The potential use of Benefit-Cost Analysis in developing the Basin Plan

A REPORT PREPARED FOR THE MURRAY–DARLING BASIN AUTHORITY

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1 Introduction

The MDBA commissioned the Centre for International Economics (CIE) to complete a benefit-cost analysis (BCA) of various sustainable diversion limits (SDLs) as part of the MDBA's program of economic and social analysis designed to support the setting of SDLs. Frontier Economics was engaged to peer review the CIE's BCA. The MDBA sought a high-level review to ensure the methodologies adopted are broadly sound and any caveats are well-understood.

Frontier Economics has also been asked to provide strategic insights into how BCA can best be used to inform decision-making on the Basin Plan.

The remainder of this paper is structured as follows:

- Section 2 provides a broad discussion of the potential role of BCA in informing the Basin Plan.
- Section 3 suggests approaches to applying BCA to maximise its usefulness as a decision-making tool for the Plan.

2 The potential role of BCA in the plan

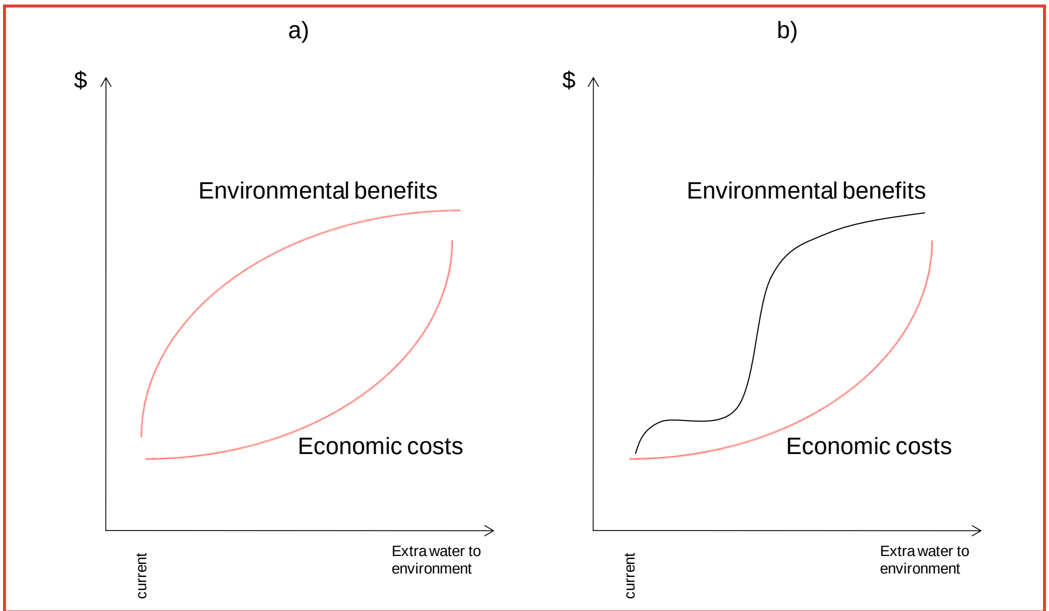
2.1 The optimisation problem for the Basin Plan

Our understanding is that, under the *Water Act 2007*, the MDBA has the task of setting SDLS that optimise environmental and socio-economic-outcomes from the allocation and use of water in the Murray-Darling Basin, subject to given constraints — namely returning the environment to a sustainable minimum level.

This implies that setting "optimal" SDLs requires balancing the environmental *benefits* from allocating more water to the environment (relative to the status quo) with the economic *costs* (associated with reduced agricultural production) from doing so. This idea is represented in Figure 1 below which sets out stylised total benefit and total cost relationships with water allocated to the environment. Figure 1 (a) shows an example where environmental benefits increase as more water is allocated to the environment, and relatively greater environmental benefits are secured from the initial volumes of water allocated to the environment. In contrast, the economic costs of allocating water to the environment are relatively small initially, but rise sharply as increasingly valuable irrigation activities become constrained by lack of water.

