Title: Evaluating an incentive program for improvement in land management: The sustainable landscape program at Mackay

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A number of government strategies and programs have been developed to encourage improvements in agricultural practices that will minimise adverse water quality impacts. One recent program that has been implemented was the Sustainable Landscapes Program (SLP) at Mackay, Queensland, where incentive funds were used to encourage voluntary changes in a range of activities. In this paper, the efficiency of the bid selection process in the SLP is reviewed. The results indicate that selection through a competitive tender mechanism rather than a grant-based mechanism would have generated increased efficiencies, but that it was appropriate to focus on sediments as the key measure of environmental outcomes.

Keywords: competitive tenders, water quality, bid selection

Paper presented at the 51st Annual Australian Agricultural and Resource Economics Society Conference, Queenstown, New Zealand, 13-16 February, 2007.

1. Introduction

In recent decades governments in developed countries have created a myriad of programs to pay agricultural producers to improve environmental outcomes or to generate ecosystem services. Examples include the Conservation Reserve Program (CRP) in the United States, the National Farm Stewardship Program in Canada, and the Countryside Stewardship and Organic Farming Scheme in the United Kingdom (Smith 2006). In Australia the National Heritage Trust (NHT) programs and the National Action Plan for Salinity and Water Quality (NAPSWQ) have typically involved payments to farmers for cost-sharing or as incentives to improve infrastructure or changing management actions. These overlay a number of other initiatives including regulatory measures, taxation incentives, other granting programs, suasion and education initiatives and, more recently, the development of market-based instruments.

In many cases the 'piecemeal' development of these different funding arrangements means that they do not satisfy efficiency criteria at either economic or bureaucratic levels (Smith 2006). There are four key reasons why programs may not be very efficient. First, there is overlap and inconsistencies between programs and initiatives. Second, some programs have multiple objectives, such as those that are aimed at subsidizing farming operations as well as generating environmental outcomes. These issues of complexity, overlap and poorly defined outcomes indicate why many support mechanisms have the potential to create perverse incentives.

A third key issue is that most programs tend to be 'supply driven', where many projects are selected on the basis of what agricultural producers can supply and the priorities of the political and bureaucratic process (Smith 2006). It is rare that the underlying demands of the public for conservation are explicitly taken into account or balanced against the potential costs of supply. A consequence is that public funding for agricultural and environmental support programs is often committed without any clear appraisal of the efficiency gains.

A fourth key issue is that within programs the selection of suitable projects for funding is not very efficient (Kirwin et al. 2005). In some cases this arises from the design of the mechanism. Many government support programs are focused on the use of grants, which essentially involve set payments for certain types of actions irrespective of the real opportunity costs that landholders might face. Other inefficiencies relate to the links between payments and actions, where most programs focus on landholders providing certain inputs (such as establishing riparian fencing) rather than focusing on the supply of required outputs (e.g. improved water quality).

The development of more market-like processes such as conservation auctions has been suggested to improve the efficiency of public funding for conservation programs (Babcock et al. 1996; Latacz-Lohmann and Van der Hamsvoort 1997, 1998; Cason and Gangadharan 2004). These competitive auction mechanisms typically generate cost efficiencies compared to fixed rate payments to landholders because the discriminatory nature of the bidding process allows heterogeneity in opportunity costs to be revealed and more closely matched with supply (Latacz-Lohmann and van der Hamsvoort 1997, 1998). As well, conservation auctions are typically focused on the supply of conservation outcomes from landholders, while traditional grant mechanisms tend to centred on input measures.

There has been developing interest in applying market-based instruments in Australia, particularly conservation auctions as shown by the BushTender program (Stoneham et al. 2003), and the subsequent funding for the National Market-based Instruments program (REF). However, there has been little direct evidence generated about the efficiencies of using a market-like process over a more traditional granting mechanism. In this paper, evidence about this issue is presented in relation to the Sustainable Landscape Program administered to improve water quality in a sugar cane region of north Queensland. The funding program for cane farmers in the Mackay region was conducted in 2005/2006 to provide incentives for better storm water management and the subsequent reduction of nutrients and sediments into regional waterways.

A key issue is whether the process used to select the projects that were funded generated efficient outcomes. The research reported here involved a comparison of the bid selection process between grant and completive tender mechanisms, allowing some conclusions about efficiency measures to be drawn. The paper is structured in the following way. Some theory relating to the purchase of environmental services and conservation auctions is provided in the next section, followed by an overview of the program run for canefarmers in Mackay in section three. An analysis of project selection is provided in section four, with discussion and conclusions provided in the final section.

2. Public funding for environmental services: Grants and conservation auctions

Marked-based instruments (MBIs) are relatively new mechanisms but they are increasingly being considered for the management of natural resources and the environment. They are more targeted mechanisms because they can provide land users with more tailored incentives to minimize abatement costs (Rolfe 2006). Moreover, incentives to discover cheaper ways to achieve outcomes provide dynamic ways of reducing the future costs of achieving targets (Whitten et al., 2004).

Stavins (2000) define MBIs as "instruments or regulations that encourage behaviour through market signals rather than through explicit directives regarding pollution control or methods". MBIs may be appropriate mechanisms to achieve improved NRM programs, with the capacity to engage landholders voluntarily, focus funding on targeted outcomes, and deliver services at significantly lower cost. The NMBIWG (2005) add that MBIs have the capacity to attract landholder engagement and encourage voluntary change through the development of appropriate metrics.

