Case Studies in Integrated Management

Development of the Murray-Darling Basin Plan, Australia

Barry T Hart
Member, Murray-Darling Basin Authority, Canberra, Australia
and Director, Water Science Pty Ltd, Echuca, Australia

1. Introduction

The Murray–Darling Basin is Australia's most iconic river system, and arguably the most important from a social, economic and environmental viewpoint.

The last 4 years has seen the culmination of major reforms in the integrated management of the Basin's water resources. This has been a journey that has occurred over the past 100 years since it was recognized in the 1970's that some form of integrated management was required for this river system. But until the last 15-20 years progress has been slow as will be discussed.

This chapter first describes the characteristics of the Basin, then briefly reviews these earlier reforms, and finally provides a summary of the largest reform – the development of the Murray-Darling Basin Plan (which passed into law on 22 November 2012) (Aust Govt, 2012a). The chapter concludes with comments on some of the important lessons learned over the journey in recent times.

This paper does not discuss the implementation of the Basin Plan, a process that will occur in the period between 2013 and 2019, and beyond. This process will no doubt have its share of challenges, but by the end of 2019, Australia will have successfully implemented water reform the scale of which has not been accomplished elsewhere in the world (see www.mdba.gov.au for details on the Basin Plan implementation).

2. Characteristics of the Murray-Darling Basin

The Murray-Darling Basin (catchment) has an area of around 1 million km^2 (or one seventh the area of Australia) and is located in south-eastern Australia (Fig. 1). The system is divided by climate into northern rivers (Darling system) and southern rivers (Murray system). The Darling system is more influenced by tropical weather patterns with most rainfall occurring in the summer (Dec-Mar), while the Murray system is more winter-spring (June-Sept) rainfall dominated. The essential physical, ecological, socio-economic and political features of the Basin may be found in MDBA (2010), MDBA (2011 a-c), Rogers & Ralph (2011) and MDBA (2012).

Most of the flow in the Murray–Darling system originates from the Australian Alps that run essentially north to south down the eastern side of the catchment. And while the Alps dominate the rainfall and runoff, by far the greater proportion of the Basin is made up of extensive plains and low undulating areas, mostly no more than 200 m above sea level. A consequence of the extent of the Basin is the great range of climatic and natural environments; from the rainforests of the cool eastern uplands, to the temperate woodland savannah country of the south-east, to the inland sub-tropical areas of the north, and to the hot, dry semi-arid and arid lands of the western plains.

The Murray–Darling Basin has been home to Aboriginal people for at least 50,000 years, sustaining their cultural, social, economic and spiritual life. There are now over

2 million people living within this Basin and dependent on its water resources. Outside the Basin a further 1.3 million people are dependent on its water resources, most living in the southern city of Adelaide.

Although the Basin covers a large area, runoff is very low compared with other major river systems around the world. Inflows to the rivers of the Basin have ranged from 118,000 GL in 1956, a wet year, to less than 7,000 GL in 2006, a dry year. Prior to significant human changes in the Basin, about 32,000 $GLyr^{-1}$ (or 6% of average annual rainfall) occurred as run-off and flow into the Basin's rivers and streams. Also, on average, an additional 1,000 $GLyr^{-1}$ is transferred into the Basin from external sources for an annual mean of 33,000 $GLyr^{-1}$, but the year-to-year variations in the Murray-Darling system are very large.

The Murray-Darling Basin is one of the most productive agricultural regions in Australia, representing 20% of Australia's total agricultural land area, but contributing almost 40% of the annual gross value of agricultural production in Australia (MDBA, 2012). Irrigated agriculture is the major user of the Basin's water resources (currently around 40%) and contributes around 37% of the Basin's agricultural output. Key agricultural products in the Basin include fruit and nuts, vegetables, table and wine grapes, dairy, rice, cotton, grain, sheep and beef cattle.

The Basin has a large area of floodplain forests and wetlands, with 16 of the wetlands being Ramsar listed. It also supports a great diversity of nationally and internationally significant plants, animals and ecosystems, many of which are now threatened, vulnerable or degraded. The degradation of floodplain River Red Gum forests, native fish populations, water bird populations and the Coorong coastal lakes at the end of the system, are now well documented (MDBA, 2010, 2011c). Much of this degradation has been caused by the increasing regulation of the Murray–Darling River system for consumptive use over the past 100 years.

3. Recent Reforms

In the early 1990s it was recognized that there was an urgent need to reform water resource management in the Murray–Darling River system. There was general agreement that the system was over-allocated with too great a proportion of the water resource allocated for consumptive uses (mostly irrigation). This led to a number of important changes in the management of the Basin's water resources over the past 30 years, culminating in the Murray-Darling Basin Plan.

The first of these changes occurred in 1995, when Basin governments[1] through the Ministerial Council agreed to a cap[2] (an upper limit) on the surface water diversions in the Murray-Darling Basin in response to reports that confirmed diversions in the Basin had grown rapidly, could grow further and that this growth had caused decline in river health. The two reported objectives of the Cap were: (a) to maintain and where possible improve existing flow regimes, and (b) to achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs. In fact, the real reason for the Cap was to place 'a line in the sand' to ensure things did not get worse for both the environment and the users.

---

[1] The Basin governments include the Federal Government and the governments of Victoria, New South Wales, Queensland, South Australia and the Australian Capital Territory.

[2] http://www.mdba.gov.au/what-we-do/managing-rivers/the-cap

Then in 2004, the Council of Australian Governments (COAG) adopted the National Water Initiative (NWI)[3], the aim of which was to phase out overuse of water, reform the water entitlement system, and develop an active water market. This intergovernmental agreement established the National Water Commission (NWC) and set it the task of achieving a nationally compatible market, regulatory and planning based system - one that would manage surface and groundwater resources for rural and urban use, and optimise economic, social and environmental outcomes.

