Integrated assessment of public investment in land-use change to protect environmental assets in Australia

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11 January 2011
Working Paper 1108
School of Agricultural and Resource Economics
http://www.are.uwa.edu.au

This is a pre-publication version of:
Pannell, D.J., Roberts, A.M., Park, G., Alexander, J., Curatolo, A. and Marsh, S. (2012). Integrated assessment of public investment in land-use change to protect environmental assets in Australia, *Land Use Policy* 29(2): 377-387.

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Citation: David J. Pannell[a,c,*], Anna M. Roberts[b,c,d], Geoff Park[c,e], April Curatolo[b], Sally P. Marsh[a] and Jennifer Alexander[b] *Integrated assessment of public investment in land-use change to protect environmental assets in Australia* Working Paper 1108, School of Agricultural and Resource Economics, University of Western Australia, Crawley, Australia.

Abstract

A framework for comprehensive integrated assessment of environmental projects is developed and applied in partnership with a regional environmental body. The framework combines theory with practice, bringing a pragmatic and efficient approach to the rigorous assessment of projects for a large number of environmental assets in the north central region of the state of Victoria, Australia. Key features of the study include extensive participation of decision makers and stakeholders, integration of a comprehensive set of information about projects, explicit assessment of uncertainties and information gaps, and analysis of the most appropriate policy mechanism for each project. The process of applying the framework involved four steps: identification of around 300 important environmental assets in the region, filtering the list of assets to remove those that are less likely to provide opportunities for cost-effective public investment, development and detailed assessment of projects for a subset of assets, and negotiation of funding for projects. The analysis assisted the environmental body to make strong business cases for a number of environmental projects, resulting in funding for those projects. Implications for land-use policy include that environmental projects vary widely in their cost-effectiveness, requiring careful targeting of funds if environmental benefits are to be maximised. Many existing environmental programs use simplistic analyses to support decision making, resulting in missed opportunities for substantially greater environmental benefits. Promoting adoption of improved analytical methods is very challenging, requiring changes in mind-set and culture in environmental organisations. Widespread adoption is unlikely unless funders create incentives by rewarding those project proponents who undertake rigorous and comprehensive project assessments that focus on achievement of environmental outcomes.

JEL codes: Q20, Q50

Introduction

There are many policy programs around the world that attempt to alter land use or land management in order to improve environmental conditions. Examples include the Conservation Reserve Program in the United States of America (Bangsund et al., 2004); Rural Development policy in the European Union (European Commission, 2008); the National Farm Stewardship Program in Canada[1]; and Caring for our Country in Australia (Anonymous, 2008).

Evaluation of proposed investments in these programs is very challenging. For example, Hajkowicz (2009) notes that reports from various OECD countries (GAO, 2002; OECD, 2002; Auditor General, 2008) have identified difficulties in targeting, monitoring and evaluating expenditure under environmental programs.

The challenges are many and varied. Analysts wishing to contribute to decision making processes must often deal with severe knowledge gaps (Hennessey and Mischini, 2006), lack of clarity about goals (Auditor General, 2008), limited funding (Fuller et al. 2010), the need to integrate diverse information types (Ferraro, 2004; Wallace, 2006), institutional complexities

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[1] http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1181580519716&lang=eng (accessed 23 Dec 2010)

(Seymour et al., 2008; Sterk et al., 2011), and the need to compare benefits of different types. Not surprisingly, many programs are implemented without being informed by analyses that deal well with these issues (e.g. Falconer and Saunders, 2002; Weinberg and Claassen, 2006), and this limits the potential for programs to achieve valuable environmental outcomes. Australia faces the same set of difficulties as elsewhere. It is now well recognised that there is substantial scope for improvement in the design and implementation of Australian environmental programs that focus on land-use change (Auditor General, 2008; Hajkowicz, 2009; Pannell and Roberts, 2010).

The North Central Catchment Management Authority (NCCMA) engages with its regional community in planning and delivering publicly funded projects to conserve land, water and biodiversity assets in the north-central region of the state of Victoria. It is one of 56 similar bodies around Australia (Seymour et al., 2008). NCCMA was concerned about the effectiveness of some of its existing projects, and in 2005 formed a partnership with us to attempt to improve the achievement of environmental outcomes from public investment. Initially, the focus was on dryland salinity (Roberts and Pannell, 2009). From late 2007, at the request of NCCMA, the work was broadened to include projects addressing all types of environmental threats in the region, including soil erosion, declining water quality, loss of habitat, and pest invasion. The broader approach encompasses all types of natural assets in the region, including wetlands, waterways, biodiversity (e.g. native vegetation and threatened species protection) and agricultural land.

All of the challenges listed earlier were creating difficulties for NCCMA. Working in partnership, we set out to undertake a rigorous, integrated and comprehensive analysis to support their decision making about investment priorities. A variety of studies have analysed the spatial targeting and prioritisation of environmental investments (e.g., Antle and Valdivia, 2006; Ferraro, 2004; Khanna et al., 2003; Watanabe et al., 2006; Wilson et al., 2007; Yang et al., 2005). The methods used here were developed with an awareness of these studies and of a number of existing tools, models and frameworks, including Assets, Threats and Solvability (ATS) (Hajkowicz and McDonald, 2006), Conservation Action Planning[2], and Multicriteria Landscape Assessment and Optimisation (MULBO) (Meyer and Grabaum, 2008). We found than none of the existing tools provided the desired combination of usability, rigour and comprehensiveness. For example, none included the capacity to analyse the choice of policy mechanisms, most did not adequately consider landholder behaviour, and many were too complex for non-specialists to use.