The reality, however, is more likely to look like that illustrated in (b), which shows threshold effects in expected environmental benefits. In this case, a minimum threshold amount of water must be delivered to the environment before further environmental benefits can be realised (such as to support minimum ecological functions).

Figure 1: Total environmental benefits and economic costs from allocating more water to the environment



In principle, the 'optimal' allocation of water to the environment occurs when the two curves in either (a) or (b) are furthest apart, as this maximises the difference between environmental benefits and economic costs. Allocating any less water to the environment would result in foregone environmental benefits greater than their associated economic costs, and allocating any more water to the environment would incur economic costs greater than the value of the environmental benefits.

2.2 Benefit-Cost Analysis

Benefit-Cost Analysis (BCA) is a widely used and accepted approach to policy evaluation. BCA is attractive as an evaluation tool because:

- it enables valuation of impacts in terms of a single, familiar measurement scale (that is, money) and can therefore assist in showing that implementing a specific option is worthwhile relative to the status quo. In particular, it can incorporate monetary estimates of environmental costs and benefits
- it enables consideration of the gains and losses to all members of society from a proposed policy
- it provides decision makers with quantitative information about the likely effects of a regulatory proposal
- it helps discover cost-effective solutions to policy problems by identifying and measuring all costs.

BCA involves a comparison of costs with benefits to determine if an activity is worthwhile (also called the net present value). If the net present value is positive, benefits exceed costs and the proposal is deemed to have a positive net social benefit.

While BCA provides a sound conceptual framework for thinking about the optimisation problem in setting SDLs, operationalising the framework in a way that is useful for policy decision-making presents a number of challenges. Perhaps the most obvious one is how to compare economic costs and environmental benefits in a common currency.

This is because some types of costs and benefits can be difficult to value in dollar terms (e.g. because particular services are not bought or sold in a market). In particular the quantification of environmental outcomes and determining societal values for these outcomes in monetary terms is challenging. However, there are techniques for doing so and some have been incorporated into the BCA by CIE. The alternative to attaching a dollar value to environmental benefits is to simply list them and compare them against the estimate of economic monetary costs and make a judgement as to whether the environmental benefits are worth pursuing. In this case, it is necessary to make a value judgement about the worth of the environmental benefits.

2.3 How BCA could inform setting SDLs – illustrative example

Because BCA generates information on costs and benefits, it can be used to help understand which aspects of a policy are most costly and which are less costly, for the respective benefits achieved.

