



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

# Screening options and setting priorities for River Murray floodplains

Brenda Dyack, Jeff Connor and Darla Hatton MacDonald <sup>1</sup>

**Key words:** Environmental flows, Floodplain, The Living Murray, Non Market Valuation, Cost Benefit Analysis, Multi-Criteria Analysis, Full Economic Assessment

## Abstract

As consumptive demands have grown in the Murray River basin, ecological health has declined and debate over how water should be allocated has grown. Additional structured thinking about the trade-offs involved in finding a balance for the overall environmental integrity of the Murray River basin is necessary. This paper describes how economic analysis can contribute to a screening process for seeking this balance that incorporates biophysical information as well as market and non-market benefits for a range of possible investments in floodplain health. This screening process can help decision makers successively filter the options, narrow the field and evaluate whether it is in society's interest to let particular floodplains decline with no further intervention.

## 1. Introduction

The Murray-Darling Basin is one of Australia's largest river systems, which extends across one-seventh of the continent from Roma in Queensland to Goolwa in South Australia and has a population of nearly two million people with another one million outside the region heavily dependent on its resources. The Basin includes the three largest rivers in Australia - the Darling River at 2740 km, the Murray at 2530 km and the Murrumbidgee at 1690 km. The Basin has been

---

<sup>1</sup> The authors are economists with CSIRO Land and Water, Policy and Economic Research Unit. This paper expresses the views of the authors. The paper is based in part on a research project supported by the South Australia Department of Land Water and Biodiversity Conservation and the CSIRO Water for a Healthy Country National Research Flagship, Murray Basin Water Benefits project. This support is gratefully acknowledged. Valuable advice was provided by Judy Goode, Melissa Bright, Lisa Mensforth, Jonathan Clarke, Tony Herbert and Ingrid Franssen of the Government of South Australia, Katja Goodhew of the MDBC and the collegial advice of Mike Young, Jim McColl, Ian Overton, Ian Jolly of CSIRO Land and Water. Any errors or omissions remain the responsibility of the authors. Contact Author: [brenda.dyack@csiro.au](mailto:brenda.dyack@csiro.au)

highly developed over the past 200 years and now generates about 40 per cent of national income derived from agriculture and grazing. It supports one quarter of the nation's cattle herd, half of the sheep flock, half of the cropland and almost three-quarters of the irrigated land. Water has been extracted from the Murray-Darling system for irrigation and other uses since the early 1900's, but the volume extracted has risen dramatically since the mid-1950s. While this has brought many economic and social benefits, the health of the rivers and wetlands has suffered.<sup>2</sup> Currently, wetlands are degrading and the mouth of the system at the Coorong in South Australia is closed. There is concern that the 'Cap', or official limit, on water diversions from the rivers has been exceeded and that water is unavailable in the system to support a healthy river and floodplain environment. Quiggin (2001) discussed the problems, noting that, given water scarcity relative to demands, the common pool characteristics of the Basin water, and given the institutions governing how water is taken from the rivers, there are inefficiencies that will not be resolved easily. The consequence is that degradation has continued.

States and Commonwealth Governments are facing political pressure over the condition of the Murray-Darling Basin. The main policy now determining investments in renewal and management in general has been in place since November 2003 when the Murray-Darling Basin Ministerial Council (MDBMC) announced The Living Murray (TLM) 'First Step Decision' towards its vision of a healthy River Murray system sustaining communities and preserving unique values (MDBMC 2003). The First Step was made in support of the more general TLM initiative, which was announced earlier in 2002 by the MDBMC with the goal of taking collective action to return the River Murray to the status of a 'healthy working river' thus addressing the degradation that has been evident in the decline in native fish populations, decline in wetlands and decline in water quality (MDBMC 2002).

One of the key objectives of the intergovernmental agreement supporting TLM First Step includes a commitment to invest \$500m over five years in cost effective, permanent, recovery of water to

---

<sup>2</sup> Facts and figures are from the MDBMC website: [http://www.mdbc.gov.au/river\\_murray/river\\_murray.htm](http://www.mdbc.gov.au/river_murray/river_murray.htm)

achieve environmental outcomes. In terms of volumes of water, up to an estimated average of 500 GL/year of 'new' water over a five year period is committed to environmental flows with this water coming from 'a matrix of options' including infrastructure improvements and rationalisation, on-farm initiatives, efficiency gains, and market based approaches and purchase of water from willing sellers (MDBMC 2003). In addition, the MDBC's \$150m Environmental Works and Measures program has been realigned so as to support TLM objectives. The program is aimed at support of construction of structures to manage existing water flows (MDBMC November 2004).

