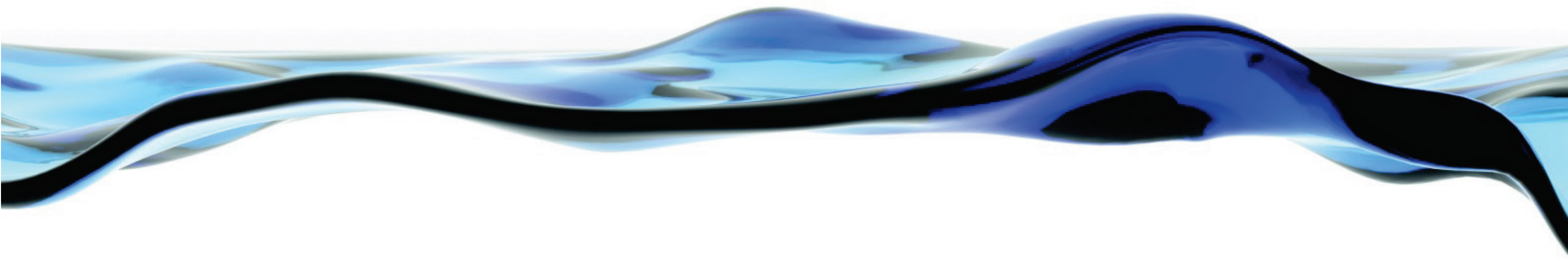
A compilation of reports informing a socioeconomic assessment of the Guide to the proposed Basin Plan

Edited by Dr Jeff Connor



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Preface

The *Water Act (2007)* requires the Murray–Darling Basin Authority to prepare and implement a Basin Plan for the integrated and sustainable management of water resources in the Basin. The October 2010 release of the Guide to the proposed Basin Plan was a first step in this process and a major milestone for water management in Australia.

Within the Guide, the MDBA described scenarios that could meet the environmental water requirements for the Basin. The scenarios describe long-term average sustainable diversion limits for the Basin designed to return additional water to the environment.

Prior to the release of the Guide, the South Australian Government, through the Goyder Institute for Water Research, commissioned a science review of the Guide proposals in order to provide a South Australian perspective on the environmental and socioeconomic implications of the proposed sustainable diversion limits. The science review was undertaken by CSIRO as a member of the Goyder Institute.

This report is one of several prepared as a part of the science review. Key findings from this and other related reports have been synthesized and released in 'A science review of the implications for South Australia of the Guide to the proposed Basin Plan: synthesis' (CSIRO, 2011).

This report is a compilation of reports that were prepared to provide background information for the science review. The reports reflect the project structure and are based on the information and data available at the time of their writing (September to December 2010). The reports have been peer-reviewed and are:

- Report 1 – Collation and commentary on socioeconomic studies relevant to the SA River Murray
- Report 2 – Review of the approach to socioeconomic analysis in the Guide to the proposed Basin Plan
- Report 3 – Review of the core socioeconomic studies underpinning the Guide to the proposed Basin Plan.

Terms and abbreviations

The report uses terminology used by MDBA in their Guide to the proposed Basin Plan (MDBA, 2010a; 2010b), except where this is inconsistent or conflicts with the reporting needs of this review.

ARI	average return interval (usually expressed as ‘1-in-5 years’, for example)
BCA	Benefit Cost Analysis
BSMS	The MDBA’s Basin Salinity Management Strategy
CDL	current diversion limit
cease-to-flow	‘zero’ flow, i.e. no water is coming down the river from upstream
CES	Constant Elasticity of Substitution
CEWH	Commonwealth Environmental Water Holder
CGE	Computable General Equilibrium
CLLMM	The Coorong, Lower Lakes, and Murray Mouth – a key environmental asset
CoPS	Monash University’s Centre of Policy Studies
EC	electrical conductivity; a measure of salinity – the more salt the higher the EC. EC is usually expressed in microSiemens per cm at 25°C (µS/cm)
EWRs	environmental water requirements
GDP	Gross Domestic Product
GHG	Greenhouse gases
GL/year, GL/y	gigalitres per year (10^9 litres per year)
GRP	Gross Required product
GVIAP	Gross Value of Irrigated Agricultural Production
GVP	Gross Value Produced
Key ecosystem function site	equivalent to ‘hydrologic indicator site for key ecosystem functions’ as used in the Guide
Key environmental asset	equivalent to ‘hydrologic indicator site for key environmental asset’ as used in the Guide
LMD	Lower Murray-Darling
LTCE	Long-Term Cap equivalent
MDB	Murray-Darling Basin
MDBA	Murray–Darling Basin Authority
MJA	Marsden Jacob Associates
ML/year, ML/y	megalitres per year (10^6 litres per year)
NRM	Natural resource management
NWI	National Water Initiative
O&M	Operation and maintenance
Riverland–Chowilla	a key environmental asset
RSMG	Risk and Sustainable Management Group
RtB	Restoring the Balance
SAMRIC	South Australia Murray-Darling Basin Resource Information Centre
SDL	sustainable diversion limit
SEWPaC	Sustainability, Environment, Water, Population and Communities
the Basin	the Murray-Darling Basin
the border	the River Murray at the South Australian border
the Guide	the Guide to the proposed Basin Plan

the Plan	the Basin Plan
tonnes/year, tonnes/y	tonnes per year
ToR	Terms of reference
WftF	Water for the Future initiative
WTM	Water Trade Model

Scenarios and EWR optimised flows

Baseline	the flow that comes across the border under the current water sharing plans in all regions in the Basin. In the Guide it represents an average annual flow of 6783 GL at the border.
Without development	the baseline scenario with storages, urban and domestic usage and all river management rules removed. Since unregulated inflows are not adjusted for upstream usage or change in landuse in this scenario, it is not the same as a pre-development (or 'natural') flow sequence. In the Guide it represents an average annual flow of 13,592 GL at the border.
3000	the current sharing plans adjusted for 3000 GL/year of water being returned to the environment, spread across the regions of the Basin. In the Guide it represents an average annual flow of 8661 GL at the border.
3500	the current sharing plans adjusted for 3500 GL/year of water being returned to the environment, spread across the regions of the Basin. In the Guide it represents an average annual flow of 8966 GL at the border.
4000	the current sharing plans adjusted for 4000 GL/year of water being returned to the environment, spread across the regions of the Basin. In the Guide it represents an average annual flow of 9290 GL at the border.
MDBA Riverland–Chowilla EWRs optimised flow	a daily flow series at the border, optimised to meet the EWRs for Riverland–Chowilla as they are described in the Guide
SA Riverland–Chowilla EWRs optimised flow	a daily flow series at the border, optimised to meet the EWRs for Riverland–Chowilla as specified by SA for the purposes of this assessment (see Chapter 2)
MDBA CLLMM EWRs optimised flow	a daily flow series at the border, optimised to meet annual volumes at the barrages required to meet the EWRs for the CLLMM as described in the Guide (MDBA, 2010)
SA CLLMM EWRs optimised flow	A daily flow series at the border, optimised to meet annual volumes at the barrages required to meet the EWRs for the CLLMM as specified by SA for the purposes of this assessment (see Chapter 2).

Models and data

Guide annual model Guide annual (volumes)	The model used to derive the long-term average annual volumes reported in the Guide, and the annual volumes made available in December 2010, noting that these were aggregated from monthly results
BigMod daily model BigMod daily (flow) BigMod annual (volumes)	The MDBA's MSM-BigMod model and its results. A configuration of the model was provided for each scenario, together with daily flow and diversions data. These data were aggregated to annual volumes for comparison with Guide annual volumes.

Report 1 – Collation and commentary on socioeconomic studies relevant to the SA River Murray

Rosalind Bark, Onil Banerjee, Darla Hatton MacDonald, Darran King and Jeff Connor

Contents

Introduction

This report, the first in the compilation, provides a synopsis and commentary on socioeconomic studies, in most cases commissioned by the Murray–Darling Basin Authority (MDBA) in their development of the Guide to the proposed Basin Plan (MDBA, 2001a).

The studies have been categorised as follows:

- Chapter 1 – Core studies
- Chapter 2 – Synthesis reports
- Chapter 3 – Irrigation and economic impact
- Chapter 4 – Regional economy
- Chapter 5 – Environmental values
- Chapter 6 – Social survey-based vulnerability assessments
- Chapter 7 – Other.

For each study, this report provides a synopsis followed by commentary on the concordance of the studies with economic principles and the degree to which conclusions are supported by analysis. Some of these studies are discussed in more detail in Report 3 in this compilation, which uses a similar report structure.

1 Core studies

The literature reviewed here includes core studies that underpin the Guide to the proposed Basin Plan (MDBA, 2010a) as well as other relevant studies that review the economic or socioeconomic impacts of reduced diversions in the Murray-Darling Basin. The studies are grouped under one of six themes: core studies, reviews of relevant literature, irrigation and economic impact, regional economy and structural adjustment, environmental valuation, socioeconomic assessment, and an other category. To avoid repetition, note that the detailed analysis of the core studies and a table comparing the results of the economy-wide socioeconomic studies are reported in Report 3. Analysis of all other studies using the terms of reference schema follows in this report.

1.1 ABARE–BRS (2010a)

Synopsis

The *Water Act 2007* mandates the MDBA to 'act on the basis of the best available scientific knowledge and socioeconomic analysis' in developing the Basin Plan (*Water Act 2007*, s. 21 ss. 4(b)). In this report ABARE–BRS delivered an economic analysis of potential effects of three sustainable diversion limit (SDL) scenarios (3000, 3500 and 4000 GL) presented in the Murray–Darling Basin Authority's (MDBA) Guide to the proposed Basin Plan (MDBA, 2010a). ABARE applied a two-stage modelling approach in which its Water Trade Model was used to estimate the direct effects of changes in SDLs on the gross value of irrigated agricultural production (GVIAP) and non-irrigated gross value product (GVP) for each sustainable yield region. In a second stage, these estimates of GVIAP and GVP were implemented as production shocks in ABARE's AusRegion computable general equilibrium (CGE) model to estimate economy-wide impacts. The modelling results provide guidance on identifying those sectors and associated communities that are likely vulnerable to structural adjustment.

For ease of communication the report focuses on the results from the 3500 scenario which represents a 29% reduction in total water use (groundwater and surface water). The results of this modelling estimated that Basin GVIAP declines by 15%, or approximately $940 million with intraregional and interregional trade in water. This is a potential 1.3% drop in gross regional product (GRP) or a 0.13% reduction in gross domestic product (GDP). Irrigator profit is estimated to decline by almost 8% and employment by 0.10% in the Basin with the largest declines in the western NSW region. Although these reductions are small the adverse impacts are concentrated within specific crops and industries, and geographically. For instance, the modelling estimates large negative impacts in the Murrumbidgee sustainable yield region and in broadacre irrigated agricultural areas, meanwhile, the horticulture, fruits and nuts, grapes and beef cattle sectors are estimated to be less impacted. Specifically with regards to the South Australian portion of the Basin, GRP and employment were estimated to decline by 1.5% and 0.03%, respectively.

The modelling output identifies those towns and sub-regions that are likely to be adversely affected by reductions in irrigation water and related expenditures. The most severely impacted regions are: Moonie, Queensland; the Murrumbidgee and Gwydir, NSW; the Goulburn-Broken, Victoria; and the SA Murray. Flow-on impacts from irrigated agriculture to downstream processors means non-agricultural regions are impacted such as: Macquarie, Namoi, Barwon-Darling, Murray, NSW; and Loddon, Victoria. The WTM data are aggregated into seven regions in the CGE model; this complicates the assessment of sub-regional socioeconomic impacts. Therefore, ABARE–BRS used irrigation survey data and irrigation farm expenditure data from 2007–08 to identify a list of 88 towns that are highly dependent on expenditure by irrigated agriculture. Using a composite index of community vulnerability – high dependence on irrigated agricultural industries and limited adaptive capacity – ABARE–BRS identify two regions with high vulnerability: the Border Rivers, Gwydir, Namoi and Macquarie-Castlereagh regions in the north-east and the Lachlan, Murrumbidgee and Murray regions in the south.

Commentary

Approach

The report uses ABARE's Water Trade Model to estimate the socioeconomic impacts of three prescribed levels of reduced SDLs on irrigated agriculture. The Water Trade Model is a comparative static partial equilibrium model of economic production from irrigated agriculture that uses statistical inputs from ABS census datasets and hydrological data to model expected returns to land and water in the MDB. The model is a key input to the MDBA's assessment of socioeconomic impacts in irrigated agriculture. The report explores the impacts in 22 sustainable yield regions that are input into a computable general equilibrium model, AusRegion. The report incorporates a sensitivity analysis that examines the impact of wet and dry years under the 3500 scenario.

Overall assessment

Overall the ABARE Water Trade Model is well designed and considered. It does a good job of estimating the potential economic impacts of the proposed SDLs although it does present some deficiencies in its approach and concerns regarding a few of the modelling assumptions. Of those limitations, some are due to the difficulty of locating high quality data that extend across the Basin given local, regional and state agency variations in data collection and storage procedures. There is room for improvement in some of the methodology, scope and scale of the approach, and in the documentation of the reporting. The best practice in science economics is to report all data assumptions and technical relationships in a way that would allow another appropriately qualified researcher to reproduce the results. In reviewing this report we found several instances where insufficient documentation has not allowed us to completely test or understand the process described although the report does provide the reader with information, assumptions, and caveats. The report focuses on the medium-term; a ten-year time horizon. This is appropriate given that the water reductions will be incrementally introduced and that the regional economy and employment markets will take time to transition. A short-run perspective would not add much because irrigated agriculture in the MDB is always adapting to short-term shocks such as inter-annual climate variability. The CGE model used, AusRegion does not explicitly model a water sector nor does it account for distinct irrigated agricultural and non-irrigated agricultural sectors. Capital is treated as sector-specific which may underplay the role farm resource reallocation may have in economic adjustment in the medium- to long-term. The environmental benefits associated with SDLs and increased environmental flows are not considered.

1.2 Morrison and Hatton MacDonald (2010)

Synopsis

People hold values for environmental, social and commercial consequences of changing water allocations and water management. This report summarises the available non-market valuation studies undertaken inside and outside the Basin. Values from 15 studies are evaluated and used in the calculation of the benefits associated with the development of SDLs. Values estimates for each region of the Murray-Darling Basin were prepared on up to five attributes: recreation, healthy native vegetation, native fish, frequency of waterbird breeding, and waterbirds and other species. The environmental values provide information on the benefits of a SDL which can be compared to the costs to agriculture. It also provides information on relative value of water for different environmental goals, including providing water to different riverine attributes (e.g. waterbird breeding vs. native vegetation), providing water to different locations (upstream vs. downstream) and to different asset classes. The aggregate value of improving the Coorong from poor to good quality was estimated at $4.3 billion using some conservative assumptions.

Commentary

Approach

This report reviews the literature and then undertakes a benefit transfer to assemble the non-market values associated with the Basin.

Overall assessment of the study's conclusions

The report outlines a package of improvements and calculates an overall benefit. The study findings suggest that the economic values of environmental improvements resulting from plan implementation are likely to be large in dollar terms, likely of similar order of magnitude to estimated costs to irrigation. All the key assumptions are outlined for the calculation of aggregate benefits. A critical assumption is that the existing studies provide an adequate guide to the underlying community values for the whole Murray-Darling Basin. Existing studies provide patchy coverage of the different types of environmental assets. Some of the early studies are in the northern Basin are overly conservative in nature. Very recent studies which focus on the River Murray and the Coorong use a ten year payment vehicle and perhaps a more realistic scenario.

1.3 Marsden Jacob Associates (2010a)

Synopsis

Marsden Jacob Associates (MJA) were commissioned by the MDBA to develop economic and social profiles of irrigation communities in the MDB in order to assess the socioeconomic impacts of changes in water availability with the setting of the SDLs. The synthesis report (MJA, 2010a) is accompanied by a series of other reports, including one describing irrigator surveys (MJA, 2010b) and one that pertains specifically to SA (MJA, 2010c). The MJA reports complement the ABARE–BRS modelling results reported above by providing detailed information on the diversity of the farm-level irrigation sector and farmers, plus dependent communities. At the time of writing the actual SDLs were unknown; therefore to assess the impacts of reduced water availability in the Basin, MJA examined three scenarios: a 20%, 40% and 60% cut in diversions. The higher end of these scenarios would, if implemented, require more drastic cuts in consumptive uses of water than those envisaged by the Guide to the proposed Basin Plan (MDBA, 2010a) and those modelled by ABARE–BRS, above (ABARE, 2010a).

