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Comparing a best management practice scorecard with an auction metric to select proposals in a water quality tender

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Abstract

The focus of this paper is to compare different evaluation frameworks for selecting landholder proposals to improve water quality. The case study is a water quality tender performed in the Burdekin region in Northern Australia in 2007/2008 where bids could be assessed using an inputs-based best management practice scorecard or an outputs-based auction metric. The scorecard approach and other variants of multi-criteria analysis are commonly applied in grant schemes, where landholder proposals are rated by a range of inputs-based criteria. Output-based approaches are typically applied in water quality and conservation tenders, where an environmental benefits index is constructed to summarise the cost-effectiveness of each proposal. The case study evaluation reported in this paper demonstrates that multi-criteria analysis type assessments are flawed, and that the efficiency of public funding can be more than doubled by using auction metrics to assess proposals for landholders to improve water quality.

Keywords: water quality tender; auction metric, best management practice, input-based; output-based; Great Barrier Reef

1. Introduction

Substantial government expenditure is directed at achieving better land management practices, and the opportunity cost of misallocated resources is of growing concern (Hajkowicz et al. 2008; Pannell 2009). The need to improve the economic efficiency of funding programs has meant more attention is being given to the way in which individual projects are being assessed, compared and selected for funding, both in terms of their cost-effectiveness as well as the environmental outcomes they provide (Hajkowicz 2009).

A number of different assessment methods have been applied to evaluate and compare projects for selection in conservation incentive schemes (e.g. Stoneham et al. 2003; Lowell et al. 2007; Windle and Rolfe 2008). The simplest approach often used in Australia has been to allocate funding through local or regional groups and use reference panels to choose how the funding can be allocated. Landholders submit proposals that implement prescribed management activities, often with fixed payment rates per activity, and then organising groups or reference panels select the preferred projects for funding. The focus of the local or expert assessment panel approach has generally been on encouraging adoption of best management practices (BMPs), fostering attitudinal changes, and improving participation and knowledge. The approach has been popular as it applies local knowledge to assess projects, has an equity-based focus, and imposes few requirements on landholders or granting agencies to generate actual outputs.

Simple grant-based approaches have the potential for substantial resource mis-allocation. An implicit assumption underlying this approach is that promotion of activities will transfer into widespread changes in farming practices and improved environmental outcomes, with little evidence that this occurs in practice (Pannell 2001, Paton et al. 2004). The objectives of these funding approaches are often not specified clearly, there is rarely much scientific or objective information available to assess proposals, and local assessment groups may be restricted by skill shortages and self interest. As well, these approaches tend to discount both the bio-physical and socio-economic variation between landholders and the land they manage, so that cost-effectiveness is rarely a factor in selecting between proposals (Ferraro 2004; Latacz-Lohmann and Van der Hamsvoort 1997, 1998; Stoneham et al 2003; Wünscher et al. 2008).

To address these varying concerns, there has been developing interest in more detailed and rigorous methods of assessing proposals from landholders. This allows the proposal selection process to be more comprehensive and automated, and reduces the subjectivity of relying only on selection panels. Two main approaches can be identified. The first is to apply a criteria weighting approach, where a range of evaluation criteria are selected and then a simple assessment process is used to score for each criteria. This type of evaluation can be described in the general family of multi-criteria analysis (MCA) techniques (Hajkowicz et al. 2008). The second approach is to assess the benefits of each proposal against the costs involved, and to then use that information to select the most cost-effective projects. This type of evaluation can be described within the families of economic evaluation methods of cost-benefit and cost-effectiveness analysis (Latacz-Lohmann and Van der Hamsvoort 1997, 1998; Stoneham et al. 2003).

The criteria weighting approach has been widely employed in the assessment of environmental proposals from landholders, with programs such as the Conservation Reserve Program (Kirwan et al. 2005) and the Environmental Quality Incentives Program (Breetz and Fisher-Vanden 2007) in the United States, as well as the Environmental Stewardship Scheme in the United Kingdom (Boatman et al. 2004) applying a basic scoring approach. More complex weight-based scoring approaches have been applied in MCA evaluations in Australia (e.g. Greiner et al. 2005, Hajkowicz 2006). MCA has political economy benefits from including stakeholders and generating agreement, and can be implemented in short time frames. However, it suffers from several shortcomings as a mechanism to allocate resources in terms of the arbitrary selection of criteria for assessment, the selection of and potential subjectivity of stakeholders in setting weights, the vagueness of the objectives to be maximised, and the lack of a basis in economic theory (Bennett 2005; Dobes and Bennett 2009). Although the method can include landholders' costs as an assessment category, it is not designed to select the most cost effective projects nor is it able to predict the outputs from the range of projects selected.

There is growing interest in the application of economic assessment methods to the selection of environmental proposals from landholders (Latacz-Lohmann and Van der Hamsvoort 1997, 1998; Stoneham et al. 2003). These are typically implemented as auction-like mechanisms where the task is to select between different bids where there are variations in both the environmental outputs that will be generated and the costs involved. The selection task is simplified in a conservation auction with the use of an auction metric to assess the environmental outcomes of each proposal in a single score that can then be compared against the costs of the proposal. The assessment allows the policy maker to select the proposals that will maximise the environmental outputs for any given budget allocation. The metric assessment process can also range from being relatively simple to a very complex process depending on the level of sophistication used to assess environmental outcomes. One of the main advantages of the output-based metric approach is that it directly determines the environmental outputs from any potential investment.

Assessing environmental benefits is complex and there is no consensus about how an environmental objective might be defined or what features need to be optimized (Metrick and

Weitzman 1998; Trousdale and Gregory 2004). Even when there is some agreement on what components may be important in a specific situation, there are many plausible scoring functions (Ferraro 2004) and analytical functional forms (Hajkowicz et al. 2007; Johansson and Cattaneo 2006) for a given context. In addition, the aims and objectives of different funding schemes will be reflected in the project evaluation framework, which can also affect the outcomes (Breetz and Fisher-Vanden 2007; Latacz-Lohmann and Van der Hamsvoort 1997; Rouquette et al. 2009).