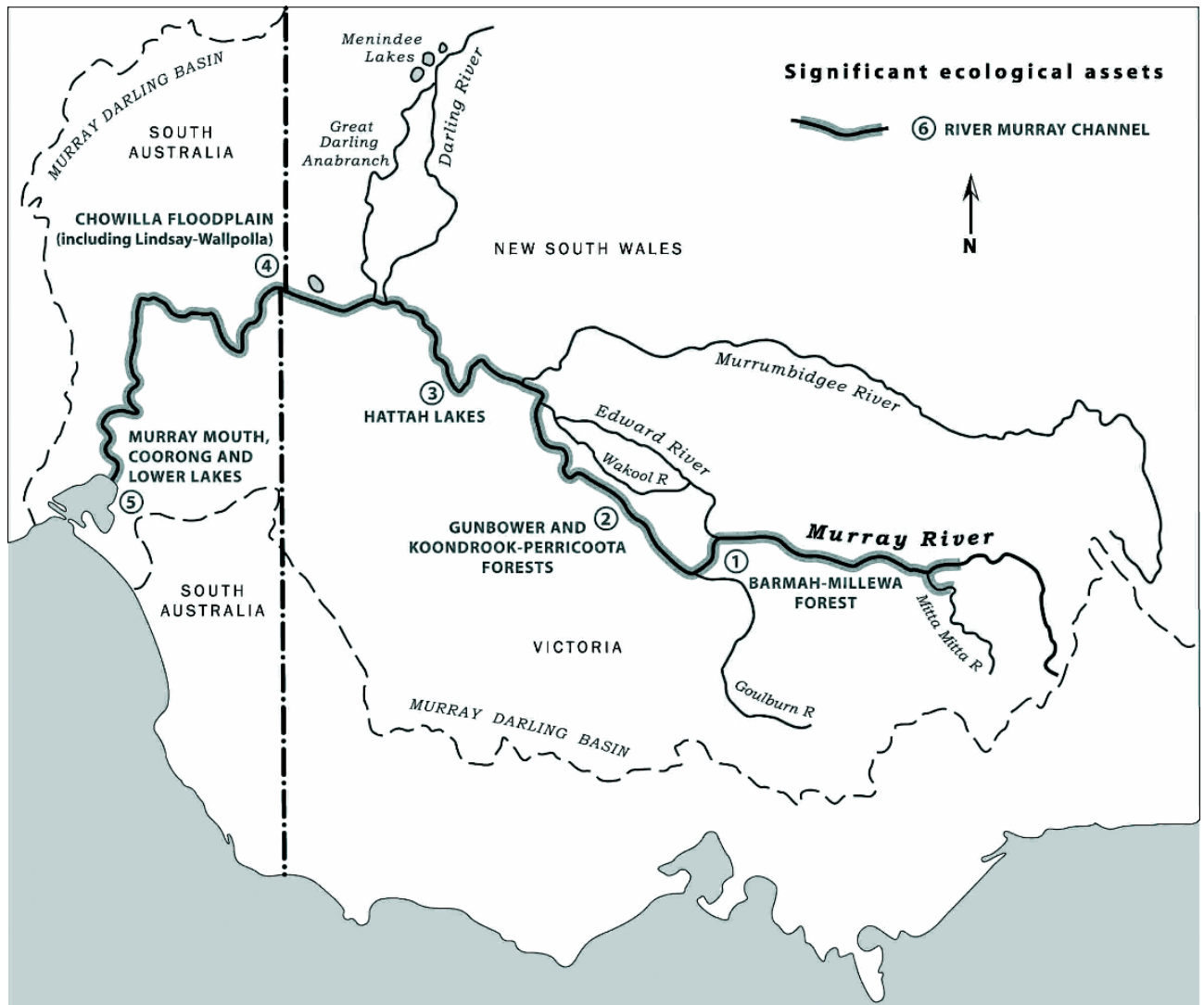
In the lead up to TLM decisions a great deal of analysis of the biophysical, social and economic impacts of a range of flow options for the Murray was undertaken (MDBC July 2004; Brennan 2004; Bennett and Gillespie 2004; Bennett 2002). TLM 'First Step Decision' articulated an 'in principle' commitment to begin making broad TLM commitments with a focus on 'maximising environmental benefits' for what are now called the 'significant ecological assets' (SEAs) shown in Figure 1. Six SEA sites have been chosen by TLM process. These are:

1. Barmah–Millewa Forest;
2. Gunbower, Koondrook–Perricoota Forest;
3. Hattah Lakes;
4. Chowilla Floodplain and Lindsay–Wallpolla;
5. Murray Mouth, Coorong and Lower Lakes and,
6. The River Murray Channel as a whole.

The policy statement says that the SEA sites have been chosen because:

1. Their ecological values are of regional, national and international importance;
2. There is concurrence that they are at risk and require improved flow regimes;
3. The assets are positioned along the river and encompass a range of habitats; and,
4. There is a reasonably well-developed understanding of the actions (including works) needed to achieve objectives for them that will allow some action to begin now.

In effect, the 'First Step' sets priorities at two levels. The first level is a high level choice of six particular sites over and above other possibilities along the Murray. At the next level, TLM sets goals for each SEA and allocates indicative funds for investments in certain priority goals at each



**Figure 1:** The Living Murray – Location of the six significant ecological asset sites.

**Source:** Murray-Darling Basin Commission

site. For example, \$18.8 million is the indicative budget that has been allocated for the priority environmental objectives for Chowilla with a focus on achieving the following outcomes: watering high-value wetlands so as to maintain the current area of River Red Gum and at least 20 per cent of the original area of Black Box eucalypt vegetation along with an increase in area and condition

of wetland littoral vegetation, an increase in distribution and abundance of native fish and an increase in success of colonial bird-breeding events.

This paper responds to the need now to set priorities and hence to choose among the many complex options for investments in floodplain health by suggesting a screening process that sequentially filters investment options. The suggested screening process incorporates the full range of relevant information available and also the range of methods that biophysical scientists, economists and other policy analysts have developed for choosing among options where choices involve complex trade-offs in multiple biophysical terms as well as in benefit and cost dimensions. The recommended screening process filters options according to biophysical considerations first, economic considerations second and social considerations in the third step. Notably, these approaches are not offered as a simple linear process or as a substitute for an integrated catchment management approach, but as techniques that could be used to help rank options and make the trade-offs in decision-making transparent to those stakeholders likely to be affected by any decision. At each step, the appropriate choice of methods depends on characteristics of the problem at hand. Relevant considerations in deciding which methodology to choose include factors such as the range of multiple options involved, the range of multiple outcomes expected, the range of benefits and costs that matter, the extent to which benefits and costs can be measured with certainty in monetary and non-monetary terms, and consideration of whose interests are to be represented in the process of narrowing down the choices under consideration. These considerations are discussed in the paper.

