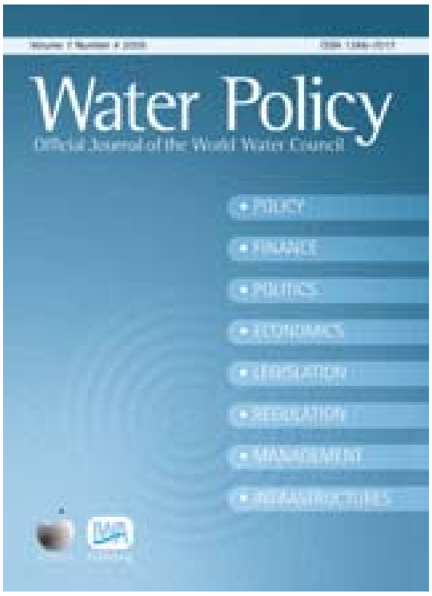
Water Policy
Official Journal of the World Water Council
POLICY
FINANCE
POLITICS
ECONOMICS
LEGISLATION
REGULATION
MANAGEMENT
INFRASTRUCTURES

Water Policy 15 (2013) 871–894

Legislating for sustainable basin management: the story of Australia's Water Act (2007)

Dominic Skinner* and John Langford

Department of Infrastructure Engineering, The University of Melbourne, Parkville, Victoria 3010, Australia
**Corresponding author. E-mail: dominic.skinner@unimelb.edu.au*

Abstract

Australia's Millennium drought, a 13-year dry period unprecedented in the instrumental record, inspired a change in the extant water management principles. The Water Act of 2007 was introduced and required the preparation of a Basin Plan to set environmentally sustainable levels of water extraction and to reduce the over-allocation of water entitlements that threatened water security. The Act was unusual in that environmental considerations were initially interpreted as a non-negotiable constraint on other water uses because of the legislative context in which it was written. This framing shaped subsequent negotiations during development of the Basin Plan. The recent passing of this Plan into law provides a conclusion to this complex, messy and, at times, irrational reform process. The path taken, from genesis of the Act to its eventual culmination in the Basin Plan, provides internationally important lessons in legislating for sustainable water management in inter-jurisdictional river basins. However, the reforms have also created new opportunities for ongoing improvement, including the mutual benefits derived from managing environmental water and irrigation water cooperatively.

Keywords: Best available science; Environmental water; Federalism; Murray–Darling; Water reform

Introduction

> '*Die Politik ist keine Wissenschaft, wie viele der Herren Proffessoren sich einbilden, sondern eine Kunst*.'[1] – Otto Eduard Leopold von Bismarck
> '*Good decisions come from experience. Experience comes from making bad decisions*.' – Mark Twain

Australia's most recent water reform, the Water Act (2007), is an ambitious piece of legislation that seeks to return water allocations in the Murray–Darling Basin (MDB) to sustainable levels and to

[1] Politics (and policy development) is not a science, as many professors might imagine, but rather a craft.

doi: 10.2166/wp.2013.017

coordinate planning and decision-making at the Basin level. The Act achieved this by establishing and requiring the Murray–Darling Basin Authority (MDBA) to produce a Basin Plan that set sustainable limits to water diversions in the Basin by 2019. The Basin Plan received final approval from Australia's Federal Water Minister in December 2012. Throughout this reform period, the Water Act has been criticized over its legal validity within Australia's federated system of government, the principles of governance on which it is based, the primacy it gives environmental considerations in decision-making, and the way it appoints the scientific institution as the arbiter of the final outcome. We tell the story of the Water Act from genesis through to implementation, and show that, while many criticisms may be valid, they are themselves part of the beautifully dynamic and interconnected art of policy-making.

In telling this story, we present recent developments in Australia's water reform agenda in the context of 'best practice' water management principles. This case study aims to show Australia's path towards sustainable water reform, in all of its complexity, and contains important lessons for transboundary catchment management. These lessons include the challenges of integrating and coordinating inter-jurisdictional governance and management systems in a federated nation; balancing economic, social and environmental factors when negotiating between entrenched special interest groups; the limitations of the current 'de rigueur' idea of the importance of public participation; and achieving a specific outcome within the extant legal and governance framework of laws, policies and principles.

The paper is divided into five sections. To provide a theoretical context for the case study, we begin with a description of current thinking about best practice catchment management. This context guides the interpretation of the reform process in subsequent sections. It is here that we outline the interactions between values and knowledge as two distinct policy inputs. Next, we introduce the MDB and the historical and legislative context in which the Water Act was conceived and introduced. The third section introduces the Water Act itself and discusses the legal mechanisms used to transfer the coordination and decision-making responsibilities from negotiated consensus between many jurisdictional governments to the Commonwealth Government. The fourth section outlines the process of translating the Water Act into the final Basin Plan and the controversy associated with the Act's legal framing. We end by highlighting the transferrable lessons that arose during the reform process. In this section, we also discuss some mechanisms to improve both economic and environmental outcomes.

Best practice catchment management

Reform occurs within a pre-existing framework of laws, policies and principles that dictate what mechanisms are available to achieve a specified goal. This inherent path-dependency suggests that reforms will always be provisional, with policy settings incrementally adjusted to accommodate circumstances, knowledge and societies' values that evolve dynamically within the extant policy framework (Blackbourn, 2006). Within these constraints, current best practice water management is based around the principles expounded in theories like integrated catchment management or integrated water resources management. These ideas state that, amongst other things, management should occur at the catchment scale, decision-making should promote public engagement, consensus positions should be negotiated among different jurisdictions and stakeholders in these catchments, and that a balance between economic, social and environmental considerations should be the goal of management (Falkenmark, 2004; Pahl-Wostl *et al.*, 2007; OECD, 2011).

Decision-making in catchment management is characterized by uncertainty, complexity, and multiple legitimate stakeholder perspectives (Ison *et al.*, 2007). Water systems are made up of a complex series of interactions with social and ecological interdependencies (Hoff, 2009). Global changes are making problems at the catchment scale more intractable through a growing demand for a scarce resource (Vörösmarty *et al.*, 2000), greater and unpredictable envelopes of variability (Milly *et al.*, 2008), and increasing institutional complexity (Wallis & Ison, 2011). Thus, while public participation has increasingly become 'de rigueur' in the ideals of integrated catchment management (Bulkeley & Mol, 2003), questions arise about how this participation ought to be included in complex decision-making. These questions broach the relative importance of values and knowledge in deciding the objectives and targets to manage towards.

Complex public policy problems, including those faced by catchment managers, are resolved with decisive leadership rather than complete knowledge about different possible outcomes (Head, 2008). Decisions involve value judgments made using incomplete and at least somewhat uncertain knowledge. A decision should be made in the best interest of the public, which represents a broad cross-section of views and opinions. Inevitably, therefore, judgments made will lead to disagreements between different stakeholders with different perceptions of value at different scales of analysis (Zia *et al*., 2011). Successfully navigating these difficulties is the art of policy-making that Otto Eduard Leopold von Bismarck described.

Values are expressed in policy discourse as statements of specific objectives (Keeney, 2006). The central entry point for public participation in decision-making is in setting these objectives. Developing clear and robust objectives requires detailed, creative discussions between decision-makers and stakeholders concerned with the decisions being made. The challenge for resource managers is to set objectives at a level of specificity that demonstrates what a resource is meant to achieve for society. There is a temptation to leave objectives ambiguous, so as to maximize support from different stakeholders. This can work well until conflict arises (Cullen, 2011).

Knowledge and evidence enter the policy discourse in many forms. There is no 'gold standard' form of knowledge, as perspectives depend on the framework in which they are introduced into the discussion (Hammond, 1996; Jamieson, 1996). There are, instead, multiple lines of evidence that are woven together to inform policy, rather than determine it (Head, 2008). If science or other lines of evidence are used to frame objectives and guide policy outcomes, they risk becoming politicized and having their uncertainties manipulated to justify prior notions of value for a particular interest group (Oreskes, 2004; Sarewitz, 2004). This undermines both the preparation of sound policy and the reputation of the evidence base that was used to guide the decision (Pielke, 2007).

