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*Climate change and agriculture –
meeting the challenges and opportunities*

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and Mark Howden



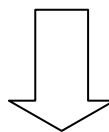
Overview

- What makes us vulnerable?
- What impacts may occur?
- What can farmers and natural resource managers do?
 - manage impacts
 - build adaptive capacity

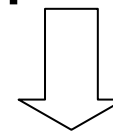


What makes us vulnerable?

Vulnerability = **Impacts** - Adaptation



Manage
risk

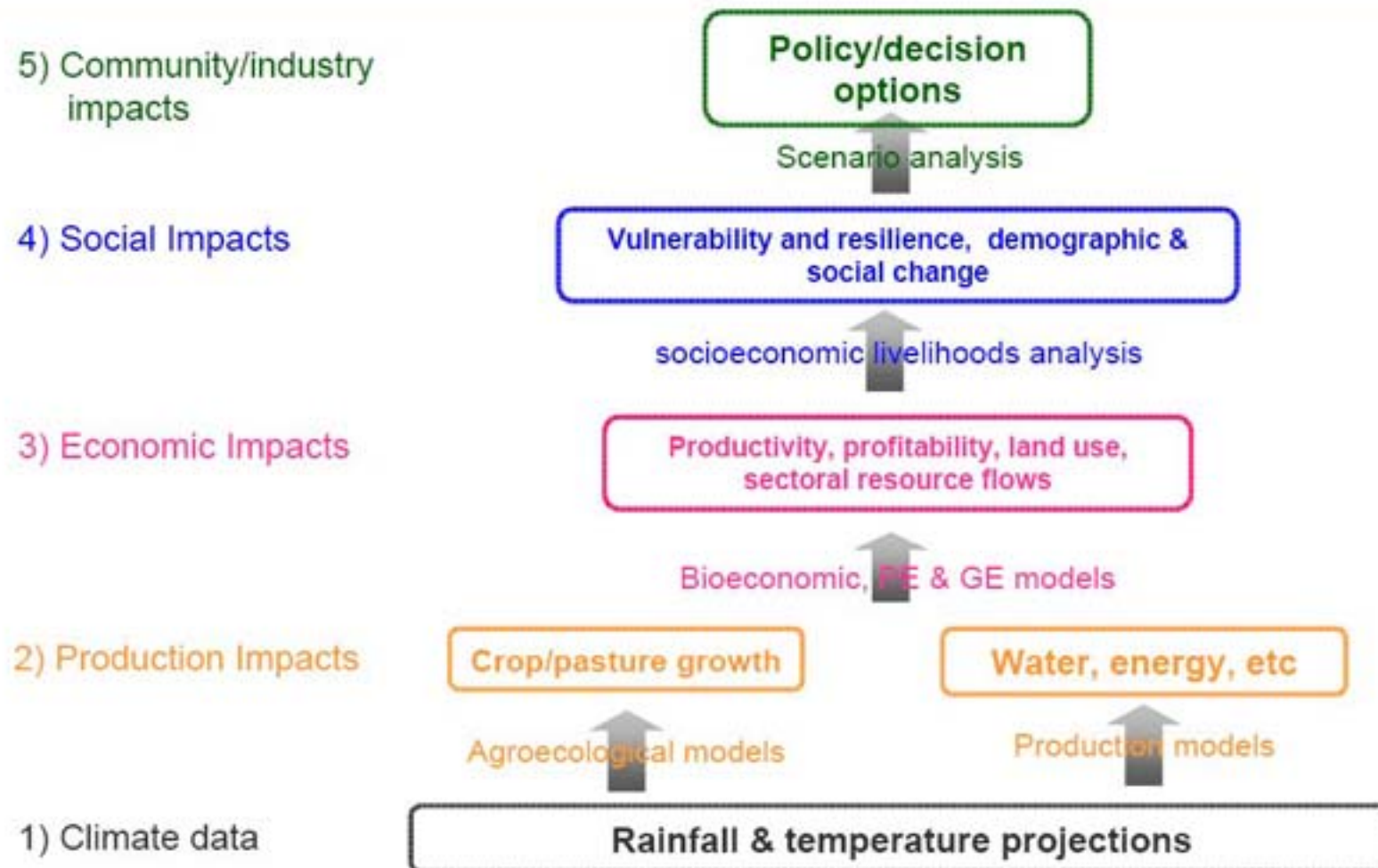


Build
adaptive
capacity

Impacts a function of the degree of climate change and the sensitivity to this change

Adaptation actions to enhance the capacity to cope, respond, thrive!

What approaches can we use to predict impacts, and evaluate adaptation options?





Future 'climate' changes: Australia

- Higher temperatures (1 to 6°C by 2070)
- Lower rainfall in the southwest and south-east but possibly more monsoonal rain in the north
 - reduced soil moisture and river flow (e.g. 16 to 35% reduction in MDB flows by 2050), water quality issues too
- Higher potential evaporation



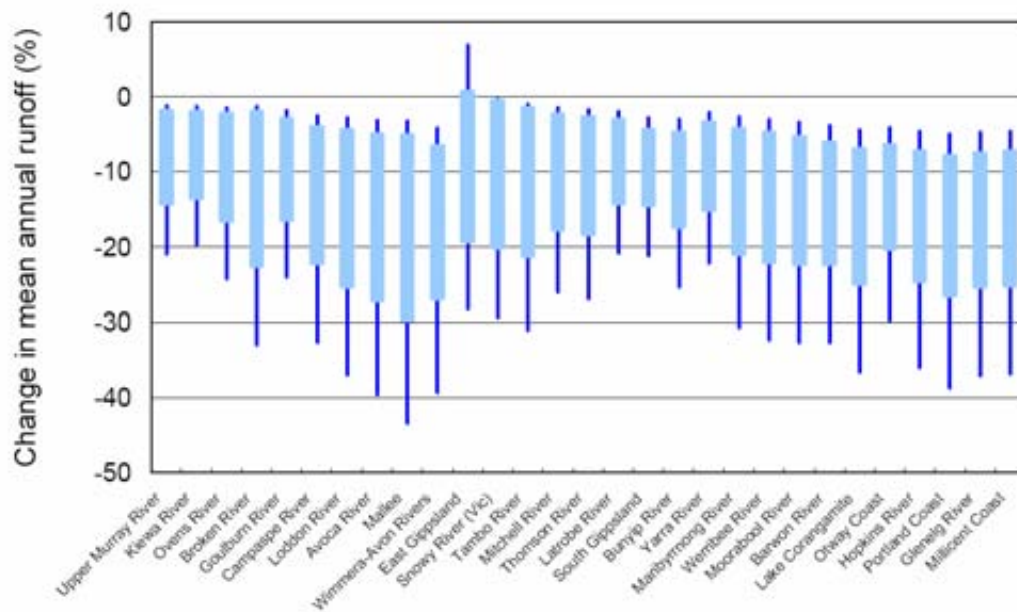
Implications of climate change for agriculture

- Effects of climate are pervasive
 - many effects resulting from extremes
 - but mean climate important too
- Challenges in southern Australia
- Possible opportunities in northern Australia
- CO₂ effect positive for production, but dependent on management
- Existing studies patchy
 - neither the detailed system nor the broader economic analyses comprehensively undertaken



Water resources

- Reduced runoff and soil moisture.
- Changes in supply & peak stream flow timing.
- Increased irrigation demand & competition for water between cities, irrigators, industry and environmental flows.
- Deterioration of water quality during drought & fire episodes





Agriculture



- Enhanced plant growth due to more carbon dioxide may be offset by warmer and drier conditions.
- Reduced wheat yield likely as well as quality declines due to reduced grain protein and more heat-shock proteins.
- Reduced grape quality.
- Vigour of pasture growth may increase, but forage quality may decline.
- More heat-stress for cattle, and less cold-stress mortality for lambs.



