CHARLES DARWIN UNIVERSITY

The converging insecurities of food, water, energy and climate, and their implications for 21st Century farming systems

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IFSA Berlin, 2 April 2014

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Personal declarations

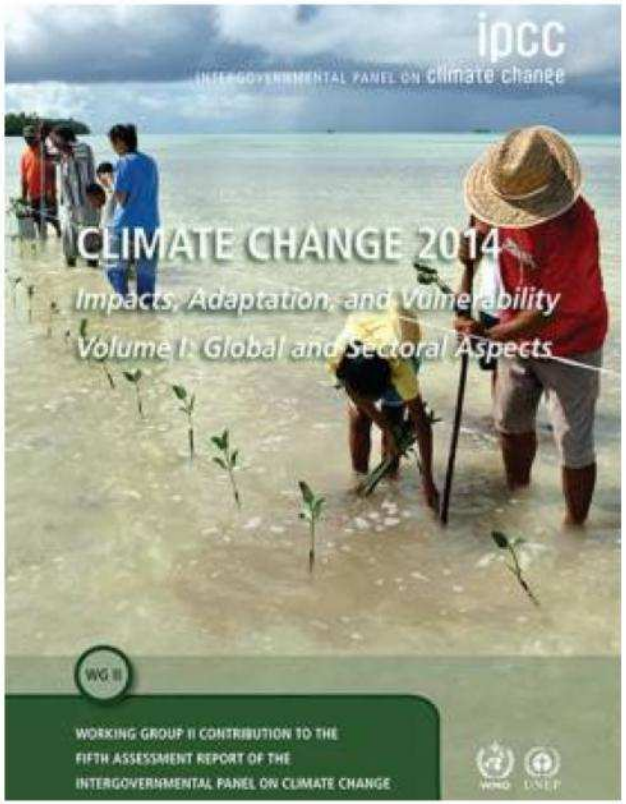
- Farming background south-eastern Australia
  - Family farming in the district since 1860s, own farm managed since 1987
  - 450ha: 30% farm forestry, 10% environmental reserves, 60% leased for sheep
- Studied forestry and rural sociology (Melbourne)
- Extension Officer/Project Manager 1982-88
- National Landcare Facilitator ‘89-92
- Studied Agricultural Knowledge Systems (Wageningen) 92-3
- Environment Policy Executive 1995-2000
- CEO, Research funding authority 2000-06
- Private Consultancy (strategy & policy) 2007-10
- Academic, Charles Darwin University 2011—

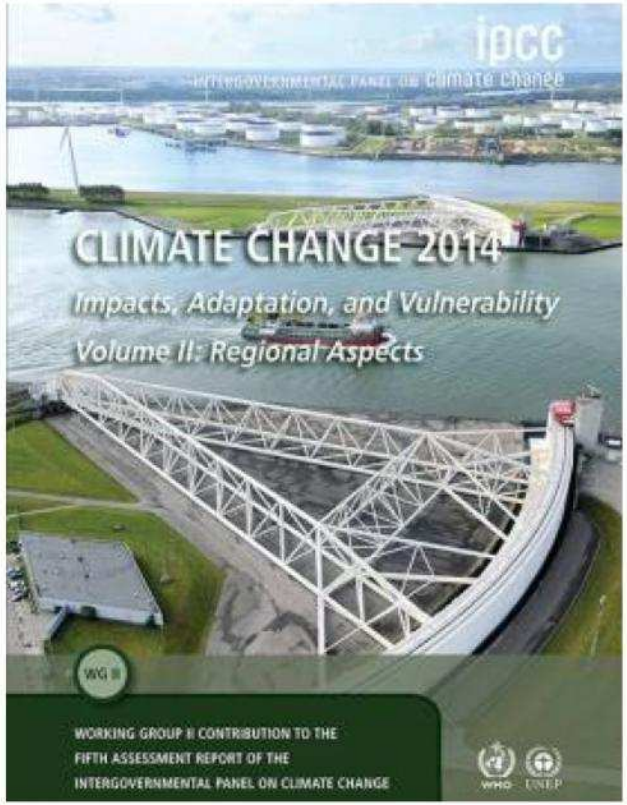
Key Points

- Food, water, land and energy are intricately interconnected
- Long-term security concerns, amplified by climate change, affect all
- These ‘converging insecurities’ interact and compound each other
- The world needs to improve food production, distribution & consumption, but not by enlarging the agricultural footprint
- Farming systems will be key determinants of human quality of life
- There is no ‘magic bullet’, but some key elements of farming system design
- Farming systems must be nested within much better integrated approaches to food, water and energy than we’ve ever tried before
- This poses major challenges for farming systems policy, research, extension, education and human resources

