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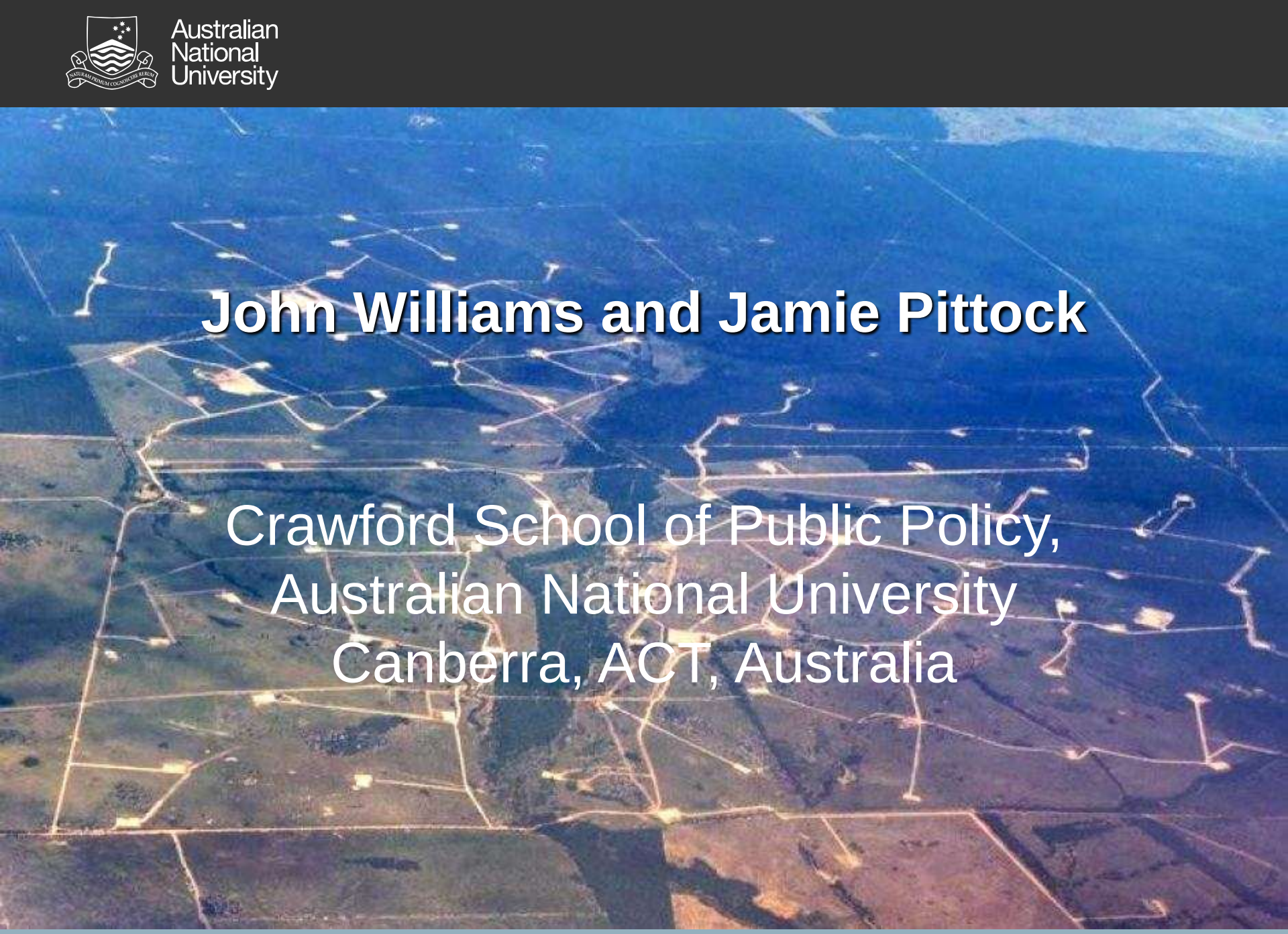
THE WATER, FOOD and ENERGY NEXUS

Lessons for the water-energy-food-climate tradeoffs with expansion of unconventional gas production in the US and Australia



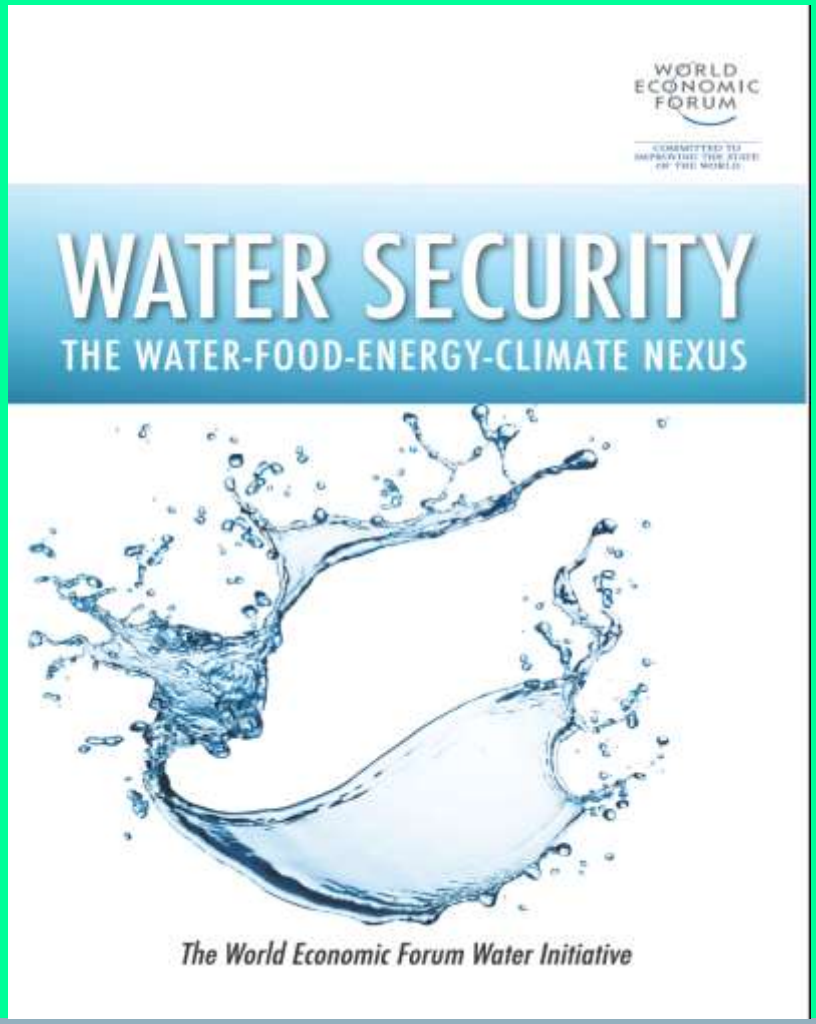
John Williams and Jamie Pittock

Crawford School of Public Policy,
Australian National University
Canberra, ACT, Australia

Water-Food-Energy-Climate NEXUS

In 1911, John Muir observed,

'When we try to pick out anything by itself in nature, we find it hitched to everything else in the Universe.'



Water-Food-Energy-Climate NEXUS

- **A century later, a gathering of the World Economic Forum discovered the same phenomenon. Four hundred top decision-makers listed the myriad looming threats to global stability, including famine, terrorism, inequality, disease, poverty, and climate change.**
- **Yet when we tried to address each diverse force, we found them all attached to one universal security risk: fresh water.**

MARGARET CATLEY-CARLSON, Patron, Global Water Partnership, 2008-2010
Chair of World Economic Forum Global Agenda Council on Water Security.

*"Water sits at the nexus of so many global issues… including **health, hunger and economic growth**. And sadly, water scarcity takes its greatest toll on **society's least fortunate**.*
I am absolutely convinced that the only way to measurably and sustainably improve this dire situation is through broad-scale collaborative efforts between government, industry, academia and other stakeholders around the world."

INDRA NOOYI, Chairman and CEO of PepsiCo, Inc., Member of International Business Council, World Economic Forum1.

"In shaping our shared energy-water-climate future, the evolutionary contest between growth and finite-planet narratives is just as important as the dynamics of the natural world.

The future therefore depends upon the evolution of more subtle and resilient narratives about human-earth interactions, in which energy, water and climate are central.

The evolutionary fitness test for these narratives is to empower a transition to a society that lives within the means of a finite planet and improves global wellbeing at the same time."