The final steps in these water reforms occurred in January 2007 when the then Prime Minister (John Howard) outlined a $10 billion, 10-point National Plan for Water Security[4] to improve water efficiency and address over-allocation of water in rural Australia, particularly in the Murray-Darling Basin. In his speech, Prime Minister Howard made it clear that for this plan to work there must be a clear recognition by all - especially by state and territory governments - that the old way of managing the Murray–Darling Basin had reached its use-by-date, and that 'the tyranny of incrementalism and the lowest common denominator must end'.

Later in 2007 (August), the Australian Parliament passed the Water Act (2007) (Aust Govt, 2012b), with Basin governments agreeing that the Australian Government take a larger coordinating role in the integrated management of the Basin's water resources. Further reforms in 2008 involved the Basin States ceding some of their powers to the Australian Government, a significant change since under the Australian Constitution, State governments have responsibility for managing their State's water resources.[5]

This Commonwealth Water Act (2007) established a new Murray-Darling Basin Authority (MDBA), with a mandate to rebalance water allocations between the environment and consumptive uses, through the development and implementation of a Basin Plan. The development of this Basin Plan is now complete, having been approved by Commonwealth Parliament in November 2012 (Aust Govt, 2012a), although its implementation will occur over the period 2013-2019 (and beyond).

The next section covers the process that lead to the development of the Murray-Darling Basin Plan.

4. Developing the Basin Plan

4.1 The need for a Basin Plan

Community concern that the Murray–Darling River system was over-allocated with too great a proportion of the water resource allocated for consumptive uses (mostly irrigation) has been growing since the early 1990s (NWC, 2009). This is particularly so in the southern Basin, which is the most regulated.

River regulation has resulted in two major changes to the hydrology of these southern rivers: (a) most of the small to medium sized flows are now trapped in the many dams that have been built or captured in large on-farm storages, and (b) the flows are largely reversed (or dampened) with the historic strong winter and spring flows now diminished, and flows in summer and autumn increased to meet the demands of irrigators.

---

[3] http://nwc.gov.au/nwi

[4] http://pandora.nla.gov.au/pan/10052/20070321-0000/www.pm.gov.au/docs/national_plan_water_security.pdf

[5] There have been a number of calls over the years for the Commonwealth to take over state responsibility for surface water and groundwater management, although this would probably require the Australian Constitution to be altered via a referendum (Kildea and Williams, 2010).

These changes to the hydrology have resulted in a gradual degradation in the systems water-dependent ecosystems (MDBA, 2010). The most obvious examples included: the degradation (and death) of many river red gums trees, particularly in the lower reaches of the River Murray; a significant reduction in the numbers of waterbirds and native fish throughout the system; the poor ecological health of the Coorong located at the end of the system; and during the millennium drought (2000-2010) a significant reduction in the water levels in South Australia's lower lakes (Alexandrina, Albert) exposing acid sulfate soils with consequent degradation due to acid formation, and closing of the Murray Mouth (Brooks et al., 2009; Kingsford et al., 2012).

These issues provided the catalyst for the new Water Act (2007) and the development of the Basin Plan.

4.2 Key elements of the Basin Plan

The Basin Plan is a high-level plan aimed at ensuring the water resources of the Murray–Darling Basin are managed in an integrated and sustainable way to achieve *a healthy working Murray–Darling Basin*[6] *that supports strong and vibrant communities, resilient industries, including food and fibre production, and a healthy environment* (the Vision).

Importantly, much of this integrated management will occur through regional water resource plans developed and administered by relevant state governments, who will develop and implement their water resource plans in the period leading up to 2019.

Key elements of the Basin Plan include:

4.2.1 Long-term average sustainable diversion limits

The Basin Plan aims to achieve a healthy working basin through the establishment of new long-term average sustainable diversion limits (SDLs) that reflect an environmentally sustainable level of water use (or 'take'). These SDLs are limits on the volumes of water that can be taken for consumptive purposes (including domestic, urban and agricultural use), and are set at both a catchment and a Basin-wide scale. The SDLs are essentially a new cap on consumptive water take that need to be met as long-term averages, with annual compliance to be assessed by taking into consideration the particular circumstances of each water year.

The Basin Plan establishes a long-term SDL of 10,873 GL/y, which to be achieved will require an additional 2,750 GL/y to be recovered for the environment, or around a 21% adjustment to the current consumptive water allocations over the Basin[7]. It should be noted that the SDL includes all water used for consumptive purposes, including diversions from rivers and interceptions, the latter mostly being water held in farm dams or used by commercial plantations.

Not all catchments require water to be recovered for the environment. For example, the Paroo and Warrego catchments are largely unmodified, with little water abstracted for consumptive uses.

The basis on which the SDLs were determined – the ecologically sustainable level of take (ESLT) - is discussed below.

---

[6] A healthy working river has been defined as a managed river in which the natural ecosystem has been altered by the use of water for human benefit, but in which the altered system retains its ecological integrity while continuing to support strong communities and a productive economy (MDBA, 2011b).

[7] The reduction is around 25% in the highly regulated southern Basin, and around 12% in the less developed northern Basin.

4.2.2 Basin-wide environmental watering strategy

The introduction of SDLs and other reforms will result in more water returned to the environment (currently an extra 2,750 GL/y long-term average). However, this in itself is not enough to ensure the best possible environmental outcomes. The Basin Plan also requires that the MDBA develop a Basin-wide Environmental Watering Strategy (BWS) to ensure that the size, timing and nature of river flows maximises the benefits for the environment.

The BWS establishes a framework for planning and coordination of environmental watering across the Basin, including objectives, standards and priorities. The states will be required to develop environmental watering plans for individual rivers and their catchments. Priorities for annual environmental watering events will be done by the relevant governments (Federal and state), and will be achieved in collaboration with environmental water holders[8], local communities and Indigenous people. The BWS will be reviewed every five years.

The first BWS is scheduled to be published 2014.

4.2.3 Water quality and salinity management plan

The Basin Plan also includes an integrated Water Quality and Salinity Management Plan that provides a Basin-wide framework of objectives and targets for ensuring Basin water is 'fit for purpose' - that is, suitable for irrigation and recreational uses, maintaining aquatic ecosystems, and for drinking water after treatment.