A novel framework was developed to meet the specific needs of this study. Results had strong implications for the priorities of the NCCMA, and have had a profound impact on their resource allocation. In addition, they have strong implications for the policy programs that provide funding to the NCCMA and similar organisations, in Australia and elsewhere. These will be discussed, and current responses by Australian governments to these implications will be outlined. The framework developed for this analysis is broadly applicable to other environmental management bodies, and has since been adopted by a number of them. Progress with, and prospects for, broader adoption of the framework are discussed.

Thus, the aims of study are (a) to identify improved priorities for land-use change projects in the north-central region of Victoria, (b) to identify implications of this work for associated

[2] http://conserveonline.org/workspaces/cbdgateway/cap/index_html (accessed 27 Dec 2010)

land-use policy programs, and (c) to consider issues around broader adoption of the framework developed.

Methods

Overview of the integrated assessment framework

We identified a set of requirements for the methodology of the analysis based on discussions with NCCMA, review of existing projects and processes, discussions with managers of policy programs who provide funding for projects, and review of other relevant analyses and tools. The requirements for the methods relate variously to content, timing, communication and process.

(a) *Consideration of a comprehensive set of information*. Past prioritisation processes used by NCCMA had been relatively simple. They had considered only a subset of relevant information, most commonly information about environmental threats and project costs. We identified a much longer list of information that should be considered when evaluating potential environmental investments, all of which were included in the analysis:

- Clear identification of the environmental asset(s) to be protected or enhanced, including spatial location and extent;
- The significance or value of each environmental asset, relative to others;
- The threats that are affecting or are likely to affect the environmental asset;
- Specific, measurable, time-bound goals for each asset;
- Works and actions that are proposed to be undertaken to achieve the goals;
- The time lag between undertaking the project and the generation of benefits;
- The future degree of environmental damage with and without the proposed work and actions;
- The risk of technical failure of the project;
- Positive and negative spin-offs from the project (e.g. impacts on other environmental assets);
- The likely extent of adoption by private landholders of the works and actions that would be required to achieve the stated goals;
- The risk that, despite new public investment, private landholders will adopt new works and actions that would further degrade the environmental asset;
- Legal approvals required to undertake the works and actions;
- The policy mechanisms/delivery mechanisms to be used to encourage and facilitate uptake of the required works and actions;
- Socio-political risks;
- Costs of the current project;
- Annual maintenance costs required to maintain benefits after the current project is complete; and
- The risk of not obtaining those essential maintenance costs, such that project benefits are lost.

(b) *Able to analyse several hundred potential projects in a reasonable time frame*. Given the expectation that there would be several hundred projects in contention, it was not considered feasible to apply a fully comprehensive analysis to every possible project. Indeed to do so would not be an efficient use of the organisation's human resources. Therefore we developed an approach in which an initial simple analysis eliminates some projects, followed by detailed analysis of projects that are more likely to be worth the effort. The approach starts with staff and community members spatially identifying important environmental assets in the region – every asset considered important by any stakeholder group was included on the list. Then a simple filtering process is applied, involving application of a set of key criteria (more details below) to reduce the full list of asset-based projects to a smaller set judged to have good prospects of being worth analysing in detail. A detailed analysis (also explained below) was applied to assets on this shorter list. We recognise that there is a risk that this pragmatic approach may result in some good projects being discarded prior to the detailed-analysis step. Nevertheless, given that the supply of funds for environmental projects is always much too small to resource all possible projects, there will still be more than sufficient cost-effective projects proceeding through the process to utilise the available funds.

(c) *Participation of environmental managers and stakeholder organisations*. In order for the results of the analysis to be accepted and utilised by the organisation, it was important for staff and board members of the organisation to be involved in conducting the analysis to the fullest extent possible. The strategy developed included extensive involvement of people from the organisation and other stakeholders at all three stages of analysis. Stakeholders involved were from the Victorian government, water authorities, local government, technical experts, non-government orgaisations, conservation and other community groups. At the asset-identification stage, staff, board members and stakeholders contributed to the generation of the list of important assets. At the asset filtering stage, a committee drawn from these groups applied the simplified set of criteria to the full set of important assets. At the detailed assessment stage, small teams of staff were responsible for collecting and processing the information required. Results were provided and explained to the board of the organisation for decision making.

(d) *Consultation with the community and technical experts*. It was important to capture values, preferences and knowledge from members of the community for use in the analysis. Ten community workshops were held in different parts of the region. These were open to the public and attracted 20 to 50 participants in each, totalling around 300 participants. The main purpose of these workshops was to identify assets that community members considered to be important (i.e. the asset identification stage), but a range of additional information was captured and used later.

Technical experts were used extensively, including specialists in ecology, rivers, wetlands, pests and agriculture. A range of experts contributed to all three stages of the analysis. There were two workshops with technical experts, and then these and other experts were involved in providing information needed for the filtering and detailed assessment stages. Altogether, around 20 experts contributed, drawn from local government, state government (Department of Primary Industries and Department of Sustainability and Environment), water authorities, and non-government conservation organisations.

