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Editorial

Water Reform and Planning in the Murray–Darling Basin, Australia

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This special issue on the Murray–Darling Basin (MDB) brings together multiple perspectives from different disciplines. It includes an overview of what has occurred in terms of water planning in the Basin, a critical evaluation of key aspect of water reform in the Basin, the science behind key basin planning decisions, the hydro-economic modeling of the Basin and their deficiencies, the challenges of public policy making and implementing plans that adequately account for climate change and variability, the critical importance of stakeholders in delivering outcomes accepted by communities, and methods to link ecological responses to economic models to deliver on key planning objectives. In addition to highlighting the key findings of these contributions, this editorial examines key recent water reforms and changes in planning in the MDB, Australia. In particular, it reviews the important developments since 1995 and highlights the principal means by which the 2012 Basin Plan is expected to deliver reduced surface water diversions by 1 July 2019. Further, the editorial evaluates the Australian government-funded water recovery program intended to reduce water diversions and focuses on the effects on stream flows, cost effectiveness and the results to date. The editorial concludes with six key insights in terms of water reform and water planning at a basin scale.

1. Introduction

The Murray–Darling Basin (MDB) is located in south-east Australia and is defined by the catchment of the Darling River (2,740 km in length) that has its source in Queensland and the Murray River (2,520 km in length) with its source in the Australian Alps at the junction of the states of Victoria and New South Wales. The Basin is large, encompassing more than 1 million km^2, and is subject to very large variations in flow as a result of extended droughts and occasional widespread floods, as shown by the annual flows at the Mouth of the Murray River (see Fig. 1). A consequence of the large fluctuations in inflows has been the construction of large dams to provide water storages (Pigram 2007), principally for irrigation during the summer months.

While the Basin is small in terms of its flows compared to other rivers in the world with similar sized catchments, it has been the focus on numerous reviews in terms of its governance. In part, this is because of several policy initiatives undertaken in terms of water planning in the MDB going back more than a century (Connell 2007; Martin 2005; Musgrave 2007). A key year in terms of recent water reforms in the MDB was 1995 (see Fig. 2) when the Australian (federal) and state governments agreed to place an upper limit on surface water (ground water was not included) diversions (called the 'Cap') from the Basin's rivers and streams. In 2004, the National Water Initiative (NWI), signed by the Australian and state governments, sought to establish a nationally consistent water market (Grafton and

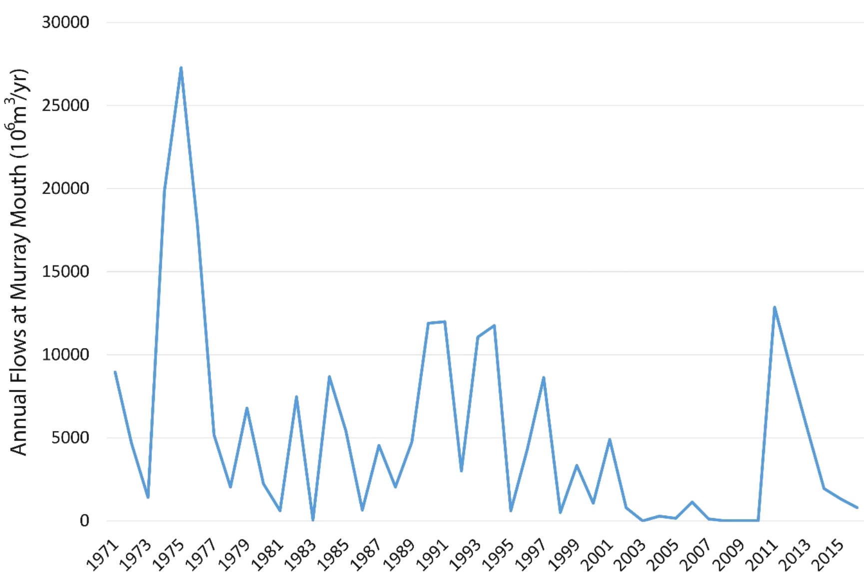

Figure 1. Flows at the Murray River Mouth (million m^3/year)