Geography and governance in the MDB

A brief introduction to the MDB

Early European settlers to Australia brought with them grand dreams of taming the rivers, greening the desert, settling the inland, and making land productive (Lines, 1991). But Australia is the driest inhabited continent on Earth, and the uncertainty of managing water scarcity and high supply variability shaped and continues to shape water management. Water availability is expected to decline in the MDB with climate change, making the reform agenda more pressing (CSIRO, 2008). Despite these challenges, the MDB is Australia's premier food-producing region, containing high-value agricultural land and unique environmental assets.

The Basin covers 1,059,000 km^2 (about 14% of Australia's land mass; Figure 1) and spans four States (Queensland, New South Wales, Victoria and South Australia) and the Australian Capital Territory. It contains Australia's three longest rivers: the Darling River (2,740 km), the River Murray (2,530 km) and the Murrumbidgee River (1,690 km) (MDBA, 2010a). The southern MDB, which includes the Murray and Murrumbidgee Rivers, is where the majority of water resources are found. The region is fed by winter rains and snowmelt from the high country along the western slopes of the Great Dividing Range. The northern MDB receives most inflows from tropical summer rains in Queensland and northern New South Wales. The rivers flow inland to the west, crossing expansive semi-arid plains. The

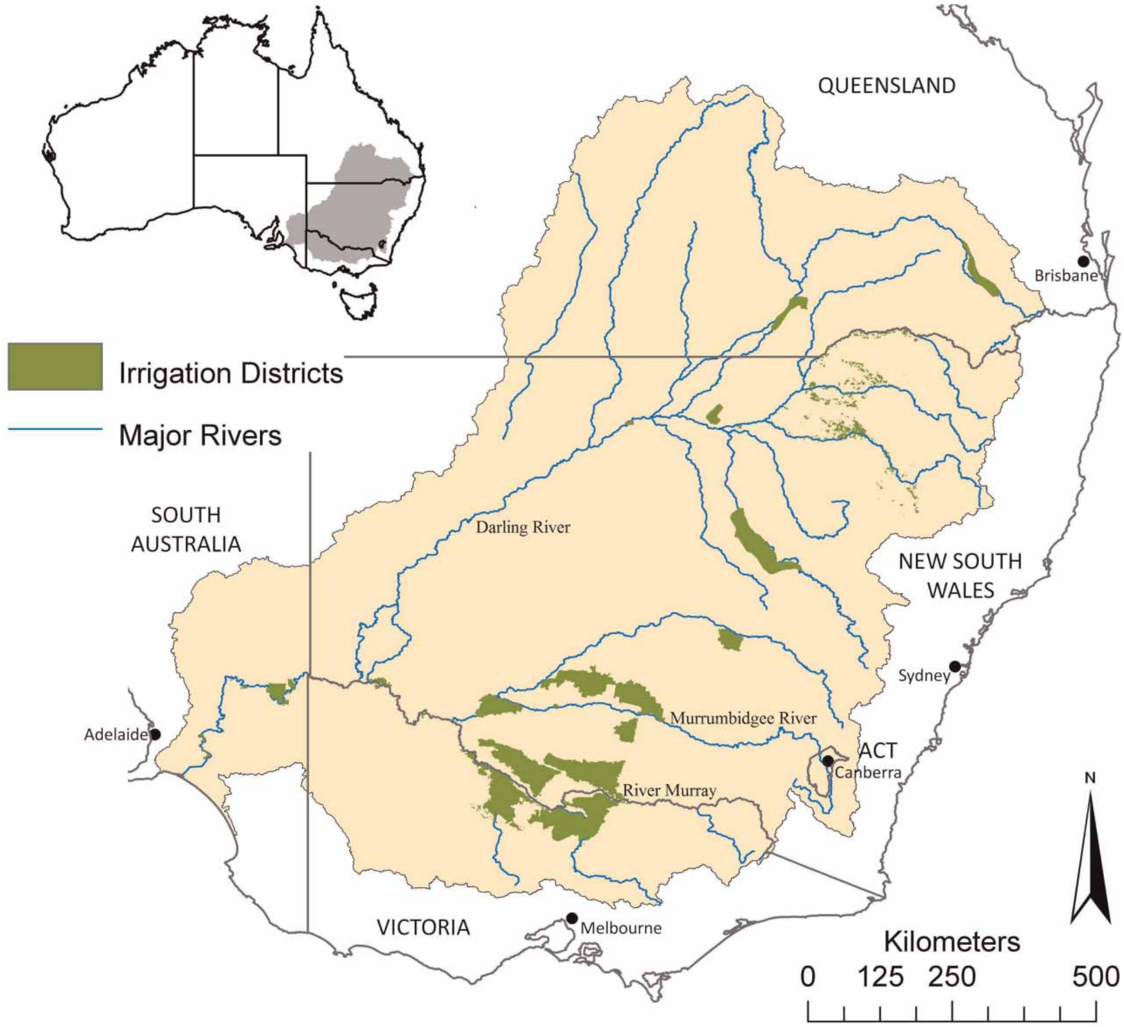

Fig. 1. The Murray–Darling Basin is located in southeastern Australia, spanning four States and the Australian Capital Territory (ACT). The border between Victoria and New South Wales follows the River Murray. Irrigation districts are shaded.

Darling River enters the Murray at Wentworth, which flows into South Australia before turning south towards the Southern Ocean.

The average annual rainfall in the MDB supplies about 530,000 GL of freshwater, of which 94% evaporates or transpires and 2% recharges groundwater aquifers. The remaining 4%, or 24,000 GL, of rainfall becomes run-off that enters streams and rivers (Pink, 2010). The MDB is naturally an inefficient system because of its low hydrological gradient and resulting slow flows. Consequently, of the water that flows into rivers, almost half is evaporated, transpired or seeps into groundwater aquifers. This water is not necessarily lost, as it often provides a significant environmental benefit or contributes to water resources elsewhere in the Basin. Before regulation, the annual average flow through the Murray Mouth and out to sea was only 12,000 GL (Skinner, 2011).

By 2004, annual surface water extraction in the MDB had reached over 11,000 GL/yr, and public water storage capacity was over 30,000 GL, or almost 130% of the average annual system-wide inflows (MDBMC, 1995). This extensive control and use of water resources restricted all but the largest floods to within channel conveyance flow. The consequent reduction in water loss every year due to evaporation and transpiration from floodplains and wetlands was almost 4,000 GL/yr (Close, 1990). Of the 11,000 GL of surface water allocated for consumptive use by 2004, 83% was extracted for irrigation, about 2% was used by households drawing water from the Basin, and 13.8% of water was accounted for by transmission losses delivering water to irrigators and households (Pink, 2010). The remaining water (1.2%) was used for mining, manufacturing and in other industries.

The historical context in which the Water Act was introduced

Water management has been an ongoing contentious issue in Australia (Cathcart, 2009). Different priorities were placed on river-use by the colonies during negotiations to frame Australia's Constitution, which was drawn up, then agreed to at Federation in 1901. South Australia's economy was reliant on the connectivity that paddle-steamer trade enabled, whereas upstream, in New South Wales and Victoria, development through irrigation was a more pressing concern. As a result, water rights under Australia's Constitution are only clarified once, in section 100, to explicitly prevent the Commonwealth Government from curtailing a State's right to water for conservation or irrigation (Kildea & Williams, 2010). This clause was included to satisfy concerns from the two upstream States that Commonwealth management would threaten the security of their water entitlement.

Section 100 does not provide any certainty to riparian rights between States, nor about other means through which the Commonwealth Government can leverage legislative and administrative powers (Williams & Webster, 2010). Historically, therefore, water sharing within the Basin was governed by negotiated agreement and consensus between State and Commonwealth Governments rather than a constitutional framework ensuring a right of supply (Connell, 2011). Decisions were made by the River Murray Commission until 1987, and thereafter by an intergovernmental Ministerial Council. Enactment of decisions in both cases required a consensus that consisted of unanimous support and identical legislation passing into law in each jurisdiction. These negotiated agreements included the *River Murray Waters Agreement* of 1915, which was superseded by the MDB *Agreement* in 1987 (Eastburn, 1990). In general, States have the right to use inflows from tributaries in their jurisdiction, with notable exceptions. The River Murray forms the border between New South Wales and Victoria, so inflows above the Hume Dam, a major storage on the Upper River Murray, are shared equally between the two States. South Australia is the last State that the River Murray flows through and has almost no inflowing tributaries. It is therefore entirely reliant on provisions from upstream States and was guaranteed an entitlement flow of 1,865 GL/yr to be met in equal portions by Victoria and New South Wales (Eastburn, 1990).

