Associate Professor Neville Crossman

The ecosystem services framework for measuring costs of inaction and (co-) benefits of action

Overview

- Short definition of ecosystem services
- Three case studies
  - Cost of inaction – economic losses from the Millennium Drought in Australia, 1999-2011 (Banerjee et al., 2013)
  - Benefits of action – economic benefits of smart irrigation infrastructure investment in north Victoria, Australia (Crossman et al., 2010)
  - Benefits of action – multiple benefits from restoring river systems in south-east Australia (Crossman et al., 2015; Bark et al., 2016)
- Summary and way forward
  - Ecosystem services and the '3 pillars' of drought management planning and preparedness

Definition of ecosystem services

'The benefits humans derive from nature'

(Millennium Ecosystem Assessment, 2005)

'… flows of materials, energy, and information from natural capital stocks which combine with manufactured and human capital services to produce human welfare'

(Costanza et al, 1997, Nature)

Why ecosystem services?

- Healthy ecosystems provide a myriad of benefits to people - economic, environmental, social
- Having policy impact– e.g. EU nature-based solutions
- Multi-disciplinary - captures biophysical, social, economic disciplines
- Directly links changes in land and water management to people
- Provides an organising framework and common platform for assessing benefits and trade-offs
- At the core of resilience thinking

From ecosystems properties to benefits, value & management

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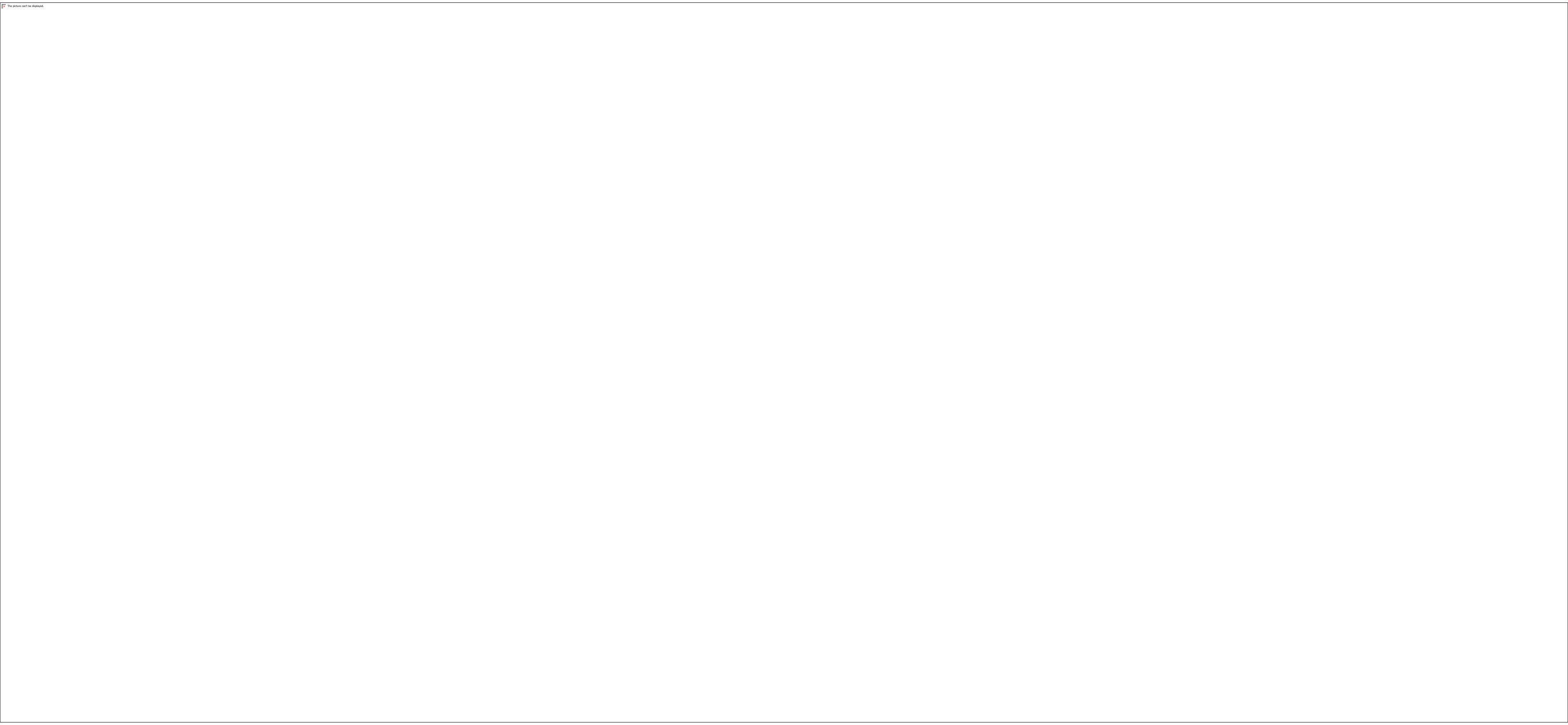
Source: A. P.E. van Oudenhoven, K. Petz, R. Alkemade, R. S. de Groot, L. Hein (2012) *Framework for systematic indicator selection to assess effects of land management on ecosystem services,* **Ecological Indicators, doi:10.1016/j.ecolind.2012.01.012**