The focus of the research reported in this paper is to compare a farm management scorecard MCA-like assessment mechanism with an output-focused metric approach. The two assessment mechanisms have been applied in a water quality improvement scheme focused on reducing emissions into the Great Barrier Reef (GBR) lagoon. Both the assessment systems were developed for the same purpose and with the same objective in mind; to select projects which would provide the most water quality benefits for a set amount of public funding. The metric had an additional objective of also identifying the predicted cost per unit of pollutant reduction.

The GBR is a major iconic asset of international importance. The area of approximately 35 million hectares is protected by the Australian and Queensland Governments as a marine park, and has had World Heritage site status since 1981. A key focus of current protection efforts, such as the Reef Rescue program, is to address issues of poor water quality that may be entering the GBR lagoon. Concerns about the impacts of poor water quality on the health of the GBR have been expressed in a number of recent studies and reports (Furnas 2003; Productivity Commission 2003; SQCA 2003, Haynes et al. 2007; Independent Panel of Scientists 2008; GBRMPA 2008). Agricultural practices from grazing, farming and irrigation activities are identified as the key contributors to water quality issues. Improvements in water quality are expected to lead to improved seagrass and reef health, and to increase the resilience of the reef against future environmental pressures (De'ath and Fabricius 2008).

The comparative analysis reported in this paper makes a contribution to the literature in three important ways. First, it adds to a very small pool of case studies of water quality assessments for both scorecard MCA-like approaches (e.g. Greiner et al. 2005, Hajkowicz 2006) and auction metrics (e.g. Lowell et al. 2007). Second, it provides a comparison between use of the two approaches, demonstrating the superior performance of a metric approach. Third, the results suggest that the current policy focus on simplistic scorecard approaches may be leading to substantial resource misallocation.

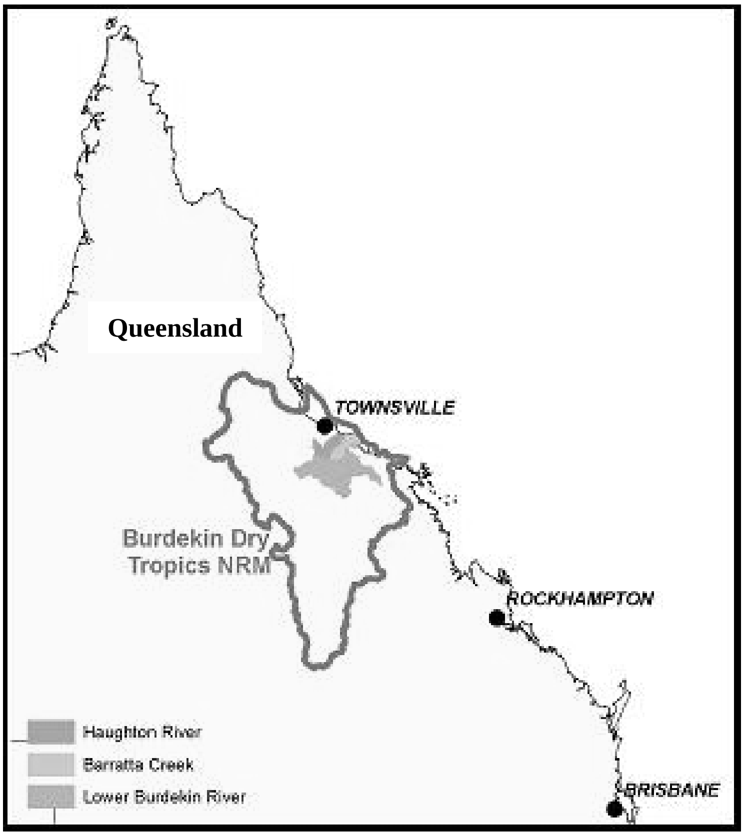
The paper is ordered as follows. An overview of the Burdekin water quality tender is provided in the next section. The results are presented in three separate sections with the performance of the input-based scorecard and the output-based metric reported in Section 3 and Section 4 respectively. A comparison of the two methods is made in Section 5 and the discussion and conclusions are presented in the final section.

2. The Burdekin water quality tender

The Burdekin River catchment covers an area of 133,000km^2 and is the second largest river basin draining into the GBR. The region is subject to climate variability and severe episodic events, generating large variations in river flows. Grazing is the dominant land use occupying over 98% of the area (Productivity Commission 2003) and is the main source of sediment reaching the coast, particularly in the higher rainfall grazing areas. The Burdekin is also Australia's largest sugar growing region, producing about 28% of Australia's total sugar production (Buono 2005). Sugarcane production, mainly concentrated in the coastal areas, is the primary source of nutrient runoff from the region (Scheltinga and Heydon 2005). The impact of agricultural emissions on water quality entering the GBR is an important concern in the region (Dight 2009).

In 2007/2008, the Burdekin water quality tender was implemented in the Lower Burdekin region (which includes the Lower Burdekin River, Haughton River and Barratta Creek). (Figure 1). Public funds of $600,000 were allocated to the scheme with the aim of providing landholders with financial incentives to improve their farm management practices and reduce emission runoff from their farms.

Figure 1. The lower Burdekin case study region



There are three key elements in a water quality tender that govern the process and influence the final outcomes:

- Auction design, where the process for conducting the tender and the rules of engagement are specified;
- Metric design, where the mechanism for evaluating the amount of environmental benefit involved in landholder bids is provided; and

Contract design, where the rules for specifying, monitoring and enforcing agreements are specified.

