



The role of science and values in setting sustainable diversion limits

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Introduction

Australia is faced with a historic opportunity to improve environmental outcomes in the Murray-Darling Basin. So far, the debate has focussed on the volume of water required to achieve environmental objectives rather than on what those environmental objectives are, and how they were chosen. The current state of knowledge makes it difficult to confidently link environmental objectives with volumes of water at a Basin level. Choosing environmental objectives requires value judgements that can only be informed, not guided, by science. As a result, we suggest moving towards an adaptive management framework where environmental water is delivered, its delivery is monitored and the environmental objectives and targets are optimised iteratively.

The Murray-Darling Basin Plan has generated considerable debate around the extent to which the *Water Act 2007* gives environmental outcomes primacy over social and economic considerations. On the one hand is the interpretation that environmental outcomes, as defined by science, must be given ultimate priority and that social and economic considerations are brought in only once environmental water requirements has been decided upon. An alternative interpretation is that the *Water Act* provides scope for balancing environmental, social and economic factors as it is not possible to define environmental outcomes based on science alone, and that the process of setting environmental outcomes includes value based decisions that inherently allow for social and economic factors to be considered. The discussion has largely focussed on how much water is “enough” for the environment, as well as the issue of balance between social, economic and environmental factors. We argue that setting sustainable diversion limits, as required by the *Water Act 2007*, necessitates values-based decisions regarding the environmental outcome sought, within the constraints of fulfilling international water requirements. This is because science cannot define what is sustainable in the absence of values-based decisions about what outcomes are to be achieved.¹ In this context, the role of best available science is to inform rather than to specify. Therefore, it is not possible to definitively state how much water is required for the environment based on science alone without clearly stating what environmental outcomes are being sought. The unavoidable role of values in determining these outcomes must be acknowledged and made transparent. We believe that the environmental objectives and targets used to underpin the Murray-Darling Basin Plan, and the inherent contribution of values in setting these targets, have received insufficient attention in the debate regarding what constitutes a sustainable level of water extraction. We explore this concept with reference to the development of the first two steps in the Basin planning process, the *Guide to the Basin Plan*, an initial position paper for discussion, and the *Proposed Basin Plan*, the first draft. We argue that setting sustainable diversion limits is a values-based decision informed by science and that there is no one clear threshold that can be defined as sustainable based on science alone.

The Murray-Darling Basin: Context

The biophysical health of the Murray-Darling Basin is in serious decline. The Basin is one of the most important in Australia. It covers over one million square kilometres (approximately 1/7th of Australia’s total land area), produces 70 per cent of Australia’s irrigated agriculture, and approximately 40 per cent of Australia’s gross value of agricultural production.² The Basin includes over 30,000 wetlands, 16 of which are formally recognised as internationally important under the Ramsar Convention on Wetlands.³

In 2007, a basin-wide assessment of river health found that of the 23 river valleys that make up the Basin only the Paroo was in good health. Two river valleys, the Border Rivers and Condamine, were moderately healthy and the remaining 20 river valleys were in either poor or very poor health.⁴

The Basin covers four Australian states, Queensland, New South Wales, Victoria and South Australia plus the Australian Capital Territory. As water is a state responsibility within Australia, there has been a long history of multi-jurisdictional management in the Murray-Darling Basin. In 1915, the River Murray Waters Agreement was established, the Murray-Darling Basin Commission (MDBC) was created in 1988 and the Murray-Darling Basin Agreement began in 1992. The MDBC implemented a number of major reforms including; a cap on surface water diversions (agreed in 1995), the Basin Salinity Management Strategy (2001), The Living Murray (2004), Native Fish Strategy and the Sustainable Rivers Audit (2003). The cap on surface water diversions was undertaken without specific reference to environmental objectives or targets; instead it aimed to limit the unsustainable growth in surface water diversions that threatened the security of supply. Following a major review of cap implementation in 2000, the Commission recommended to the Murray-Darling Ministerial Council that the level of the cap continue to be refined to reflect increased understanding of the environmental requirements of the system. As a result, the MDBC established the Living Murray Program as a first step in provision of environmental water comprising an additional 500 GL/yr long term annual average environmental water entitlements.⁵ This step-wise process was present in policy documents describing both the surface water cap⁶ and The Living Murray. Despite these reforms, the significant millennium drought from 1997–2010 in south-eastern Australia placed additional stress on the biophysical systems of the Basin, and raised awareness of water resource management issues throughout Australia.