Ecosystem services supplied by freshwater ecosystems



Case study 1
Ecosystem service costs of inaction

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Case study 1

<u>The problem</u>

How to measure the full range of costs of drought – economic, environmental, social?

Case study 1

Background

- Australia's Millennium Drought worst in living memory; lasted from 1997-2010
- Severely impacted south-eastern Australia, including the country's biggest river system, Murray-Darling Basin (MDB)
- MDB contains about 66% of Australia's irrigated agriculture
- At its peak, water availability was <40% of long term average in southern MDB
- Major environmental impacts:
  - Salinity; floodplain health declines; aquatic ecology impacts
- Economic costs of environmental impacts of drought poorly documented and understood

Case study 1

<u>The solution</u>

Used ecosystem services framework to:

1. Identify and categorize the many social, economic and environmental impacts in southern MDB
2. Clearly articulate the links between biophysical changes and economic costs / impacts
3. Put impacts into a common language via monetary valuation of impacts

Case study 1

<u>Methods</u>

- Catalogue estimates of expenditures incurred by Commonwealth and State governments, communities and individuals
  - Directly observable defensive, mitigation, rehabilitation expenditures and damage costs
- Avoided costs, replacements costs, travel costs, stated preference and market price valuations

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Case study 1

Results

Case study 2: ecosystem service benefits of action

Ecological Economics 69 (2010) 1031–1042

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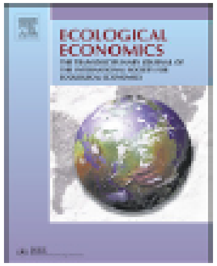

Analysis

Reconfiguring an irrigation landscape to improve provision of ecosystem services

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Case study 2

The problem

How to intelligently invest in irrigation given a future with less water?

Case study 2

Background

- Millennium Drought prompted major water reforms and investment in water infrastructure
  - Less water available for irrigation to meet needs of environment and increase resilience to future droughts
- Federal government allocated ~ AUD 13 billion to modernizing irrigation water delivery infrastructure and purchasing water allocations
  - Water availability reduced by ~25%
- Many irrigation districts were redesigned to meet reduced irrigation footprints
- Need intelligent approaches to maximise benefits and increase resilience
  - Also important to avoid stranded assets

Case study 2

<u>The solution</u>

Used ecosystem services framework to:

1. Clearly articulate the links between biophysical changes and economic benefits of alternative land use arrangements and water availability scenarios
2. Identify spatially explicit priority locations for investing in irrigation and restoring landscapes
3. Put benefits into a common language via monetary valuation of benefits of action

Case study 2

Methods

- Spatial modelling to identify:
  1. Best areas to irrigate
  2. Best areas for ecological restoration for ecosystem services (biodiversity, water quality and amenity) benefits
  3. Economic values of irrigation and ecosystem services under alternative land use arrangements
- Decision tree and optimisation model to identify alternative land uses and management actions
  - Identify land parcel to target for irrigation, ecological restoration or rain-fed agriculture