Key aspects of the Burdekin water quality tender design included:

- single bidding round;
- sealed bids;
- discriminatory pricing[1];
- an (unspecified) reserve price;
- multiple bids allowed from landholders;
- one year contracts for successful bidders[2];
- simple contracts used to secure agreements; and
- simple monitoring and reporting processes.

The tender included both sugarcane growers as well as cattle producers and an outputs-based metric was specifically designed to evaluate all project proposals. However, the sugar industry had already developed an assessment method based on a BMP scoring system. All sugarcane projects proposals submitted in the tender were assessed under both the BMP scorecard and the auction metric approach. While only the auction metric was applied in the actual tender, it was possible in a post tender exercise to compare the outputs from the two assessment methodologies. Only the sugarcane projects are considered in this paper.

2.1. BMP scorecard assessment method

The BMP scorecard was developed by the Lower Burdekin Sugar Working Group which comprised a range of representatives from the sugar industry. A MCA approach was taken where the views of industry representatives were used to identify the key management activities to be considered and the relative weightings for each. The scorecard was specifically designed to evaluate projects for a water quality incentive scheme by applying a weight-based scoring approach to assess the relative merits of a farm enterprise. The scorecard assessed the farmer's use of 39 different management activities under the following four broad categories:

- Farm Management
- Water Management
- Nutrient Management
- Pesticide Management

Each activity listed on the scorecard was assigned a score. The activity scores were then summed and weighted by category to generate a total score, which was then scaled to 100%. Essentially the scorecard approach assessed the overall management practices of landholders submitting proposals, with an implicit assumption that landholders with higher quality farming practices would generate larger environmental improvements from their proposals. A summary of the scorecard details is presented in Table 1 with full details outlined in Appendix 1.

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[1] The most efficient pricing rule in a single shot auction where landholders have no prior experience with the mechanism. A uniform pricing rule may become more efficient if the auction is repeated over time and bidders have the opportunity to learn about prices from previous rounds.

[2] Set by government funding requirements.

Table 1. BMP scorecard management categories, scores and weights

Management category	Category components	No of management activities	Max score	Category Weighting
Farm Management				**10**
Management Skills & Property Planning	a) Management capacity b) Farm design c) Infrastructure	7	100	5
Land Preparation & Management	a) Land preparation b) Fallow management c) Tillage operations d) Soil amelioration	8	100	2.5
Crop Management	a) Crop husbandry b) Harvesting	4	100	2.5
Water Management				**40**
	a) Irrigation management/ control	8	100	30
	b) Irrigation timing & scheduling	3	100	10
Nutrient Management				**50**
	a) Fertilizer rate	2	100	30
	b) Fertilizer timing	1	100	10
	c) Fertilizer placement	1	100	10
Pesticide Management				**10**
	a) Product	1	50	
	b) Rate	2	35	
	c) Application	2	15	
		Total	**900**	**110**
		Final score		**100%**

2.2. Water quality auction metric assessment method

Water quality tenders are designed to identify landholders who can generate water quality improvements at lowest cost. An auction metric was designed to assess the environmental outputs from each project proposal in a single environmental benefits index that could then be compared against the costs of the proposal. The auction metric was based on a five step process (Figure 2).

Figure 2. Standard steps in applying a water quality metric

Step 1: Assess on-farm reduction in pollutants for each proposal →
Step 2: Make adjustments for farm and distribution factors →
Step 3: Account for impacts over time →
Step 4: Represent impacts in a single index →
Step 5: Rank proposals by ratios of index / cost

First, an estimate was made of the amount of each type of emission reduction that would result from the management practice change in each proposal. Second, adjustments were made to account for the effectiveness of the different projects and to consider factors that could impact on net environmental outputs. Third, further adjustments were made to account for the temporal scope of the different projects[3]. In this case, the duration of project benefits

[3] In the actual tender, further adjustments were included to account for additional factors not directly related to the environmental outcomes. For comparative purposes they have been removed from this assessment outlined in this paper. See Rolfe et al. 2007 for details.

could vary from one year to five years depending on whether the project involved a potentially short term management change or more long lasting benefits associated with a higher capital outlay on infrastructure improvements. Fourth, the estimated emission reductions were converted to proportions of catchment emission targets as outlined in GBRMPA (2001).[4] This allowed the different types of emissions to be represented in the same units and then summed for each proposal into a single environmental benefit index, known as the environmental benefits score (EBS). The last step in the process was to calculate the cost effectiveness of the proposal by dividing the EBS by the cost (the landholders' asking price). This relative bid value was then used to rank the proposals in terms of cost effectiveness and select the ones that generated the largest water quality improvements per dollar of investment.

There are key differences to note between the scorecard and auction metric approaches. First, the auction metric was focused on rewarding environmental outputs, whereas the scorecard approach was more focused on the inputs in terms of management actions. Second, the auction metric was focused on assessing the predicted changes in environmental outputs generated by the landholder proposal. In comparison, the scorecard approach was focused more generally on overall farm management rather than environmental improvements. Third, the auction metric was focused on marginal environmental improvements wherever they occurred, while the scorecard approach was automatically weighted in favour of farmers who already had high levels of BMP adoption. Fourth, although both assessment approaches involved simplification, the auction metric achieves this by modelling linkages between farm management changes and environmental improvements, a process that is open to scientific scrutiny and technical improvement. In contrast the scorecard approach involved subjective assessment to determine relative scores, a process that was not open to independent assessment and improvement.

3. Performance of the BMP scorecard evaluation method

All landholders who submitted a project proposal/s in the tender received a field visit, with each separate project proposal receiving a BMP score. The scorecard was completed in the presence of the landholder by one of the local industry extension staff, with a member of Burdekin Dry Tropics NRM (the implementing agency) also present as an observer.