In the early 1990s, a government report suggested that the poor performance of inefficient government-owned utility-based industries was reducing Australia's overall economic performance and productivity in comparison to other OECD countries (NWC, 2011). In response, the Commonwealth Government transferred responsibility for water delivery into the economic portfolio, and water was included in economy-wide, market-based competitive reforms under the National Competition Policy (NCP) (Skinner, 2012). In 1994, the Council of Australian Governments (CoAG; the peak intergovernmental forum consisting of the Prime Minister, the Premiers and Chief Ministers of the States and Territories, and the President of the Local Governments Association of Australia) agreed to adopt the NCP. The Commonwealth tied funding to successful implementation of these reforms by the States. The changes to water management introduced by CoAG aimed to achieve full cost recovery for water delivery services (with the intention of reducing future reliance on government funding to upgrade aging irrigation infrastructure) and to separate the operational activities from regulation and policy-making. The reforms also aimed to unbundle the property rights of water extraction from the ownership of land, thereby allowing the implementation of a water market with tradable water entitlements to optimize productive output.

An audit of MDB water resources in 1995 showed that only 63% of entitlements were active and that almost 17,000 GL of entitlements had been granted (72% of total annual average inflows) (MDBMC, 1995). A water entitlement was like a share in a company, which translated into ownership of a certain share of the water resource. Each year, water allocations (like company dividends) were made against these entitlements to accommodate variable inflows. This over-allocation threatened any reforms from achieving their desired benefits and risked eroding the security of water entitlements. A cap on water diversions was introduced to limit further extraction of water from the MDB to 1993–1994 levels. The cap did not limit development; it prevented increases in water use (including the activation of previously unused licenses), thus requiring water efficiency measures to be the main driver of productivity gains (MDBMC, 1995).

In 2004, the National Water Initiative (NWI) was approved by CoAG. This program was an ambitious reform program to promote economic development and create a strong regulatory framework to balance growth, with a second priority to improve the health and resilience of ecosystems dependent on surface water and groundwater. Its aim was to achieve a balance between pursuing increased agricultural productivity and resource security through expanded water markets and more tightly defined water entitlements while ensuring environmental sustainability of the aquatic and riparian systems reliant on the river (NWC, 2011).

In the same year as the NWI began, concerns about over-allocated water had extended management proposals for the Basin's ecosystems to include water recovery programs designed to reduce the impact of over-allocation and increase the security of supply (Jones & Milligan, 2011). As a result, the Living Murray Initiative was set up, with the aim of returning 500 GL of water recovered through infrastructure upgrades and, once opportunities for water savings were less readily available, through water buybacks (Table 1). This environmental water was allocated to six iconic ecological sites in the Basin. The Living Murray Initiative was considered a first step towards reaching a

Table 1. Programs to improve environmental outcomes in the MDB through the increase of environmental flow provision either as rules-based agreements[a] (pre-2004) or secured water entitlements (post-2004).

Year	Program	Agreements to deliver environmental water	
1987	*Victorian Murray Wetlands Environmental Water Agreement*	27.6 GL[b]	
1993	*Barmah-Millewa Forest Environmental Water Agreement*	100–150 GL[c]	
1998	*Murrumbidgee Environmental Contingency Allowance*	25–200 GL[d]	
2000	*Murray Additional Environmental Water Allowance*	5.4 GL[e]	
2000	*NSW Murray Wetlands Environmental Water Agreement*	30 GL[f]	
2002	*Lower Darling River Environmental Contingency Allowance*	30 GL[g]	
Environmental Water shifted from rules-based flow delivery to recovery of secure water entitlements			
		Buyback	Infrastructure & Savings
2004–2009	*The Living Murray Initiative*	225.3 GL	261.7 GL
2004–2009	*Cap to NSW Water Sharing Plans*		206 GL
2004–2009	*Other State Recovery Programs*		77 GL
2004–2012	*Water for Rivers*	16.5 GL	38.5 GL
2009	*Water gifted from Queensland to the Commonwealth*	11 GL	
2009	*NSW Wetlands Recovery Program*	4 GL	
2009–2012	*NSW Riverbank Program*	41 GL	
2009–2012	*NSW Rivers Environmental Recovery Program*	14 GL	
2009–2019	*Sustainable Rural Water Use and Infrastructure Program*		75 GL[h]
2009–2019	*Restoring the Balance*	1094 GL[i]	
2012–2019	*Northern Victoria Irrigation Renewal Program Stage 2*		214 GL
2012–2019	*Menindee Lakes Project and other proposals*		400 GL
2013–2019	*Environmental Works and Measures*		650 GL[j]
2013–2019	*Remaining Buybacks under the Restoring the Balance Program*	247 GL[k]	

[a]Rules-based agreements meant that the environmental flows were delivered as part of the river operating rules and the environment received a lower share of water during drought (Williams, 2010).
[b]Allocated to Hird and Johnsons Swamps.
[c]100 GL/yr is shared between Victoria and NSW with a provision to carry over up to 700 GL. An additional 50 GL/yr was agreed to in 2001 if water sales reach 30%.
[d]Environmental allocation is 25 GL/yr, increasing to 200 GL/yr as water allocations to productive users approach 100%.
[e]Allocated whenever the high security water entitlements are allocated less than 97% of the entitlement.
[f]For use in NSW Wetlands only.
[g]Water delivery is provisional on the Menindee Lakes storages (two large shallow lakes on the Darling River near Wentworth) being controlled by the MDBA, which happens when the combined volume of the lakes is more than 480 GL, and having been filled to over 640 GL since the last time the lakes fell below 480 GL. Otherwise, the water is controlled by NSW.
[h]Northern Victoria Irrigation Renewal Program Stage 1.
[i]As at 30 September 2012.
[j]Works to provide environmental benefits equivalent to 650 GL of environmental water.
[k]Assuming 650 GL of water entitlement equivalents are met with environmental works and measures. Otherwise, the remainder will come from buybacks before 2019.

'healthy, working river', with an explicit recognition that more water would be needed. The definition of a healthy, working river was that of a river that is managed to provide a sustainable compromise, *agreed to by the community*, between the condition of the river and the level of human use (emphasis added; CRC for Freshwater Ecology, 2003).

The Water Act (2007)

The principles of governance that underpin the Act

Australian water management programs, in the same way as reform ideals such as integrated catchment management, had embraced a number of key principles (Blackmore, 1995). These included negotiation towards a consensus, participative decision-making that brought together relevant stakeholders and ensured balance between environmental, social and economic impacts of a policy. However, the Water Act was introduced in a political environment where community perceptions were that incremental, negotiated agreement between stakeholders and different jurisdictional decision-makers was too slow (Young & McColl, 2008). This was exacerbated by the propensity of both Australia's major political parties to blame other governments of the opposite political persuasion (Anderson, 2010), and the urgency, brought on by drought, to achieve environmental aims that had been the subject of ongoing reform attempts since 1995 (Skinner, 2012). Malcolm Turnbull, the Environment Minister responsible for drafting the Water Act, wrote that 'in the 1890s our founding fathers missed a big opportunity when they drafted our Constitution in not putting the management of interstate waters under federal jurisdiction. In 2007, we rectified that mistake with the Water Act' (Turnbull, 2010). A central aim of the Act was to centralize decision-making responsibility at the Federal Government level to both expedite adaptation and to manage the MDB as a whole, in the national interest.