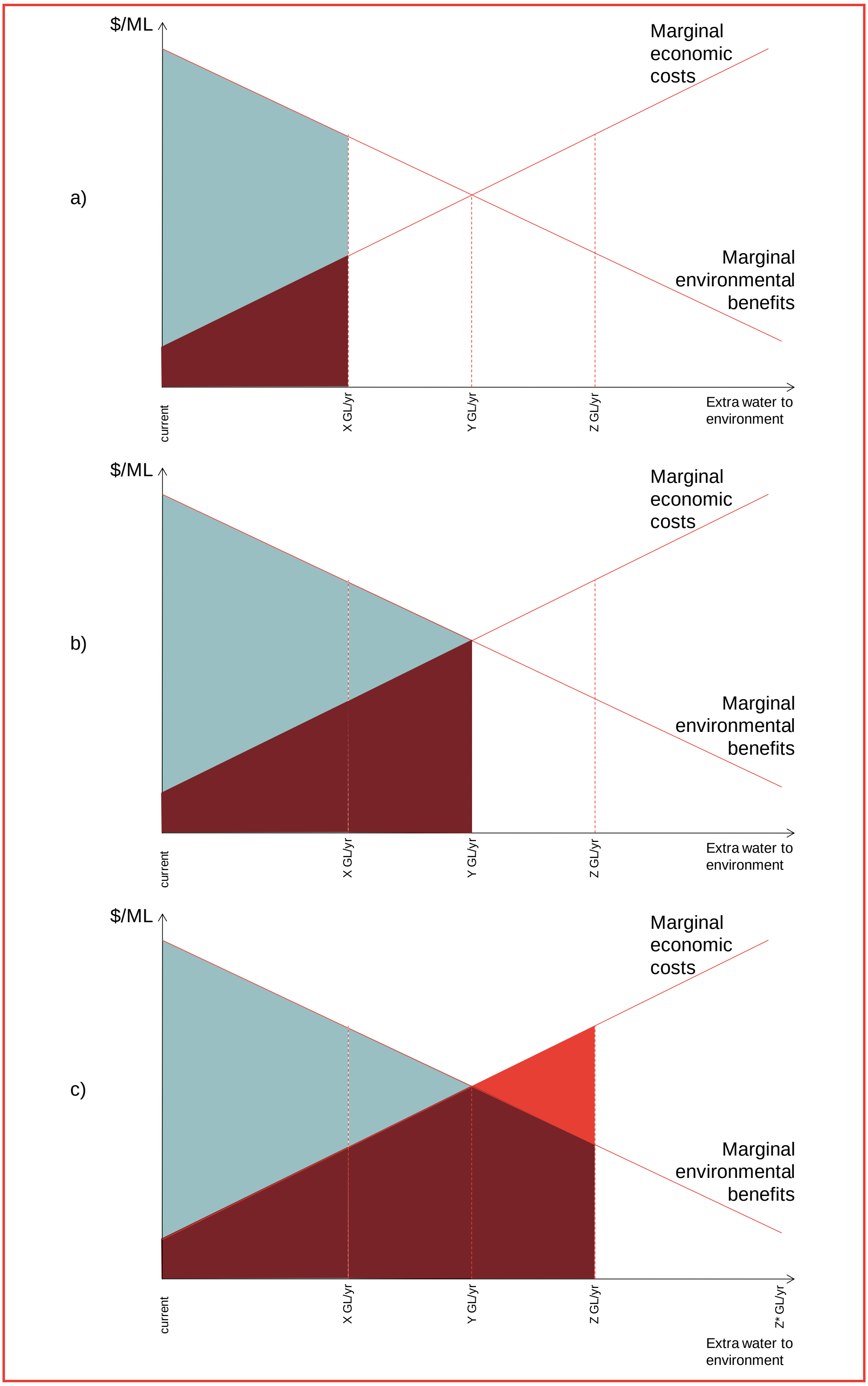
In Figure 2(a), the total shaded area (blue plus dark red) represents the total environmental benefits from returning an average of X GL/yr to the environment relative to the current situation. The dark red shaded area represents the total economic costs of this reallocation. Consequently, the blue shaded area is the net benefit of the proposal. As illustrated, X GL/yr a year is preferable to the current arrangements because there are positive net benefits from the change. However, as discussed below for (b), more water could efficiently be allocated to the environment as the benefits of doing so exceed the costs.

In Figure 2(b), the total shaded area (blue plus dark red) represents the total environmental benefits from returning an average of Y GL/yr to the environment. The dark red shaded area represents the total economic costs of this reallocation. Consequently, the blue shaded area is the net societal benefit of the proposal. In this example, the net benefit is maximised because all of the water for which benefits exceed costs has been reallocated. Any further reallocation to the environment would have estimated economic costs that exceed the value of the environmental benefits. This means that the proposal of Y GL/yr optimises the economic and environmental outcomes because any extra water returned to the environment from Y GL/yr to Z GL/yr has a greater economic cost than the environmental benefit it produces. This is the goal for policy makers, as it shows the greatest possible benefits to the community from diverting water to the environment.

It is important to note that the presence of a net benefit relative to the status quo does not guarantee this optimal level has been reached. Recall from (a) that there was a net benefit from allocating an extra X GL/year to the environment relative to the current situation, but this net benefit increases when moving to (b) or Y GL/year.

Allocating more water to the environment beyond Y GL/year could provide net benefits relative to the status quo, however these net benefits will not be maximised. This is illustrated in (c) below. For every GL beyond Y GL/year, the increase of the marginal economic costs by more than the marginal economic benefits is represented by the bright red triangle. However, at Z GL/year there is still a net benefit relative to the status quo, measured as the blue triangle minus the bright red triangle. (It is only when the amount of extra water reallocated to the environment reaches Z* GL/year that there are no net benefits at all.)