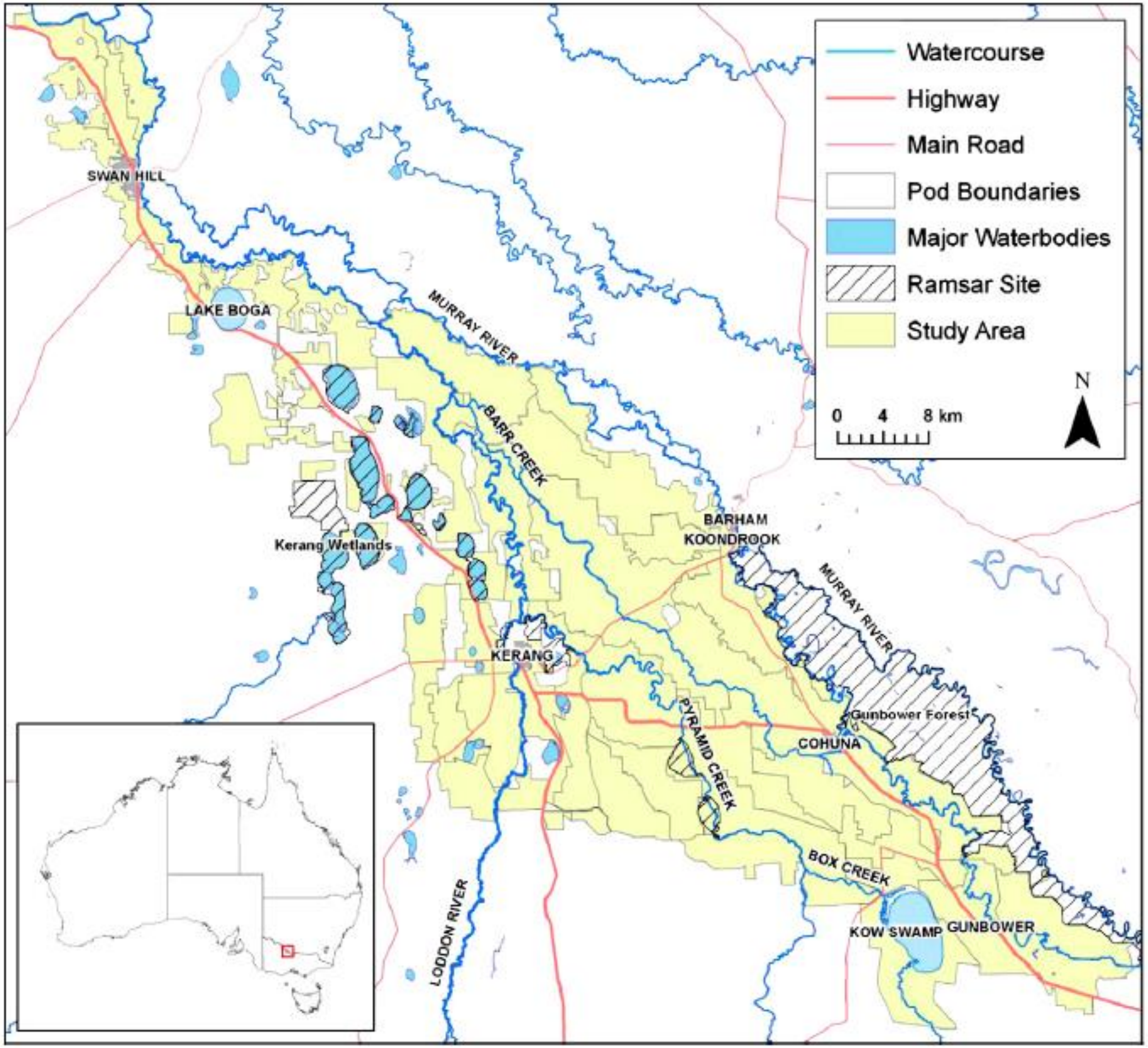

Fig. 1. The Torrumbarry Irrigation Area in northern Victoria, Australia.