The year 2007 saw a federal election that the then Coalition Government (conservative) looked like losing. The election coincided with the lowest annual recorded inflows into the MDB (only 1,110 GL), which, after already a decade of drought, became a major public issue (Figure 2). The environmental vote was shaping up to be a deciding factor in the election, which likely influenced the drafting of water reforms that year. Initially, in January, the Coalition Government introduced the National Plan for Water Security with over AUD$10 billion of federal money to improve irrigation efficiency (the

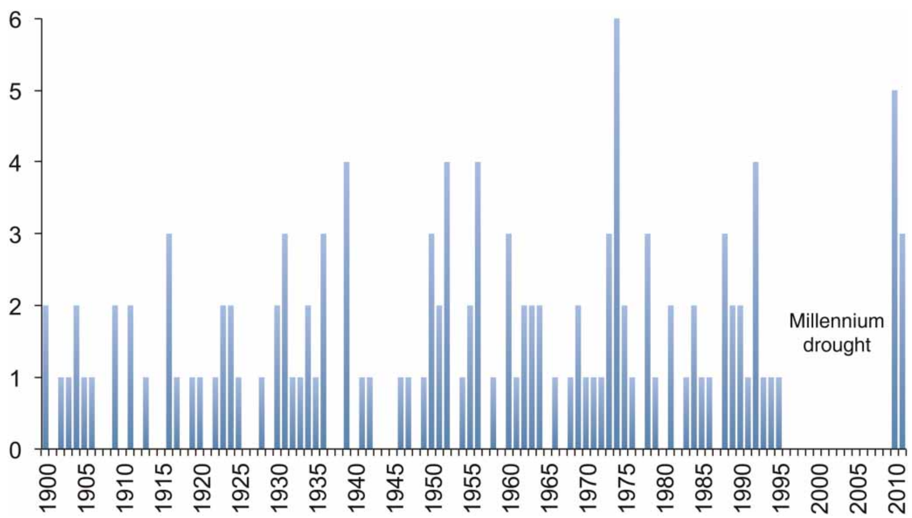

Fig. 2. The number of 'wet' months each year in the MDB. A wet month is defined as having rainfall in the top 90th percentile. The Millennium drought (1997–2010) had no wet months for 15 years.

Sustainable Rural Water Use and Infrastructure Program, worth AUD$5.8 billion), reduce the over-allocation of water entitlements through water buybacks (Restoring the Balance Program, that included AUD$3 billion), and establish the Commonwealth as the Basin-wide coordinator.

By February, New South Wales, South Australia and Queensland State Governments (all Labor) had agreed to refer their legislative power over water rights to the Commonwealth. But by June, negotiations with the Victorian State Government (also Labor) had reached a deadlock, with the State demanding an increased share of the federal money before agreeing to cede its responsibility of water management to the Commonwealth Government (Kildea & Williams, 2011; Figure 3). By July, the Coalition Government changed tack, and sought to draw on the widespread public concern over the drought-induced decline in river health and the common perception that incremental decision-making through negotiated

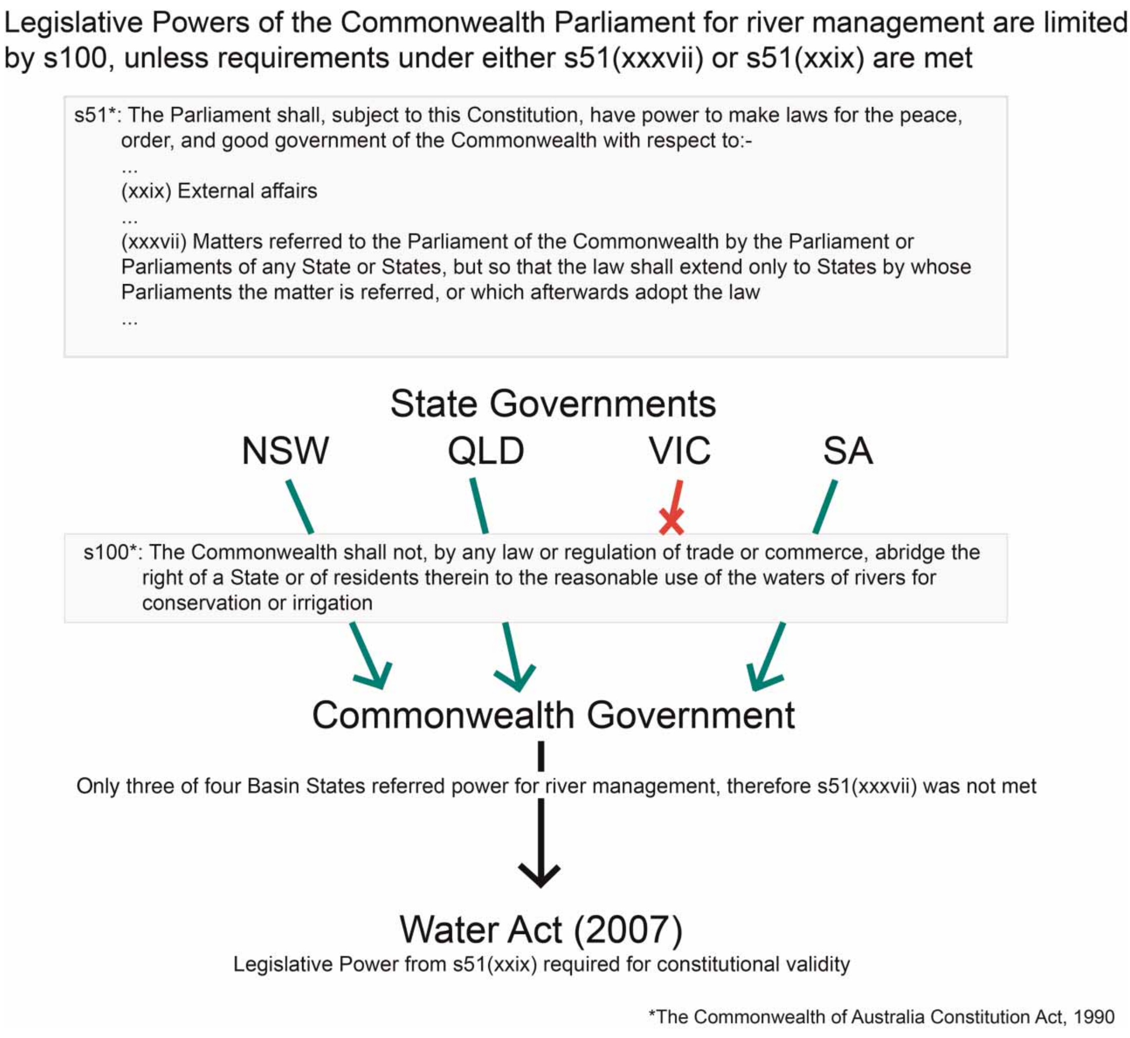

Fig. 3. The constitutional mechanism used by Australia's Commonwealth Government to establish the Water Act and wrest control of river management in the MDB from the State Governments.

agreement was progressing too slowly, and, at least in part, to appeal to pro-environmental voters in the forthcoming election. To circumvent the requirement for State referral, the Commonwealth drafted legislation based on its various Constitutional powers, but relied heavily on its external affairs power over international environmental treaties, such as the Ramsar Convention on Wetlands and the Convention of Biological Diversity (see Figure 3). This meant that the Act was predominantly a piece of environmental legislation. Despite this, the Commonwealth's Water Act (2007) was passed into law through both houses of parliament, with unanimous support from both major parties, in August 2007. Both parties again passed minor amendments the following year.

The Water Act marked a distinct shift away from the principles of consensus, negotiation and balance that were central to the decision-making process in the MDB during previous decades (Blackmore, 1995; Connell, 2011). In making the decision to rely on its responsibility for external affairs, John Howard, the Prime Minister at the time, observed that while the Commonwealth had extensive powers, they were 'not as extensive as to give us a close to ideal scheme' (Howard, 2007). From the outset, therefore, Howard conceded that the failure to negotiate a consensus had influenced the framing of the Act (Kildea & Williams, 2011).