(e) *Training and support*. Given the changes in thinking and procedure required to implement the new approach, training was a crucial component. We developed a two-day training program for staff to explain the procedure and its logic, to allow discussion of concerns, to identify and correct misconceptions and to discuss the likely challenges that they would face. The overall process was codified and documented as a step-by-step procedure. At each stage, the researchers provided detailed guidance, assistance and feedback.

(f) *Simplicity and user-friendliness*. The set of information listed at (a) is much more extensive than the information that had previously been considered by the organisation. Some participants more used to simplistic approaches to project development and prioritisation argued that the new approach was too complex and difficult, and some had difficulty understanding particular important concepts. For these reasons, an important methodological requirement was to make the approach as simple and clear as possible, without sacrificing information and concepts that we considered essential. In response, we included a simple filtering stage prior to detailed project assessment, and the detailed assessment stage was designed to be simple and easy to understand. It was supported by a web-based project assessment form, including context-sensitive help and Frequently Asked Questions.

(g) *Dealing with uncertainty*. There are usually important uncertainties or knowledge gaps associated with environmental projects (e.g. Newburn et al., 2006; Hennessey and Mischini, 2006). To deal with information weaknesses, three key elements were included in the third stage of the process (detailed project assessment): (i) the team conducting each analysis rated the quality of information available, (ii) key knowledge gaps were identified and recorded, and (iii) the project description for each asset was required to state explicitly how knowledge gaps would be managed. Options for the latter included: information was adequate to proceed to project implementation; there were information gaps that would be addressed as part of the project; the project would start with a feasibility assessment phase for say the first year; or information gaps were so pervasive and serious that further research was needed before any project could be evaluated.

(h) *Identification of appropriate policy mechanisms*. Previous analysis of Australian salinity projects (Ridley and Pannell, 2005) had found that many projects employed inappropriate policy mechanisms. For example, a common problem was relying on education and awareness raising to promote practices that were economically highly unattractive to landholders (Pannell et al., 2006; Kingwell et al. 2008). There exist many papers and reports concerning the selection of policy mechanisms for environmental programs (e.g., Aidt and Dutta, 2004; Bruneau, 2004; Hodge, 2000; Jensen and Vestergaard, 2003; Richards, 2000; Weitzman, 2002). Most of these studies included a relatively narrow range of policy mechanisms, and involved relatively complex analysis. However, the Public: Private Benefits Framework of Pannell (2008, 2009) included a broad range of mechanisms in an approach that was simple enough for environmental managers without a background in economics to understand, so it was built into the process.

Based on the levels of public net benefits (i.e. external benefits) and private net benefits arising from a project, the framework recommends a mechanism out of extension (i.e. communication, education, etc.), positive incentives, negative incentives, technology development and no action. Potential incentive mechanisms consist of financial or regulatory instruments that potentially include polluter-pays mechanisms (e.g. command and control, pollution tax, offsets), beneficiary-pays mechanisms (e.g. subsidies, conservation auctions and tenders), and market-based mechanisms (e.g. tradable pollution permits)

Figure 1 illustrates the version of the Public: Private Benefits Framework that was used in this study. It is based on an assumption that any investment should generate a Benefit: Cost Index of at least 2. As the framework is fully documented by Pannell (2008), its theoretical basis and explanations behind the choice of policy mechanisms are is not presented here.

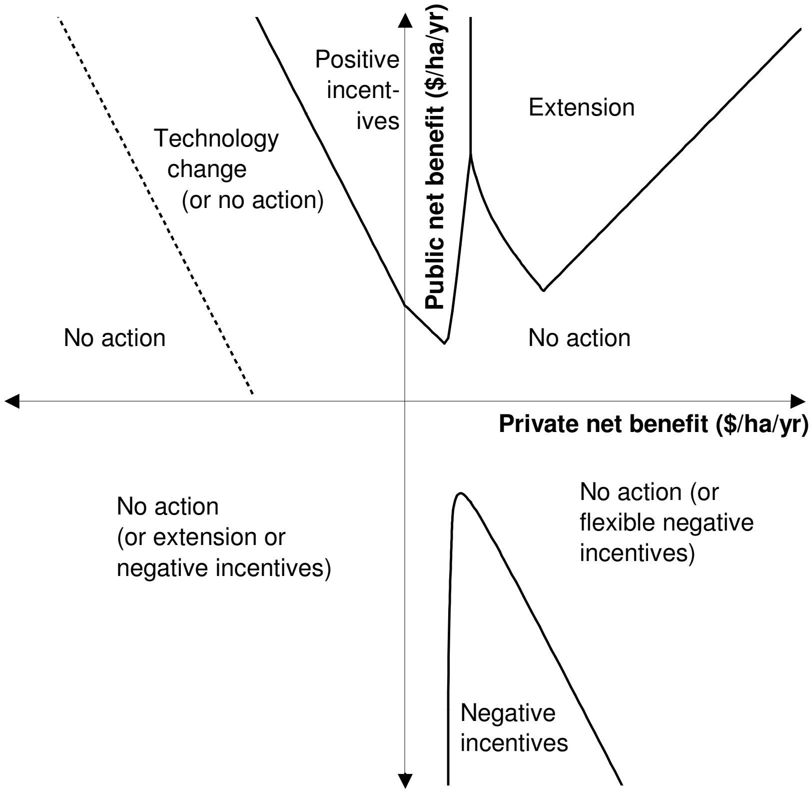

Figure 1. Public: Private Benefits Framework as used in this analysis (source: Pannell, 2009).