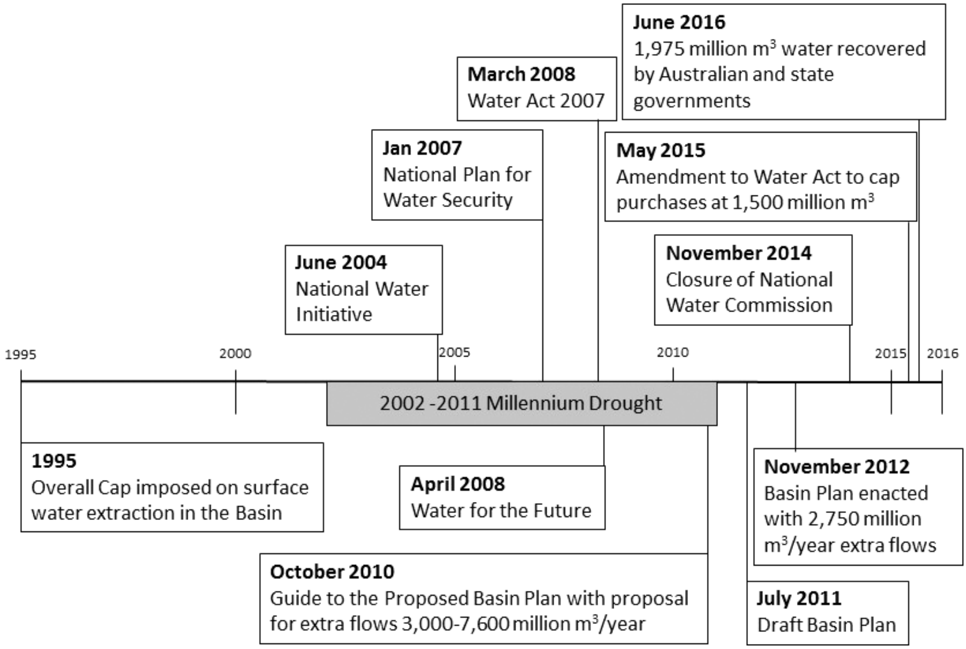

Figure 2. Timeline of Water Reforms and Events in the MDB

Horne 2014), to improve statutory water planning and accounting, and to secure environmental sustainable levels of water extractions (Stoeckel and Abrahams 2007) within the MDB.

As shown in Fig. 2, a new stage of institutional and market reforms began in 2007. At that time, the Australian Government committed to funding a number of measures to re-balance water between irrigation and environmental needs. In particular, the Australian government committed A$10 billion over 10 years under the *National Plan for Water Security* to facilitate the implementation of the NWI (Grafton 2007). The *National Plan* was a $10 billion ‘rescue package’ announced in January 2007 at the height of what was to be a near decade-long drought, called the Millennium Drought and that ended in 2010–2011. Following a change in the Australian government in the second half of 2007, this funding package was increased to A$12.8 billion and renamed *Water for the Future* (Grafton 2010).

Water for the Future provided the financial means to ensure the successful delivery of the *Water Act* 2007. This Act established the Murray–Darling Basin Authority (MDBA) and made it responsible for developing the Basin Plan and setting enforceable Sustainable Diversion Limits (SDLs) (Connell and Grafton 2011). *Water for the Future* had a, more or less, a two-to-one ratio of funds allocated for subsidies for off and on-farm infrastructure improvements relative to the direct purchase of water entitlements. In total, A$3.1 billion was committed to directly purchase water entitlements from willing sellers and A$5.8 billion was allocated to investing in and subsidizing the efficiency and productivity of water use and management both on-farm and off-farm (Crase and O'Keefe 2009). By 2015, approximately A$5.3 billion of these funds has been spent — A$2.2 billion on directly purchasing water entitlements and A$3.1 billion on infrastructure improvements and subsidies (Hart 2015).[1]

This editorial provides a critical review of the Basin reform process. First, in Section 2, it reviews the six other contributions on Basin reform and planning that comprise this special issue. An overview of a key aspect of water reform, the establishment of SDLs in the Basin, is presented in Section 3. Section 4 evaluates the economics and effectiveness of water recovery for the environment, which is core to recent Basin water reform. Section 5 concludes with six key insights about the MDB water reform and water recovery processes.

2. Special Issue: Water Reform and Economic Planning in the MDB, Australia

This special issue responds to recent water reforms in the MDB. The papers are contributions presented at a symposium entitled 'Basin by Numbers': Science, economics, community and environment' (see http://www.anu.edu.au/events/the-basin-by-numbers-science-economics-community-environment) that took place at the Australian National University (ANU) to review the state of play in the Basin and water planning in the Basin in September 2015. It featured researchers, community leaders and policy makers and was sponsored by the Goyder Institute for Water Research and the ANU UNESCO Chair in Water Economics and Transboundary Water Governance. Six presentations at this symposium were subsequently submitted as papers to form this special issue, Water Reform and Planning in the MDB, Australia.