The survey results report the intentions of farmers with respect to the three water reduction scenarios in the in-person interviews but only the first two scenarios in the telephone-based interviews. The telephone survey results (1021 completed surveys) show that under the 20% reduction scenario; 25%, 32%, and 38% of rice, horticulture, and dairy farmers surveyed, respectively, indicated that they would change their farming practices (e.g. adopt dryland farming and less intensive use of water). Under the 40% reduction scenario these percentages changed to 36%, 25%, and 30%, respectively. Between 20% to 30% of farmers surveyed reported that they would exit the industry under the 20% scenario, while 30% of dairy, nearly 40% of horticulture, and 50% of all rice farmers surveyed said they would exit with a 40% cut in water. The study reports that farmers are more likely to exit if they are: middle-aged, highly dependent on irrigation water, experiencing financial stress, and have low feelings of personal wellbeing and optimism. The study also identifies those communities that are reliant on agricultural processing for employment; these regions may require additional community assistance in the transition period.

Commentary

Approach

MJA used the modelling results of three SDL reduction scenarios: 20%, 40% and 60%. They report on the exposure, sensitivity, adaptive capacity, impact mitigation and residual vulnerability of 12 sub-regions. The assessment utilised community profile data and published analysis of the economic impacts (income and employment) of irrigation water reduction from ABARE, ABS, and BRS. In addition MJA conducted 250 in-person interviews with irrigators and their suppliers plus with local and community leaders. A larger group of farmers was surveyed by telephone. From a group of 1500, 1021 surveys were completed. The surveys provide data to: determine sensitivity to resource change, characterise socioeconomic profiles in the Basin, and also measure personal wellbeing and community values.

Overall assessment on the study's conclusions

The study is not an economic study per se; rather it is socioeconomic assessment of the Basin community. Consideration of socioeconomic challenges in the design and implementation of the Basin Plan may ease structural adjustment and mistrust. The report recommends measures to reduce the impacts of the SDLs on communities by: reducing exposure and sensitivity, strengthening adaptive capacity, provisioning communities with structural adjustment programs, and addressing residual vulnerability. Some specific recommendations are to: sequence implementation, provide compensation, secure environmental water from those tributaries where socioeconomic costs are lower, invest in non-water options to improve the resilience of ecological assets, and manage a wider portfolio of water to meet environmental water requirements, such as shorter-term leases and option contracts. The report agrees with the Productivity Commission's recommendations that actions be taken at the state and federal levels to reduce barriers and transaction costs to water trades. The report stresses the importance of rolling out policies on buybacks and any structural adjustment programs in tandem with the Basin Plan to allay affected communities and therefore smooth implementation. In addition they suggest thoughtful management of the dissemination of information on the entirety of the Basin Plan and connected policies.

1.4 Jackson, Moggridge and Robinson (2010)

The MDBA commissioned CSIRO to undertake a scoping study on the impact of SDLs on Indigenous people in the Basin. The background for this report is that national water policy initiatives should give regard to Indigenous issues (National Water Initiative, 2004). The *Water Act 2007* requires the MDBA, to 'maximise the net economic returns to the Australian community from the use and management of the Basin water resources' (*Water Act 2007*, s. 3(d)(iii)). Furthermore, in developing the Basin Plan, the MDBA has to have 'regard to the following ... social, cultural, Indigenous and other public benefit issues' (*Water Act 2007*, s. 21 ss. 4(c)(v)). Note that the *Water Act 2007* does not incorporate concrete requirements for water volumes specifically allocated to Indigenous nations. It also does not require the MDBA to consult with Indigenous nations (*Water Act 2007*, s. 42 ss. 1) though it can (*ibid* s. 42 ss. 3). In 2006 a Memorandum of Understanding was signed between a confederation of Indigenous nations (the Murray Lower Darling Rivers Indigenous Nations) and the predecessor to the MDBA.

Synopsis

Jackson et al. (2010) provide a literature review on Indigenous socioeconomic status and demographics, water rights, uses and values, and engagement in the Basin Plan process. In order to identify the potential impacts from the setting of SDLs they draw on three case studies, none of which is in SA, that catalogue Indigenous access to water, water management, and the spectrum of inter-connected Indigenous water values. These case studies also provide information on data gaps and a future research agenda. The report is not an economics report but it does provide a framework for incorporating Indigenous water values in a full socioeconomic analysis. The authors propose that Indigenous communities have a role in co-managing environmental flows for the dual purpose of enhancing environmental *and* Indigenous values.

Commentary

Approach

Jackson et al. (2010) undertook a literature review and surveyed three Indigenous communities to: catalogue Indigenous water access and involvement in the Basin Plan process; identify interconnected Indigenous water uses, values, and priorities; illuminate probable impacts, both negative and positive, of SDLs on Indigenous people; highlight data inadequacies; and frame a future research agenda. The description and cataloguing of Indigenous water use is a necessary first step in describing 'the uses to which the Basin water resources are put (including by Indigenous people)' which is mandated in the *Water Act 2007* (s. 22 ss. 1(b)). It is also an essential step in incorporating Indigenous values in a full socioeconomic analysis of the Basin Plan.

Overall assessment on the study's conclusions

The authors do not provide a definitive answer on how reduced diversions will impact Indigenous communities. As a scoping study it provides a roadmap for cataloguing and accounting for Indigenous water rights and water values in a full socioeconomic analysis of the Basin Plan. Utilising a review of relevant literature and case study information the authors identifies data limitations and the diverse range of Indigenous water values. The authors provide insights into how SDLs might positively (increased environmental flows watering culturally-important sites) and negatively (reduced commercial/agricultural water entitlements) impact Indigenous livelihoods. The *Water Act 2007* requires the Basin Plan to have regard for Indigenous issues and the authors provide a proposal for fine-tuning the Basin Plan to increase Indigenous benefits. They propose that Indigenous communities have a role in co-managing environmental flows for the dual purpose of enhancing environmental and Indigenous values.

2 Synthesis reports

2.1 BDA Group, Grafton and McGlennon (2010)

Synopsis

The report identifies and provides a synthesis of more than 100 social and economic studies in the Murray-Darling Basin since 2000 for the MDBA. The executive summary provides a series of key research highlights on water buybacks, reduced water availability, water market reforms, valuation work and integration studies. Geographically, the majority of studies of water use focus on the lower connected Murray. This is attributed in part to the significance of these regions but also due to the broader policy questions arising with the greater regulation of flows and allocations compared to the northern catchments. The accumulated literature focuses on surface flows and allocations from rivers and storages, with little attention to the use of groundwater resources.

The principal questions evaluated in the hydro-economic studies identified include ‘the effects weather and/or climate-related reductions on returns in irrigated agriculture and water quality (salinity); the effects of different environmental flow regimes (including reduced water diversions) and government 'buyback' programs on returns in irrigated agriculture and water quality (salinity); and, the effects of water trade, restrictions on water trade, and water pricing reforms on returns in irrigated agriculture and water quality (salinity)’.

Commentary

The report provides a good listing of the existing studies from 2000 to March 2010. The report highlights that ‘no existing model or suite of models is capable of meeting all likely expectations, ongoing liaison with service providers will be critical to ensure only realistic model development is attempted in the available time and that the modelling effort is targeted to shed the maximum light possible on the policy issues at hand’. The report recommended that the non-market values associated with the Basin’s key assets be assembled, using either benefit transfer or primary data collection. This recommendation led to the commissioning of the Morrison and Hatton MacDonald (2010) report.

Overall assessment

It is a thorough literature review and provides an overview of economic techniques in the first 50 pages.

2.2 Productivity Commission (2010)

The Productivity Commission (2010) reviewed a number of key studies designed to estimate the impacts of water buybacks on MDB regions. As a review study it is not assessed further but the key points from the report are summarised here:

- Studies suggest impacts are unlikely to be large at the Basin level.
- Real consumption may increase in the most southern MDB regions and therefore implies a net gain to these communities, though the assumption that buyback participants will continue farming may bias results.
- Irrigators are paid for the water they sell which leads to an increase in real consumption. Without compensation, the effect is negative; with payment, the effect may be positive or negative and depends to a degree on the whether or not the compensation payment is spent in region.
- Some towns may experience larger reductions in GRP than others (Productivity Commission, 2010, p. 333).

2.3 Banerjee and Connor (2010)

Synopsis

Banerjee and Connor (2010) conducted a literature review on the water buyback experience and modelling that was conducted to inform expectations on the impacts of proposed SDL. To summarise we quote their findings:

- 'At the national level, compensation for reduced reliability of entitlement could be expected to increase spending in the Murray-Darling Basin (MDB) region but displace other public expenditure; the net impact would be equal to the forgone agricultural production and other consumptive use values of production, less the values of ecosystem services resulting from improved environmental water flows.
- Assessments of the impacts of water buybacks concluded that all if compensation payments were spent locally, consumption impacts from revenues earned by water entitlements sold would exceed consumption impacts that would have resulted from less irrigation in the Basin.
- At a micro-level, some smaller towns and communities may be adversely impacted; and assets from some up- and down-stream industries would be left stranded.
- Assessments of reduced irrigation water economic impacts concluded that some redeployment of farm resources such as labour and machinery from irrigated to dryland agriculture can be expected and that this should offset some of the economic impacts of reduced regional irrigation activity.
- Evaluations of long-run demographic trends suggest that, in the long run, Basin Plan regional economic impacts will be small compared to the combined economic impact of other regional economy drivers such as technological innovation, demographics, commodity prices, weather and climate.
- Smaller towns or sectors are likely to experience a more significant adjustment to reduced water.
- Drivers that may either offset or exacerbate the impacts of reduced allocations, include: (a) commodity prices – high commodity prices would tend to compensate for reduced production resulting from less water while low commodity prices would tend to exacerbate the impacts, and (b) weather and climate – if the enactment of the plan coincides with a period of high rainfall, impacts would obviously be somewhat offset, whereas if enactment coincides with a period of low rainfall, adverse impacts would be more severe.'

Commentary

Banerjee and Connor's (2010) review provided an analysis of all previously mentioned studies with the exception of Dixon et al. (2010a) which was unpublished at the time. In addition, they reviewed some qualitative analysis of community and farmer socioeconomic profiles.

3 Irrigation and economic impact

3.1 Frontier Economics (2010)

Synopsis

This report assesses the relative importance of water availability, water policy and non-water related factors in influencing the process of adjustment in the Basin. There is no attempt to forecast the impacts of the Basin Plan as it and the SDLs were not available at the time of writing. Structural change is the ongoing process of change in the relative size of industries, in the characteristics of the workforce, and in the size and mix of activities within regions. It is the aggregate response of the numerous individual adjustment decisions influenced by market, social, environmental and technological factors, as well as government policy. Adjustment and structural change drives national productivity and innovation. Frontier Economics says the debate about adjustment often arises in situations where the benefits and costs of change are unevenly distributed. Attempts by governments to slow down or defer adjustment can distort the process of change and reduce the related benefits. Irrigation has been evolving over time with cost-price squeeze, farm consolidation, debt, domestic and international markets changing. This change will continue with or without water scarcity or policy reform. There are strategies to help irrigators manage risk with clear information, trading rules, volumetric restrictions, as well as the timing of the adjustments. Adjustment pressures by irrigation crop type across the Basin are outlined. For SA, the report suggests that small block horticulture in Victorian Sunraysia and the SA Riverland are going to be under pressure with many staying in business due to their off-farm income. Adjustment may be hindered by landuse planning from irrigation to semi-urban landuse. Further downsizing of total production within the Basin may be required to address the current conditions of over-supply and very low prices. Change could be expected to occur over the next 5 years regardless of changes in water availability.

Commentary

Approach

This is a descriptive economic analysis that focuses on the main irrigated agricultural crops in the Basin (dairy, rice, wine grapes, cotton, horticulture). As part of the plain language discussion, the market for each irrigated commodity is discussed in terms of the relevant structural adjustment factors including the dependence on international markets, price volatility and productivity gains. No primary data collection or modelling is undertaken. The data and graphs are compiled from a variety of third party reports and sources such as ABS.

Assumptions

- Economic efficiency should be a primary consideration to governments.
- Water should be re-allocated up to a point where the marginal benefit to the environment is equal to the marginal cost to irrigators.

Concordance with economic principles

- In line with any undergraduate textbook on regional economics and agricultural economics.

Overall assessment on the study's conclusions

Frontier Economics has provided a very readable report about structural adjustment as an on-going process.

- Individual irrigators have found ways of managing drought. The water market has been critical in helping different industries survive. Off-farm income has been essential.

The report is clear in terms of the types of policies which can hinder economically efficient structural adjustment. During this period of change driven by market conditions and drought, water market barriers, particularly the Victorian 4% annual limit on inter-district trade in entitlements, have distorted the water market, constrained the buyback program, and added additional uncertainty for irrigators as they make these tough financial and personal decisions. Further, when water policy is unclear or not effectively communicated, irrigators are likely to make uninformed and inefficient adjustment decisions.

3.2 Wentworth Group of Concerned Scientists (2010)

Synopsis

The Wentworth Group (2010) report provides insights into the options available to the MDBA to achieve reduced SDLs. The purpose of the document is to influence the policy debate about how best to obtain environmental water. They utilise modelling results from a combined economic and hydrologic model. The Basin is modelled as 18 catchments. The results of their analysis are that reductions in SDLs, in most catchments, are less than 10%, except for the Murray and Murrumbidgee catchments where reductions are 39% and 65% respectively. These cuts in agricultural water translate into reductions in irrigator profit of 12% and 26%, in these two catchments respectively. Irrigator profit reductions in all other basins are 2% or less. Total irrigator profits are estimated to decline $2.7 billion over a 50-year time horizon.

Using their modelling output and current MDB budget allocations of $8.9 B, the authors propose three alternative programs for purchasing environmental water. The three options are: the status quo; a blended approach; and new approach that employs a reverse auction and a community development program. The first option does not secure the 4400 GL reduction in SDLs required; it secures just 2910 GL exhausting the $8.9 billion program fund (at $ 3058/ML). This is largely a result of the high cost of incremental water secured from irrigation efficiency (see *Assumptions*). The authors note that the long timeframe of these programs might not be in concordance with the environment's watering needs. Option 2 is more cost-effective securing the 4400 GL at a total cost of $8.5 billion (at $ 1932/ML). This option also incorporates an accelerated expenditure of program funds. $400 million is available for infrastructure investment or transitional payments. The third option assumes willing irrigators would sell their water for a 'reasonable return' – equivalent to the net value of lost profit, $2.7 billion – and that 3200 GL could be purchased (at $886/ML). Note that this value per ML is far below market prices. Program savings ($5 billion) could be utilised to off-set third-party impacts and for transitional assistance. The authors note that the expenditure of these funds would require new or adapted governance mechanisms between federal and state agencies to ensure socioeconomic objectives are attained.

Commentary

Approach

The report begins with the scientific basis for SDLs and the assumption that two-thirds of natural flow is required to maintain a healthy riverine and estuarine ecosystem. Achieving this would require CDLs to be reduced by 4400 GL. Note that this reduction is higher than the modelling reported in ABARE–BRS (2010a) and close to the 40% cut modelled by MJA (2010a). Because approximately 1200 GL has already been acquired for the environment in previous programs, they model incremental reductions of 3200 GL, an approximate 30% cut from the long-term Cap equivalent (LTCE). Next they utilise a combined economic and hydrologic model that divides the Basin into 18 catchments. From this they calculate the profit per ML of consumptive water in agriculture. They then use these results to choose the most cost-effective water entitlements to extinguish in each catchment to meet the overall target. Results are presented in terms of cuts to diversions and irrigator profit, by catchment. The authors use their data to evaluate the cost-effectiveness of three options to achieving reductions in SDLs: (1) extend current entitlement buyback ($3.1 billion fund) and irrigation investment programs ($5.8 billion fund); (2) combine current programs into a single program and purchase environmental water based on lowest costs and an environmental benefits index; and (3) combine current programs into a single program but purchase water on a more local basis paying a 'reasonable return' for lost or eroded entitlements and compensating third-party impacts to ease structural adjustment. The report ends with recommendations on how best to secure water for the environment.