(i) *Testing for internal consistency of projects*. We found that many existing projects were not internally consistent: the works and actions being sought (if indeed they had been specified) would not actually achieve the project goals, and/or the policy mechanisms being used would not deliver the desired works and actions. To address this, the detailed project assessment process included a series of seven consistency checks, in which participants were required to confirm that particular responses were consistent with earlier responses.

(j) *Accounting for time*. Time considerations, affecting both the benefits and costs of projects, were accommodated in the detailed assessment stage. Long time lags until benefits are realised can have a large impact on project cost-effectiveness (Graham et al., 2010). To allow for this, we elicited the time lag until the majority of benefits were expected, and used standard economic discounting methods (Hanley and Spash, 1995) to express benefits in 'present value' terms (using a real discount rate of 5 per cent). Costs were expressed separately for an initial project phase (three years) followed by annual maintenance costs, which were assumed to be required for 20 subsequent years. Discounting was applied to the maintenance costs but, for simplicity, not to the initial project costs, introducing a very slight upward bias in costs.

(k) *Expressing asset significance or value quantitatively*. In previous decision processes used by NCCMA, asset significance or value was not assessed. In this study, two options for representing asset value were considered: a scoring system which would allow asset value to be expressed relative to some standard asset, or the use of non-market valuation (Champ et al., 2003; Kanninen, 2007) to provide dollar values for each asset. The scoring system was chosen for two reasons: non-availability of relevant non-market values for all assets being assessed, and discomfort by some stakeholders with the concept of expressing environmental values in dollar terms. However, if preferred, and if the information was available, use of non-market values in the scoring metric would be straightforward. A benchmark score of 100 (corresponding to an asset value of A$2 billion) was defined for assets of high national significance, and other assets were scored relative to this.

(l) *Calculation of cost-effectiveness of projects*. The final requirement we identified was for the detailed project analysis to focus on the efficient achievement of environmental outcomes. Previous processes used by NCCMA and other similar organisations had evaluated projects on the basis of the severity of threats, and/or expected cooperation from landholders, without considering the feasibility of reducing the threats, and without connecting the works and actions to outcomes, both of which are crucial when considering the efficiency of projects. Hanley et al. (1999) also observe that evaluation of agri-environmental programs in the United Kingdom has tended to be based on participation rather than efficiency of achieving outcomes. To foster the focus on outcomes, the process used in this study emphasised the identification of particular environmental assets that were intended to benefit from the projects. Assets were defined spatially as the starting point for the analysis.

The set of information specified at (a) was chosen as the essential set required to fully evaluate environmental outcomes. The information was combined into a Benefit Cost Index (BCI), which was used to rank projects by cost-effectiveness.

$$BCI = \frac{V \times W \times F \times A \times B \times P \times G \times DF_B(L) \times 20}{C + PV(M)} \qquad (1)$$

where

V = significance or value of the asset (score out of 100)

W = multiplier for proportional impact of works on asset value

F = multiplier for technical feasibility risk (probability that the project will not fail due to problems with technical feasibility)

A = multiplier for adoption of changed management by private landholders (proportion of adoption level required to achieve goal)

B = multiplier for risk of adoption of adverse practices (probability that the project will not fail due to adverse adoption)

P = probability that socio-political factors will not derail the project, and that required changes will occur in other institutions

G = probability that essential funding subsequent to this project will be forthcoming (e.g. this project may be the first phase in a longer project, or ongoing payments to landholder may be needed to retain the benefits generated by this project).

L = time lag until the majority of anticipated benefits from the project occur (years)

DF_B = discount factor for benefits (proportion), depending on L. Consistent with standard economic theory, the discount factor is calculated as $DF_B(L) = 1/(1 + r)^L$, where r is the real discount rate, assumed to be 5%.

C = short-term cost of current project ($ million in total, over the three-year life of project)

M = annual cost of maintaining outcomes ($ million per year, beyond the immediate project).

$PV(M)$ = present value function to convert a stream of future annual maintenance costs (assumed constant in real terms) to a total equivalent present-day value. Assuming that the discount rate is 0.05 and the time frame for paying these costs is 20 years, commencing in year 4, $PV(M) = 10.7 \times M$.

Of the 16 information items listed at (a), 13 contribute to the calculation of the BCI. The remaining three are either embedded within BCI calculation (policy mechanism) or are captured qualitatively (legal approvals, spin-offs from the project).

A design feature of the *BCI* is that it allows cost effectiveness to be compared across projects of different scales (spatial, temporal or budgetary) and across different types of natural resource assets (e.g. rivers, wetlands, threatened species, agricultural soils). A higher *BCI* is preferred, irrespective of project scale or asset type.