Auctions can be a cost-effective means of allocating funding to improve improve diffuse source environmental outcomes, including water quality (NMBIWG 2005). The auction mechanism when run as a competitive tender appears as one of the simplest market-based instrument to use. The processes for developing auctions have been detailed in a number of reports (Stoneham et al. 2003; Windle and Rolfe 2005). During a competitive bidding process, indexes are used to rank bids and identify the most cost-effective ones.

Competitive auction mechanisms can increase the cost effectiveness of conservation contracting on private land because it introduces an element of competition between producers, so the scope for rent seeking behaviour is reduced and landholders have incentives to reveal their true costs of changing behaviour. Competitive auctions also allow discriminatory pricing to be adopted as compared to the uniform pricing in devolved grants, generating further efficiencies. Another advantage of auctions is that they better inform governments about real abatement costs. However, a number of auction mechanisms that have appeared to be theoretically and normatively correct have failed in the field, indicating that care needs to be taken in applying such mechanisms (Rolfe and Windle 2005; PC 2003).

3. The Sustainable Landscape Program

The Sustainable Landscape Program (SLP) was funded by the Australian and Queensland Governments to improve water quality flowing into the Great Barrier Reef region. Issues of poor water quality have been identified as key threats to the Great Barrier Reef in Queensland (Haynes 2001; GBRMPA 2001; Science Panel 2003), with runoff from agriculture identified as a key contributor (Furnas 2003; Science Panel 2003). There are few private incentives for the land users either to reduce soil loss from grazing and farming land, or to minimize loss of nutrients (mostly applied as agricultural fertilizer). While regulatory mechanisms have been employed to control point-source emissions, there has been more emphasis with agriculture on suasion, extension and incentive mechanisms to change management practices and improve environmental management.

There are major concerns about water quality issues in the Mackay region. Key issues have been identified in previous studies (Brodie 2004; Rhode et al. 2006; Mitchell et al. 2005), and include fish kills associated with low dissolved oxygen, mangrove dieback, declining coral reef health and high concentrations of sediments, nutrients and herbicide residues in major stream flow events. Brodie et al. (2003) estimate that the region's rivers contribute over two million tonnes of sediments, 6,000 tonnes of nitrogen and 1,600 tonnes of phosphorus annually on average to the inshore regions of the GBR. This helps to explain why the region, which contains many reefs close to the coast (in the zone strongly affected by run-off), is classified as being at greatest risk (CRC 2003b).

Water quality issues differ according to landuse. Brodie (2004) reports that aquatic ecosystem health in the region varies from poor in the intensively used urban and agricultural areas of the lower Pioneer and Proserpine flood plains to almost natural in the forested catchments. Fertilizer application rates on farming land are some of the highest in the state, with potential contributions to nutrient residues. Changes in farming practices such as trash blanketing following green cane harvesting, minimum tillage, controlled traffic farming and multi-row planting can reduce sediment and nutrient movement. However opportunities exist to stimulate greater farmer involvement and hence higher compliance with these best practices (Hildebrand 2002).

The Sustainable Landscape Program in Mackay provides an example of the developing interest in new institutional, policy and funding mechanisms, where incentives and voluntary agreements are used to achieve management changes. The SLP was designed by the regional body (Mackay Whitsunday Natural Resource Management Group) as a devolved grant process to *accelerate the adoption of the most sustainable and innovative practices by land managers throughout the Mackay Whitsunday Region*. Between August 2005 and May 2006, almost 300 agreements were signed with about 200 land managers for approximately $1.72 million in funding agreements.

Land Managers could receive incentives for four different groups of activities: grazing, cane, native vegetation and stormwater activities, with a number of subcategories as follows:

- Grazing
  - Nutrient Management (Soil Test):
  - Pasture & Stock Monitoring:
  - Strategic Fencing (Land Types):
- Sugarcane
  - Control Traffic & Minimum Till Plant Cane:
  - Minimum Till Legume Fallow & Plant Cane
- Native Vegetation
  - Revegetation
  - Weed Control
  - Stock Fencing
  - Watering points
  - Sand Ladders
  - Coastal Fencing
- Stormwater structures
  - Constructed Wetland
  - Sediment / Detention Basin
  - Swale / Grassed Waterway

The SLP program was consistent with a devolved grant process in a number of ways. For most of the projects, the type of activity and level of support available was specified, consistent with a devolved grant program. As well, the allowable activities were focused on input measures rather than output measures. The proposals received from landholders were assessed by the compliance with input measures, with uniform funding levels for some types of actions (e.g. soil tests). However, the stormwater projects shared some elements of a competitive tender process as landholders designed the projects and identified the levels of funding required.

The bid selection process is a key characteristic that defines whether a devolved grant or competitive tender process is being followed. In a competitive tender, the bid selection process is typically undertaken by assessing the environmental benefits that result from a program into a single index, identifying the relative value of each proposal, and then ranking proposals by relative values. Bids can then be selected in order of the best relative value proposals until funding is exhausted or another selection criteria has been met. By contrast, bid selection in a devolved grant process is often criterion based, focused on required actions (inputs) rather than the outputs generated, and assessed in a more subjective manner (eg by a selection committee). An evaluation of the bid selection process for the stormwater projects is provided in section four.