Forests

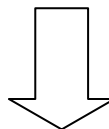
- Climate change could affect a hierarchy of interacting issues such as changes in hydrology, fire regimes, pests, and plant composition.
- Native forests are often located where growth is limited by nutrients and water, so the CO₂ fertilisation effect is uncertain.
- Number of extreme fire danger days (Total Fire Ban) may rise 10-40% by 2020 and 20-120% by 2050.



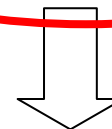


What makes us vulnerable?

Vulnerability = Impacts - Adaptation



Manage
risk



Build
adaptive
capacity

Adaptation actions to enhance the capacity to cope, respond, thrive!

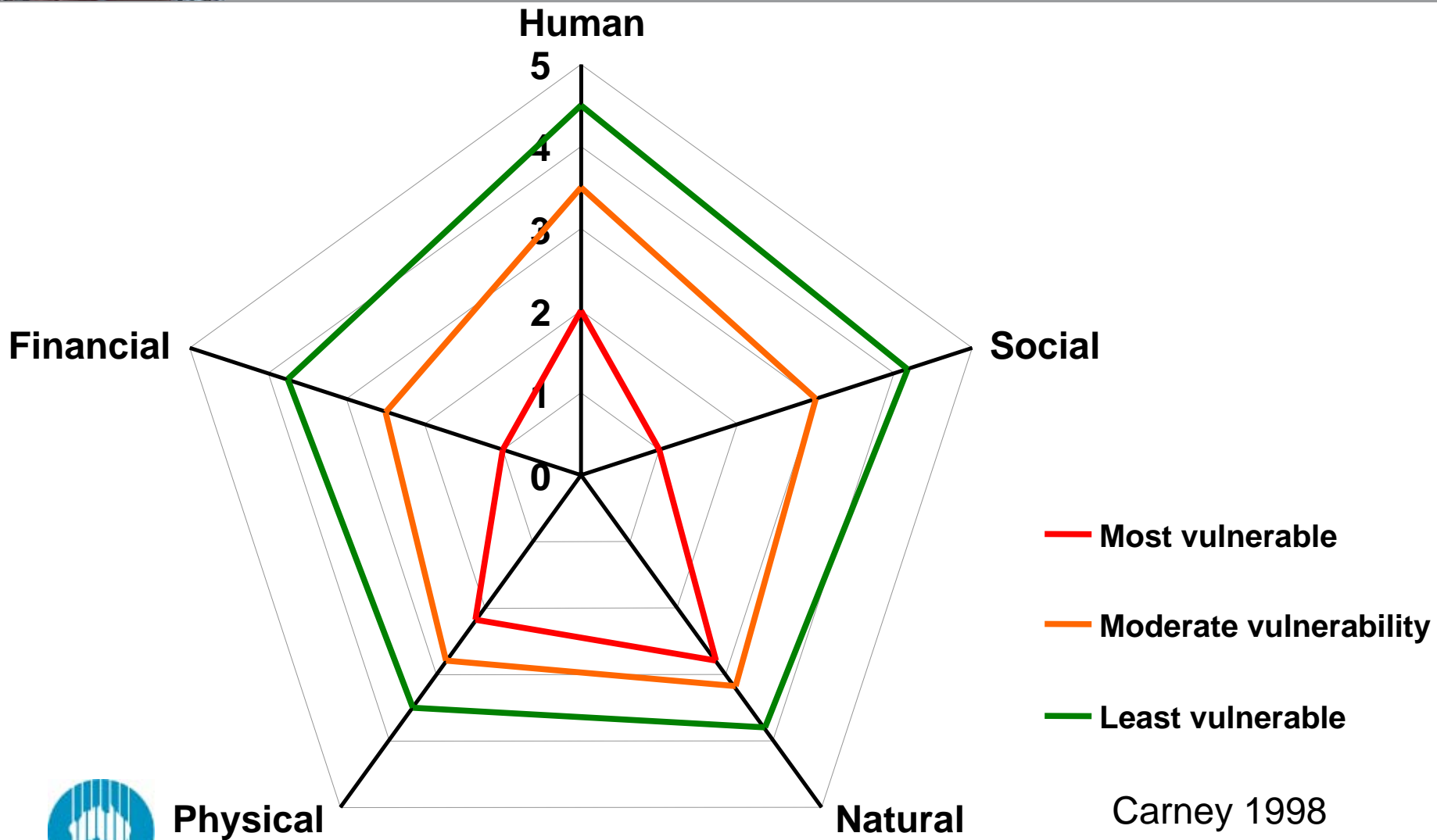


Adaptive capacity

- Human
 - Education
- Social
 - Partnerships, internet use
- Natural
 - Degradation, productivity
- Physical
 - Area cropped, diversity
- Financial
 - Average income, off-farm income