Equation (1) differs from many scoring metrics used for environmental decision making in that it does not involve addition of weighted variables (e.g. Hajkowicz and McDonald, 2006). Because the value of benefits from a project is proportional (or approximately so, in the cases of A and B) to each variable in the numerator, it is important that they be multiplied rather than added in order to rank projects accurately. Inclusion of weights in the multiplicative equation would make no difference to the ranking of projects.

The *BCI* is useful for comparing alternative projects competing for a fixed budget. If the question is whether the overall budget should be increased, we would ideally like to have available dollar values for the environmental assets, rather than the score V. In the absence of non-market values, an approximate guide is to assume that a V score of 100 corresponds to a total dollar value of $2 billion. Given that assumption, the BCI formula is designed to behave similarly to a Benefit: Cost Ratio, in that a BCI exceeding 1.0 is desirable. This is achieved by including the 20 factor at the end of equation (1) to scale the results appropriately.

Summary of the procedure

Elements of the procedure have been discussed above. In overview, the step-by-step procedure developed for the analysis was as follows. The approach has been documented as the Investment Framework for Environmental Resources (INFFER, see www.inffer.org) in order to make it available to other environmental managers.

Step 1. Asset identification. A list of 287 important environmental assets in the NCCMA region was developed from the community workshops and input from other stakeholders. Information about each of the assets was entered into a database and each asset was identified spatially.

Step 2. Asset filtering. The list from step 1 was filtered to remove assets with low probabilities of supporting cost-effective investments. This process was conducted in a two-day workshop involving around 30 invited participants, including staff from the NCCMA, staff from state government agencies and other people with knowledge of the environmental assets. Participants were assigned to one of three groups, which worked on wetlands, waterways and biodiversity respectively. In the first phase of filtering, a simple likert-style scoring criteria was used to assess two criteria: asset significance (exceptional, very high, high or moderate) and the severity of threats to asset condition (very high, high, moderate, low).

Assets that scored exceptional or very high for significance and very high or high for threats were subjected to a second phase of filtering. In the second phase, workshop participants responded to five yes/no questions about each asset:

- Is the environmental or natural resource asset identified clearly, including spatially?
- Will it be possible to define a goal for the asset that is specific, measurable and time-bound?
- Is there evidence that management actions can make a real difference, sufficient to achieve a worthwhile goal for the asset?
- If the desired works and on-ground actions are mainly on private land, is it likely that full adoption of those actions (over the required scale) would be reasonably attractive to fully informed land managers?
- If the project requires changes by other organisations (e.g. local government, state government departments) is there a good chance that this will occur?

An asset was required to have 'yes' responses to most (and ideally all) questions in order to proceed to Step 3. Following the two stages of filtering, of the original 287 assets, only 33 were deemed suitable for detailed analysis.

Step 3. Detailed analysis of projects. From the list of assets developed in step 2, a subset of 11 was selected for detailed analysis. They were chosen on the basis of likely interest by funders (primarily the state government) and, in some cases, continuity of existing projects. For each detailed analysis, a person with good knowledge of the asset was nominated to lead and coordinate the process of collecting data and completing a template, the Project Assessment Form. In most cases, this person was a CMA staff member. They devoted approximately five days (with help from others) to the preparation of each analysis, although the time required varied depending upon the size and complexity of the project. Data came from a variety of sources, including technical experts, other CMA staff, and previous research. The researchers provided comment and feedback on several drafts of each project analysis.

Step 4. Negotiation of funding. There are two main funding sources for the NCCMA: the Victorian Government and the Australian Government. Information from the detailed project assessments was used to develop project proposals for either or both government investors. Notably, neither government required the level of comprehensiveness and rigour undertaken in this analysis.

The NCCMA undertook this process over two rounds, in 2008 and 2010. Over that time, approximately three months was allocated to step 1, one month to step 2, three months to step 3 and one month to step 4. (These time frames indicate the passage of time, rather than the work-time requirements of staff, most of whom were directly involved for only short times on any one task.) Around 30 of the 50 staff of the organisation, and around 25 outside stakeholders, were actively involved in the process in some way.

Results

Prioritisation of and filtering of environmental assets

Environmental assets identified in step 1 included wetlands, waterways, native vegetation and threatened species. Results from the first filtering process (based on asset significance and severity of all threats) are summarised in Table 1. From the 287 assets, 59 were identified as being of exceptional or very high value and under high or very high threat. Two assets (both critically endangered native grasslands) were of exceptional value and under very high threat (Avoca Plain and Patho Plains grasslands). Of the 57 other filtered assets, there were 10 wetlands, 14 river reaches, 17 areas of natural habitat and 16 threatened species/communities.

Table 1. Number of environmental assets falling into different rating categories for asset significance and threat, from step 1 of the analysis. Assets in shaded cells were subjected to additional criteria in Table 2.

Significance	Threat				
	Very high	High	Medium	Low	Total
Exceptional	2	0	2	0	4
Very high	27	30	21	10	88
High	12	46	36	14	108
Medium	3	16	39	29	87
Total	44	92	98	53	287

Table 2 shows that only 32 of the 59 assets met all five of the criteria in the second phase of the filtering process. There was a steady reduction in the number of assets still under consideration as the five criteria were progressively applied (from left to right). In other words, all five criteria played a role in determining the final set of projects to carry forward to step 3.

