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Main Article:

Implementing a Process for Integration Research: Ecosystem Services Project, Australia

Steven J. Cork
CSIRO Sustainable Ecosystems, GPO Box 284, Canberra, ACT 2601, AUSTRALIA
steve.cork@csiro.au

Wendy Proctor
CSIRO Land and Water, GPO Box 1666, Canberra, ACT 2601, AUSTRALIA
wendy.proctor@csiro.au

Abstract

This paper reports on the design and implementation of a multi-phase interactive process among a set of scientists, policy makers, land managers, and community representatives, so as to facilitate communication, mutual understanding, and participative decision making. This was part of the Ecosystem Services Project in Australia. The project sought to broaden public understanding about the natural ecosystems in Australia. The study reported here pertains to one of the project sites--the Goulburn Broken catchment, a highly productive agricultural watershed in the south-east of Australia. The paper demonstrates how, starting from a condition of diversity of ideas and interests among the participants, systematic dialogue and mutual learning could be generated, leading to identification of options for more sustainable land management practices. The concept of "ecosystem services" was used as an integrative tool across disciplines and community perspectives. The concept of scenarios was used to encourage future-focussed thinking among the participants. The idea of "stakeholder jury" was used to promote deliberation. A process of multi-criteria evaluation was used to facilitate convergence of viewpoints, through informed trade-offs and compromises. This experience led to the development of a process for integration research, which helped in harmonising across diverse understandings and values in a transparent and structured manner.

Keywords: ecosystem services; research partnerships; deliberative multi-criteria evaluation

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1. Introduction

This paper presents an account of implementing a multi-phase interactive process among a set of participants representing different knowledge systems and different values, with an aim to facilitate communication, mutual understanding, and participative decision making. This was part of a broader research project to develop public understanding about the natural ecosystems in Australia. It happens to be a domain well known for its complexity, involving multiple scientific disciplines, as well as a variety of institutions and stakeholder communities. Integrating multiple knowledge systems and perspectives in order to generate shared understanding that can be a basis for future action is already known to be an extremely difficult task. Therefore, the interactive process described here could be taken as tool for *integration research.*

In 1999, CSIRO, Australia's national scientific research agency, began the Ecosystem Services Project, that aimed to do a detailed and comprehensive assessment of the benefits that people get from a selection of natural ecosystems in Australia and to make that information available for use by a wide range of decision-makers. It was felt that this project had great public importance because it sought to integrate across a range of scientific disciplines as well as other forms of knowledge held by local communities. At the heart of the project was the concept of ecosystem services, which had been developed over several decades by ecologists and economists around the world trying to find ways to bring thinking in these two broad disciplines together (Daily, 1997; De Groot, Wilson, & Boumans, 2002; Mooney & Ehrlich, 1997).

The strong focus on partnership with stakeholder communities and exploration of the concept of ecosystem services as an integration and communication tool, made this project different from traditional scientific undertakings. For this reason, funding had been difficult to find; the project proceeded only because of the major support from a philanthropic foundation that was interested in the project's potential to meet social objectives (Abel et al., 2003).

A range of studies of various size and extent was initiated. This paper focuses on the largest of the studies, in the Goulburn Broken catchment in south-eastern Australia. We, the authors, were associated with the study during 1999-2003. The context was characterised by diverse land uses, a broad mix of partners, and audiences with different motivations, background, and goals. There was also a need to draw on science from a range of biophysical and social disciplines. These characteristics demanded a strong focus on integration of ideas, beliefs, and skills.

2. The Partners: Roles and Expectations

There were five major partners in the study discussed in this paper:

- a major national research and development agency (CSIRO)
- a philanthropic foundation (The Myer Foundation)
- a research and development funding agency (Land & Water Australia)
- an apex natural resource management body (Goulburn Broken Catchment Management Authority), and through it
- leaders from communities within the study area (the Goulburn Broken catchment of north-central Victoria and south-eastern Australia).

CSIRO is one of the world's largest and most diverse scientific research organisations, aiming to improve quality of life as well as the economic and social performance of a number of industry sectors through research and development. CSIRO's culture is diverse but the pursuit of scientific excellence is a unifying theme. Performance of research for the benefit of communities has long been a characteristic of CSIRO endeavours, but engagement in *research partnerships* with communities has been a relatively uncommon occurrence, as it has been with scientific organisations worldwide. The CSIRO team sought to bring high quality science to bear on the question of benefits from ecosystems, but also had a strong commitment to listening to and learning from their partners.

The Myer Foundation is a philanthropic foundation, supported by three generations of the Myer family, which seeks to promote creativity, innovation, tolerance, and the fulfilment of potential for all in society. These funders were keen to see the outputs of the research communicated widely and effectively to diverse audiences with the intention of broadening thinking about environmental management. This expectation led to a strong communication focus in the project.

Land & Water Australia is a statutory research and development corporation within the Australian government's Agriculture, Fisheries and Forestry portfolio. This corporation is responsible for research and development aimed at the productive and sustainable management of the land, water, and vegetation resources underpinning Australia's primary industries and regional communities. This funder brought expectations of high quality science and effective communication to key decision makers at different levels.