The first of the six papers in the special issue 'sets the scene' and is contributed by Kneebone and Wilson, both of whom work for the MDBA. They provide a

[1]Given there are approximately 14,500 irrigators in the Basin the direct payments (through the purchase of water entitlements from willing sellers) and indirect payments (though infrastructure projects and infrastructure subsidies) to irrigators, to date, amounts to $A365,000 per irrigator (in nominal dollars). If the entire A$8.9 billion allocated in *Water for the Future* for both water entitlements purchases and infrastructure were spent then it would amount to in both direct and indirect payments to about A$600,000 per irrigator.

useful chronology and a description of the principal features of the Basin Plan that was enacted in November 2012 from the perspective of the MDBA.

In the second paper of the special issue, Connell persuasively argues that engagement with stakeholders, other than irrigators, has been inadequate. In his view, meaningful participation by Basin communities should include elected regional bodies which would make the decisions about how and when to use the approximately 1,700 million m^3 of water, based on long-term averages, held by the Commonwealth Environmental Water Holder on behalf of the Australian government exclusively for environmental purposes (Department of Environment and Energy 2016).[2] Such participation, as argued for by Connell, would be consistent with 'citizen power' rather than 'tokenism' (Arnstein 1969) that typified many of the interactions in the processes leading to the Basin Plan (Mulligan 2011).

Capon and Capon provide a science perspective to one of the great controversies about the Basin Plan, namely, the volumes of environmental water that should be 'put back', or rather not extracted, from the Basin water resources to protect and restore water-dependent ecosystems. Their key point is that, while stream flows are critically important for riverine ecosystems, there is no sound scientific basis to determine what is the appropriate volume required for environmental water requirements of key wetland assets. Rejecting quantified targets which are at the core the Basin Plan, they argue for multi-faceted ecological responses in terms of alternative flow regimes which, along with socio-economic and cultural considerations, should be used to evaluate trade-offs about when, where and what or who should receive water allocations.

Alexandra reviews the Basin Plan from the perspective of its highly variable inflows and a possible drying trend in the southern part of the Basin associated with climate change. His focus is not on the science *per se*, but on the public policy making that occurred when formulating the Basin Plan. Specifically, he highlights the failure of the Basin Plan to explicitly include climate change in the determination of SDLs. Not including climate change in the determination of SDLs also contradicts the MDBA's initial advice in its guide, namely, "The intent is to have a Basin Plan that will work well regardless of the climactic conditions over the next 20 years", and that there should be ". . . a climate change allowance in the proposed surface water long-term average sustainable diversion limits (SDLs)" (MDBA

[2]As of 30 June 2016, the Commonwealth Environmental Water Holder had water entitlements in terms of long-term sustainable yield of water equal to 1,692 million m^3/year. This volume is less than the volume which the Australian government claims has been recovered as of 31 May 2016 of 1,975 million m^3/year, and which includes state government recoveries (162 million m^3/year) and 'other recoveries' of 49 million m^3/year (Department of Agriculture and Water Resources 2016).

2010). To improve future decision-making, Alexandra recommends much better integration of science and policy, coupled with scenario planning methods.

Settre *et al.* (this issue) give another view on uncertainty in the Basin, but from the perspective of hydro-economic modeling. After extensively reviewing the literature, they conclude that the models used to inform policy could be very substantially improved, especially in terms of how they account for uncertainty. They also argue for methods that better account for stochastic uncertainty and also more comprehensive sensitivity analysis in the presentation of model results.

The closing paper by Farquharson *et al.* provides a worked example of how ecological responses and economic modeling, applied to the Goulburn River which is a tributary to the Murray River and located in the southern part of the Basin, can be combined to make more informed decisions about trade-offs. In their work, they calculate the marginal value of water from increasing environmental flows to raise the numbers of the fish species, Golden Perch (*Macquaria ambigua*), versus using the water for irrigation purposes by dairy farmers.

Other issues were covered at the ANU September 2015 Symposium including allocations of cultural water and priorities for Indigenous communities (Jackson 2012), rural communities (Miller 2011) and the science to understand the relationship between stream flows and effects on ecosystems (Williams 2011). Unfortunately, these symposium contributions were not able to be included in this special issue. Nevertheless, collectively all six papers provide a valuable narrative of the water reform process in the MDB, and how it may unfold to 2024, the year when the last actions of the 2012 Basin Plan are expected to be completed.