Table 2. Number of environmental assets remaining in contention for detailed assessment following a series of 'yes'/'no' questions to assess their suitability. The criteria are applied cumulatively from left to right.

Asset significance/ threat	Starting number (from Table 1)	Spatially explicit definition of asset	'SMART' goal could be specified	Technical effective-ness of works	High adoption by land-holders	Cooperation from other organisa-tions
Exceptional/ Very high	2	2	2	2	0	0
Exceptional/ High	0	0	0	0	0	0
Very high/ Very high	27	24	21	19	18	18
Very high/ High	30	26	20	16	15	14
Total	59	52	43	37	33	32

Detailed project assessment

Thirty-two of the originally identified assets were suitable to progress to detailed project assessment phase. Of these, only 11 were selected by the NCCMA to progress at the moment; the remainder were judged to be insufficiently well aligned with current funder priorities.

The two exceptionally high-value assets (Patho Plains and Avoca Plains grasslands) did not meet the pre-assessment filter criteria of landholder adoption. Despite this, the Victorian Government requested that proposals be developed, increasing the final number to 13 detailed project assessments.

Results for eight projects covering 12 assets are summarised in Tables 3 and 4. Two projects involved aggregations of multiple assets – one with four assets and one with two. These aggregations were made on the basis that the assets were similar in relation to threats, management actions, adoption and unit costs. One other assessment was not completed to a high standard and is not reported. (Each project was analysed by a different team of NCCMA staff with support and guidance of the researchers, and so there was variation in the quality of the analyses.)

Table 3 Scores from step 2 and budgets for assets

Asset name	Significance score	Threat score	Estimated project cost A$ million (over three years)	Funding received[A] A$ million
Upper Loddon and Campaspe river reaches (4 assets)	VH	H	1.9	2.5
Loddon River	VH	VH	2.5	3.3
Brush-tailed Phascogale[B]	VH	H	2.7	2.0
Avoca river reach 7	VH	VH	1.7	0.225
Northern Plains grasslands (Patho and Avoca Plains)[B]	E	VH	1.6	0.9
York Plains wetlands	VH	VH	3.8	2.5
Eleven threatened orchids	VH	VH	0.42	0.1
Grey-crowned Babbler	VH	VH	0.53	0

[A] Funding has only been received for two years so far. Further funding is expected.
[B] These projects were submitted for funding to both the Victorian and Australian Governments. Others were submitted only to the Victorian Government.

Table 4. Calculation of Benefit: Cost Indices for each of the eight final projects.

Asset name	*V*	*W*	*F*	*A*	*B*	*P*	*G*	*L*	*C*	*M*	Benefit: Cost Index
Upper Loddon and Campaspe river reaches (4 assets)	5	0.15	0.92	0.6	1	0.85	0.5	10	1.9	0.15	0.6
Loddon River	15	0.2	0.92	0.8	1	0.85	0.5	20	2.5	0.15	1.7
Brush-tailed Phascogale	5	0.25	0.92	0.6	1	0.85	0.5	10	2.7	0.07	1.0
Avoca river reach 7	3	0.25	0.87	0.6	1	0.98	0.5	17	1.66	0.05	0.8
Northern Plains grasslands (Patho and Avoca Plains)[B]	3	0.1	0.82	0.6	0.7	0.85	0.7	4	1.6	0.03	0.5
York Plains wetlands	5	0.5	0.87	0.6	1	0.98	1.0	7	3.8	0.1	3.7
Eleven threatened orchids	6	0.25	0.92	1	1	0.85	0.7	10	0.42	0.04	11.9
Grey-crowned Babbler	5	0.25	0.82	0.6	1	0.85	0.5	10	0.53	0.08	2.3

Table 3 shows the significance and threat scores from step 2, the proposed project budget, and the level of funding received so far. Table 4 shows the BCI for each project, and the parameter values used to calculate each BCI. Consistent with the specified criteria, all of these assets have a significance score of at least Very High and a threat score of at least High.

Three of the projects in Table 3 are for rivers, with BCIs ranging from 0.6 (indicating a low level of cost-effectiveness) to 1.7 (moderate cost effectiveness). The three projects differed in the ambitiousness of their goals – that is, in the thoroughness of environmental repair that they sought. This had an impact on the resulting BCI, with less ambitious goals having higher cost-effectiveness, due to fewer adoption challenges and costs that were more commensurate with benefits.

The Upper Loddon and Campaspe river reaches, despite having BCIs less than 1, received funding from the Victorian government. Avoca River reach 7 is the most highly valued reach of this river, which is one of only two undammed inland rivers in Victoria. There was considerable uncertainty about various aspects of the proposed project, so the low BCI was not considered reliable. As a direct result of this analysis, funding was allocated for further research to fill the information gaps. The Loddon River is of high community and political significance, and so was allocated a large proportion of the requested funding.

The York Plains wetland project had a high BCI (3.7). The Victorian government were initially reluctant to fund the project for several reasons: (i) It had a large budget per unit area compared with most existing river and wetland projects. This largely reflects that our analysis estimated a realistic budget, including payment to farmers of the opportunity costs of lost agricultural production, whereas most existing projects are under-funded; (ii) the wetlands are largely located on private land; (iii) the asset was not registered formally as a high-value asset on the state register. Ultimately, the rigour of the project assessment process and persistence of the NCCMA in funding negotiations led to significant funding for the project (although not as much as requested).