Australia is a federation of states, each with its own government. Within states, planning and management of land use are increasingly being done at a catchment (watershed) scale by committees or authorities, whose composition, method of selection, and degree of authority differs among the states. In the state of Victoria, in south-eastern Australia, catchment plans are developed, and their implementation is overseen, by catchment management authorities whose members are appointed by government to represent catchment communities. Catchment management authorities reflect the strong focus on water in land management in Australia and the strategy of the Victorian government to devolve authority for managing land and water resources to regional institutions. The Goulburn Broken Catchment Management Authority was established in 1997 as the apex natural resource management body in the catchment of two major rivers--the Goulburn and the Broken. The Goulburn Broken Catchment Management Authority focuses on protecting and enhancing land and water resources as well as improving the region's social wellbeing, environmental quality, and productive capacity, in a sustainable manner. It works closely with the community and partner organisations.

In the Ecosystem Services Project, the Goulburn Broken Catchment Management Authority was primarily interested in obtaining and communicating relevant information to support regional decisions about land-use change. It facilitated the involvement of a wide range of stakeholders from the catchment's communities in the project. These stakeholders brought various objectives, preconceptions, and expectations, as well as deep knowledge about local environmental, social, and economic processes, to the workshops they attended.

3. Study Area

Over nine studies of ecosystem services were supported or encouraged by the Ecosystem Services Project (Abel et al., 2003). This paper deals with only one of those--the Goulburn Broken catchment of north-central Victoria, in the south-east of mainland Australia.

In natural resource management, a catchment (or watershed) refers to the land area from which water drains into major watercourses. The Goulburn Broken catchment is diverse in terms of land-use. In the irrigated northern region (270,655 ha), the primary uses are horticulture (growing flowers, fruits, and vegetables) and irrigated dairy pasture. The central region (1,397,130 ha) is dominated by dryland grazing and cropping. The southern, high country, region (690,603ha) is valued for its timber, tourism, and recreational uses. Approximately two-thirds of the catchment has been cleared for agriculture.

The population of the catchment is currently about 190,000 and is predicted to grow to approximately 210,000 by 2021, especially in areas within two hours drive of Melbourne, one of Australia's largest cities. This is leading to increased interest in the land for rural living, cheaper housing, and new industries, making traditional agricultural enterprises economically less attractive. These new buyers of land prefer those areas where native vegetation is till present ands this creates an economic value for this component of biodiversity not recognised in the past.

Leaders of the catchment communities have established an ambitious vision for the catchment. They believe that research into conservation of native species, hydrology, and sustainable land management as crucial to achieving that vision. The communities and agencies in the catchment have extensive experience in developing and applying innovative approaches to natural resource management.

The catchment is also part of the Murray-Darling basin, a system of catchments that has been the focus of cooperation among state and national governments since 1915, because of concerns about land degradation, especially due to rising water tables that are bringing salt to the surface. The Goulburn Broken catchment is a major contributor of salt and nutrients to the Murray River and improved management of natural resources in the catchment has important implications for downstream users.

4. Purpose of the Study

As mentioned earlier, this study was set up as a part of the Ecosystem Services Project. Broadly speaking, the project aimed at creating a collaborative learning process among scientists and communities, which would provide the necessary information to policy developers and decision makers to move towards more sustainable land management practices (Cork, Shelton, Binning, & Parry, 2001; Cork, Proctor, Shelton, Abel, & Binning,

2002). As a broad approach, the project sought to utilise the concept of ecosystem services to facilitate communication among scientists and communities.

The concept of ecosystem services has been developing for several decades as a way to focus attention on human dependence on ecosystems for health, prosperity, and well being. We saw it as a potentially powerful tool for participative research because it simplifies the complexity of ecological processes into a small number of integrated benefits or "services," that people with different backgrounds are able to understand with minimal explanation. In this way, it had the potential to engage community members in deliberation about issues usually requiring specialist economic and ecological knowledge.

Table 1 provides a classification and examples of ecosystem services, which are defined as: "The conditions and processes by which natural ecosystems, and the species that make them up, sustain and fulfil human life" (Daily, 1997, p. 3).

Table 1. *Classification and Examples of Ecosystem Services* (adapted from Daily, 1999)

Category of Ecosystem Service	**Examples**
Production of goods	*Food:* Terrestrial animal and plant products, forage, seafood, spice *Pharmaceuticals:* Medicines, precursors to synthetic drugs *Durable materials:* Natural fibre, timber *Energy:* Biomass fuels, low-sediment water for hydropower *Industrial products:* Waxes, oils, fragrances, dyes, latex, rubber, precursors to many synthetic products *Genetic resources:* The basis for the production of other goods
Regeneration services	*Cycling and filtration processes:* Detoxification and decomposition of wastes, renewal of soil fertility, purification of air and water *Translocation processes:* Dispersal of seeds necessary for re-vegetation, pollination of crops and native vegetation
Stabilising services	Coastal and river channel stability, compensation and substitution of one species for another when environments vary, control of the majority of potential pest species, moderation of weather extremes (such as temperature and wind), partial stabilisation of climate, regulation of the hydrological cycle (mitigation of floods, droughts, salinity)
Life-fulfilling services	Aesthetic beauty, cultural, intellectual, and spiritual inspiration, existence value, scientific discovery, serenity
Preservation of options	Maintenance of ecological components and systems needed for the future, supply of goods and services awaiting discovery

We worked with our partners in the Goulburn Broken catchment to interpret previous work on ecosystem services in ways that we thought made sense to a broader cross-section of stakeholders. The two key elements of our message were:

- Ecosystems provide services in much the same way as other service-providers, like bakers, newsagents, chefs, hairdressers, book publishers, etc.