3. Water Reform and SDLs in the MDB

A key event in the water reform process was the release of the Guide to the Proposed Basin Plan in October 2010 to a 'storm' of protest by irrigators (Miller 2011). The recommended surface water and ground water SDLs, defined as the total long-term average water diversions across the entire Basin, included in the Guide were intended to ensure desirable end-of-stream flows and meet environmental water requirements of key assets. The determination of the surface water SDLs involved a calculation that average stream flow should be 60% of what it would have been without development or water diversions. Specifically, the Guide recommended with 'high' uncertainty (in terms of the environmental effects) that the reduction in Basin surface water diversions should be 3,856 million m^3/year, on average. However, with a 20% plus or minus confidence interval, this resulted in a lower recommended reduction in the Basin's long-term average surface water diversions of 3,000 million m^3/year. The Guide also included a 'low' uncertainty volume by which surface water diversions in the Basin should be reduced by a volume equal to 6,983 million m^3/year. With a 10% plus or minus confidence interval this resulted in an upper limit recommendation of a reduction in the Basin's long-term average surface water diversions of 7,600 million m^3/year.

The recommended reductions in surface water extractions in the Guide were subsequently revised downwards to 2,750 million m^3/year when the Basin Plan was enacted in November 2012 and represented a fragile compromise between the federal government and state governments. The 2,750 million m^3/year planned reductions in surface water extractions was enacted despite the fact that an independent scientific study by CSIRO (2011) in 2011 concluded that an increase in environmental flows of 3,000 million m^3/year, based on long-term averages, would be insufficient "...to meet the South Australian environmental water requirements" and would also be insufficient to meet the salt export requirements specified by the MDBA.

Opaqueness about how the final determination of the SDLs in the 2012 Basin Plan was arrived at, led the Australian Senate inquiry into the 'Management of the Murray–Darling Basin' in March 2013 to recommend to the MDBA to provide a "concise and non-technical explanation of the hydrological modeling and assumptions used to develop the 2,750 million m^3/year return of surface water to the environment within the Basin Plan." (Senate Rural and Regional Affairs and Transport References Committee 2013). As of December 2016, this recommendation has still not been acted on.

Related to the lack of transparency in Basin planning and management has been the closure of key organizations responsible for auditing water governance performance, such as the National Water Commission in 2014. In addition, funding has been cut to key monitoring and reporting functions (Horne 2014) such as the disbanding of the Sustainable Rivers Audit (MDBA 2012) undertaken by an independent group of scientists and that provided an assessment of the ecological health on the rivers in the Basin.

In November 2012, the MDB Plan (MDBA 2012) was enacted to give effect to the Water Act 2007. The central element of the Basin Plan is the introduction of a limit on both surface and ground water diversions, as defined by SDLs. The enacted SDLs are supposed to take effect by 1 July 2019 and are intended to provide environmentally sustainable limits on the quantities of surface water and ground water that may be taken from the Basin water resources. While the Basin Plan seeks to reduce permissible surface water extractions by, on average, 2,750 million m^3/year, it actually increased permissible ground water extractions by 1,548 million m^3/year (Pittock *et al.* 2015), based on long-term averages. This is despite the fact that surface and ground water are highly connected in the Basin and that increased ground water use lowers base flows to rivers (Evans 2004; Wentworth Group of Concerned Scientists 2012).[3] In addition to setting long-term average permissible extractions, the Basin Plan includes an environmental watering plan to coordinate the delivery of environmental outcomes across the Basin. Water trading rules have also been introduced to reduce restrictions on trade and improve market transparency and confidence.

4. Water Recovery in the MDB

Water for the Future outlined in 2008 a 10-year funding plan to ensure water extractions within the MDB would be at environmentally sustainable levels, as determined in the Basin Plan. This was to be achieved by 'water recovery' or the acquisition of water entitlements from irrigators so as to reduce their average level of water extractions and, thereby, increase environmental flows. In other words, water recovery 'bridges the gap' between current levels of water diversions and what is required to ensure environmentally sustainable levels of water diversions (MDBA 2011). Under *Water for the Future*, water would be recovered by: (1) the use of reverse tenders to purchase water entitlements from willing sellers; (2) the subsidization of improvements to water infrastructure to reduce off-farm losses, primarily through state-owned projects; and (3) on-farm subsidies to reduce water losses and where at least 50% of the 'savings', in the form of water entitlements, would be transferred to the Australian government.[4]

The Basin Plan set a target to reduce water extractions to sustainable levels with a proposed reduction in surface water extractions, in terms of the long-term average, of 2,750 million m^3/year by 1 July 2019. In addition, to help resolve a political impasse with the South Australia state government, the Australian government agreed to an additional aspirational target of increasing stream flows by a volume equivalent to 450 million m^3/year of water and set aside A$1.77 billion for 'efficiency measures and constraints management' (Hart 2015) under the *Water Amendment* (*Water for the Environment Special Account*) *Act 2013* for this purpose (McCormick 2016).

[3]Evans (2004) estimated that, on average, in the MDB, for every 100,000 m^3 of ground water extracted, surface water will, ultimately, be reduced by 60,000 m^3.