In 2007, a new Commonwealth Water Act introduced the requirement to undertake a Basin-wide planning process to manage water resources in the national interest based on environmentally sustainable levels of diversions. Between 2007 and 2008 a series of reforms were implemented that included the referral of state powers relevant to the Murray-Darling Basin Agreement to the Commonwealth Government. This enabled the Murray-Darling Basin Authority (MDBA), a new federal agency established by the Water Act, to undertake the responsibilities of the MDBC. The Water Act 2007 is discussed further below.

The MDBA has been working towards the development of a Basin Plan consistent with the requirements of the Commonwealth Water Act 2007. To date, there have been three major steps in this process:

1. The Guide to the Basin Plan, a policy discussion paper, was released in October 2010;
2. The Proposed Basin Plan, a draft of the plan for public consultation, was released in November 2011; and
3. The revised Proposed Basin Plan was released in May 2012 following the formal public consultation and submission processes.

It is useful to note that the elements of the Water Act 2007 that related to the Basin Plan were not materially revised as a consequence of the referral of powers from the states for the management of the Murray-Darling Basin. As a result, the Basin Plan provisions are based on the Federal Government's external affairs powers under the Australian Constitution.⁷

Challenges for defining environmental outcomes, objectives and targets

Before we explore how environmental objectives were chosen to define sustainable diversion limits by the MDBA, it is worth briefly considering some of the general issues facing water practitioners in terms of setting environmental water requirements. Throughout this discussion, we assume that there will be some level of trade-off between environmental outcomes provided by flow and productive use generated from water extraction. That is, there is no intention to return flow regimes to pre-development or “natural” conditions, as this would require all available water to be allocated to the environment. Therefore, the trade-off between consumptive use and the environment necessitates an understanding of the relationship between water supply, including impacts of infrastructure and management regimes, and environmental outcomes.

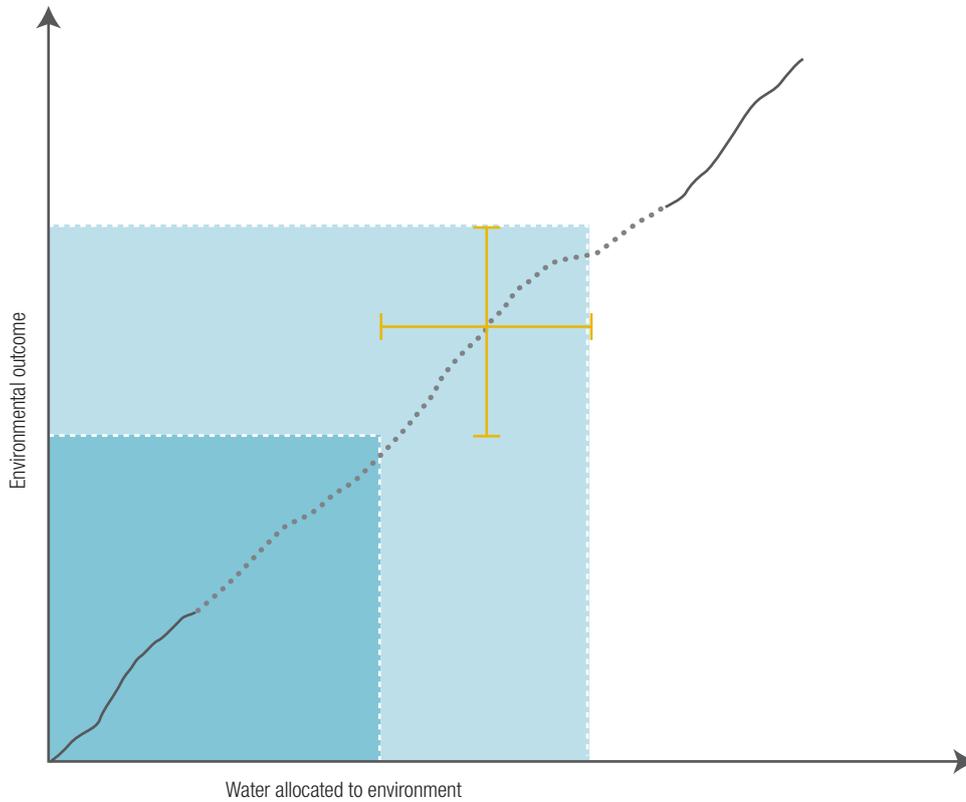
At one level it is simple to hypothesise that environmental outcomes are likely to improve as water allocation to the environment increases (Figure 1). The challenge faced by practitioners is that the definition of what constitutes environmental outcomes is complex for two reasons. First, defining what “environmental outcome” or “health” actually means is challenging. What metrics should be used? While it may be possible to define environmental outcomes for particular components of the ecosystem, for example fish or birds or particular forest types, as more features are sought to be included, the complexity increases enormously. There has been a considerable amount of scientific work done on indicator species or ecosystem based approaches.⁸ While there is certainly science available to inform some of these questions⁹ there is also a degree to which the issues in which we are particularly interested drive the approach taken. The larger the scale and complexity, the greater the need for an interdisciplinary approach to the analysis. This scale, complexity and inter-disciplinarity introduces both great uncertainty about relationships and the need for more judgements about how to frame research, and hence, provides more opportunity to introduce values into the discussion, either explicitly or covertly.¹⁰