Adaptive capacity & livelihoods

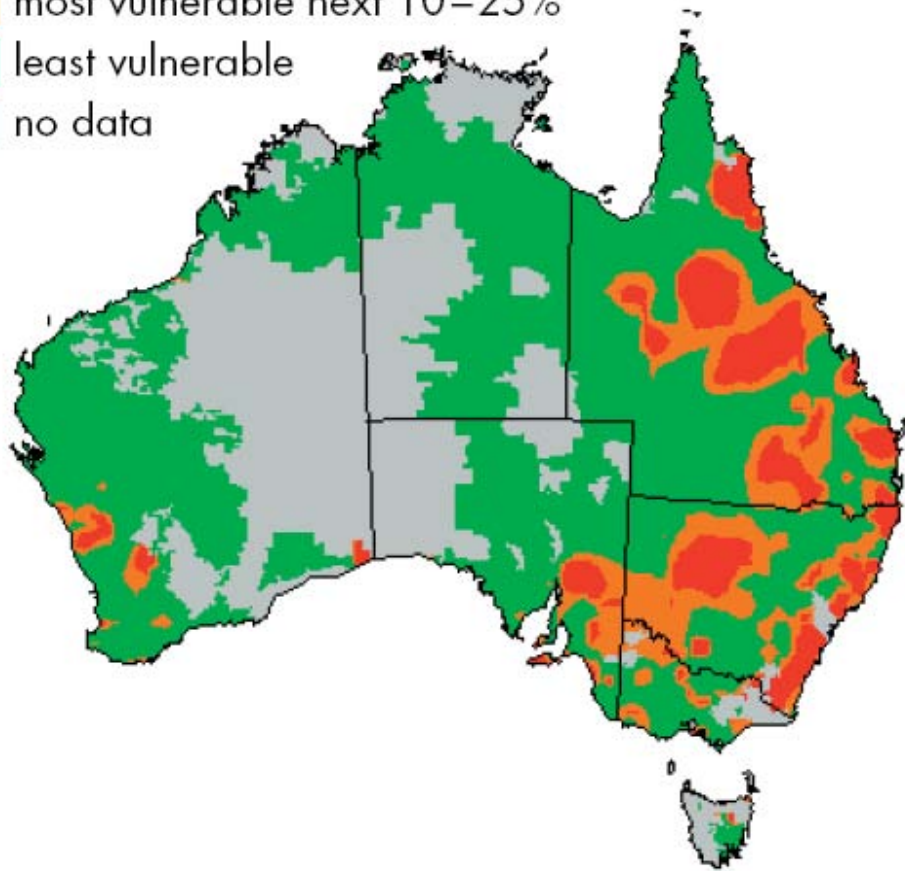




Mapping vulnerability

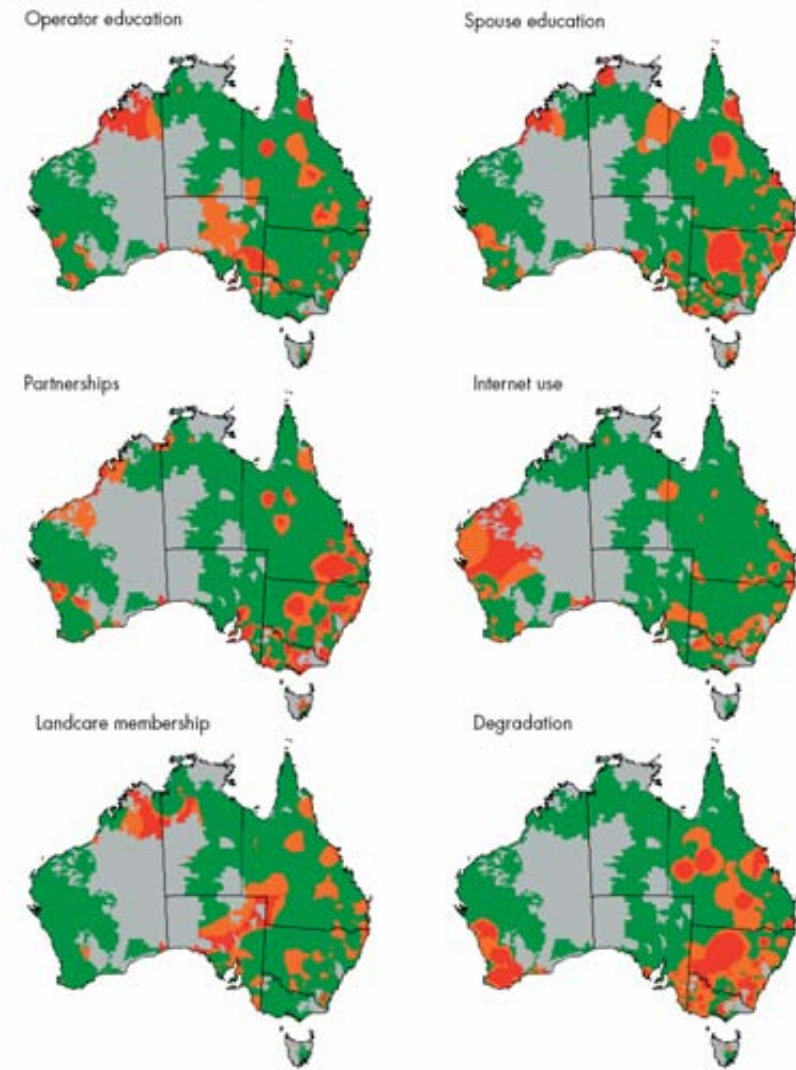
1 Vulnerability across Australian agricultural regions

- most vulnerable – top 10%
- most vulnerable next 10–25%
- least vulnerable
- no data



2 Factors contributing to the vulnerability of broadacre regions

- most vulnerable – top 10%
- most vulnerable next 10–25%
- least vulnerable
- no data