[4]In terms of the On-farm Irrigation Efficiency Program funded by the Australian government, it is expected that at least 50% of the savings in the form of water entitlements will be transferred to the Australian government. Each on-farm sub-project that is funded should generate a minimum of 20,000 m^3 of water savings of which at least 50% (or 10,000 m^3) would need to be transferred from any one water entitlement.

As of 31 May 2016, the Australian government had acquired 1,813 million m^3/year of water, and state governments 162 million m^3/year, based on long-term yield or average allocations to water entitlements (Department of Agriculture and Water Resources 2016) for a total of 1,975 million m^3/year. Of the total acquired by the Australian government, about 1,166 million m^3/year was acquired through the direct purchase of water entitlements while 595 million m^3/year has been obtained through infrastructure improvements and subsidies. Subtracting the overall volume of water acquired to date of 1,975 million m^3/year from the target 2,750 million m^3/year gives a volume to be recovered or additional water that needs to be acquired by 1 July 2019, under the Basin Plan, of 775 million m^3/year.

In 2015 the Australian government legislated to cap water entitlement purchases at 1,500 million m^3/year, and also stated that no further water entitlement purchases were planned (Hunt *et al.* 2015). Consequently, the remaining water that needs to be recovered by the Australian government will have to be obtained from: (1) infrastructure subsidies or (2) supply measures that are "... actions such as environmental works or changes to river operation rules that enable the use of less water while achieving equivalent environmental outcomes to the modelled outcomes for the 2,750 million m^3/year recovery target under the Basin Plan." (Department of the Environment 2014).

When fully implemented, the claim is that supply measures that include reconfiguring lakes and storage systems or changes in the way water is delivered to the environment, can be used to adjust downwards the volume of water that needs to be recovered to meet the 2,750 million m^3/year target in the Basin Plan (MDBA 2016), possibly by as much as 650 million m^3/year (Department of Sustainability Environment Water Population and Communities 2013). Whether this is possible, or even desirable given that it will increase the overall level of surface water diversions in the Basin from what diversions would be in the absence of supply measures, is highly contested (Horne 2014; Pittock *et al.* 2015). In any case, under the Basin Plan the maximum adjustment downward in the SDL as a result of any adjustments, including supply measures, is limited to the equivalent of 540 million m^3/year.

4.1. *Stream flow effects of water recovery*

If the proposed supply measures are assumed to be fully effective — in other words provide in-stream benefits equivalent to the maximum permissible under the Basin Plan of 540 million m^3/year — then the *additional* water that would need to be recovered to meet the Basin Plan 2,750 million m^3/year water recovery target by 1 July 2019 by infrastructure subsidies alone is *at least* 235 million m^3/year

(775 million m^3/year water not yet acquired less 540 million m^3/year from supply measures). This would be in addition to the 595 million m^3/year of environmental water already acquired through infrastructure subsidies.

A legitimate concern about the effectiveness of further water recovery from additional infrastructure subsidies is that "... if infrastructure investment was half as cost effective as buybacks, and 50 per cent of the water savings were allocated to the environment, the $5.8 billion budget could yield savings of another approximately 595 million m^3 of annual flow." Productivity Commission (2010). In other words, for the budget available, further infrastructure activities and subsidies alone may fail to deliver the volume of water required to meet the 2,750 million m^3/year target under the Basin Plan even allowing for a 540 million m^3/year adjustments as a result of supply measures.

The challenge in terms of the effectiveness of water recovery is that it is highly likely that water savings from infrastructure subsidies will, at least in part, run counter to the supply measures because they will reduce return flows. This is because, as noted by the Productivity Commission (2006), "Capturing return flows that contribute to downstream allocations, for example, does not create overall system savings". Qureshi *et al.* (2010) and Adamson and Loch (2014) also stress that reducing water extractions via infrastructure improvements off-farm or on-farm does not necessarily increase environmental flows because it depends on how the 'saved' water was previously utilized. Moreover, if water that were 'wasted' generated return flows then the volume of environmental flows may even decrease. For instance, Adamson and Loch (2014) show that it is even possible in normal or wet years for environmental flows to be *reduced* with infrastructure subsidies as a consequence of change in return flows. The possibility also exists that irrigators may even expand the area of their land irrigated if they are allowed to keep the water 'savings' from subsidies (Productivity Commission 2006).