Second, the expression of water available for use adds complexity. For the purpose of the Basin Plan, water available for consumptive use must be expressed in terms of long-term annual averages (a requirement of the 2007 Water Act). From an environmental perspective it is the flow regime that is important. This relates to a particular flow level, for a particular amount of time, at a particular time of year rather than a simple long term annual average volume. In essence, complexity and uncertainty characterise the use of science in informing the outcomes likely from a marginal increase in water allocated to the environment (see Figure 1).

Regardless of the challenges involved in estimating marginal environmental outcomes from changes to water availability, science is only part of the process of setting environmental outcomes. The critical question that must be addressed is what do we intend to define as the sustainable point in the relationship between environmental outcomes and water availability. We argued above that science does not provide us with a complete understanding of the relationship between available water and environmental outcomes. But our question here is how we define the point on these curves that is sustainable. In other words, what environmental outcomes do we, as a society, choose to preserve, and at what cost?

Science alone cannot provide the answer. Even if we were able to start from a base of a comprehensive understanding of the relationship between environmental outcomes and water availability we still need to know what we are aiming to achieve, and we

FIGURE 1
COMPLEXITY AND UNCERTAINTY CHARACTERISE THE SCIENCE USED TO INFORM
THE LIKELY EFFECT OF INCREASED WATER AVAILABILITY TO ACHIEVE BASIN-WIDE
ENVIRONMENTAL OBJECTIVES.



need to do this at a level of specificity that is meaningful. We also need to have some idea of how the community values environmental outcomes and the tradeoffs and their benefits and costs with agriculture or development that are involved. In other words, qualitative concepts such as healthy or resilient are not specific enough, and therefore lack precision and measurability unless they are clearly defined in a tangible way.

Given these complexities, adaptive management approaches have been employed in other river basins such as the Glen Canyon Dam Adaptive Management Program in the Colorado River Basin in the USA. Specific environmental objectives and targets are set, a management strategy is developed to address these objectives, a monitoring framework is established to determine whether or not these targets have been achieved, then the process is reviewed and repeated iteratively to progressively move towards the objectives and targets. Adaptive management is often referred to as a structured approach to learning while responding to the inevitable uncertainty associated with the management of complex systems.¹¹

The task for the Basin Plan was to define environmental outcomes and establish water requirements to achieve these across a river basin that covers one million square kilometres. This is a significant exercise that, as far as the authors are aware, has not been attempted on this scale anywhere else in the world. For example the Living Murray Initiative¹², which was accurately described as a “first step” decision, did not seek to define a sustainable limit; rather it aimed to gain the maximum environmental benefit for a specific volume of water. In that instance the Murray-Darling Ministerial Council decided the volume of water.