Assumptions and limitations

- SDL reduction of 4400 GL from LTCE.
- Water preferentially taken out of least productive activities first.
- Model does respect hydrologic properties of the river system and ensures that flows are two-thirds of pre-development flows at the end of each tributary and at the Murray Mouth, and that the water requirements of important environmental assets in the upper Murray system are met.
- 2000–01 data used.
- No substitutability of other inputs for water: underestimates the capacity of irrigators to use less water.
- No water trade modelled: over-estimates lost irrigator net profits.
- Buybacks modelled to cost $2283/ML and irrigation efficiency to cost between $4600/ML and $11,400/ML. These assumptions drive their analysis: Options 2 and 3 only purchase water; funds remaining are put towards infrastructure investment or other transition payments.
- No consideration of temporary water leases, water options, or other non-permanent opportunities for obtaining water.

Concordance with economic principles

The modelling looks at the impact of reduced SDLs on the irrigated agricultural community only. The impact of buybacks or transitional payments are not modelled. It does not address the benefits of environmental water. No substitutability of other inputs for water: underestimates the capacity of irrigators to use less water. The model omits irrigator adaptation decisions from the model, i.e. dry land farming and intraregional and interregional trade in water which means that irrigator lost profits are likely overstated.

Reliability and representativeness

It is hard to compare the results to the ABARE–BRS (2010a) report because of the different assumptions used: the base years are different; number of catchments differ; water trade allowed/not allowed; dry land farming allowed/not allowed.

Accuracy of data

We have no issues with the data sources used.

Overall assessment on the study's conclusions

The report is intended to add to the policy debate on the most cost-effective mechanisms to obtain environmental water. The options considered are reasonable but Option 3 provides an absolute efficiency alternative, or a benchmark against which to compare the eventual preferred option; it is highly unlikely water can be purchased below $1000/ML. There are some issues with the model assumptions but the overall study conclusion that there are alternatives to achieving the set aims is a helpful addition to dialogue on the MDB Basin Plan. We would like a little more discussion about the environmental benefits of their plan as compared to the stated ecological aims behind the SDLs. The authors note that the reductions in SDLs that they model are different from the environmental water required to return environmental flows to two-thirds of their predevelopment levels. The model essentially reduces SDLs more in the Murray than its tributaries because of differences in agricultural productivity per unit of water modelled. This is somewhat of a concern because the lost profit estimates may be overstated because the model omits irrigator adaptation decisions from the model, i.e. dry land farming and intraregional and interregional trade in water.

Key implications for South Australia

This study by only focusing on net returns in irrigated agricultural concludes that very large reductions in SDLs are economically appropriate in the Lower Murray catchment. However, the data is not at a fine enough geographical scale to make these broad conclusions. The cost-benefit calculation would be different if the model incorporated ecological and ecosystem service benefits in a full socioeconomic cost benefit analysis.

3.3 Dairy Australia (2009)

Synopsis

The study acknowledges that the most recent drought has forced major structural change in the Lower Murray-Darling dairy industry. In the period 2001–02 to 2008–09, milk production declined by 30%. In response to reduced water allocations dairy farmers have adapted by adopting more flexible farming systems, particularly with respect to forage and feeding. There has been a shift away from perennial pastures and towards annual crops and pastures and lucerne. Other farmers purchased feed. These shifts and other changes to farm management, including investment in water use efficiency, have required capital investment. Total farm debt in the region in this sector increased by 41% in the period 1999–2000 through 2007–08. Nevertheless, in this same period, the regional sector as a whole returned an average rate of return on assets of 6% with the top quartile of dairy farmers in the Lower Murray-Darling performing significantly better.

Survey data reveals that almost half of the dairy farmers surveyed reported that they had plans to upgrade on-farm irrigation systems (improving farm layout, automation and irrigation technology) in the next two years. This is the continuation of an adaption trend: the application of irrigation water declined by 17% from 4.2 ML/ha in 2000–01 to 3.5 ML/ha in 2005–06 – however, at least a portion of this reduction might be explained by reduced water allocations. Parallel to increased on-farm efficiency gains, dairy farmers are active participants in the water market with almost a third participating in temporary water trading in 2006–07. In this same year, 3% of dairy farmers traded permanent entitlements. Other water flexibility mechanisms were also deployed by dairy farmers in the Lower Murray-Darling; in 2009 two-thirds of dairy farmers carried over water.

The dairy processing industry has undergone adjustment in response to reduced regional milk production. This sector has: invested in new product mixes and manufacturing processes; imported raw milk or intermediate products; and decommissioned some infrastructure.

Looking toward the future, the report evaluates three water availability scenarios that represent different levels of climate change. All three scenarios factor in environmental water, urban uses, water trade, and two competing agriculture sectors – mixed farming and horticulture. It is concluded that even in the worst-case scenario, dairy farming will remain viable in the Lower Murray-Darling. This assumes that dairy farmers continue to modernise the irrigation distribution system and undertake other adaptation measures such as buying in feed.

Commentary

Approach

The report brings together recent literature and relevant stakeholder input. Modelling results from Monash University's Centre of Policy Studies and Fresh Logic are also presented. The report depicts the Lower Murray Darling dairy industry's adaptation and restructuring response to the most recent drought. Three water supply availability scenarios are evaluated for their impacts on dairy farmers in the Goulburn-Murray Irrigation District, namely – the historic repeats, medium climate change, and the 2000s drought repeated.

Assumptions

The report assumes that dairy farmers will continue to adapt to changes in water availability with investments in water efficiency on-farm and at the irrigation distribution system level as well as in other measures, such as forage purchases. An implicit assumption is that there are still significant irrigation efficiencies to be had.

Concordance with economic principles and compatibility with other economic studies

The adaptive capacity of the dairy farmers is supported by survey results from Marsden Jacobs and Associates (MJA, 2010a). However, the specific socioeconomic profile of the SA River Murray below Lock 1 (MJA, 2010c) paints a different picture, suggesting that dairy farmers in Lower Lakes have limited opportunities to adapt. The Dairy Australia report does not provide sub-regional assessment though the authors clearly state that 'each dairy farm business in the Lower Murray-Darling is unique' (p12). Each farmer has different goals, skills, risk preferences and farm resources.

Reliability and representativeness

The report presents facts and data. Without knowing the actual adaptive capacity or the relative costs of adaptation it is difficult to judge whether or not the outcomes for the three climate change scenarios are representative.

Accuracy of data

The data used are factual.

Overall assessment on the study's conclusions

The report provides an in-depth look into adaptive responses in the LMD dairy industry during the recent drought as such it is invaluable to assessing how farmers actually respond to reduced water availability. The report identifies high adaptive capacity in this sector. The survey results from other work support this conclusion (MJA, 2010a). However, there are farmers who are doing less well and this is also supported by the socioeconomic profiling of the Lower Lakes dairy industry (MJA, 2010c).

Key implications for South Australia

The study highlights that the Lower Murray-Darling dairy industry has adapted to the current drought and has the capacity to remain viable going forward. Dairy Australia makes a plea for certainty in water policy and for further reforms to water markets to ensure transparent, flexible, and less costly trading. They also make recommendations for implementing more cost-effective pricing of water under a future buyback program or other voluntary programs, specifically one that takes into account irrigation distribution system efficiencies and conveyance losses. It is argued that this would encourage greater coordination between any buyback and irrigation efficiency programs as well as reinforce market signals to encourage less efficient irrigation areas to either adapt or sell entitlements.

4 Regional economy and structural adjustment

Economy-wide and employment impacts of SDLs have been assessed in the literature primarily using Computable General Equilibrium (CGE) modelling. Both ABARE and Monash University's Centre of Policy Studies (CoPS) have undertaken such analysis using models developed in-house. In this section, the results of these analyses are briefly presented and their respective models and model results are compared and contrasted. The section concludes with a discussion of the implications of these results for SA and recommendations for the MDBA.

4.1 Hone, Foster, Hafi, Goesch, Sanders and Dyack (2010)

Synopsis

Hone et al. (2010) applied the Water Trade Model and AusRegion in a similar fashion as ABARE–BRS (2010a) described above. The authors evaluated a scenario where the Government spent $1.5 billion in an environmental water purchase assuming the price to be paid was similar to that of the 2007–08 tender valued at $2300/ ML. This translated to 6% of surface water entitlements in the Basin and an average of 630 GL in long-term cap equivalents (Hone et al., 2010, p. 1). This analysis estimated a 2.4% decline in the gross value of irrigated agricultural production (GVIAP). Regional effects varied with horticulture-intensive regions experiencing smaller declines in GVIAP compared to broadacre regions upstream. They report that: ' … the broader economic effects of the buyback will be almost indistinguishable at the national level (less than 0.01% of gross domestic product), and 0.1% or less of gross regional product (GRP) for five of the seven aggregated regions in the Basin' (p. 3). For the South Australian portion of the Murray-Darling Basin, the decline in GRP amounted to 0.33%.

Commentary

The CGE model used, AusRegion does not explicitly model a water sector nor does it account for distinct irrigated agricultural and non-irrigated agricultural sectors. Capital is treated as sector-specific which may underplay the role farm resource reallocation may have in economic adjustment in the medium to long term. The environmental benefits associated with SDLs and increased environmental flows are not considered.

4.2 Centre of Policy Studies: Dixon, Rimmer and Wittwer (2010a and 2010b)

Dixon et al. (2010a) developed and applied the dynamic CGE TERM-H2O model to evaluate the impact of a government buyback of water from irrigators in the Southern Murray-Darling Basin (SMDB). The scenario analysed is a Commonwealth water buyback of SMDB permanent water rights to an annual allocation of 187.5 GL in 2009 and another 187.5 GL in 2010 for a total of 1500 GL by 2016. Over the period this amounted to a reduction in consumptive water of almost 23%. The authors estimated that the buyback would result in increased economic activity and in the price of water with little effect on farm output. At the end of the simulation period, the reduction in GDP amounts to 0.0059% (Dixon et al., 2010a, p. 12) or alternatively put, 17 hours of economic growth (Dixon et al., 2010, p. 28). By the end of the simulation period, farm output declined by 1.3% for the SMDB and by 1.1% for the Murray Lands. Household consumption for the SMDB increased by 0.34% and 0.39% for the SMDB and Murray Lands, respectively (Dixon et al., 2010a, p. 15).

In an earlier application of the TERM-H2O framework, researchers at Monash University took on the question of whether spending of income from water buybacks could produce regional benefits large enough to offset losses from irrigation-sector income spending (Dixon et al., 2010b). The model simulated the purchase of 187.5 GL per year over an eight-year period for a total of 1500 GL. The study examined two opposite extremes – all compensation money spent inside and all spent outside the region. It found that when all compensation monies were spent inside the region, increased overall consumption more than offset losses from forgone irrigated agriculture sector spending. For example, in the Central

Murray region, a gain of 1% in aggregate consumption was estimated from 2009 and 2018 when compensation was spent inside the region; when compensation was spent outside the region, aggregate regional consumption was estimated to drop by 1.5% (Dixon et al., 2010b, p. 28). Employment impacts for the southern Basin as a whole varied between approximately 0.025% and 0.2%; the impact for the SA Murray Lands was close to 0.13% (Dixon et al., 2010b, p. 25).

4.3 Judith Stubbs and Associates (2010)

Judith Stubbs and Associates assess the socioeconomic impacts of reductions in irrigation water on employment and other socioeconomic indicators. This work predicted a loss of 6000, 14,000 and 28,000 jobs for a 10%, 25% and 50% reduction in water allocations respectively for an annual cost of lost productivity of $0.6 billion, $1.4 billion and $2.7 billion respectively. These estimates were made assuming reductions in irrigation water were equally distributed amongst irrigated uses and in the absence of water trading (Judith Stubbs and Associates, 2010, p. 64). The Stubbs report was not adequately referenced and the methodology used to arrive at these figures was not presented. Attempting to discern the grounds upon which Judith Stubbs and Associates based their estimates, a best guess is that a simple linear relationship between GL and employment by agricultural sector was established whereby ' … one GL of water employs around 2.3 people if used for cotton, and around 38.0 people if used for vegetables' (Judith Stubbs and Associates, 2010, p. 18). Since employment effects were estimated in the absence of water trading, results were severely biased and therefore unreliable.

4.4 ABARE–BRS (2010b)

Synopsis

This study (ABARE–BRS, 2010b) was commissioned by the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) as an extension to ABARE–BRS (2010a). As in ABARE–BRS (2010a), the economic impacts of a 3500 GL reduction in water diversions was assessed in a two-stage modelling approach. Differing from ABARE–BRS (2010a), this study employed a dynamic version of AusRegion enabling analysis of the year-on-year effects of policy intervention for the period 2007-09 to 2020-21. In addition, reduced water diversions were evaluated while implementing additional policy responses, namely, the $3.2 billion Water for the Future (WftF) water entitlement purchase program, the $4.4 billion WftF infrastructure investment program, and the purchase of additional water entitlements to address the gap between the targeted 3500 GL reduction in diversions and volumes purchases through the WftF program ABARE–BRS (2010b, p. 1).

Model results estimated that WftF and infrastructure investment would reduce the impacts of reduced diversions on GRP from –1.3% to –0.7%. Employment was estimated to fall by 0.1% at the Basin level and by 0.03% at the national level. Considering the WftF entitlement purchase, the WftF infrastructure investment program and additional gap closing measures to meet the 3500 GL target, employment impacts were offset, leading to an estimated 0.1% increase in employment for the Basin. At the national level, however, there was a net reduction in employment of 0.04% (ABARE–BRS, 2010b, p. 33).

Commentary

In a first scenario, the 3500 GL reduction in water diversions was implemented in the model first in New South Wales, Queensland and South Australia beginning 2014–15 and in Victoria in 2018-19 (ABARE–BRS, 2010b, p. 22). The second scenario considered the 3500 GL reduction, the WftF entitlement purchase, the WftF infrastructure investment program and additional gap closing measures to meet the 3500 GL target. The $3.1 billion in water entitlement purchases were modelled as household transfers and were considered household savings. These purchases were distributed over time according to a time profile supplied by SEWPaC. The annualised interest income (5% rate of interest) from these savings was used to shock household consumption. Investment in irrigation infrastructure amounting to $4.4 B was distributed over a 10-year period and was assumed to result in a water savings of 10%. This infrastructure investment policy was implemented in the CGE model as a shock to the construction and services industries (ABARE–BRS, 2010b, p. 31).

Model assumptions and implications

- The AusRegion model does not explicitly model a water sector nor account for distinct irrigated agricultural and non-irrigated agricultural sectors. This sectoral specification may overlook important substitution effects. For example, grains produced in dry land agriculture may substitute for irrigated pasture in livestock rearing.
- In the data, no distinction was made between irrigated and non-irrigated land. The result is that shifts between the two land types may be obscured.
- Capital was treated as sector-specific in the AusRegion model. Therefore, although results were presented as long-run, modelling capital as sector-specific could underplay the role farm resource reallocation may have in economic adjustment in the medium to long term (ABARE, no date, p. 3-4).
- Household utility was modelled as a constant difference of elasticities functional form where the proportion of additional income (the marginal budget share) spent on a commodity increase for luxury goods as incomes rise.
- The structure of production is nested- non-energy intermediate inputs, primary factor inputs and natural resources were modelled as Leontief functions while the labour and capital composite was modelled with a Constant Elasticity of Substitution (CES).
- Commodity composition followed the Armington assumption where imported goods are imperfect substitutes for domestic ones.

Concordance with economic principles

- As with other CGE models, the AusRegion model is based on the Walrasian equilibrium.

Reliability and representativeness

Magnitudes of effects were small and the accuracy of the model is limited therefore results should be interpreted carefully.

The environmental benefits associated with SDLs and increased environmental flows were not considered and therefore the costs of reduced water availability were likely over-stated.

Accuracy of the data

- The report uses the best data available.
- Non-resource input-output flows were based on data from CoPS, presumably from the 2001–02 reference-year.
- Data was also generated with input from the ABS 2001-02 Agricultural Survey and ABARE–BRS farm survey data. Government expenditure, tax, demographic and balance of payment data was obtained from ABS.
- This application of AusRegion used land, labour, capital and natural resources to produce 31 commodities, 16 of which were agricultural commodities. In addition to commodities, the model represented households, state and federal governments, a finance sector and a foreign exchange market.