This plan will be implemented over the period 2013-2019, with the initial focus on implementing salinity and flow management targets.

4.2.4 Water trading rules

A water market - the buying and selling of tradeable water rights - has been in place in the Murray-Darling Basin for over 30 years. Most activity is in the southern connected system, with trading of both permanent and temporary water occurring[9]. The introduction of a water market is generally regarded as a major success (NWC, 2011; Grafton et al., 2012; Horne, 2012), in helping to ensure that water reaches its highest value use. The water market was very important in assisting many irrigators to survive the recent millennium drought (2007-2010) (NWC, 2012).

The water trading rules in the Basin Plan are aimed at ensuring that all the Basin's water markets will function consistently, fairly, efficiently, effectively and transparently. These new rules will commence from 1 July 2014.

4.2.5 Water resource plans

Water resource plans set out how water resources will be managed, usually for a 10-year period, for a water resource plan area. They are being developed by the Basin states and will need to be approved by the Commonwealth Water Minister. There are a number of water resource plans already in place in the states, but these will need to be updated so they are consistent with the Basin-wide planning framework, including the sustainable diversion limits. The MDBA has published a Handbook for Practitioners (MDBA, 2013) to assist states in updating their water resource plans. These new plans must all be in place by 2019 (with the first plans due in 2016).

---

[8] The Water Act (2007) established the Commonwealth Environmental Water Holder (CEWH; www.environment.gov.au/ewater) with the responsibility for effectively using the Australian Government's environmental water portfolio (see Docker and Robinson, 2013). Some of the states also have established an equivalent environmental water holders and an environmental water portfolio (see www.vewh.vic.gov.au for details on the Victorian Environmental Water Holder).

[9] www.mdba.gov.au/what-we-do/managing-rivers/water-trade

4.2.6 Monitoring and evaluation

The Basin Plan requires the MDBA to report on the effectiveness of the Plan every year and on the impacts of the Plan after 5 years (Australian Government, 2012a). The Basin Plan sets a series of evaluation questions to guide the evaluation reports, in particular, focusing on the extent to which the objectives, targets and outcomes of the Plan have been achieved, how the Plan has contributed to changes in the environmental, social and economic conditions of the Murray-Darling Basin, and how could the Basin Plan be improved. Importantly, these evaluation reports must also assess *'to what extent has the program for monitoring and evaluating the effectiveness of the Basin Plan contributed to adaptive management and improving the available scientific knowledge of the Murray-Darling Basin'* (Aust Govt, 2012a, p149).

4.3 Ecologically sustainable level of take

The Water Act (2007) required that the new SDLs are determined on the basis of an assessment of the Environmentally Sustainable Level of Take (ESLT). This is a new concept in that it required the MDBA to develop a robust and scientifically defensible method for determining the water requirements for the Basin's water-dependent assets, but at the same time to take into account the need to minimize the social and economic impacts of any reduction in take.

It is important to note that the ESLT does not specify a detailed environmental flow regime that must be delivered. Rather, it is a method that estimates the minimum amount of water that will enable the achievement of an ESLT and Basin-wide environmental objectives. Ultimately, the environmental outcomes achieved through the Basin Plan will be dependent on the environmental flow decisions made at a regional and local scale, in response to future climatic conditions and ecological responses.

The method used to develop this is key component of the Basin Planning process is summarised in this section (see MDBA (2011c) for full details). The steps involved in the method are shown diagrammatically in Figure 2.

4.3.1 Identify Basin-wide environmental objectives

To achieve a healthy working Basin, the Basin Plan identified four high-level environmental objectives: (a) to protect and restore water-dependent ecosystems of the Basin; (b) to protect and restore the ecosystem functions of water-dependent ecosystems; (c) to ensure that water-dependent ecosystems are resilient to risks and threats; and (d) to ensure that environmental watering is coordinated between managers of planned[10] environmental water, owners and managers of environmental assets, and holders of held[9] environmental water.

4.3.2 Identify the key ecological values across the Basin

The Water Act (2007) defines the ESLT as the volume of water that can be taken for a water resource without compromising the key ecological assets and key ecological functions of the water resource.

---

[10] 'Held' environmental water is water that has been purchased for the purpose of achieving environmental outcomes, generally it has the same conditions of use as an irrigation water entitlement; 'Planned' environmental water is water that is committed in a water resource plan for the purpose of achieving environmental outcomes. During the 'millenium dought' (2000-2010), there were an number of instances where state water resource plans were either suspended or the planned environmental watering requirements were put on hold.

The MDBA identified 5 criteria for assessing the *key environmental assets*, these being based on international obligations (RAMSAR, Biodiversity), description of the ecological character of Ramsar wetlands and criteria for identifying high conservation aquatic ecosystems (MDBA, 2011c). It is estimated that there are over 30,000 wetlands and many thousands of kilometres of rivers and streams in the Murray-Darling Basin. However, there is no comprehensive inventory of these assets and little is known about most of them. The preliminary inventory identified over 2,400 named key environmental assets (and many more unnamed assets) of which 24 were used in the modelling to obtain the ESLT as is described below.

A set of 14 Basin-wide *key ecosystem functions* was also identified, including disturbance through cease-to-flow periods and bankfull and overbank flows, sediment (organic and non-organic) delivery to and from floodplains and to downstream reaches, dispersal of aquatic communities, and in-stream primary production (via periphyton, phytoplankton and biofilms).

4.3.3 Determine the environmental water requirements for these

A total of 24 'hydrological indicator sites' were chosen to represent the large number of key ecosystem assets (wetlands and rivers) and key ecosystem functions. This hydrological indicator sites approach was based on two key principles: (a) water-dependent ecosystems require a flow regime (threshold/volume, duration, frequency, timing) which sustains their ecological values and functions; and (b) many water dependent ecosystems are hydrologically connected.

The water requirements for these assets and functions were then modelled by determining the various component of the flow regime needed to meet the targets and objectives. The sum of these flow events then made up the environmental flow requirements for the site.