The next section provides a discussion of specific characteristics of the problem of setting priorities for floodplain health investments. Section 3 outlines generic methods for setting priorities across options and discusses the pros and cons of the methods in the floodplain context. Section 4 explains the key implications of choosing particular methods for ranking options at each of the recommended three steps, given the particular characteristics of this problem. Section 5 provides a

summary of the recommended screening procedure for setting priorities for floodplain renewal for the River Murray and concluding comments.

## **2. Threats to the ecological health of floodplains and challenges to setting investment priorities to mitigate threats**

The appropriate choice of a methodology for setting public investment priorities depends on the specific characteristics of the investment options under consideration and the parties making the choices among the options. This section outlines some of the key characteristics of the range of options that could be considered to deal with floodplain health for the Murray while subsequent sections address the question of who is making the choices and how priorities could be set.

One characteristic of the issue that makes choice among floodplain health intervention options particularly challenging is the large number of possible interventions. There are multiple threats to floodplain health with the level of threat varying spatially across and within SEA sites. In addition, there are multiple interventions that could be considered at multiple scales across and within SEA sites (Connor 2004). Table 1 outlines the major threats and an illustrative range of possible interventions that have been discussed in recent times as possibilities to mitigate threats.

Conceptually at least, one alternative, labelled as option 1 in Table 1, is not to intervene and to allow further degradation, which is essentially to choose to let certain parts of some floodplain ecological communities die. The alternative to option 1 is in effect not one alternative, but a wide range of options for intervention. The choices involved may be understood best by considering the threats that face floodplains first and then the options that exist for dealing with the threats. There are two *primary* threats to ecological health of floodplains at SEA sites as illustrated in Table 1: an elevated watertable and a lack of inundating flood events that water the floodplain vegetation. Under the current highly regulated river regime there is a lack of inundation of sufficient magnitude and frequency to renew what is referred to as the freshwater lens that exists above the watertable

<b>THREAT</b>	<b>INTERVENTION OPTION and INVESTMENT ACTION</b>
	1. Triage - No further intervention, allow further degradation
<b>Elevated groundwater level in root zone</b>	<b><i>REDUCE GROUNDWATER LEVEL</i></b>
	2. Change lock management to lower water table
	3. Build or augment salt interception scheme to lower floodplain water table
<b>Lack of floodplain inundation</b>	<b><i>INCREASE FLOODPLAIN INUNDATION</i></b>
	4. Supply environmental water to floodplain – new water purchase
	5. Infrastructure such as regulator to augment the inundation impacts of natural floods and supplemental environmental flows
<b>Post inundation salt loads</b>	<b><i>DEAL WITH POST INUNDATION SALT LOAD</i></b>
	6. Flow management to dilute salt or move salt downstream and out the mouth in ways that reduce downstream salinity impacts
	7. Additional salt interception scheme investment to reduce downstream salinity impacts
<b><i>SOME COMBINATIONS</i></b>	
A. 2+ 4, 2+ 5 B. 3+ 4, 3+ 5	Lock management plus additional flow or control structures to target high water table and lack of inundation SIS plus additional flow or control structures to target high water table and lack of inundation
(4 or 5) +(6 and/or 7)	Focus on additional flow or control structures to target lack of inundation and manage post inundation salt impacts
2 and/or 3 +(4 or 5) +(6 and/or 7)	Focus on actions to address high water table, lack of inundation and manage post inundation salt impacts

**Table 1: Some Investment Choices for Floodplain Health Improvement**



and is vital to the ecological health of the eucalypts. Where lack of inundation is a threat, restoration would require additional inundation which fundamentally requires alteration in the river flow regime including some allocation of additional water for the environment (option 4 in Table 1). An additional option (option 5 in Table 1) is to build water regulation infrastructure capable of blocking water routed through channels where additional inundation is ecologically desirable. Such infrastructure can increase the inundation levels resulting from flow provision in targeted areas (Overton, 2005).

The other primary threat to floodplains outlined in Table 1 is high water table levels. Naturally saline water tables are elevated above pre-European levels and levels are continuing to rise in some areas either as a result of lock operations, or as a result of irrigation drainage. Where the result is highly saline water rising into the rooting zone of ecologically significant Red Gum and Black Box eucalypt communities there is risk of significant die back.

In the absence of intervention, the high groundwater in the root zone will continue without the inundations of magnitude and timing sufficient to ensure the health of ecologically significant River Red Gum and Black Box communities. As such, Option 1 provides a meaningful reference for analysis of the other options in terms of the opportunity cost of 'doing nothing'. The 'no intervention' option implies that there will be a distinct and high cost outcome that includes the cost of continuing die back of ecologically significant floodplains, and loss of benefits that healthy floodplains provide.

Two widely discussed interventions to lower water tables are outlined in Table 1: option 2, alteration of lock operations and option 3, diverting inflows with pumps at the edge of ecologically significant floodplains with salt interception schemes (SIS). Option 3 is being seriously considered in current MDBC and States planning for additional investment to augment existing salt interception and drainage disposal infrastructure. This represents a change in that to date, SIS

have been primarily built with the objective of reducing river salt concentration with less emphasis on floodplain ecological health.

In some cases where floodplains are threatened by both high water tables and lack of inundation, removal of both threats would be required to ensure floodplain health. Depending on the nature of the multiple threats that tend to vary across and within sites, combinations of option 2 and 4 or 5, or 3 and 4 or 5 are the main possibilities to intervene.