Overall assessment on the study's conclusions

- The results of ABARE's analysis are concordant with what economic theory might suggest, though there are a number of concerns that require further information and analysis:
    - It is not clear what price was paid for the water under the WftF program and how the acquisition of environmental water and infrastructure investment was spatially distributed.
    - The WftF program in the model was introduced as transfers to households where transfers were considered household savings. Annualised interest incomes from these savings were used as positive shocks to household consumption. From the documentation of the model methodology and results, the implications of introducing the policy shock in this way are unclear.

- The difference between the volume of water acquired through the WftF program and the 3500 GL target was not made explicit.
- Implementation of various simultaneous shocks does not enable evaluation of the economic response of individual policy interventions.

5 Environmental values

5.1 Hatton MacDonald, Morrison, Rose and Boyle (in press)

Synopsis

To support decision-making on the management of the River Murray and Coorong, a survey was designed to elicit willingness to pay for improvements in environmental quality. Over 3000 Australians responded to this survey. The study focuses on key River Murray environmental quality indicators: the frequency of bird breeding along the River Murray, increasing native fish populations in the River Murray, increasing the area of healthy vegetation along the River Murray, and restoring water bird habitat in the Coorong. State/Territory models were jointly estimated using a panel multinomial logit error-components model. Willingness to pay estimates for improvements in environmental quality were calculated for the River Murray and the Coorong. Respondents were found to be willing to pay most for the Coorong and to improve waterbird breeding frequency. Respondents from the Australian Capital Territory were found to have significantly higher willingness to pay whereas those in Victoria had a significantly lower willingness to pay than respondents in other states. Using slightly different assumptions than Morrison and Hatton MacDonald (2010) above, total willingness to pay for improving the Coorong is $3.8 billion. Total willingness to pay to increase the frequency of waterbird breeding from every ten years to every four years, to increase native fish populations from 30% to 50% of original levels, to increase the area of healthy native vegetation from 50% to 70% and to improve waterbird habitat quality in the Coorong is equal to $8.5 billion using a 28% discount rate.

Commentary

This study is relevant for South Australia. The study was funded by CSIRO but the MDBA was aware of the study and the paper has been supplied to the Centre for International Economics for the benefit-cost analysis being undertaken for the MDBA.

Approach

Choice modelling survey via mail-out to a geographically stratified sample across Australia.

Assumptions

- aggregation of values assumes that 30% of non-respondents have values the same as respondents.
- Aggregation of values assumes a 28% discount on 10-year cost to households but presents 5 and 15% as well.
- The attributes in the choice experiments are sufficiently independent in the minds of respondents for the trade-offs to occur i.e. water bird breeding along the River Murray, native fish, healthy vegetation and the Coorong.
- Attending to scale as an additive model is appropriate in the econometric model.

Concordance with economic principles

The survey used to elicit values employs the standard techniques to minimise potential bias i.e. employs ‘cheap talk’ to remind respondents of the importance of answering truthfully to reduce the potential for hypothetical bias. Further, the authors remind respondents that these improvements will cost money and to take this seriously. Respondents are quizzed about the information in the survey to see if they have read the information. Respondent to treat each set as independent.

Overall assessment on the study's conclusions

The study presents demographically weighted multinomial panel error-component estimates of the willingness to pay of South Australians and other States/Territories from primary data collected by CSIRO. Values can be used in cost-benefit analysis of River Murray and Coorong. Values should not be used for minor rivers or wetlands outside the southern connected River Murray system.

6 Social survey-based vulnerability assessments

6.1 Marsden Jacob Associates (2010c)

The very real concerns of socioeconomic dislocation resulting from reductions in irrigation water in the Basin is reflected in the fact that half of the reports commissioned by the MDBA that underpin the plan focus on socioeconomic vulnerability and assessments, see Report 3 for detailed analysis of ABARE–BRS (2010a), Marsden Jacob Associates (MJA) (2010a; 2010b), and Jackson et al. (2010). Here we present a companion report to MJA's synthesis report (2010a) that specifically profiles SA irrigation and irrigation dependent industries and communities below Lock 1.

Synopsis

Concern about the health of the Lakes, the Coorong and the Murray Mouth prompted the federal government to announce a $21 million 'early works package' of emergency measures to triage ecologically significant ecosystems. This report provides commentary on some of the adaptive responses of irrigators and communities to the most recent drought. In the period 2005-06 to 2009-10 irrigator allocations were 54% of the historical average. In 2008–09 allocations were just 18% and many irrigators were challenged to access river water or river water of acceptable quality. The report makes assessments about those sectors that likely can adapt to permanent reductions in water availability. It also identifies key industries and communities that are likely to benefit from higher water volumes and water levels in the Lower Murray, the Lower Lakes, Coorong and Murray Mouth.

Commentary

Approach

The study reports on drought impacts to, and adaptive responses in, six sectors: (1) horticulture below Lock 1; (2) dairy in the reclaimed Murray Swamps; (3) dairy in the Lower Lakes; (4) viticulture at Langhorne and Currency Creeks; (5) other water-dependent sectors, namely boating, tourism and commercial fishing; and (6) rural water supply. These adaptive responses provide insights into the capacity of these same irrigated sectors to respond to permanent cuts in water diversions, and additionally, into some of the likely benefits accruing from higher flows and water levels.

Assumptions

The study provides commentary on the likely responses by the irrigated sector to three scenarios: a 20%, 40% and 60% permanent cut in diversions. For the 20% cut scenario, they assume high adaptive capacity across most sectors, with dairy in the Lower Lakes providing an exception.

Compatibility with other economic studies

This study is geographically specific. The overall conclusion that most water-dependent industries adapted to the drought, and likely have capacity to adapt to permanent cuts in water diversions of 20%, is likely sound. This concords with the conclusions of Frontier Economics (2010; see Section 2.2.3) and Dairy Australia (2009; see Section 2.3.2).

Reliability and representativeness

The report provides detailed information on the socioeconomic profiles of irrigation-dependent communities in the Lower Murray.

Accuracy of data

The report is not an economic analysis but rather an assessment of adaptive capacity. The study would have been more useful from the SA perspective if the declines in employment across irrigated agricultural and regional economy during the drought had been reported; this would be a benchmark against which to assess likely impacts of a permanent reduction in diversions.

Overall assessment on the study's conclusions

The study assumes that a permanent 20% cut in water diversions would be absorbed by the region with little dislocation and that the benefits from higher flows and water levels could be substantial. These conclusions are in concordance with: the adaptive capacity exhibited by the region during the drought; conversely by the level of defensive spending (see Report 3. Appendix B) in response to low flow and water levels and estimates of the value of the environmental benefits of SDLs (see Chapter 3 in 'Socioeconomic science review of the Guide to the proposed Basin Plan' further on in this compilation). However, for their 40% permanent cut in water diversions the study assumes drastic restructuring in irrigated agriculture that is at least somewhat questionable given that this sector adapted, for example by expanding dry land acreage, constructing pipelines, utilising groundwater supplies, and water trading, to much more severe drought conditions in the period 2005-06 through 2009-10.

Key implications for South Australia

The report notes that improvements in water flows and water levels will likely provide significant benefits to the SA community. However, any future reductions in diversions will impact irrigated agriculture – some irrigated agricultural sectors will have the adaptive capacity to absorb future diversion reductions of up to 20%, such as viticulture, and others, such as dairy in the Lower Lakes, will not. Note that Dairy Australia's (2010) conclusions do not necessarily concord with this outlook for Lower Lakes dairy farmers.

7 Other

7.1 Rizza (2010)

The study by Adrian Rizza (2010) on the potential response of the banking industry to the implementation of the Basin Plan is reviewed here.

Synopsis

The report provides an assessment of the likely response of the banking industry to changes in water availability in the Basin. The author is concerned that the banking industry will foreclose on the loans of many irrigators facing reduced water availability. Perceived uncertainty in the size of the SDLs reduction, in the rules and price setting regime for irrigation water buybacks, and the form of any transition payments, are cited as key reasons for banks to reassess their loan exposure in the Basin.

Commentary

Approach

The report provides an assessment on the likely capital market response to the Plan. The author provides information on bank practices, debt holdings, brief case studies of likely impacts in the dairy, rice, horticulture, and cotton sectors as well as to irrigation infrastructure. The report ends with some recommendations to the MDBA, for instance, that information on buybacks and transitional payments are released with the Basin Plan, that bankers are involved in farm efficiency programs, and that the optimal time to release the Basin Plan is at close of business Friday before a long weekend.

Assumptions

- Most irrigators hold large debt holdings and banks will likely foreclose on these loans with the implementation of the Basin Plan. There is no acknowledgement that some irrigators are making profits and likely will continue to after the implementation of the Plan.
- Buyback money would rarely be retained by the entitlement seller because of the large debt ratio of most irrigators. Therefore, little of the buyback money is likely to be available for irrigators and communities to ease structural adjustment.
- Water entitlement sales will reduce productive capacity even with water trading. This assumes that irrigators cannot adapt, for instance by substituting other factors of production for water, investing in irrigation efficiency improvements, or planting less-water intensive crops, etc.
- Irrigation-reliant communities with less than 25,000 people are unlikely to be viable.
- Banks are unlikely to lend to irrigators wishing to restructure their businesses.
- The buyback program is ‘press release issued during an election campaign’ (p. 10) and not a requirement of the *Water Act 2007* (s. 77 and s. 83).

Concordance with economic principles and compatibility with other economic studies

The report is not an economics report it is an assessment of the capital industry’s likely response to the Plan. Many of the assumptions made are discordant with economic principles, for instance, irrigators can and do adapt to changes in water availability, for instance in a drought, and successful irrigators are always likely to find banks willing to provide them with loans to grow or restructure their businesses. The size of a community per se is not a definitive metric of its economic viability. Other assumptions are in opposition to the *Water Act 2007* which mandates the buyback payments.

Reliability and representativeness

This report has been critiqued by many in the financial industry. It is unlikely that banks will foreclose on the entirety of the irrigation sector in the Basin.

Accuracy of data

The report relies on assessment and interviews.

Overall assessment on the study's conclusions

This report caused some concern when released because it raised the spectre that the banking sector would pull out of irrigated agriculture in the Basin. It was soon criticised by financial analysts.

8 Preliminary conclusions

This literature review has provided insight into the information available to the MDBA when it made its decisions on environmental flow requirements. Ecosystem needs were weighed against the potential impacts of reduced water availability to the irrigation sector, the regional economy, local irrigation-dependent communities and Indigenous groups. A number of core studies underpinned the Guide to the proposed Basin Plan (MDBA, 2010a) and the quality of the science and research is generally high (see Report 3 in this compilation). When read together the core studies do form an almost coherent whole. The synthesis report is the Guide to the proposed Basin Plan itself (MDBA, 2010a). There is still much work to be done to assess: whether the SDL scenarios will prove adequate to restore key ecosystem functions and assets; the environmental benefits associated with SDLs; the most cost efficient and effective environmental water plan; the rules governing the Commonwealth Environmental Water Holder; rules and requirements for state environmental water plans; the buyback program; and any transitional programs. These issues are discussed in ‘Socioeconomic science review of the Guide to the proposed Basin Plan’ further on in this compilation.

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Report 2 – Review of the approach to socioeconomic analysis in the Guide to the proposed Basin Plan

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Contents

Introduction

This report has three terms of reference:

- review how the Basin Plan approach relied on interpretation of the *Water Act 2007*
- review and critique the approach to socio-economics in development of sustainable diversion limits (SDLs)
- provide a review of advantages and disadvantages of a benefits-cost analysis (BCA) approach.

Chapter 1 contains an overview of the key requirements of the *Water Act 2007* and the 2004 National Water Initiative relevant to determining the scope of socioeconomic assessment required in the Basin Plan development and implementation process.

Chapter 2 contains our interpretation of the approach to fulfilling the socioeconomic assessment requirements taken by the Murray–Darling Basin Authority (MDBA) as expressed in the Guide to the proposed Basin Plan (MDBA, 2010a).

Chapter 3 contains a review and critique pointing to opportunities to advance and improve socioeconomic science in the future development and implementation of the Basin Plan, the State Water Plans, and in the Parliamentary Enquiry on the Plan socioeconomic impacts.

In this report reference is made to two closely related companion technical reports, which are included in this collation of reports. Much greater detail on the technical aspects of the socioeconomic assessments contracted by the MDBA in the process of the development of the Guide to the proposed Basin Plan is provided in Report 3. A more synoptic review and commentary on the many additional relevant studies documenting various aspects of the socioeconomic impacts of less water is provided in Report 1.

1 Requirements of the *Water Act 2007* and National Water Initiative relevant to socioeconomic assessment

In order to review the socioeconomic assessment for the Guide to the proposed Basin Plan to date, and suggest constructive approaches to progress further assessment, it is useful to consider relevant requirements outlined in the underpinning legislation. One requirement of the *Water Act 2007* is that the Basin Plan development and implementation process have regard for the National Water Initiative (NWI). A review of the NWI standards for government water planning evaluation provides another useful benchmark for review. The relevant *Water Act 2007* and NWI passages are summarised here.

1.1 *Water Act 2007*

The overarching objectives of the *Water Act 2007* are:

- To give effect to international biodiversity agreements (s. 3(b) & s. 20(a))
- To establish and enforce sustainable diversion limits for MDBA surface and groundwater resources (s. 20(b))
- To manage water resources in the basin to protect and restore key ecological assets and biodiversity of the Basin (s. 3(d), s. 20(c))

Within the context of these overarching objectives there are a series of economic objectives including requirements to:

- Use and manage basin water resources in a way that optimises: economic, social and environmental outcomes (s. 3(c), s. 20(d))
- Maximise net economic return to the Australian community from the use and management of Basin water resources (s. 3(d)(iii))
- Achieve efficient and cost effective water management and administrative practice (s. 1 ss. 3(g))
- Improve water security for all uses of Basin water resources (s.3(e))

Section 21(4) outlines what outcomes are to be optimised including:

- Consumptive use and other economic uses of Basin water resources (s. 21 ss. 4(c)(ii))
- Social, cultural, Indigenous and other public benefit issues (s. 21 ss4(v))
- Meeting salinity and water quality objectives (s. 20 (a–b))

Section 21(4) also outlines that socioeconomics analysis for the plan have regard for:

- Act on the basis of the best available scientific knowledge (s. 21 ss. 4(b))
- Have regard for the National Water Initiative (s. 21 ss. 4(c)(i))
- The diversity and variability of Basin water resources and the need for adaptive management (s. 21 ss. 4 (c)(iii)).

Also relevant to what constitutes adequate and appropriate scope of economic analysis are:

- Mandatory items required for Act implementation (Section 22)
    - Identification of risks to Basin water resource availability from: interception, climate change, limits to knowledge (Item 3)
    - Strategies to manage or address the risk identified in item 3 (Item 5)
    - Sustainable diversion limits (Item 6) and transition arrangements (Item 7)
    - An environmental watering plan (Item 9)
    - Rules for water trading (Item 12)
- Provision that water entitlement holders be compensated at market rate for loss of entitlement or erosion of water right reliability as a result of the plan – and a methodology to attribute reliability losses to the plan (Sections 77 and 83).

Water Act 2007 process and timeline

The process and timeline to complete implementation of the Basin Plan (MDBA, 2010a) is by late 2011. This to be followed by the accreditation of water resource plans (MDBA, 2010a, Figure 12.2) whereby:

- States propose surface and groundwater management plans
- the MDBA evaluates these Plans against criteria for accreditation to ensure that they meet mandatory requirements such as environmental flow targets
- the MDBA approves state water resource plans for accreditation and the Minister accredits approved plans for a period of 10 years or
- the MDBA recommends that plans not be accredited. At this point the Minister can overrule this recommendation and accredit the plan or recommend that the MDBA prepare the relevant plan. If MDBA is directed to prepare a water resource plan the Minister can approve this plan or direct the MDBA to revise the plan.

Indicative timing for this process, at the time of this writing is for (MDBA, 2010a: Figure 12.1):

- SA Groundwater Plans to be initiated in 2013 and to be completed by 2014
- most other plans to be initiated in 2014 and completed by 2017
- NSW groundwater plans to be initiated in 2017 and completed in 2019 and
- Victorian surface and groundwater plans to be initiated in 2019 and completed in 2021.