The MDBA used an integrated set of hydrological models for the Basin, linking together individual models used by states for water resource planning, that simulated flow regimes over an historical period of 114 years (1895 to 2009). These models can represent different river operations and water sharing arrangements, including: (a) the current flow regimes with all the dams and operational rules in place, and (b) the 'natural' or 'unmodified' flows assuming the dams and operations are not in place.

Bank full and overbank flows*:* For the wetland and floodplain forest assets (e.g. Macquarie Marshes, Barmah Forest) an assessment was made, based on the best available knowledge, of the flow-discharge threshold (related to the spatial extent of the event), the duration for that flow threshold, the required timing (seasonality) and the required frequency of events (e.g. wetlands - annual flooding, red gum forests – inundation frequency ca.1 in 3 years, and black box forests – inundation frequency ca. 1 in 8-10 years). These large water-dependent ecosystems (of which approximately 20 were modelled) require the largest volumes of water and essentially to set the size of the environmental water needs for the Basin.

Fresh flows: these are required to support in-stream processes and biota, and were assessed in terms of required flow magnitude, duration, timing and frequency.

Baseflows (or low flows): these are generally confined to the lower parts of the channel and are important in maintaining riffles and pools, and refugia during times of drought.

4.3.4 Selection of ESLT options for assessment

Initial MDBA modelling, and past assessments by other organisations, indicated that a Basin-wide reduction in diversions of 2,800 GL/y would provide a reasonable compromise between improved environmental outcomes with minimal social and

economic impacts. However, there was some controversy over this assessment, with irrigators and rural communities suggesting the reduction should be less, and environmental groups and the South Australian government suggesting it should be more.

The MDBA agreed to run two additional scenarios - 2,400 GL/y and 3,200 GL/y – representing a difference of ±400 GL/y to the 2,800 GL/y reduction scenario. It should be noted that 400 GL/y represents less than 5% change to the long-term flows at Wentworth[11].

4.3.5 Environmental outcomes for each scenario

The modeling showed some key differences between environmental outcomes associated with the three ESLT options. The most significant differences are evident for the Murray downstream of the Murrumbidgee junction, including the Coorong, Lower Lakes and Murray Mouth, particularly during dry conditions. Both the 2,800 and 3,200 GL/y reduction in diversions options showed a greater capacity to mitigate potential drought periods when there is extreme environmental stress.

Modeling also showed the 2,400 GL/y reduction option would compromise the ability to manage salinity levels within the Coorong, to maintain an open Murray Mouth, and to maintain the resilience of lower elevation parts of the lower River Murray floodplain and associated wetlands during dry periods.

The modeling showed the 3,200 GL/y reduction option provided incremental improvements in some indicators compared with the 2,800 GL/y reduction option. However, the MDBA considered this option would have unacceptable adverse social and economic effects

4.3.6 Assess environmental outcomes against the social and economic impacts

The MDBA commissioned over 20 studies on the social and economic implications of rebalancing water sources under the Basin Plan (MDBA, 2012). From a macro-economic viewpoint the economic modeling estimated that the Basin Plan is likely to have a small overall effect, reducing agricultural production by no more than 9 per cent and gross regional product by less than 1 per cent, and that the reduction in the aggregate value of Basin production will be more than offset by underlying economic growth over the period to 2019 (MDBA, 2012).

However, these studies did show that the local effects could be significant for smaller rural communities with high dependency on irrigated agriculture and limited capacity to adjust to the changes.

In deciding on the optimum ESLT, the MDBA used the results of the above studies and also took into account the following:

- The ESLT was set within the constraints and operative rules of the current system which has been designed for irrigation and other water use,
- Protecting the reliability of entitlements by avoiding third party impacts,
- Managing the held environmental water portfolio according to existing rules, in order to retain the productive capacity of the water dependent enterprises,
- Taking note of the effects in rural communities of the Commonwealth government investment in water buy-backs and irrigation infrastructure modernisation,
- Providing more time for the adjustment by allowing for a 7 year transition for the implementation of the Basin Plan.

[11] Located near the confluence of the Murray and Darling river systems (Fig. 1).

4.3.7 Select the optimal ESLT (and SDL)

At the end of this process, a new long-term SDL of 10,873 GL/y (compared with the baseline (2009) diversion limit of 13,623 GL/y) was established. This will require that an additional 2,750 GL/y be recovered for the environment or around a 21% reduction in the consumptive water allocations available prior to this change being contemplated. The recovered volume will be made up of 2,289 GL/y (25% change) in the southern Basin and 390 GL/y (12% change) in the northern Basin, and 71 GL/y in the unconnected systems (Lachlan, Wimmera).

As at 30 September 2013, the progress towards 'bridging the gap' was assessed as 1847 GL[12], around 67% of the total required. This water, in turn, becomes Commonwealth environmental water holdings, once it is processed and formally registered. As at 31 October 2013, the Commonwealth environmental water holdings totalled 1,233 GL long-term average annual yield (or 1,687 GL of registered entitlements), around 45% of the total needed.[13]

5. Key lessons from this reform

The process to develop the Basin Plan took around 4 years. This section contains a personal reflection on some of the key aspects of this journey, and seeks to draw out a number of key lessons from this exercise.

5.1 Initial question of whether the Water Act required a focus on the environment or on a triple bottom line

The Basin Plan development did not get off to a good start. In 2009 and much of 2010, there was much controversy over various interpretations of the Water Act that diverted attention from the key tasks. Many in the community were concerned that the Water Act was actually an 'environmental' act, with the sole purpose being to redirect consumptive water to the environment, with little concern for the social and economic impacts this could cause.

This was never true, although the wording of the Water Act was not helpful. It required the MDBA to achieve better outcomes for the water-dependent assets and ecological functions of the Basin, and at the same time to *'promote the use and management of the Basin water resources in a way that optimises economic, social and environmental outcomes'*[14]. This wording was confusing to many who saw the meaning of 'optimise' as vague and open to manipulation.