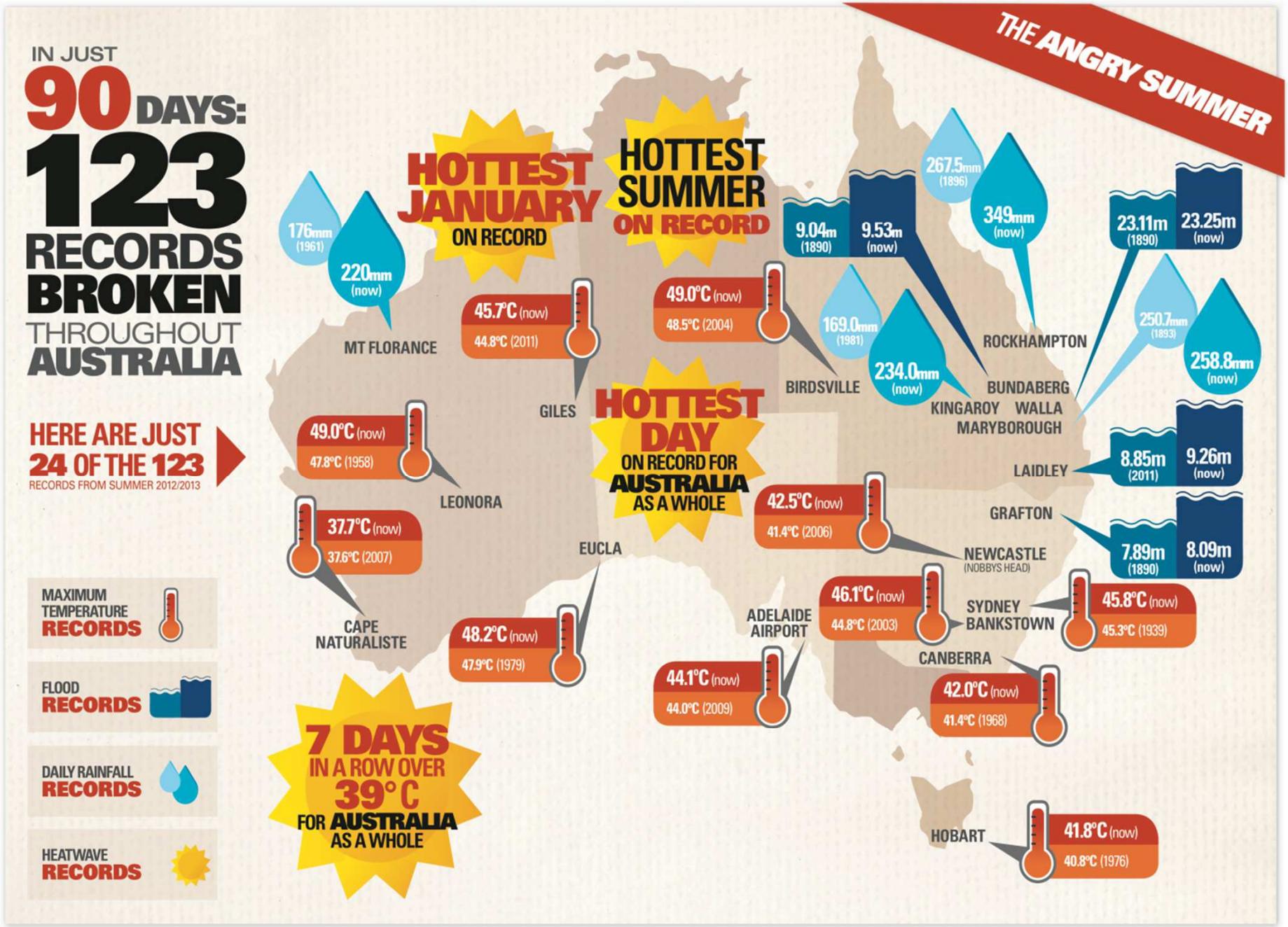
The climate is changing

Climate Change 2014: Impacts, Adaptation, and Vulnerability





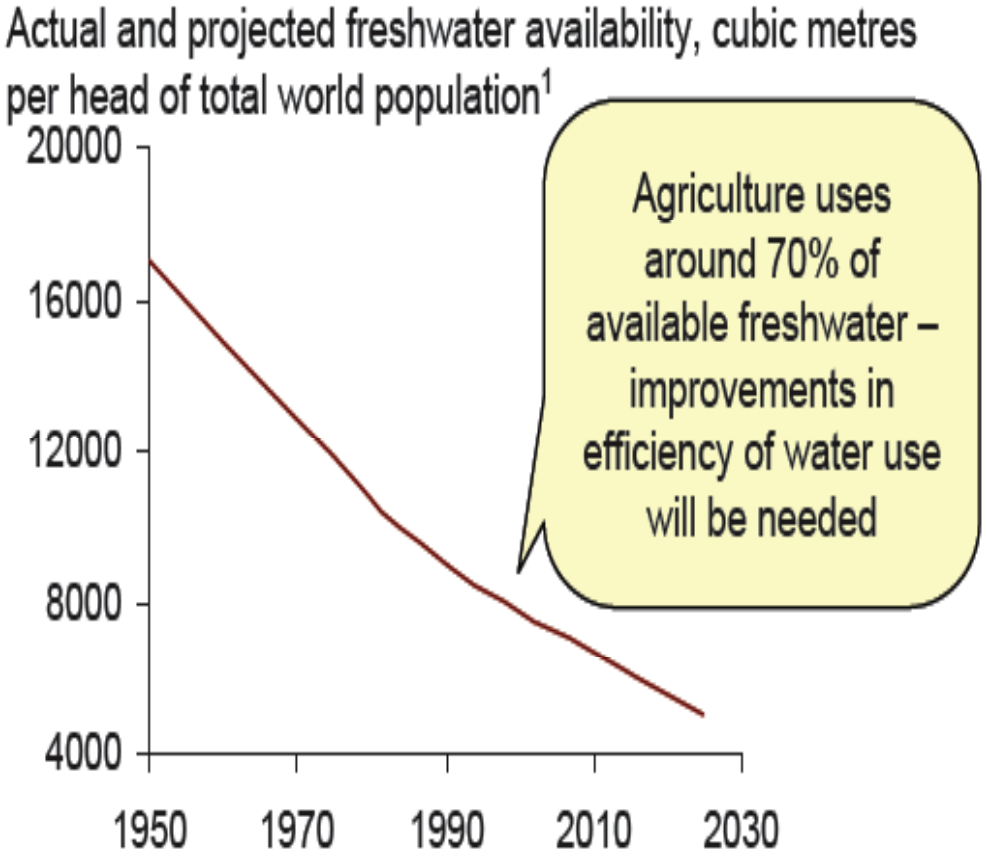
http://ipcc-wg2.gov/AR5/report/



DATA SOURCES: BoM. (2013a). *Special Climate Statement 43 – extreme heat in January 2013*; DATA SOURCE: BoM. (2013b). *Special Climate Statement 44 – extreme rainfall and flooding in coastal Queensland and New South Wales.*

The Mary River, Northern Australia
floodplains affected by rising sea levels

Water availability per capita is declining



- Each calorie takes one litre of water to produce, on average
- In terms of water resources, all the world's major irrigated food producing basins are effectively 'closed' or already over-committed

IWMI Comprehensive Assessment of Water Management In Agriculture
http://www.iwmi.cgiar.org/assessment/

Land & soil

- **FAO assessed trends in land condition** (measured by Net Primary Productivity) **from 1981-2004**
- **Land degradation is increasing in severity and extent:**
  - >20 percent of all cultivated areas
    >30 percent of forests
    >10 percent of grasslands
- 1.5 billion people depend directly on land that is degrading
- **Land degradation is cumulative.**
  - Limited overlap between 24% of the land surface identified as degraded now and the 15% classified in 1991, because NPP has flatlined near zero in degraded areas