© CSIRO Land and Water
Photography by Willem van Aken

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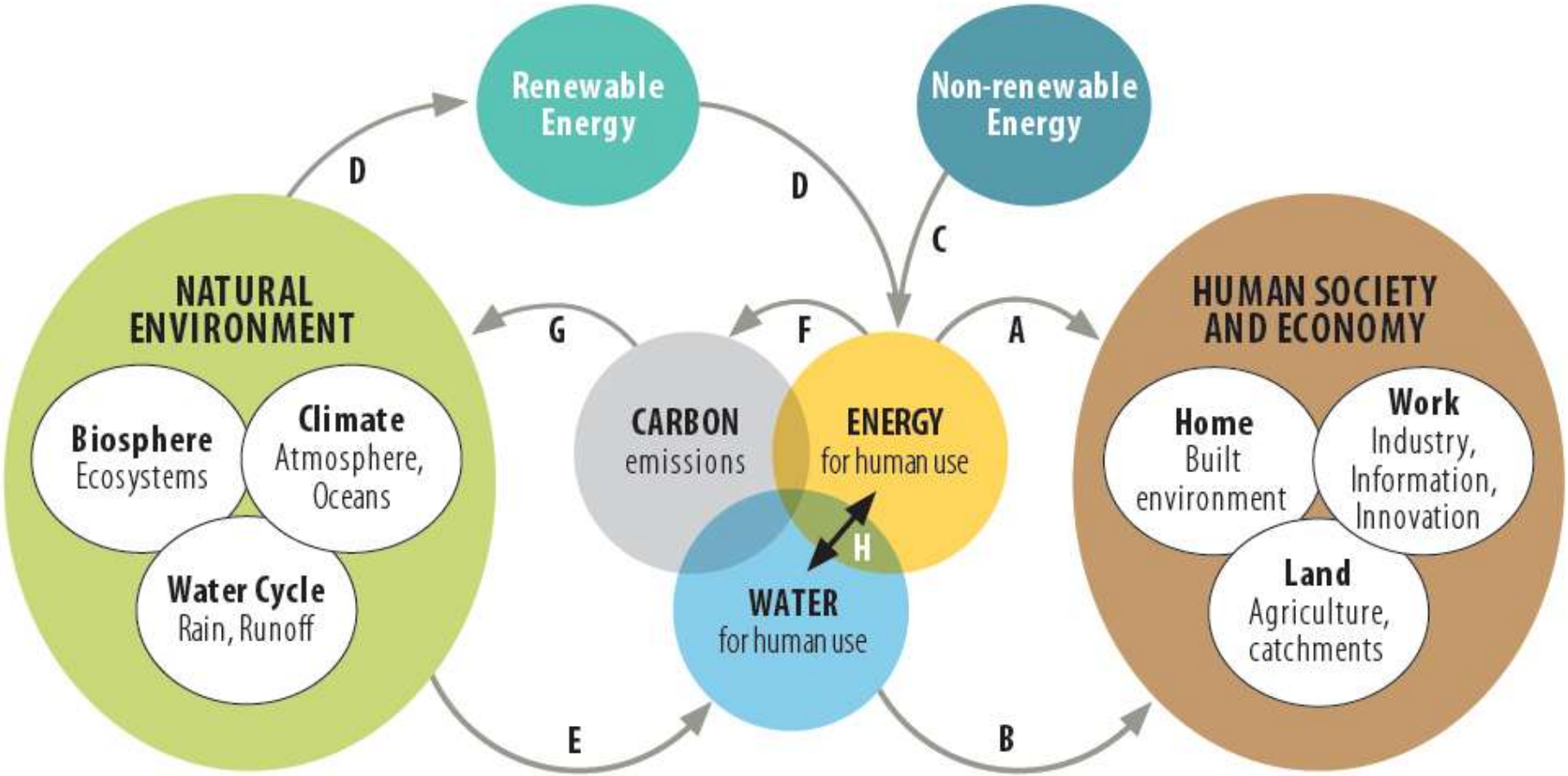
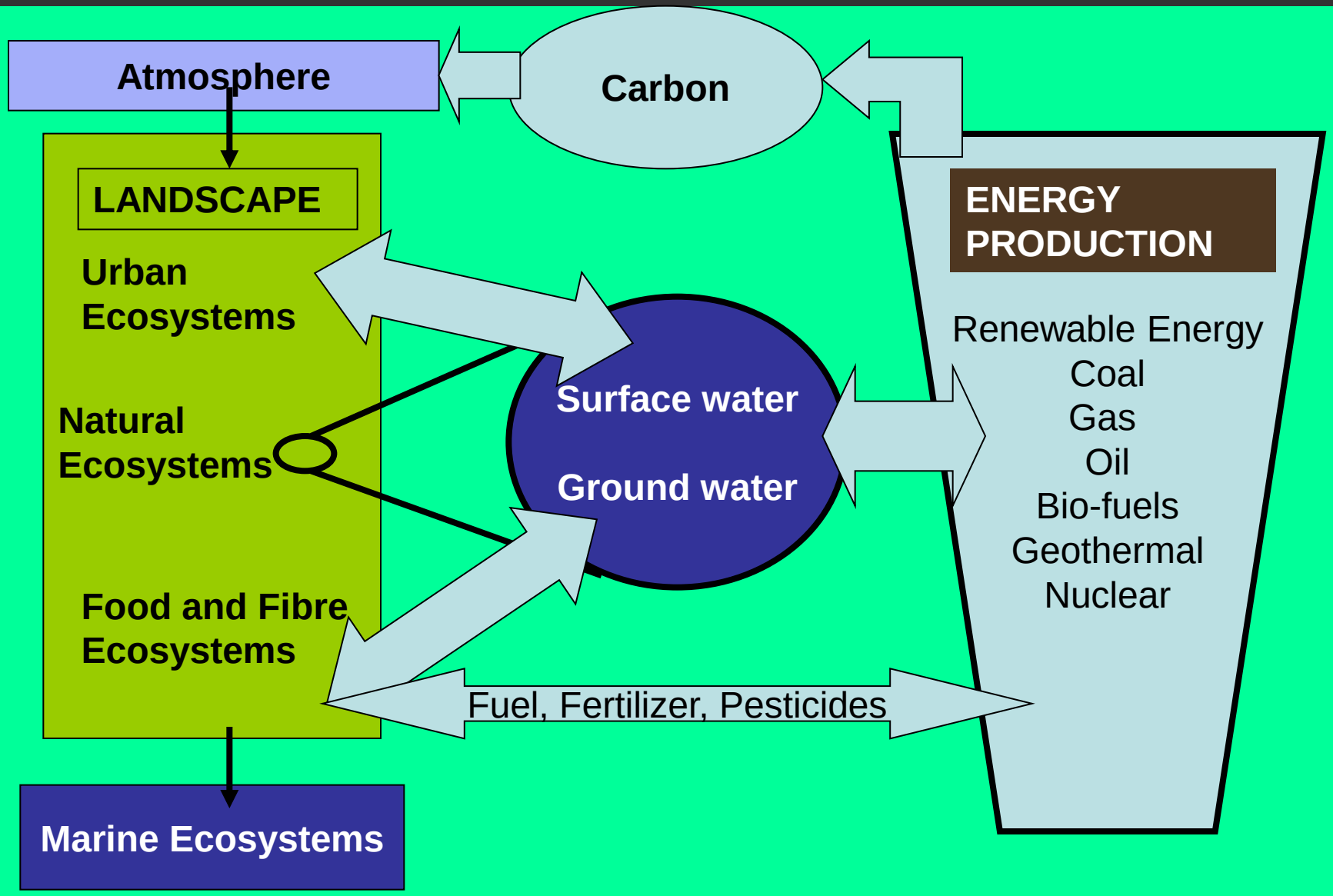
Water-Food-Energy-Climate NEXUS




Atmosphere
Carbon
LANDSCAPE
Urban Ecosystems
Natural Ecosystems
Food and Fibre Ecosystems
Surface water
Ground water
ENERGY PRODUCTION
Renewable Energy
Coal
Gas
Oil
Bio-fuels
Geothermal
Nuclear
Fuel, Fertilizer, Pesticides
Marine Ecosystems