4. Assessing the bid selection process

The stormwater projects involved a range of proposals for engineering and diversion works to intercept water, allowing sediments and some nutrients to settle out before it left farm boundaries. In many cases the structures used to intercept water could be used as impoundments for managing irrigation supplies on farm, thus generating private benefits. In some cases natural wetlands were integrated into the settling and filtration schemes. These had additional benefits in terms of the biodiversity that may be supported and the increased removal of nutrients. A key focus of the management of stormwater projects was to capture early season flows, which were those associated with early spring rains and increased nutrient and sediment levels.

4.1 Criterion assessment used in the SLP

In the SLP, the assessment followed a criterion basis, where proposals were categorised into one of five levels of priority (categories 1 – 5). In the stormwater projects, the initial assessment for priority was on the basis of the relative value of outputs gained, but other adjustments were then made on the basis of compliance with different criteria. Projects which were rated in the three highest priority levels (1, 2 or 3) were eligible for funding. The initial level of prioritisation was generated by identifying the cost per tonne of sediment trapped.

Table 1. Priority levels for sediment opportunity costs in SLP criterion

$ / tonne of sediment trapped	Priority level assigned
< $20 / tonne	2 (High)
$20 - $40 / tonne	3 (Medium)
> $40 / tonne	4 (Low)

After the initial priority setting, four further adjustments were performed.

(a) If the structure was to be managed as a wetland, the initial priority setting moved up by one level. This recognised the biodiversity benefits and increased nutrient filtration likely to be associated with wetlands compared to more engineering structures.

(b) An adjustment for '% of total cost required' to build the structure was applied to recognise the different levels of private cost sharing. This was applied as follows to adjust the initial priority setting:

Table 2. Adjustments in SLP criterion according to cost-sharing levels

% of total cost required	Priority level adjustment
40%	Reduced the priority by one level
30%	No change
20%	Increased the priority by one level

(c) An adjustment was made to identify the ability of the proposal to capture Event 1 flows (100 millimetres of rain in 48 hours). If the proportion of Event 1 runoff captured by the structure was more than 50%, the priority setting moved up one level,

(d) If the final priority was low (4 or 5), the ‘% of total cost required’ (funding level) was reduced to the point where the priority became at least level 3. Proposals receiving these adjustments were then essentially made back to landholders as counter offers in case they would proceed with the project with reduced levels of public funding.

The effect of the stormwater assessment model was that projects were only assigned into three priority groups (1, 2 or 3), making it difficult to assess the relative benefits of the different stormwater proposals.

4.2 Developing a benefits index

An alternative way of assessing the bids was to rank them as if a competitive tender had been performed. In this case, a metric would have been developed to assess the environmental outputs of each proposal, and then compared to the proposal costs to identify the relative benefits. The potential environmental benefits of a stormwater project could encompass:

- Reductions in Total Suspended Solids (TSS) or sediments,
- Reductions in Total Phosphorus (TP),
- Reductions in Total Nitrogen (TN),
- Improvements in biodiversity.

The potential reductions in TSS, TN and TP were provided with the stormwater models that were used to assess the different proposals. The test process followed three stages:

- Establish a new metric to assess the environmental benefits for each bid. The two main improvements relate to the summarizing of TSS, TN and TP trapped into a single index and the use of specific climate data for each project. A weighting was also tested to represent the benefits of biodiversity being enhanced in wetlands projects.
- Compare for each bid the cost of the action to the environmental improvement.
- Rank the bids from the most cost-effective to the less cost-effective and compare them with the level of priority accorded from the SLP prioritising process.

4.3 The Stormwater Model

The new metric was based on the existing data in the Stormwater Model used in the SLP to help prioritise the Stormwater Projects. A detailed assessment had been made of each stormwater proposal, and the Stormwater model used to indicate the likely project outcomes. The structure volume, type and area of each landuse in the catchment above the structure were entered into the stormwater model. For each landuse the model applied different coefficients for the volume of runoff and concentration of pollutants (Suspended Sediment, Nitrogen and Phosphorous) in the runoff.

Table 3: Runoff coefficients and concentration of pollutants in the runoff

Landuse	Runoff coefficient	TotalP (kg/ha/yr)	Particular P/TP	Desolved P/TP	TN (kg/ha/yr)	PN/TP	DN/TP	TSS (T/ha/yr)
Cane	0.5	2	0.6	0.4	15	0.3	0.7	33
Grazing	0.4	0.3	0.9	0.1	3	0.65	0.35	4
Residential	0.9	1.3	0.5	0.5	7	0.5	0.5	2
Commercial	0.9	2	0.5	0.5	10	0.5	0.5	2
Bushland	0.6	0.15	0.5	0.5	1.5	0.2	0.8	1

Size and frequency of events over the wet season

Specific Climate Data for each bid were used in the model. Total Annual Rainfall was determined for each property with the Bureau of Meteorology (BoM) data through the GPS location of the properties. Monthly data from the BoM show that, in the Mackay/Whitsunday region, the Wet Season (December-March) generates 70% of the annual rainfall. The model calculated runoff volumes and pollutant loads for two different event sizes. It was assumed that Event 1 is a 100mm event over a 48 hour period and Event 2 is a 300 mm event over a 48 hour period. To make the model simple, the standard wet season was set to be the same for all the catchments. It was one 300mm event plus several 100mm events, depending on the Wet Season Rainfall for each property. The remainder of the year's annual rainfall was assumed to occur in small events that do not generate runoff.