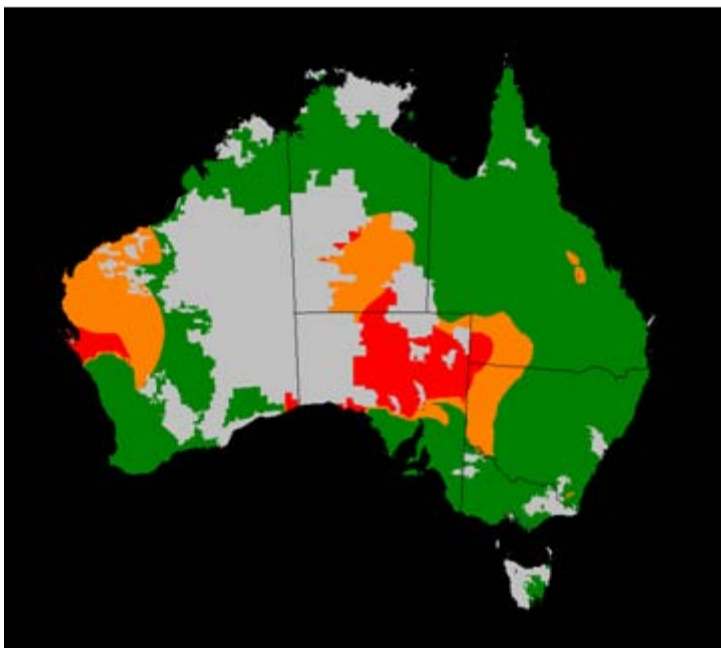




Vulnerability = impacts - adaptation

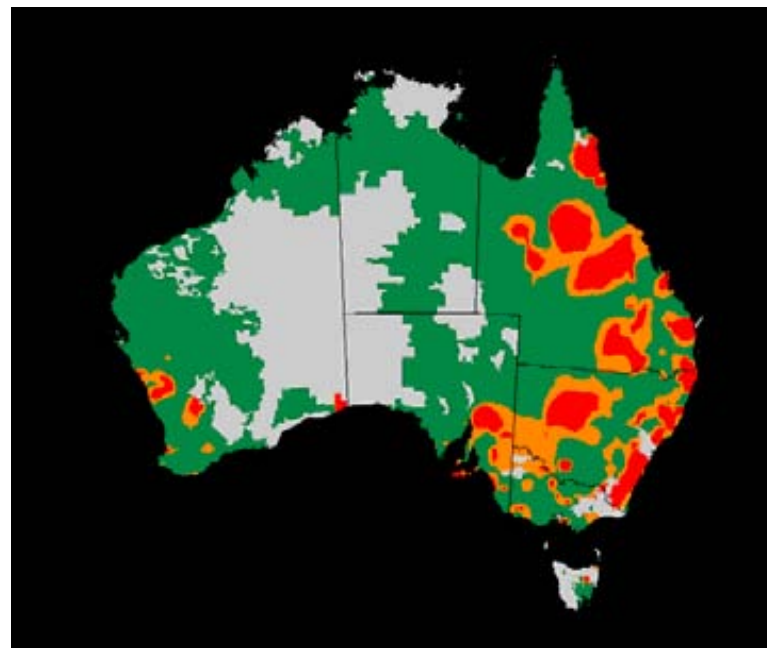
Impacts

Extreme pasture growth conditions



Adaptive capacity

Human, social, natural, physical & financial



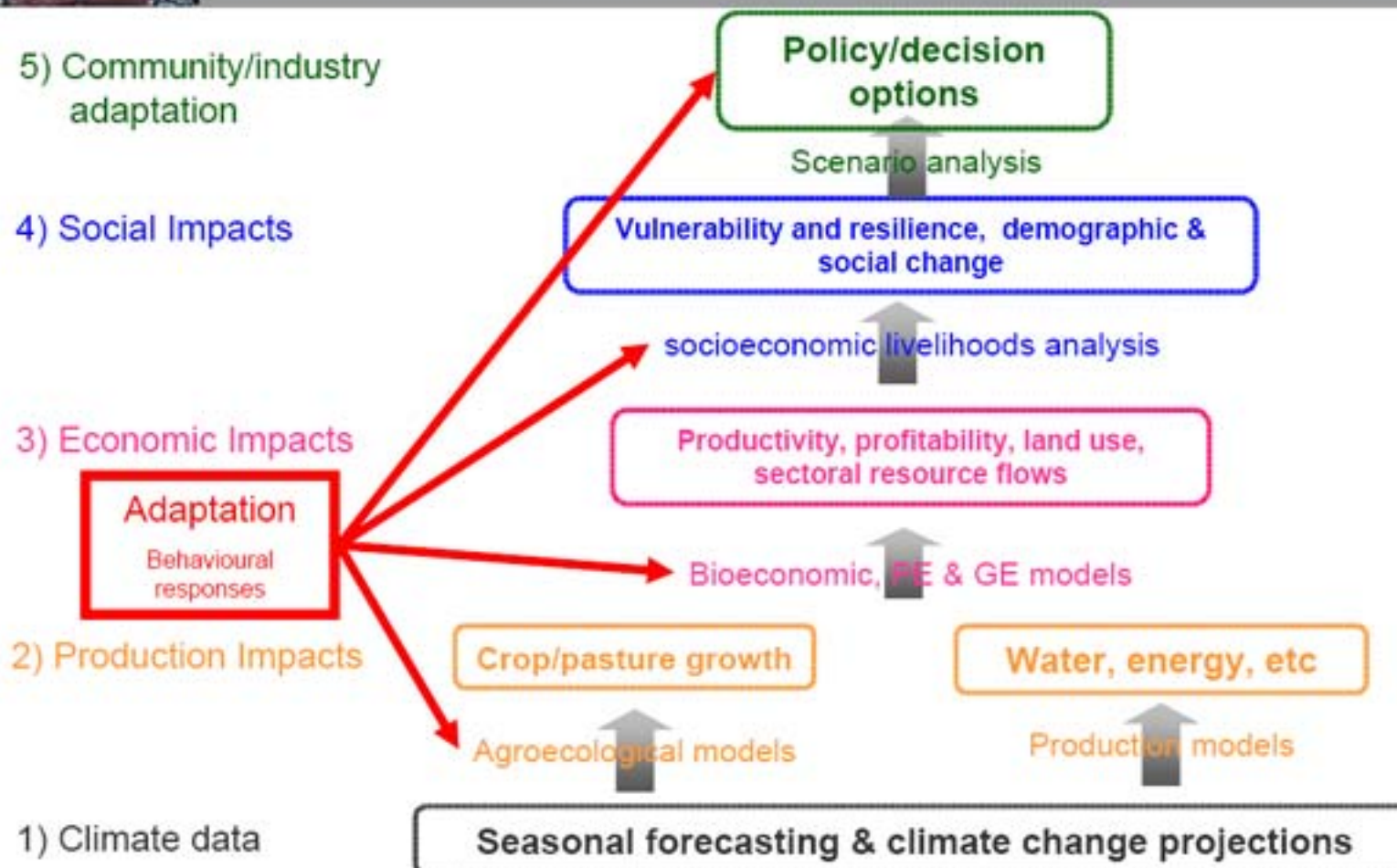
 most vulnerable

 least vulnerable

 moderately vulnerable



What approaches can we use to predict impacts, and evaluate adaptation options?





Possible On-Farm Adaptation

- Develop additional climate risk offset approaches:
 - zero tillage and other minimum disturbance techniques;
 - retaining residue,
 - extending fallows and staggering planting times,
 - row spacing and planting density, and
 - altering fertilizer rates to maintain grain or fruit quality consistent with the prevailing climate.

- More opportunistic plantings:
 - accounting for environmental condition (e.g. soil moisture), and
 - climate (e.g. seasonal climate forecasting)

- Expand routine record keeping:
 - Weather
 - Production
 - Degradation,
 - Pest, diseases and weed invasion



Possible On-Farm Adaptation

- Improve efficiency of water distribution systems:
 - reduce leakage and evaporation
 - Improve irrigation practices, and
 - moisture monitoring

- Learning from farmers in currently more marginal areas.

- Selection of varieties with appropriate thermal time and vernalisation requirements:
 - heat shock resistance,
 - drought tolerance,
 - high protein levels,
 - resistance to new pests and diseases and perhaps that set flowers in hot/windy conditions

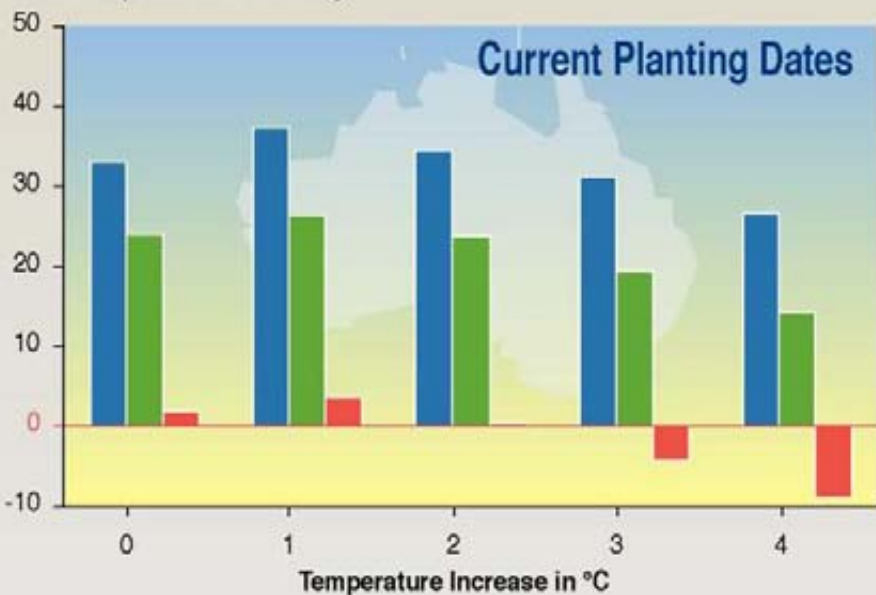
- Diversifying income including through altering the integration with other farming activities