- Like other services, ecosystem services are about transformations of a set of inputs into a new output of greater value (monetary and otherwise).

5. Challenge of Integration

Prior to commencing the project, we interviewed a range of policy makers, land managers and scientific researchers to understand the key problems that they faced with respect to human-environment interactions in rural Australia. We became aware of the diversity of ideas, interests, and viewpoints prevailing among them. To fulfil the broader purpose of the project, a meaningful process of communication would have to be established among these diverse actors. That constituted the key challenge before us.

Policy makers and economists had been grappling for decades with ways to account for the full costs and benefits of environmental inputs and impacts (Bingham, et al., 1995; Bockstael, Freeman, Kopp, Portney, & Smith, 2000; Heal, 2000). For policy makers, the key questions were how to measure "externalities" (i.e., impacts that go beyond the site of action) both in space and time, and how to determine who was causing them and who was being affected. The policy makers were also interested in promoting awareness and understanding of these issues in a way that would foster productive dialogue across communities of interest. Evidence from elsewhere suggested that the concept of ecosystem services could help here (Daily, 1997).

Land managers did not seem to have believable and understandable information on the impacts of management practices. Typically the questions they most wanted us to address were: (a) What benefits will we, or society, get from conserving the environment or biodiversity? and (b) Who gets these benefits and who pays?

In 1999, when the project was set up, there was a resurgence of discussion in the literature about the economic value of the environment (e.g., Costanza, 1998; Costanza et al., 1997). In Australia and internationally, there had been discussion of this issue sporadically for many years (e.g., Bingham, et al., 1995; Bockstael, et al., 2000; Costanza & Farber, 2002; Heal, 2000; O'Neill, Kahn, & Russell, 1998; Young, 1992). There still remained, however, a lack of clarity about the underpinning issues among many involved in the debate (Daily & Ehrlich, 1999). Tension existed between those who thought economic evaluation of the

environment would improve the consideration of environmental issues in decision-making and those who considered that putting any monetary value on nature was misguided or even ethically wrong. These differences called for greater understanding of economic theory and how it might relate to human welfare and ethics (El Serafy, 1998; Heal, 2000; Norgaard, Bode, & Values Reading Group, 1998; Pearce & Moran, 1994).

Early in the project, we convened a two-day workshop for economists and ecologists from universities, other research organisations, and state and national government agencies to identify what each discipline would need for integration. A number of key issues insight emerged:

- Economics is not a unified discipline. Economists can interpret simple questions very differently, depending on their background and sub-disciplinary interests.
- Non-economists interpret the concept of *value* in many different ways, but even economists from different sub-disciplines define and deal with it very differently.
- Economic analysis usually requires information about rates of change in something being valued with respect to the change in the actions being taken; while ecologists often investigate impacts in terms of a set of discrete treatments that often do not allow response (or change) relationships to be derived.
- Where ecologists do get interested in responses, they usually find non-linear relationships (i.e., rates of change are different under different resource conditions); while economics finds it hard to deal with non-linear change.
- While all the participants recognised that people's perceptions of the value of the environment would vary with time and place, depending on what social processes and institutional arrangements are in place, still there was no common framework to account for the social and institutional factors.

Our early experiences in the study made us keenly aware of the nature of the challenge before us. We would have to start from a condition of diversity of ideas and interests among our stakeholders. Somehow, we would have to put in place a process to promote dialogue and mutual learning which would facilitate policy and decisions towards more sustainable land management.

6. Development of a Research Framework

We considered the above challenge, i.e., the challenge of designing a process to promote dialogue and mutual learning that would lead to policies and decisions for sustainable land

management, as a challenge of integration research. The following paragraphs describe our engagements with the stakeholders and the gradual development of a multi-phase approach to address the above challenge. Our engagements were informed by the following ideas: (a) giving the stakeholders a voice within, and control over, the study, (b) responding to the immediate priorities of the communities associated with the study, (c) using the concept of *scenarios* to encourage future-focussed thinking, (d) ensuring appropriate methods of deliberation which would enrich the available viewpoints, (e) introducing the idea of multi-criteria evaluation to facilitate convergence of viewpoints, through informed trade-offs and compromises, and (f) drawing out the maximum possible value from the notion of ecosystem services, especially as a tool for integrating across disciplines and community perspectives.

During the study period, our engagements with the stakeholders were guided by the above ideas. From this experience, we could recover a research framework that might serve as a model for integration research elsewhere.

6.1. Giving Voice to Stakeholders

We identified our key stakeholders as regional policy makers and various influencers, including local government, various advisory agencies, industry and community representatives, and representatives of non-government organisations like Landcare (Lockie, 2004) and conservation groups. We engaged all of these stakeholders, from the very beginning of the project and in ways that promoted mutual understanding and learning.

A key component of our integration strategy was the way in which we engaged with stakeholders, including funding partners, research participants, and community representatives. In addition to the major partners in the project, over 40 community representatives took part regularly in planning and assessment workshops. These people represented a range of industries, land uses, and government and non-government organisations. Community representatives from the catchment constituted half of the steering committee, one of whom was designated the chairperson.