A total of 77 sugarcane projects were assessed in the tender with more than $1.84 million worth of funding being requested[5]. In this section, the operation of the BMP scorecard is examined as if the whole $600,000 budget had been allocated based solely on the BMP assessment. The prediction models used to evaluate the tender are applied to predict the level of environmental improvements that would have resulted from the BMP selected project. A sensitivity exercise is then completed to determine which of the main BMP scoring categories had the most influence on project selection.

BMP scores ranged from 91.61% to 13.64% for all the projects and from 91.61% to 76.85% for the 18 projects[6] that would have been selected (Figure 3), comprising:

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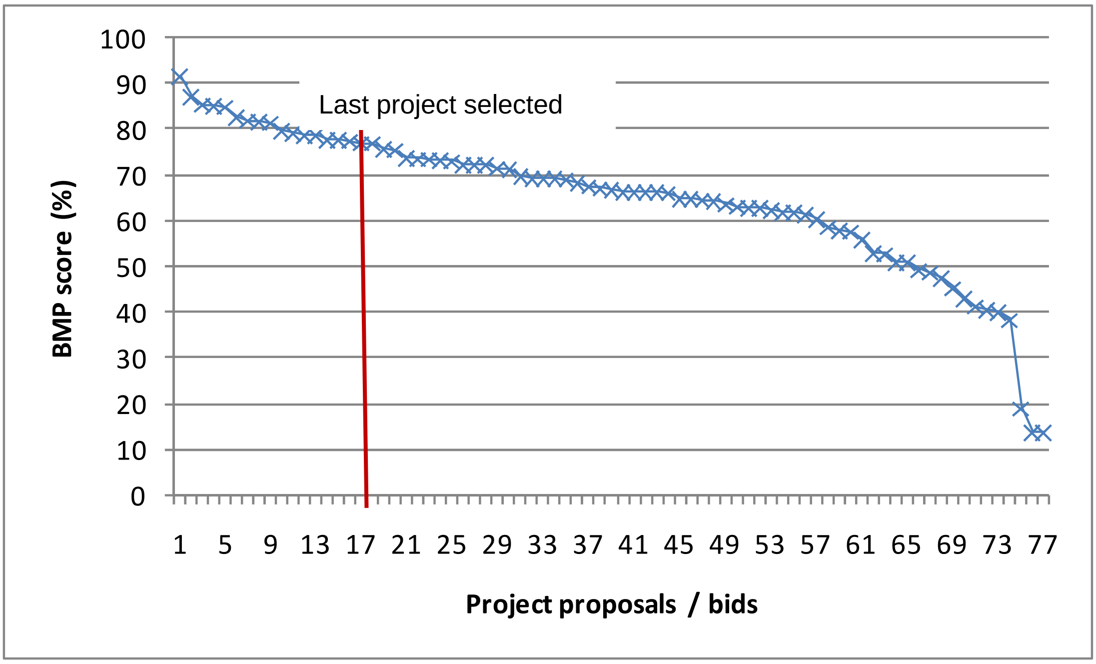
[4] At the time all the case studies were conducted, these were the only available catchment targets.
[5] There were also some cattle grazing projects funded in the actual tender.
[6] The first 17 projects accounted for less than the full $600,000. In order to make a subsequent comparison with the metric assessment, the 18th project was included with a proportional calculation adjusting project details to account for the exact funding allowance.

6 recycle pit projects;
9 water management projects;
2 nutrient management projects; and
1 pesticide management project.

Figure 3. Project selection using the BMP score



Had these projects been implemented they would have resulted in[7]:

43,326 kg of reduced nitrogen emissions. The average reduction cost was $13.59/kgN, ranging from $2.20/kgN to $260.16/kgN; and
15 kg of pesticide reduction at a cost of $734.78/kg.

3.1 Factors influencing scorecard project selection

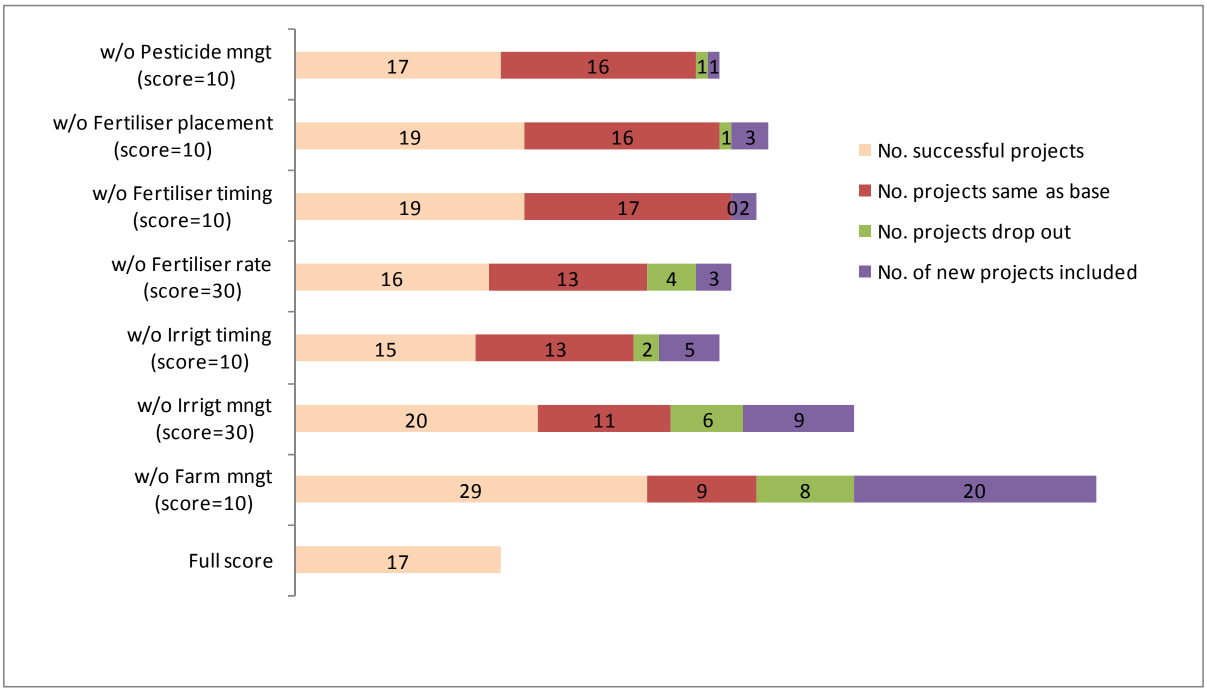
There were four main management categories in the scorecard, each with different weights, and a number of different activities and potential scores within each category. Landholders' performance in different management categories was not consistent across the complete range of BMP categories. This meant the landholder who achieved a high score in a single category did not necessarily have a high overall score. For example, less than half the landholders (47%) in the top 25% of the single farm management category score were included in the final selection. On the other hand, 74% of the best water management projects (those in the top 25% of the single category score) were successful in the final selection.