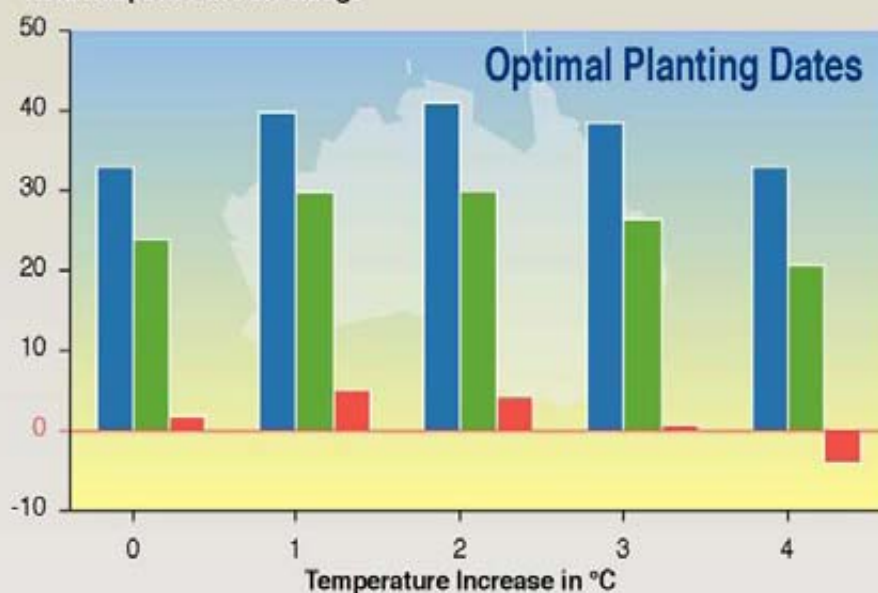
Impacts: Wheat Case Study

Australian Wheat Yield for CO₂ levels of 700 ppm and a Range of Changes in Temperature and Rainfall

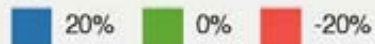
Yield Response in Percentage



Yield Response in Percentage

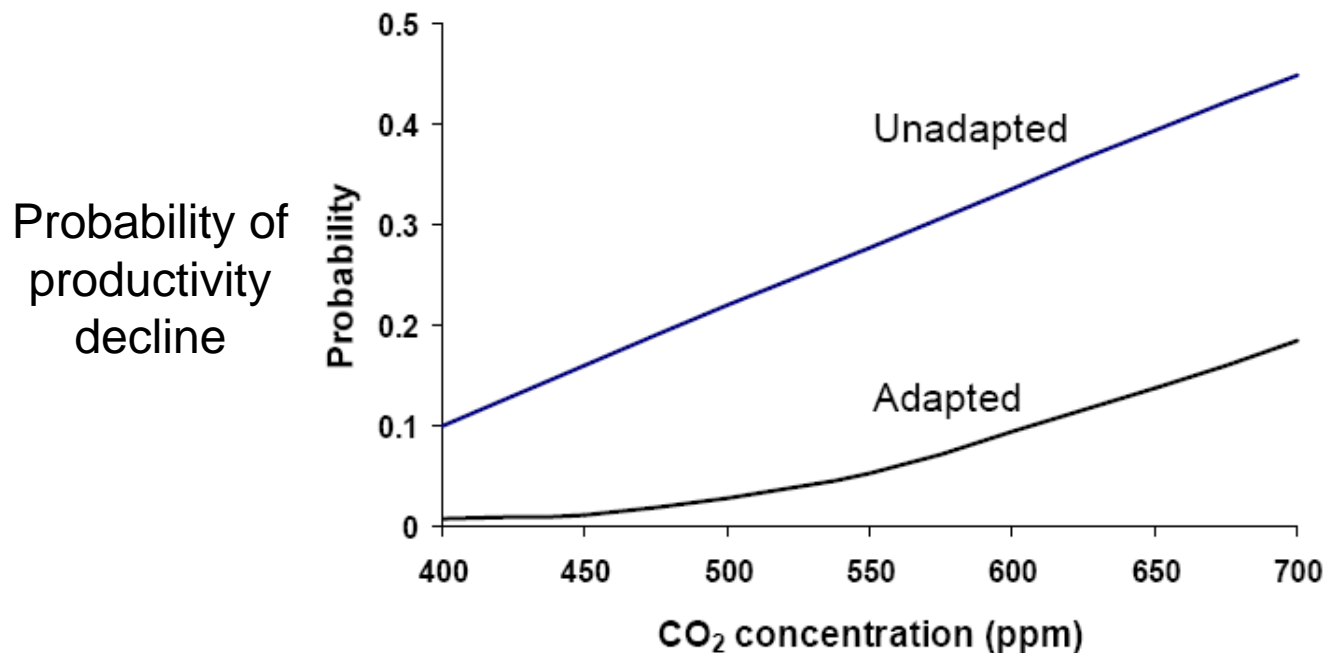


Yield response is shown for rainfall changes





The value of adaptation



- Without adaptation the risk increases from about 12% at levels of 400ppm CO₂ to about 45% at 700ppm
- With adaptation, a small likelihood of reduced production up to CO₂ levels of 450ppm, then much lower probabilities thereafter.
 - Adaptation: new varieties and earlier planting window
 - Buys time