Pollutant load detained and pollutant load trapped by the structure

For each event the model calculated the volume of water and pollutant load that was detained in the structure. The proportion of the pollutant load detained that becomes trapped by the structure depends on how the structure was managed (Sump, Wetland or Irrigation Supply).

- If the structure was to be managed as a Sump it was assumed that 100% of the pollutant load detained was trapped by the structure. This was because the water in the Sump would always be moved to a larger storage or recycled through an irrigation system before the next event occurs.
- If the structure was to be managed as a Wetland it was assumed that 75% of the suspended solids detained and 75% of the particulate nutrients (nitrogen and phosphorous) detained would be trapped. This was because 25% of the suspended solids and particulate nutrients, as well as 100% of the dissolved nutrients will still be in solution when the next event occurred and displaced the water detained in the Wetland.
- If the structure was to be managed as an Irrigation Supply, an average of the Wetland and Sump results was used. This was because it was assumed that following half of the rainfall events water would be required for irrigation and the structure would be empty when the next event occurred.

4.4 Measuring Environmental Benefits

The pollutant load trapped was multiplied by number and size of the Rainfall Events to obtain the quantity of each pollutant trapped by the structure by year. In this way, the model generated:

- Total Suspended Solids trapped annually (TSS in tonnes/year)
- Total Phosphorus trapped annually (TP in kg/year)
- Total Nitrogen trapped annually(TN in kg/year)

In the new metric, one objective was to summarize TSS, TP and TN in a single index to use as a measure of benefit. Because of the different quantities and impacts involved, it was not appropriate to The easiest way of comparing the relative benefits of each action was to weight them according to the relative contribution they make to address each problem (the level of downstream emissions). The principle was to identify the proportional reductions for TSS, TP and TN for each bid against the total catchment emission. Then, the relative scores could be scaled according to the importance of any biodiversity involved.

Data concerning the total catchment emissions was sourced from the GBR Catchment Water Quality Action Plan[1] (GBRMPA 2001). Current pollutant emissions have been determined for the three subcatchment of the Mackay/Whitsunday region, Pioneer River Catchment, Whitsunday Catchment (O'Connell River + Proserpine River) and Plane Creek Catchment.

The proportional reductions for TSS, TP and TN for each project were calculated as follows:

%TSS Reduction = TSS Annual Trapped / Current SubCatchment Sediment Export

%TP Reduction = TP Annual Trapped / Current SubCatchment Phosphorus Export

%TN Reduction = TN Annual Trapped / Current SubCatchment Nitrogen Export

To make the results more legible, the percentages were multiplied by 1000. Three versions of the Total Benefit Score (TBS) could then be calculated as follows:

*TBS1 = (%TSS Reduction + %TP Reduction + %TN Reduction)*1000*

*TBS2 = (%TSS Reduction)*1000*

*TBS3 = (%TSS Reduction + %TP Reduction + %TN Reduction) * 1000 * 25% (Wetland)*

Where:

- TBS1 = benefits score based on sum of proportional reductions in sediments and nutrients,
- TBS2 = benefits score based on proportional reductions in sediments only,
- TBS3 = benefits score based on proportional reduction in sediments and nutrients with a 25% loading for wetlands projects to account for additional biodiversity benefits.

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1 This is a Report to Ministerial Council established to prioritize catchments according to the ecological risk present to the Reef, and to recommend the minimum targets for pollutant loads that would halt the decline in water quality entering the Reef.

The 25% loading for biodiversity benefits associated with wetlands projects was an arbitrary level selected to test if a loading factor made a major change to the metric assessment.

5. Analysis of bid appraisal

In conservation auctions, the benefits index is compared with the costs of each proposal to rank the merits of each proposal. For the stormwater projects in the SLP, the level of incentives required by landholders to build the proposed structures on their farms was used as a measure of the cost of the proposal. This is the amount of public funding that would have been required to achieve the environmental outcomes[2]. The Total Cost-Benefit for each proposal can be calculated as follows:

Relative Bid Value = $ / Total Benefit Score

To facilitate the analysis, the bids were ranked in order by relative bid value. They could then be compared with the level of priority that was attributed to them under the SLP. Comparison occurred through charts comparing the two variables and by a simple statistical analysis (one-way ANOVA and crosstabulations) to show if there is any significant difference between the prioritisation processes.

At the end of June 2006, 93 Stormwater projects had been approved for a total funding level of $691,671, with an average funding of $7,437 (ranging from $280 to $39,200). Of the 93 approved projects, 4 were not active and 13 (12 of which are from the same property) were not complete at the time of the analysis. As well, one outlier result (an urban water project) was removed from the analysis to leave 75 bids for comparative analysis.

Below are the results of the Stormwater Model for the 75 selected projects using TBS3 for the benefits score (Figure 1). The Cost Benefit Index ($/TBS3) varies from 6.00 to 425.11. In the second graph (Figure 2), the two highest bids have been excluded to illustrate more clearly that substantial variation in opportunity costs exists across the submitted bids.