The range of interventions that require consideration in a thorough biophysical analysis is complicated even more by the fact that additional salt loads can be expected in the river in periods directly following inundation. The result is likely to be very significant urban and agricultural salinity damages. Hence, most of the current discussion about potential floodplain intervention includes discussion of strategies to deal with what is called 'post inundation' salt. As illustrated in Table 1, this is, in principle, possible through additional salt interception (option 7), or with option 6 changes in river flow or weir operations to dilute the salt or move it down the river and out the mouth in ways that do not cause unacceptable damages.

For any given ecologically significant area of an SEA site there is a range of options including no intervention, and possibly options 2 or 3 to lower groundwater, options 4 or 5 to increase inundation and options 6 and 7 to deal with post inundation salt load. The enumeration of possible combinations illustrated at the bottom of Table 1 suggests that there may be as many as 47 reasonable options and combinations of options at any given area within an SEA. Considering further that there are multiple possible locations within each SEA where intervention would be possible, and that most interventions can be provided at a range of scales (some, such as flow provision can in principle be provided at a near infinite range of scales), it is clear that there are hundreds if not thousands of investment options that could be considered. An important implication of the large number of options is that several levels of filtering will likely be necessary to arrive at a reasonably small set of options for ultimate detailed evaluation.

Adding to the complexity of making choices where there are multiple options is the element of uncertainty. Because of the nature of the threats, options and goals, there is no accurate, determinate, quantitative way to measure biophysical impacts of investment actions. Uncertainty about biophysical impact of interventions arises from incomplete understanding of biophysical processes and from uncertainty regarding future natural conditions such as rainfall patterns that influence impacts of interventions. The uncertainty of outcomes of interventions varies across options in ways that are not understood with enough certainty to allow researchers to be sure of the best ranking. However, qualitatively, many of the factors that influence relative effectiveness of intervention options at reducing floodplain threat are well understood. For example, it is known that Red Gum communities are more responsive to inundation intervention than Black Box communities. In addition it is understood that interventions to lower water tables or provide inundation are more likely to provide floodplain benefits when taken in areas with reasonably healthy trees threatened by further decline, given current conditions, than in areas with primarily dead or dying trees. An implication of such uncertainty is that to rank options on biophysical effectiveness will require methods that can deal with inherent qualitative or quantitative uncertainty.

### **3. Setting priorities for floodplain investment**

The basic problem facing the MDBC and member States is that floodplain remediation involves complex choices with multiple options for investment each with distinct costs, benefits and trade-offs involved. As discussed above with reference to Table 1, one characteristic of the problem is the complexity introduced by the large number of choices. The discussion illustrated the challenge involved in setting priorities when there are multiple options for intervention at multiple sites some of which are quite discrete in nature (e.g. build a salt interception scheme or do not) and others that can be implemented on continuous range of scales (e.g. any floodplain can be inundated with a range of volumes). Adding to the biophysical complexity of the issue is the fact that each option is characterised by considerable uncertainty regarding biophysical responses. A further

characteristic of the problem is the incomplete and uncertain information about costs and benefits of investments. Hence, from an economic perspective, decisions are complicated because of the information gaps but also because alternatives such as pump, pipe or weir investments involve large up front costs and ongoing operating costs but benefits are uncertain, potential dollar value estimates for many benefits are missing and usually occur far in the future. From a social perspective, setting priorities is also challenging, given the need to manage a common pool resource in a context where there are upstream and downstream jurisdictions as well as private and public interested groups and individuals. There has been a commitment to considerable public consultation in the lead up to policy initiatives such as TLM. Ultimately, however, it is not clear how this input contributes to decisions that are officially made through a process that involves resolution through negotiated agreements between jurisdictions through MDBC processes. Whether or not the most socially desirable priorities are set by decision making bodies in any arena is debatable. Here we do not address that debate but offer some approaches for contributing to a process for identifying socially desirable outcomes for floodplain management.

In light of the complexity introduced by these characteristics of the problem of choosing floodplain management investments, it is clear that a decision support process to help address each of these characteristics is valuable. What is described here is a decision support process that includes three steps that screen options. At each step there are three basic activities: screening, or filtering, the threads of available information; augmenting information gaps; and, reducing uncertainty. The suggested steps are intended to reduce the number of options for final consideration according to the best methods available from the biophysical, economic and social perspective and thus simplify and clarify the process of ranking investment options. Sequentially screening the options is one approach to integrating the biophysical, economic and social considerations in the ranking process that involves using the best available tools from multiple disciplines. The remainder of this section outlines the recommended screening process for filtering the wide range of floodplain investment options.

### **3.1 Biophysical, Economic and Social Screening**

The recommended approach involves three steps that are geared to successively rule out options with unacceptable tradeoffs. For example, in the first step, biophysical options are screened so as to identify those options that are likely to maximise environmental outcomes. In the second step, economic analysis is used as the screen to evaluate costs and benefits, including, if appropriate, the non-market values of costs and benefits. In the third step, a social screen is applied so as to gain consensus on the limited set of what is considered at that point to be the best set of options, all things considered.

For each of the biophysical, economic and social screening steps there are multiple methods for evaluating options. This section provides discussion of the implications of choosing among various methods alone or in combination and suggestions about where different methods may best contribute to an informed decision making process. It may be that screening processes for complex decisions are best made by a cycle of repeated adaptive iterations with information gaps reduced over time and uncertainty reduced in line with better information. Decisions can be taken when necessary as the cycle continues and repeats.

### **3.2 Biophysical screening**

Biophysical screening is the first step that narrows the set of options that are feasible using biophysical assessment criteria. For example, one biophysical assessment criterion is the potential for success in restoring ecological health. As outlined above, uncertainty relating to outcomes of interventions such as flow provision and salt interception, means that certain quantitative measures of biophysical benefits such as 'hectares of ecological significant floodplain saved', are not possible. Thus, the set of feasible options identified through biophysical screening can represent a ranking of the best options given available information and also given the uncertainty of outcomes. A number of approaches are available ranging from expert input,

construction of biophysical benefits indices that include weighted sums of desirable characteristics, to qualitative assessments.