The Commonwealth *Water Act 2007*

The Water Act was drafted as a piece of environmental legislation. It enabled the Federal Government to create new water resource planning requirements for the water resources in the Murray-Darling Basin, based on the Commonwealth's external affairs powers under Australia's Constitution. The Act therefore relies on the requirements to fulfil international environmental agreements such as the Ramsar Convention on Wetlands and the Convention on Biological Diversity. The general basis on which the Basin Plan is to be developed is outlined in Section 21 of the Water Act. In summary the important elements of this section are that:

- The plan must give effect to relevant international agreements;
- The Basin Plan must acknowledge the significant adverse impacts on the conservation and sustainable use of biodiversity that water resource development has had;
- The plan must promote sustainable use of the Basin water resources to protect and restore the ecosystems, natural habitats and species that are reliant on the Basin water resources and to conserve biodiversity; and,
- The plan must promote the wise use of all the Basin water resources and promote the conservation of declared Ramsar wetlands.¹³

Section 4 of the Water Act defines the environmentally sustainable level of take for a water resource as the level at which water can be taken from the water resource that, if exceeded, would compromise:

- Key environmental assets
- Key ecosystem functions
- The productive base
- Key environmental outcomes

The Water Act does not define the concept of “key” nor does it define ecosystem functions or the productive base. This means that there is scope for debate in the definition of these terms.

The Water Act gives emphasis to the environment ahead of social and economic considerations.¹⁴ There is an ongoing debate about the veracity of the Water Act's framing within international agreements and the Commonwealth's external affairs power that is beyond the scope of this chapter. Instead, we use the published legal advice from the Australian Government Solicitor to illustrate the scope for social and economic considerations to be included as part of the fulfilment of international agreements. This advice suggested that the environment did not necessarily need to be given precedence to the exclusion of all social and economic considerations because:

“...the international agreements themselves recognise economic and social factors and their relevance to decision making...The Water Act further makes clear that in giving effect to those agreements the Plan needs to optimise economic, social and environmental outcomes. Therefore, where a discretionary choice must be made between a number of options the decision-maker should, having considered the economic, social and environmental impacts, choose the option which optimises those outcomes.”¹⁵

The Act also specifies the use of “best available science” in setting environmental objectives and sustainable diversion limits. Yet neither task, defining the environmental objectives or deciding upon how much water to allocate to achieve these objectives in the broader context of economic, social and environmental factors are scientific questions. Instead, they are decisions that require judgement, negotiation and consultation

informed by science and analysis of tradeoffs. It is the relevant Federal Minister who has decision-making responsibility for the Basin Plan, whereas the Authority (made up of six individuals selected based on expertise including the Chief Executive of the MDBA) has the responsibility for developing the Plan and recommending it to the Minister.

It has been argued that specific international treaties (for example the Ramsar Convention on Wetlands¹⁶), provides a level of specificity to setting of environmental objectives that allows science to determine the volumes of water required. In doing so, this argument portrays what should be a values-based judgement as one that can be justified using scientific truth. The implication is that decisions defining sustainable levels of extraction are objective and based on science. We argue that this obscures the extent to which values have, and must, influence these decisions.

Once environmental objectives and targets have been defined, a second step is required to quantify how much water is needed to meet these targets. While science is crucial in undertaking this analysis it cannot be based on science alone. Given the level of uncertainty associated with these calculations there is also a requirement to define and decide the level of risk we are willing to take in terms of success in achieving these objectives. This is also a values-based decision that can be informed by science, not a scientific decision in itself. In the following section, we explore how environmental objectives were set during the Basin planning process.

In moving from defining the share of sustainable diversion limits to implementation of environmental watering, the Water Act also required the establishment of the Commonwealth Environmental Water Holder. Water held by the CEWH must be used in accordance with the Environmental Watering Plan set out in the Basin Plan. The Environmental Watering Plan provides the requirements for delivery of environmental water and establishes a framework in which adaptive management can occur.