Figure 2: Benefits and costs of different proposed SDLs



If the above examples represented the situation in the MDB, the BCA would find all the proposals (moving from current to either X GL/yr, Y GL/yr or Z GL/yr) to have benefits greater than the costs, and are therefore better than the current arrangements. It would also find that the extra benefits from increasing the volume of water to the environment from X GL/yr to Y GL/yr outweigh the additional costs, but that additional costs exceed the benefits when increasing the volume from Y GL/yr to Z GL/yr.

The comparison of the net benefits of different scenarios is necessary for the MDBA to determine the SDL that optimises environmental and economic outcomes. Estimating the costs and benefits of specific options can help policymakers and others to understand the shape of the environmental benefit and economic cost curves, whether or not there are threshold effects, and the trade-offs that may be required to reach an optimal outcome.

BCA can also help communicate more clearly the costs and benefits of options and, due to the rigour imposed by the BCA framework, help to justify them.

While a valid tool, any BCA is only as good as its assumptions, scope and ultimately the data on which it relies. BCA cannot capture every impact under every possible situation and, since it reports at an aggregate level, may not identify localised impacts. This means that BCA can inform and guide decision-making, but judgement about the validity of the assumptions, scope and data used is still required.

3 Suggested approaches to maximise the usefulness of BCA as a decision-making tool for the plan

This section outlines our concerns with the current application of BCA to the Basin Plan and suggests approaches to maximise the usefulness of BCA as a decision-making tool for the Basin Plan.

3.1 Concerns with the current approach

3.1.1 Insufficient options assessed

The Guide to the proposed Basin Plan proposed three key options that the MDBA was proposing — namely a reallocation of 3000GL/yr, 3500GL/yr and 4000GL/yr on average to the environment. It is our understanding that the MDBA is currently using the CIE BCA to consider sensitivity of estimated benefits and costs to long-run average volume reallocation scenarios for the SDL scenarios presented in the Guide (3000, 3500, 4000 GL/yr). In essence we understand that this analysis is seeking to estimate the costs and benefits of each of these options for long-term average SDLs. This draws on modelling of the environmental and economic impacts of these long-run average volume changes.

We understand that the rationale for this approach was the expectation that volumes less than 3000GL/yr would not be sufficient to meet required environmental outcomes, and those volumes greater than 4000GL/yr would result in unacceptably high socio-economic costs. However, media discussion around the possible content of the draft Basin Plan suggests that newly proposed SDLs may be outside this range.

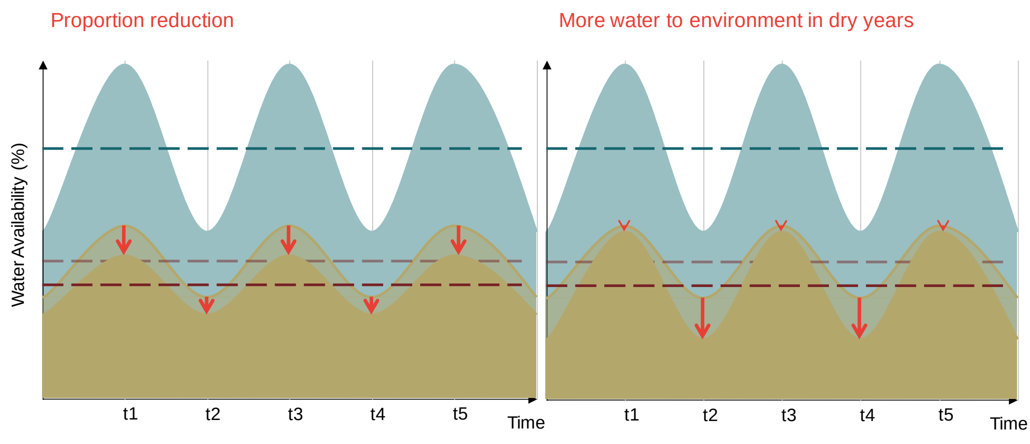
3.1.2 Use of averages overly simplifying

The Guide contains more detailed proposals on how these average reallocations to the environment of 3000 GL/yr, 3500 GL/yr and 4000 GL/yr are to be achieved — as will any future Draft or Final Basin Plan. For example, the Guide effectively defines how the 3000GL/yr scenario would be sourced between valley water resources (such as for local environmental watering requirements as well as for contributions to downstream needs such as the Murray Mouth). It also makes decisions about how this average volume would be allocated across different seasonal conditions (through proposed water resource plan accreditation rules and the MDBA's 'principle of equitable sharing').

