ADDRESSING THE WICKED PROBLEM OF WATER RESOURCE MANAGEMENT: AN ECOSYSTEM SERVICES APPROACH

By E. Hearnshaw, J. Tompkins and R. Cullen
Faculty of Commerce, Lincoln University

INTRODUCTION

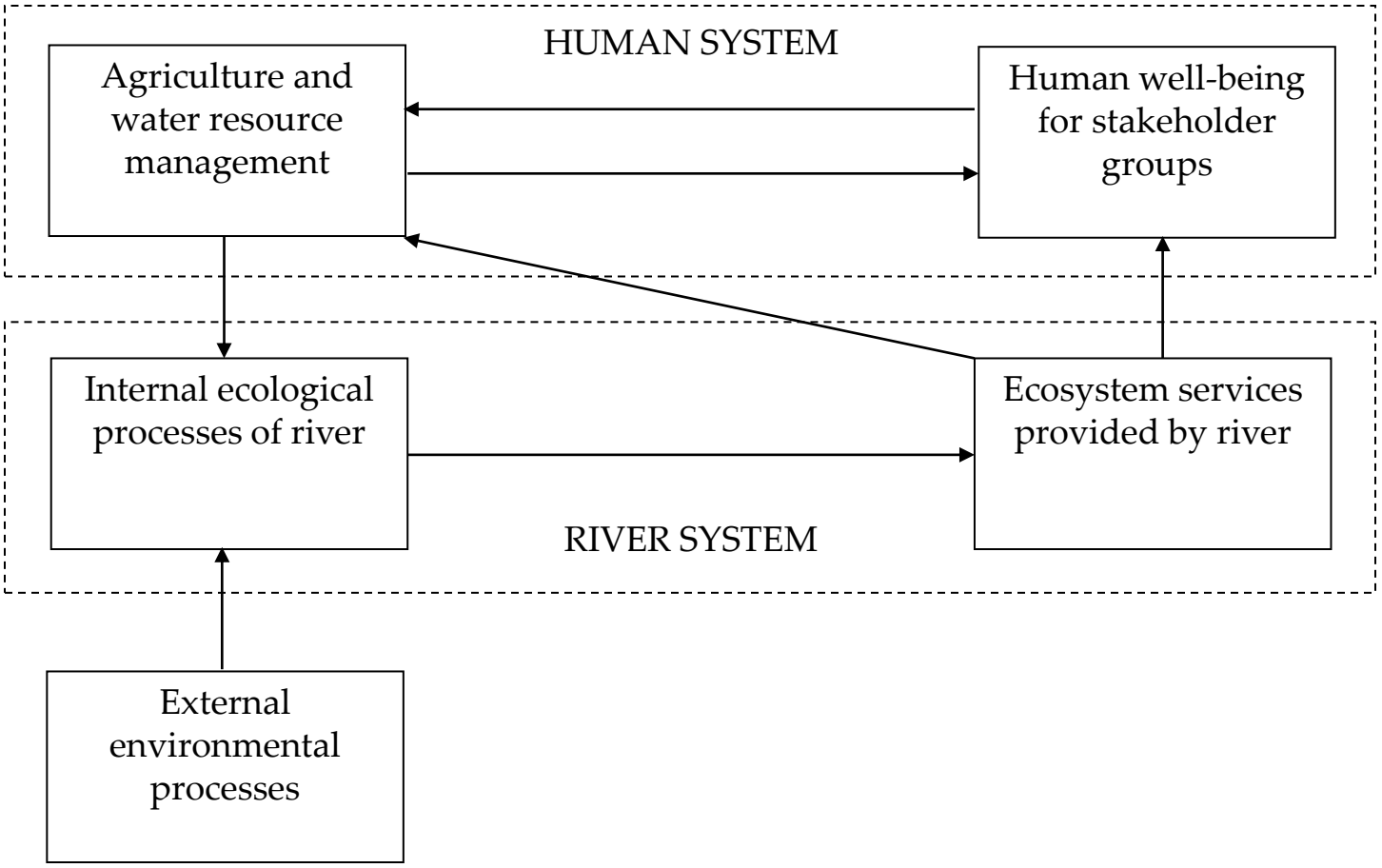
- Increasing water demand in Canterbury for irrigation
- Problem is water resources are scarce:
  - Rivers have reached maximum allocation limits while maintaining acceptable minimum river flows
- Investment in large water storage projects the **solution**?
- Water storage provides gains to farmers, but can result in losses to in-stream values
- Gains and losses lead to stakeholder disputes
- Systematic assessment required to ascertain whether this solution is **sustainable**