Case study 2

<u>Results</u>

NPV of benefits: $233m-$373m

Case study 2

Results

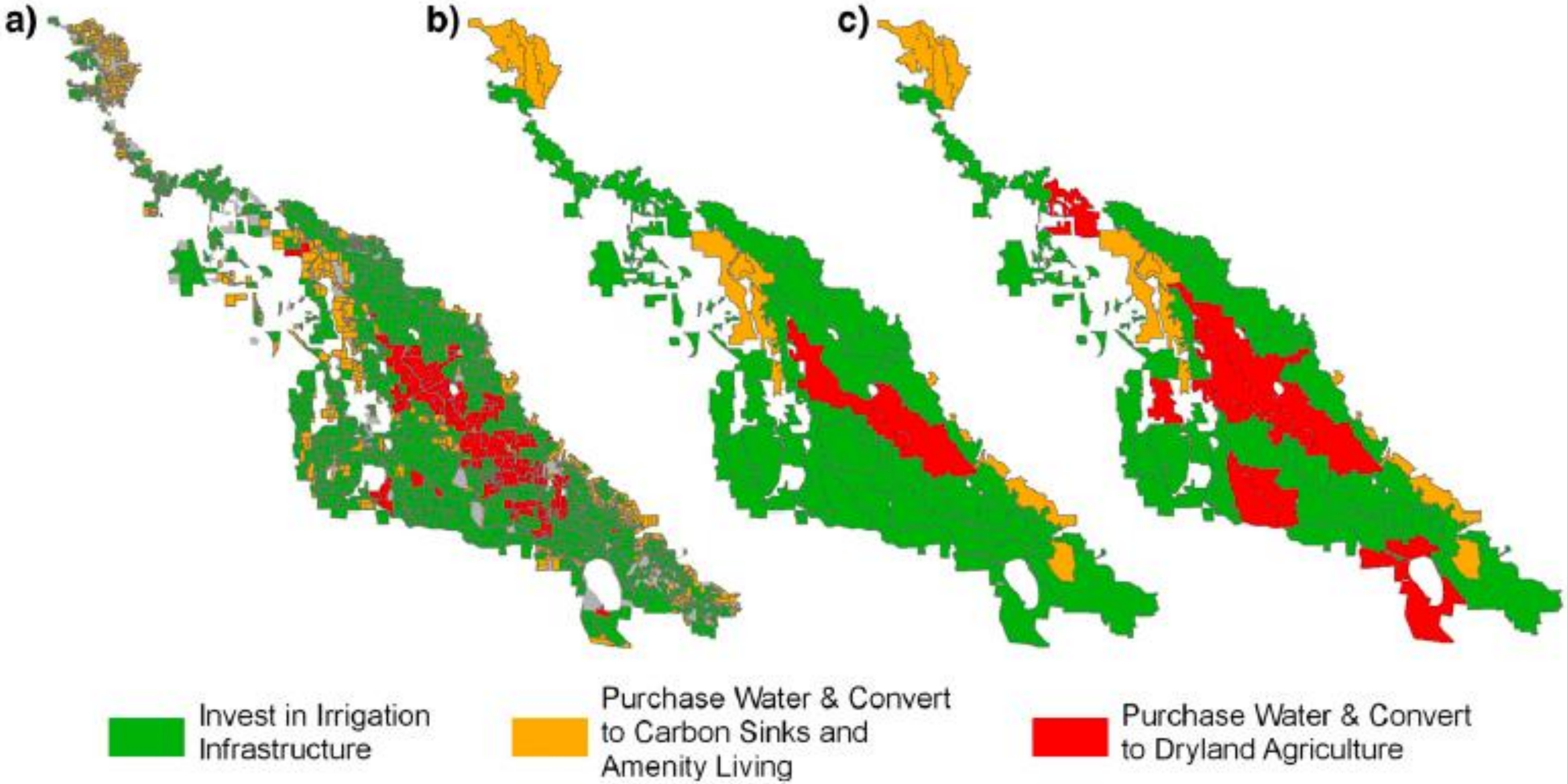

Fig. 5. a) Properties that belong to the green, amber and red groups for targeting investment in irrigation infrastructure modernisation and water purchases; b) the up-scaled pod level category membership, and; c) the category membership after optimisation.