Australian National University

Title: Australian clima nflicts and synergies

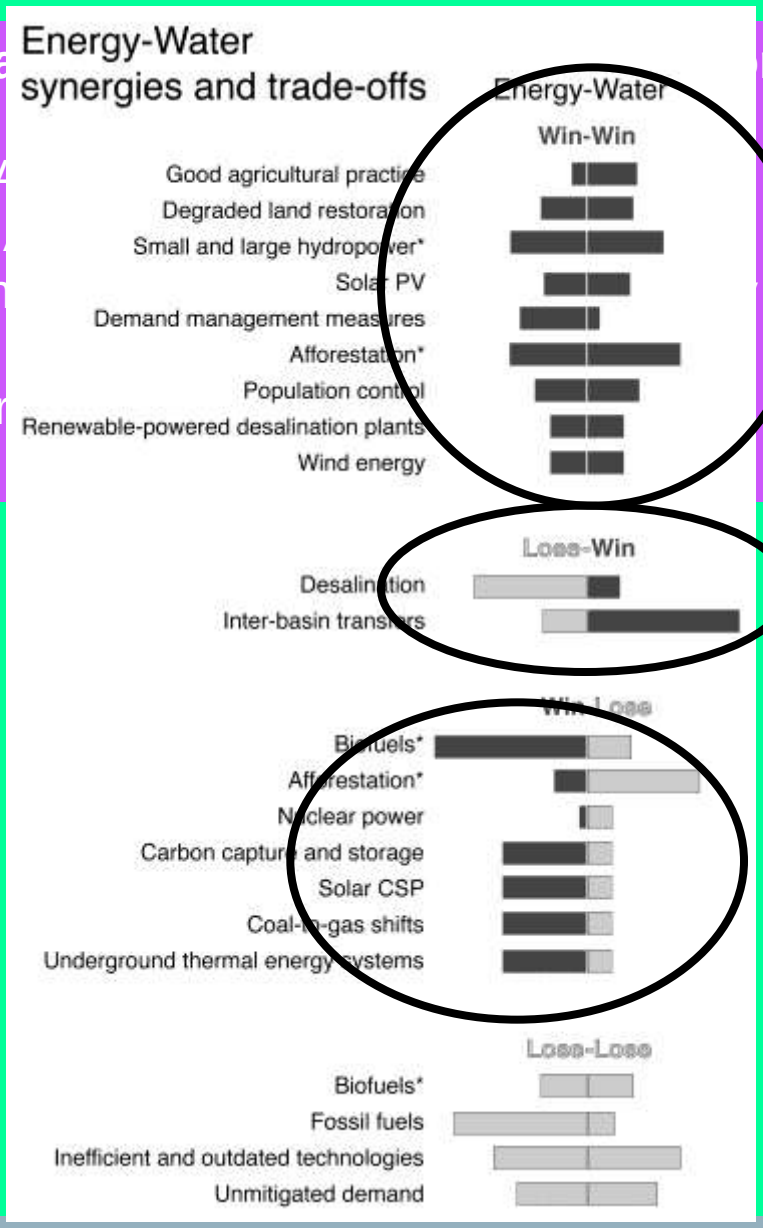
Authors

Dr Jamie Pittock, The A

Dr Karen Hussey, The

Mr Samuel McGlennon

In preparation for Austr



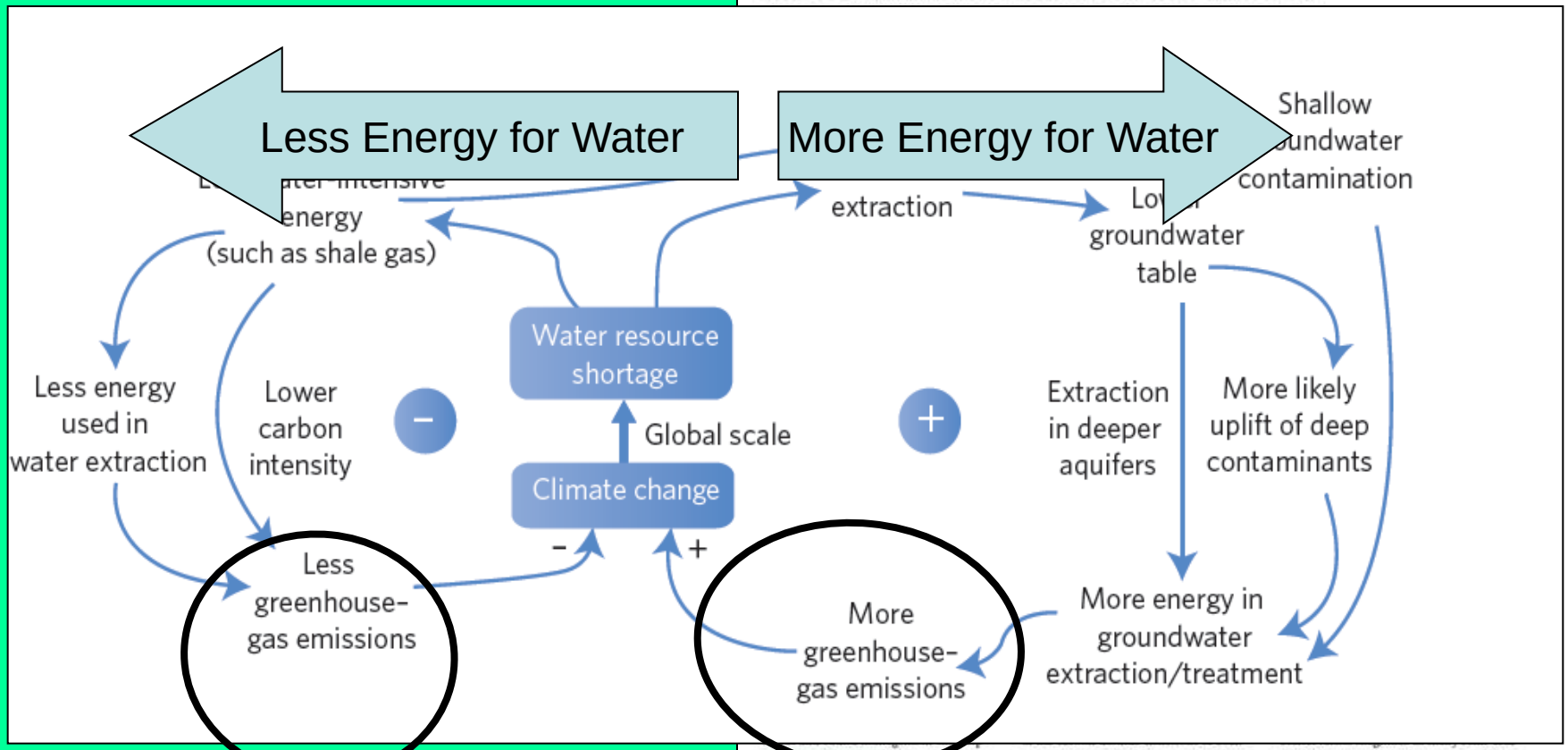
GAS ENERGY WATER NEXUS

COMMENTARY:

Shale gas can be a double-edged sword for climate change

Deyi Hou, Jian Luo and Abir Al-Tabbaa

Shale gas can be a powerful tool in combating climate change. However, its exploitation may also lead to undesired environmental effects that can conversely worsen climate change.