http://www.fao.org/newsroom/en/news/2008/1000874/index.html

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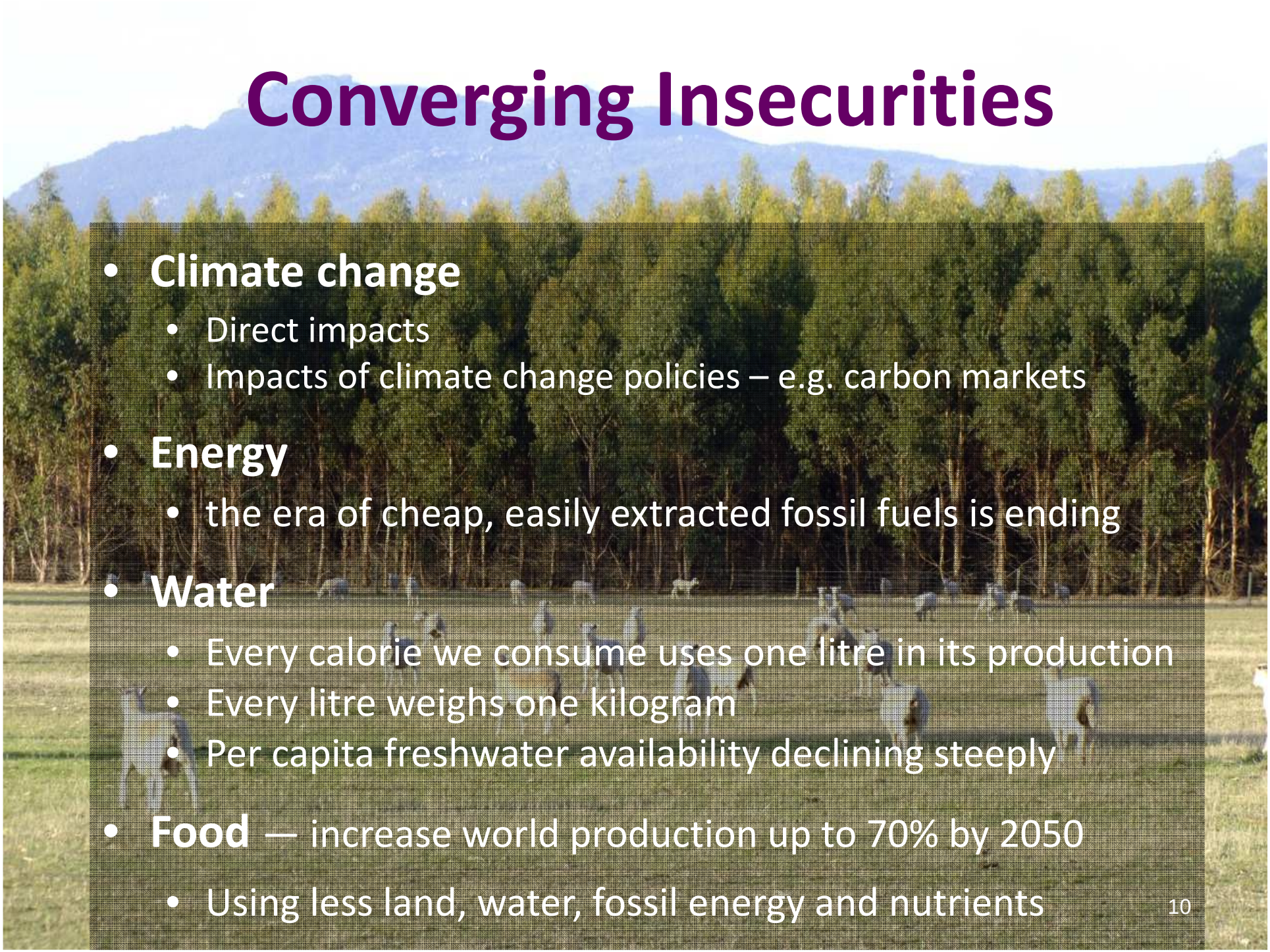
The world needs more food

- The world needs to increase food production by **up to** 70% by 2050, & improve distribution — **diet is the key driver**
- We have done this in the past, mainly through clearing, cultivating and irrigating more land, + intensification and better varieties
- Climate change and oil depletion is narrowing those options, with limits to water, land, energy & nutrients. We need to grow food:
  - Using less land, water & energy and emitting less carbon
  - Using nutrients more efficiently
  - Improving nutrition, distribution, animal welfare
  - Looking after rural landscapes, biodiversity, amenity & communities
- **We also need to look at demand-side solutions**

Converging Insecurities

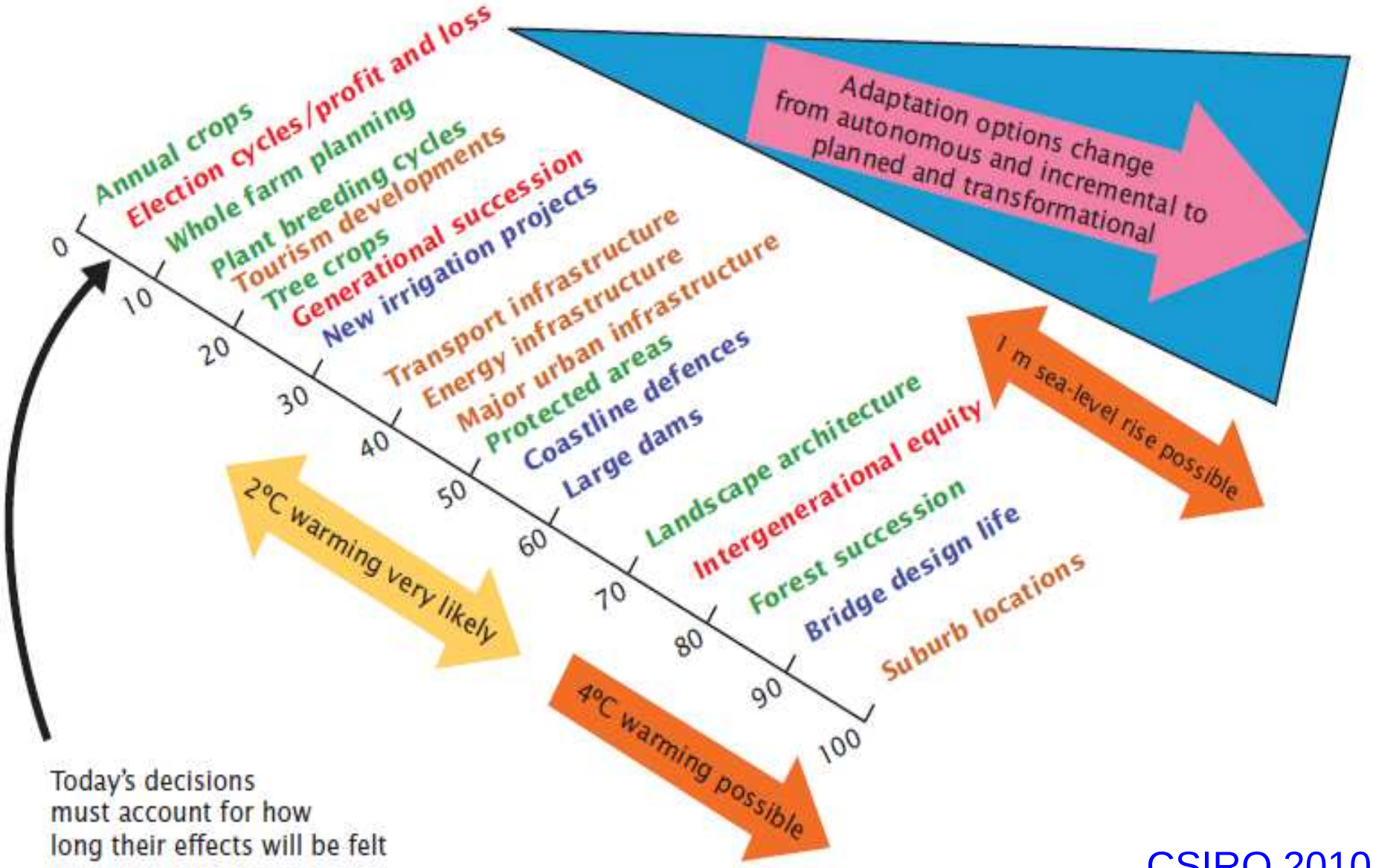


- **Climate change**
  - Direct impacts
  - Impacts of climate change policies – e.g. carbon markets
- **Energy**
  - the era of cheap, easily extracted fossil fuels is ending
- **Water**
  - Every calorie we consume uses one litre in its production
  - Every litre weighs one kilogram
  - Per capita freshwater availability declining steeply
- **Food** — increase world production up to 70% by 2050
  - Using less land, water, fossil energy and nutrients