A SUSTAINABLE SOLUTION?

ECOSYSTEM SERVICES

- Ecosystem services:
  - Used to assess the many values from rivers
  - The collection of goods and services provided by ecosystems (*e.g.* rivers) that provide human well-being
  - Produced from ecological processes through "**complex interactions** between biotic and abiotic [factors]" (De Groot *et al.*, 2002)

ECOSYSTEM SERVICES



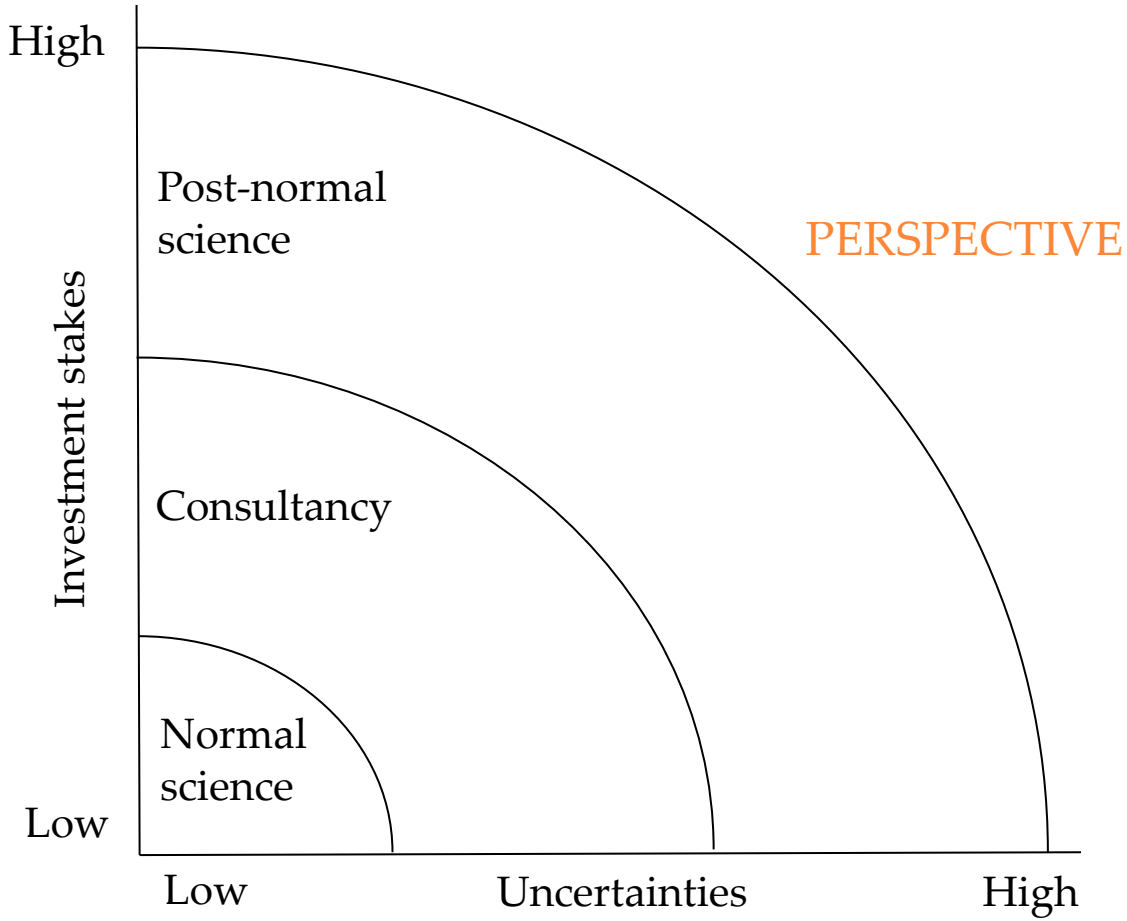
WICKED PROBLEMS

- Managing water resources in Canterbury is identified as a wicked problem (Frame & Russell, 2009)