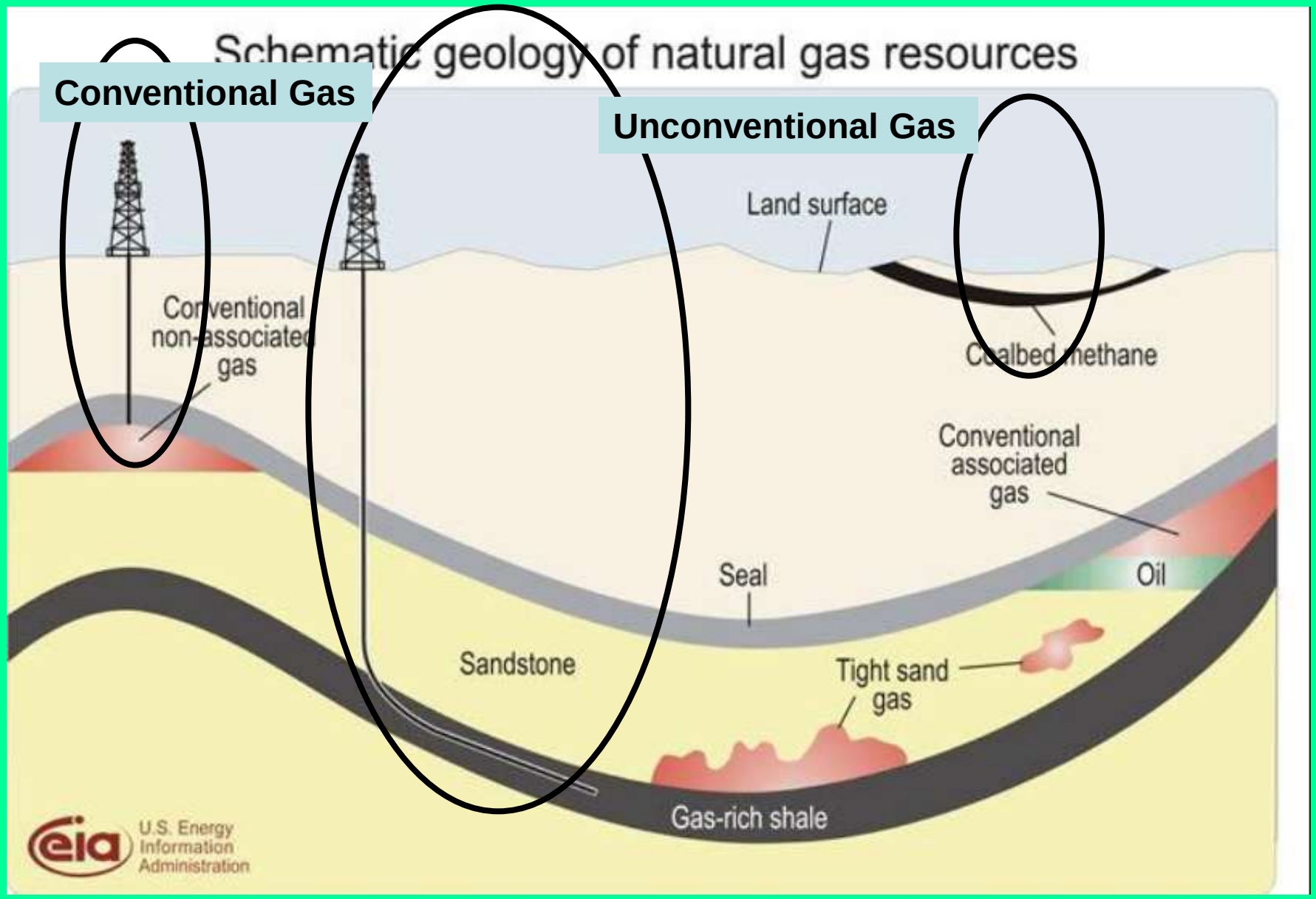


ENERGY- UNCONVENTIONAL GAS

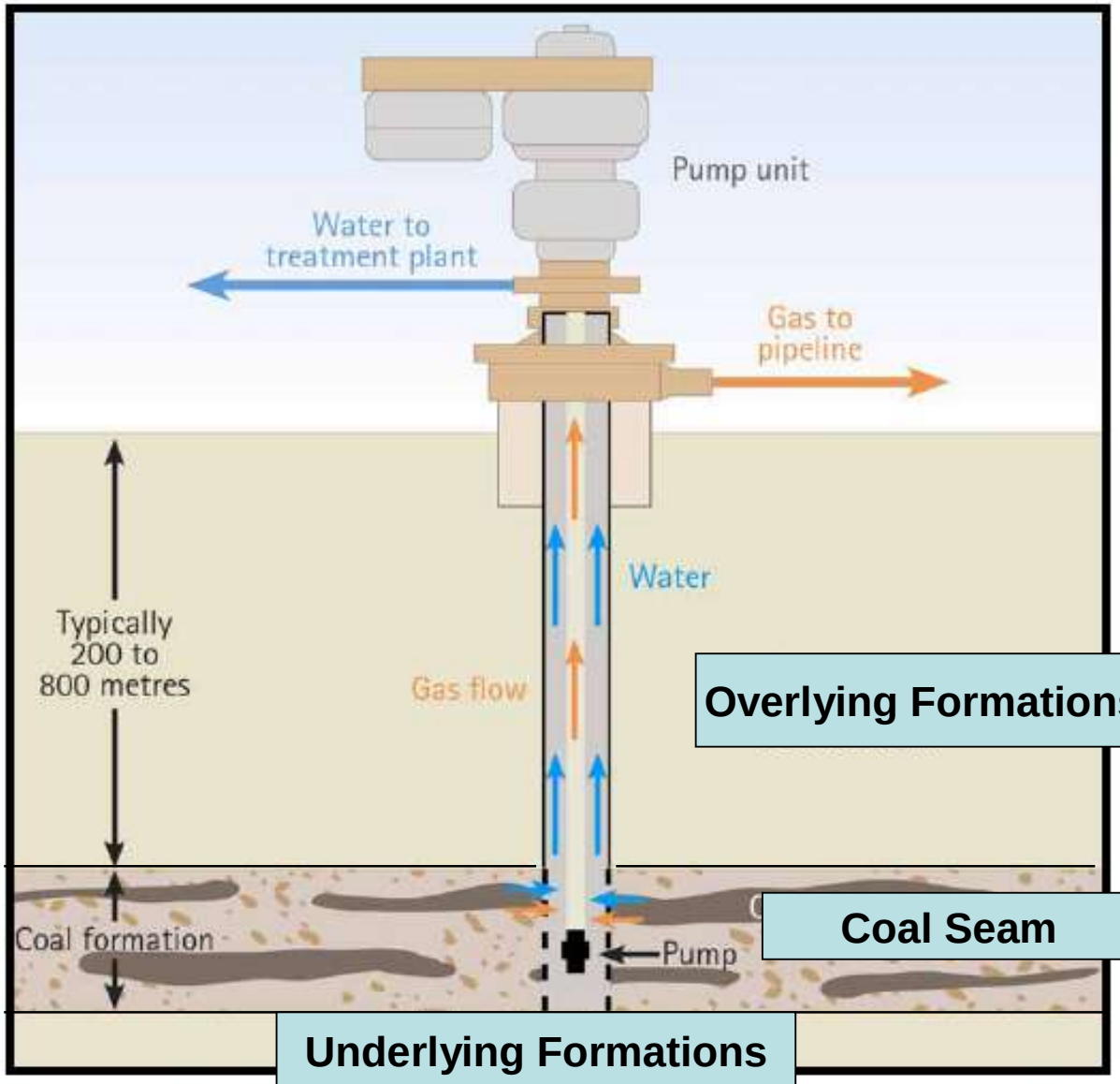
- **Unconventional Gas Production intersects strongly with natural resource management in Australia and USA**

In relation to gas operations, the following possible impacts need to be considered, separately and together

- effects on biodiversity via effects on habitat and vegetation;
- impacts on land used for agricultural and forestry production;
- effects on surface-water and groundwater resources;
- air emissions, including from processes related to gas production;
- social impacts, including effects on community amenity; and
- economic impacts, local, regional and national.


Schematic geology of natural gas resources
Conventional Gas
Unconventional Gas
Land surface
Conventional non-associated gas
Coalbed methane
Conventional associated gas
Seal
Oil
Sandstone
Tight sand gas
Gas-rich shale
U.S. Energy Information Administration

Simple Drill Well Layout for CSG Production



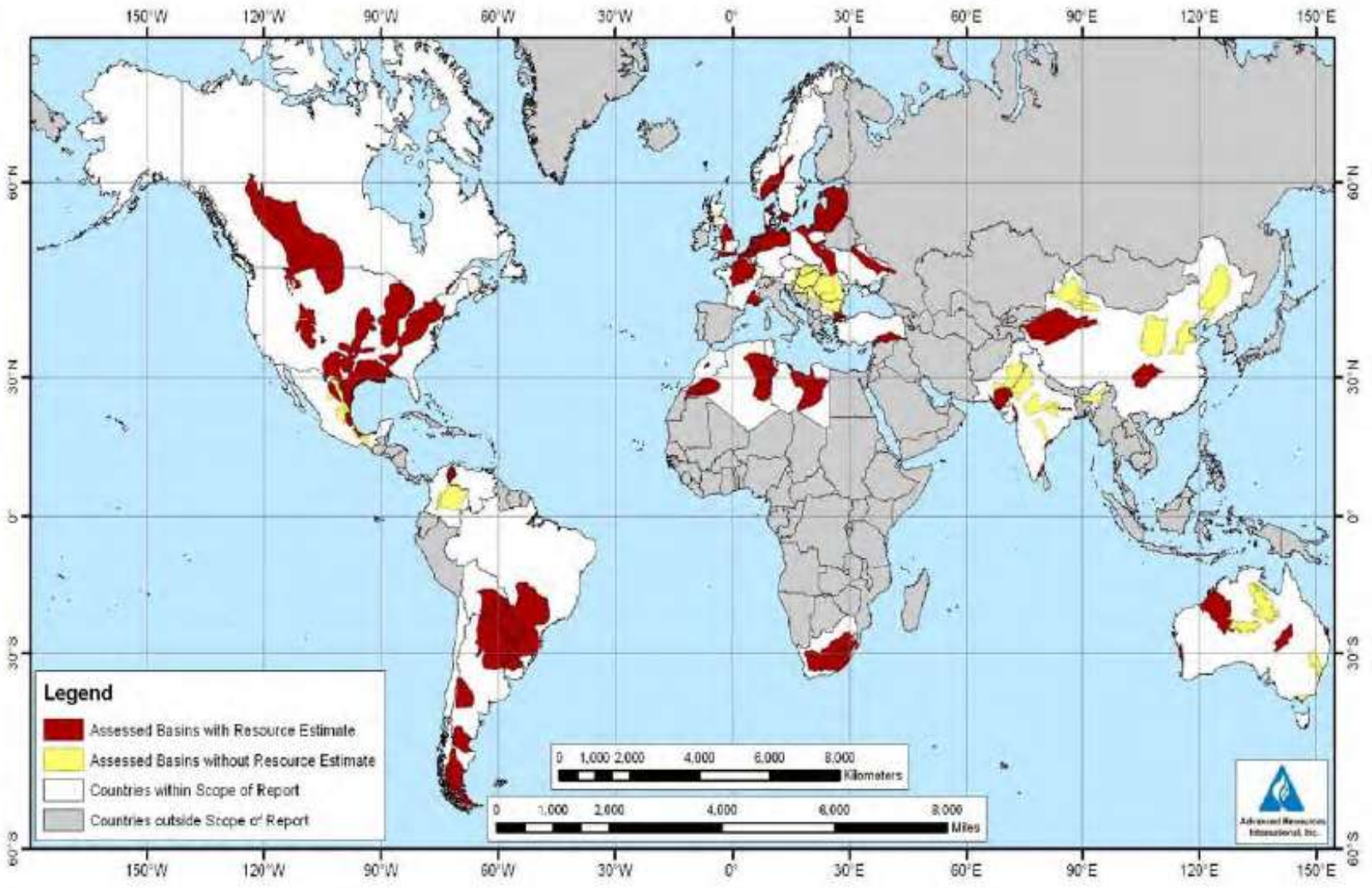
Global Shale Gas Resources

World Shale Gas Resources:
An Initial Assessment of 14 Regions
Outside the United States

Table 1-2. Risked Gas In-Place and Technically Recoverable Shale Gas Resources: Six Continents

Continent	Risked Gas In-Place (Tcf)	Risked Technically Recoverable (Tcf)
North America	3,856	1,069
South America	4,569	1,225
Europe	2,587	624
Africa	3,962	1,042
Asia	5,661	1,404
Australia	1,381	396
Total	22,016	5,760