A sensitivity analysis was conducted to identify how key design factors influenced project selection[8]. This involved 'turning-off' each category component in turn to see how this affected project selection (Figure 4). Overall, the selection of projects using the BMP score

[7] Only nitrogen and pesticide reductions were estimated as sediment and phosphorus emissions from sugarcane farms were not considered an important environmental risk in the region.
[8] In this exercise, no adjustment was made to account for any surplus funding if the last selected project did not account for the full $600,000 allowance.

was relatively sensitive to adjustments as there was not a great difference in the scores of the selected projects. The highest scoring project (91.61%) was only 19% higher than the last selected project (76.85%). The category components that had the least impact on project selection were fertiliser timing, fertiliser placement, and pesticide management. The irrigation management score had more influence on project selection than the rate of fertiliser application even though they were both weighted at 27% of the total score. The category that had the most impact on the final project selection was farm management, even though it only represented 9% of the final score. The notable outcome of this exercise is that the broad scope of the scorecard approach means that the key policy target areas of reducing fertilizer and pesticide applications (SQCA 2003; GBRMPA 2008; Dight 2009) ended-up playing relatively minor roles in the final assessments.

Figure 4. A comparison of project selection with assessment adjustments

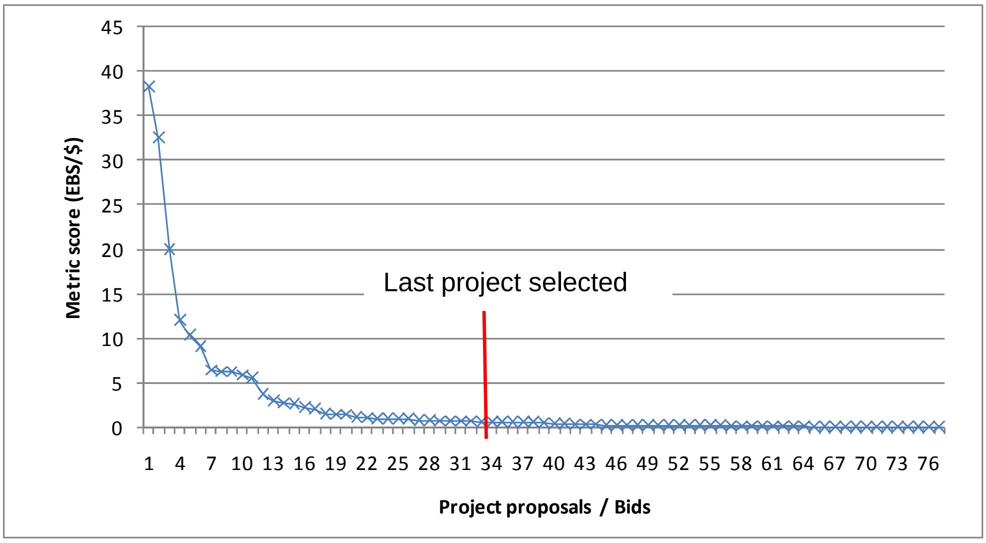


4. Performance of the metric evaluation method

The auction metric was applied across the same project proposals in the tender to identify the most-effective uses of public funds. This was done by assessing the relative bid value for each proposal, calculated by dividing the environmental benefits score (EBS) by the cost of the project. The highest ranked projects were selected in turn until the budget limit had been reached. Accounting for the full $600,000 worth of funding meant that 33 projects were selected out of the 77 project proposals submitted (Figure 5). This included:

10 recycle pit projects;
8 water management projects;
10 fertiliser management projects; and
5 pesticide management projects.

Figure 5. Project selection using the metric assessment



The environmental output from these projects was predicted to result in:

86,654 of kg reduced nitrogen emissions at an average cost of $6.27. Costs ranged from $0.65/kg to $23.83/kg of nitrogen reduction.

46.06 kg of pesticide reduction at an average cost of $1234.61/kg reduction. Costs ranged from $642/kg to $16,667/kg of pesticide reduction.

4.1 Factors influencing metric project selection

The auction metric assessed each project in terms of the predicted reductions in nutrients and pesticides entering the Great Barrier Reef lagoon, with assessments taking account of factors such as soil type, management factors and temporal effects. The models underlying the inclusion of each of these factors can be tested to identify the sensitivity of the final scores and ranking of proposals to the way the different factors are included. Overall, the metric evaluation method resulted in a much wider range in scores compared with the BMP scorecard approach and this meant the process was much less sensitive to changes in the scoring system and category weighing. For example, ignoring any temporal benefits for projects with capital costs (instead of assessing these for up to five years) only changed the ranking of some projects but not the group that would have been selected.