- Wicked problems arise from:
  - Stakeholders with **conflicting** preferences
  - **Incomplete** and **contradictory** understanding of complex interactions between numerous factors

- Over-simplifying wicked problems leads to unsustainable solutions

POST-NORMAL SCIENCE



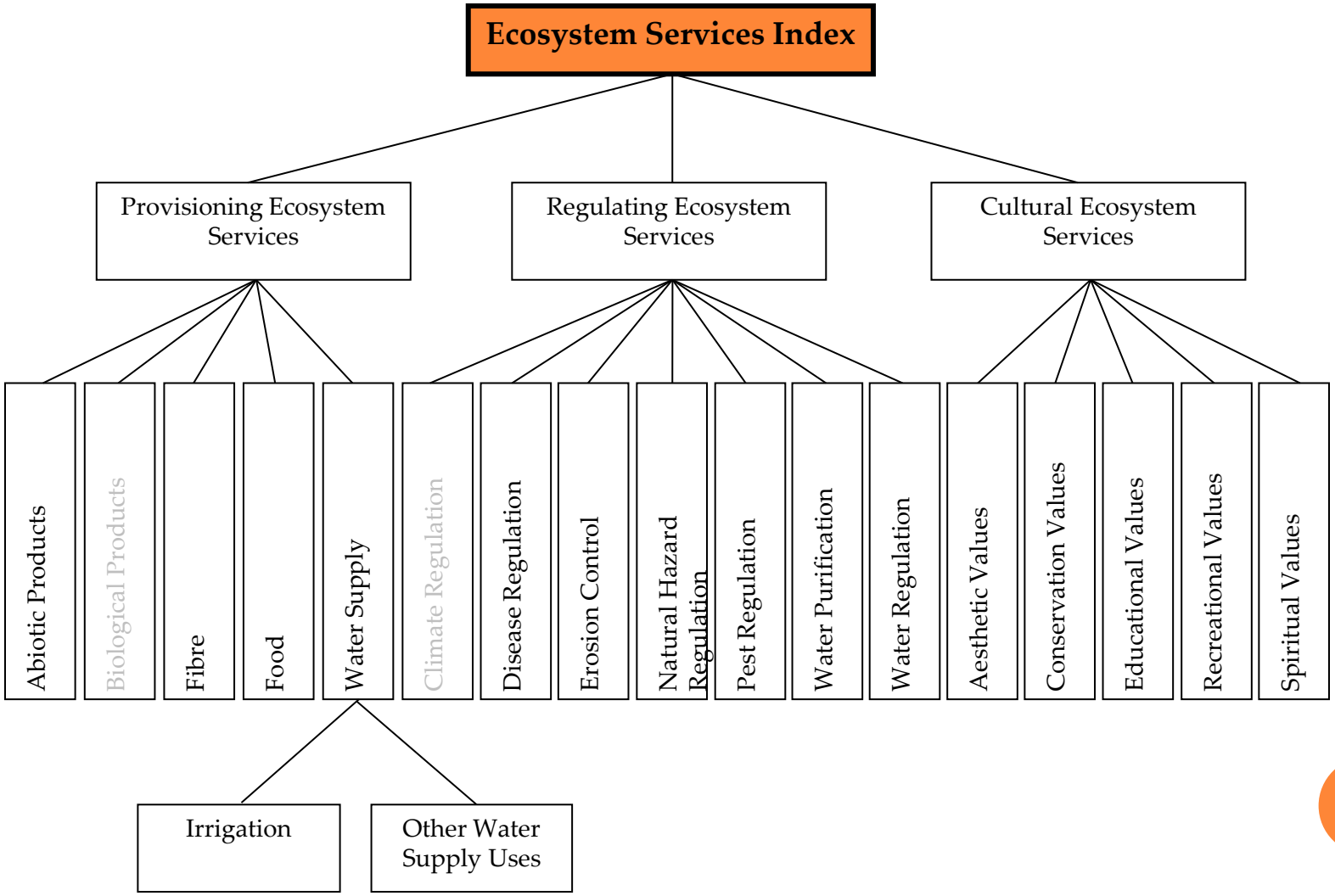
INTEGRATED MANAGEMENT

- Post-normal science recognizes the impossibility of transcending **perspective** to value-free objectivity
- Using many perspectives of 'scientists' improves objectivity towards a common 'factual' perspective
- Integration between scientists and stakeholders required
- **Integrated water resource management** provides greatest promise for sustaining ecosystem services
- Lack of research with methods that aid integration and accommodate conflict/contradiction, yet remain quantitative