Figure 1. Relative bid values for 75 projects using TBS3

2 Total project costs would have been higher, as some private investment was required as a part of the program guidelines.

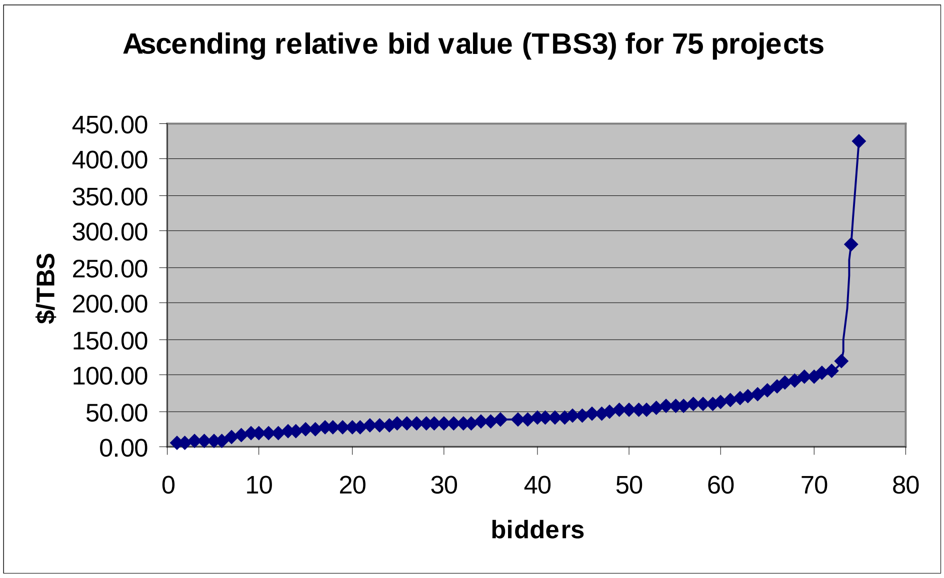
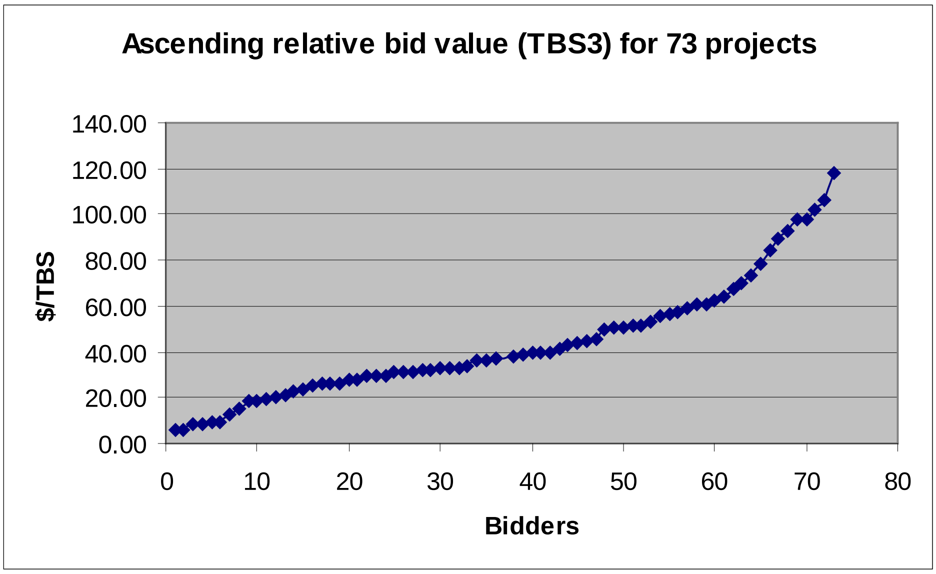