The nature of the partnership between the research team and the community representatives was defined in a two-day workshop at the beginning of the study, attended by around 40 people. The participants were asked to identify their hopes, fears, and expectations from the study as well as their expectations from each other. Issues identified in the discussion included the following:

- how the project team would interact with community-based organisations and conservation groups;
- pressure on a small pool of volunteers from the many participative projects underway at the time;
- concerns among the community members that scientists would be motivated by short term career goals and would not commit to longer term community goals;
- concerns among the scientists that their skills and resources would be overestimated;
- concerns by the community members that their knowledge and capacity to contribute would be overestimated;
- recognition by the research team that they would be guests in the catchment; and
- a self-imposed responsibility of the community members to welcome the researchers into their catchment.

These issues were developed into an *informal agreement* between the research team and the community participants. This agreement was a fundamental component of the integration strategy. We revisited it annually to check how well expectations were being met, especially how well the participants were playing their roles in supporting one another and whether this was facilitating the study.

6.2. Responding to Immediate Priorities

One of the first messages from the community representatives was that they could not wait for four years until a detailed study was completed. They asked for a rapid assessment within the first year. This request was met in the form of a qualitative inventory, based on existing data and expert judgement about the state of ecosystem services, the perceived relationships between land use and ecosystem services, and the expected future trends (a summary is presented in Figure 1).

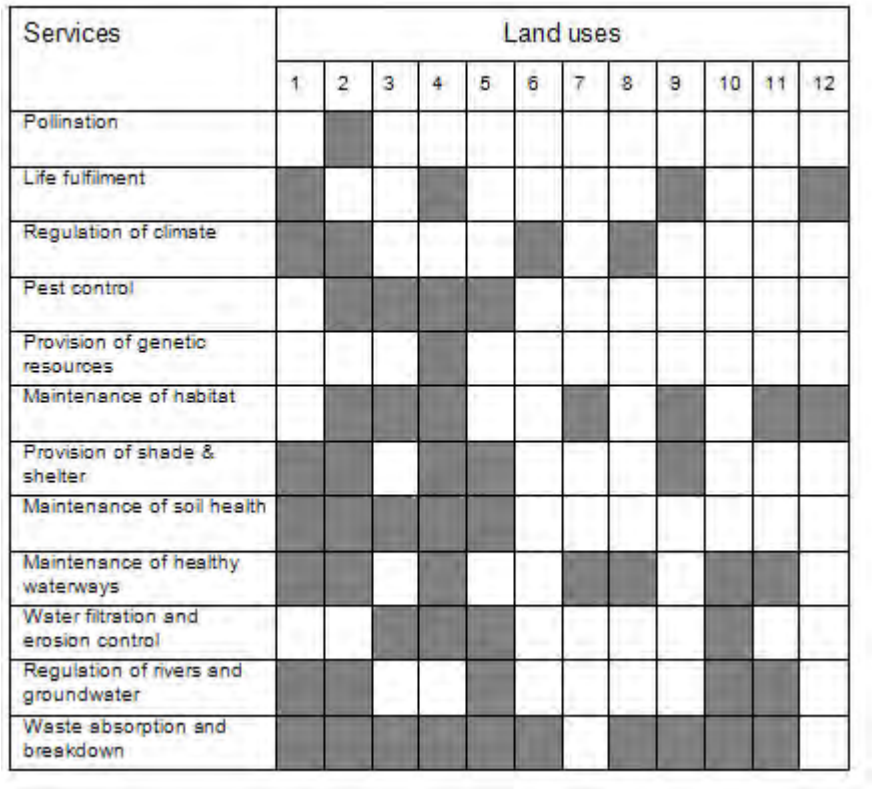

Figure 1. Importance of Various Ecosystem Services

Note. Ecosystem services are presented in the row headings. Land uses are presented in the column headings. Importance is indicated by dark shading. Key to column headings (land uses): 1 Dairying, on farm; 2 Fruit and grapes; 3 Vegetables; 4 Grazing; 5 Crops; 6 Intensive animal farming; 7 Forestry; 8 Food processing; 9 Housing; 10 Water production; 11 Recreation; 12 Areas of cultural/future options.

6.3. Encouraging Future-Focussed Thinking

Identifying a set of major issues for the future of the Goulburn Broken catchment was essential to give context and focus to the study. Five major issues were identified out of the consultation associated with the rapid assessment process mentioned above:

- impact of dairy farming on the environment, especially under potential intensification of dairying in the future;
- effect of land management on the lower Goulburn River floodplain;
- effect of re-vegetation in the dryland sub-catchments;
- contribution of the ecosystem towards tourism and recreation in the upper catchment; and
- role of the environment in the economy of the entire catchment.

For each major issue, a set of future scenarios were developed, including a "business as usual" scenario and others relating to major possible future changes in land use, some of which are indicated in the list above. The scenarios were developed with inputs from stakeholders selected for their association with the management of the catchment, their knowledge, experience, and skills (Abel et al., 2003; Binning, Cork, Parry, & Shelton, 2001).

6.4. Ensuring Adequate Deliberation and Learning

To ensure that the stakeholders were able to both participate effectively in the study and learn from available information, the concept of a *citizens' jury* was adopted. A citizen's jury provides an opportunity for its members (jurors) to express an informed view on a subject and to question experts as a way to improve their understanding of the issues. Typically, the jury is asked to deliberate over a given question and reach consensus. Expert witnesses are asked to provide information where the jury requires it and the jury is given time to discuss and deliberate over the decision. This process of reaching consensus through iterative deliberation effectively means that agreement is reached about how options are weighted (James & Blamey, 2000; Ross, Buchy, & Proctor , 2002).