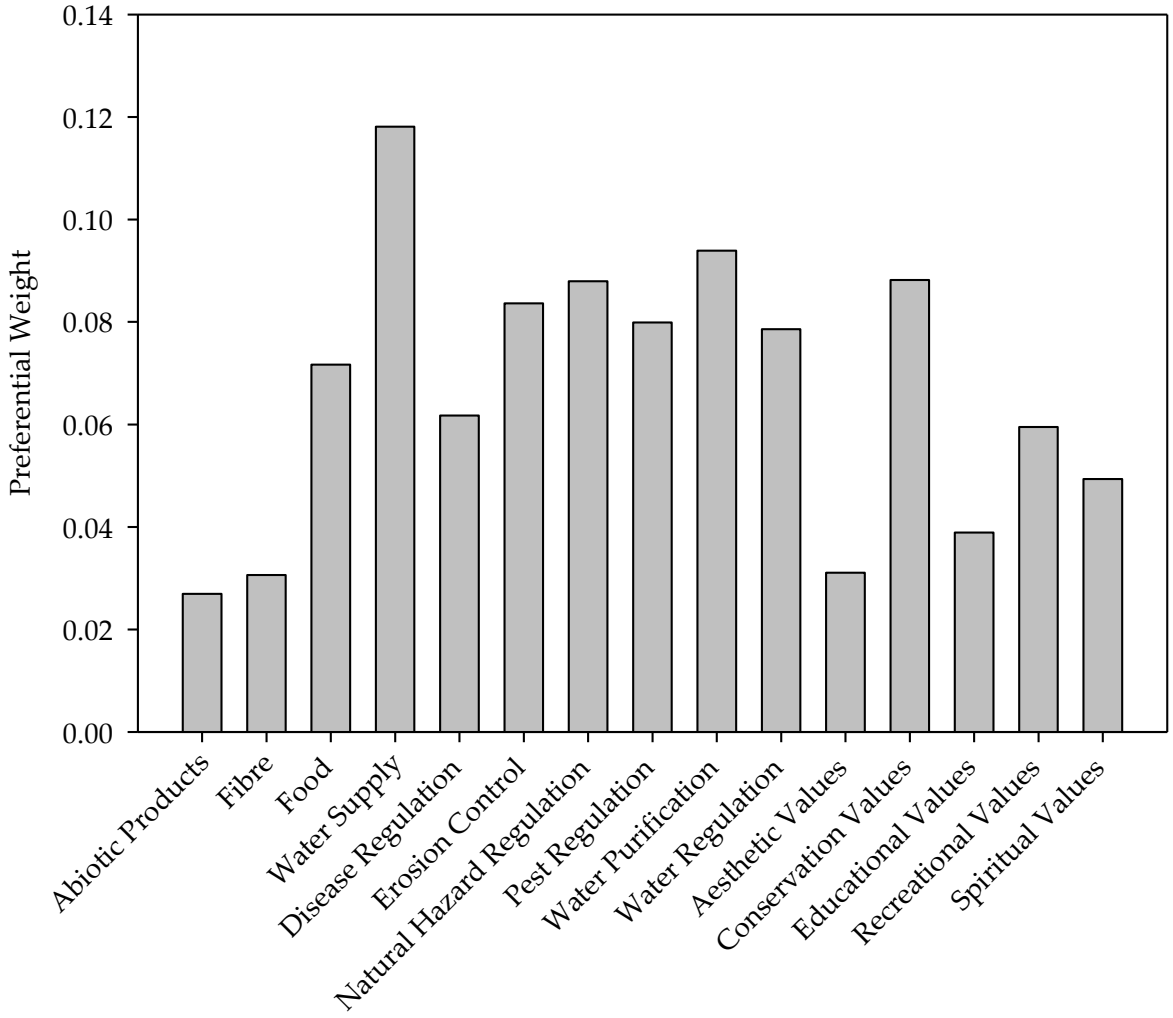
ECOSYSTEM SERVICES INDEX

- Missing markets for ecosystem services leave them undervalued
- Problem usually tackled with non-market valuation
  - But, these methods can be costly and time-consuming
- Despite difficulty monetizing ecosystem services, Boyd and Banzhaf (2007) recognize the need for "standardized units of account to measure the value of ecosystem services"
- Fortunately, ecosystem services can be assessed by a utility index; $ESI = \sum w_n s_n$