Profound technical challenges

1. To decouple economic growth from carbon emissions
2. To adapt to an increasingly difficult climate
3. To increase water productivity
   - decoupling the 1 litre per calorie relationship
4. To increase energy productivity
   - more food energy out per unit of energy in
   - while shifting from fossil fuels to renewable energy
5. To develop more sustainable food systems
   - in competition for land and water with the resources & energy sectors
   - while conserving biodiversity and
   - improving landscape amenity, soil health, animal welfare & human health
6. **TO DO ALL OF THE ABOVE SIMULTANEOUSLY!**
   - **improving sustainability and resilience**

Scales for response to climate change



CSIRO 2010

We need a third agricultural revolution — policy elements

Set high level goals for agriculture by 2030: e.g.

- doubling water, energy and nutrient productivity
- becoming a net carbon sink
- becoming a net energy producer (from renewables)

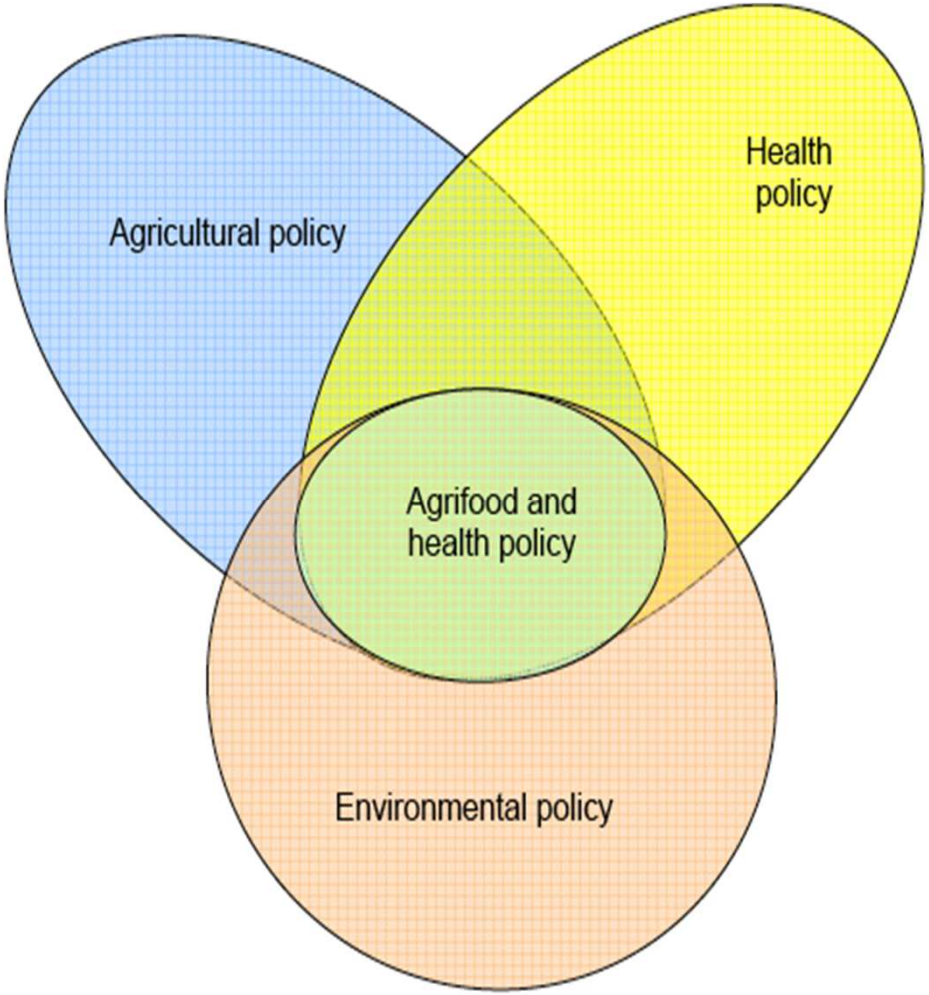
Reposition agriculture as integral to the food, health, energy and water systems

Re-engage urban populations with ag and food systems

Rebrand agriculture as sexy, 'new economy'

All of the above will require a new breed of professionals

Policy
- time for new alliances & perspectives



- Healthy farms, healthy landscapes, healthy food, healthy people & healthy communities are interconnected
- We are not used to seeing farming systems connected to health systems
- This needs to change
  - in research, in assembling the evidence base, in policy and in leadership

Source: Tyrchniewicz and McDonald (2007)

We need a third agricultural revolution — technical elements

- Closed loop farming systems (water, energy, nutrients, carbon)
- Smart metering, sensing, telemetry, robotics, guidance
-
-
-
-

2nd Generation lignocellulosic biofuels

Developing an efficient supply chain for woody energy crops via mallee eucalypts integrated into wheatbelt farming systems

Trees harvested on a 5 year rotation, coppice regeneration, integrated processing plant can produce electricity, transport fuels, activated charcoal and essential oils (natural solvents)

Biocarbon/energy integrated into farming systems vs replacing them

- Mallees occupy 8-10% of farm area
- Minimal food production trade-off
- 48 x more energetically efficient than corn ethanol
- 300-550mm rainfall zone
  — minimal water yield loss and low opportunity cost
- Co-benefits for salinity, erosion control and biodiversity

We need a third agricultural revolution — technical elements

- Closed loop farming systems (water, energy, nutrients, carbon)
- Smart metering, sensing, telemetry, robotics, guidance
- Better understanding of soil carbon & microbial activity
- Radically reducing waste in all parts of the food chain
- Integrated production of food, fibre, energy and carbon offsets
- Farming systems producing renewable bioenergy (2nd generation)
  - **IDEA: a 'beyond oil' tractor drivetrain?**
- **Urban food production, recycling urban waste water & nutrients**