The Water Act required the establishment of the MDBA, whose task it was to develop a Basin Plan. The central aim of this Basin Plan was to make use of best available science to define the environmentally sustainable level of take. In other words, how much water can be allocated away from the environment without compromising key environmental assets, key ecosystem functions, the productive base of the water resource, or the key environmental outcomes. The Water Act does not define the concept of 'key', nor does it define ecosystem functions or the productive base. These terms are left open to debate. Through defining the environmentally sustainable level of take in this way, the Act requires that the Plan specify the sustainable diversion limits (SDLs) for the MDB. This is the volume of water, expressed as a long-term average annual volume that can be extracted from the Basin upon implementation of the Plan by 2019 for productive use in irrigation, industry and for urban supply. The Act does not specify any mechanism for recovering excess water entitlements, to shift from the current level of extraction to these SDLs.

The Basin Plan was developed in three distinct stages. The first was the release of 'The Guide to the Proposed Basin Plan' (The Guide). This was a policy discussion paper released in October 2010 that proposed the range of 3,000–4,000 GL of environmental water for further consideration. Negative reaction to The Guide from some irrigation communities was immediate. This was driven by a media that thrives off shock and awe tactics and a lack of control over the public message by the MDBA, which had remained silent until the release of the document (Wahlquist, 2010). In November 2011, the MDBA released the Proposed Basin Plan that had undergone significant alterations since The Guide's poor reception. Finally, the revised Proposed Basin Plan was released in May 2012, which incorporated the formal public consultation process and began the final negotiating phase that culminated in the Basin Plan being signed into law in December 2012.

The Act also establishes a second institution, the Commonwealth Environmental Water Holder (CEWH), whose principle responsibility is accounting for and delivering environmental water in accordance with the Basin Plan. Any water saved through measures being pursued to return river allocations to within their SDLs is transferred to the CEWH. When the water recovery requirements are complete, the CEWH will hold a third of all water entitlements in the Basin, and these will be managed at a federal level (Connell, 2011).

Constitutional validity and environmental primacy

Much ink has been spilled lamenting the inadequacies of the Water Act, but criticisms focussed on two areas: its constitutional validity, and the permissible flexibility in balancing environmental considerations with social and economic impacts. First, the Constitutional constraints imposed on the Commonwealth's desire to wrest the basin-wide coordinator's role away from the Ministerial Council, meant that the Act chart a very specific course in developing the Basin Plan to maintain its legality. If the external affairs powers under section 51 of the Constitution are not satisfied, then section 100 takes effect, precluding the Commonwealth's involvement in setting water rights. Previous High Court rulings about the use of external affairs powers (for example, the Franklin River Dam case brought by Tasmania) did not 'confer upon the Commonwealth a plenary power over the general subject matter of the treaty' (Rothwell, 2011, p. 3). Instead, to be Constitutionally valid a 'law must prescribe a regime that the treaty has itself defined *with sufficient specificity* to direct the general course to be taken by signatory states' (Rothwell, 2011, p. 3). This restriction limits flexibility in setting environmental objectives and targets through which to define an 'environmentally sustainable level of take' to those defined by the relevant international agreements on which the Commonwealth's external affairs powers are based (Rothwell, 2011). With the environmental objectives already set, science is tasked with determining how best to meet them, assuming that the international agreements provide enough specificity to undertake these predictions scientifically. While some commentators suggest that these international agreements do provide the level of specificity to define sustainable diversion limits (Pittock & Finlayson, 2011), others disagree (e.g. Rothwell, 2011; Davis & Skinner, 2012).

The second criticism of the Act is that it gave environmental considerations primacy in determining sustainable diversion limits. Rob Freeman, the Chief Executive Officer of the MDBA, confirmed that 'the environmental envelope is the first consideration and then, where you land in that envelope is determined by social and economic issues' (Australian Senate, 2010, p. 21). In trying to remediate this second criticism of the Act and ensure balance between social, economic and environmental factors, the MDBA soon ran into issues of constitutional validity. The Act's framing and the issue of balance became central themes in negotiating the Basin Plan, and these will be discussed in more detail later.

Setting environmental objectives

There was limited public consultation during the development of The Guide, which relied on advice from State Governments and scientific experts to set environmental objectives based on relevant international agreements. In contrast, the earlier Living Murray Initiative had successfully combined community engagement with detailed scientific assessment and overarching government decisions based on values, to establish agreed environmental targets and objectives (Jones & Milligan, 2011). To mitigate the public outcry following The Guide's release, the concept of a 'healthy, working river', which had been central to the Living Murray Initiative's success and explicitly required community consultation, was reintroduced into the debate. This recognized the complex social and ecological interactions within the Basin and attempted to recast the planning process as giving consideration to social, economic and environmental factors (Boully & Maywald, 2010).

The biggest change between the Guide and the Proposed Basin Plan was the completion of the detailed, Basin-wide hydrological modeling of environmental water requirements. This modeling highlighted the limitations of 'operational constraints' in the system, which prevented more than 2,750 GL of water from being returned to the environment without flooding land, low-lying towns or bridges, or increasing the diameter of dam off-take pipes. Further, the development of the Proposed Basin Plan was still constrained by the Act's requirements to set environmental objectives and targets through the use of relevant international agreements. Although consultation increased, it focussed on reaching a balance between environmental, social and economic considerations, rather than on setting environmental objectives. Using international treaties to set environmental objectives and targets will rarely provide the level of specificity to guide on-the-ground management decisions (Davis & Skinner, 2012). Moreover, determining environmental objectives requires value-based decisions that should involve extensive public participation, and the Water Act replaces this with a constitutional requirement to follow relevant international agreements. The acceptable level of risk associated with scientific uncertainty in predicting the volume of water to meet these objectives is also a values-based decision that received little negotiation or stakeholder engagement (Davis & Skinner, 2012).

The planning process

The Guide to the Proposed Basin Plan

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 focussed on assessing the existing inventories of aquatic ecosystems, with some input from State departments and scientists. 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 relevant to international agreements on which the Water Act was based. However, it was both logically and logistically difficult to set environmental objectives and targets to calculate water requirements for all of these key environmental assets because information was often very limited. Instead, a subset of indicator sites was considered, to identify required flow regimes for particular parts of the river system. The justifying logic was that, given rivers are hydrologically linked, particular flow regimes will provide benefits to multiple sites and it was not necessary to 'add up' water requirements for all sites.

This logic formed the basis of the hydrological indicator site method, which enabled detailed modelling of water requirements to meet the objectives and targets for a smaller number of environmental assets (MDBA, 2010a). 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 (MDBA, 2010b).

At the time The Guide was released, this hydrological indicator site work was ongoing. So, instead, the preliminary results used a simplified approach to set water requirements as a percentage of the end-of-river natural flow regime (MDBA, 2010b). Therefore, the water volumes presented in the Guide to the Basin Plan for the reductions in surface water diversions were informed by 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 Guide reported that a reduction in water entitlements of between 3,000 and 7,600 GL/yr long-term average flows reflected different levels of certainty in achieving improved environmental objectives. This was defined as between 60 and 80% of the natural flow at the end of each valley. The MDBA then decided to limit the upper range of the environmental water requirements to 4,000 GL/yr, as the social and economic impact beyond this level was judged to be too significant (MDBA, 2010a).

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 was evident by consistent misinterpretations about these issues (Davis & Skinner, 2012). Together with limited public consultation prior to the release of the Guide (Briscoe, 2011), the limited success of the MDBA's communication strategy contributed to the negative response to the Guide when it was released in October 2010 (Wahlquist, 2010).

The debate surrounding The Guide 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.

Reinterpreting the Act

The level of vitriol surrounding debate about The Guide made it clear that the current interpretation of the Act, as primarily an environmental piece of legislation, was politically unworkable when it came to preparing and implementing the Basin Plan. What followed the release of the Guide was a very public dispute over the interpretation of the Act, in an effort to recast the issue as a mistake by those in charge at the MDBA. This deliberate reinterpretation of the Act should also be seen as a strategy to keep the reform process on track rather than a comprehensive belief in the idea that the Water Act did not give precedence to the environment.

