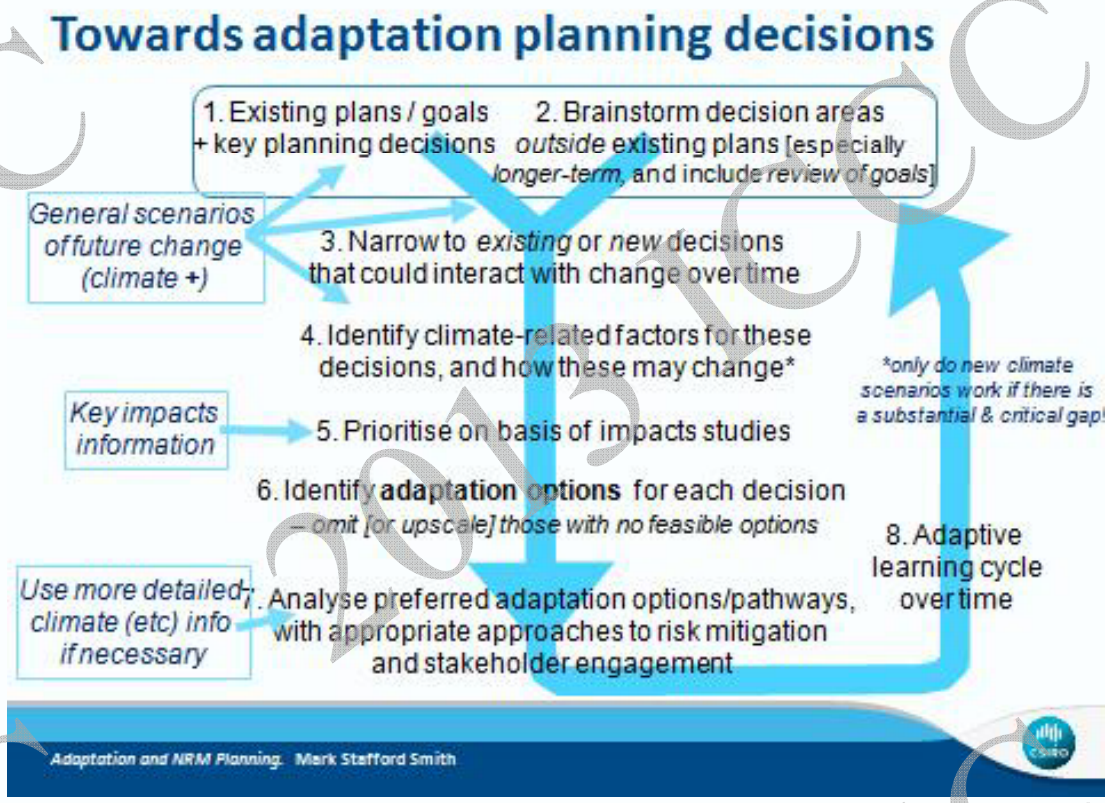
React: act on demonstrated present risks, or "what has happened".

Business-as-usual: follows today's trends and practices, only fixing when actually damaged.

Project in progress

Protect if ...	**Protect existing assets against climate hazard X if:** ▪ **Exposure to future hazard exceeds the *defined exposure trigger* [ET], based on the high climate outlook for the relevant asset life; and** ▪ **Protection expenditures for the most cost effective option are less than C% of the current replacement cost of the assets at risk;**
otherwise accommodate if ...	Accommodate through upgrade of existing assets if: ▪ Exposure to future hazard exceeds the *defined exposure trigger* [ET] as above; and ▪ Upgrading asset design standard reduces expected damage to *acceptable levels* and is generally expected to be cost effective over asset life, based on high climate outlook;
and only retreat if ...	Retreat existing assets if: ▪ Exposure to future hazard exceeds the *defined exposure trigger* [ET] as above; and ▪ Location of asset does not meet cost effectiveness criteria for protection above; or ▪ No cost effective protection option has been identified; and ▪ No cost effective accommodate option or upgrade has been identified.

How much information?