Figure 1-1 Map of 48 Major Shale Basins in 32 Countries



Some Background…

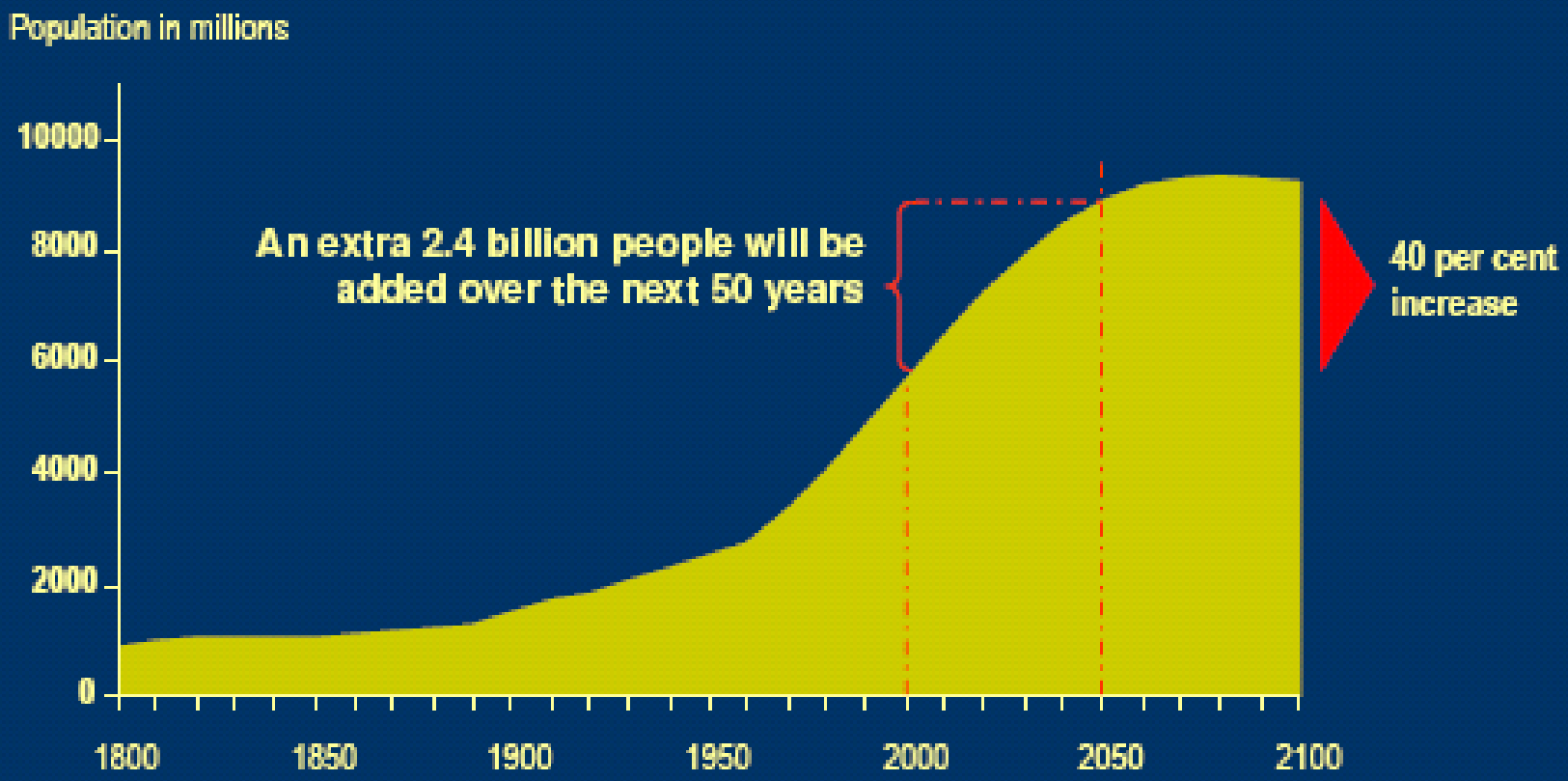
Biodiversity Loss

Figure 3.3: Part of the Pilliga Forest in the northern part of NSW.

FOOD….

[Source: ACIAR at www.aciar.com.au]

The dimension of the problem

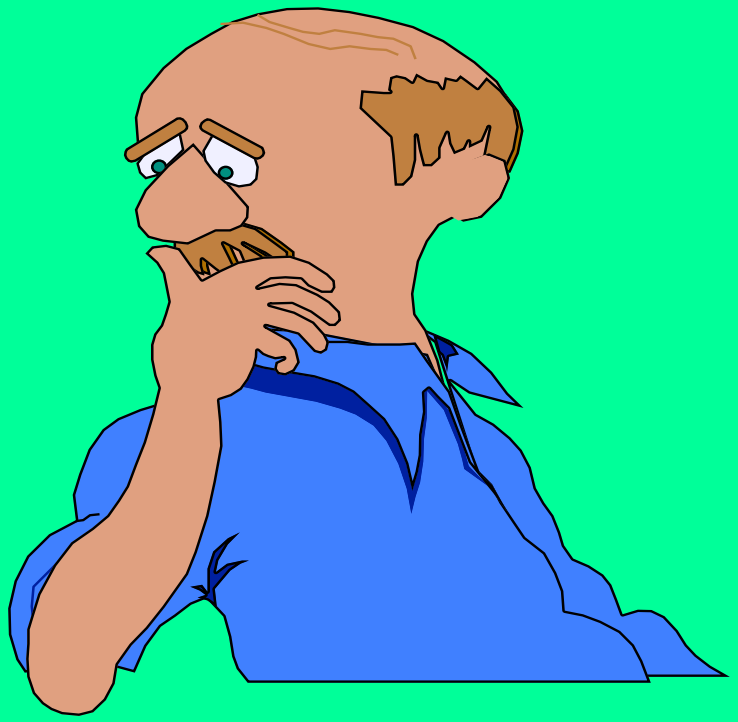


Data source: United Nations World Population Prospects Database: 2006 revision

Food or Environment

To avoid the emerging food crisis without further and increased damage to the environment…..

- at a time of rising costs for energy
- water shortages
- Specter of climate change



Is a challenge that appears to slipped from our gaze

Can Agriculture co-exist with gas?

Water Scarcity

Food production under irrigation faces increasing competition for water as more water will need to be returned to damaged rivers and estuaries and climate change threatens declining snow and rainfall in river catchments. Photo: John Williams

The following issues, with respect to unconventional gas production and water resources, must receive attention

- **water extraction to de-pressurise coal seams, and the impacts of subsequent water pressure changes on water movement to and from freshwater aquifers located in other strata of the geological basin.**

- **replacement of the extracted water in coal seams once gas production has ceased. The water originally extracted is likely to have been disposed of or used, and must be replaced from sources rarely specified and by some redistribution mechanism within the geological stratigraphy.**

The following issues, with respect to unconventional gas production and water resources, must receive attention

- **disposal of the extracted water and salt and other chemical entities liberated from coal and other geological fabric during the dewatering process;**
- **the containment management and disposal of fraccing fluids. Management of fraccing fluids and any resultant contamination is a high profile issue with the general public.**

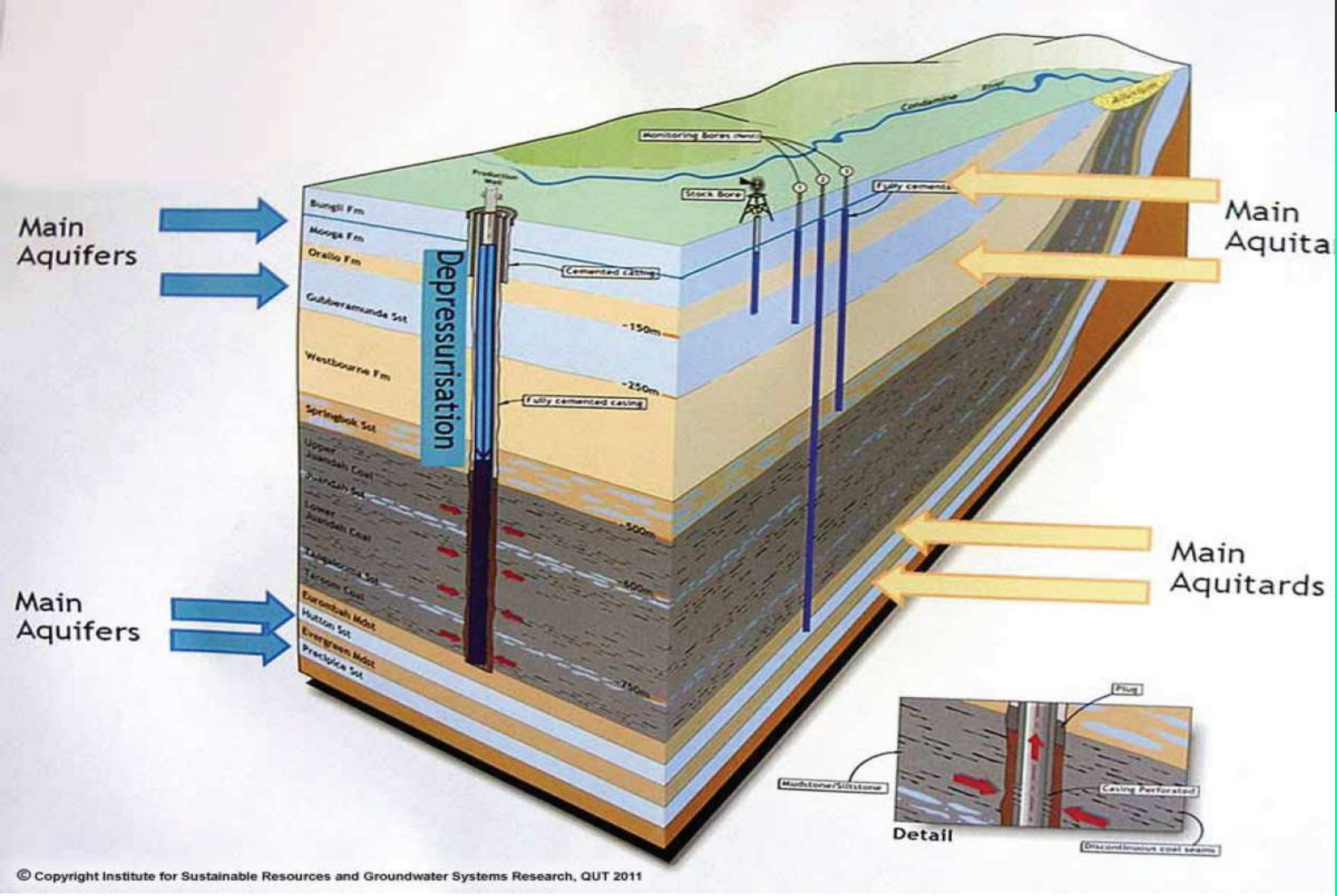
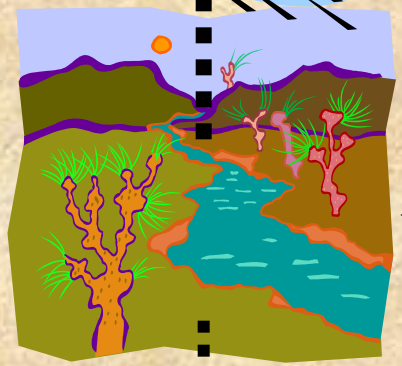