The Guide to the Draft Basin Plan

The Guide to the Basin Plan, released in October 2010, presented the preliminary results of the MDBA's work on defining the environmentally sustainable level of extraction. The initial step in the process of setting environmental objectives and targets was to define what aspects of the environment were to be considered key as required by the Water Act. This work focussed on an assessment of the existing inventories of aquatic ecosystems with some input from Basin states and scientific experts. Criteria were developed to filter the available information about environmental assets to provide a rationale for the potential definition as "key". These criteria were influenced by the factors that are relevant to international agreements and other principles of conservation biology on which the Water Act was based. However, it rapidly became apparent that it would not be logical, or logistically possible, to set environmental objectives and targets and subsequently calculate the water requirements for all of these key environmental assets. As river systems are hydrologically linked, particular flow regimes within a river will provide benefits to multiple sites. This meant that it was not necessary to "add-up" water requirements for all sites. Additionally, information about water requirements for many key sites was very limited. Therefore, by choosing a subset of indicator sites, it was considered possible to identify required flow regimes for particular parts of the river system.

This led to the development of a hydrological indicator sites method, which included a subset of key environmental assets, to enable detailed hydrological modelling of

environmental water requirements. In broad terms, the hydrological indicator site method required objectives and targets to be set for each site, and then hydrological models used to assess the flow regimes, and ultimately total water volumes, required to achieve these objectives and targets. The critical question then becomes how were these environmental objectives and targets chosen?

To set the environmental objectives and targets, the MDBA used the requirements of the Act in relation to international agreements as the underpinning logic for environmental objective and target setting. Where possible, in the case of Ramsar sites at least, the Ecological Character Description at the time of listing was used to develop site-specific environmental objectives and targets.¹⁷

The concept of setting detailed objectives and targets was essential to inform the hydrological modelling. However, this work was ongoing at the time of release of the Guide to the Basin Plan. Essentially, these preliminary results were translated from site-specific environmental objectives to a simplified approach of setting targets as a percentage of natural flow regimes at the end-of-system.¹⁸ This simplification presented a particular communication challenge that made it more difficult to move beyond the discussion of total long term volumes and environment versus social, economic and environmental outcomes.

Therefore, the water volumes presented in the Guide to the Basin Plan for the reductions in surface water diversions were informed by more specific environmental objectives and targets (which were in themselves based on judgements in terms of the application of international agreements), which were then used in hydrological modelling and broadly approximated to a simplified end of system flow analysis.

The result of this approach was that the Guide proposed a reduction in surface water extraction of between 3000 to 4000 GL/year long term average flows. The range of 3000 to 7600 GL/year long term average flows reflected the level of certainty of achieving improved environmental objectives and which were defined as between 60 – 80 per cent of the natural flow at the end of each valley. The Authority then decided to limit the upper range of the environmental water requirements to 4000 GL/year long term annual average as the social and economic impact beyond this level was judged to be too significant.¹⁹

The complex set of assumptions that underpinned the analysis, in particular how environmental objectives and targets were set, the role of science and the degree of discretion in choosing particular environmental objectives and targets were not communicated successfully. This, together with the limited public consultation prior to the release of the Guide, contributed to the negative response to the Guide when it was released in October 2010.

The debate surrounding the Guide to the Draft Basin Plan became focussed on environment versus social and economic impacts and the numerical value of the total reduction. There was significantly less discussion and consideration of the environmental objectives and targets that underpinned the range of potential reductions.

The Proposed Basin Plan

A number of significant changes occurred between the Guide to the Draft Basin Plan and the release of the Proposed Basin Plan for consultation in November 2011 and the plan provided to the Minister in May 2012. Arguably the most important of these was the completion of the detailed hydrological modelling of the environmental water requirements across the Basin. This represents a dramatic increase in sophistication in the analysis of the environmental water requirements beyond the simple end of system flow calculations that were used to inform the numbers presented in the guide.