1.2 The National Water Initiative

The Plan is to have regard for the National Water Initiative. Here the most relevant guidance is on the appropriate socioeconomic input to the Basin water plan are requirements for government water resource management and planning to:

- provide adequate opportunity for productive, environmental and other public considerations to be identified and considered in an open and transparent way
- recognise that settling the trade-offs between competing outcomes will involve judgements informed by best available science, socioeconomic analysis and community input
- recognise the need to manage the impacts of assets potentially stranded by trade out of serviced areas and not (to) become an institutional barrier to trade
- adopt the following principles for determining the most effective mix of water recovery measures: (i) consideration of all available options for water recovery, including investment in more efficient infrastructure, purchase of water on the market, investment in more efficient management practices; (ii) assessment of the socio-economic costs and benefits of the most prospective options, including on downstream users, and the implications for wider natural resource management outcomes (e.g. impacts on water quality or salinity); and (iii) selection of measures primarily on the basis of cost effectiveness and with a view to managing socio-economic impacts.

2 Guide to the proposed Basin Plan approach to *Water Act 2007* socioeconomic requirements

The approach to addressing socioeconomic requirements in the Guide to the proposed Basin Plan is outlined in Volume 2, Section 4.3 Social and economic implications of providing additional water to the environment (MDBA, 2010b) and in several places in Guide to the proposed Basin Plan, Volume 1, Chapter 7, Social and economic considerations in reductions in current diversion limits (MDBA, 2010a). In this section we review our understanding of the extent of and approach to socioeconomic assessment as described in *Water Act 2007* enabling legislation and National Water Initiative (NWI) guidance on water planning.

2.1 The socioeconomic assessments undertaken

The Guide (MDBA, 2010b, p. 130) states that:

> Economic models were used to assess impacts at Basin-wide, regional and industry level in terms of the effects on irrigated agricultural production. Social impact assessment methods were used to complement this analysis and to describe in more qualitative terms the potential impacts at industry and local levels.

Six specific studies are listed as the basis for Plan guide socioeconomic assessment:

- ABARE–BRS (2010a) – Economic modelling estimated potential impacts of three reductions to sustainable diversion limits (SDLs) on irrigated agriculture and Gross Regional Product. This study was supported by a similar analysis using competing but conceptually similar models by Monash University's Centre of Policy Studies (Wittwer, 2010) and the University of Queensland (Mallawaarachchi et al., 2010).
- Vulnerability and adaptive capacity at the community level for 12 key regions. This involved community demographic, industry composition profile descriptions (Marsden Jacob Associates, 2010). In addition, interviews were conducted to assess local response to various levels of water allocation reduction.
- ABARE–BRS (2010b) – A demographic analysis to characterise communities in the Basin on the basis of their relative sensitivity, adaptive capacity and vulnerability to reduced irrigation diversions.
- A review of indigenous cultural, social and environmental interests in the Basin's water resources by CSIRO. Jackson, Moggridge and Robinson (2010) provide some qualitative insight into how the Plan might impact Indigenous water interests and how the Plan could be implemented to improve Indigenous outcomes.
- An assessment of possible responses of the financial sector to the Plan (Rizza, 2010).
- A review of existing economic valuation studies of potential environmental benefits of the Plan (Morrison and Hatton MacDonald, 2010).

The fine detail of the findings from these studies is described in more detail in Report 3 of this collation. In short ABARE–BRS (2010a) estimated that the cost of a 3500 GL/year reduction in water available for irrigation at $800 million/year or a 15% decrease in gross value of agricultural product in the Basin. Marsden Jacob Associates (2010) concluded that communities perceived economic viability thresholds. Cuts to water availability of greater than 40% were expected to require major structural changes in both the irrigation and associated processing industries. Economic estimates of benefits associated with enhanced environmental flow are described in Morrison and Hatton MacDonald (2010). However in the Guide (MDBA, 2010a) no attempt is made to quantitatively assess economic value of plan benefits or formally weigh benefits against costs in a full economic benefit cost framework.

Using the information from the commissioned studies summarised above and information characterising potential ecological impacts of various SDL levels, the MDBA concluded that:

> in light of the scale of estimated economic and social implications that may be experienced if current diversion limits were reduced by more than 4,000 GL/y, the MDBA concluded that such a reduction would not meet the requirements of the *Water Act 2007* to optimise outcomes. The focus of the economic modelling was therefore narrowed to reductions in 3,000 to 4,000 GL/y range. (MDBA, 2010b, p. 145).

2.2 The further implementation described in the Guide to the proposed Basin Plan

The Guide foresees many significant details of implementation being worked out in the process of State water plan development and implementation. Essentially, Basin Plan implementation is expressed as being a two-part process with the first stage (essentially what has been done to date) identifying new long-term sustainable diversion limits (SDLs). Going forward from here 'Arrangements will also be needed to incorporate SDLs in water management decisions and optimise the outcomes from water available to the environment'. (MDBA, 2010b, p. 161).

Key steps in this process include:

Environmental Water Management Plan development and implementation

- Basin states will be required to develop strategic environmental watering plans for each surface water planning area and these plans will need to be submitted to the MDBA within 12 months of the Basin Plan being adopted.
- A Basin Environmental Watering Committee will be established and chaired by the Authority. This committee will annually publish a statement of environmental water priorities.
- Environmental water delivery will remain the responsibility of Basin States or river operators at the request of environmental water holders.
- Managers of environmental water will be required to make their decisions about environmental watering having regard for the annual statement of environmental watering priority.

Water Quality and Salinity Management Plan development and implementation

- The Authority will set water quality and salinity objectives, targets and management requirements.
- These will require operating authorities and infrastructure operators and regional NRM authorities (catchment management boards) to comply with certain principles when making flow management decisions.
- Water quality and salinity targets set under the Plan will not impose direct mandatory compliance obligations on government.
- Some water quality targets such as salinity will involve detailed content identified in States water plans requiring accreditation.

Critical Human Needs Water Plan implementation

The *Water Act 2007* states that the Basin Plan needs to take into account critical human water needs (s. 86 ss. 2(a)). The way that Basin water resources are managed potentially impacts water quantity available from the Murray and quality attributes of this water that makes it more or less suitable for human consumption requirements in Australia's urban and rural areas.

Decisions on how water from each state's share is used; which water uses will be treated as 'critical' for specific communities; and how risks associated with the provision of critical human water needs are managed are left to state governments. Critical human needs pose significant implementation challenges.

- 'While the Basin Plan will set out the quantities to meet these critical human needs, and for delivering that water through the river system (conveyance water) .., it will be the responsibilities of each State to meet those needs … It is expected that states will use carryover or reserve arrangements to set aside water for critical human needs to ensure sufficient water is available at the start of each year' (MDBA, 2010a, p.148)

Critical human needs also pose significant governance and coordination challenges to the implementation of the plan. The Schedule for Water Sharing is being co-developed with the Basin Plan and rules regarding governance are not yet fully determined.

- 'The Schedule for Water Sharing is a new schedule to the [Murray Darling Basin] Agreement that is being developed in parallel with the proposed Basin Plan provisions for critical human water needs. This schedule will provide some of the key mechanisms to set aside, deliver and account for the critical human water needs and conveyance reserves'.

- 'If the Basin Plan provisions relating to critical human water needs affect state or Border River water sharing arrangements, the application of those provisions will be limited unless the Ministerial Council has agreed to that they will be given full application' (MDBA, 2010a, p.150).

Conveyance water

The MDBA has determined SA River Murray conveyance requirements as a minimum of 1596 GL/year – 150 GL/year for evaporation and seepage from major storages, 750 GL/year for losses by evaporation and seepage in the River Murray system between major storages and 696 GL/year for dilution and losses between the SA border and Wellington. The Guide to the proposed Basin Plan further states (p. 149) that the MDBA is required (*Water Act 2007* s. 86D) to include a reserves policy and that 'The Authority proposes that conveyance reserve protection will give protection for a potential worst-case scenario of extremely low inflows at times when there is also very little storage. Depending on prior conditions, this is expected to be sufficient to provide for a sequence of at least two dry years'.

2.3 MDBA interpretation of the *Water Act 2007* socioeconomic approach

The MDBA appears to have taken essentially a two-stage approach to Plan development and implementation with regard to optimisations. In a first step, they have:

- Assessed Basin ecological water requirements and ecological outcomes that would be achievable with 3000, 3500, 4000 and 7600 GL/year returned to the environment, managed across flow years consistently with ecological objectives (see Report 3 in this compilation, Appendix A).
- Estimated cost of foregone opportunity to irrigate with this water and made a judgement that sacrificing economic opportunities with diversion reductions greater than 4000 GL/y on a long-run average basis would not be worth the greater potential ecological benefit.
- Made a judgement that sacrificing ecological health as the result of setting long-run SDLs at less than 3000 GL/year would too greatly endanger Basin ecological health.

From the quote below, these judgements appear to have been made as the first step in the process of fulfilling the *Water Act 2007* requirement to optimise social, economic and environmental outcomes.

> 'if current diversion limits were reduced by more than 4000 GL/y, the MDBA concluded that such a reduction would not meet the requirements of the Water Act to optimise outcomes' (MDBA, 2010a, p.161).

In a second step the MDBA envisions further development and implementation to 'incorporate SDLs in water management decisions and optimise the outcomes from water available to the environment.' (MDBA, 2010a, p. 161).

The key mechanisms to realise this appear to be:

- The process of accrediting States' surface and groundwater plans. There are opportunities to set criteria that these plans must meet to be consistent with the MDBA's environmental objective.
- Establishment of a Basin Environmental Watering Committee chaired by the MDBA and the annual publication of a statement of environmental water priorities which environmental water holders will be required to regard in making decisions about environmental water allocation.
- The MDBA setting water quality and salinity objectives, targets and management requirements.
- Developing certain principles that operating authorities, infrastructure operators and regional NRM authorities (catchment management boards) will be required to comply with when making flow management decisions.
- Developing a new Murray-Darling Basin Agreement Schedule for Water Sharing with provisions to set aside, deliver and account for the critical human water needs and conveyance reserves.
- Possibly seeking Ministerial Council agreement for Basin Plan provisions relating to critical human water needs that affect state or Border River water sharing arrangements.
- Developing a conveyance reserves policy and that 'will give protection for a potential worst-case scenario of extremely low inflows at times when there is also very little storage'.

2.4 Critique of the approach

Benefits not sufficiently regarded

The *Water Act 2007* objectives require optimising economic, social and environmental outcomes (s. 3(c), s. 20(d)). To maximise net economic return to the Australian community consideration of benefits accruing to the Australian community is required as well as costs. The requirement that environmental benefits be thoroughly considered is further clarified in the NWI requirement for water planning to include: 'assessment of the socio-economic costs and benefits of the most prospective options, including on downstream users, and the implications for wider natural resource management outcomes (e.g. impacts on water quality or salinity)'.

The main focus of substantive quantitative and interview-based socioeconomic assessments to date for the Basin Plan has been on costs of the plan, in particular the cost to the irrigated agricultural sector from reduced water supply (ABARE–BRS, 2010a; Marsden Jacob Associates, 2010). The rationale for this focus expressed in the Guide to the proposed Basin Plan is that irrigation is the largest single consumptive use of water in the Basin. We agree with the need for substantive quantitative effort to assess this cost and conclude in our more detailed technical review of Socioeconomic Assessment (Report 3 in this compilation) that the assessment of this aspect of cost is generally of high quality (some second order technical issues with this assessment are covered in Recommendation 5 and in Report 3).

Restoring flows to the Basin environment would result in substantive benefits to those who enjoy recreation and aesthetic values associated with a healthy Basin ecosystem (Morrison and Hatton MacDonald, 2010). Additionally, there are significant damage, mitigation and adaptation costs associated with the numerous measures such as infrastructure pumping, treatment, land rehabilitation that could occur in the absence of the Basin Plan (see Report 3, Appendix B). These costs (including to critical human needs, see Report 3, Appendix C) are likely to be particularly high when dealing with very low flows especially during drought, and could be avoided or mitigated through optimal implementation of the SDLs and environmental water plans.

Although there are challenges associated with valuing benefits, well tested methods are available and greater effort to link economic value to improvements in ecosystem health driven by improved river flow is warranted. Such effort may well be justified in review of Stage 1 justification of SDL level setting where more information on costs than on benefits was presented in the Guide (MDBA, 2010a). While ultimately some judgement must be made regarding the level of SDL, the case for the Basin Plan could be more solidly grounded in a benefit cost framework with a stronger assessment of benefits. Such effort can certainly be valuable in the second stage in giving effect to the Basin Plan and should be included to guide efforts in optimising operational implementation. Possibilities to estimate benefits and use these estimates in further plan development and implementation are discussed in the recommendations.

Positive regional income streams from Commonwealth payments ignored

The *Water Act 2007* includes the provision that the Commonwealth government will provide payment for the entitlements sold at the market rate for loss of entitlement (s. 77) or erosion of water right reliability (s. 77 and s. 83) as a result of the Basin Plan. Furthermore, the Commonwealth is committed to continue with market water entitlement purchasing, irrigation infrastructure investment and potentially other transfer payments to affected communities. These actions will generate positive regional income streams possibly of equal or greater value to regional income stream losses from reduced irrigation (Dixon et al., 2009; Banerjee and Connor, 2010). The analyses reported in the Guide (MDBA, 2010a) and ABARE–BRS (2010a) and in Marsden Jacob Associates (2010) do not account for these economic impacts. Ignoring this effect is not in line with economics best practice, and overestimates the adverse regional economic impacts of the plan.

Stochastic nature of inflows not yet considered in socioeconomic assessment

Two mandatory items required for *Water Act 2007* implementation are:

- Identification of risks to Basin water resource availability from: interception, climate change, limits to knowledge (s. 22 ss. 1(3))
- Strategies to manage or address the risk identified (s. 22 ss. 1(5)).

The nature of risks to reliability of water supply for consumptive and environmental uses from factors like climate change and interception and how the Plan would impact water management as these risks evolve will significantly influence socioeconomic impacts of the Plan. Incidences of very low inflows similar to, or worse than, those that occurred in the recent drought could be more frequent under climate change. The costs, if adequate measures to ensure against adverse impacts are not in place, could be very high. On the other hand, highly conservative policies, for example in setting reserves to deal with risk, may have high costs of forgone opportunity to use water consumptively or for the environment.

Truly realising Basin Plan optimisation objectives would require rigorous stochastic risk-based assessment of economic costs and benefits of policy for setting critical humans needs, conveyance and water quality rules. It is not clear from reporting in the Guide, the extent to which any rigorous stochastic assessment of risk has been conducted. There is no indication that an economic analysis to account for potential benefits of the plan in improving water quality and reducing critical human needs water supply risks has been undertaken.

There is also a lack of conceptually correct accounting for variability of water supply and how it might change with developments of climate, interception and other risks in the assessment of irrigation sector impacts. This is acknowledged in the ABARE-BRS (2010a, p. 35) report which recommends accounting for changes in allocation reliability profiles over time in future socioeconomic assessment of irrigation sector impacts. The way that the environmental water holder ultimately operates is likely to influence significantly the time profile of water supply to irrigation. Meaningful assessment of Plan socioeconomic impacts should account for these effects.

Effectiveness will depend on Basin Plan accreditation process

The key outcome of the Guide (MDBA, 2010a) appears to be a determination of a range for the long term average SDL – 3000 to 4000 GL/year (see Report 3, Appendix A). The Guide explains that a great deal of the detail regarding how the plan will actually operate will be determined in the process forward from here. Plans will be developed by the States for strategic environmental watering, water quality and salinity, and critical human needs. The MDBA will provide criteria for the States to regard in developing these plans and have the authority to require revision of plans that do not meet criteria and ultimately the Minister can reject plans that are judged non-compliant and direct the MDBA itself to develop suitable plans in such cases.

The MDBA notes the importance of developing clear criteria, and shared assessment frameworks for States to follow in developing State Plans that together maximise benefits for the Basin as a whole. There is a long way to go from what is published in the Guide to an effective set of criteria for accreditation and a shared platform for developing and coordinating State' Plans. There is a considerable challenge in setting criteria that will lead to optimal outcomes where adaptive response to evolving conditions and coordination amongst States are required.

A shared framework is needed for MDBA, state water planning and Parliamentary enquiry assessments

The Guide does not provide convincing evidence that sufficient integrated modelling capacity exists to allow for development of criteria that will lead to optimisation of social, environmental and economic outcomes of Basin water management. Some particular concerns are:

- the treatment of climate change as an allowance for a fixed 3% reduction in inflow as opposed to any stochastic notion of uncertain future inflow
- requirements that water quality is to be handled by States individually, and to the extent that flow requirements to meet water quality objectives require States cooperation, changes to the Water Act is by consensus.