There were three projects focussed on threatened species, two fauna (Brush-tailed Phasgogale, Grey-crowned Babbler) and a project to protect endangered orchids. BCIs for these projects ranged from marginal (1.0 for the Brush-tailed Phascogale) to high (11.9 for the Eleven threatened orchied). The relatively positive assessment of these projects was due to the small scale of the projects and the high technical feasibility of protection. The analyses gave funders confidence that the projects were cost-effective. The Phasgogale project was put forward to both governments and received full funding (approximately two thirds from the Australian Government). The Grey-crown Babbler project did not receive funding because it was not put forward to investors, due to concerns about weaknesses in the analysis. The orchid project received small initial funding.

The analysis for the Northern Plains grasslands indicated a low BCI (0.5), in part because there is a risk that this project will not prevent adopt by landholders of practices that will damage the asset (B = 0.7). The project would require enforcement of existing land-use regulations – something that has typically not occurred in the past. Clearing of remnant native grasslands is prohibited by law, but is attractive to landholders who can earn more money from cropping than from grazing grassland. Despite the low BCI, the Victorian and Commonwealth governments were keen to support a small project in this area, providing just over half of the budget for the assessed project.

A key question is the extent to which this analysis influenced the funding results reported in Table 3. Overall, the detailed project assessment assisted the NCCMA to obtain public funding for four projects for the protection of environmental assets (York Plains, Avoca river reach 7, Brush-tailed Phasgogale, threatened orchids). Funding for the York Plains project was particularly noteworthy as wetlands located on private land have traditionally been over-looked in Australia. The analysis also showed that the Loddon River project would be cost-effective, but our judgement is that the governments would have funded this project even without the analysis, due to the high community and political importance of the river. For similar reasons, two projects with low BCIs received funding (Upper Loddon/Campaspe Rivers, Northern Plains grasslands). In one sense, the analyses of these two projects were ineffective, since funders ignored the low BCIs. However, for all of the latter three projects, the analysis contributed to improved design of the funded projects, and gave increased confidence about their feasibility (if not their cost-effectiveness).

The analysis also had broader influences on the NCCMA, notably on the proportion of their budget allocated to projects that aim to protect specific assets, as opposed to projects that promote general environmental improvements, not linked to specific assets. In 2003/04 only 7% of the total budget was allocated to asset-based projects compared with 35% in 2009/10 (Table 5). In 2003/04 the few asset-based projects were funded without systematic or transparent analysis, in contrast to 2009/10. As a result of this increase, NCCMA was able to maintain its budget at approximately the same level (Table 5), over a period when many other similar bodies in Australia have seen substantial reductions in funding.

Table 5 Public investment in the North Central CMA region before and after moving to a spatially-explicit asset-based approach

	2003/04	2009/10
Spatially explicit asset focussed	$1.5 million	$6.9 million
Other funding	$19.0 million	$13.1 million
Total	$20.5 million	$20.0 million

Discussion

The quality of the analysis of environmental investment options was a substantial improvement on previous practices of this organisation and other similar organisations. Improvements in the new approach include that it is more comprehensive, notably in its explicit consideration of the links between action and outcomes, and the links between project delivery mechanisms and landholders decisions to change land use. It requires a specific, measureable, time-bound goal to be stated. It assesses the relative cost-effectiveness of different investment options. It includes checks for internal consistency of information. It analyses the most appropriate type of policy mechanism to change land use for each project.

Despite these advantages, the experience of this study highlights that achieving change in the investment analysis practices of an organisation can require considerably more than simply provision of improved information or an improved analytical tool. Equally important were: the establishment of a strong partnership between the organisation and the researchers; high levels of trust and credibility; open communication channels; active participation of staff, board members and other stakeholders; effective communication of technical issues to non-specialists involved in the process; responsiveness of the researchers to the needs of the organisation; patience and persistence when the process of organisational change was slow or difficult; training and support for participants in the process; and a degree of pragmatism about what is possible, particularly the requirement to deal with large numbers of potential projects in a reasonable time frame. The success of the project has depended very much on strong leadership from the senior staff and the board of the NCCMA over several years.

The study highlighted some previously under-recognised lessons about the factors that most strongly determine the cost-effectiveness of environmental projects. One such factor is the effectiveness of works and actions in improving or protecting environmental assets. Socio-political factors are also crucial, including the likely level of adoption of change by landholders, cooperation from other organisations, and the likelihood of securing long-term funding beyond the current project. Notably, these are all factors that were not considered by the NCCMA prior to this study, and indeed have rarely been considered by any Australian organisations responsible for allocating public funds to environmental projects. Concerns about the level and quality of information linking actions to outcomes have been expressed by other authors in Australia (e.g., Hajkowicz and McDonald, 2006, Hajkowicz, 2009) and internationally (e.g. Falconer and Saunders, 2002; Weinberg and Claassen, 2006). We also noted a tendency for cost-effectiveness to decline with increases in the scale of the project and/or the level of ambitiousness of the project goal. Ambitious goals require extensive changes in land-use (Roberts et al., 2011), foregoing the opportunity to select those actions that would be cheapest to achieve and/or most effective in promoting environmental improvements.