One attractive method for screening options is an approach such as that offered by Overton and Jolly (2004) and Overton (2005). The approach can be thought of as a risk assessment based approach to ranking options based on a partially subjective assessment of threats to floodplain health and potential effectiveness of intervention options at achieving certain outcomes. Outcomes may be hectares of floodplain protected or other biophysical indices of ecological health (e.g. an index of leaf area). The result is a set of options that are most likely to achieve the goal with a probability distribution characterising an estimate of the potential for success. This approach is one way to address the fact that outcomes cannot be assessed in a deterministic way and it is more useful to assess the options within a risk-based evaluation context. Options judged to have the greatest potential for floodplain benefits per unit intervention effort could be identified for particular sites and sections of sites based on a qualitative assessment. Knowledge about site attributes influencing the potential biophysical threats and responses to interventions could be included in the qualitative assessment of the likelihood of success. Examples, of information that could help determine the likelihood of success of certain options include the following.

- Type of vegetation – Red Gum is more responsive to inundation and reduced salinity of groundwater than Black Box eucalypts.
- State of vegetation health - Intervention at SEA sites or parts of SEA sites where vegetation has suffered minor degradation is more likely to be successful.
- Source of high water table – high water table from drainage inflow can be more successfully mitigated with SIS than high water table resulting from lock operation.
- Depth of water table - conditions throughout a particular floodplain will typically vary as to the depth of the water table, thus intervention with SIS at some sites is more likely to be effective than at other sites.

- Inundation potential – lower positions in the floodplain can be flooded with less additional flow and smaller water regulation infrastructure investments. Inundating higher landscape positions requires more water and/or greater infrastructure and may involve greater damage to built infrastructure.

Using such an approach could allow the set of options and best sites for targeting to be reduced. The analysis can be extended to include only those options that achieve results within desired time frames and for specific sites. As biophysical information gaps are filled and uncertainty reduced with further research, the information set can be revised and options reassessed.

### **3.3 Economic Screening**

Economic screening is geared to narrowing the field of options to those that can improve economic efficiency. In a world of perfect information, for public investments, the approach evaluates all costs, benefits, opportunity costs and externalities in a cost-benefit framework and ideally, options are ranked according to their net present value (NPV), all things considered (Boardman *et al.* 1996; Hanley and Spash 1993; Arrow *et al.* 1996). The main goal is to maximise public good and achieve *pareto* optimality. This approach can be well supported by economic theory and the approach has been adopted widely (Arrow *et al.* 1996).

In practice, and especially for environmental projects, there is insufficient information available to readily evaluate NPV using a full and complete cost-benefit framework for screening the options that maximise public good (Farrow and Toman 1999). In effect, an economic screening usually, and practically, involves its own three steps. The first step in economic screening is geared to first determining the options that are lowest cost using a cost effectiveness analysis. The next level of economic analysis involves assessing the size of any gap in net benefits between costs and available benefits information. A third step involves evaluating whether further assessment of benefits is appropriate, especially non-market benefits. A full and complete economic cost-benefit

analysis may involve extensive non-market benefits assessment and incorporation of estimated non-market benefit values into a full cost-benefit analysis or other approaches for ranking options as described below. Each of these three levels of potential economic analysis is briefly summarised here with the purpose of explaining what they each can contribute to an economic screening procedure for ranking River Murray floodplain investments.

### **Cost Effectiveness**

The most basic approach to screening and ranking options according to economic feasibility may proceed without including economic external benefits information often taking the form of cost effectiveness analysis (CEA). In such an analysis, the goal is to evaluate the least cost option for attaining a particular biophysical target, for example. The target could be to achieve a given biodiversity benefits index score or to achieve a specified percentage of floodplain recovered.

While most categories of cost can be estimated with readily available data (e.g. cost of water acquisition and building weirs), there often is limited information about market benefits, such as camping fees and fishing licenses, and typically almost complete absence of information on non-market benefits such as the recreational, amenity or existence values associated with floodplain health improvements. Because the value of benefits that would result from biophysical changes are not included in a typical CEA, there is a clear risk of unknowingly rejecting options with relatively high benefit value if they have high costs as well. Without analysis of benefits, there is no way of knowing if options that generate significant benefits have been rejected in favour of low benefit options. This is most likely where benefits are ambiguously correlated with biophysical outcomes (e.g. where recovery of two different areas of physically similar floodplain have very different recreational value due to factors such as accessibility differences).



## Threshold Gap Analysis

Threshold Gap Analysis (TGA or Break Even Analysis) provides a framework for including information on market transactions relating to benefits. Because it includes information about at least market benefits, TGA can make a useful contribution to screening options beyond that provided by a CEA. Such analysis goes beyond CEA and compares the dollar value, in present value terms, all available costs and benefits of a project (Kahn 1989). A number of techniques can be used to measure direct expenditures, changes in productivity or improved production rates/returns on and off site, replacement cost or defensive expenditure. Benefits include the discounted sum of all the revenues and other values that are generated as a result of an investment. For example, benefits could include estimated increased camping fees collected as a result of increased usage of a floodplain due to its improved condition. However, there is often uncertainty regarding future dollar value of cost and benefit flows for both CEA and TGA. These risks and uncertainties can be incorporated in the analysis by using sensitivity analysis or an expected value approach where probability distributions are known.