5. A comparison of the scorecard and auction metric selection methods

In this section a comparison is made of the two methods and differences in the projects selected and the environmental benefits they provided. Thirty-three projects were selected with the auction metric and 18 projects with the BMP scorecard.

Only eight (24%) of the 33 projects selected with the auction metric had the highest BMP scores and would have been selected under the BMP scoring system (Figure 6). A paired sample T test indicates there is a significant difference between the two groups (t=5.64). Alternatively, if projects had been selected using the BMP scoring system, only 18 projects would have been selected and this would have included only eight of the auction metric selected projects (Figure 7). A paired sample T test indicates there is a significant difference between the two groups (t=1.94).

Figure 6. Auction metric scores and BMP selected projects

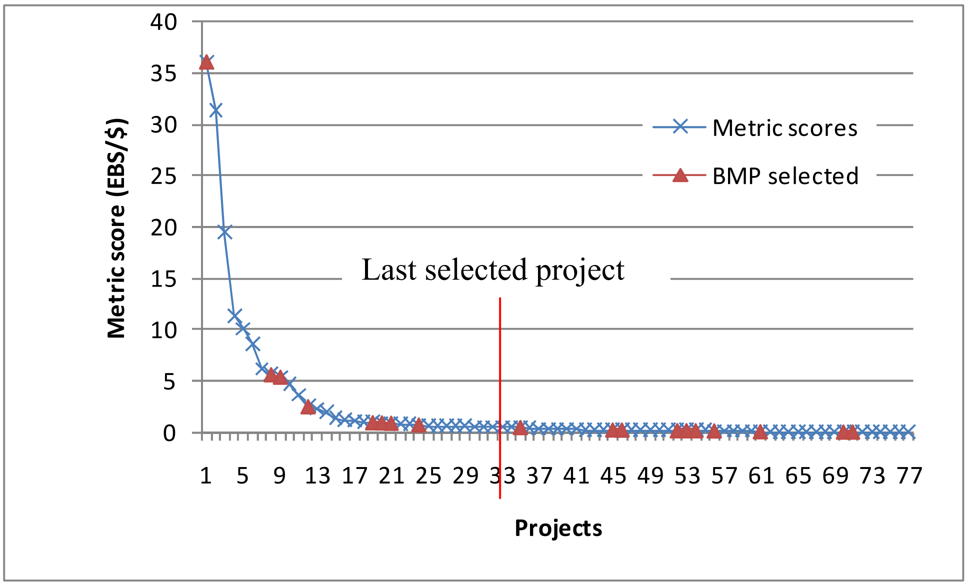
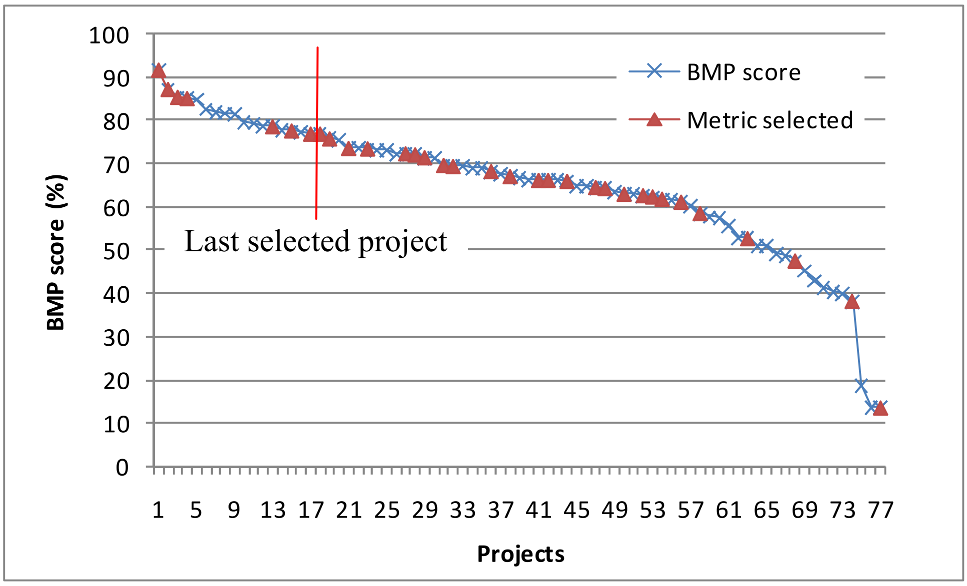


Figure 7. BMP scores and auction metric selected projects



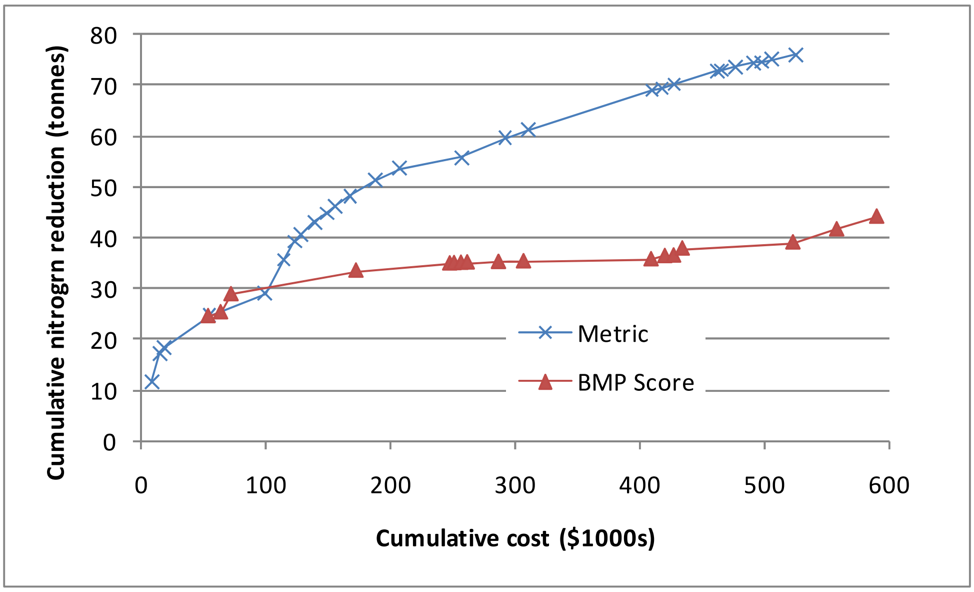
A comparison of the outputs from the different assessment methods indicates that there was little similarity in the projects selected under the two scoring systems (Table 2).