The project also has broader lessons and implications for land-use policy in Australia and internationally. We have demonstrated that different environmental projects vary widely in their cost-effectiveness at achieving environmental outcomes, highlighting the importance of using a sound analytical process to prioritise investments. It seems clear that decision making processes currently used by most government departments and regional organisations in Australia are not sufficiently comprehensive or rigorous to correctly identify highly cost-effective projects. Achieving changes to the practices of environmental decision makers is very challenging and resource-intensive. If policy makers wish to foster improved environmental decision making, we suggest that they need to provide clear, explicit and extensive guidance about the methods to be used, and resources for training and support of users. The general guidelines usually provided in Australia are not sufficient.

The study highlights that policy makers need to adopt a stronger focus on the achievement of environmental outcomes. Without explicitly considering outcomes when projects are prioritised, it is unlikely that the most cost-effective projects will be identified. Most programs focus mainly on financial accountability and the extent of land-use change, without analysing the environmental outcomes achieved (e.g. Auditor General, 2008; Roberts and Pannell, 2009). The focus on specific environmental assets in this analysis assisted the NCCMA in assessing the achievement of outcomes.

Based on our experience in this study, we believe that the approach used has the potential to substantially improve decision making about environmental projects in many programs. As noted earlier, the approach has been codified (under the name INFFER) and made available to other environmental organisations and government departments. Uptake so far has been encouraging. Of the 56 regional environmental bodies in Australia, over 20 (across four states) have undergone some training in INFFER. Most of these have at least piloted some aspects of the approach, and several have made decisions to adopt it comprehensively.

In the state of Victoria, the Department of Sustainability and Environment is responsible for providing guidance and funding to 10 regional environmental bodies, including NCCMA. In 2009 it announced that it would begin to utilise INFFER for particular investment decisions, and that it would "provide training and support in the application of INFFER" (Department of Sustainability and Environment, 2009, p. 32). Governments in several other states have also expressed interest in the approach and have been briefed by the researchers, although no others have adopted it at this stage. In 2009, the Australian Government recommended to applicants for funding under the Caring for our Country program that they consider using INFFER when developing their applications.

Internationally, INFFER has been used to evaluate two land-use-change projects in Italy. In Canada, staff from the national government and three provincial governments have agreed to undertake the INFFER training program, and a pilot application of the framework will commence in 2011. In the Netherlands, the Public: Private Benefits Framework, a key component of INFFER, has been applied to a dairy-farming-dominated agro-landscape (Parra-López et al., 2009). The INFFER approach has potential to be used beneficially in programs where program managers are able (politically and administratively) to give priority to the cost-effective achievement of environmental outcomes, rather than being required to maximise participation of landholders. The availability of training, documentation, and software for the framework assists new users to adopt it.

In communicating and working with potential users of INFFER, we have observed two broad groups. Some decision makers appreciate that the INFFER is much superior to their existing decision frameworks, and are willing to bear the additional costs involved (mainly staff time). They are convinced that the difference made by being more rigorous and comprehensive in their decision analysis is substantial, and worth the effort.

Others are not so convinced. They are used to using simpler approaches, and have not recognised that, for example, omission of key variables from the analysis, or use of a poorly designed metric for assessing projects, can make a very great difference to the ranking of projects and the value of environmental outcomes. Without an appreciation of the benefits of adopting an improved decision framework, they are unwilling to bear the additional costs.

For the latter group, adoption depends on signals from high-level policy makers and funders. The required signals would include rewards for decision makers who make sound project prioritisation decisions. For example, organisations that put forward projects that are well analysed and well justified should have higher probabilities of receiving funding. Up to now this has mostly not been the case in Australia, but the first steps in this direction are being made by the Victorian government.

Even for organisations in the first group, we find that there are substantial challenges in the process of adopting INFFER. Compared to their past practices, it requires development of new skills by staff, allocation of greater time and resources to the decision process, and most importantly changes in mind-set and organisational culture (Roberts and Pannell, 2009). Training, user support and feedback on draft project assessments are required to foster these changes and to provide quality assurance of the outputs.

Conclusion

Working collaboratively with the NCCMA, the analysis has identified new priorities for funding of environmental projects in the north central region of Victoria, Australia. The new priorities are substantially different from those developed previously by the organisation using much simpler and more partial analyses. Even amongst a group of projects that had passed an extensive screening process to remove less attractive projects, detailed analysis shows that the cost-effectiveness of different projects varies greatly, and in ways that were not expected by the organisation. A number of the new priority projects emerging from the analysis have received funding.

The study demonstrates that a rigorous and comprehensive decision analysis process can successfully be delivered in an environmental organisation that previously employed much simpler decision processes. Success factors included strong commitment from the leadership of the organisation, a strongly participatory approach with the organisation and researchers working in partnership, and provision of training and ongoing support to participants. The need for changes in mind-set and culture mean that the process of adopting a rigorous decision process is long and sometimes difficult.

A key implication for environmental policy makers is the need to explicitly focus programs on the efficient achievement of environmental outcomes, not just the scale of activity. Identifying investments that really will achieve outcomes requires a rigorous and comprehensive analysis of the project options. Adoption of improved analytical methods can be encouraged through the signals and support that an environmental program provides to decision makers.

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