In this study, t he jury comprised a group of natural resource managers (stakeholders) rather than randomly chosen members of the public (citizens); therefore it was called a "stakeholder jury." These people had already been involved in the Ecosystem Services Project and many had also been involved in developing a strategy for recreation and tourism management that was about to be implemented in the region.

To give our jurors an exposure to the expert judgements possible on matters affecting the future of the catchment, an attempt was made to synthesise relevant scientific data and local knowledge. Within the five major issues relevant to the future of the catchment specified earlier, key questions for biophysical and social science were identified. A range of social and economic analyses were conducted, largely utilising the results and data from existing studies done in the catchment (Abel et al., 2003). Some of these analyses involved novel approaches to incorporating expert judgment (including local knowledge and experience) along with scientific data. The analyses involved researchers and technical experts from CSIRO, universities, private consultancies, Victorian state land management agencies, and the Goulburn Broken Catchment Management Authority.

Results of these analyses were made available in the jury meetings, which lasted for one day. To facilitate convergence of viewpoints, the approach of multi-criteria evaluation was adopted, as described next.

6.5. Introducing Deliberative Multi-Criteria Evaluation

We combined the deliberative process of the stakeholder jury with method of *multi-criteria evaluation*. The resulting process was labelled Deliberative Multi-Criteria Evaluation (Proctor & Drechsler, 2003, in press). This was needed for two primary reasons. First, since making decisions about ecosystem services requires consideration of a wide range of biophysical, social, and economic data, by people with sometimes differing values and beliefs, a method was needed to make these trade-offs clear to the decision makers. Second, since the value (monetary or otherwise) of environmental benefits depends on people's understanding and perceptions of those benefits, a method was needed to help decision makers be aware of the best available information before making a decision.

Multi-criteria evaluation is a means of simplifying complex decision-making tasks that may involve many stakeholders, a diversity of possible outcomes, and many and sometimes intangible criteria by which to assess the outcomes. It is an effective way to identify trade-offs in the decision-making process and to achieve compromise. It also provides structure and transparency to the decision-making process. Alternatives, or options, are identified and investigated, a set of criteria is identified to rank these alternatives, preferences or weights are assigned by decision-makers, and this information is used to explore a satisficing outcome. These characteristics made multi-criteria evaluation a key (although not sufficient) component of our integration strategy in the Goulburn Broken catchment study. The process we followed is described below (Section 7), in some detail.

6.6. Facilitating Communication

The concept of ecosystem services was a useful integration tool in that it helped us bring together information and people with very different backgrounds in ways that addressed many of the needs of policy-developers, land managers, and other decision makers. It provided a framework for thinking about the benefits of different options in a way that had meaning for people with different backgrounds.

Due to the high priority of communication in this project, we developed a communication strategy in partnership with a group of communication professionals. It had the following components:

- encouraging two-way communication on ecosystem services between the research team and stakeholders, through a variety of vehicles, including Internet, e-mail networks, newsletters, workshops, public forums, and media interviews and features;
- ensuring ecosystem services become central to national policy debates on natural resource management, through developing networks with policy makers;
- creating understanding of the importance of ecosystem services among landholders, through regional communication plans and extension staff;
- facilitating the creation of markets for critical ecosystem services, through developing networks with the investment community; and
- creating national awareness of the ecosystem services project, through media, partner networks, and an education strategy.

From the very beginning of the study, the focus on communication was to promote mutual understanding and learning among the stakeholders.

7. The Deliberative Multi-Criteria Evaluation Process

The aim of the Deliberative Multi-Criteria Evaluation process was to achieve integration of ideas, values, beliefs, and information among the participants, while making the inputs and outputs of that decision-making process open to inspection and analysis. The process was implemented in relation to only one major issue, i.e., ecosystem services supporting tourism and recreation in the upper catchment.

7.1. Preparatory Steps

Prior to the formal jury meeting, the jury members developed a set of scenarios (options) for the future land management of the upper catchment (Table 2) and a set of criteria for assessing the relative merits of these options (the left-hand column in Table 3). An impact matrix (Table 3), showing values for each of the assessment criteria, was prepared by experts from various organisations.

Table 2: *Five Options for Managing Tourism and Recreation in the Upper Catchment* (indicating which types of management are included in each option)

	Current	Max ES	Max Soc	Max Ec	Mix
On-site management:					
Fences	S	✓	S	X	S
Boardwalks	S	✓	S	X	S
Toilets	S	✓	S	X	S
Car parks	S	✓	S	X	S
Horse yards	S	✓	S	X	S
Weed control	S	✓	S	X	S
Riparian zone management:					
Fencing		✓	X	X	S
Demand management:					
Scheduling/ closures/ limiting numbers		✓	✓	X	S
Marketing sustainable activities		✓	✓	X	S
Use of private land		✓	✓	X	S
Education:					
Signs/ pamphlets		✓	X	X	S

✓=present, X=not present, S=some present

Note. The Options are: *Current*--a continuation of current policies and practices; *Max ES*--a strategy of strong protection of threatened ecosystems, allowing little utilisation by industries; *Max Soc*--a strategy to maximise social outcomes by maximising employment, job creation and job training in the recreation and tourism industries, with minimal regard to environmental protection; *Max Ec*--a strategy to allow access to all areas and to maximise short-term profits to the recreation and tourism industry; *Mix*--a sustainable tourism/ society/ environment mix that incorporates the items found in the Goulburn Broken Catchment Management Authority Upper Goulburn Recreational Waterway Strategy. For more details, see Proctor and Drechsler (2003, in press).