Consistently, the Act was interpreted as a piece of environmental legislation. The Productivity Commission concluded that the Act 'requires the MDBA to determine environmental water needs based on scientific information, but precludes consideration of economic and social costs in deciding the extent to which these needs should be met' (Productivity Commission, 2010, p. 114). Mike Taylor, the Chairman of the MDBA at the time and a former Commonwealth bureaucrat, claimed that 'the Act mentions the environment 258 times, sustainability 60 times, irrigated agriculture three and agriculture once' (Bonyhardy, 2011, p. 323). The High level review panel for the MDB Plan also found that 'the driving value of the Act is that a triple-bottom-line approach (environment, economic, social) is replaced by one in which environment becomes the overriding objective, with the social and economic spheres required to 'do the best they can' with whatever is left once environmental needs are addressed' (Briscoe, 2011, p. 4).

The Australian Government Solicitor (AGS) gave a briefing called Swimming in New Waters: Recent Reforms to Australian Water Law that was released before the public reinterpretation began. That document concluded that the Act's focus was on setting environmentally sustainable diversions (Briese *et al.*, 2009). When the AGS was later requested to provide advice during the public dispute over the Act's interpretation, its findings were used to support the concept of balance. However, even these updated findings stated that the Act's primary concern must be towards meeting the environmental requirements of the international treaties, but that '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 impacts' (Orr & Neville, 2010, p. 1). In her submission to the senate inquiry on this matter, Professor Lee Godden suggested that the Act and the Basin Planning process was 'not a generic 'trade-off between environmental and socio-economic factors' which can be remedied by 'balancing, as popular debate has suggested' (Godden 2011, p. 2). Godden went on to say that the 'legal provision points to the complex task of integrated decision-making giving effect to special measures … for biodiversity protection, while ensuring that the overall sustainability of the resource is retained to support ecosystems within the basin' and that '*in implementing international agreements, the Basin Plan must be prepared to achieve conservation outcomes at first instance*' (original emphasis; Godden, 2011, p. 2).

The public rhetoric was notably different to the majority of advice about the Water Act's requirements. Minister Burke suggested, 'what the legal advice clarifies is that it is completely open to the MDBA to go down a pathway which optimizes all three; optimizes environment, social and economic impacts' (Lane, 2010). He further claimed that 'anything they read that says that or anything they hear that says that [namely, that the Water Act gives environment precedence] is wrong' (Kenny, 2010a). Mike Taylor concluded from these public comments that 'quite clearly, it means we'll have to find less water for the environment because the implication is to treat environment, social and economic equally' (Taylor, 2010a). However, just over a month after this public dispute began and after again seeking legal advice on the interpretation of the Water Act, which provided 'further confirmation that [the MDBA] cannot compromise the minimum level of water required to restore the system's environment on social or economic grounds' (Taylor, 2010b), Mike Taylor resigned.

In January 2011, Minister Burke appointed Craig Knowles, the former NSW water minister and member of the Ministerial Council, as the new Chair of the MDBA. In confirming his acceptance in the idea of balance, Knowles stated, 'there was enough scope in this Act to work on a balanced approach' (Morton, 2011) and that 'the only way to avoid legal challenges … is to get a sensible balance' (Hockley, 2011). This reinterpretation of the Water Act, regardless of its legal validity (which would only ever be formally established through the court system), allowed planning to continue.

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. Arguably the most important of these was the completion of the more sophisticated hydrological modelling of environmental water requirements. This modelling allowed the analysis of particular flow regimes actually being achieved within the current modified system. The modelling showed that operational constraints prevented water from reaching environmental assets and limited the benefits of providing more than 2,750 GL of environmental water (MDBA, 2012). Consequently, this became the environmental water requirement used to define the environmentally sustainable level of take. This was permissible under the Water Act, which stated that the preparation of the Basin Plan must consider the 'fact that the use of the Basin water resources has had, and is likely to have, significant adverse impacts on the conservation and sustainable use of biodiversity' (s21(2)(a)(i) Water Act, 2007). Examples of operational constraints include limiting flow to prevent the flooding of private land, bridges and towns, and also the size of pipes in dam off-takes and previously institutionalised rules around dam operation.

The proposal to begin with a reduction in current diversion limits of 2,750 GL/yr long-term annual average in the Basin Plan has been criticised by many as being insufficient. The arguments put forward are that this volume will not fulfil the requirements of international agreements and will therefore contravene the Water Act (e.g. Environment Defenders Office, 2012) or that the value is less than that which science specifies as required to achieve a healthy river system (Pittock & Finlayson, 2011). The Wentworth Group of Concerned Scientists argued that the MDBA had failed to examine options to remove these constraints and was settling for a politically convenient target rather than a scientifically defensible one (Wentworth Group of Concerned Scientists, 2012). Yet it was also science, in the form of updated hydrological modelling, which provided the politically palatable target of 2,750 GL water recovery.

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 focussed explicitly 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 included consideration of social and economic factors. In addition, the reviewers acknowledged that while the provision of an additional 2,800 GL/long-term annual average (which was the volume used for the review rather than the 2,750 GL/long-term annual average provided in the Proposed Basin 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 to woodlands on the higher floodplains under the 2,800 GL/yr scenario. The assessment of the review was that this is a function of both operational constraints and insufficient provision of environmental water to meet all environmental objectives and targets chosen (Young *et al.*, 2011).

The final plan

By mid-2012 there was still no consensus between the States on the draft plan. South Australia, the State furthest downstream in the MDB, was threatening a High Court challenge, arguing that the 'MDBA has inappropriately taken into account social and economic interests and physical and operational constraints in determining the environmentally sustainable level of take' and that this 'is not consistent with the Water Act and obscures the scientific process required to derive a robust and defensible sustainable diversion limit' (Caica, 2012, p. 2). Conversely, Victoria and New South Wales, the two largest upstream States, suggested that environmental works and measures could offset the need for environmental water delivery without compromising environmental outcomes. Both States sought a reduction to the water recovery targets by 650 GL to accommodate the effect of engineering programs aimed at delivering an environmental benefit with less water (Ministerial Council, 2012). This suggested that both States wanted to minimize any further water recovery from their jurisdictions, as the new target of 2,100 GL had, for the most part, already been met (Figure 4; Table 1).

South Australia sought to have the outcomes of higher water volumes modeled without the river operating constraints to assess whether this would improve environmental outcomes. In October 2012, the MDBA released this modeling, which suggested that 3,200 GL of environmental water with constraints relaxed would achieve significant additional environmental benefits (MDBA, 2012). Under this scenario, the number of environmental indicators that were achieved increased from 11 (out of 18) with the 2,800 GL modeled scenarios (none of which would be achieved without the 2,800 GL) to 17. Importantly, the modeling again showed that there would be little additional environmental benefit of delivering more water if the constraints were not removed, as water would not reach the higher floodplains. In recognizing the importance of removing these constraints, and the benefits to floodplain farmers that this would provide (Kingsford, 2012), many floodplain graziers voluntarily waived their rights to compensation if water managers flooded their land (Wroe, 2011).

The Water Amendment (Long-term Average Sustainable Diversion Limit Adjustment) Bill 2012 was introduced by the Commonwealth Government to accommodate these different State positions. It removed the requirement for parliamentary approval to adjust SDLs and allowed for improvements to any of the triple-bottom-line considerations to be pursued provided the measures would have no negative effect on the other factors. This made it easier to both increase environmental water allocated to the