In retrospect, I believe it would have been better for the MDBA to have clearly spelled out at the start that the Water Act did require the MDBA to take a triple bottom line approach, by rebalance the water 'take' to obtain improved outcomes for the environment, but in a way that *minimised* the social and economic impacts. This exercise was never going to be a win-win situation – there were always going to be winners and losers, although the fact that the Commonwealth Government had allocated a significant investment to water buy-backs and infrastructure modernisation meant that no consumptive water would be compulsorily acquired.

Additionally, the policy focus was initially on the irrigators as those who would be impacted, with little consideration of the additional effects on those dependent upon irrigation, e.g. the food processing industries, local irrigation suppliers and the

---

[12] See http://www.mdba.gov.au/sites/default/files/surface-water-recovery-summary-30-September-13.pdf

[13] www.environment.gov.au/topics/water/commonwealth-environmental-water-office/about-commonwealth-environmental-water

[14] Water Act (2007), Section 3(c).

general community, particularly in those small rural communities highly dependent upon irrigation and with little capacity of adapt to the changes.

Lesson - Major reform processes should start with a clear initial statement of the objectives of the process (i.e. what needs to happen – in this case more water for the environment), an outline of the process to be followed, who is likely to be adversely affected and what the processes will be to minimise these impacts. Of course, even with this approach there will still be groups who will not accept the changes and will fight to extract what they can from the process (i.e. 'rent' seeking).

5.2 Effective engagement with community is vital

The MDBA started the process of engaging with the community very poorly.

First, the MDBA did not fully appreciate the existing resentment in the rural community with the number of contentious reforms that State jurisdiction had instituted over the decade before the Basin Planning process got underway. For example, Victoria had introduced a new Farm Dams policy in 2002 (Blackmore et al., 2001) and the Northern Sustainable Water Strategy in 2009 (DEPI, 2009), while New South Wales had significantly reduced groundwater allocations in many groundwater systems over the period since the late 1990's. Additionally, rural communities in the Murray-Darling Basin were feeling very fragile because of the extended drought that had affected them for almost 10 years.

Second, the attempt to introduce an additional community consultation step by preparing a 'Guide to the proposed Basin Plan' in 2010 was a failure and arguably put the reform process back many months.

The Water Act requires the MDBA to develop a 'proposed Basin Plan' (with appropriate consultation), to make this available over a 16-week period received submissions, to take note of these submissions in modifying the Plan, then submit the modified Plan to the Ministerial Council, and after addressing Ministerial Council comments, to submit the final Basin Plan to the Federal Water Minister. However, given the complexity of the task, the MDBA decided to prepare a 'Guide to the proposed Basin Plan' in 2010 and to use this as a basis for initial consultation with the community.

This process failed on two counts. First, the Guide (MDBA, 2010) was too large and complicated to be an effective engagement document. The Guide was prepared in two large volumes; Volume 1: Overview (223pp); Volume 2: Technical Background (3 Parts (1188pp)). The sheer size of the documents deterred most community members. There should have been simpler documents summarising the main points to be made.

Second, the time for community members to read and assimilate the main facts was far too short and there was no pre-exposure to the ideas. The Guide was launched on Friday 8 October 2010, and starting early the following week, the MDBA commenced a series of large (1000-3000 people) regional public meetings to explain the details. Not surprisingly, these ranged from hostile to extremely hostile, with the extreme being the burning of a number of copies of the Guide at the meeting in Griffith.

Community members assumed the worst since they simply did not have enough time to read the Guide before the meetings, no simple messages were conveyed to them, and they had had no input into the development of the Guide. Their analysis of the situation was simple: less water for irrigation, less money into the local community, therefore issues with health, education and other services.

As a result there was a considerable lack of confidence in the water reform process and the MDBA. It was indeed a major setback for the process.

However, at the commencement of 2011 (half way through the 4-year period), a new Chair of the MDBA was appointed and soon after a new Chief Executive Officer. This change in leadership of the Authority saw some major changes in direction, with a significantly improved engagement with Basin communities and with the State agencies.

The focus was on honest and genuine engagement, making a greater effort to know the 'players', mostly through smaller round-table meeting with community leaders, and having a consistency of staff involved in these meetings.

Without this changed process of genuine engagement it is doubtful that the Basin Plan would have been successful.

Lesson - genuine engagement with key stakeholders is essential in achieving any major reform. However, effective engagement requires a long-term commitment, a genuine desire to engage, skilled and professional staff to run the process, and sufficient resources to sustain the process.

5.3 Evidence-based decision-making

Contemporary natural resource management and policy development requires evidence-based decision-making (Conroy & Peterson, 2013). This was made evident in the Water Act, which required the MDBA 'to act on the basis of the best available scientific knowledge and socio-economic analysis' in developing the Basin Plan[15]. This is one of the few pieces of legislation that specifically requires this approach.

Above we have outlined the process used to develop the ESLT. This required the development of an iterative method to determine, at both a local catchment scale and at the Basin scale, the volume of environmental water that would result in improved environmental outcomes and minimal social and economic impacts on Basin communities. To achieve this balance required use of both the best available scientific knowledge and robust social and economic analysis.

However, even with a concerted effort to assemble the best available science and social and economic information, and make it publically available on the MDBA web site, it was still necessary for the MDBA to make a number of judgements. Important judgements made by the MDBA included: (a) as far as possible water-dependent assets should receive between 60-80% of the water they would have received before development; (b) the current areal extent of wetlands and floodplain forests would be maintained but not extended; and (c) the judgement that a recovery of 2,750 GL/y of water for the environment would satisfy the requirement to 'optimise the social, economic and environmental outcomes'[16].

The important point here is not that judgements were made, but that the options considered, the evidence supporting each option, and the reasons for selecting the final option were documented and made widely available.

An important consideration regarding evidence-base decision-making is the question of the relevance, robustness and quality of this information. The MDBA adopted a general principle that all reports and research should, as far as possible, be peer

---

[15] Water Act (2007), Section 21, 4(b).

[16] This was based on evidence relating to the environmental outcomes and social and economic impacts for three recovery options: 2,400 GL/y, 2,800 GL/y and 3,200 GL/y.

reviewed, and this has been done. One important example was the peer review of the ESLT methodology done by a CSIRO-lead team (Young et al., 2011).