Table 3. *Impact Matrix Showing Values for a Set of Assessment Criteria (left-hand column) Against the Options*[1]

	Indicator	Current	Max ES	Max Soc	Max Ec	Mix
Ecosystem services:						
Water quality	*mg/l* P[2]	0.02	0.005	0.05	0.1	0.0
Water quantity	Discharge '000 megalitres	150	250	100	125	150
Biodiversity	QI[3]	6	10	3	5	10
Sediment filtration	QI	3	8	6	8	8
Erosion control	QI	7	10	7	4	7
Nutrient management	QI	3	8	7	3	8
Shading	QI	5	10	6	2	8
Stream health	ISC[4]	35-41	42-50	35-41	26-34	35-41
Aesthetics	QI	5	8	6	2	7
Social and cultural:						
Public access	QI	5	1	7	10	5
Jobs	'000	15	18	20	25	18
Cultural/ Heritage sites[6]	BI[5]	0	1	1	0	1
Education[6]	BI	0	0	1	0	1
Economic:						
Costs	AUD mn	2.5-3.5	0	2.5-2.5	0	18.3
Benefits	AUD mn	5.5-6.5	0	6.4-49	4.3-40.1	9-57.3

Note. Taken from Proctor and Drechsler (2003, in press) and Abel et al. (2003).
[1]The options are described in Table 2
[2]milligrams per litre of phosphorous (*mg/l* P)
[3]Qualitative index: High = 10, Low = 1
[4]ISC = Index of stream condition: Very poor = 0-19, Poor = 20-25, Moderate = 26-34, Good = 35-41, Very good = 42-50
[5]Binary index: 1 = present, 0 = not present
[6]These were added during the stakeholder jury meeting

Before the jury meeting, the jury members were asked to rank the assessment criteria (Figure 2a). These rankings were used, in conjunction with the impact matrix, to produce an initial scoring of the options (Figure 3a). The implications of each juror's preferences were assessed and then aggregated using a multi-criteria decision software program called *ProDecX* (Klauer, Drechsler, & Messner, 2002; Proctor & Drechsler, 2003, in press). The procedure compares preferences for all options in a pair-wise manner for each criterion. This means that for options that consistently have a low preference, the resulting value can be negative (Figure 3). Figure 2 also shows a measure of the variability (uncertainty, standard deviation) of each aggregated value as a positive number. Note the high level of disagreement among jurors at this stage, indicated by the disparate rankings in Figure 2a and the high uncertainties in Figure 3a.