The goal in TGA is to gain guidance from the Benefit Cost Ratio (B/C). A B/C ratio with a value of greater than 1.0 is often used as an indicator of whether or not a project may be a 'good investment' from society's point of view. If the B/C ratio is greater than 1.0, the option is considered clearly in society's interest based on the efficiency criterion. If the B/C ratio is less than 1.0 then the size of the Gap guides the next step. If the Gap is small then it is likely that there are sufficient non-market benefits due to amenity or existence values that, if included in dollar values, would justify the investment. If the Gap is Large, this is not clearly the case and other assessment techniques may be called for to assess whether there are sufficient benefits to fill the Gap, increase the B/C ratio to greater than 1.0 and thereby justify the public investment.

The challenge with TGA is that the TGA approach can be unsatisfactory in settings such as floodplain investment choices. This is because the TGA approach would necessarily involve assessment of too many choices to consider each with a diverse range of benefits. Furthermore,

the benefits typically have not been valued already in dollar terms and also, there is typically an uncertain timing of benefits that occurs far in the future while significant and more certain costs are up front. Suggested ways of dealing with this have included a low or zero social discount rate for benefits. For a discussion see Quiggin (2001), Young (1993) and Young and Hatton MacDonald (2005). Hence, for all these reasons, TGA on its own is likely to be insufficient for ranking floodplain investment options systematically.

### **Economic analysis with non market valuation studies of benefits**

There are two main reasons for pursuing non-market valuation. One reason is to provide a key link between biophysical outcomes of investments and values people attach to the changed conditions and the second is to avoid mistakes in ranking options. One approach to including estimates of the non-market values of investment options is to augment a TGA with estimates of non-market benefits based on information from existing studies as part of a benefit transfer approach (BTA). As a first cut, existing studies can be used to form a judgment about whether or not it is likely that non-market values are sufficient to produce a positive B/C ratio. A number of studies of wetland and River health exist where the studies evaluate different areas and different sets of attributes for different contexts and interested groups (Whitten and Bennet 2005b, 2005a; Hatton MacDonald and Morrison 2005; Van Bueren and Bennett 2004; Morrison *et al.* 2002; Whitten and Bennett 2002; Bennett and Morrison 2001; Whitten and Bennett 2000; Herath 1999; Bennett *et al.* 1997; Devousges *et al.* 1992; Smith 1992; Loomis 1992). While Bennett and Gillespie (2004) concluded that it is not possible to adapt many of these values to the Murray context in a rigorous way, the results of existing studies can certainly provide estimates on limits to the range of benefits likely to derive from floodplain remediation along the Murray.

Given that benefits transfer may not be informative enough, the choice of non-market valuation technique is essentially between use of Revealed and Stated Preference approaches. Revealed Preference techniques are useful when there are non-market values that involve benefits close to known experience for use values. In these cases, the 'behaviour trail' can be followed and

techniques such as Travel Cost and Hedonic pricing models can be used to estimate willingness to pay based on consumer behaviour and the cost of surrogate goods or services in related markets. For use values and non-use values of attributes that are outside the immediate experience of individuals, Stated Preference techniques such as Contingent Valuation and Choice Modelling are called for (Adamowicz 2004; Bennett and Adamowicz 2001). For example, a significant change in condition due to floodplain remediation at remote sites such as Chowilla may be outside the experience of many people. A Stated Preference technique may be useful for eliciting willingness to pay for such a significant change in state.

In some cases, data derived from Travel Cost or other Revealed Preference studies may be combined with Stated Preference techniques so as to be particularly helpful in providing estimates of the value attached to drastically changed environments with complicated contexts and concepts. What can be particularly useful in ranking alternatives is that Stated Preference techniques can be designed so as to impose a spending constraint thus realistically limiting desires in a way that is not straightforward when biophysical indices are used on their own (Morrison and Hatton MacDonald 2005).

### **3.4 Social Screening**

Regardless of the size of the Gap, the goal at a final screening step is to reduce the range of options considered to a set that is not only biophysically feasible and economically viable but also acceptable socially. This involves a step that is likely to go beyond *pareto* optimality goals of cost-benefit analysis considered in the second step. The social screening step can incorporate distributional issues as well and seeks to find a ranking that gains agreement about what is desired by the interested groups. The ranking identified by the final social screening step sets the priorities for floodplain investments. Defining the interested groups is also part of the challenge. If it is all of society, then cost-benefit analysis may be best, however, given data gaps and uncertainty as well as distributional issues and the reality of the current decision making institutions in the Basin, it is

likely that the group best suited to ranking options is smaller, and more knowledgeable about the Basin.

As well, a final social screening step can include more information than CEA and TGA because these approaches require that benefits and costs should be expressed in dollar value terms. For some options there will be no easy way to express biophysical changes, and certain types of benefits following on from biophysical changes, in dollar terms. However decision makers may wish to include them in the assessment. An option for addressing this is Multi-Criteria Analysis (MCA). MCA is a broader framework, which nests cost-benefit analysis, and is geared to establishing rankings based on overall benefit. MCA is useful for measuring the utility of competing options where each leads to multiple outcomes some of which may be measurable in monetary terms and others of which are measured in some other units (Teclé 1992; Massam 1988). Other similar frameworks for assessing options by determining weights and priorities include focus groups, deliberative juries and expert panels. In each of these approaches, a group is surveyed for its preferences for options, thus allowing ranking of the options.

MCA brings together the views of people or groups who have an interest in the outcome of a policy or management decision. The goal of the process is to determine the weights that interested participants attach to attributes that characterise the available options. The main aim is to rank actions and come to a consensus decision via the MCA approach. The method is attractive because it provides a way to elicit information about preferences that are held by those who have an interest in the decisions but where all the information is not available in dollar terms.