4.2. *Cost effectiveness of water recovery*

Notwithstanding the effect on stream flows of water recovery through infrastructure subsidies and supply measures, the cost effectiveness of such an approach is highly questionable.[5] To illustrate the problem, A$4.4 billion of the A$5.8 billion

[5]Almost immediately after the announcement of the *National Plan for Water Recovery* it was observed that "The key point is that expenditure of public money for public benefits, as announced in the water plan, should not be constrained to particular investments or infrastructure, but should be allocated to those approaches that generate the highest marginal water." And, "To ensure the public receives the highest net return per dollar spent, policymakers will need to resist calls by self-interested irrigators to direct public investments into projects that generate the highest net private (rather than public) benefit." (Grafton 2007).

allocated for infrastructure under the *Water for the Future* was originally set aside for state-based infrastructure projects. For some state projects, such as Northern Victoria Irrigation Renewal, the extra cost of water acquired from infrastructure greatly exceed what it would have cost to recover the same volume of water from willing sellers via the purchase of water entitlements. For instance, according to the Productivity Commission, the "…Australian government may pay up to four times as much as recovering environmental water through infrastructure upgrades than through water purchases. In other words, a premium of up to A$7,500 per 1,000 m^3 year may be paid for recovering water through infrastructure upgrades…" (Productivity Commission 2010). In some cases, the projects that have been funded have acquired water at a cost as high as A$14,714 per 1,000 m^3 (Sunraysia Modernisation Project which cost A$103 million for 7 million m^3/year).

The high costs of ensuring equivalent volumes of stream flows, other than by purchasing water entitlements directly from willing sellers, is also true of the 'efficiency and constraints' management. This program has a total budget of A$1.77 billion and an aspirational target equivalent to in-stream flows of 450 million m^3/year that is over and above the 2,750 million m^3/year target in the Basin Plan. This works out at a costs of just under A$4,000 per 1,000 m^3.

The alternative to acquiring water for the environment by infrastructure subsidies is to purchase water entitlements directly from willing sellers. Until 2014, the Australian government spent approximately A$2.2 billion acquiring water entitlements from irrigators using reverse tenders, but such purchases have now been halted (Hunt *et al.* 2015). The average cost of acquiring such water entitlements purchases to the Australian government has been about A$2,000 per 1,000 m^3/year — an amount that is much less than the average cost of acquiring water through infrastructure subsidies, even if infrastructure subsidies were to have no impact on return flows. Indeed, if the Australian government had chosen to acquire the 2,750 million m^3/year required under the Basin Plan entirely from the purchase of water entitlements it would have cost $5.5 billion while currently it is projected to spend $8.9 billion to achieve the same volume of water recovered.

An important issue with on-farm infrastructure subsidies is that they are likely to favor perennial (such a viticulturists) versus annual (such a rice farmers or cotton growers) irrigators given the higher net return per 1,000 m^3 for perennial farmers (Adamson and Loch 2014). If, indeed, this is the case, then subsidies may reduce the resilience of the overall system because in drought years there would be a greater proportion of irrigators more dependent on irrigation to maintain their livelihoods. The economic consequence is that this will likely increase the marginal cost of water in drought periods and impose greater costs on net purchasers of water. This is because annual irrigators will, with infrastructure subsidies, likely have a small share of the overall water entitlements and, thus, fewer of their entitlements will be available for sale during periods of high water prices.

The reason that direct purchase of water entitlements by the Australian government have been halted, despite their cost effectiveness relative to infrastructure subsidies, is that many irrigators claim that such purchases negatively affect both irrigators and their communities. Contrary to these claims, however, the direct purchase of water entitlements to the government by willing sellers increases, rather than decreases, the gross domestic product in the Basin (Wittwer and Dixon 2013). Further, even large reductions in surface water extractions (30%) as a result of buybacks from willing sellers impose much smaller decreases in gross value of irrigated agriculture, and also irrigation profits (Grafton and Jiang 2011). This is because water trading between regions in the Basin provides an effective way to mitigate reductions in surface water extractions (Grafton and Horne 2014). These benefits of water trade can be very large and were estimated to be A$1.5 billion in 2007–2008 during the worst year of the Millennium Drought (National Water Commission 2012). Trade in water allocations is also a key reason why the gross value of irrigated agriculture production changed very little despite large reductions in water allocations during the Millennium Drought (Kirby *et al.* 2014).

4.3. *Results to date of water recovery*

Despite the fact that there have been expenditures, to date, of more than $5 billion under the *Water for the Future* and the Australian government is about 70% towards achieving its target of reducing extractions by 2,750 million m^3/year by 1 July 2019, there is, as yet, no discernible change in surface water diversions within the Basin (see Fig. 3). As shown in Fig. 3, the volume of surface water diverted in the MDB peaked in 2000–2001 and then stayed at lower levels during the Millennium Drought before rising again after the drought in 2010–2011, and then falling back in 2014–2015 as a result of less-than-average inflows (and water storages), over the period 2013–2015. Water application rates by MDB irrigators followed a similar pattern such that the average volume of water applied per hectare was the same in 2014–2015, as it was in 2002–2003, at the onset of the Millennium Drought (see Fig. 4).