Figure 2.18: Block diagram of general stratigraphy of Surat Basin. Source: QUT b (2011).



Leakage

Leakage

De-watering

Re-injection

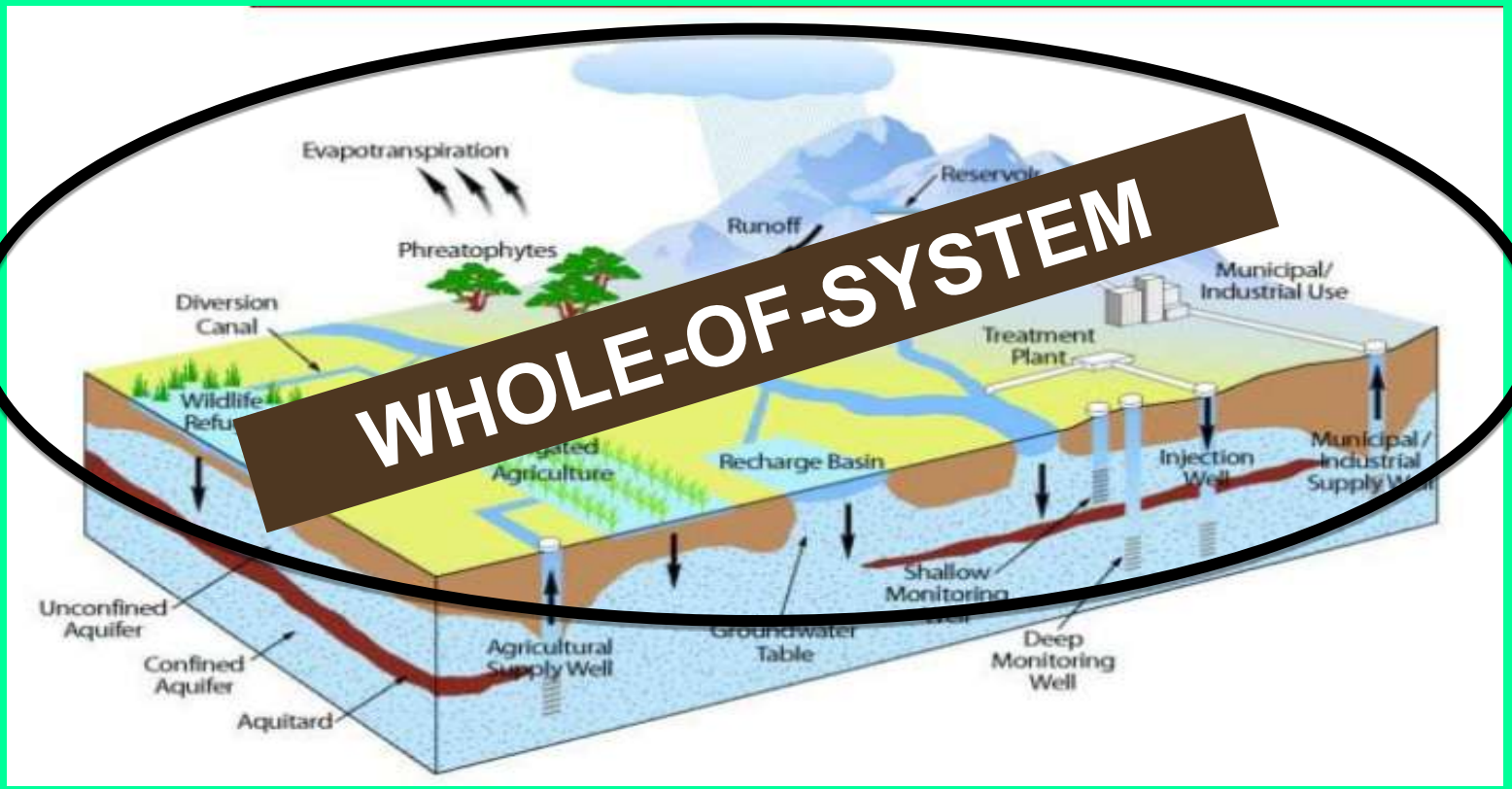
Groundwater flows to coal seam???

coal seam

Some Ways Forward……

- **Strategic Regional planning to give:**
  - **Impact Assessment**
  - **Cumulative Risk Assessment**

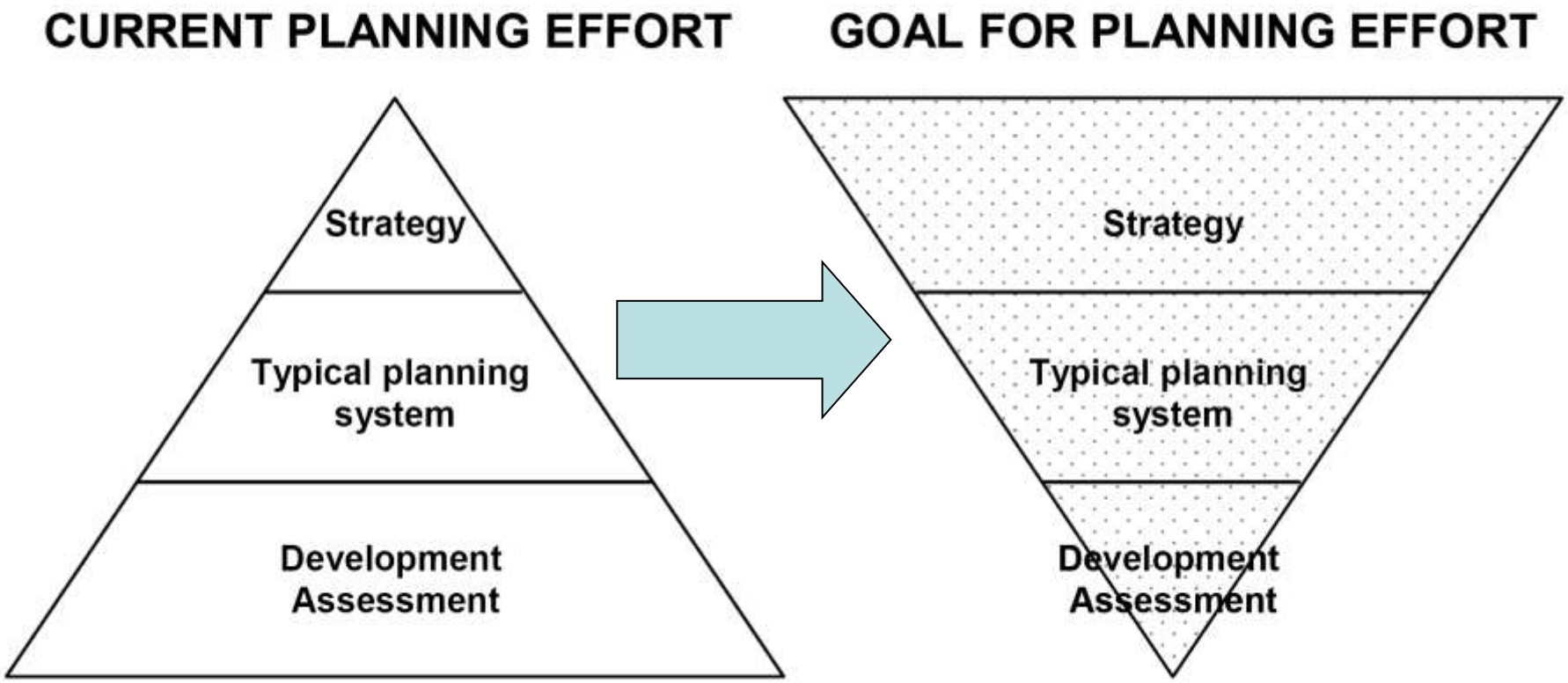
Integrated action, based on sound science, to manage ecological function for water, food, energy in the landscape for all users, for now and the future



Australian National University

Planning resources are disproportionally focussed on development assessment rather than strategic planning.