Practically
DRY
FARMED
FOR
FLAVOR
Santa Barbara
FARMERS MARKET
1ST PLACE
BEST
HEIRLOOM TOMATOES
ORGANIC
Heirloom
Tomatoes
$3.00/lb

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- Integrated production of food, fibre, energy and carbon offsets
- Farming systems producing renewable bioenergy (2nd generation)
- Urban food production, recycling urban waste water & nutrients
- **Detailed product specification and labelling**
- **More accountable agriculture generating better returns to farmers**

Sustainable Intensification

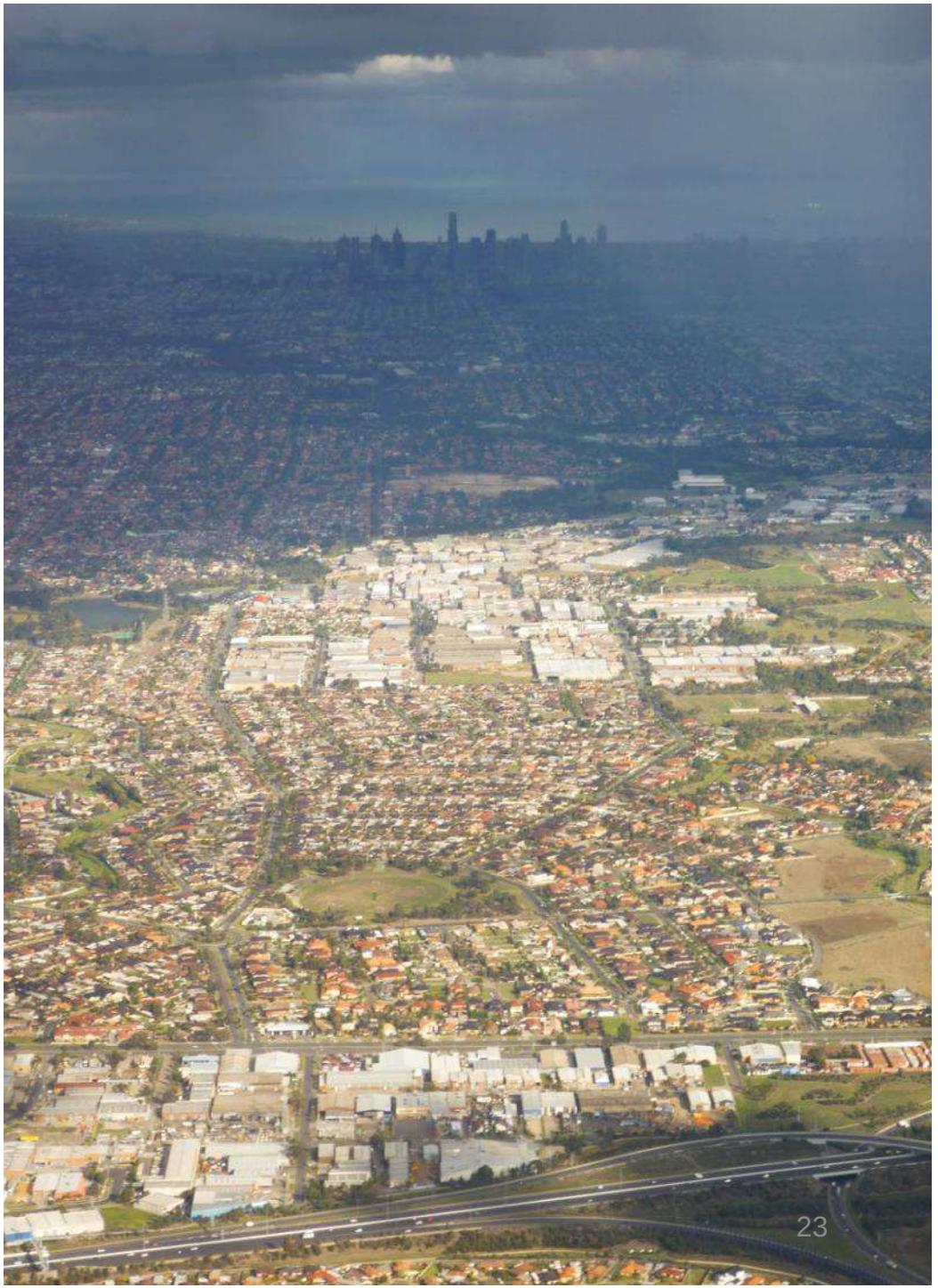
- A valid objective, but we can't intensify everywhere
- We can manage some landscapes more intensively, but others need to be managed more extensively, and/or for other goods and services
- Need clear criteria on where to intensify:
  - e.g. soils, water, infrastructure, proximity to markets
- Within the context of regional land use and watershed management plans

Planning landscapes & infrastructure

- **How can this all 'fit' at a landscape and regional scale?**
- **The landscape needs to be re-plumbed, re-wired and re-clothed**
- **We need new planning approaches that:**
  - are robust under various climate change & demographic scenarios
  - improve resilience (e.g. flood performance & recovery, ensure habitat connectivity & buffering, protect refugia, don't crowd coastlines)
  - reduce greenhouse gas emissions (energy, transport, food)
  - rethink transport networks (greener, tougher, smarter)
  - safeguard productive soil and allow for intensification where appropriate
  - facilitate recycling of water, nutrients and energy
- ✸ **Leading, educating and bringing the community on board**

Regions around cities are fertile ground for **farming systems innovation**

- Cities suck in water, energy and nutrients from their hinterland
- Much of which becomes waste
- Replumbing, rewiring and recladding is required on a massive scale
- Cities also attract people, and are part of the sustainability solution, not the problem
- Agriculture should see cities as allies and opportunities



Sustainability and Resilience

- Complementary concepts
- Sustainability remains relevant and desirable
  - Living within our means
  - Thinking long term (inter-generational equity)
  - Distinguishing between depletable and renewable resources
  - Avoiding or limiting actions that degrade, pollute, over-use or compromise ecosystem function
- **BUT:** Sustainability is less instructive around:
  - Social and cultural dimensions
  - Operating in contexts with inherent variability

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Resilience

– the cool new kid in town?