To assess these you still need an idea of future projections

- How much information do decision-makers need?
  - Getting a first pass understanding of risky sectors, etc
  - Detailed engineering risk analysis of a piece of infrastructure

➢ Climate Futures idea

Climate Futures web tool for projections

Major scenarios based on changes in temperature and rainfall

- Linked to other general changes at regional scales for each major scenario

2055 A2

		Surface Temperature - Annual (° C)			
		Slightly Warmer < 0.50	Warmer 0.50 to 1.50	Hotter 1.50 to 3.00	Much Hotter > 3.00
Rainfall - Annual (% change)	Much Drier < -15.00				
	Drier -15.00 to -5.00			Likelihood: 8.3% 2 models	
	Little Change -5.00 to 5.00		Likelihood: 4.2% 1 model	Likelihood: 29.2% 7 models	
	Wetter 5.00 to 15.00			Likelihood: 45.8% 11 models	Likelihood: 4.2% 1 model
	Much Wetter > 15.00			Likelihood: 8.3% 2 models	

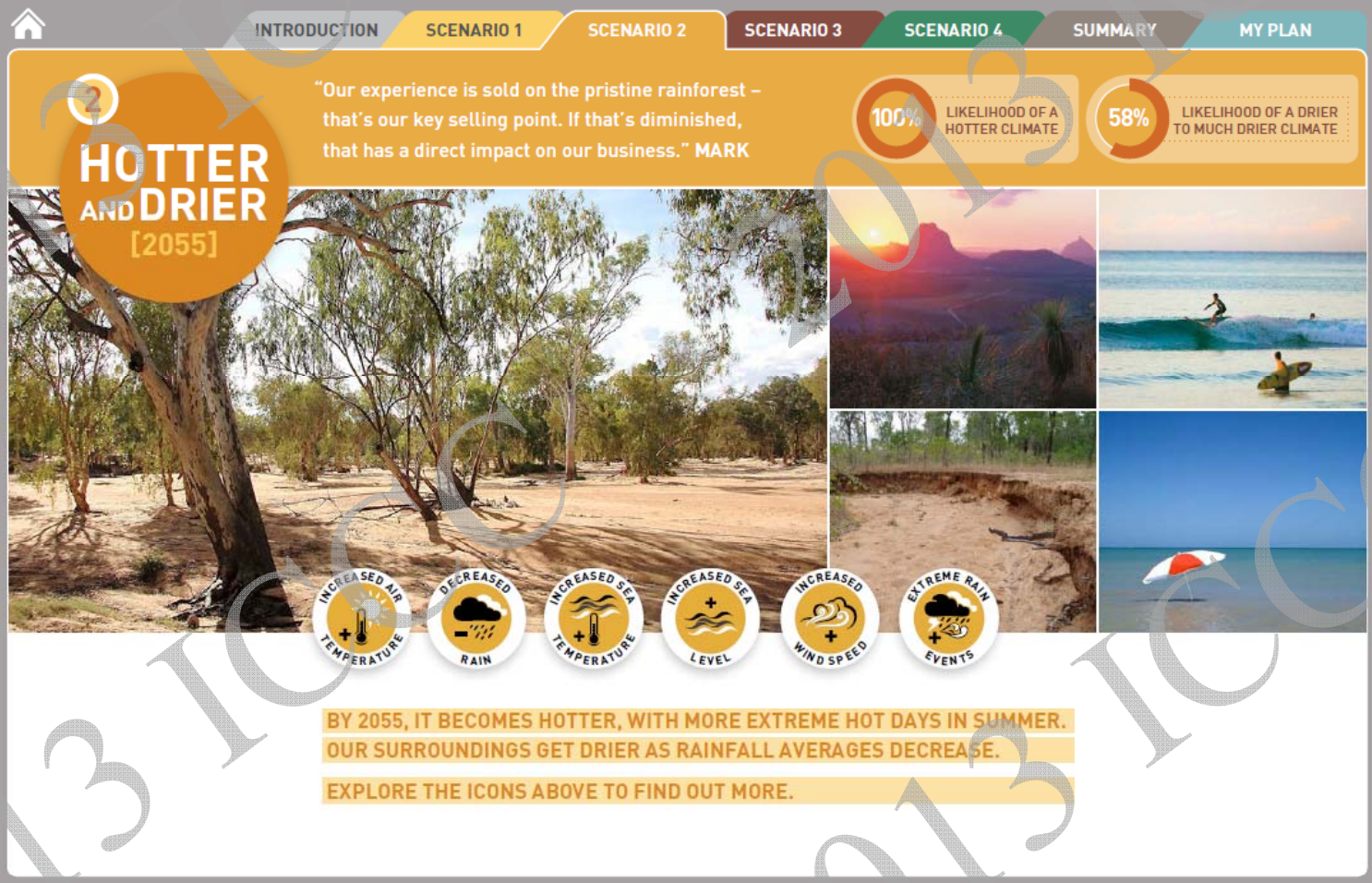
Export to Word...