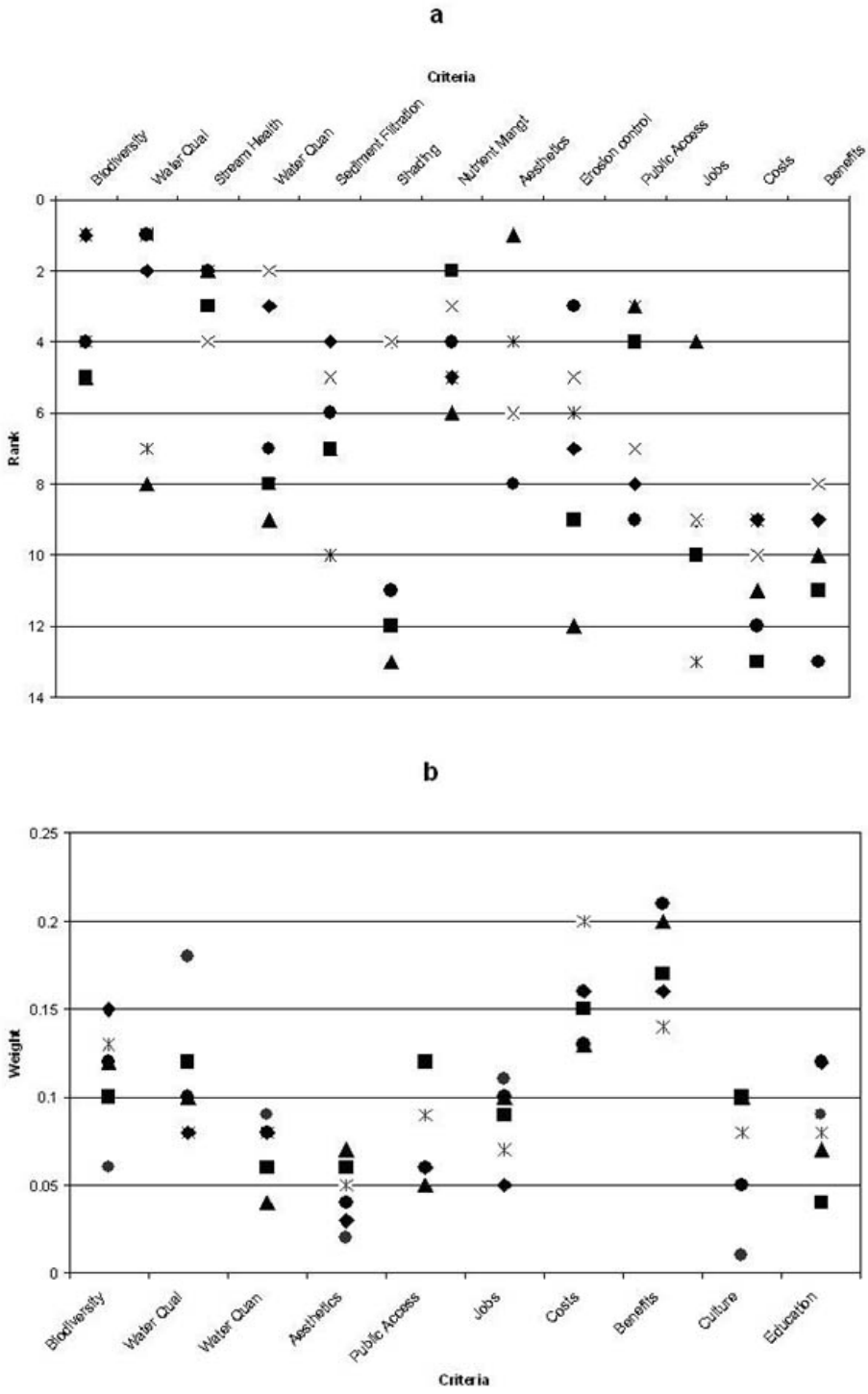

Figure 2. Jury Rankings of Assessment Criteria: (a) at the Beginning of the Jury Meeting, and (b) at the End

Note. Different symbols denote individual jurors. Note that, as a result of the jury's deliberations, a smaller number of criteria were used at the end.

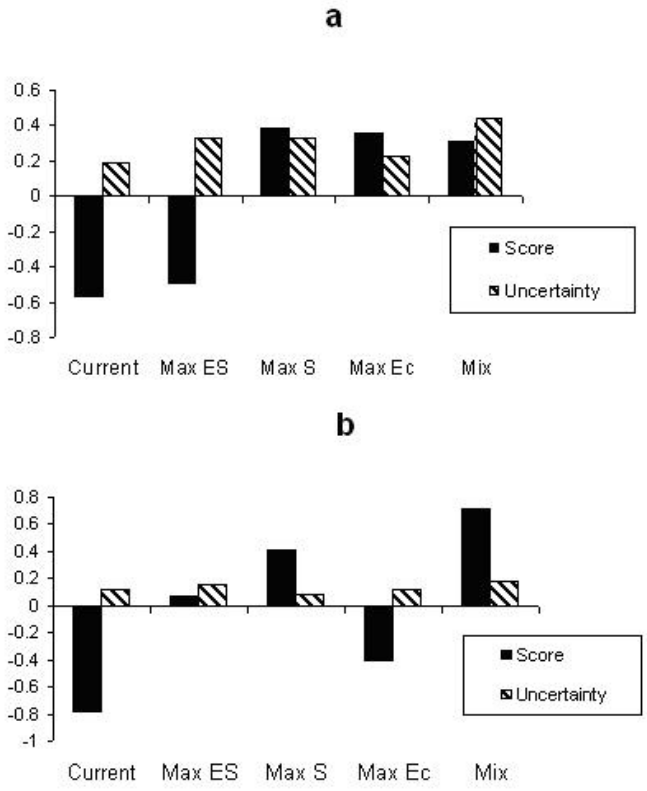

Figure 3. Preference Scores and Uncertainties for Each Option after Aggregation of Scores by Individual Jury Members using *ProDecX:* (a) Prior to the Jury Deliberations, and (b) after the Deliberations

Note. The options are as in Table 2.

7.2. The Jury Meeting

At the jury meeting, which lasted for one day, the members were asked to consider the information contained in the impact matrix (Table 3) as well as information provided to them during their questioning of four experts (an employee of the local water authority, an environmental manager, a state government natural resource manager, and a member of the local parliamentary council). Using *ProDecX* and a whiteboard to explore the implications of changing their weightings, they debated the issues until consensus was reached.

An example of the sort of insight that emerged was the initial ranking of the Sustainable Mix (Mix) option as third (Figure 3a). This option was based on the strategy that was about to be

implemented in the catchment with the support of the organisations that were represented by the jury members.

At the end of the meeting, preferences for assessment criteria (Figure 2b) and the rankings of options (Figure 3b) had changed dramatically and levels of disagreement about rankings were much lower (Figure 3b).

7.3. Sensitivity Analysis

Sensitivity analysis allowed us to assess how critical a consensus on the criteria weights was, which criteria have the biggest effect on variability in the ranks, and at which point in the decision process sufficient consensus on the criteria weights has been reached in order to come to a fairly unique rank order of options. In this study the sensitivity analysis revealed that exact consensus on the weights for criteria was not important but that the process of each jury member defending their weightings in discussion was vital because of the important information that was revealed.

7.4. Outcomes

The deliberative multi-criteria evaluation drew attention to inconsistencies between expectations of some key stakeholders and the current regime of recreation and tourism strategies (the “business as usual” scenario). The stakeholder jury endorsed the Sustainability Mix strategy after considering new information and one another’s viewpoints. The process and stakeholder involvement were too limited to expect them to lead to rapid changes in policy, but the potential of approaches like this was demonstrated to the community leaders in the catchment. Their feedback indicated that they saw it as a promising way to deal with complex and apparently intractable decision challenges.