Importantly, the completion of more detailed hydrological analysis allowed for the evaluation of the practicalities of particular environmental flow regimes actually being achieved within the current modified system; that is, the operational constraints to actually delivering the water. Examples of operational constraints include flooding land, bridges and towns, but also the size of pipes in dam off-takes and previously institutionalised rules around dam operation. Therefore in the case of the proposed Basin Plan, the detailed analysis linking environmental objectives and targets with flows were used as inputs and the final sustainable diversion limits also considered the limitations provided by existing system operational constraints.

The proposal to begin with a reduction in current diversion limits of 2750 GL/year long term annual average in the Basin Plan has been criticised by many as being insufficient. The arguments put forward are that this volume won't fulfil the requirements of international agreements and will therefore contravene the Water Act²⁰ or that the value is less than that which science specifies as required to achieve a healthy river system.²¹ However, few of these reviews provide detail on what objectives and targets are informing this scientific analysis and what is required by international agreements, with some exceptions.²² However, we argue that, regardless of whether these reviews provide specific information on the environmental objectives and targets used to define what a sustainable outcome is, any decisions regarding environmental objectives and targets inherently include values as part of the decision making process. Science and international treaty requirements alone cannot provide a completely objective framework for assessment.

Scientific review

As described above, the Water Act requires the Basin Plan to be based on best available science. Consistent with standard scientific practice, an independent review of the methods being developed to calculate environmental water requirements was initiated early in the Basin planning process. The results were published with the release of the Guide to the Basin Plan in 2010.²³

The subsequent work to develop environmental water requirements for the Proposed Basin Plan was reviewed through a panel process led by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Importantly, the review questions did not address the selection of the environmental objectives and targets themselves.²⁴ Rather, they were framed around the robustness of the science and methods used to calculate environmental water requirements. We believe this is a sound approach as it is consistent with the concept that science is only a tool to inform the negotiation and political decision-making.

The review of the science supporting the environmentally sustainable level of take confirmed that the technical methods used to assess environmental water requirements were defensible. The reviewers stated explicitly that the review was focused on the use of science to calculate water requirements to meet the ecological and hydrological objectives and targets, but not the choice of the targets themselves, which necessarily includes the consideration of social and economic factors. In addition, the reviewers acknowledge that while the provision of an additional 2800 GL/long term average (which was the volume used for the review rather than the 2750 GL/long term annual average provided in the proposed plan) will deliver some environmental benefits, not all environmental and hydrological targets will be met. In general, these unmet targets result from the inability to get water onto the higher floodplains under the 2800 GL/yr scenario. The assessment of the review is that this is a function both of operational constraints and insufficient provision of environmental water to meet all environmental objectives and targets chosen.²⁵

The review is consistent with our argument that science does not choose what is “correct” in terms of setting environmental objectives and targets. In the case of the proposed Basin Plan the initial environmental objectives and targets set were modified through the application of operational constraints as a limiting factor in terms of provision of additional water to the environment at this stage of the planning process.

Concluding remarks

We have argued throughout this chapter that insufficient attention has been focussed on reviewing and debating the environmental objectives and targets used as inputs to the calculation of sustainable diversion limits. We suggest that environmental objectives and target setting inherently includes social and economic considerations, because deciding on what environmental assets, functions and outcomes should be conserved is fundamentally a values-based decision.

An adaptive approach to managing water resources is essential to accommodate the inescapable uncertainty of planning for a river basin as large and as complex as the Murray-Darling. However, for an adaptive management approach to be successful, a set of environmental objectives and targets, with enough specificity to be meaningful, is required. These environmental outcomes provide a target to iteratively manage towards, and also allow changes in community values to be reflected in changes to the targets both explicitly and transparently. The adaptive management approach would be beneficial irrespective of how the Water Act is interpreted.

Given that the operational constraints have informed an initial environmental water allocation, it is important to now update the environmental objectives and targets that can be achieved with this volume of water. The next step is to assess whether these new environmental objectives and targets are acceptable, and to what extent the operational constraints could or should be adjusted. This then allows not only a clear starting point to be defined, but also the goals that can be met through incremental improvements with adaptive management.

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