- The capacity of a system to absorb shocks, reorganise and retain the same functions
  - As resilience declines, it takes a progressively smaller shock to push a system across a threshold
- Adds value in explicitly embracing change and variability
- Introduces the useful concept of thresholds or tipping points
- Explicitly embraces scale
  - Resilience at a given scale requires an understanding of at least one scale up & one scale down

Building resilience

Factors affecting resilience*

- Diversity: biological, economic (e.g. energy sources), social
- Modularity (connectedness, engagement)
- Tightness of feedbacks
- Openness – immigration, inflows, outflows
- Reserves and other reservoirs (e.g. seedbanks, nutrient pools, soil moisture, memory, knowledge, young people)
- Overlapping institutions
- Polycentric governance & leadership
- **Useful diagnostics for farming systems analysis?**

* Source: Brian Walker http://www.australia21.org.au/buildingAustraliasResilience-papers.htm

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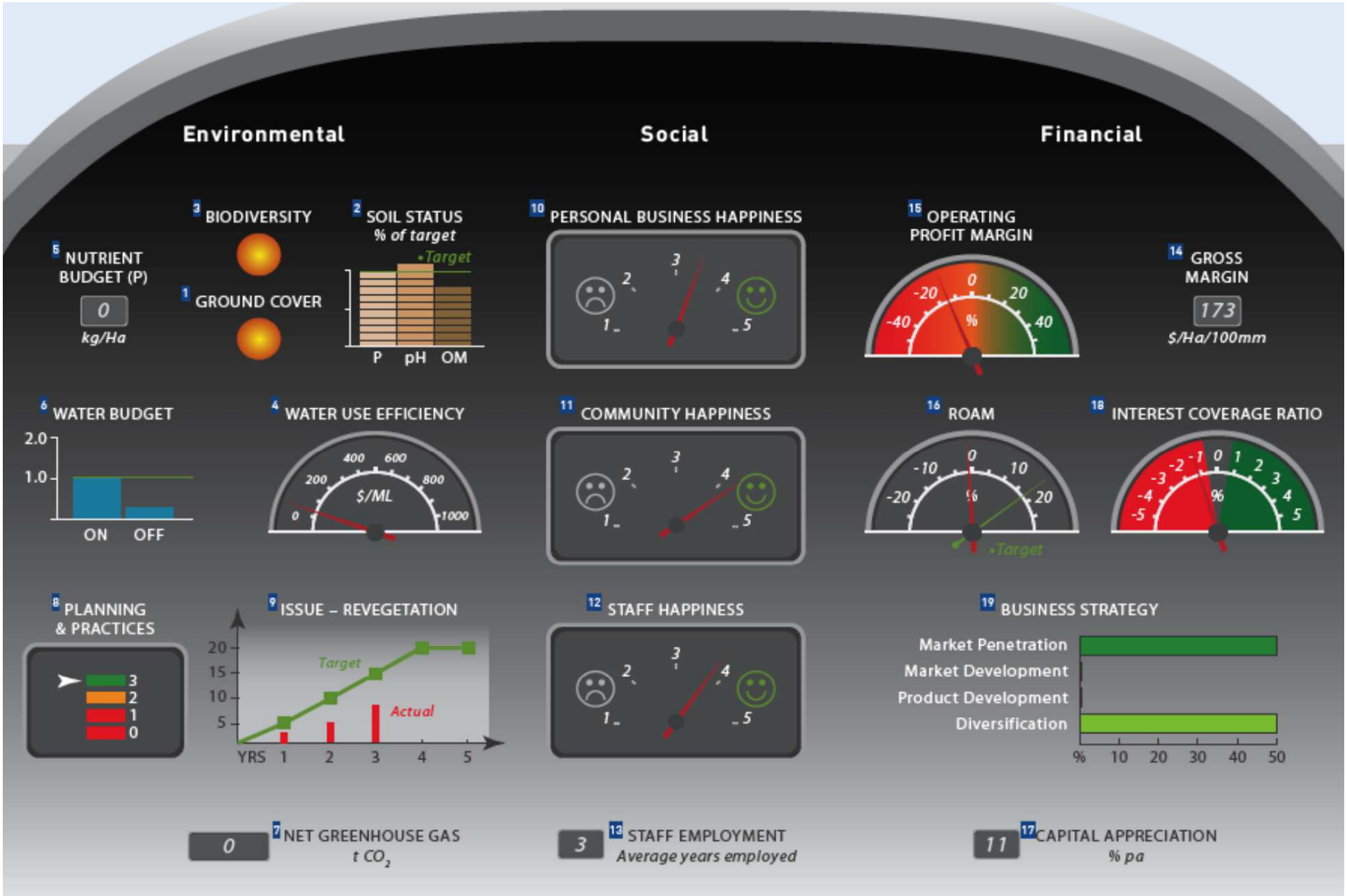
The integration imperative

- **Managing whole landscapes**
  - "where nature meets culture" (Simon Schama)
  - beyond 'ecological apartheid'
  - landscapes are socially constructed
  - Improving farming systems = people management
  - engage values, perceptions, aspirations, behaviour
- **Integration**
  - across issues — e.g climate, energy, water, food, biodiversity
  - across scales — industries, agencies, governments, timeframes
  - across the triple helix — landscapes, lifestyles & livelihoods