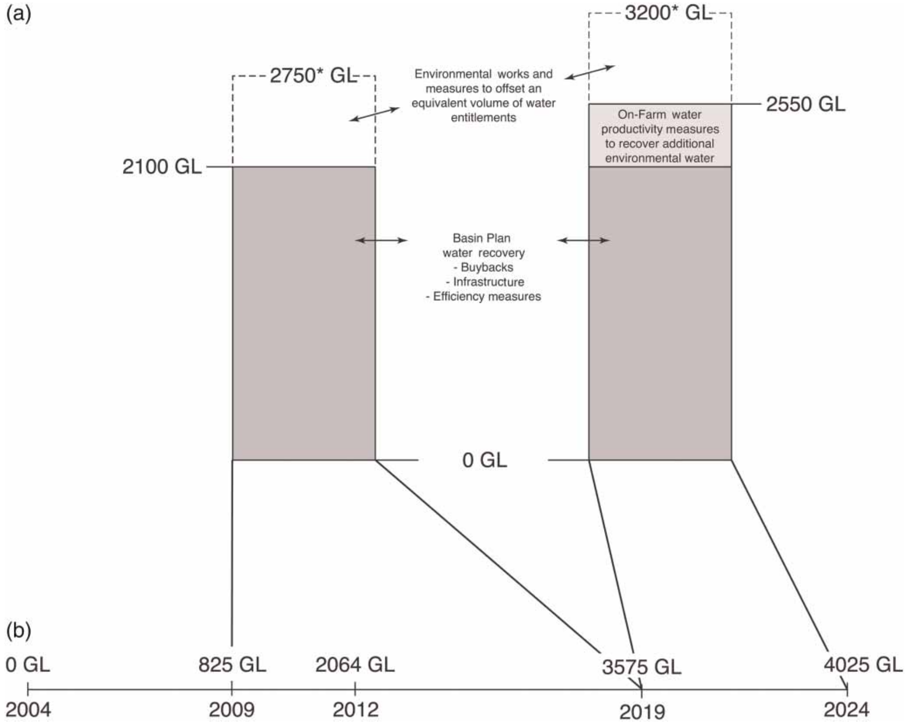

Fig. 4. Environmental water entitlements (and equivalents*) recovered through the Basin planning process (a) and the timeline for recovery of all secure entitlements for the environment in the MDB (b).

CEWH beyond the 2,750 GL target and reduce the requirement for ongoing water recovery efforts. It achieves the latter by allowing States to propose and deliver on environmental works and measures programs by 2019 to achieve an equivalent environmental benefit using less water. The onus for finding these projects is on the States, with the Federal Government committed to achieving the full 650 GL of water with buybacks if insufficient proposals are put forward for consideration. One concern with this provision for environmental works and measures is that it involves site-specific water delivery. Thus, while at one site the same environmental objectives can be met using engineering measures, the amount of water flowing downstream after meeting the objectives could be greatly reduced compared with achieving that benefit using environmental flows.

On 26th October 2012, Julia Gillard, then Prime Minister of Australia, gave a press conference with Tony Burke, the Water Minister, and Jay Weatherhill, the Premier of South Australia. They announced an additional AUD$1.77 billion in Commonwealth funding to invest in on-farm water productivity improvements between 2019 and 2024 and to adjust the constraints that prevent high levels of environmental flow from being delivered to floodplains. Water entitlements for water saved with this funding would be transferred to the CEWH, providing another 450 GL of water. At the time of the announcement, the Government had allocated AUD$56 million of this money and required future governments to pay into a fund to enable financing of the infrastructure works beginning in 2019 (Taylor, 2012). This meant that 3,200 GL of water with relaxed constraints, which should meet 17 of 18 environmental targets, would be delivered by 2024 (Figure 4).

Initial reaction to this announcement from upstream States was negative, with the Victorian Water Minister stating that he would not support a plan that returned 3,200 GL to the environment. The NSW Water Minister stated that he would not sign up to the plan until it could be fully funded (Wroe & Arup, 2012). However, the South Australian Premier suggested the agreement was sufficient, if water was delivered, to drop the threat of High Court action. Despite the opposition from upstream States, the additional 450 GL of water recovery was approved by the Federal Water Minister and was not disallowed by the Commonwealth Parliament. The Minister also signed the final Basin Plan, which was still based on the headline number of 2,750 GL, into law in December 2012.

Achieving consensus …

In introducing the Water Act, the Commonwealth Government committed to funding all water recovery required to reach the Sustainable Diversion Limits (Kenny, 2010b). It also, following the hostile reception to the Guide, shifted priorities to achieving the remaining water recovery through investments in infrastructure or through strategic buybacks where it could be shown that any negative economic or social impacts would be prevented (Burke & Crean, 2011). The additional 450 GL of water recovery post-2019 will come exclusively from infrastructure improvements. In effect, these commitments mean the aggregate effects of the Basin Plan on irrigation are minimized, while the investment into irrigation communities over the next decade is substantial. It also means that an additional 3,980 GL (over 30% of all water entitlements in the Basin; Table 1) of secure water entitlements will be held and delivered for environment benefit by 2024, compared with none prior to 2004. Nevertheless, the Victorian Water Minister stated unequivocally that he would not support a Basin Plan that provided 3,200 GL to the environment as it would cause 'sustained flooding of towns and private land, which is totally unacceptable to Victoria' (Wroe & Arup, 2012, p. 7). The Australian Green Party also argued against the Plan, saying it did not deliver enough water to the environment.

The Water Act gives the Federal Water Minister, Tony Burke, legislative authority to overrule continuing negotiations and make a judgement on the final shape of the Basin Plan (provided he can ensure that it will not be disallowed by the Commonwealth Parliament). The level of vitriol surrounding the debate about water reform in Australia suggests that this is necessary, as a complete consensus will unlikely ever be realized. Despite these powers, Burke continued to negotiate between the States for months after the MDBA delivered its Proposed Basin Plan for his approval. The major change that resulted from these negotiations was the Water Amendment Bill that led to the additional 450 GL of environmental water and the ability for States to offset continued water recovery by developing programs to achieve an environmental outcome with less water. The consensus, when it was achieved in the form of the passage of legislation, did not involve complete agreement. But, as Tony Burke stated, 'the purpose of the reform is to return the system to health … If you compromise on restoring the system to health, you have abandoned the reform' (Burke, 2012).

Further issues arising

The role of science

Science is a tool to inform policy formulation. It is not, in its own right, sufficient to balance competing interests, nor to decide which objectives to achieve and at what cost. Tasking science with arbitrating the decision-making process has, on numerous occasions, ended in conflict, mistrust of decisions, and the politicization of the science involved (e.g. Oreskes, 2004; Sarewitz, 2004). The framing of the Water Act, in drawing its constitutional validity from international agreements, adopts the logic that takes objectives from international agreements and requires science to decide how much water is required to reach them (Briscoe, 2011).

Prior to the Water Act, the role of science and the organizations that conducted research was 'often irrelevant for long periods of time but they [could] provide findings that suddenly bolster[ed] some positions in public controversies, discredit[ed] others and shift[ed] the basic assumptions upon which such debates are conducted' (Connell, 2011, p. 4000). Instead, stakeholders engaged iteratively with either the Federal or State Governments as a focal point for special interest groups. The framing of the Act limited participative decision-making and stakeholder involvement in two ways. First, it specified that the environmental objectives and targets had already been established by international agreements. Second, it tasked science with the role of interpreting these objectives and establishing how much environmental water to allocate to meet them. This made science both the arbiter of decision-making and the vehicle for debate between stakeholders.

The role of science in society and in policy development is to understand the consequences of different choices, thereby allowing informed and transparent decision-making (Lubchenco, 1998). The different choices should be derived from the political process by balancing the goals of numerous stakeholders. Science is a technical discipline. And, relying on it exclusively prevents other forms of knowledge, including the decades of experience in managing the Basin's water resources that have been developed by irrigators, catchment managers and engaged locals, from actively contributing to the debate. In drafting the Water Act to take its objectives from international agreements and requiring science to translate these objectives into a volume of water, the political and policy issues became misinterpreted as technical issues. The resulting debate politicized science, which can lead to reduced trust in scientific findings that could bolster, discredit or shift basic assumptions in future policy debate (Jamieson, 1996; Beck, 2011).

Economic and social disaster?

The technical interpretation of the Water Act is that it gives environmental considerations precedence over economic and social considerations. The obvious question, given the controversy over this framing, is to ask what impact the Basin Plan has on communities in the MDB. In this way, we can determine whether or not the claims of devastation to irrigation communities and businesses are justified. This is particularly important because achieving a balance between social, environmental and economic considerations is often difficult without an organized environmental stakeholder to counteract the demands of more vocal stakeholders representing entrenched social and economic interests (Bonyhardy, 2011).

Various water recovery programs have been implemented in the MDB since 2004 with the aim of securing water entitlements for the environment and reducing the extent of over-allocation (Table 1). Over the last 8 years, a total of 2,708 GL of water was recovered for environmental purposes (only 839 GL of which was recovered before the Basin Planning process began). Compared with the Millennium drought, these reductions in water volume are relatively minor. The 3 years from the 2006–2007 water year were respectively 6,415, 7,726 and 7,381 GL lower than the sustainable diversion limits in the Proposed Basin Plan. However, despite these severe reductions in water availability (over 70% lower than long-term averages), the gross value of basin-wide irrigated agricultural output declined less than 15% throughout the drought (ABS, 2010).