Figure 2. Relative bid values for 73 projects using TBS3



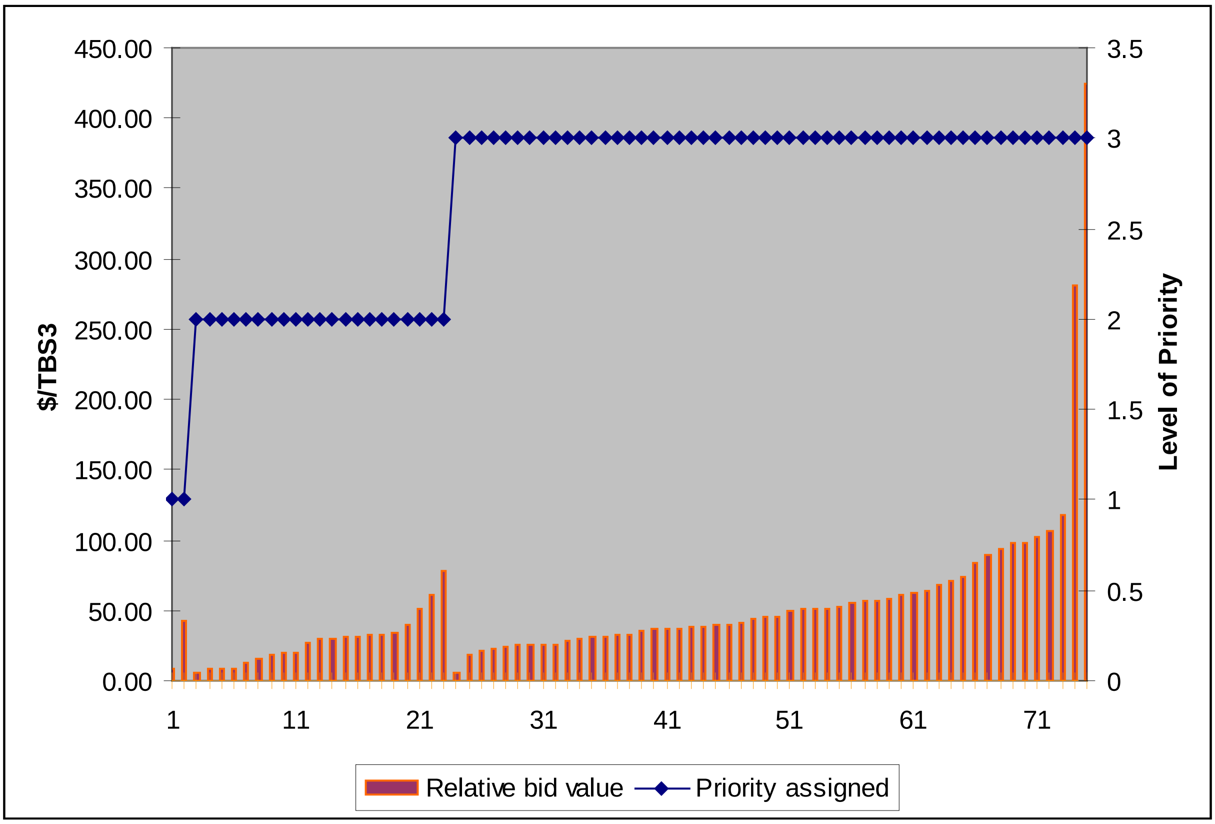
The results of the bid assessment process demonstrate the large variation in incentives per unit of environmental output that were nominated in the stormwater projects. It also demonstrates that some projects were much more efficient than others. For example, the 10 most highly ranked projects cost $67,940 and were modeled to capture 11,985 tons of sediment ($5.67/ton), 604 kilograms of phosphorus ($112.53/kilo), and 3,838 kilograms of nitrogen ($17.70/kilo). In comparison, the 10 lowest ranked projects cost $41,496 and were modeled to capture 539 tons of sediment ($77.05/ton), 32 kilograms of phosphorus ($1,283/kilo), and 231 kilograms of nitrogen ($179/kilo)[3]. The level of cost-effectiveness varied by at least a factor of ten between the 10 most highly-ranked projects and the 10 most lowly-ranked projects.

3. Note that this excludes the urban water project which had higher costs.

5.1. Comparison with the level of priority assigned

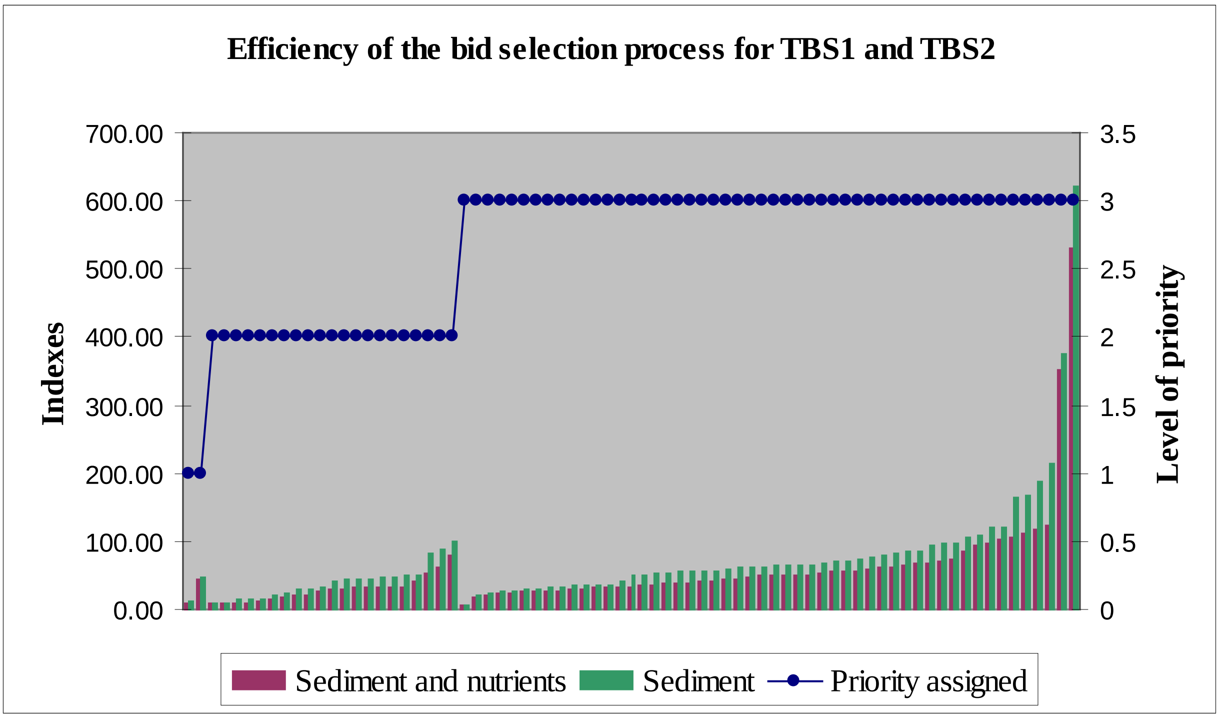
A key issue was whether the prioritization approach applied in the SLP ranked projects in the same way that the competitive bid assessment with the different metrics ranked projects. The figure below shows the comparison of the Cost-Benefit Index of each bid against the level of priority that has been attributed to them under the SLP. The benefits score has been calculated from the TBS3 estimate as being the most complete measure.