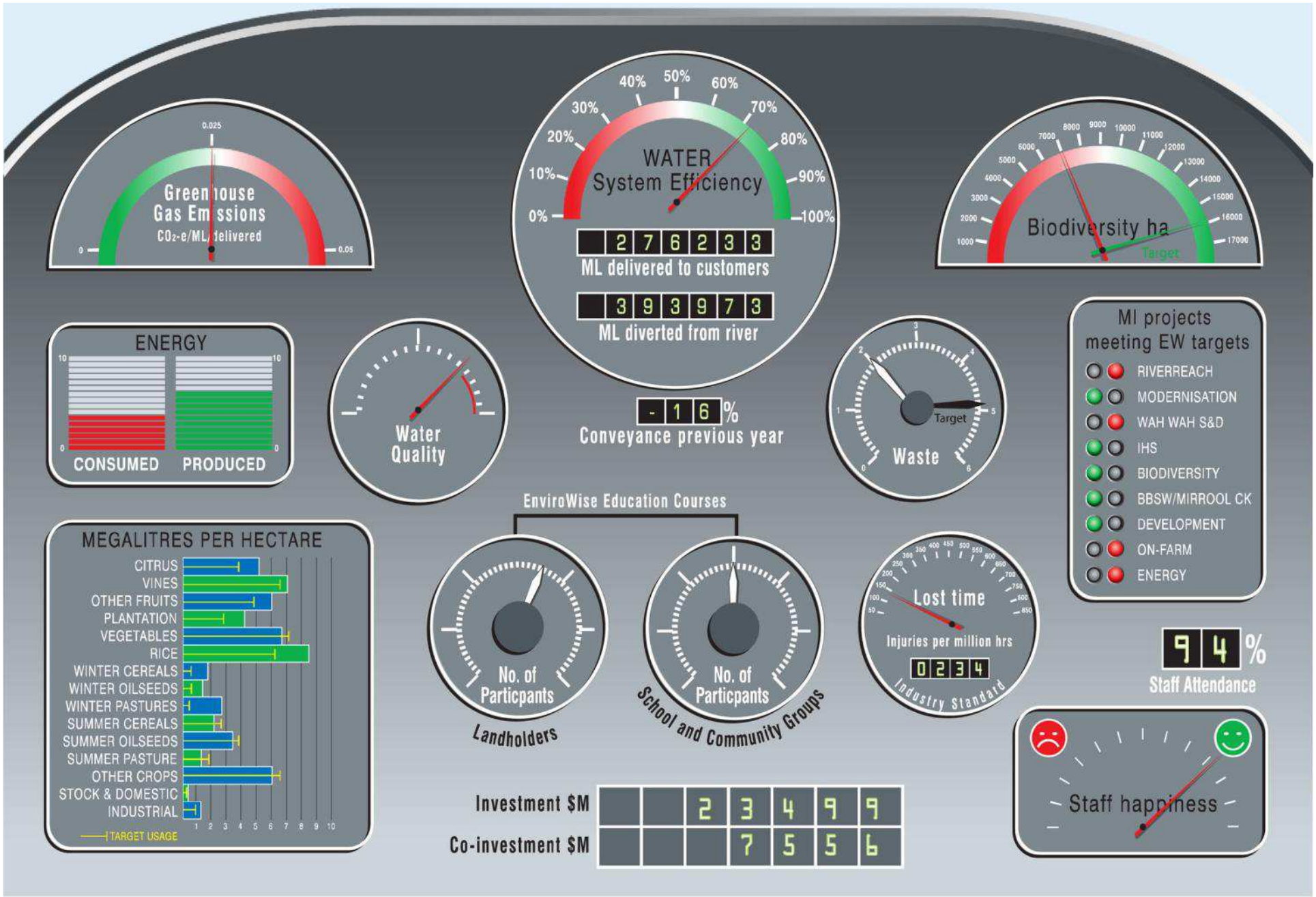
Farm Sustainability dashboard



Murrumbidgee Irrigation System

- MI is a farmer-owned bulk water distributor and seller
  - $1B GVAP, and $7B value-add of food, wine and fibre production
- 100 year old irrigation & drainage network being modernised
  - Replacing ‘leaky’, gravity-fed open earthen channels
  - Piping and pressurisation will treble energy consumption
  - And hence greenhouse gas emissions
- Options:
  - Biomass energy plant - 0.5m tonnes p.a. of ag & food process waste
  - Solar thermal power plant on linear easements (C price-dependent)
  - Conversion to biodiesel
  - Carbon offsets through large scale tree planting
- **Turning a water company into a water, energy & carbon company**
  - Liberating opportunities through a **more integrated approach**

Irrigation System sustainability dashboard



Governance

"How society shares power, benefit and risk"

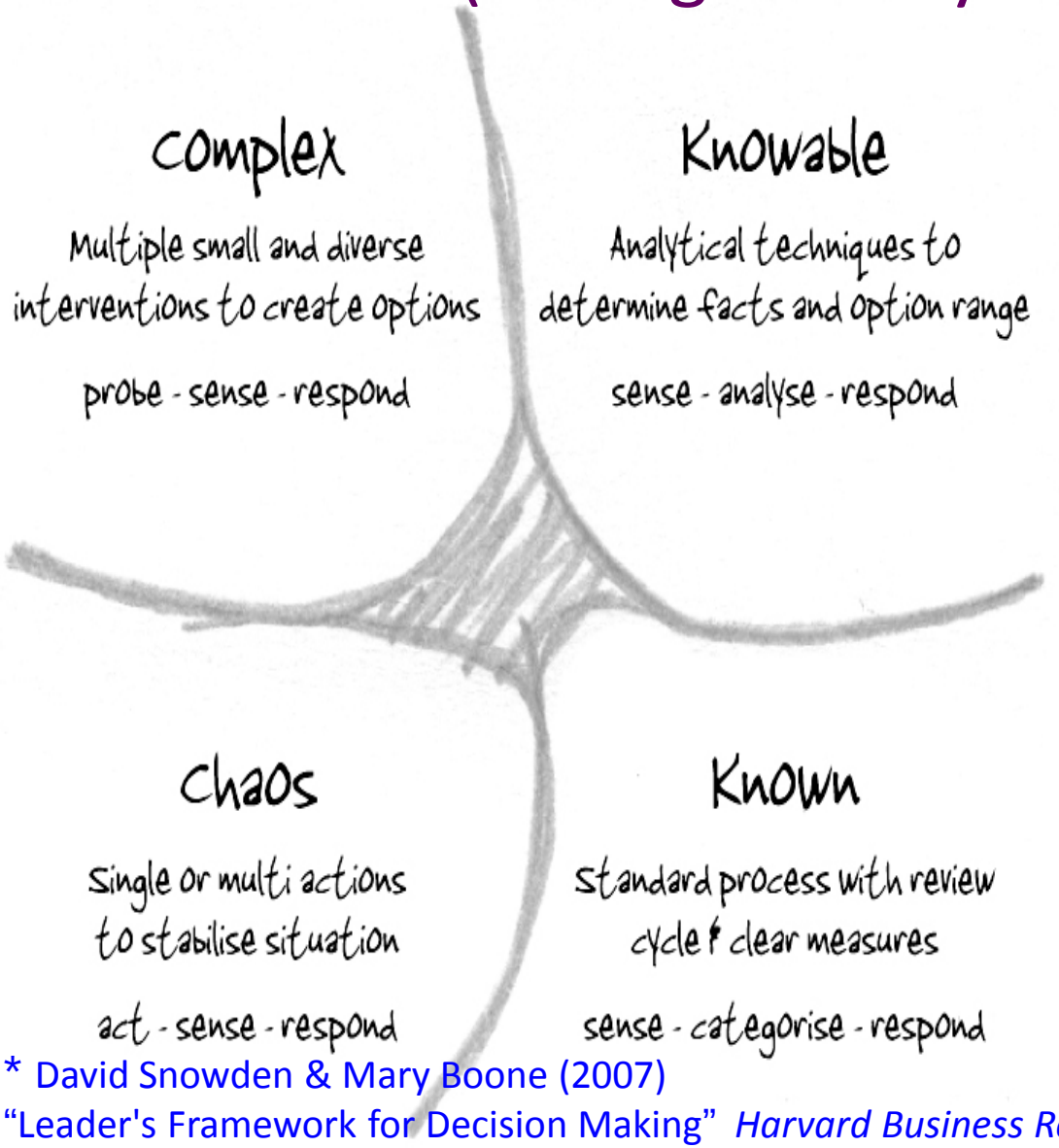
- Vertical and horizontal distribution of benefits, costs and risks, in space and time
- Need to honour the past and respect local values, without being tied by them
- Lowest common denominator consensus rarely makes big advances
- Local institutions are essential, but not sufficient
- As everything becomes more interconnected, better governance becomes more vital, and more difficult

Our agricultural innovation system is so last Century…

- **Big challenges for agriculture:** climate, water, food, energy, land use planning, biosecurity, social license
- **All cross-sectoral, with strong public-good dimensions**
- Yet our innovation architecture is overwhelmingly commodity-based, production-focused, farm-based, agri-centric, with at best modest incentives for public-good, system-level innovation
- Innovation system architecture for the 21st Century needs a more integrated approach to research, technology development, extension, education, marketing and governance