Additionally, the MDBA has since established a high profile Advisory Committee on Social, Economics and Environmental Sciences (ACSEES)[17].

Lesson – although evidence-based decision-making is now an essential component in contemporary natural resource management and policy development, judgements will still need to be made in reaching final decisions. It is vital that the 'evidence' used in the decision-making should be documented and made widely available, and 'judgements' are clearly identified.

5.4 Eco-hydrological modelling was essential

The Murray-Darling Basin is a large and complex system (see Section 2) that spans two major weather zones, with summer rainfall dominating the northern part and winter-spring rainfall dominating the southern part. Additionally, the hydrology has been significantly modified over time through the construction of many dams and locks, this being particularly so in the southern basin.

It has been recognised for some time, that a detailed understanding of the hydrology is essential to the effective operation of the Murray-Darling river system for consumptive purposes. To this end, the States and MDBA have invested in the development and use of hydrological models for river operations. However, this has lead to a number of different hydrological models being used within the Basin.

In the period 2006-2008, CSIRO undertook what was known as the 'sustainable yields project', the aim of which was to assess the current and future water availability in the Murray-Darling Basin (CSIRO, 2008). This was the world's largest basin-scale investigation of the impacts on water resources of catchment development, changing groundwater extraction, climate variability and climate change. An essential part of this project was the linking of these hydrological models to cover the whole Basin.

Since that time, there have been further developments in both the hydrological (Podger et al., 2010) and eco-hydrological models being applied in the Murray-Darling Basin. The application of the Murray River-Flow Inundation Model (RM-FIM) and more recently the Murray Darling Basin-Flow Inundation Model (MDB-FIM) are assisting with the prediction of extent of floodplain inundation for given river flow conditions (Overton, 2005; Peake et al., 2011). The RM-FIM model was used in the development of the ESLT (MDBA, 2011c).

Currently, Australia's new national hydrological modeling platform – known as Source – is being rolled out in Australia and overseas by eWater. This modeling platform is suitable for assisting in managing catchments, rivers and urban water (See www.ewater.com.au).

Lesson - robust and acceptable hydrological and eco-hydrological models are essential tools in integrated water resources management. They are needed to assist in the operation of rivers for both consumptive and environmental outcomes, and to explore outcomes associated with different policy and river management options.

[17] http://www.mdba.gov.au/what-we-do/research-investigations/asees

5.5 Approach to social and economic aspects

The Murray-Darling Basin can be described as a 'socio-ecological system', that is one characterised by strong links between the social (human) and ecological systems making up the basin. Unfortunately, the strength of these linkages and their importance is not always appreciated in major natural resource reform processes, a case in point being the Water Act (2007) where the social dimension of the reform was poorly considered. It seems that socio-ecological modelling is more advanced in fisheries, rangelands and wildlife management than in water resources management (Schulter et al., 2012)

It was obvious from the start of the Basin Planing process, that the rural communities of the Basin were most concerned about the possible social and economic impacts of any proposed changes to the consumptive water 'take'.

However, the MDBA's early approaches to addressing the social and economic effects were somewhat limited in that they focused largely on the macroeconomic costs, which over the Basin are likely to be relatively small[18], and did not highlight the fact that social and economic changes in rural communities are driven by commodity prices, climate variability, technological change and irrigation efficiency, as well as by irrigation water volumes.

The community was more interested in what the impact would be in their region, rather than Basin-wide impacts.

The MDBA responded by commissioning over 20 studies and drawing on many others, and undertaking a large number of consultations with the Basin communities. This work has been synthesised into an over-arching socio-economic analysis (MDBA, 2012).

Also, in an attempt to balance the ledger, the MDBA commissioned CSIRO to assess the likely benefits from making more water available for the environment (CSIRO, 2011). These benefit-cost analyses where much of the benefit is in non-use terms are difficult. Never the less, CSIRO (2011) assessed that the economic benefits in terms of habitat ecosystem services, water quality, recreation and tourism were significant.

Lesson - major reforms of natural resources, such as water, must consider the system as a social-ecological system, with the human and ecological aspects considered together in optimising the social, economic and environmental outcomes from the reform.

5.6 Government commitment

The recent water reforms in the Murray-Darling Basin have been assisted by the extraordinary commitment of both Federal and State governments to the process.

Key commitments were:

- The COAG establishment of the National Water Initiative in 2004 – this involved the Commonwealth Government and the Basin State governments working together on this major initiative (http://nwc.gov.au/nwi),

[18] Economic modeling estimated that the Basin Plan is likely to reduce agricultural production by no more than 9 per cent and gross regional product by less than 1 per cent, and that the reduction in the aggregate value of Basin production will be more than offset by underlying economic growth over the period to 2019 (MDBA, 2012).

- The new Commonwealth Water Act (2007), enacted by the Howard coalition government, with further reforms in 2008 based on the Basin state governments referring some of their powers to the Commonwealth to permit this to occur,
- The Howard governments commitment of $10 billion to this water reform process, with this financial commitment subsequently honoured and augmented by the Rudd-Gillard labour governments,
- And more recently the new Abbott coalition government's committed to 'implement the Basin Plan in full and on time'.[19]

Since the original commitment of $10 billion, Australian Governments have now committed over $13 billion for programs in support of water reform in the Murray-Darling Basin (originally called *Water for the Future*). Much of this funding is for investment in upgrading rural water infrastructure to improve water use efficiency on and off farm, with a share of water savings helping to 'bridge the gap' to the sustainable diversion limits under the Basin Plan. There has also been substantial investment in purchase of water entitlements for environmental use.

Wheeler and colleagues (Cheesman & Wheeler, 2012; Wheeler et al., 2012, 2013) have analysed the success of this buy-back program, while Crase et al. (2012) and others have criticised this focus by the government on infrastructure investment in preference to water buy-back.