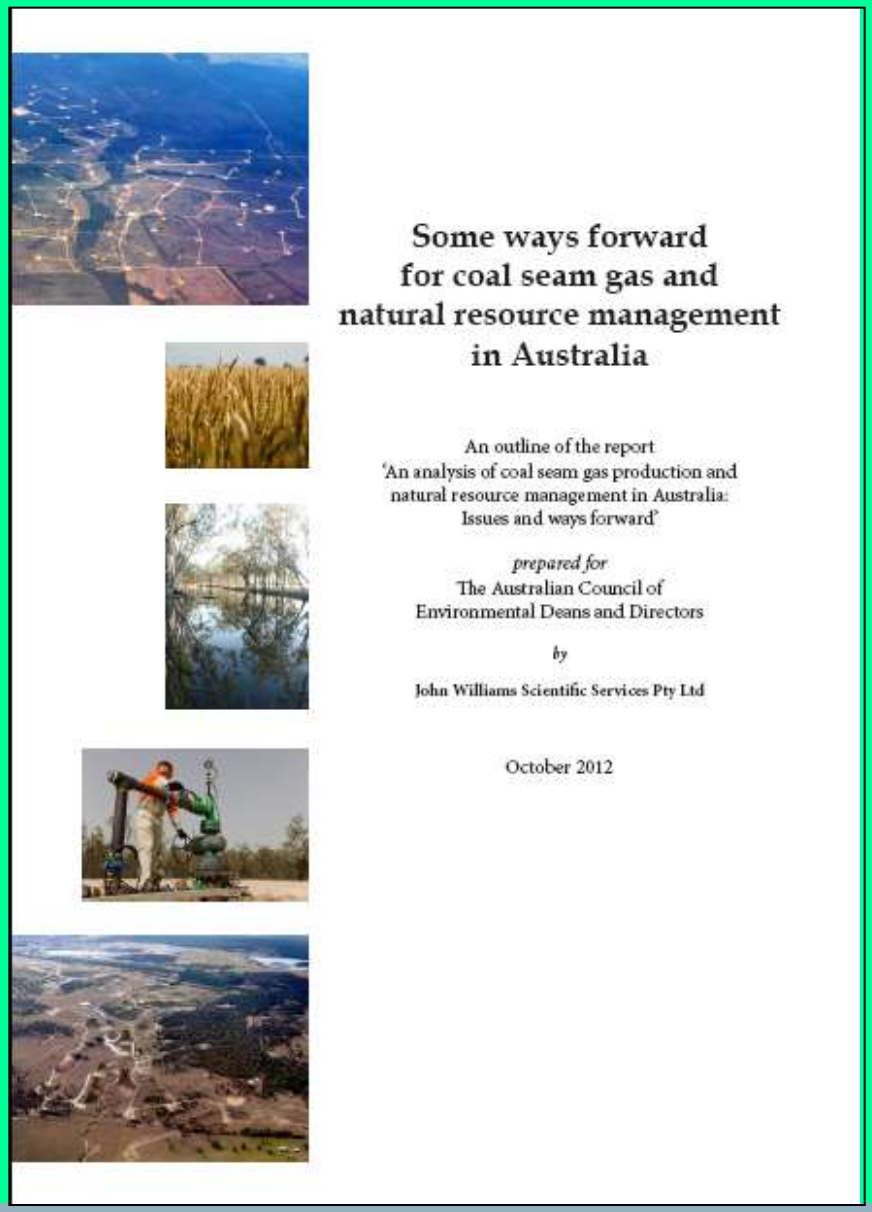
Figure 4 **Changing the focus of planning efforts**



Source: http://www.planning.org.au/documents/item/1867 accessed 14 February 2011.

The approach used for assessing gas developments (and any other developments) should be:

- **first, to understand <u>regional landscape capacity</u> (how much degradation can the landscape incur before it starts to lose function), and then to determine if there is capacity for the development without crossing landscape limits.**



Some ways forward for coal seam gas and natural resource management in Australia

An outline of the report
'An analysis of coal seam gas production and natural resource management in Australia: Issues and ways forward'

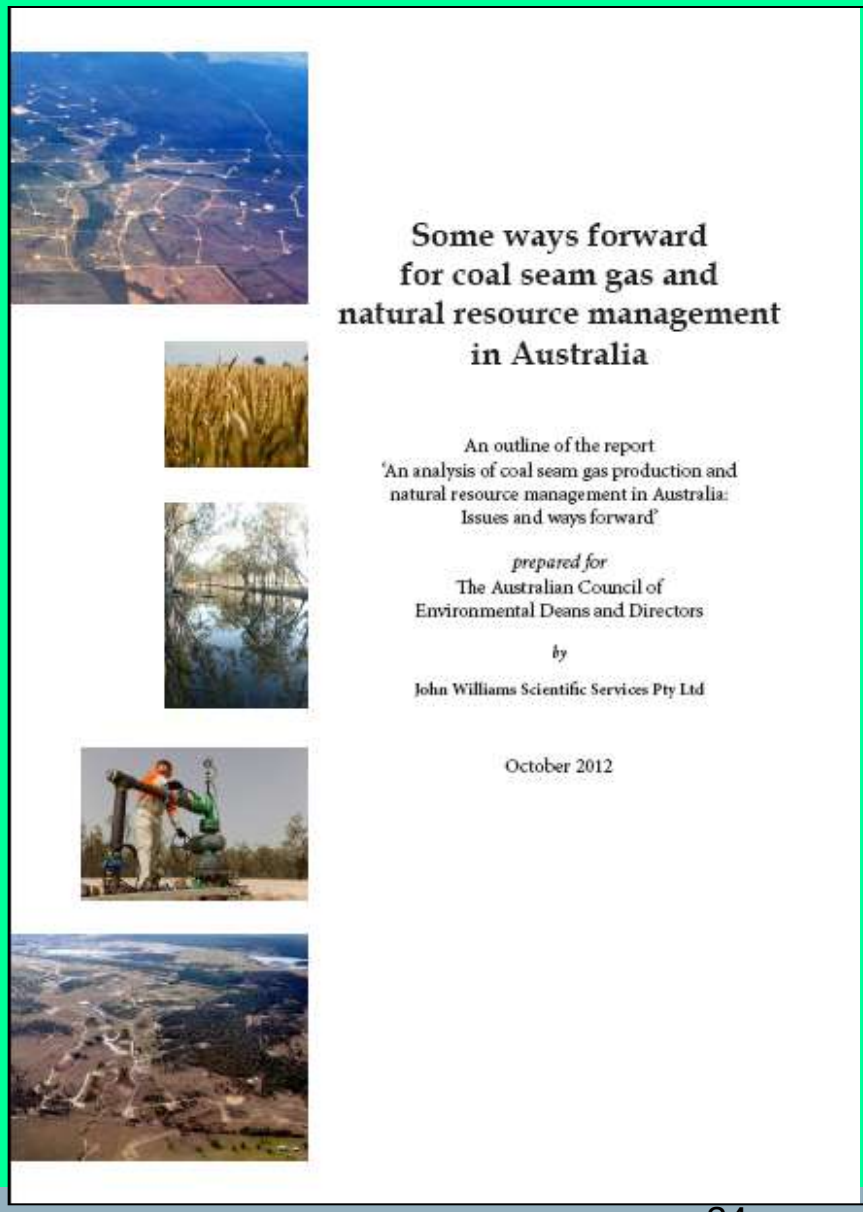
prepared for
The Australian Council of Environmental Deans and Directors

by

John Williams Scientific Services Pty Ltd

October 2012

Current development approval processes should be updated to approve new developments only on the basis of landscape limits and the expected cumulative impacts of the existing and proposed developments.



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Regional Strategic Planning

- **It is possible and desirable to use our knowledge of landscape process to work out upfront where we can safely mine and where mining would compromise agriculture, water resources , biodiversity other land uses and landscape environmental function.**

Regional Strategic Planning

- It is folly to secure one natural resource while putting at risk renewable long term resource use. The need is paramount for:
  - good long term regional land use planning to avoid such perverse outcomes
  - Recognition of limitation of EIS approach…leads to death by 1000 cuts!
  - Need non statutory regional and landscape planning to inform statutory planning

Regional Strategic Planning

- **Good regional and catchment action planning (CAP) with appropriate spatial definition should be able to identify**
  - ***no go areas* for mining for gas and coal**
  - ***go with care areas* in which mining can be conducted without unacceptable perverse outcomes within a regulation framework.**

Integrated Catchment Management

Basic principles:

1. Take a holistic approach to the management of land, biodiversity, water and community resources at the water-catchment (watershed) scale
2. Involve communities in planning and managing their landscapes
3. Find a landscape functional integration between resource use for mining, agriculture, tourism, urban development etc…

Principles for a new planning system

- Planning based on best available information
- Planning at the right scale
- Whole-of-government alignment
- Community engagement
- Cumulative Risk management
- Independent audit, monitoring and evaluation
- Open access to information

NSW Natural Resources Commission (2005) *Standard for Quality Natural Resource Management*, September.

Strategic Planning Principles

- **whole-of-government;**
- **part of a consistent hierarchy of aligned, nested plans;**
- **integrated across different levels of government**
- **able to be adjusted in response to changing circumstances**
- **developed with early and effective community engagement**

[Australian Productivity Commission benchmarks]

Call for a new focus in research and academic leadership to support policy

- A whole-of-system perspective in teaching and research to elucidate the nature of the crossovers and feedbacks between
    - gas energy production,
    - climate-change mitigation,
    - water resources,
    - food and fibre production
    - protection of biodiversity.