Proponents of MCA suggest that the real value of MCA, and part of the motivation for its development, is that it is useful for assessing complex contexts and complex concepts in the same exercise. As there is no strict adherence to a particular metric, such as 'dollars', current informed judgement about a range of information is easily incorporated in the process. Trade-offs can be assessed within and across sites and because of the nature of the process itself, the activity of

participating in an MCA can in itself lead to group consensus as well as allow people to consider options that involve a completely changed state.

One of the major differences between MCA and most non-market valuation techniques is the number of people involved. Non-market valuation studies typically survey 200-2,000 people while MCA techniques typically involve less than 20 carefully selected people who have an interest in the issue and usually, some expert knowledge.

For the floodplain investment decisions discussed here, MCA can be used at the final social screening step or at a number of different points in the decision making process. For example, MCA can precede a CEA or TGA as a framework for combining all available information for a group to evaluate and thereby rank options. Of course, MCA works best when the information set supporting the ranking process is as complete as possible including biophysical and economic values. Hence, information obtained through the process of undertaking a CEA followed by a TGA with or without non-market values included, can be an invaluable input to the MCA approach. (Hajkowicz et al, 2000).

#### **4. Implications of Screening**

In considering River Murray floodplain intervention options, the choice is among multiple options with one of them being to take no further intervention and allow further degradation in some areas. The complexity of the issue means that there is no simple way to answer questions about what types and levels of intervention are appropriate where. The choice is a complex, simultaneous problem of considering multiple options. Without a process that can usefully screen options, complex decision making of this sort can lead to one of two results: a deadlock in decision making or a high chance of a sub-optimal choice. The proposition advanced in this paper is that results of a less than rigorous process for considering choices are too costly to bear given that there are better ways to make choices and set priorities. The solution proposed in this paper is to use three

main steps based on the best information and the best biophysical, economic and social analysis. The steps sequentially deal with the complexity of the choice of both floodplain investment options and the choice of methods for screening options.

Four key implications about the choice of methods for screening that are identified in this paper are direct consequences of the nature of the issue at hand. First, the problem involves a very large set of potential biophysical options and biophysical impacts of options that are not understood with certainty. Hence, there is a need for research intensive efforts to fill biophysical knowledge gaps a need to develop and use methodologies that deal with inherent complexity and uncertainty regarding biophysical impacts of options. Second, there are significant non-market benefits involved. Without further non-market valuation work, there may be benefits associated with each option that are not evaluated or reported in the same metric. A distinct possibility arises that options with large, but unquantified, benefits may be overlooked because they have relatively high costs. Third, given that non market valuation may be necessary and that outcomes of many of the options under consideration are well outside of current experience (e.g. massive die back of River Red Gum communities), Stated Preference techniques such as Choice Modeling may represent the only viable non-market valuation method. Fourth, the political context in which decisions about floodplain investment will be made will require consensus among relatively small numbers of State, regional and MDBC experts. MCA and other methods that include deliberative processes would be well suited to help in reaching consensus on setting priorities for floodplain investments.

## **5. Conclusions**

The recommended approach for assessing floodplain options includes the following sequential steps as part of a screening process:

- 1 Biophysical screening: identify the options that are feasible, have the greatest possibilities of success and achieve the most desirable outcomes from a biophysical perspective.
- 2 Economic screening:

- 2.1 Financial screening: identify the least cost options for those options that have been filtered by biophysical screening.
  - 2.2 Threshold Gap Analysis: identify the Gap between identified costs and benefits including market benefits and with some benefit transfer, if possible and if required and rank options.
  - 2.3 If the Gap is a Large Gap: Full Cost-Benefit Analysis with Non-Market valuations, where appropriate.
- 3 Social Screening for Consensus: Multi-Criterion Analysis to assess options as socially acceptable at any stage in the screening process using all available relevant information and especially if there is some additional important non-monetary information that cannot be included in a Cost-Benefit Analysis and if the Threshold Gap is small (and non-market valuation is not essential for ranking).

These recommendations arose through applied work in this area with interdisciplinary teams and resulting careful consideration of the complex biophysical, economic and social dimensions of the problem. The resulting recommendations are distinctly different than the standard cost-benefit approach that economists might have been inclined to offer without an understanding of the complexity of setting priorities in the floodplain context.

Each level of screening provides valuable information and provides a reduced set of options to consider. Confidence is instilled by the process itself whereby each step of screening is undertaken according to methods that are chosen as best, according to the best practice guidelines of each respective discipline: biophysical sciences, economics and social analysis. The implications of using particular methods have been raised. The final observation is that in undertaking the screening procedure for setting investment priorities, no step can be left out. Ultimately, given the complexity of the context and the complexity of the decisions, it is necessary to consider adaptive iterations with information gaps and uncertainty reduced in line with better information as a requirement to reach stable consensus over time.

## References

- Adamowicz, W. L. (2004). What's it worth? An examination of Historical Trends and Future Directions in Environmental Valuation, *Australian Journal of Agricultural and Resource Economics* 48:3, pp. 419-444.
- Arrow, K., Cropper, M., Eads, G., Hahn, R., Lave, L., Noll, R., Portney, P., Russell, M., Schmalensee R., Smith, K. and Stavins, R. (1996). Is there a role for Benefit-cost analysis in environmental, health and safety regulations?, *Science* 272, pp. 221-222.
- Bennett, J. (2002). Non-market Valuation Scoping Study, Report prepared for the Murray-Darling Basin Commission, The Living Murray Project, September 2002.
- Bennett, J. and Gillespie, R. (2004). Linking Science, Community Consultation And Economics: The Living Murray Project, Paper presented to the 2004 AARES Conference, Feb 2004, Melbourne.
- Bennett, J. and Adamowicz, W. (2001). Some Fundamentals of Environmental Choice Modelling, Bennett, J. and Blamey, R. (Eds.), *The Choice Modelling Approach to Environmental Valuation*, Edward Elgar, pp. 37-72.
- Bennett, J. and Morrison, M. (2001). *Estimating the Environmental Values of New South Wales Rivers*, Report 2, The Environmental Value of NSW Rivers Project.
- Bennett, J., Blamey, R. and Morrison, M. (1997). Valuing damage to South Australian wetlands using the Contingent Valuation Method. *LWRRDC Occasional Paper* 13/97, Canberra.