Case study 3: ecosystem service benefits of action

Ecosystem Services 22 (2016) 381–391

Contents lists available at ScienceDirect

Ecosystem Services

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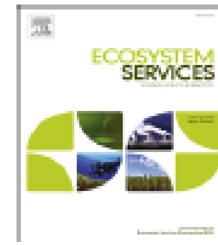

Integrated valuation of ecosystem services obtained from restoring water to the environment in a major regulated river basin

CrossMark

Rosalind H. Bark [a,*], Matthew J. Colloff [b,c], Darla Hatton MacDonald [d,e], Carmel A. Pollino [f], Sue Jackson [g], Neville D. Crossman [h]

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Case study 3

<u>The problem</u>

How to quantify the multiple benefits of decreasing water abstraction and increasing environmental flows to rivers?

Case study 3

<u>Background</u>

- Water reform prompted by the Millennium Drought reduced water available for irrigation to meet needs of environment and increase resilience to future droughts
- Reduced water absractions are about 30% of long term average abstractions
- Reduced irrigation considered by local communities as a very negative, controversial policy
  - An example of 'costs of action' – reduced farm income
- Need framework to identify, communicate and value the benefits rising from reduced abstractions

Case study 3

<u>The solution</u>

Used ecosystem services framework to:

1. Clearly articulate the links between biophysical changes and economic benefits of enhance ecosystem resilience to drought
2. Put benefits into a common language (to compare to costs) via monetary valuation of benefits of action

Case study 3

<u>Methods</u>

- Integrated hydrological-ecological-economic models
  - Team of 25 hydrologist, ecologists, economists, geographers
- Compared scenario of reducing water abstractions by 30% against a counter-factual
- Estimated many ecosystem service changes and values between two scenarios in river and across many floodplains