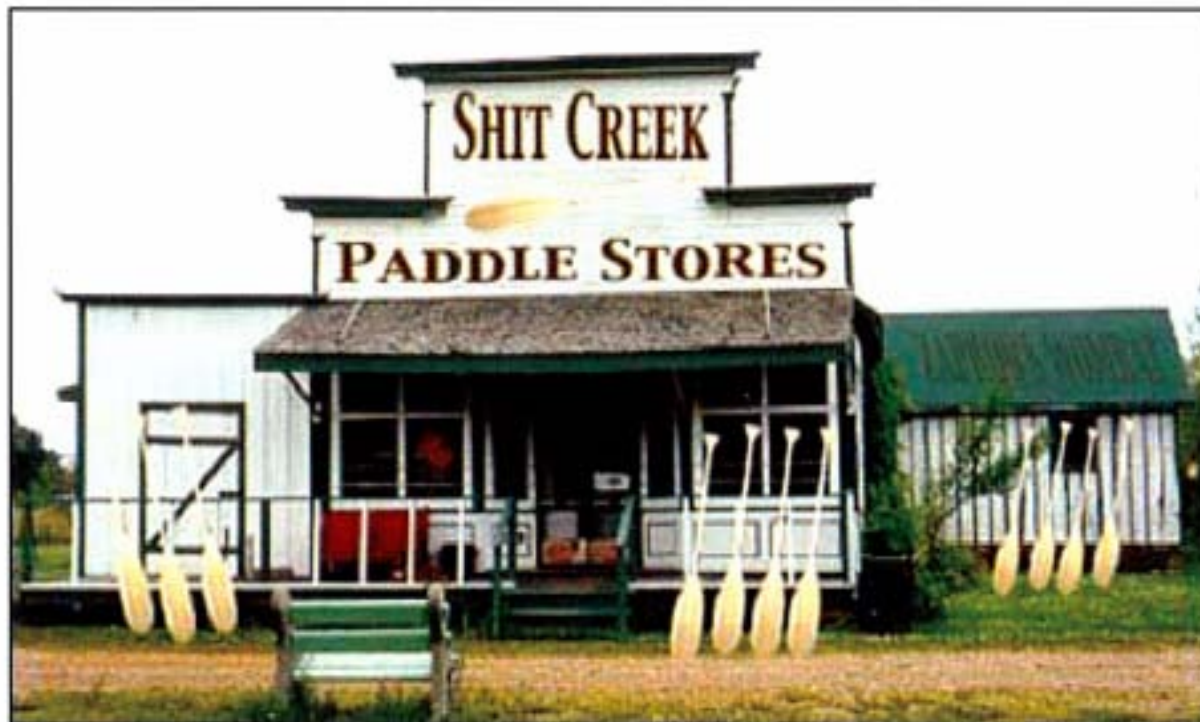


Adaptation pre-conditions

- Confidence that climate changes are real and will continue.
- Motivated to avoid risks and use opportunities.
- Demonstrated technical and other options available and implementation issues understood.
- Support for transitions to new locations, landuses and practices.
- Monitoring for continuing improvements in adaptation (what is working, what is not and why).



Adaptation is all about creating opportunities





THANK YOU

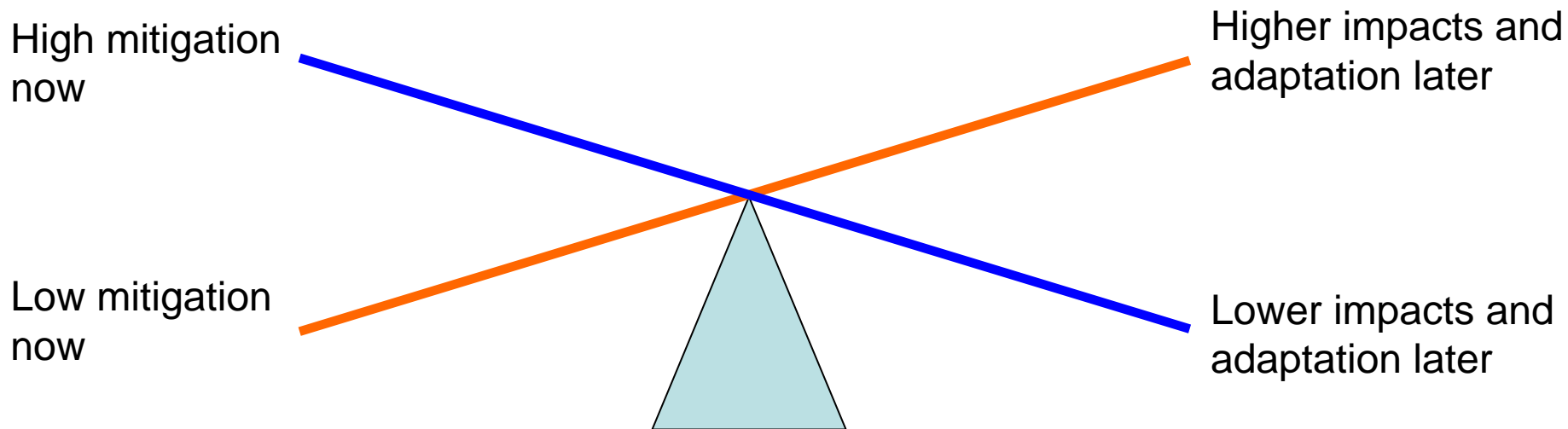
Choosing shorts or long underwear on a particular day is about weather; the ratio of shorts to long underwear in the drawer is about climate.

Charles Wohlforth, *The whale and the supercomputer. On the northern front of climate change*, North Point Press, 2004, p 150.

- **CSIRO Sustainable Ecosystems**
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- www.cse.csiro.au



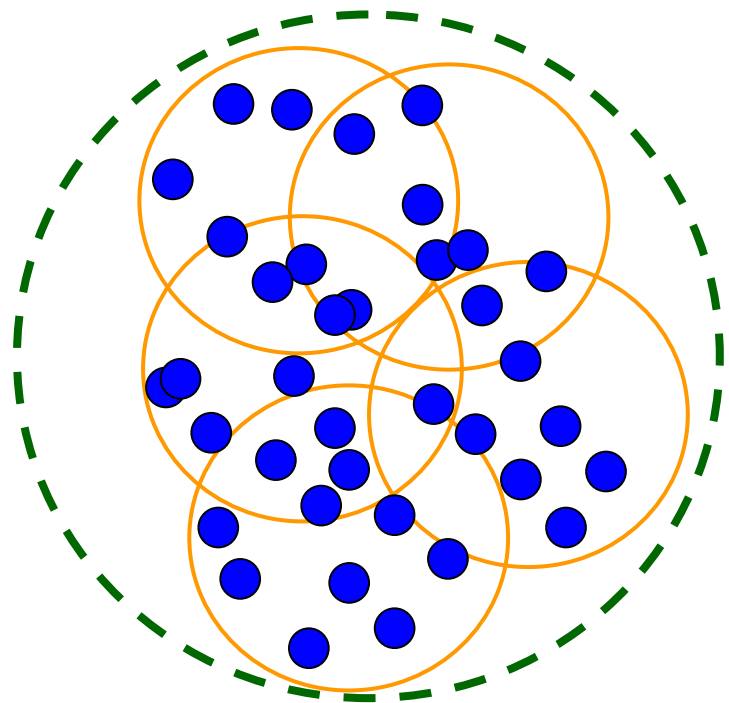
Adaptation/mitigation see saw



- Can we phase in adaptations to get a better outcome ?