It is my view that the three most important components that contributed to the success on this major water reform were:

- The development of a robust and defensible Basin Plan – this took some time to achieve, and despite some challenges along the way, most stakeholders eventually agreed (some reluctantly) that the Basin Plan had achieved its aims to rebalance the water 'take' to obtain improved outcomes for the environment, while at the same time minimise the social and economic impacts to those living in the Basin.
- The large investment portfolio allocated by the Commonwealth government to support the changes – without these it is certain that the reform process would have received considerably more challenge, and probably would not have been ultimately successful,
- The on-going bipartisan support of government's – both Commonwealth and State and Territory – to this reform process.

Lesson - major water reforms take time and much dedication to achieve, and are assisted if there is bipartisan political support and sufficient financial commitment to make it work.

6. Acknowledgements

It is difficult to do justice in a short paper to the enormous amount of new thinking, hard work, collaboration, compromise and dedication that went into the development of the Murray-Darling Basin Plan. Many were involved including: the MDBA and staff, officials from the Commonwealth Department of Environment and State and Territory water departments, rural water authorities, catchment management authorities, peak industry and environmental groups, the research community, indigenous groups (MLDRIN, NBAN) and many rural community members.

[19] Senator Birmingham's statement November 2013 - http://www.youtube.com/watch?v=Fch8tK7O5yA&feature=youtube_gdata).

I hope my attempt to summarise the key component of the Basin Plan does justice to the enormity of the process. The last section is my personal reflection on some of the key aspects of this Basin Plan journey as one who has been intimately involved from the beginning.

I thank the following for their insightful comments on an earlier draft to the paper: Dr James Horne, Dr Tony McLeod, Greg Raisin, Jody Swirepik and Ian Burns.

7. References

Aust Govt (2012a). *Water Act 2007 – Basin Plan 2012*, *Extract for the Federal* Register of Legislative Instruments (28 November 2012), Australian Government, Office of Parliamentary Counsel, Canberra, 245pp.

Aust Govt (2012b). *Water Act 2007 (with amendments)*, Australian Government, Office of Parliamentary Counsel, Canberra, 571pp.

Blackmore, D., Davey, S., Fisher, T., Forster, C., Sutherland, P. and Walsh, P. (2001). *Farm Dams (Irrigation) Review Report*, Report to Department of Natural Resources and Environment (now Department of Environment and Primary Industries), April 2001, Melbourne, 24pp.

Brooks, J.D., Aldridge, K.T., Deegan, B.M., Geddes, M.C., Gillanders, B. and Paton, D.C. (2009). *An ecosystem assessment framework to guide the management of the Coorong*, University of Adelaide, Adelaide.

Cheesman, J. and Wheeler, S. (2012). *Survey of water entitlement sellers under the Restoring the Balance in the Murray-Darling Basin Program*, Report by Marsden Jacob Associates for Department of Sustainability, Environment, Water, Population and Communities, Canberra,

Conroy, M.J. and Peterson, J.T. (2013). *Decision Making in Natural Resource Management: A Structured, Adaptive Approach*, Wiley-Blackwell, Stafford, Qld.

Crase, L., O'Keefe, S. and Dollery, B. (2012). Presumptions of linerarity and faith in the power of centralised decision-making: two challenges to the efficient management of environmental water in Australia. *Agricultural and Resource Economics* **56**: 426-437.

CSIRO (2008). *Water Availability in the Murray-Darling Basin - Summary of a Report from CSIRO to the Australian Government*, Murray-Darling Basin Sustainable Yields Project, CSIRO, October 2008, Canberra, 12pp.

CSIRO (2011). *Assessment of the ecological and economic benefits of environmental water in the Murray-Darling Basin*, Report to MDBA by CSIRO Multiple Benefits of the Basin Plan Project, November 2011, Canberra, 181pp.

DEPI (2009). *Northern Region Sustainable Water Strategy*, Department of Environment and Primary Industry, Melbourne, 206pp.

Docker, B. and Robinson, I. (2013). Environmental water management in Australia: Experience from the Murray-Darling Basin. *Water Resources Development* **29**(4).

Grafton, R.Q., Libecap, G.D., Edwards, E.C., O'Brien, R.J. and Landry, C. (2012). Comparative assessment of water markets: insights from the Murray-Darling Basin of Australia and the Western USA. *Water Policy* **14**: 175-193.

Horne, J. (2013). Economic approaches to water management in Australia. *International Journal of Water Resources Development* **29**(4): 526-543.

Kildea, P. and Williams, G. (2010). The Constitution and the management of water in Australia's rivers. *Sydney Law Review* **32**: 595-616.

Kingsford, R.T., Fairweather, P.G., Geddes, M.C., Lester, R.E., Sammut, J. and Wlaker, K.F. (2009). *Engineering a crisis in a Ramsar wetland: the Coorong, Lower Lakes and Murray Mouth*, Australian Wetlands and Rivers centre, University of NSW, Sydney,

MDBA (2010). *Guide to the Proposed Basin Plan – Overview.* - Murray-Darling Basin Authority, October 2010, Canberra.

MDBA (2011a). *The Living Murray Story*, Murray-Darling Basin Authority, Publication Number 157/11, Canberra, 95pp.

MDBA (2011b). *Delivering a Heathy Working Basin – About the Draft Basin Plan*, Murray-Darling Basin Authority, November 2011, Canberra.

MDBA (2011c). *The proposed 'environmentally sustainable level of take' for surface water of the Murray-Darling Basin: Methods and Outcomes*, Murray-Darling Basin Authority, November 2011, Canberra, 218pp.

MDBA (2012). *The socio-economic implications of the proposed Basin Plan*, Murray-Darling Basin Authority, May 2012, Canberra, 35pp.

MDBA (2013). *Handbook for Practitioners: water resource plan requirements*, Murray-Darling Basin Authority, October 2103, Canberra, 108pp.

NWC (2009). *Australian Water Reform 2009: Second Biennial Assessment of Progress in the Implementation of the National Water Initiative*, National Water Commission, Canberra, 306pp.

NWC (2011). Water markets in Australia: a short history, National Water Commission, Canberra.

NWC (2012), Australian water markets report 2011-12, National Water Commission, Canberra (nwc.gov.au/publications/topic/water-industry/water-markets-11-12).