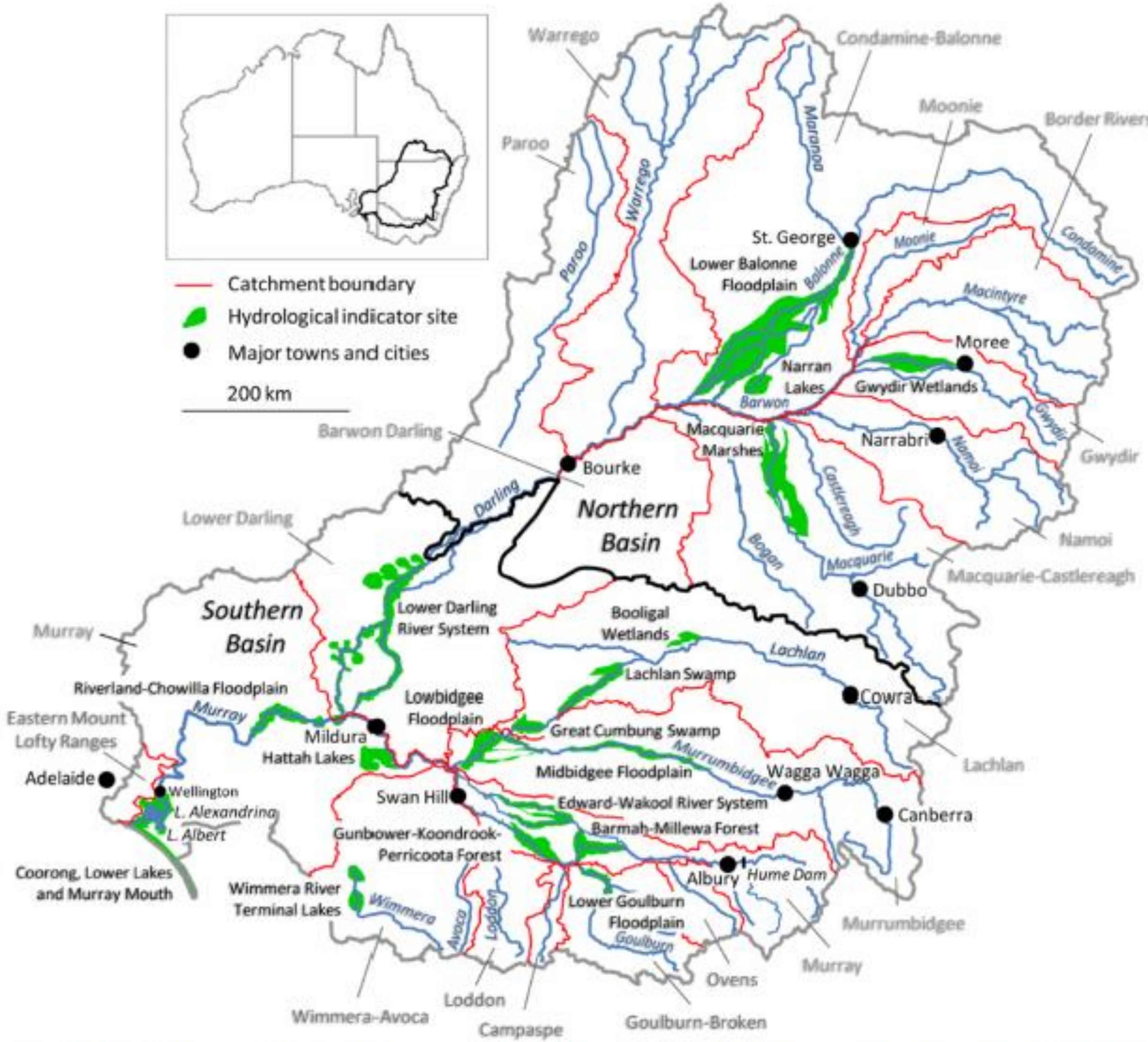

Fig. 1. The Murray-Darling Basin showing the major catchments, rivers and key hydrological indicator sites, subject to ecological targets under the Basin Plan (MDBA, 2012a). Inset: location map within Australia.