Adaptation pre-conditions

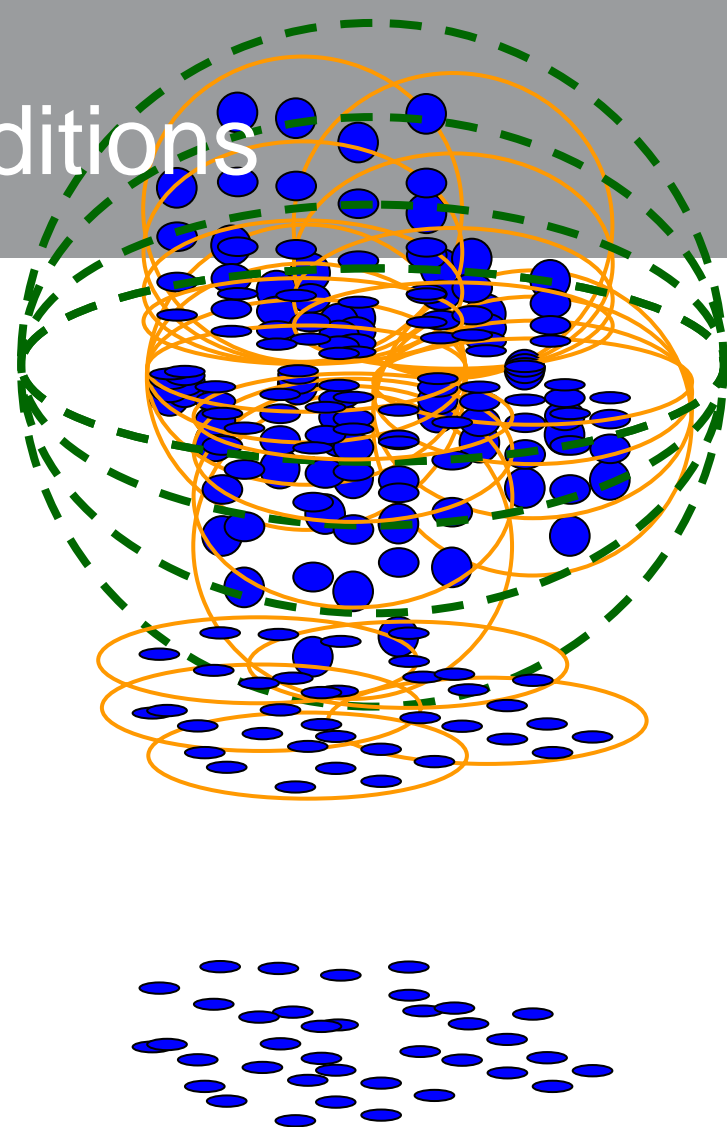


Polycentric

National

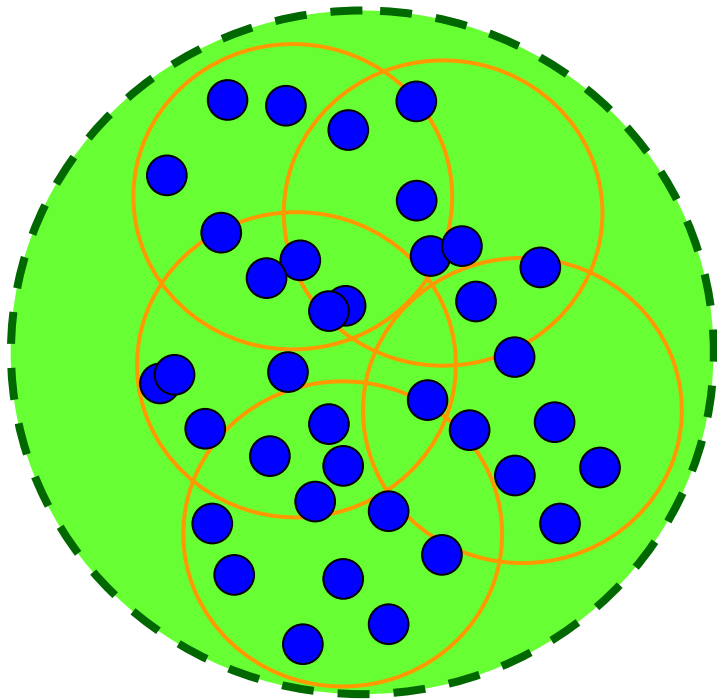
Regional

Local



Nested

Science as a communication medium



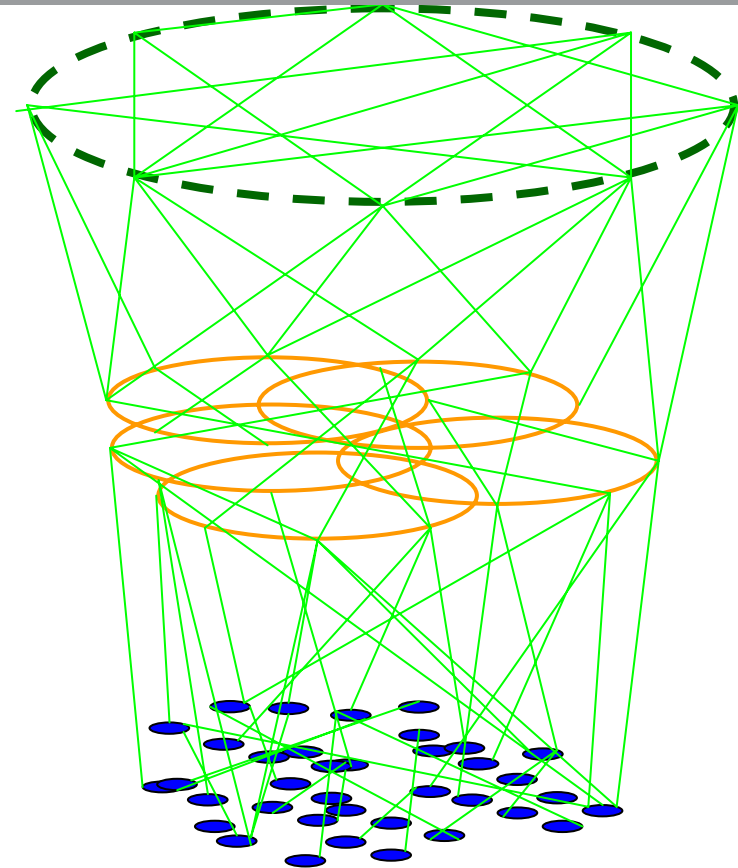
Polycentric



National

Regional

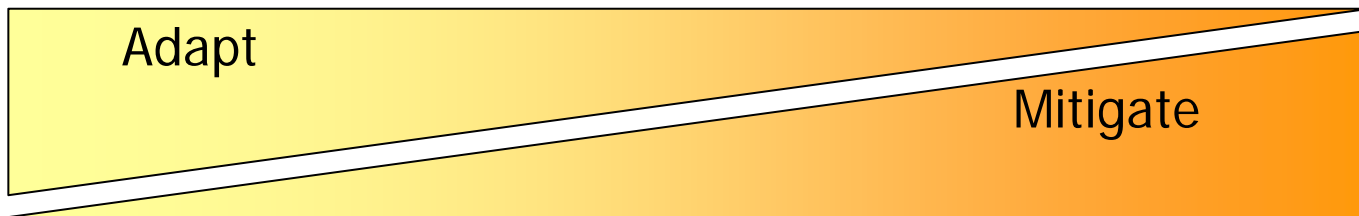
Local



Nested



Adaptation and mitigation



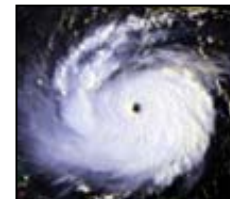
TEMPORAL
now future



SPATIAL
field farm catchment region state



ECONOMIC
enterprise business industry sector





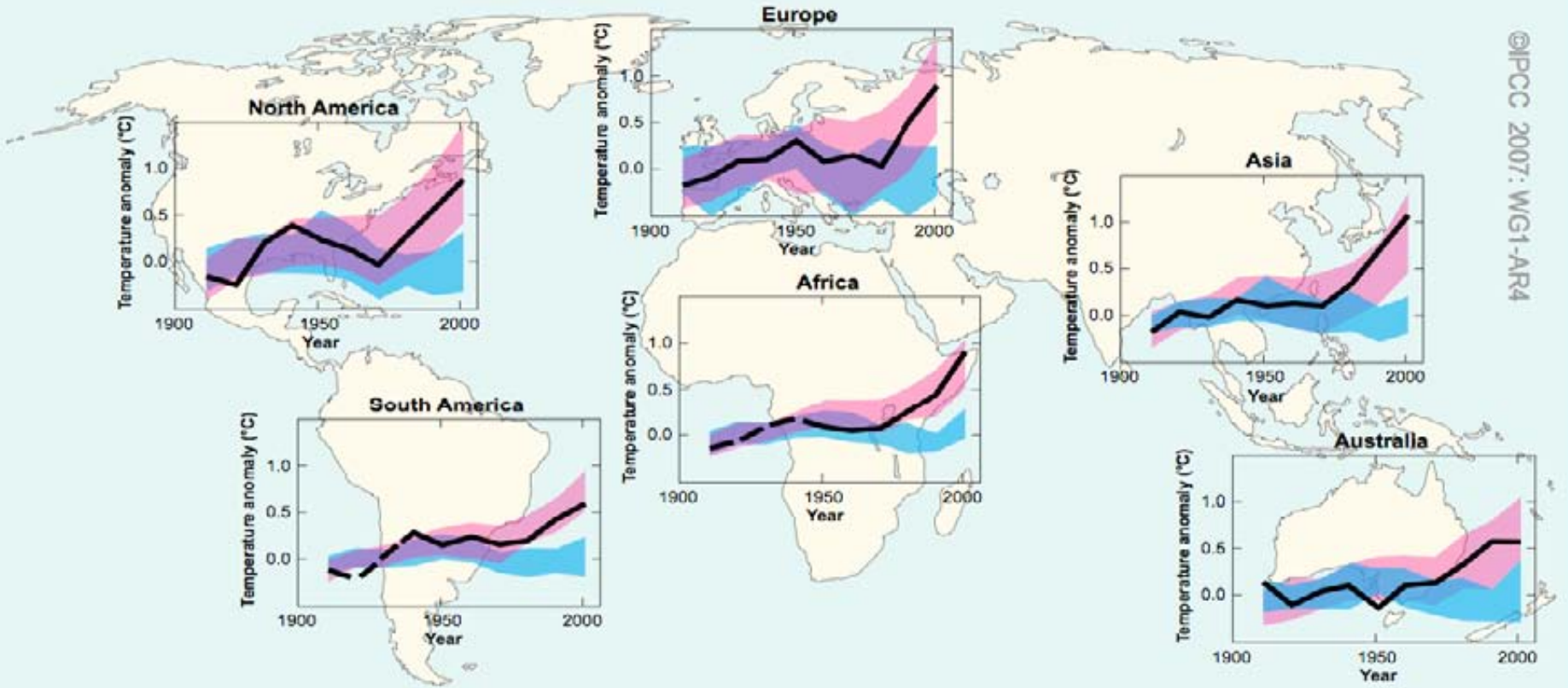
2030 projections for NSW

	Low Global Warming		High Global Warming	
	<i>Estimate of Change</i>	<i>Uncertainty</i>	<i>Estimate of change</i>	<i>Uncertainty</i>
Annual average temperature	+0.6 °C	±0.2°C	+1.3°C	±0.6°C
Average sea level	+3 cm		+17 cm	
Annual average rainfall	0%	±6.5%	0 %	±15%
Seasonal average rainfall				