Implications for knowledge needs

(through the Cynefin* lens)



- Climate change spans all of these domains
- If temp increase > 2ºC, then disorder & chaos will dominate
- The challenge is to handle the necessary range of responses
  - to work across these domains
  - to develop system-wide perspectives
  - & the associated knowledge systems and learning strategies to enable and support systemic analysis and response

* David Snowden & Mary Boone (2007)
"Leader's Framework for Decision Making" *Harvard Business Review*

Farming Systems Research Priorities

We need a bigger share of Research spend on:

blue sky

- e.g. energy, closing waste loops, ICT, public good GM, web-based societal learning systems

Metrics

- e.g. C, H2O, energy, nutrients for accountable agriculture

Farming system risk and resilience

- biosecurity
- extreme events
- energy shocks
- mass migration of people

cross-sectoral

- agriculture/health system links
- urban and peri-urban agriculture (shorter supply chains)
- regional planning (spatial optimisation food, water, carbon, energy)
- social acceptance of agriculture

Extension needs a fundamental rethink

- The quickest way to double productivity is to narrow the gap between the average & the best farmers
  - and to shorten the long tail in most sectors
- Traditionally we've done this through extension and education
  - But many governments have cut extension
- Private sector can sell products, but not set up for cross-industry, regional scale or public good extension (or newcomers to farming)
- **Web 2.0 and 3.0 a major opportunity** **complementing** face to face
- Extension (non-coercive, information-based intervention) is rarely used in an integrated way with other policy instruments (e.g. planning, regulatory, pricing, taxing, financing, property rights)

Rebranding Agriculture and Farming

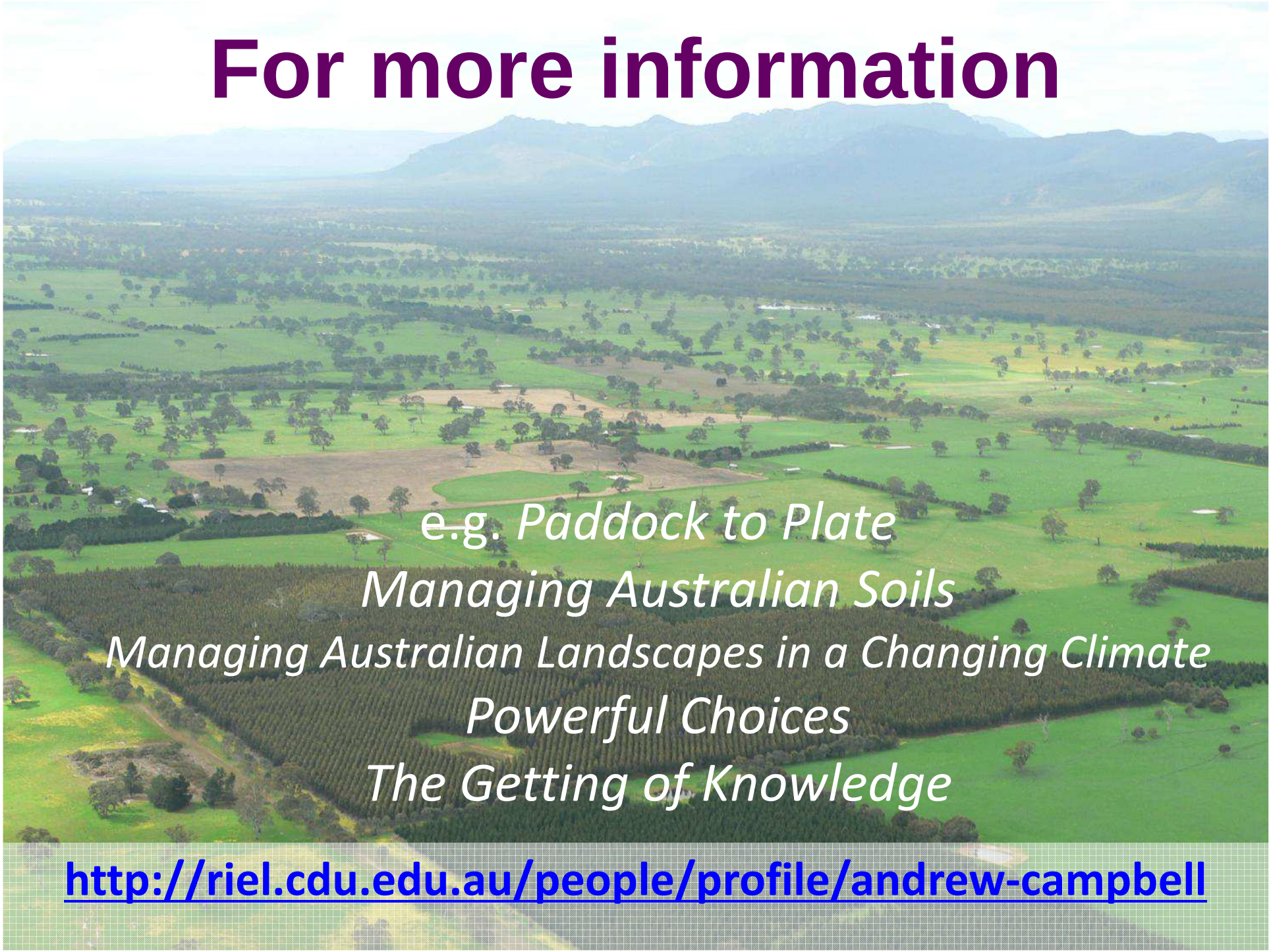
- Agriculture and Farming are tired and faded brands
  - negative connotations in terms of profitability, lifestyle, 'old economy', environmental damage and animal welfare
  - **often judged by worst practice**
- We have to re-think, re-tool, re-skill and re-brand
- Agriculture must be seen as core to the food system, the health system and the energy system
  - with a new story around human health, nutrition, carbon, water, energy, biodiversity and human survival
- **Make farming systems sexy & relevant**

In Summary

- Food, water, land, energy and health are interconnected
- Climate change intensifies interactions, trade-offs and risks
- Farming systems are central to the future of humanity
- Farming systems need to be nested within more integrated approaches to food, water, energy and human health
- Innovation is required across a broader canvas than the current institutional architecture is delivering
- Smarter Planning, R&D, Extension and Education are needed
- **This presents extraordinary challenges and opportunities for farming systems professionals, & professional bodies like IFSA**

GO FOR IT!

For more information



e.g. Paddock to Plate

Managing Australian Soils

Managing Australian Landscapes in a Changing Climate

Powerful Choices

The Getting of Knowledge

http://riel.cdu.edu.au/people/profile/andrew-campbell