Case study 3

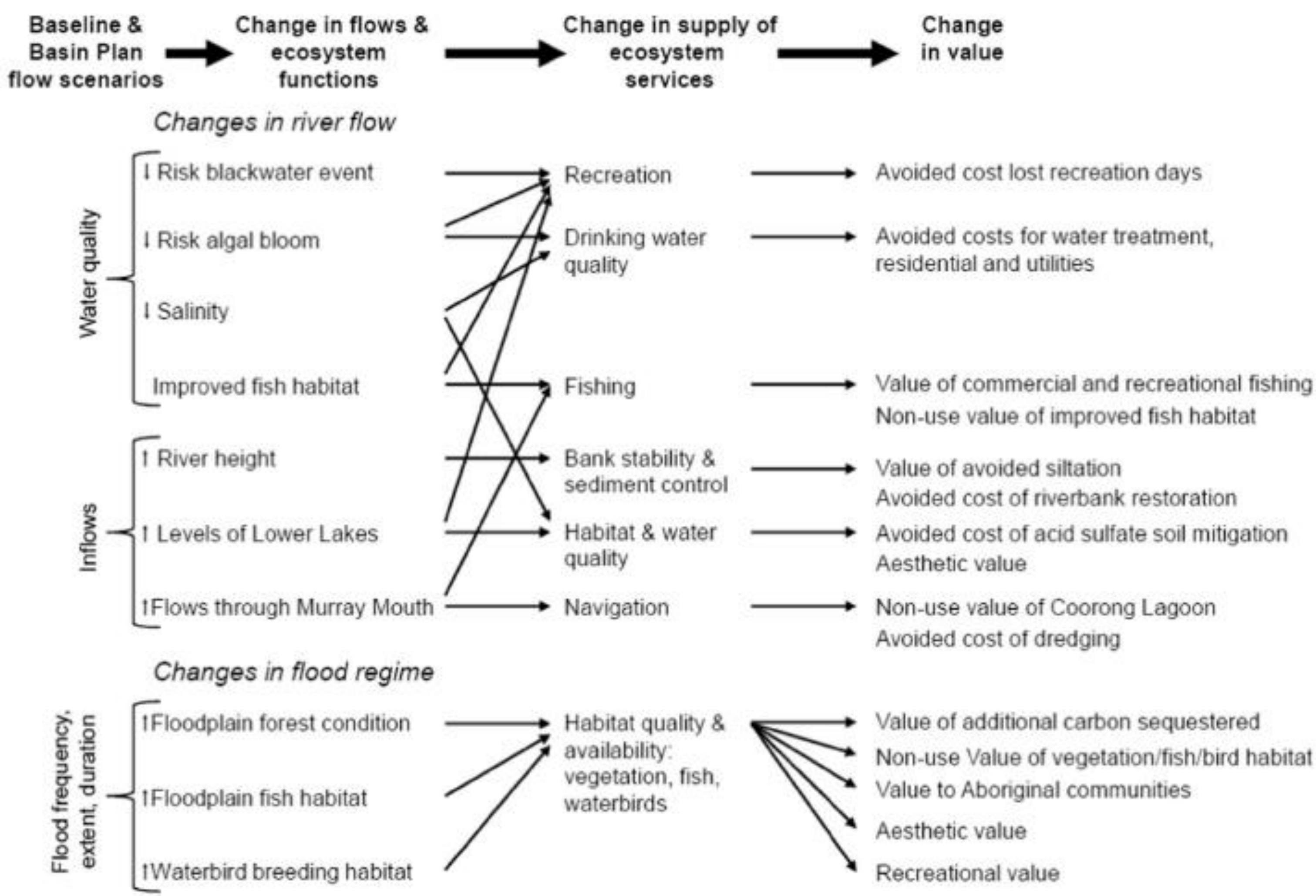

Fig. 2. Ecosystem services assessment: conceptual linkages. Connections between policy intervention, changed river flows and inundations patterns, modelled ecological responses and incremental change in ES flows and the monetary valuation of incremental changes.

Case study 3

Results

- $3b - $8b in improved habitat condition
- $120m - $1b in carbon sequestration
- $340m in aesthetic appreciation and $160m in tourism benefits
- Plus many measurable improvements to:
  - water quality (reduced blackwater events, cyanobacterial blooms and Lower Lake acidification)
  - flood-dependant ecosystems (bird-breeding events, floodplain vegetation)

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Ecosystem services and the ‘3 pillars’

Pillar 1: Drought monitoring and early warning systems

- Need indicators to measure ecosystem service and economic impacts in (near) real time
- Link these indicators to monitoring, early warning indices,
  - e.g. crop yields, river flows and floodplain health, soil erosion, NPP, fisheries catches; tourism activity; conflict escalation; human mental health, e.g. reports of suicide
- Make use of remote sensing, but keep focus on the local
- Novel techniques such as citizen science offer much potential

Pillar 2: Drought vulnerability & impact assessments

- Well-being is a complicated process, but should capture human-environment relationships
- Incorporate ecosystem service cost/benefit indicators into drought vulnerability and risk assessments
- Link/couple to drought M&EWs
  - Common indicators/indices
  - New indicators useful for both pillars
- Allows robust estimates of economic, social AND environmental vulnerabilities

Pillar 3: Drought preparedness and risk mitigation

- Use ecosystem services to document co-benefits and no-regrets outcomes
- Use ecosystem-based approaches to land and water management to increase resilience to next drought
- Many actions to diversify land use, economic production and ecosystems – will have multiple social, environmental and economic benefits
- Ecosystem service costs/benefits of risk mitigation investments offer a way to measure:
  - Direct & indirect outcomes
  - Aggregated performance measures (using common currency)

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Drought forecasting isn't just about water – to get smart we need health and financial data too

April 22, 2016 12.13am EDT

Neville Crossman, Ian Overton, Jamie Hannaford, Kerstin Stahl, Kevin Collins, Mark Svoboda, Mike Acreman, Nicole Wall. The Conversation, 22 April 2016, https://theconversation.com/drought-forecasting-isnt-just-about-water-to-get-smart-we-need-health-and-financial-data-too-57068

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