The remarkable performance adjusting to severe drought resulted from the adaptability of leading Australian irrigators in the context of the recently introduced water markets. The markets enabled water to be traded to the highest value form of production (Fargher & Olszak, 2011). Essentially, this provided a buffer against the variability of water supply. In the same way, water markets are expected to buffer the re-allocation of water entitlements to the environment by allowing water to shift to higher value uses and thereby reduce the impact of restructuring considerably (Wittwer & Dixon, 2011).

The economic and social effects of buybacks on irrigated agriculture are further diluted when considered in context of all agriculture in the MDB. In 2005–2006, irrigated agriculture produced only 31% of the Basin's total agricultural output (ABS, 2008). There are four sources of water for agricultural production in the Basin: entitlements to extract water from rivers, from groundwater, rainfall on irrigated land, and rainfall on non-irrigated land. It is important to note that reducing agricultural water entitlements only affects the first two of these, and hence the maximum loss of productive capacity is the difference between irrigated outputs versus dryland agricultural techniques.

Economic modeling of impacts associated with recovering 3,500 GL of environmental water (as part of the preparation for the 2010 Guide to the Basin Plan) suggested 500 jobs could be lost as a direct result of water buybacks (Wittwer, 2011). But this estimate did not consider the benefits of the additional demand (and consequent higher price for the productive factor) resulting from the Government-funded buybacks, nor the investment in infrastructure upgrades to improve the productivity of water delivery and on-farm uses. Indeed, even without considering the benefits of infrastructure investments, the increased value of water rights for buybacks of only 1,500 GL was modeled to deliver a net economic benefit to irrigators and regional communities, with household consumption rising by 0.34% (Dixon *et al.*, 2011). This rise in modeled household consumption was explained by the higher value of irrigators' water assets, as demand for entitlements was maintained through government buybacks and a greater flow of capital into communities (from buybacks) than was lost to decreased production.

Environmental water entitlements provide another benefit, albeit indirect, to irrigators. Water security in river basins with high flow variability was traditionally achieved using large dams. More recently, markets have set up the ability to trade water between different catchments and activities, thereby providing a second buffer against variability of water supply. Water held for environmental release will likely provide a third buffer against this variability, as environmental water releases are mostly designed to increase the frequency of small and medium floods. During drier years, the CEWH and other holders of environmental water can sell the rights to use their water to irrigators, suppressing the cost of water during scarcity and increasing the available resource. In wetter years, when rainfall increases as a source of water for productive use, and water is cheaper and more abundant, environmental water holders are likely to purchase additional water or release their allocations as environmental flows. This provides another mechanism to increase the security of supply to irrigators, and provide greater resilience in the face of climate change and water variability. It also overcomes the decreased water security associated with the over-allocated resource prior to the re-allocation of water entitlements.

Despite these benefits, the irrigation lobby successfully shifted the water recovery efforts established to fill the gap between current and sustainable diversion limits towards a focus on infrastructure investments that cost AUD$3,000–7,000/ML more than voluntary buybacks from willing sellers (Wittwer & Dixon, 2011). The Commonwealth Government, despite financing these upgrades, only secures half of the water recovered, with the remaining savings being kept by irrigators or irrigation districts. Inevitably, the marginal public benefit from investments in infrastructure efficiency will decline with the amount invested (Connell & Grafton, 2008). Moreover, there are persistent questions raised about many forms of infrastructure-based water 'efficiency' as savings from one farm or distribution network do not necessarily translate into hydrological gains (Crase & O'Keefe, 2009; Young & McColl, 2009; Crase, 2010). This occurs as water loss, from inefficient water use, often finds its way downstream, where it is already allocated to another use. Improving water use efficiency can, in certain cases, have the perverse effect of decreasing water availability.

The fact that even the forecast minor economic and social impacts were minimized, at considerable extra cost, as part of a reform process that gives environmental considerations precedence, shows just how difficult it is to achieve equal balance between economic, social and environmental issues when attempting to implement sustainable water reform.

Moving to a new era of mutual benefit

Throughout this Basin planning process, and in previous decades, the water needs for irrigation and the environment have often been treated as mutually exclusive. This falsely dichotomous abstraction has largely been drawn to serve the political purposes of particular interest groups. The distinctive 'battle line' between irrigators and environmentalists in the Basin planning process was a fundamental weakness in the decision-making process and is one that has arisen internationally too (Doremus & Tarlock, 2008). Irrigators have been instrumental in initiating many environmental programs throughout the MDB, and they are also key beneficiaries of environmental improvements. Moreover, opportunities arise, in the context of a functioning market and secure environmental water entitlements, to manage water for the mutual benefit of environmental and irrigation outcomes that have been lost in the debate (Farms, Rivers and Markets Project, 2012).

Removing river-operating constraints will allow water to flow onto floodplains, with significant environmental improvements and benefits to floodplain graziers and other farmers. Removing these constraints would also allow water managers to 'piggy-back' environmental flows on an irrigation water release, thereby decreasing transmission losses and the environmental water required to get water onto higher floodplains.

In a recent study, water requirements to sustain River Red Gum forests along a section of the Goulburn River, in the Victorian MDB, were modeled (Western *et al.*, 2012a). Results showed that counter-cyclical trade of environmental water reduced the required volume of entitlements held by the CEWH to sustain the forest and that the same environmental outcome could be achieved with less water delivery and using water of lower market value. Overall, the study suggested efficiency gains of approximately 20% could be achieved by introducing counter-cyclical trade. Environmental water management within the water market, therefore, provides significant efficiency gains to both consumptive and environmental water users. Moreover, this method of water management had the additional benefit of providing environmental water that was not site specific, as 'irrigating' a forest or wetland would be.

As another example, the CEWH can deliver water to wetlands in winter and allow irrigators to re-use this water by pumping it out of the wetland during high irrigation demand in summer or once it has been there long enough for ecological processes to run their cycle (Western *et al.*, 2012a, b). This more closely mimics the natural flow regime in which river ecology has evolved where wetlands would fill during winter and naturally draw down over summer through evaporation. It also makes water more readily available to irrigators by removing the delay between placing a water order and it being delivered from upstream water storage.

Both examples show the potential for increased environmental water productivity, and should therefore qualify as a form of environmental works and measures that could contribute to the 650 GL target to be met by 2019. However, for counter-cyclical trade to be effective, river operating constraints need to be removed and this is only set to occur after 2019. This mismatch in timing should be remedied as a matter of priority with the investment in removing operating constraints brought forward. This would allow for continued research and implementation of the efficiency gains that can be achieved through more sophisticated river operations and environmental water trading practices. Investing in environmental science and research is also essential to increasing environmental water productivity in the new water management framework. A more robust scientific understanding of the outcomes of environmental flow delivery is an ongoing need and will help inform new methods and different operating regimes in which the triple-bottom-line outcomes can be optimized. Adaptively managing environmental flow delivery to accumulate knowledge and to inform this enhanced cooperation is essential to its long-term success.

The Water Act is an ambitious reform agenda that aims to recover water for the environment to an extent that is as yet unprecedented globally. The Act, formulated during a devastating drought and during politically difficult times, set about allocating water resources sustainably, which necessarily relied on decisive leadership that could not be replaced by more or better science. The final outcome has led to increases in irrigation productivity, significant environmental benefits, and higher water security for all water users, which will improve resilience and adaptive capacity for future droughts and climate change.

Acknowledgements

The authors would like to acknowledge the comprehensive and insightful discussions with John Briscoe that helped initiate and shape this manuscript. Without the detailed discussions with many Australian water industry practitioners, as part of the Australian Water Project that the authors coordinated and led, this manuscript would not have been possible. The critical comments of two anonymous reviewers are also greatly appreciated and have helped improve the final manuscript.

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Received 15 January 2013; accepted in revised form 24 June 2013. Available online 26 July 2013