Figures 3 and 4, combined, beg the question why such a large expenditure by the Australian government on water recovery (A$5.3 billion) has, to date, delivered so little in terms of either a sustained reduction in water application rates at a Basin scale or a decrease in Basin-level surface water diversions? One reason for no discernible difference in Basin-wide surface water diversions is that a substantial proportion of the water entitlements acquired by the Australian government were

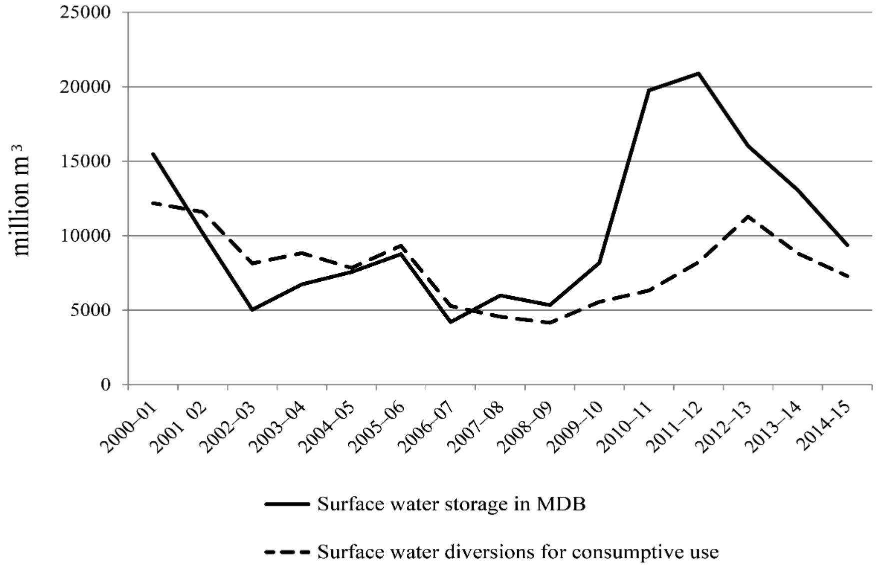

Figure 3. Surface Water Storage, Announcement and Diversion in MDB (million m^3/year)

Source: Water storage was sourced from MDBA water audit monitoring reports, water diversion and allocation announcement were provided by the MDBA.

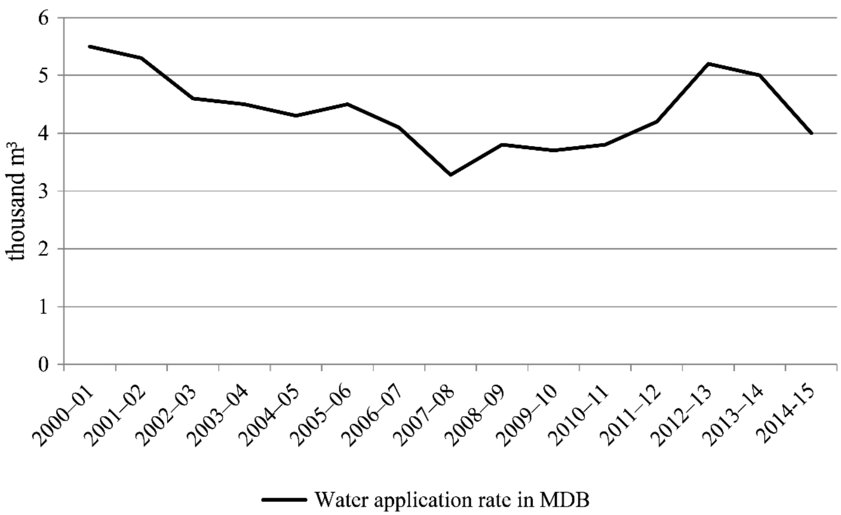

Figure 4. Water Application Rate in MDB and Australia (1,000 m^3/ha)

Source: ABS, Water Use on Australian Farms, cat. No. 4618.0.

not fully utilized by their previous owners. Indeed, Wheeler *et al.* (2014) who have analyzed irrigation survey data observe that irrigators in the Basin between 2006–2007 and 2010–2011 used just 72%, on average, of the physical volumes of water allocations that were allocated to their water entitlements.[6] Thus, irrigators who have either sold or reallocated water entitlements to the Australian government through infrastructure subsidies may have maintained a similar level of water diversions as previously by simply using a greater share of the water allocated to their remaining entitlements.