Figure 3. Relative bid values (TBS3) compared to assigned priority



The results show that some of the bids accepted in the higher priority levels (1 and 2) were relatively more expensive than bids rated as priority 3. The results suggest that the level of priority accorded to each landholder and funded under the SLP does not match very well with an appraisal of benefits relative to public investment. This means that some landholders have been prioritized too high or too low compared to the real cost-efficiency of their bids.

The same pattern is evident if the benefits index is calculated in a different way, focused on sediments and nutrients (TBS1), or sediments only (TBS2). The results show that the different benefits index gives the same result, but that the 'sediment only' index tends to demonstrate larger variations in the relative bid value.

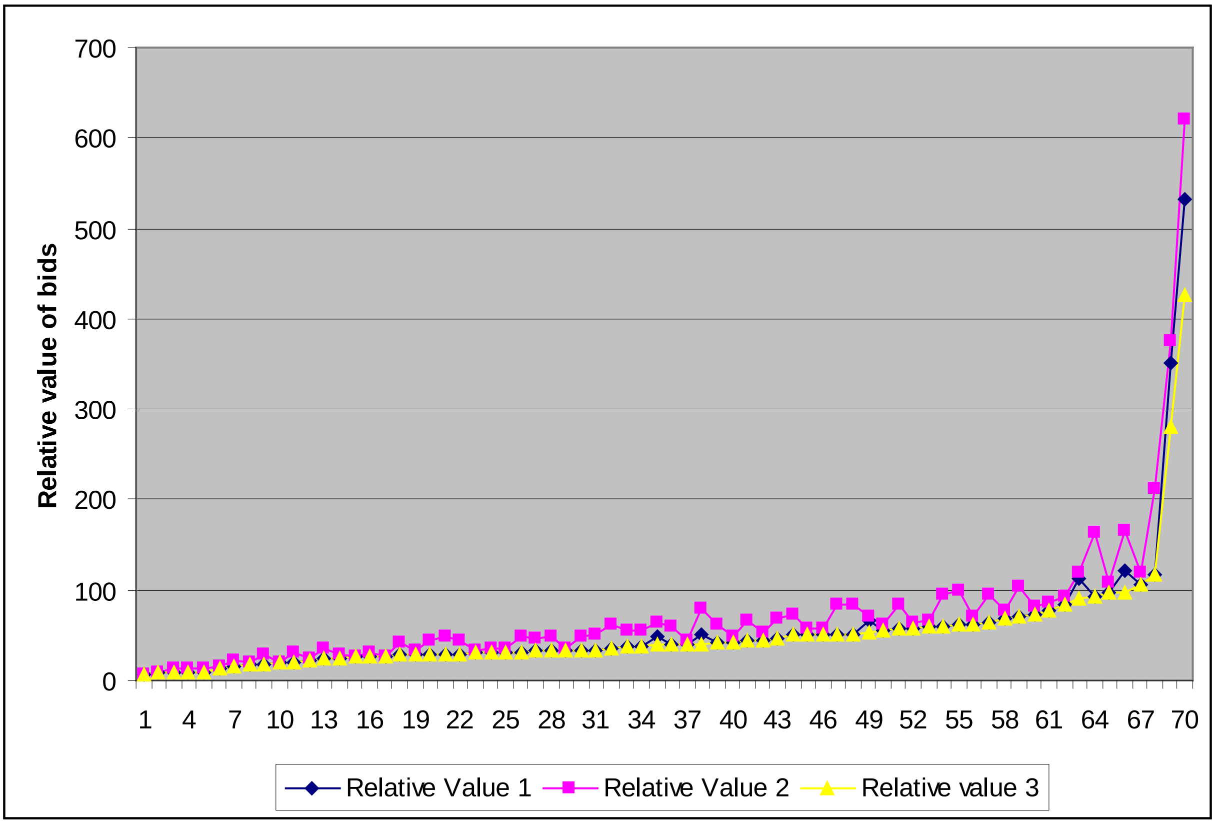


An ANOVA was performed to test if there was a significant difference between the level of priority assigned and the relative bid values. A significant difference was identified at the 5% level for each version of the relative bid values (using the different benefits scores)[4]. This confirms that the prioritization approach used may not have been fully efficient in identifying the relative values of the different project proposals.

5.2.3. Differences between the benefit indexes

A key issue in the selection of the stormwater projects is how comprehensive the benefits index should be. The comparisons between the indexes show that they are strongly correlated (98.5% between TBS1 and TBS2, 98.7% between TBS2 and TBS3, 99% between TBS1 and TBS3). The correlation of the relative values can be viewed in the graph below, where the relative values are arranged in ascending order for TBS3. (TBS3 corresponds to Relative Value 3 and so on). The results show very little difference between TBS1 and TBS3, indicating that addition of a wetlands weighting did not change the priorities very much. There is slightly more difference between the relative values from TBS2 and the other assessment scores, indicating that an assessment based only on averting sediment movement will be similar but not equivalent to more comprehensive measures.