Boardman, A. E., Greenberg, D.H., Vining, A.R. and Weimer, D.L. (1996). *Cost-Benefit Analysis: Concepts and Practice*, Prentice-Hall Inc, New Jersey.

Brennan, D. (2004). Peer Review of MDBC Report, *Scoping of Economic Issues in the Living Murray, with an emphasis on the irrigation sector*, May 2004.

Connor, J. (2004). *Multi objective framework for assessing salt interception options – preliminary concept development within an economics construct*, Draft Client Report to the Murray-Darling Basin Commission, July 2004.

Desvousges, W. H., Naughton, M.C. and Parsons, G.R. (1992). Benefit Transfer: Conceptual Problems in Estimating Water Quality Benefits using Existing Studies, *Water Resources Research* 28:3, pp. 657-683

Farrow, S. and Toman M. (1999). Using benefit-cost analysis to improve environmental regulations, *Environment*, March 41:2 p.12.

Hajkowicz, S., Young M., Hatton MacDonald D., Wheeler S. and Young D. (2000). *Supporting Decisions: Understanding Natural Resource Management Techniques*, CSIRO Land and Water Client Report, June 2000.

Hanley, N. and Splash, C.L. (1993). *Cost-Benefit Analysis and the Environment*, Edward Elgar Publishing Limited, UK.

Hatton MacDonald, D. and Morrison, M. (2005). *The Value of Habitat and Agriculture*, CSIRO Land and Water Client Report, CSIRO Land and Water, Policy and Economic Research Unit, Adelaide, Folio No S/04/1017.

Herath, G. (1999). Estimation of Community Values of Lakes, A Study of Lake Mokoan in Victoria, Australia, *Economic Analysis and Policy*, 29:1.

Kahn, A. E. (1989). *The economics of regulation: principles and institutions*, Wiley, New York.

Loomis, J. B. (1992). The Evolution of a More Rigorous Approach to Benefit Transfer: Benefit Function Transfer, *Water Resources Research* 28:3, pp. 701-705

Massam, B. (1988). Multi-criteria Decision-making Techniques in Planning, Diamond, D. and McLoughlin, J. (Eds.), *Progress in Planning*, Vol. 30, Part 1, Pergamon Press, Oxford.

Morrison, M. and Hatton MacDonald D. (2005). Valuing Biodiversity: A Comparison of Compensating Surplus and Compensating Tax Reallocation. CSU Working Paper Series.

Morrison, M., Blamey, R., Bennett, J. and Louviere, J. (2002). Choice modelling and tests of benefit transfer, *American Journal of Agricultural Economics* 84, 161-170.

Murray-Darling Basin Commission, (2004). *Scoping of Economic Issues in the Living Murray, with an emphasis on the irrigation sector*, July, Final Report.

Murray-Darling Basin Ministerial Council (2004). *The Living Murray Environmental Works and Measures Program*, November, Canberra.

Murray-Darling Basin Ministerial Council (2003). *Communiqué on the First Step Decision of The Living Murray*, November, Canberra.

Murray-Darling Basin Ministerial Council (2002). *The Living Murray*, July, Canberra.

Overton, I. C. (2005). Modelling Floodplain Inundation on a Regulated River: Integrating GIS, Remote Sensing and Hydrological Models, *River Research and Applications* (forthcoming).

Overton, I. and Jolly, I. (2004). *Integrated Studies of Floodplain Vegetation Health, Saline Groundwater and Flooding on the Chowilla Floodplain South Australia*, May, CSIRO Land and Water Technical Report No. 20/04.

Quiggin, J. (2001). Environmental economics and the Murray-Darling river system, *Australian Journal of Agricultural and Resource Economics* 45:1, pp. 67-94.

Smith, K.V. (1992). On Separating Defensible Benefit Transfers From Smoke and Mirrors, *Water Resources Research* 28:3 pp. 685-694.

Tecle, A. (1992). Selecting a multicriterion decision making technique for watershed resources management, *Water Resources Bulletin* 28:1, pp.129-140.

Van Bueren, M. and Bennett, J. (2004). Towards the development of a transferable set of value estimates for environmental attributes, *Australian Journal of Agricultural and Resource Economics* 48, 1-33.

Whitten, S. and Bennett, J. (2005a). *The Private and Social Values of Wetlands*, Edward Elgar, Cheltenham, UK (forthcoming).

Whitten, S. and Bennett, J. (2005b). Transferring the Environmental Values of Wetlands, Rolfe, J. and Bennett, J. (eds.), *Choice Modelling and the Transfer of Environmental Values*, Edward Elgar, Cheltenham, UK (forthcoming).

Whitten, S. and Bennett, J. (2002). A Travel Cost Study of Duck Hunting in the Upper South East of South Australia, *Australian Geographer*, 33:207-221.

Whitten, S. and Bennett, J. (2000). Wetland Management Trade-offs in the Upper South-East of South Australia, *Rural Society* 10(3):341-360.

Young, M. D. (1993). *For our children's children: Some practical implications of inter-generational equity and the Precautionary Principle*, Resource Assessment Commission Occasional Publication No. 6.

Young, M. D. and Hatton MacDonald, D. (2005). How Should We Discount the Future? An Environmental Perspective, *Discounting*, Schilizzi, S., (ed.), Elsevier (forthcoming).