Another reason why water recovery has achieved so little in terms of reduced surface water diversions is the high level of the surface water Baseline Diversion Limit (BDL) established in the Basin Plan. The BDL was calculated by the MDBA (2011: pp. 85–86), based on the state of affairs as of 30 June 2009, and is the sum of measured long-term average annual water diversions (10,636 million m^3/year), estimated diversions from non-regulated streams (267 million m^3/year), estimated interceptions from farm dams (2,384 million m^3/year), and estimated interceptions form plantations (336 million m^3/year). As a result of this method of calculation, the Basin BDL for surface water was established at 13,623 million m^3/year (MDBA 2012) — a volume that greatly exceeds the measured annual total volume of surface water diverted in the Basin in any year from 2000–2001 to 2014–2015, or in any year prior to setting of the Cap in 1995.[7]

Setting a Basin BDL higher than what has been diverted in the past means that the Basin SDL is also correspondingly higher, set at 10,873 million m^3/year in the Basin Plan, a volume that exceeds the average annual level of surface water diversions since the imposition of the Cap in 1995 and is approximately one third of the total surface water inflows into the Basin.[8] In sum, by setting the surface water BDL at such a high level, by undertaking supply measures that reduce the adjustment required to move from the BDL to the SDL, and by acquiring water entitlements that are less than fully utilized collectively mean that the *actual*

[6]In the five years before the Cap was established in 1995, only 63% of the water that was permitted to be diverted by irrigators was actually diverted which may be partly explained by limitations imposed by irrigation infrastructure (Murray–Darling Basin Ministerial Council 1995).

[7]The greatest annual volume of surface water diverted in the Basin over this 15 year period was in 2000–2001, before the Millennium Drought, when the volume was 12,175 million m^3. Total surface water diversions averaged 10,684 million m^3/year over the period 1988–1989 to 1992–1993 (Murray–Darling Basin Ministerial Council 1995) while *if* the full development of existing entitlements, at that time, had been allowed the total surface water diversions would have been 12,344 million m^3 (Murray–Darling Basin Ministerial Council 1995).

[8]The average annual surface water diversions in the Basin from 2000–2001 to 2014–2015 was 7,956 million m^3/year, but was highly variable and ranged from a low of 4,154 million m^3 in 2008–2009 to a high of 12,175 million m^3 in 2000–2001.

reduction in measured surface water diversions in the Basin will be much *less* than the 2,750 million m^3/year target in the Basin Plan.

5. Key Insights

The contributions in this special issue collectively provide a number of insights for water planners in the MDB, and beyond Australia.

First, as highlighted by Alexandra (this issue), highly variably inflows coupled with a possible drying trend in the southern part of the MDB associated with climate change requires full consideration of risks. Unfortunately, in the case of the MDB Plan, adequate consideration of risks was not incorporated in the setting of SDLs.

Second, adequate risk-based decision-making requires better science and policy integration and improved hydro-economic modeling (Settre *et al.*, this issue). Such modeling must adequately account for uncertainty.

Third, expenditures on water recovery should be cost effective so as to maximize the net benefits of water recovery and water reform. In the case of the MDB, billions of extra expenditures have been incurred acquiring water for the environment by infrastructure subsidies than if water entitlements had been purchased directly from willing sellers.

Fourth, as highlighted by Connell (this issue), there should be better coordinated and effective water governance and real engagement with all relevant communities, not just irrigators. Such engagement is not tokenism, but about giving power to citizens to make decisions in the interest of their communities.

Fifth, despite the focus on quantitative targets in the MDB Plan, reduced water extractions may not be the only way to support ecosystem services (Capon and Capon, this issue). Instead, approaches that focus on ecological responses and trade-offs (Grafton *et al.* 2011) (Farquharson *et al.*, this issue) might be applied. Such an approach, however, requires proper monitoring of the state of environmental assets, and the services that they provide, to properly decide on the trade-offs and the net benefits of allocating to different uses, including to in-stream flows.

Sixth, but not least, much greater transparency is required in terms of water planning (Kneebone and Wilson, this issue). Such transparency should include how planned reductions in surface water diversions and increases in permitted ground water extractions were calculated, and in ways that can be understood by Basin communities. Critically, transparency also requires appropriately funded regular monitoring and reporting of Basin ecological assets and ecosystem services and the continuing support for agencies to scrutinize and to support effective Basin-level water governance (Horne 2014). Without proper funding and capacity to ensure sufficient monitoring and reporting of diversions and environmental audits, along with the necessary management feedbacks in response to new information coupled with effective risk management, then any basin and environmental watering plan is, simply, not worth the paper it is written on.

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