Call for a new focus in research and academic leadership to support policy

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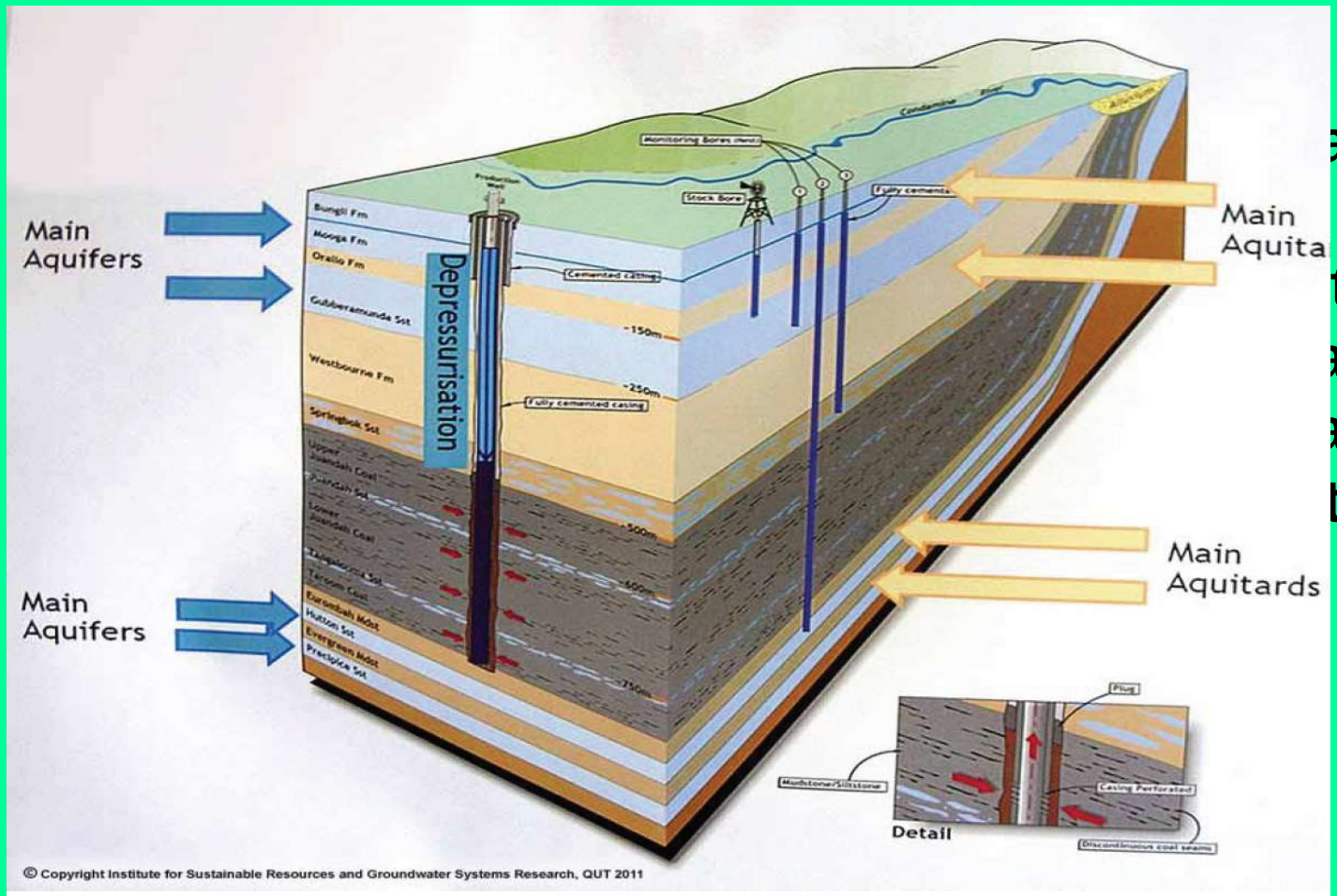

Figure 2.18: Block diagram of general stratigraphy of Surat Basin. Source: QUT b (2011).

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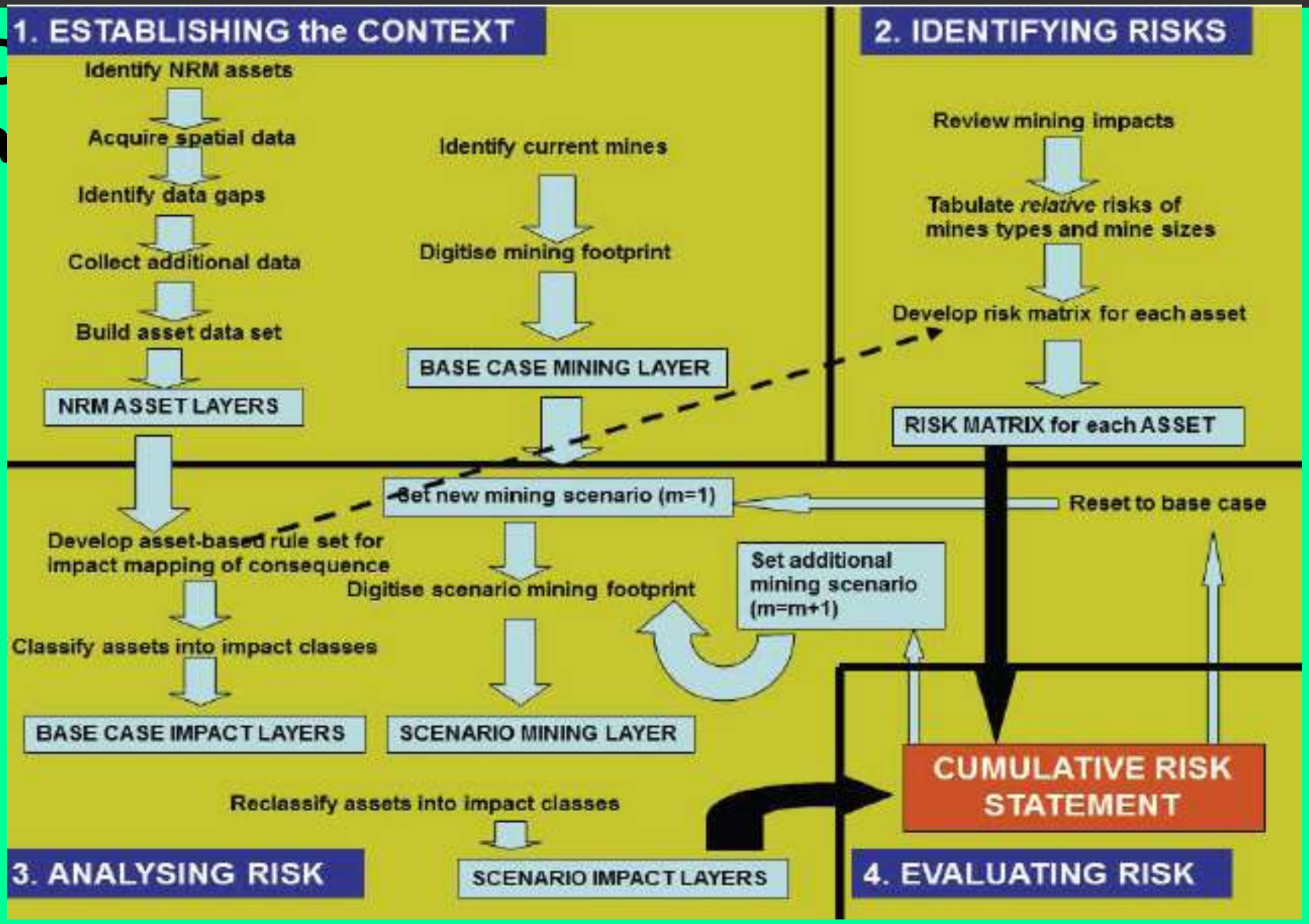
1. ESTABLISHING the CONTEXT
Identify NRM assets
Acquire spatial data
Identify data gaps
Collect additional data
Build asset data set
NRM ASSET LAYERS
Identify current mines
Digitise mining footprint
BASE CASE MINING LAYER
2. IDENTIFYING RISKS
Review mining impacts
Tabulate relative risks of mines types and mine sizes
Develop risk matrix for each asset
RISK MATRIX for each ASSET
Set new mining scenario (m=1)
Reset to base case
Develop asset-based rule set for impact mapping of consequence
Digitise scenario mining footprint
Set additional mining scenario (m=m+1)
Classify assets into impact classes
BASE CASE IMPACT LAYERS
SCENARIO MINING LAYER
CUMULATIVE RISK STATEMENT
Reclassify assets into impact classes
3. ANALYSING RISK
SCENARIO IMPACT LAYERS
4. EVALUATING RISK

Without new knowledge and its application in a whole-of-systems perspective, the way ahead will be littered with attempts to solve one problem whilst creating another.

Interventions that enable integration and optimisation of policies and actions

- Better cross-sectoral knowledge to inform decisions
- Whole-of-System Regional Strategic Planning
- Identification of technologies which have co-benefits;
- Markets with broader cross-sectoral participation (including linking water and carbon markets); and
- Better-integrated governance institutions.