Given that Basin states will be required to develop strategic environmental watering plans within 12 months of the Basin Plan being adopted, more detailed description of criteria for plan accreditation and shared integrated modelling framework to test Plans would seem to be an urgent need. There is a risk of failing to achieve social, economic and environmental optimisation, absent of a set of criteria and modelling framework that enables a transparent explanation of costs, benefits and trade-offs amongst objectives inherent in choice of criteria and State Plan approaches to meeting criteria.

3 Recommendations for further socioeconomic assessment

The Basin Plan will have far reaching impacts and significant public costs and benefits. Accordingly, a thorough socioeconomic assessment in line with best science and policy practice is desirable to provide transparency and accountability in the determination of Basin Plan implementation trade-offs and net benefits. Here the scope of socioeconomic assessment to date is considered and evaluated against requirements of the *Water Act 2007*, NWI guidelines for water planning and economics best practice guidelines such as the Commonwealth Guidelines on Benefit Cost Analysis (Australian Government, 2007). Our five recommendations follow.

3.1 Recommendation 1 – account for costs and benefits in a formal benefit cost framework

We concur with the conclusion in the Guide that 'additional work is required to have sufficient confidence in the economic value that might be put on environmental health' (MDBA, 2010a, p. 94). As a first step this requires scientific data on the ecological response of freshwater and estuarine ecosystems to marginal changes in the volume, timing and frequency of environmental watering events and changes in inundation, flooding and drying cycles. The States have been developing ecological monitoring practices to bid for The Living Murray and Commonwealth environmental water and that going forward much of this monitoring will provide key scientific data at specific sites and more generally enable the building of conceptual models for effective environmental watering practice.

We further conclude that detailed assessments of the full range of benefits, including Indigenous and cultural values, be described, and where possible quantified, as a feature of future socioeconomic assessments undertaken for the MDBA, State Water Plans and the Parliamentary enquiry. This is necessary given the *Water Act 2007* requirements to optimise environmental, economic, and social outcomes and maximise net benefits in plan implementation. Not doing so would also be inconsistent with NWI guideline recommendations that government water planning should include formal and transparent accounting for environmental benefits. We recognise that economic valuation of environmental benefits is an area of economics that remains challenging (and that little research has sought to estimate cultural values) and that some benefits, such as biodiversity and intrinsic value, will always be difficult to value in monetary terms. Still, there is a well established literature of over 30 years and there are numerous feasible methods and relevant estimates available.

As per the Commonwealth Government best practice guidelines on cost benefit analysis, there are two broad categories of approaches to economic valuation of environmental benefits (see Report 3, Appendix B). Stated preference approaches involve samples of impacted populations being asked about their willingness to pay for environmental improvements. Related market techniques involve inferring how people value the environment through observation of their expenditures in related markets (for example the willingness to pay for recreational and tourism visits, real estate adjacent to healthy environments, and to avoid damages from degraded environments). The Morrison and Hatton MacDonald study (2010) outlines how benefits of the Plan could be inferred from existing stated preference studies with some additional research relating environmental outcomes to flow. In Report 3, Appendix B and in Connor et al. (2011), some of the most promising opportunities to assess benefits with related market approaches are outlined. We recommend that estimation of benefits using both of these approaches – stated preference and revealed preference – be pursued, as estimating benefits using two separate methodologies will strengthen credibility and confidence in estimated values.

We further recommend that inclusion of ecological and externality benefits (including water quality related benefits) of enhanced flow be considered along with costs in a more formal benefit cost framework. The advantage of this approach is that it requires discipline and systematic consideration of all relevant costs and benefits in a way that should lead to more transparency in consideration of trade-offs between environmental and economic outcomes. In particular, a thorough stock-take and evaluation of costs of the 'do nothing' alternative should be completed. This would serve as a baseline against which potential benefits of the Basin Plan can be compared. Ideally this analysis would be completed before proceeding with development of water sharing arrangements.

In such future work we recommend detailed consideration of ecosystems services. An ecosystem service framework can be used to catalogue the goods and services provided by nature, for example a river or a wetland provides water purification services as well as aesthetic benefits. Some ecosystem services can be enhanced through the addition of capital infrastructure up to a critical threshold. This notion may be described as follows: starting with the river in its natural state, the diversion of the first increments of flow produce increased social welfare such as more reliable food supply achieved with irrigation and reduced flood damages with regulating dams with nominal impacts on the functioning of the river ecosystem. However, at some point the cumulative erosion of natural capital (sedimentation, salinity, acid-sulphate soils) resulting from further extraction and regulation (reduced flow and dilution and a changed hydrograph) will be greater than the incremental value of that last unit of flow regulation and extraction: a series of cascading thresholds are reached that put the riverine and estuarine system in a new entropy state with seriously eroded capacity to provide important basic ecosystem services. At this point, ecosystem services are either irreversibly lost or can only be maintained with increasingly expensive and energy intensive built capital. Table 2, in Report 3 provides a comprehensive list of reduced river flow impacts on the ecosystem services of the MDB. If the ecosystem service framework is used, as in any accounting framework, caution must be exercised to avoid double counting ecosystem service benefits.

3.2 Recommendation 2 – incorporate entitlement buybacks, infrastructure investment, and other transfer payments in local economic, regional and socioeconomic analysis

Future local economic impact work should include all negative local economic impacts arising from reduced irrigation activity as well as positive economic impacts that may arise from any local spending of water buyback income, infrastructure investment or other transfers of income. As noted in Report 3 and in Banerjee and Connor (2010), it is important to understand what proportion of income from the water buyback, other forms of infrastructure investment, or structural adjustment, is likely to be spent locally. The follow-on influence on local employment and economic activity are, as a result, not as well understood. More work to identify the types of water payment, investment or adjustment packages that will effectively stimulate regional economic activity and employment should be a priority for future socioeconomic research.

3.3 Recommendation 3 – include stochastic assessment of costs and benefits

The plan will potentially enhance water quality benefits and enhance reliability of water for critical human needs. While these benefits may be ‘collateral’ to the main objectives of the Basin Plan, they should be accounted for in socioeconomic assessment of Basin Plan impacts. To omit accounting for these benefits would be inconsistent with plan requirement to follow best practice and follow NWI guidelines.

We recommend stochastic risk based economic assessment in future development and implementation of Basin Plan details to deal with risks to water quality, critical human water needs and conveyance water and to understand economic implications of various options for environmental water management. This should include:

- stochastic accounting for water inflows, storage, consumptive and environmental water allocations, trade and carryover under alternate climate, interception and other risk scenarios
- economic assessment of costs associated with risks and economic benefits of alternate policies to deal with risks.

3.4 Recommendation 4 – develop a shared integrated modelling framework for MDBA, state water planning and Parliamentary enquiry including a socioeconomic component

The MDBA has not yet been permitted to share the flow, environmental outcome and socioeconomic modelling frameworks used in work presented in the Guide with the States. This appears to be partially because some models used are States' intellectual property and they have chosen not to allow access to all parties to the MDBA agreement. In the case of socioeconomic modelling the challenges with access seem instead to stem from the fact that all analysis to date has been sourced through consulting arrangements that do not include intellectual property sharing allowing the MDBA to share all models. What this means is that in some cases the reliability, accuracy of data, assumptions and functional relationships underpinning analysis cannot be fully scrutinised. Some specific concerns about incomplete documentation and potentially erroneous assumptions in economics models underpinning the plan are discussed in Report 3. Such concerns are an inevitable part of scientific peer review and do not suggest a lack of robust best practice science. Rather the concern is the lack of a process for sharing science in all technical detail in order to allow transparency and shared understanding of the biophysical and socioeconomic basis for decisions.

If States have no opportunity to utilise the models in their own analysis, the result may well be a proliferation of competing models and debate focussed more on modelling differences and less on substantive matters of Basin Plan implementation. Consequently, we believe that realisation of Basin Plan goals could be significantly advanced through a river modelling framework inclusive of ecological responses, economics costs and benefits with licensing arrangements that allow full access and updating by all parties impacted by and participating in the Basin Plan. This approach is best practice and a feature of water planning exercises involving multiple states in basins such as the Colorado River, USA (Garrick et al., 2008; Jerla et al., 2011). At least in the realm of economics and in the opinion of the report authors, making such capacity available on timelines that will be helpful for Plan implementation is feasible.

3.5 Recommendation 5 – review, update and fully document the range of technical parameters for use in future irrigation sector economic and regional economy modelling

A clear outcome of Report 3 is that there is a need to carefully document the technical parameters (such as the elasticity of substitution between inputs, the functional form of cost functions, irrigation efficiencies, and crop yield functions with respect to salinity and water applied) and assumptions used (models allow intra- and inter-regional and inter-temporal water trading/carryovers or not, buybacks included or not, ability to switch to dry land farming included or not) in key models. For instance, the ABARE–BRS Water Trade Model and AusRegion models were used to estimate the income, production, regional and local-economic, and employment impacts of reduced water availability on the irrigation sector and the wider economy, but without specific documentation on each step in the model run, it is challenging to understand the various scenarios presented and to compare the results with competing models. Furthermore, the choice of technical parameters and the assumptions made should conform to current best practice and understanding of crop science, irrigator behaviour and economic principles.

4 Conclusion

The MDBA has a considerable challenge to sustainably manage the resources of the Basin for the benefit of all Australians. The necessity to utilise the best available science and undertake socioeconomic analysis provides a transparent and accountable framework for review of both the process and outcome of Basin Plan development. The Guide to the proposed Basin Plan is a synthesis of a large body of ecological science and economic analysis; it is not a legislative document. There is still much work to be done in the development of the legislative document, the Basin Plan, and the many components integral to it. There are still opportunities to influence how socioeconomic analysis is used to evaluate the Basin Plan, State Water Plans, and in the Parliamentary enquiry. This report identifies some gaps both in knowledge and methodology and provides recommendations for improvement.

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Report 3 – Review of the core socioeconomic studies underpinning the Guide to the proposed Basin Plan

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Introduction

This report, the third in this compilation, focuses on core studies underpinning the Guide to the proposed Basin Plan (MDBA, 2010a). These studies, commissioned by the Murray–Darling Basin Authority (MDBA) are:

- ABARE–BRS (2010a and 2010b) – estimated impacts of Sustainable Diversion Limits (SDLs)
- Dixon et al. (2010a and 2010b) – regional, economy-wide and employment impacts of reduced water allocations
- Morrison and Hatton MacDonald (2010) – non-market environmental benefits
- Marsden Jacob Associates (2010a, 2010b and 2010c) – vulnerability and adaptive capacity at the community level for 12 key regions
- Jackson, Moggridge and Robinson (2010) – indigenous cultural, social and environmental interests in the Basin's water resources.
- Mallawaarachchi (2010) – analysis of the economic impacts of reduced irrigation in the Basin.
- Wittwer (2010) – modelling the regional economic of SDLs using the Monash University's Centre of Policy Studies dynamic regional economic TERM-H2O model.

The report also includes reviews of Judith Stubbs and Associates (2010) and Banerjee and Connor (2010), both of which, although not commissioned by the MDBA, are relevant to the development of the Basin Plan.

For each study we provide a synopsis followed by commentary on the concordance of the studies with economic principles and the degree to which conclusion are supported by analysis. We also provide detailed review and critique of methodologies and data noting where methodological and data improvements could be significantly influence overall conclusions and have significant implications for South Australia. The review is structured as follows:

- the irrigated agricultural sector (Chapter 1)
- economy-wide and employment effects (Chapter 2)
- environmental values (Chapter 3)
- community vulnerability and Indigenous values (Chapter 4).

Some key findings of this analytical report are:

- The overall economic and employment impacts are unlikely to be large.
- While the potential economic costs of reduced water diversions have been considered in detail, the economic benefits of improved environmental flows are under-represented.
- Understanding and incorporating indigenous water values in decision-making is an important and area for further research.
- Significant work remains to be done in establishing the relationship between river flow, environmental outcomes and their associated economic value.
- A deeper treatment of the benefits of sustainable diversion limits and their quantification and inclusion in a benefit cost framework would enable a future Basin Plan to stand on firmer socioeconomic ground.

1 Irrigation-sector economic impact

1.1 ABARE–BRS (2010a)

Synopsis

The *Water Act 2007* mandated the MDBA to 'act on the basis of the best available scientific knowledge and socioeconomic analysis' in developing the Basin Plan (s. 21 ss. 4(b)). In this report ABARE–BRS modelled how sustainable diversion limits (SDLs) might impact irrigated agriculture, the regional economy, and specific industries in the Basin. In so doing, the report identified those sectors and associated communities that were likely to be vulnerable to structural adjustment. The exact SDL reductions were unknown at the time of writing but the MDBA provided three possible reduction scenarios: 3000, 3500 and 4000. All were modelled in terms of reductions from long-term average surface water diversions. For ease of communication the report focused on the results from the 3500 scenario, which represented a 29% reduction in total water use. ABARE–BRS's Water Trade Model (WTM) was utilised to model outcomes for irrigated agricultural industries in 22 sustainable yield regions in the Basin (as well as impacts on non–irrigated agricultural production).

ABARE–BRS' results estimated that the Gross Value of Irrigated Agricultural Production (GVIAP) would decline by 15%, or by approximately $940 million. Irrigator profit was estimated to decline by almost 8%. Adverse impacts were specific to the type of crop, industry and region. The modelling identified broad acre irrigated agricultural as the most severely impacted with an estimated decline in GVIAP of 37% to 49%. Reductions in GVIAP to the sheep industry were estimated at 32%, with estimated declines of 23% and 10% for the cotton and dairy industries respectively. Horticulture, fruits and nuts, grapes and beef cattle experienced estimated reductions of GVIAP of less than 10%. Model results suggested the most severely impacted regions were: Moonie- Queensland (QLD); the Murrumbidgee and Gwydir- New South Wales (NSW); the Goulburn-Broken- Victoria (VIC); and the SA Murray.

ABARE–BRS used irrigation survey data and irrigation farm expenditure data from 2007–08 to identify a list of 88 towns that were highly dependent on expenditures made by irrigated agriculture. Using a composite index of community vulnerability – high dependence on irrigated agricultural industries and limited adaptive capacity – ABARE–BRS identified two regions with high vulnerability: the Border Rivers, Gwydir, Namoi and Macquarie-Castlereagh regions in the north-east and the Lachlan, Murrumbidgee and Murray regions in the south.

Commentary

ABARE–BRS applied its Water Trade Model (WTM) to estimate the socioeconomic impacts of SDLs. WTM's functional relationships were documented in Hafi et al. (2009). ABARE–BRS explored the expected impacts in 22 sustainable yield regions and identified those towns and sub-regions that were most likely to be adversely affected by reductions in both water allocations and irrigation sector expenditures. In the 3500 scenario – a 29% reduction in SDLs across the basin – GVIAP was estimated to decline by 15%, or approximately $940 million. Water was found to trade out of the Murrumbidgee, the Murray NSW and the Ovens, VIC, and into the Goulburn-Broken, Campaspe, Loddon, Murray VIC, Lower Murray-Darling and SA Murray.

Model assumptions and their implications

- The baseline and scenario data utilised long-run average annual diversion levels (10,375 GL).
- At the time of writing the actual SDLs were unknown; uniform percentage reductions in diversions by region for three scenarios were modelled with the WTM. The MDBA modelled changes to the SDLs that vary across regions within the specified ranges of 3000 to 4000 GL. Each of the three scenarios – 3000, 3500 and 4000 – were modelled independently in the WTM.
- Due to the lack of high quality and suitably representative data across the entire Basin, the ABARE–BRS WTM developed a modified dataset from the Australian Bureau of Statistics (ABS) 2000–01 and 2005–06 census. Adjustments were made to the 2005–06 census year for land use, water use and GVIAP to produce a more

representative baseline of long-run water use. The 2005–06 perennial land use areas were combined with 2000–01 annual land use areas to create a baseline land use data set. This was coupled with 2005–06 GVIAP and 2000–01 water use data.