4. For example, the F statistic for the test between the priority level and the TBS3 was 2.74 with 2 degrees of freedom.



These results mean that the "$/TSS trapped" used as a Base Priority Rate for each Stormwater Project varied in broadly the same way as the new Cost-Benefit Indexes calculated. It also means that the influence of TP trapped and TN trapped (which is taken into account in the new Index) varied in the same way (were positively correlated) as TSS trapped. While this may be partly an outcome of the model that was applied, it indicates that if only TSS trapped as used as a measure of benefits, there will be little difference in the ranking of the bids compared to when nutrient and biodiversity impacts are considered.

6. Discussion and conclusions

The use of public funds to purchase environmental services from landholders can raise a number of efficiency issues. At a broad level, a key criteria is to determine whether the value of public benefits generated is sufficient to justify the public investment in this type of program. However, the deficiency of valuation studies makes this question difficult to answer in this case study. A second group of efficiency issues revolves around how an initiative such as the SLP is consistent with the myriad of other programs and institutional arrangements, particularly when programs are designed to achieve multiple objectives.

The third group of efficiency concerns relates to the best ways of designing a program involving public funding to achieve environmental benefits. In recent years there has been more interest in Australia in moving away from traditional systems of fixed-rate grant payments to more competitive, market-like systems of allocation. These latter mechanisms include conservation auctions and biodiversity tenders, and are part of a family of market-based instruments. Key efficiency issues relate to how the design of an incentive program and the selection of proposals can be performed in ways that generate greater returns for public investment.

These issues can be explored in relation to a large investment of public funds in central Queensland to achieve improvement land management and water quality outcomes. The Sustainable Landscapes Program (SLP) was conducted in the Mackay region, where a total of $1.72 Million was allocated to approximately 200 landholders in the region between August 2005 and May 2006. In terms of landholder participation, the program has been very successful, with high levels of interest and engagement within the region. However, consistent with many other public investments in environmental outcomes, little attention has been paid to an evaluation of the cost-effectiveness of the investment or how allocations might have been improved.

The mixed goals of the SLP make any rigorous evaluation across the full program difficult. Some of the grant sub-programs, such as those giving grants for training programs and soil tests, were focused on engagement and knowledge building without any direct links to changes in environmental management. Other sub-programs involved fixed grants for actions such as revegetation and fencing without any specific appraisal of the benefits that would be generated. However, the conduct and evaluation of the sub-program relating to stormwater management did allow more analysis of the efficiency of the selection process. That analysis is the subject of the research reported in this paper.

By June 2006, $691,671 of public funding had been approved for 93 Stormwater projects, where landholders (mostly cane growers) in the Mackay region were being engaged to develop structures and management systems to intercept sediments and nutrients before leaving farm boundaries. Landholders were asked to nominate the level of public funding that they required to install the infrastructure, based on some level of cost sharing and private investment. Proposals were evaluated with the use of several criteria relating to the cost-efficiency of sediment capture, the level of cost-sharing involved and the type of mechanism being designed. Projects were funded if they were given criterion 1, 2 or 3 from a band of 1 to 5.

The data collected in the design of the infrastructure projects allowed the proposals to be evaluated in terms of the environmental benefits generated. An environmental benefits index was constructed where the levels of sediment and nutrient reduction were included, as well as a loading for wetlands projects to account for additional biodiversity benefits. Relative bid values were estimated by comparing the benefits index to the level of public funding required for each project.

Two important conclusions can be drawn from the analysis. First, there was a significant difference in bid selection between the criterion approach and the benefits index approach. Under the criterion approach, some proposals were funded that identified by the benefits index to be less cost effective. Use of the benefits index showed that per unit of funding, the 10 most highly ranked bids were at least 10 times more cost-effective than the 10 most lowly-ranked projects. While this information was essentially hidden in the criterion approach, it was much more transparent with the use of the benefits index. Even though the criterion approach was more systematic than many assessment processes for devolved grants have tended to be, the results show that a benefits index has key advantages in terms of transparency and analytical power.

The second important conclusion to be drawn from the analysis was that a simple benefits index performed well in comparison to more sophisticated structures. There was little difference in project rankings when only sediment reductions were modelled compared to when nutrient removals and a biodiversity weighting was added in. While this may be partly an outcome of the model that was used to predict sediment and nutrient movements and capture, it suggests that it may be reasonably accurate to use simply assessment metrics for project ranking and selection purposes.

The research reported in this paper indicates that the allocation of public funds to the purchase of environmental services can be improved by a more systematic evaluation of the benefits that are generated. It suggests that the criterion based approach that has been traditionally used to allocate grants to landholders may be very inefficient, and worse, may disguise the wide variation in the effectiveness of funding between farmers. The development and use of more transparent measures of environmental benefits associated with grant and incentive programs is recommended.

Acknowledgements

The research reported in this paper was funded by the Mackay Whitsunday NRM Group. The support and information received from Will Higham is gratefully acknowledged.

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