= No Evidence

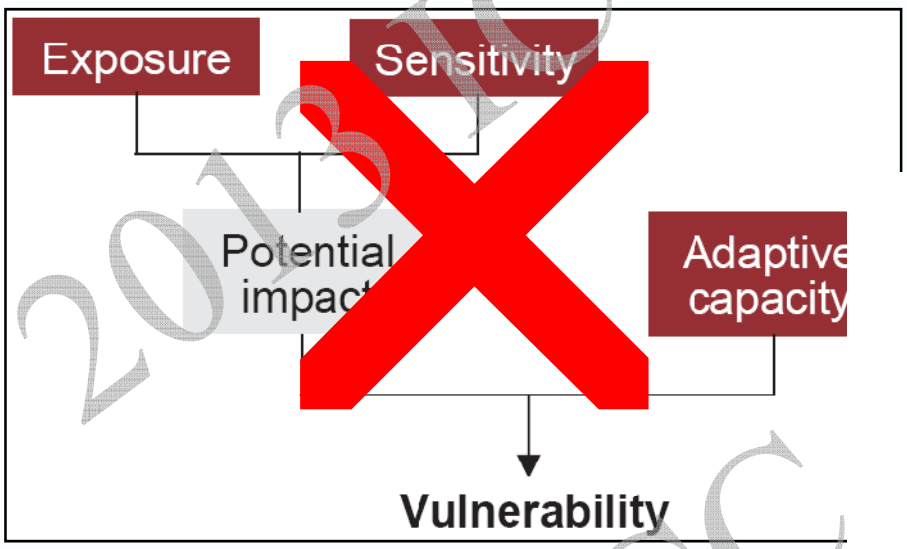
See www.pacificclimatefutures.net

- Potential to seek more detail as/when needed (in time or space)
  - E.g. daily data, extremes; regional downscaled scenarios
- Major alternative 'climate futures' stable to new findings even if details change

Interactive application for one region



Conclusion: adaptation planning – climate or decision-centred??



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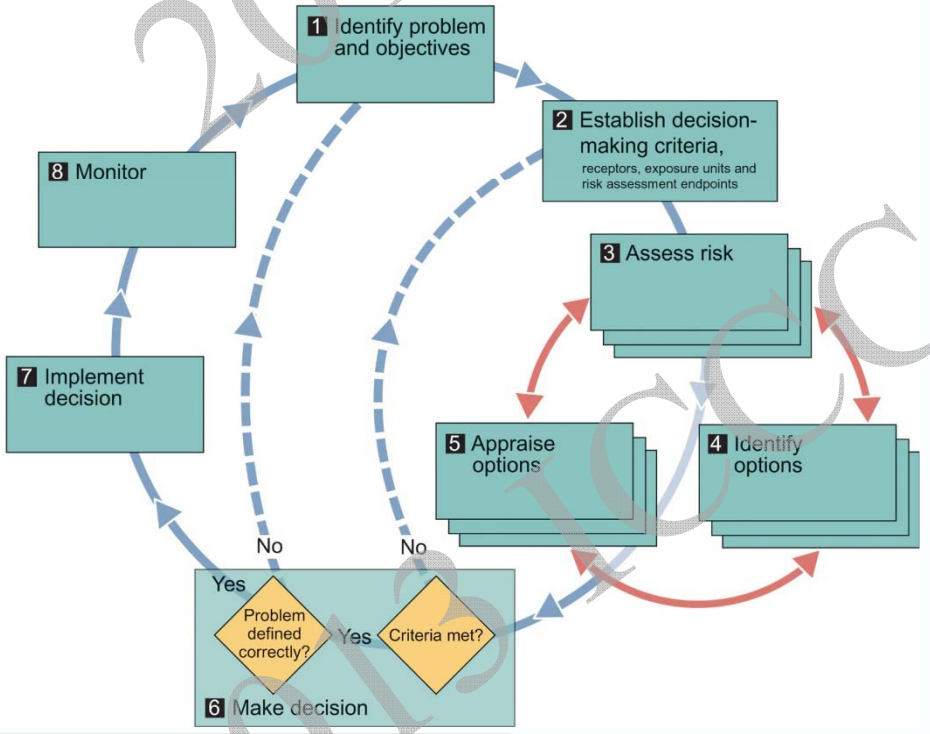

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