These implementation details can have significant implications on the benefits and the costs associated with the Plan which are not captured when simply considering average volumes to be reallocated.

In our opinion, the current approach to analyse long-term averages will not result in estimates of costs and benefits that reflect the likely outcomes, and will therefore bias the BCA. This is because a long-run average volume can be reallocated from consumptive to environmental water use in a continuum of ways (see Figure 3). For example, during dry periods, consumptive users (brown shaded area) and the environment (blue shaded area) could share reductions in water availability in proportion to the underling entitlements. Alternatively, consumptive users could bear more of the reduction in dry years but receive more water in average or wet years, while maintaining the same average long-term share. The seasonal variability of these reallocated volumes will have significant impacts on the environmental benefits that can be achieved from the Plan, as well as the economics costs of the reallocation.

Figure 3: Two options for achieving a change in the long-run average



Notes: Environmental water denoted in blue. Consumptive water denoted in brown. Red arrows represent possible changes in water sharing due to the Basin Plan. Dark red dashed line is the average of consumptive water use.
Source: Frontier Economics 2011.

In our view, the outcomes achieved under the plan will differ markedly from the benefits and costs of the average reductions that are modelled in the CBA.

The use of average changes to water availability does not reflect the actual outcomes that are likely to prevail under the more detailed implementation rules proposed in the Guide. Not accounting for these details when undertaking Benefit-Cost Analysis can significantly under- or over-estimate environmental benefits and/or economic costs — indeed it is not possible to determine whether they will be systematically over or under-stated.

Suggested approaches to maximise the usefulness of BCA as a decision-making tool for the plan

This would lead to a biased assessment of the options, as well as leaving the Plan open to criticism from any party dissatisfied with the Plan proposals.

3.1.3 No consideration of regional effects

The focus on net aggregate impacts does not adequately present local scale impacts or regional issues. We understand that the MDBA is undertaking further work on localised economic and social impacts to supplement information on this issue.

3.1.4 Lack of environmental quantification

In our view, the extremely simplified ecological response functions that CIE had to use to provide the illustrative BCA are not sufficient for use in the MDBA decision-making to inform the Basin Plan. Critically, the MDBA needs to be able understand the potential error associated with this simplified characterisation (i.e. whether the simplified characterisation is a close or poor approximation and the magnitude of the possible errors associated with it).

3.1.5 Conclusion

As discussed above, the usefulness of BCA for decision-making depends on its inputs. We do not consider that long-run average changes to water availability adequately reflect the proposed changes in the Guide to the proposed Basin Plan (the Guide), and modelling of the benefits and costs of long-run average changes will not reflect the likely outcomes of the SDLs proposed in the Guide.

Accordingly, we question whether the estimated environmental benefits and economic costs are accurate for assessing the Guide's proposals or for supporting decision-making.

This is not a criticism of the CIE's use of CBA, which we understand used the only available data. In the sections below we describe how the data can be improved, and approach refined, to provide more robust guidance for the MDBA.

Suggestions to address this are discussed section 3.2.

3.2 Improving the BCA

3.2.1 Assess broader range of options

The Guide narrowed down the range of volumes that would be reallocated to the environment from a broad spectrum that went as high as 7600 GL/yr, to between 3000 GL/yr and 4000 GL/yr.

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Modelling options outside this range should help to justify SDL proposals. If low additional water allocations to the environment are unsustainable and would entail high environmental costs, BCA should be able to demonstrate this fairly easily. This would also be true of options with high economic costs. In our view it is better, in terms of a public debate, to quantify the costs and benefits of options either side of the range, rather than to simply assert they are not worthy of consideration.