Table 2. Project outputs from the two assessment methods

Project type	Recycle pits	Water management	Nutrient management	Pesticide management	Total
Auction Metric					
No of projects	10	8	10	5	**33**
No of landholders					**29**
No selected with BMP score	2	3	2	1	**8**
Total kg N reduction	29,411	48,826	11,417		**86,654**
Total kg pesticide reduction				46	**46**
Total cost reductions	$189,300	$258,026	$95,811	$56,863	**$600,000**
Avg cost $/kg N reduction	$7.17	$5.28	$8.39		**$6.27**
Avg cost $/kg pesticide reduction				$1,234.61	**$1,234.61**
BMP Score					
No of projects	6	9	2	1	**18**
No of landholders					**11**
No selected with metric score	2	3	2	1	**8**
Total kg N reduction	7,293	33,904	2,128		**43,326**
Total kg pesticide reduction				15	**15**
Total cost reductions	$304,991	$267,009	$17,000	$11,000	**$600,000**
Avg cost $/kg N reduction	$41.82	$7.88	$7.99		**$13.59**
Avg cost $/kg pesticide reduction				$734.78	**$734.78**

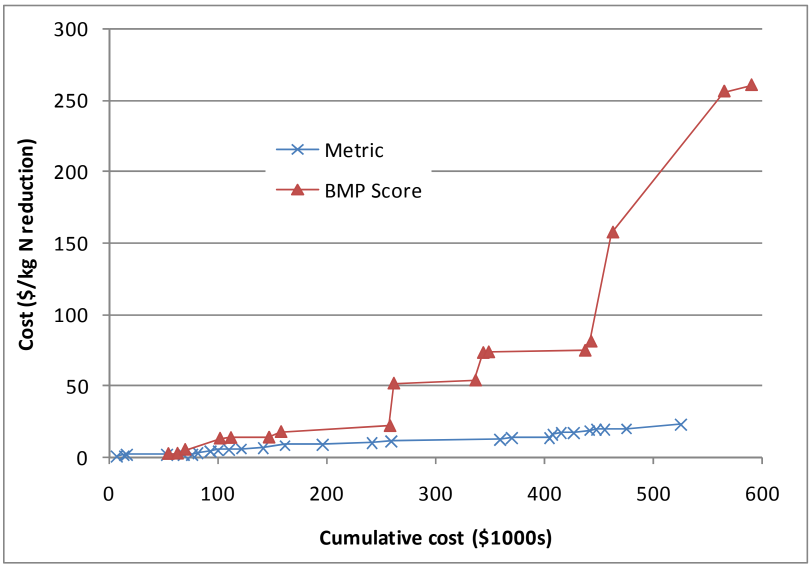
The auction metric assessment outperformed the BMP assessment in three main ways. First, the auction metric assessment resulted in twice as much reduction in nitrogen emissions and more than three times the amount of pesticide reduction compared with the BMP results. In the auction metric assessment, 86,654 kg of reduced nitrogen emission and 46 kg of reduction pesticide emissions were recorded compared with 43,326 kg and 15 kg of nitrogen and pesticide reductions respectively recorded in the BMP assessment (Figure 8).

Figure 8. Comparative quantities of nitrogen emission reductions



Second, the metric assessment resulted in the more cost effective projects being selected. The average cost per kilogram of nitrogen reduction ($6.27) was half that of the BMP assessment ($13.59). Costs ranged from $0.65 to $23.83 per kilogram of nitrogen reduction under the auction metric assessment compared with a range of \$2.20 to \$260.16 (Figure 9) in the BMP projects.

Figure 9. Comparative costs of nitrogen reductions



On the other hand, the average cost of pesticide reduction was much lower in the BMP assessment (\$734.78/kg) compared with the metric assessment (\$1234.61/kg).This was because there was only one pesticide reduction project selected in the BMP assessment.

Third, the metric assessment resulted more than double the number of landholders being engaged (29 compared to 11 using the BMP score), and more projects being funded. The metric was able to distinguish between the relative benefits of different projects submitted by the same landholder. The BMP score was focused on assessing the overall farming practice of a landholder rather than the relative merits of different projects.

6. Discussion and conclusions

This paper presents one of the first comparisons of a BMP scorecard (or MCA) and auction metric approach to evaluating water quality projects for public funding. The comparison is important in Australia because one of these broad approaches needs to be used to allocate public funding for these purposes. In this case study the same group of project proposals from cane farmers has been assessed with the two selection methods, each of which was designed explicitly to select successful projects in that water quality tender. The results demonstrate significant and striking differences in selection outcomes, and indicate that the BMP scorecard approach is flawed.

The auction metric assessment was much more successful in achieving environmental, economic as well as social objectives compared with the BMP scorecard approach.

The environmental benefits from the auction metric selected projects were 2.5 times higher than those provided by the scorecard selected projects (252 units versus 99 units).