MULTI-CRITERIA ANALYSIS



PREFERENTIAL WEIGHTS

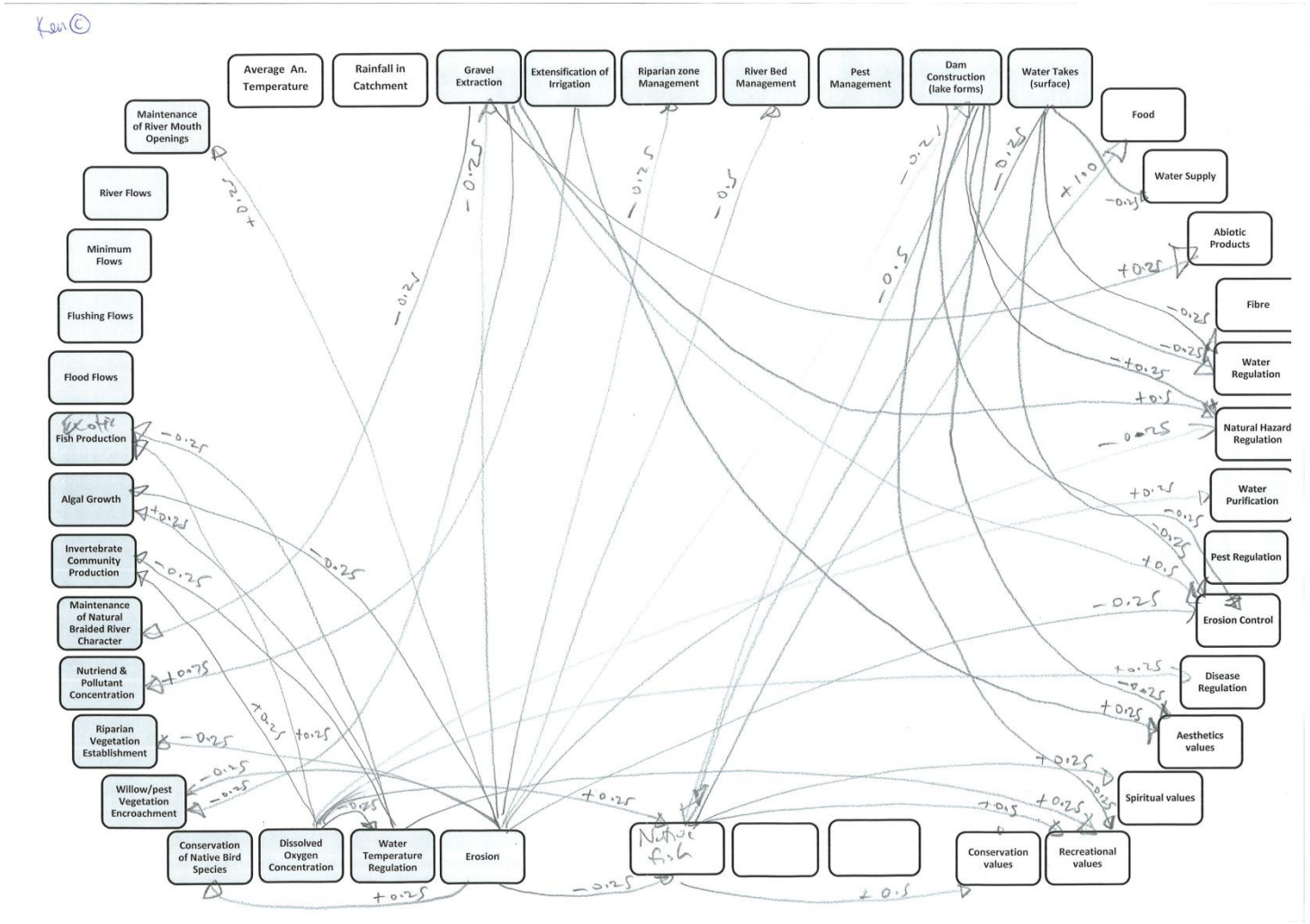


CONFLICT

- Stakeholder representatives placed into 4 groups:
  - Steering Group
  - Water Consumers Group
  - Water Conservators Group
  - Government Group
- Non-parametric statistical tests to be used to assess potential conflicts in preferential weights

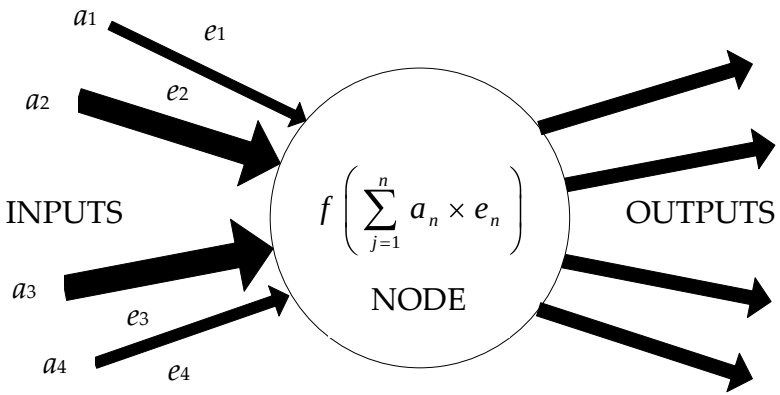
Friedman's *Q* statistic	**37.622**
Significance	<0.001
N	6

GRAPHS & CONTRADICTION



GRAPH ANALYSIS & UTILITY SCORES

- Graph analysis with and without water storage project:
  - **Static** graph analysis indicates utility scores by centrality index
  - Centrality: $L_i = id(C_i) + od(C_i)$
  - **Dynamic** graph analysis indicates utility scores by simulated activation values



SUSTAINABILITY

- **Weak** sustainability:
  - Indicated by non-declining ecosystem services index with water storage project
- **Strong** sustainability:
  - "... minimum quantity of ecosystem processes ... required to maintain a well-functioning ecosystem" (Fisher *et al.*, 2009)
  - Indicated by targets met with water storage project
  - *e.g.* native fish population shows no decrease (CWMS, 2010)
  - Lexicographic method applied for assessment

CONCLUSION

- Novel approach to address the wicked problem of water resource management
- Indicates conflicts in preferences and contradictions in understanding to aid integration
- Systematic assessment will indicate the sustainability of rivers impacted by water storage projects