BCA evaluations can also help to explore ways of achieving environmental benefits with less reduction in water for consumptive uses because they provide a measure of the economic costs associated with the water reallocation. Therefore, if the reallocation of water to the environment can be reduced by investment to make more beneficial use of existing environmental volumes, such as through engineering works to undertake wetland watering without the requirement of overbank flow, then the costs of these alternatives can be compared.

As we explore in the next section, there is considerable scope to also consider state-contingent water reallocations rather than simply average volumes. Given the differences in characteristics of environmental water demands/benefits and economic water demands this could provide scope for win-win options to refine the Plan.

3.2.2 Incorporating impacts of variability on cost and benefits

As discussed above, the way in which variability (i.e. climate risk) is assigned between irrigators, the environment and other users will have significant consequences for the costs and benefits for each. We explore this further below.

The guide sets out WRP accreditation rules that specify how the long-run average SDLs must be implemented under dry or wet period sequences, referred to as the 'principle of equitable sharing'[1]. The effect of these accreditation rules is to reallocate significantly more water to the environment under dry conditions than under wet conditions. For example, our rough calculations based on information in the Guide and CSIRO Sustainable Yields in the Goulburn suggest that the 25% reduction in the long-run average diversion limit (as set out in the Guide's 3000GL/yr scenario) would result in a 33% reduction in the long-run average volume of water available for irrigation due to relatively fixed water uses such as interception, urban demands, losses and stock and domestic. Further, the application of the 'principle of equitable sharing' means that under the same scenario the diversion limit would be required to be reduced by 41% in a dry sequence, resulting in a 54% reduction in the volume of water available for irrigation during the dry sequence (compared to the volume that would be available during the dry sequence under current water sharing arrangements). The

[1] We understand that this is embodied in the surface water tests 6-11 in the section starting page 1128.

'principle' is also applied to permitted take under median climate change assumptions.

Table 1: 3000, 3500 and 4000GL/yr scenarios in the Goulburn

	3000GL/yr			3500GL/yr			4000GL/yr		
	Long run hist. average	10-yr dry period	Median climate change	Long run hist. average	10-yr dry period	Median climate change	Long run hist. average	10-yr dry period	Median climate change
Change in Diversion Limit (CDL-SDL)	-25%	-41%	-32%	-30%	-44%	-35%	-34%	-48%	-39%
Change in water course diversions	-28%	-44%	-34%	-33%	-48%	-39%	-37%	-51%	-43%
Change in irrigated agricultural water use	-33%	-54%	-41%	-38%	-58%	-46%	-44%	-63%	-51%

Source: Frontier calculations based on the Guide, and CSIRO Sustainable Yields reports.

To fully understand the benefits and costs of the Plan, we suggest that inputs that represent the implementation of the SDL and other Basin Plan policies — not simply the long-run changes to historical water availability — be used to determine the actual costs and benefits to be included in the BCA.

Further detail on the actual effects of the SDLs will be provided by:

- the Water Resource Plan (WRP) allocation rules
- the Environmental Watering Plans (EWPs).

We suggest the MDBA create example WRP allocation rules and EWPs that meet proposed MDBA requirements. This would provide useful information on the impacts on water available for agriculture (to better inform economic and social analysis) and the water available for the environment (to better inform the analysis of environmental benefits).

3.2.3 Getting better environmental information

In our view, it should be a priority to gather more information on how much water is required to provide a given level of environmental outcomes and to incorporate this into the BCA framework. Given the MDBA has already completed analysis and modelling to inform the Guide to the proposed Basin Plan (and further work to inform progress on the draft plan) much relevant information is likely to be available. Our understanding is that modelling and analysis for the Guide determined what magnitudes of water would be required to be reallocated to the environment in order to achieve the target levels of environmental outcomes to satisfy the Water Act.

If the MDBA does not have a more sophisticated understanding of the environmental changes that result from providing more water to the environment, it is difficult to conceive any framework that can be used to establish a robust basis for decision-making in the absence of this fundamental and critical information. That is, the difficulty is one of missing information, and not specific to the BCA methodology.