- The auction metric selected projects resulted in over twice the amount of nitrogen reduction (98,004 kg versus 45,055kg) and more than 3 times the amount of pesticide reduction (46kg versus 15kg) compared with the scorecard selected projects.
- The average cost per kilogram of nitrogen reduction ($5.54) for the auction metric assessment was less than half (0.4) that of the scorecard assessment ($13.07).
- Although participation was not a specified objective in either scoring approach, the auction metric selection resulted in more than double the number of landholders being involved (29 versus 11).

The differences in results occur for three main reasons. First, the BMP scorecard approach is focused on selecting landholders who already have good BMP practices. While this may identify farmers who are more likely to be able to achieve and document further improvements, and signal the importance of high BMP standards, it effectively discriminates against proposals to move from low BMP to high BMP situations. Second, the BMP scorecard approach focused on a wide range of criteria relating to farm management in comparison to the auction metric approach of focusing on the environmental improvements generated by the proposed project. In many cases the BMP scorecard assessed farmers on criteria that were not related to the specific proposal. Third, the BMP scorecard combined the influence of different management actions through subjective weightings and then standardised the scores, in comparison to the auction metric approach of predicting actual emission reductions. The effect of the BMP scorecard was to disguise and minimise differences between proposals. In contrast, the auction metric approach was more open to critical assessment and revision as better technical information became available, provided clear predictions of the expected environmental outcomes, and allowed reduction costs per pollutant to be predicted. This provides a basis for subsequent benchmarking of project performance within and between different catchments.

Some benefits could be identified for using the BMP scorecard approach. The development and application of the scorecard involved less technical expertise and would have been quicker and easier to implement. There were also political economy benefits because of participation by industry and stakeholders, and the agreement generated about the selection and weighting of activities in the scorecard. However, these minor benefits have to be compared with the major funding inefficiencies that would have resulted if the BMP scorecard was used for project selection.

There are several caveats to note with this analysis. First, the auction metric approach is only a cost-effectiveness analysis with an implicit underlying assumption that improving water quality at these costs is worthwhile to society. Second, the auction metric relies on a number of modelling assumptions to allow predictions of environmental outcomes to be estimated for each landholder proposal. Third, only a design version of the BMP scorecard approach has been evaluated, while the auction metric benefited from being applied to select bids in the field experiment.

These caveats do not weaken the major conclusions that can be drawn from this case study. The use of BMP scorecards and other MCA-like approaches to select projects for public funding is badly flawed, and results in substantial funding inefficiencies. Given the prevalence of MCA-like approaches in allocating environmental funding in Australia, the results suggest that the effectiveness of environmental funding could be improved by moving to auction or tender mechanisms where the outcomes to be achieved are clearly defined, the potential contribution of each project is clearly assessed, and projects are selected on a cost-effective basis. In this case study the use of a tender mechanism over the BMP scorecard generated more than double the funding effectiveness. Additional benefits of using auction or tender mechanisms is that they reduce the potential for special interest groups to influence funding outcomes, they make funding allocations more transparent, and they allow the costs of environmental improvements to be benchmarked.

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Appendix 1. Extract from the sugarcane BMP scorecard

Phase	Management Considerations	Management Options	Phase Weighting	MO rating
Management Skills & Property Planning	***Management Capacity***	Accreditation (Chemcert, progrow, LWMP's etc)	**5**	0-20
		Record keeping (Economics, farm operations etc).		0-10
		Communication with R&D activities		0-2.5
	Farm design	Match row length and slope for soil type.		0-40
		Separate farm into discrete soil units in blocks.		0-15
		Vegetate riparian zones and waterways.		0-2.5
	Infrastructure	Water outlets, pipelines provision for recycling		0-10
				Max 100
Land Preparation & Management	***Land preparation***	Laser level blocks and fallow plots as required.	**2.5**	0-20
		Treat each soil type discretely.		0-10
		Adopt GPS controlled traffic technology.		0-10
	Fallow management	Maintain a weed free fallow.		0-10
		Use appropriate fallow crops.		0-10
	Tillage operations	Adopt a minimum or zero tillage system.		0-10
		March row width to machinery.		0-10
	Soil amelioration	Use appropriate soil ameliorant		0-20
				Max 100
Crop Management	***Crop husbandry***	Maximize crop potential with good husbandry.	**2.5**	0-40
		Spray out to eradicate crop on permanent beds.		0-10
	Harvesting	Green cane harvest (GCTB) where appropriate.		0-40
		Optimize harvester efficiency.		0-10
				Max 100
Water Management	***Irrigation management/ control***	Match water use to crop requirements.	**30**	0-15
		Use water meters to know water application volume.		0-5
		Adjust inflow rates (furrow)		0-2.5
		Adopt efficient application methods (OHLP,drip)		0-30
		Customize furrow shape to maximize efficiency.		0-2.5
		Minimize runoff by management & infrastructure.		0-40
		Minimize run-off from post harvest irrigations.		0-2.5
		Mix groundwater with surface water appropriately.		0-2.5
				Max 100

Phase	Management Considerations	Management Options	Phase Weighting	MO rating
	Irrigation timing & scheduling	Employ tools to improve irrigation efficiency.	**10**	0-70
		Irrigate prior to fertilizing in burnt cane system.		0-10
		Delay irrigation after fertilizer application.		0-20
				Max100
Nutrient Management	***Fertilizer rate***	Soil testing to optimize nutrient application.	**30**	0-10
		Nutrient budgeting to apply optimum rate.		0-90
				Max 100
	Fertilizer timing	Time application to maximise efficiencies.	**10**	0-100
				Max 100
	Fertilizer placement	Place fertilizer to maximise efficiency & uptake	**10**	0-100
Pesticide Management	***Product***	Use low risk products where possible.	**10**	0-50
	Rate	Adopt an integrated pest management strategy.		0-15
		Use at recommended label rate.		0-20
	Application	Use most efficient methods for spraying.		0-10
		Ensure effectively functioning spray rigs.		0-5
WQ points			**110**	MAX100