Overton, I.C. (2005). Modeling floodplain inundation on a regulated river: integrating GIS, remote sensing and hydrological models. *River Research and Applications* **21**(9): 991-1001.

Peake, P., Fitzsimons, J., Frood, D., Mitchell, M., Withers, N., White, M. and Webster, R. (2011). A new approach to determining environmental flow requirements: Sustaining the natural values of floodplains of the southern Murray-Darling Basin. *Ecological Management & Restoration* **12**(2): 1-10.

Podger, G., Yang, A., Brown, A., Teng, J., Power, R. and Seaton, S. (2010). *Proposed River Modelling Methods and Integrated River System Modelling Framework Design for use in Basin Plan Modelling*, Water for a Healthy Country National Research Flagship report to MDBA, CSIRO, Canberra,

Rogers, K. and Ralph, T.J. (2011). *Floodplain wetland biota in the Murray-Darling Basin*, CSIRO Publishing, Collingwood, Australia.

Schluter, M., McAllister, R.R.J., Arlinghaus, R., Bunnfield, N., Eisenack, K., Holker, F., Milner-Gulland, E.J. and Muller, B. (2012). New horizons for managing the environment: A review of coupled social-ecological systems modelling. *Natural Resources Modelling* **25**: 219-271.

Wheeler, S., Garrick, D., Lock, A. and Bjornlund, H. (2013). Evaluating water market products to acquire water for the environment in Australia. *Land Use Policy* **30**: 427-436.

Wheeler, S., Zuo, A., Bjornlund, H. and Lane-Miller, C. (2012). Selling the farm silver? Understanding water sales to the Australian government. *Journal of Environmental and Resource Economics* **53**: 133-154.

Young , W.J., Bond, N., Brooks, J., Gawne, B. and Jones, G.J. (2011). *Review of the estimation of an environmentally sustainable level of take for the Murray-Darling Basin*, Report to MDBA by CSIRO Water for a Healthy Country Flagship, Canberra, 36pp.

Figure 1: Location map of the Murray-Darling Basin. The basin encompasses parts of four Australian states.

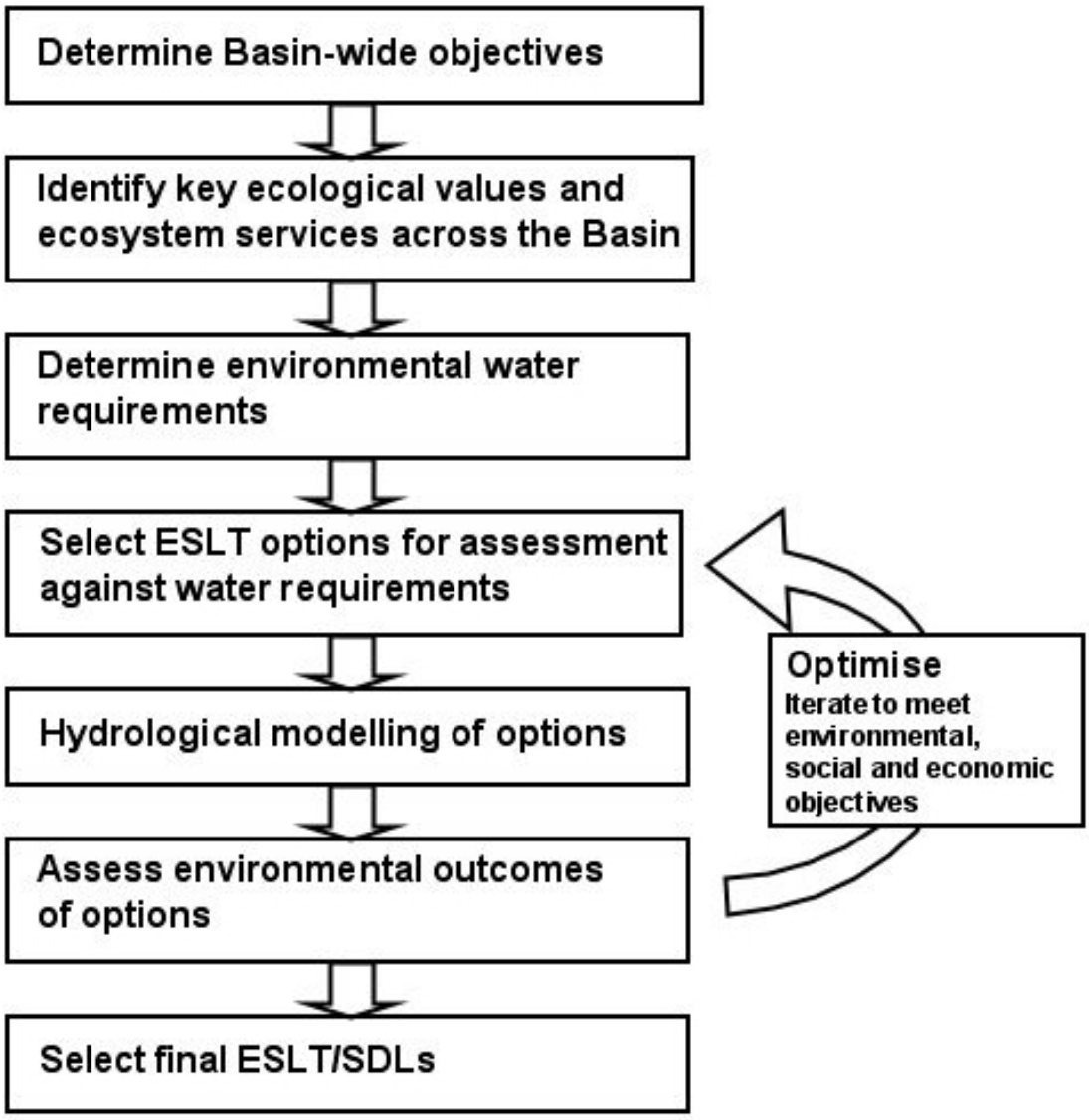

Figure 2: Framework for determining an Environmentally Sustainable Level of Take (ESLT) [modified from MDBA, 2011]