3.3 Using the BCA

3.3.1 Supporting SDL implementation

The above described more detailed input to BCA analysis could be used by the MDBA to communicate the potential impacts of the Plan in ways different to the 'long-run equilibrium economic impact' assessment that was included in the Guide.

For example, we consider that a useful tool for communicating the impacts of the Plan would be to use example scenario sequences such as average, dry or wet conditions (of, for example, 10 or 15 years). The performance of the Plan under these sequences has already been highlighted as being important in the position paper on setting SDLs. The MDBA could calculate the estimated economic costs and environmental benefits under these example sequences.

We would expect that a key finding of this type of scenario analysis would be that:

- the economic costs of implementing the Plan are greater under dry conditions, but so are the expected environmental benefits
- the economic costs of implementing the Plan under wet conditions are smaller than under dry-average conditions, but so are the expected environmental benefits given that current arrangements already provide significant volumes of water to environmental outcomes under wet conditions.

This type of analysis could also assist the MDBA in setting SDLs in a way that strikes an appropriate balance between environmental and consumptive uses under the range of possible future conditions, rather than just on average — i.e. it would help refine state-contingent water reallocation proposals. This is particularly important if the MDBA intends to stand by the proposed 'principle of equitable sharing' or similar mechanism that implies major shifts in dry sequence water availability.

Suggested approaches to maximise the usefulness of BCA as a decision-making tool for the plan

This type of analysis is feasible on the economic front, at least for aggregate economic evaluation. For example, Frontier has undertaken work for the National Water Commission on the economic, social and environmental impacts of water trade. As part of the work, in collaboration with the Centre of Policy Studies at Monash University, we considered the economic impacts over a hypothetical 10-year period with an assumed profile of water availability.

This type of analysis also seems feasible on the environmental front. We understand that ecological research work commissioned by the MDBA can compute demonstration example hydrographs for the daily flow information required for more sophisticated ecological assessment.

There are different characteristics between environmental water demands/benefits (which require base flows and flood waters) and economic water demands by irrigators (who prefer high reliability but have some options for substituting water for other inputs or interrupting production). These differences could provide scope for win-win options to refine the Plan.

3.3.2 Accounting for data limitations/gaps identified by CIE

The data limitations identified by CIE — particularly the use of averages for water flows and the lack of available information to estimate ecological response functions— mean it is not possible to use BCA as the sole mechanism for making a conclusive decision on SDLs.

However, the BCA can be an important analytical tool to assist sound decision-making and communicate the rationale of final decisions. Incomplete or imperfect information means that judgements must be incorporated into the BCA as an element of the decision-making:

- Ideally, a BCA includes information on all of the factors that contribute to benefits and costs, and this information is of high quality such that the quantified benefits and costs are accurate and precise.
- If the judgement is made that all costs and benefits are included and that the information used is complete and of high quality, then the BCA can be relied on to provide robust information to decision-makers.
- If the judgement is made that some costs or benefits have not been included in the BCA appropriately, then judgement is required to determine whether the BCA result is significantly affected, and if so in what direction, and whether this could change the finding informed by the BCA.
- If the judgement is made that the quality of the information that quantifies a specific cost or benefit is not of high quality, then it can be determined how much the BCA result is contingent on this information. This can be informed by sensitivity analysis in the BCA and the expected error-bounds of the information quality issue. This means that judgement is required as to

whether the result of the BCA should be relied upon given the extent of the low quality information in the analysis and the expected error of actual outcomes differing from the information used in the BCA.

- Explicit judgements may be required for specific elements of the BCA.

In the case of the Basin Plan BCA, a key judgement is how likely it is that the CIE's simplistic assumption about a linear relationship between water flows and environmental outcomes would be borne out in practice. In our view, there is currently insufficient information to make a judgement one way or the other rendering the illustrative BCA, or any other methodology that relied on that assumption, ineffective for supporting decisions about the optimal level of SDLs.

Suggested approaches to maximise the usefulness of BCA as a decision-making tool for the plan

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