8. Concluding Reflections

8.1. On Using Integrative Concepts

The integrative concept of *ecosystem services* was both useful and problematic. The concept was useful as a way to bring people from different backgrounds together to discuss issues of broad public importance. Most stakeholders involved in these discussions said that they gained a clearer understanding of the issues. The concept was a *communication device* that tackled issues previously addressed within the discipline of economics. Some economists argue that these issues still are more rigorously dealt with within economics.

It is important to realise that a concept such as ecosystem services is not intended to replace economics or ecology as disciplines, but only bridge them to some extent. Indeed, this is a major challenge for any integrative framework if it provokes negative reactions from established disciplines. In our view, one of the benefits of applying the concept of ecosystem services was that it exposed some of the differences in thinking and approach not just between ecologists and economists, but also between these sciences and thinking outside science. We suggest that addressing these differences remains a major challenge for science, especially at a time when the role of science in society's decision making is increasingly under question.

Our experience with over 40 community members in the Goulburn Broken catchment revealed the power and importance of the words being used for integrating ecological and economic ideas. There was overwhelming comfort with the concept of ecosystem services from the first workshop. Many farmers understood immediately that their business is managing ecosystem services on behalf of society, and that these new buzz words potentially gave greater recognition to the role of land managers in society.

Table 4. *Differences in Language and Concepts Used by Scientists and Non-Scientists*

Language of scientific papers	**Language and concepts of non-scientists**
Hydrological connectivity	Maintaining biodiversity
Geomorphic recovery	Flood and erosion control
Sediment regimes	Drinkable water
Soil porosity	Pest control
Transverse sediment transport	Recreation
Phosphate sorption	Cultural values

Note. Items in rows do not correspond one to one, because the differences are not just in the language but also in the way big issues and concepts are sub-divided.

However, there were difficulties too. It was clear from early in the project that perceptions of ecosystem services could differ between scientific disciplines and between scientists and non-scientists (Table 4). For example, most non-scientists see the provision of clean water as a service from ecosystems. But biophysical scientists identify and specialise in an array of processes that contribute to the production of clean water, including filtration of sediment, above and below ground water flows, breakdown of toxins, interactions among species and ecological communities that regulate potential pathogens, and the roles of plants, fungi, and a range of animals in maintaining soil structure and function.

Similarly, economists like to think in terms of *production functions*, i.e., the relationships between a set of inputs and a set of outputs. Estimating the marginal value of an output requires thinking about how the production of that output might change if a set of inputs changed marginally and all other parts of the system stayed constant. In ecosystems, any set of inputs is likely to affect several ecosystem services simultaneously and possibly in different directions, making marginal valuation of individual services almost impossible.

On the other hand, being forced to think about ecosystem services encouraged scientists to think about how their analytical frameworks could be made compatible with the thinking of non-scientists. Educational psychologists alerted us to concepts like the *zone of proximal development* or *scaffolding* (Newman, Griffin, & Cole, 1989), which postulates that people are only able to accept concepts and information that fall within or close to their current understanding of the world. Communicating new concepts requires building links from their current worldview. We suggest that scientists often fail to recognise that their concepts are foreign to scientists or non-scientists with different backgrounds.

The dialogue created around ecosystem services helped achieve better understanding between ecologists and economists in the course of the study. In many studies involving ecologists and economists working together, there has been a tendency to allow the economists to deal with the valuation side and the ecologists with the ecology. Because we struggled so much with defining what “service” or “value” mean, and because we had many long discussions about how ecosystem processes should be mapped to ecosystem services, the ecologists learned a lot more about the assumptions of economics than they would normally have done and the economists understood the constraints of ecological analyses.

As a result of this dialogue, we realised that any focus on measuring the economic value of ecosystem services could be naïve for several reasons. “Value” has a specific meaning in economics, relating to the difference between what people have to pay for something versus what they are prepared to pay. What people are *willing* to pay for ecosystem services depends on their understanding of those services. What they *have* to pay depends on how well ecosystem services are recognised in institutional arrangements. Our focus therefore changed to improving the understanding of decision makers about benefits from ecosystem services, understanding the financial implications of alternative land management policies, and investigating different institutional arrangements that could lead to greater recognition of ecosystem services and greater human welfare outcomes.

We also realised that the types of biophysical information required to estimate marginal changes in ecosystem services was generally not available. This caused us to incorporate expert judgement in our modelling where quantitative information was not available and to present the information in ways that allowed marginal changes to be explored visually by decision makers.

8.2. On Using Participative Decision-Making Processes

Overall, the jury members regarded the Deliberative Multi-Criteria Evaluation process to be useful in terms of breaking down the complexities of the decision problem and identifying the trade-offs involved while allowing participants to be enlightened and fully informed in making such decisions. It was also thought that such a structured and facilitated process allowed for greater discussion in a non-emotive atmosphere with all participants are given ample time to reflect and discuss where needed. Some jurors considered that the revealing of preferences and information from their work colleagues who were also on the jury was an enlightening process in itself and allowed for a much more integrative approach in tackling such difficult natural resource management problems.

We encountered some objections to the Deliberative Multi-Criteria Evaluation process. Some economists question the assumptions of this process, illustrating that participative approaches to decision-making can provoke negative reactions from the experts. We acknowledge the importance of these debates, which help to encourage development of the theoretical bases for new approaches but stress that the achievements of a truly integrative process across disciplines and communities requires us to think beyond our own disciplinary teachings and interests in order to obtain more integrative and acceptable solutions.

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