Summer	+1.5%	±8%	+3.5%	±18.5 %
Autumn	+1.5%	±8%	+3.5%	±18.5%
Winter	-3%	±6.5%	-7.5%	±15%
Spring	-3%	±6.5%	-7.5%	±15%
Annual average potential evaporation	+2.4%	±1.9%	+5.6%	±4.4%
Annual average number of hot days (>35°C)	+1 day		+25 days	
Annual average number cold nights (<0°C)	-5 days		-30 days	
Annual average number of very high & extreme forest fire danger days ^b	+1 day		+10 days	
Extreme daily rainfall intensity (1 in 40 year event) ^c	0%		+6% (east) -5% (west)	
Carbon dioxide concentration	+73ppm		+102ppm	

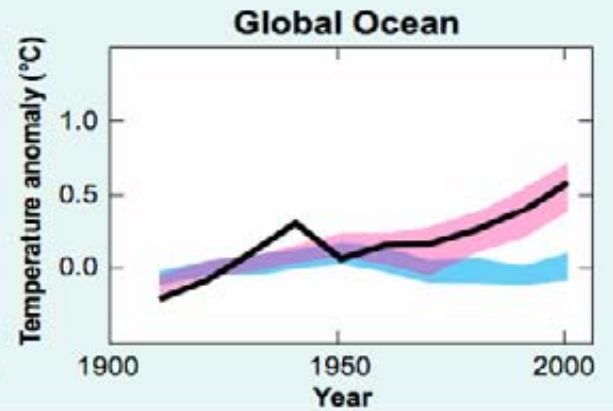
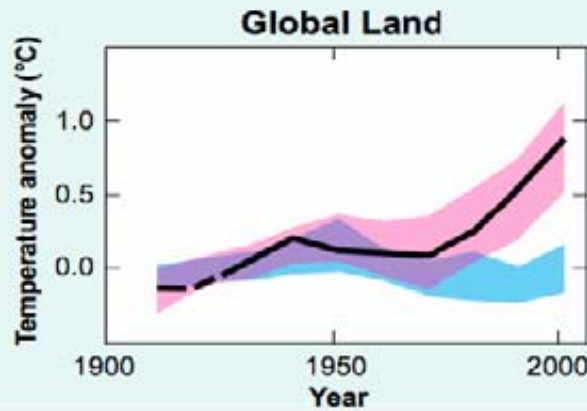
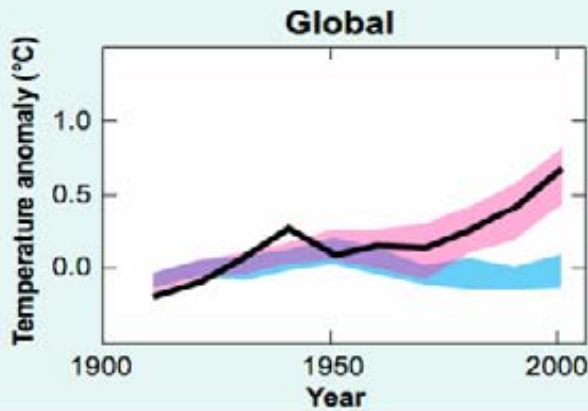
For risk assessment, it is important to consider extreme scenarios, even though they may have low probability.



Global and Continental Temperature Change



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Australian temperature trends