- Comparison with South Australia Murray-Darling Basin Resource Information Centre (SAMRIC) data shows significant divergence between national and local land use data with ABS data reporting much less irrigation and decline in irrigation during the drought years.
- Adjustment to reduced water allocations had already begun by the time the 2005–06 census was undertaken. Some of this adjustment would have been made by irrigated annual and perennial agricultural sectors. It is unlikely that improvements in irrigation efficiencies made by perennial horticulture would be lost in years of higher water allocations. Therefore, 2005–06 GVIAP figures would have been influenced by 2005–06 water use efficiencies rather than those of 2000–01. This raises questions about the representativeness of the water use efficiencies in the model, and hence the likely impacts of reduced water allocations. Assuming less than actual water use efficiency (or than that observed water use per hectare) may have resulted in an over-estimation of impacts.
- The WTM assumed that all land withdrawn from irrigated agriculture would be converted to non-irrigated agricultural production, that the region's existing non-irrigated agricultural mix remained unchanged and that Gross Value Product (GVP) per hectare were those of the ABS 2005–06 dataset. Note that the model with-interregional trade estimated an 18% reduction in irrigated land use; it is an open question of whether or not conversion of irrigated agriculture to dryland farming would be feasible without major farm-level restructuring. Furthermore, the redeployment of resources from irrigation to dry land agriculture was estimated to reduce the economic impact of SDLs by $68 million or 7%. It seems that the ABARE–BRS approaches assumed a one-for-one hectare conversion from decommissioned irrigation land to dry land agricultural activities with reduced water allocation under SDLs.
- Estimates of the environmental benefits of SDLs were not provided, rather, only the costs of reduced water allocations were reported.
- Compensation monies for environmental water acquisitions were not considered. No water buybacks or infrastructure investments are modelled even though compensation has been part of earlier programs, i.e. the Water for the Future initiative (WftF). Note that considerable adjustments have already been undertaken in irrigated agriculture.
- Although not considered by the MDBA, ABARE discussed the effects of the Government's Water for the Future programs in an additional study (ABARE, 2010b). This study was not considered in detail here although the following points are worth noting:
    - The model used a baseline and a scenario to consider the effects of the WftF program.
    - They state that the scenario considered the full $3.1 billion Restoring the Balance (RtB) program which recovers 15% of total baseline surface water and the $4.4 billion infrastructure spend to save 10% of use. Although it is possible to determine the volume of water the infrastructure investment will recover, there was no indication of what the baseline surface water volume was and hence the RtB volumes cannot be defined.
    - While assumptions on the effects of these programs on the recovery of water were provided as inputs to the model, the water volumes were not provided for assessment nor is there an indication of the spatial distribution of water purchases and infrastructure investment.
    - Results presented seem to suggest that the WftF scenario fails to achieve the full SDL reduction required. The model assumptions for this scenario indicated that any gap in water between the WftF recovery and the SDL would be covered by the Government. The reason for the reduced water recovery in the WftF scenario was not clear.
- Town-level economic impacts were based on data from the year 2007–08. This was a drought year and may not be representative of 'average' conditions.
- The model was calibrated with a quadratic cost function following Howitt (1995). Although the functional form itself was reported, the parameters used were not therefore it is not possible to evaluate its implications for model results.

- ABARE–BRS (2010a) reported the use of an equation characterising yield as a concave function of water applied in irrigation and that this function incorporated parameters derived from price elasticities of demand for irrigation water from Bell et al. (2007). The crop yield function methodology reported in Hafi et al. (2009) does not appear to use water demand elasticities and does not seem to be what was used as reported in ABARE–BRS (2010a). It would be useful to see the actual functional relationship and parameter values reported. The functional relationship and parameter estimates are key determinants of modelling outcomes; it is not possible to assess model validity without this reporting.
- The aggregate change in economic impact estimated was surprisingly linear. Economic theory and applied studies (e.g. Connor et al., 2009) have shown that this relationship is often non-linear with relatively little cost impact for the first units of water supply reductions and increasingly greater costs per unit of supply reduction at higher levels of reductions. This may be related to some deficiencies in the specification of yield/water response functions that do not sufficiently allow for deficit irrigation and improved irrigation efficiency improvements as a first and least cost response. Greater clarity of reporting of the exact functional form of the yield/water response functions and data for parameter values would enable better understanding and potential model improvement. As it currently stands the model may have over-estimated the impacts of smaller levels of water supply reductions.
- ABARE–BRS (2010a) recognised that their treatment of the potential economic impacts of water supply variability was incomplete. The model in effect produced estimates of long run costs to varying levels of average water availability which implicitly assumed uniform water allocations. ABARE–BRS (2010a) note that there are other methodologies better suited to estimating the impacts of changed inter-annual variability (see Connor et al., 2009). Use of such models would imply greater costs for more variable water supply than current model estimates. In essence more variable water supply means that in some years not all the capital assets can be fully utilised but the full cost of owning these assets persist. As a result, the effective per unit cost over a long run set of more variable supply years would be greater than the per unit cost over a long run set of less variable supply years. Connor et al. (2009) showed this effect was greatest for perennial irrigated agriculture and in situations where the degree of variability is high enough to cause a shift in crop mix to lower value crops particularly where restrictions to trade exists.
- Water trade was modelled whereby water moved out of broad acre crops (rice, hay, and cereals) towards annual and perennial horticultural crops. Institutional constraints on trade were not modelled. Intraregional and interregional water trade is subject to hydrological and environmental constraints.
- There were a number of constraints on water trade in the model and while the regional trading restrictions were presented in Appendix A7, the reporting did not clearly define all the constraints and raised the following questions:
    - The reporting in Appendix A7 was unclear with regards to main channel constraints. The table reports that restrictions apply to trade back into the region to ensure in-stream flow and in valley environmental asset watering requirements were met. It would appear to be more sensible that to ensure the environmental needs, restrictions should constrain movement of water out of the region rather than into it.
    - The mechanics of between-region water trading requires clarification.
    - The reporting did not stipulate the Barmah choke constraint.
    - A number of institutional constraints currently in place were not reported which likely results in underestimates of the impact for irrigation in SA by assuming smaller limits to trade than those that currently exist.
    - Although the reporting indicated a hydrological disconnection between regions, there was no reference to the scientific evidence for the hydrological constraints in the northern Basin and its connection with the southern basin. This could be further augmented with a reference to evidence for the hydrological constraints placed in the southern system.

Concordance with economic principles

Overall the ABARE WTM model is well designed and considered. The model provides reasonable estimates of the potential economic impacts of the proposed SDLs although it does present some deficiencies in its approach with regards to a number of modelling assumptions. Of those limitations, some are due to the difficulty of finding high quality data for the basin given local, regional and state agency-variations in data collection and storage procedures. There is room for improvement in documentation and reporting with best practice economic analysis requiring the reporting of all assumptions and technical relationships in a way that would allow the results to be reproduced.

Reliability and representativeness

The ABARE–BRS report cautioned that the modelling results were estimates and that the actual impacts of the SDLs would depend on: the way the Basin Plan is implemented in each catchment; commodity prices; autonomous irrigator adjustment; and the size and design of any entitlement buyback, assistance for irrigation infrastructure investments, and structural adjustment programs. ABARE–BRS acknowledged that its modelling should attempt to take account of the highly variable nature of natural flows.

Accuracy of data

All data used was referenced and from reliable sources. There were some issues with the model assumptions and calibration as previously noted.

Overall assessment on the study's conclusions

The study provided insights into the dynamic adjustment of irrigated agriculture, other industries and basin communities to reduced water allocations. The results suggested that the regional and local structural adjustment inherent in the SDLs could be large in some areas and some industries. The identification of these regions and industries (as well as the likely spatial distribution of any compensation) may be useful for crafting policies to mitigate these impacts and focusing efforts to explain the rationale for, and implementation of, the Basin Plan (The Nous Group, 2010).

Key implications for South Australia

Generally the ABARE model did not have sufficient resolution to capture sub-regional effects such as those experienced in SA. Essentially, the lack of sub-regional modelling would likely under-estimate the benefits to the Lower Lakes where increased flows could reduce salt loads and improve water quality in this region. It is not clear if the benefits in the Lower Lakes could offset the potential impacts in the Riverland. By treating SA as one region, ABARE–BRS' modelling missed much of this spatial variation and potentially over or under-estimated the costs and benefits to some regions.

SA was not reported as one of the more vulnerable regions in this study in part because broad acre crops are less important in the SA crop-mix and the models allow for trade in water entitlements. A reduction in the area of irrigated annual crops was estimated in the WTM and was reflected in irrigated crop survey data which validated this result to some extent. The linearity of economic impacts raises questions on how effectively the model deals with deficit irrigation and water trade for perennial irrigated agriculture. Irrigated crop survey data for SA indicates that perennial irrigated crops persist throughout drought periods either through deficit irrigation or water trade. This is expected to have considerable implications for producer's bottom line in those low allocation periods. The WTM did not adequately capture this effect since it assumed uniformly available water from year to year. This underestimated the costs of buying in water and deficit irrigation and consequent reduced yields in drier years.

The study suggested that Adelaide could be the most impacted outside-of-the-Basin region. SDLs could reduce the reliability of urban water supplies particularly during drought years. This suggestion is hard to verify given that the Critical Humans Need Plan is not yet released, and it will likely address this concern in full. Adelaide is addressing this concern in its Water for Good plan but none of the associated costs were considered in ABARE–BRS (2010a).

Whilst salinity contributions towards determining the level of expected yield were a feature of the WTM, the MDBA did not conduct salinity impact analysis for various SDLs. As a result ABARE–BRS (2010a) was unable to estimate these economic impacts. This is a serious omission for SA, both with respect to urban water supplies and for the Lower Lakes where salinity impacts exert a considerable impact on irrigation activities. Any increases in flows such as those likely to emanate from increased environmental flows will dilute salt in the system and help irrigators in the Lower Lakes avoid very high salinity damages as well as improve SA Water's supply reliability and high treatment costs.

2 Regional economy and structural adjustment

Economy-wide and employment impacts of SDLs have been assessed in the literature primarily using computable general equilibrium (CGE) modelling. Both ABARE–BRS and Monash University's Centre of Policy Studies have undertaken such analysis. In this section, the results of these analyses are synopsised and commentary is provided on concordance with economic principles, reliability, accuracy, and the representativeness of the underlying data. Following this analysis, a summary of Banerjee and Connor's (2010) literature review on what the implementation of SDLs might mean in terms of economy-wide, regional and employment impacts is provided. The section concludes with a discussion of the implications of these results for SA and recommendations for the MDBA.

2.1 ABARE–BRS (2010a)

Synopsis

ABARE–BRS (2010a) delivered an economic analysis of potential effects of the three reductions in water diversions (3000, 3500 and 4000 GL) presented in the Guide to the proposed Basin Plan (MDBA, 2010a). For the 3500 scenario, ABARE–BRS (2010a) estimated a potential 1.3% drop in Gross Regional Product (GRP), a 0.13% reduction in Gross Domestic Product (GDP) and a 0.10% reduction in employment (800 to 1000 jobs) in the Basin. Specifically with regards to the South Australian portion of the Basin, GRP and employment were estimated to decline by 1.5% and 0.03% respectively.

Commentary

ABARE conducted its modelling in two stages, applying its WTM to estimate the direct effects of reduced water diversions on the GVIAP and non-irrigated GVP for each sustainable yield region. In a second stage, these estimates were implemented as production shocks in ABARE–BRS' static AusRegion CGE model. Reliability of the results of the economy-wide modelling exercise is thus directly related to the quality of the WTM output, which is considered in detail in Section 2.1. The AusRegion model is based on design aspects of Monash University's Centre of Policy Studies' ORANI-E model.

Model assumptions and implications

- Compensation monies for acquiring environmental water were not considered in ABARE–BRS' modelling which may have resulted in biased estimates of economic and employment impacts.
- The AusRegion model did not explicitly model a water sector nor did it account for distinct irrigated agricultural and unirrigated agricultural sectors. This sectoral specification may overlook important substitution effects. For example, grains produced in dry-land agriculture may substitute for irrigated pasture in livestock rearing.
- No distinction was made between irrigated and unirrigated land in the data which may obscure production shifts between these two types of inputs.
- Capital was treated as sector-specific in the AusRegion model. Therefore, although results of the AusRegion model were presented as long-run, modelling capital as sector-specific could underplay the role farm resource reallocation may have in economic adjustment in the medium to long term (ABARE, n.d., p. 3-4).
- Household utility was modelled as a constant difference of elasticities functional form where the proportion of additional income (the marginal budget share) spent on a commodity increase for luxury goods as incomes rise.
- The structure of production was nested where non-energy intermediate inputs, primary factor inputs and natural resources were modelled as Leontief functions while the labour and capital composite was modelled as a Constant Elasticity of Substitution (CES).
- Commodity composition followed the Armington assumption where imported goods are imperfect substitutes for domestic ones.

Concordance with economic principles

- As with other CGE models, the AusRegion model is based on the Walrasian equilibrium.

Reliability and representativeness

- ABARE–BRS presents the caveat that since magnitudes of employment effects were small and the accuracy of the model is limited, results should be interpreted carefully (ABARE–BRS, 2010a, p. 39).
- The environmental benefits associated with SDLs and increased environmental flows were not considered and therefore the costs of reduced water availability are likely over-stated.

Accuracy of the data

- Non-resource input-output flows were based on data from Monash University's Centre of Policy Studies, presumably from the 2001–02 reference –year.
- Data was also generated with input from the ABS 2001–02 Agricultural Survey and ABARE–BRS farm survey data.
- The agricultural sector was largely based on ABARE farm survey and ABS data. Government expenditure, tax, demographic and balance of payment data was obtained from ABS.
- AusRegion represents 48 industries and 50 commodities, households, state and federal governments, a finance sector and a foreign exchange market.

Overall assessment on the study's conclusions

The results of ABARE's analysis are concordant with what economic theory might suggest. The study did not, however, consider the effect of compensation monies and therefore may have over-estimated potential negative economic consequences of reduced water diversions. Furthermore, given the importance of the water market to agriculture in the MDB and the absence of a water market in AusRegion, there are likely to be consequences for model results. Finally, the potential economic benefits of SDLs were not considered.

2.2 ABARE–BRS (2010b)

Synopsis

This study (ABARE–BRS, 2010b) was commissioned by the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) as an extension to ABARE–BRS (2010a). As in ABARE–BRS (2010a), the economic impacts of a 3500 GL reduction in water diversions were assessed in a two-stage modelling approach. Differing from ABARE–BRS (2010a), this study employed a dynamic version of AusRegion enabling analysis of the year-on-year effects of policy intervention for the period 2007–09 to 2020–21. In addition, reduced water diversions were evaluated while implementing additional policy responses, namely, the $3.2 billion Water for the Future (WftF) water entitlement purchase program, the $4.4 billion WftF infrastructure investment program, and the purchase of additional water entitlements to address the gap between the targeted 3500 GL reduction in diversions and volumes purchases through the WftF program ABARE–BRS (2010b, p. 1).

Model results estimated that WftF and infrastructure investment would reduce the impacts of reduced diversions on GRP from −1.3% to −0.7%. Employment was estimated to fall by 0.1% at the Basin level and by 0.03% at the national level. Considering the WftF entitlement purchase, the WftF infrastructure investment program and additional gap closing measures to meet the 3500GL target, employment impacts were offset, leading to an estimated 0.1% increase in employment for the Basin. At the national level, however, there was a net reduction in employment of 0.04% (ABARE–BRS, 2010b, p. 33).

Commentary

In a first scenario, the 3500 GL reduction in water diversions was implemented in the model first in New South Wales, Queensland and South Australia beginning in 2014–15 and in Victoria beginning in 2018–19 (ABARE–BRS, 2010b, p. 22). The second scenario considered the 3500 GL reduction in water diversions, the WftF entitlement purchase, the WftF infrastructure investment program and additional gap closing measures to meet the 3500 GL target. The $3.1 billion in water entitlement purchases were modelled as household transfers and were considered household savings. These purchases were distributed over time according to a time profile supplied by SEWPaC. The annualised interest income (5% rate of interest) from these savings was used to shock household consumption. Investment in irrigation infrastructure amounting to $4.4 billion was distributed over a 10-year period and was assumed to result in a water savings of 10%. This infrastructure investment policy was implemented in the CGE model as a shock to the construction and services industries (ABARE–BRS, 2010b, p. 31).

Model assumptions and implications

- Treatment of how water was acquired for the environment was not clear. ABARE–BRS reported that it estimated changes in household expenditures by region and implemented these as shocks to simulate government expenditure on water entitlements. How these estimates were made and their implications were not documented.
- The AusRegion model does not explicitly model a water sector nor account for distinct irrigated agricultural and unirrigated agricultural sectors.
- In the data, no distinction was made between irrigated and unirrigated land.
- Capital was treated as sector-specific in the AusRegion model.
- Household utility was modelled as a constant difference of elasticities functional form.
- The structure of production is nested non-energy intermediate inputs, primary factor inputs and natural resources were modelled as Leontief functions while the labour and capital composite was modelled with a Constant Elasticity of Substitution (CES).
- Commodity composition followed the Armington assumption.

Concordance with economic principles

- As with other CGE models, the AusRegion model is based on the Walrasian equilibrium.

Reliability and representativeness

- Magnitudes of effects were small and the accuracy of the model is limited therefore results should be interpreted carefully.
- The environmental benefits associated with SDLs and increased environmental flows were not considered.

Accuracy of the data

- Non-resource input-output flows were based on data from Monash University's Centre of Policy Studies, presumably from the 2001-02 reference year.
- Data were also generated with input from the ABS 2001/02 Agricultural Survey and ABARE–BRS farm survey data. Government expenditure, tax, demographic and balance of payment data was obtained from ABS.
- This application of AusRegion used land, labour, capital and natural resources to produce 31 commodities, 16 of which were agricultural commodities. In addition to commodities, the model represented households, state and federal governments, a finance sector and a foreign exchange market.

Overall assessment on the study's conclusions

- The results of ABARE's analysis are concordant with what economic theory might suggest, though there are a number of concerns that require further information and analysis:
  - It is not clear what price was paid for the water under the WftF program and how the acquisition of environmental water and infrastructure investment was spatially distributed.
  - The WftF program in the model was introduced as transfers to households where transfers were considered household savings. Annualised interest incomes from these savings were used as positive shocks to household consumption. From the documentation of the model methodology and results, the implications of introducing the policy shock in this way are unclear.
  - The difference between the volume of water acquired through the WftF program and the 3500 GL target was not made explicit.
  - Implementation of various simultaneous shocks does not enable evaluation of the economic response of individual policy interventions.

2.3 Centre of Policy Studies: Dixon, Rimmer and Wittwer, (2010a and 2010b)

Synopsis

Dixon et al. (2010a) from Monash University's Centre of Policy Studies developed and applied the dynamic TERM-H2O CGE model to evaluate the impact of a government buyback of water from irrigators in the southern portion of the Basin. The authors evaluated a scenario where the Commonwealth bought permanent water rights from the southern portion of the Basin to an annual allocation of 187.5 GL in 2009 and another 187.5 GL in 2010 for a total of 1500 GL by the year 2016. Over the period, this amounted to a reduction in consumptive water of almost 23%. The authors estimated that the buyback would result in increased economic activity and an increase in the price of water with little effect on overall farm-sector output. At the end of the simulation period, the reduction in GDP amounted to 0.0059% (Dixon et al., 2010a, p. 12) or alternatively put, 17 hours of economic growth (Dixon et al., 2010a, p. 28). By the end of the simulation period, farm output declined by 1.3% for the southern portion of the Basin and by 1.1% for the Murray Lands. Household consumption increased by 0.34% for the southern portion of the Basin and by 0.39% for the Murray Lands (Dixon et al., 2010a, p. 15).

In an earlier application of the TERM-H2O framework, Monash University's Centre of Policy Studies researchers took on the question of whether compensation spending from water buybacks could produce regional benefits large enough to offset losses from irrigation-sector income spending (Dixon et al., 2010b). The model simulated the purchase of 187.5 GL/year over an eight-year period for a total of 1500 GL. The study examined two opposite extremes – all compensation monies spent inside the region and all monies spent outside the region. Dixon et al. (2010b) found that when all compensation monies were spent inside the region, overall consumption increased and more than offset losses from forgone irrigated agriculture sector spending. For example, in the Central Murray region, a gain of 1% in aggregate consumption was estimated from 2009 and 2018 when compensation was spent inside the region; when compensation was spent outside the region, aggregate regional consumption was estimated to drop by 1.5% (Dixon et al., 2010b, p. 28). Employment impacts for the southern portion of the Basin as a whole varied between approximately −0.025% and −0.2%; the impact for the SA Murray Lands was close to −0.13% (Dixon et al., 2010b, p. 25).

Commentary

The Centre of Policy Studies modelled a water buyback using the dynamic TERM-H2O CGE model. This model is based on the Monash modelling tradition (Dixon and Rimmer, 2002). TERM-H2O differs from AusRegion primarily in its detailed treatment of water markets, the distinction between irrigated and non-irrigated agricultural sectors and farm factor mobility. Furthermore, rather than the two-stage approach used by ABARE, the policy shock in TERM-H2O was introduced as an exogenous reduction in the water available for agriculture with the agricultural and other sectors adjusting to this shock endogenously.

A key result in Dixon et al. (2010a, p. 17) was that irrigated industries reduced output while dryland agriculture and irrigated vegetables increased their output. Dixon et al. (2010a, p. 20) found that the rental price for irrigable land was key to explaining these results. Increases in the price of water were found to cause large declines in the rental price of irrigable land in areas with a high ratio for the value of irrigation water to irrigable land, and limited options for using irrigable land in dry-land farming. As an illustrative example, there was a large decline in the average rental price in Central Murray (New South Wales) where there is a high value ratio for water to irrigable land while dryland activity levels are low.

Model assumptions and implications

- Industry output is a Leontief function of intermediate input and a primary factor. Applying the Armington assumption, intermediate inputs are a CES function of domestic and imported goods. Domestic goods are CES functions of goods produced from specific regions.
- The primary factor is a CES function of land and operator, general capital and labour. Labour is a CES function of labour of various skill sets.
- Land and operator is a CES function of operator labour, land and specific capital. Specific capital is applied only in the irrigated livestock and irrigated perennial sectors where specific capital is considered to be orchards, vineyards or livestock herds (Dixon et al., 2010a, p. 5).
- Total land is formed via a series of nests. In a first nest relevant to the dryland livestock sector, total land is a CES combination of effective land and cereal. This specification enables substitution of cereal for land in supporting livestock. Effective land is a CES function of irrigated land, unwatered irrigable land and dryland. Dryland industries do not make use of irrigated land and therefore effective land for these industries is a CES function of unwatered irrigable land and dryland. For irrigated industries, effective land is irrigated land. Irrigated land is a Leontief function of unwatered irrigable land and water. It is assumed that irrigated land is always fully watered (Dixon et al., 2010a, p. 7). The implications of this structure is that farmers may chose to water unwatered irrigable land or not water at all- they cannot, however, vary the amount of water they apply to a particular area.
- General purpose and specific capital for a particular region varies from year to year according to depreciation and investment. The implications of this assumption should be considered bearing in mind that specific capital represents orchards, vineyards and livestock herds.
- Water may be traded freely in the southern portion of the Basin and water is sold uniformly across water rights holders. In the Guide to the proposed Basin Plan, however, reduced water allocations were not considered to be distributed uniformly across the Basin.
- It is assumed that after 2012, irrigation water becomes relatively cheaper as rainfall returns to normal levels and allocations increase to 100%. This assumes that we have seen the last of drought years by 2012 until at least 2018. With this return to 100% allocations and estimated water saving technical change of 1% reducing demand for water, in the absence of SDLs, the price of water trends downwards. With reduced diversions, the price trend is an upward one after 2012 (approximately $120/ML with SDLs vs. less than $20/ML without (Dixon et al., 2010a, p. 12). Assuming how allocations may change over time is necessary however, in the absence of a sensitivity analysis it is not clear how great an effect this may have in driving model results.
- The TERM-H2O model allows for price-induced farm factor mobility in a region, that is, productive farm resources may be reallocated between farm industries. For example, irrigated agricultural farm resources and machinery may be reallocated to dry-land farming as a result of an increase in the rental rate for a specific factor in dry-land agriculture (Dixon et al., 2010a, p. 8).
- Unwatered irrigable land may be reallocated between irrigated agriculture and dryland farming. Reduced water supply drives water prices upwards and reduces the rental value of unwatered irrigable land. The implication of these interactions is that dryland farming increases its demand for this land while irrigated farming reduces its demand. These types of interactions are absent in the AusRegion model. In TERM-H2O, however, the flexibility for irrigable land to be reallocated to dryland farming may be overstated.
- TERM-H2O's accounting for water markets also distinguishes it from the AusRegion model. Some simplifications and assumptions were made in defining this market. With regards to water prices, it is assumed

that they are the same for all industries and regions as a result of the equalizing effect of trade (Dixon et al., 2010a, p. 9). This is not necessarily representative of how water markets have historically behaved, however.

Concordance with economic principles

- TERM-H2O and the analysis provided are consistent with economic principles.

Reliability and representativeness

- Since magnitudes of economic effects were small and the accuracy of the model is limited, results should be interpreted carefully.

Accuracy of the data

- The model includes 35 industries, 17 of which are farm industries producing 10 farm commodities; the model has 19 regions.
- Core data is a 2005–06 input-output database which is assumed to be derived from the Australian Bureau of Statistics National Accounts data.

Overall assessment on the study's conclusions

- The results of Dixon et al. (2010a and 2010b) are concordant with what economic theory would suggest.
- The degree to which the assumption that water allocations will return to 100% for the next 8 years should be evaluated in a sensitivity analysis.
- The flexibility by which irrigated agricultural land may be converted to dry-land production merits further investigation.
- The assumption that water is purchased uniformly across water rights holders is not realistic and should be addressed in future modelling experiments.

2.4 Banerjee and Connor (2010)

Synopsis

Banerjee and Connor (2010) conducted a literature review on what the implementation of SDLs might mean in terms of economy-wide, regional and employment impacts. From the literature reviewed, Banerjee and Connor (2010) conclude that the overall impact of SDLs will depend on various interacting variables, with some moving slowly and others more quickly:

- Drivers that may either offset or exacerbate the impacts of SDLs, include: (a) commodity prices – high commodity prices would tend to compensate for reduced production resulting from less water while low commodity prices would tend to exacerbate the impacts, and (b) weather and climate – if the implementation of SDLs coincides with a period of high rainfall, impacts would be somewhat offset, whereas if implementation coincides with a period of low rainfall, adverse impacts would be more severe.
- At the national level, compensation for reduced reliability of entitlement could be expected to increase spending in the MDB but displace other public expenditure; the net impact would be equal to the forgone agricultural production and other consumptive use values of production, less the values of ecosystem services resulting from improved environmental water flows.
- Assessments of the impacts of water buybacks concluded that if all compensation monies were spent locally, household consumption would be greater than in the absence of SDLs and compensation monies.
- At a micro-level, some smaller towns and communities may be adversely impacted. Assets from some up- and down-stream industries may also be left stranded.

- Assessments of the economic impacts of reduced irrigation water concluded that some redeployment of farm resources such as labour and machinery from irrigated to dryland agriculture can be expected and that this should offset some of the economic impacts of reduced irrigation activity.
- Evaluations of long-run trends suggest that, in the long run, the Basin Plan regional economic impacts are unlikely to be large compared to the combined economic impact of other regional economy drivers such as technological innovation, demographics, commodity prices, weather and climate.

Commentary

Banerjee and Connor's (2010) review provided an analysis of all previously mentioned studies with the exception of Dixon et al. (2010a) and ABARE (2010b) which were unpublished at the time. In addition, they reviewed some qualitative analyses of community and farmer socioeconomic profiles.

2.5 Mallawaarachchi T, Adamson D, Chambers S and Schrobback P (2010)

Synopsis

Mallawaarachchi et al. (2010) were contracted by the MDBA to undertake analysis of the economic impacts of reduced irrigation in the Basin. The authors used their Risk and Sustainable Management Group (RSMG) water allocations model for the analysis. The model divides the Basin into 19 catchments and allocates water optimally among enterprises according to relative profitability. To capture the effect of the SDLs, as well as the effect of natural flow variability, the authors generate flow scenarios based on the 114-year historic hydrologic record and flows in the period 1998-2008. Variability in water supply for each catchment is modelled as three states of nature: wet (30% of the time), normal (50% of the time) and drought (20% of the time). They note that the 1998-2008 period was wet 10% of the time, normal 30% of the time and in drought 60% of the time. These states of nature are used as weights. Catchment data are aggregated and adjusted to match water availability and variability in the entire Basin. The authors conduct a sensitivity analysis to assess the responsiveness of irrigators to changes in water availability. SDLs are modelled with respect to the current diversion limit and represent an average 37% reduction in water availability compared to the baseline. The RSMG model has two solution modes: (1) sequential optimisation where water allocation is resolved for all 19 catchments sequentially and water trading is permitted intra-catchment only; and (2) global optimisation which finds a globally optimal water use pattern for the whole Basin, it permits trade across regions in the southern-connected Murray as well as intra-region.

The Guide to the proposed Basin Plan state-contingent scenario reduced water use by 3746 GL. This reduction in water availability reduced GVIAP of $1.445 billion, or by 16%, compared to the baseline using the global optimisation mode. Regional profit from agricultural production was found to decline by $371 million to $1.954 billion or by 16%. Water trading mitigated the impact of reduced water availability on regional economies, i.e. the reductions in GVIAP and regional product using the sequential optimisation mode were marginally larger. The authors find that the economic impact of the SDLs will vary between catchments and regions with the largest losses in GVIAP modelled for Victoria −30%, then NSW −17% and Queensland −15%. South Australian GVIAP is modelled to contract just 7%. By agricultural industry the largest declines in GVIAP are for rice, cotton and pasture for dairy.

Commentary

The RSMG is a water allocation model. The model is a partial equilibrium model and therefore the potential mitigating effect of water buybacks, and reallocation of capital and labour to other productive uses on regional product are not captured. The benefits of increased environmental water were also not modelled. Greater detail could be provided on the mechanism by which land switches from irrigated agricultural production to dryland production.

Model assumptions and implications

- RSMG baseline model calibrated with ABS 2000–01 irrigation water use data.
- Price data is 2007–08: using price data from this year makes it difficult to compare model output with BRS data.
- Baseline current diversion limit of 10,758 GL and SDLs of 3746 GL (it is not clear if water already secured for the environment is subtracted from this total).
- Dryland substitution is permitted.
- Irrigation water costs $25/ML: this homogenous price is not realistic.
- 10-year timeframe: key factors of production are assumed to be mobile.
- The water delivery constraint at the Barmah Choke is not modelled.

Concordance with economic principles

- The RSMG model and the analysis provided are consistent with economic principles; specifically optimising water allocations by altering crop mix to maximise profits. However, there are other constraints on irrigators that are not modelled.

Reliability and representativeness

- The model data for irrigated acreage by crop are compared with 2000–01 ABS baseline data and the differences are large across the major irrigated agricultural land uses. This is in part because the prices used are from 2007–08.
- The model data for water consumption by crop are compared with 2000–01 ABS baseline data and the differences are small for dairy and livestock and grapes but larger for other major irrigated agricultural land uses (rice, cereals, cotton and other horticulture). This is in part because the prices used are from 2007–08.
- The model data for GVIAP by crop are compared with 2000–01 ABS baseline data and the differences are small for dairy and livestock but larger for other major irrigated agricultural land uses (rice, cereals, cotton, grapes, and other horticulture). This is in part because the prices used are from 2007–08.
- The sensitivity analysis produces implied price elasticity of demand for water allocations results broadly in line with other research.

Accuracy of the data

There are no issues with data accuracy; the authors used the most up-to-date data available at the time of their research.

- The model has 19 regions.
- Core data is a 2000–02 irrigation water use dataset from the Australian Bureau of Statistics and price data from 2007–08.
- Streamflow sequences are from the historical record. States of nature are based on historical patterns.

Overall assessment on the study's conclusions

The modelling exercise focussed on potential land use changes as irrigators switch water use to more profitable activities. The economic impacts of these land use changes with the introduction of SDLs are estimated and found to reduce GVIAP by 16% from the baseline. This estimate is far higher than that modelled by ABARE–BRS (2010a and 2010b) and Wittwer (2010). This overestimation of the regional economic impacts from reduced water availability is because their model cannot incorporate buyback compensation; when irrigators sell their entitlements they spend a proportion of the proceeds in the local economy and this spending in turn generates other spending and jobs reducing the net local economic impact of SDLs. The benefits of increased environmental water were also not modelled.

- The RSMG water allocation optimisation model demonstrates how irrigators adopt a set of production systems to adapt to variable water availability and is useful in identifying those catchments and regions that might be most vulnerable to changes in water availability.
- The modelling demonstrates the benefits of water trade in reducing the economic impact of the SDLs. For example, economic losses in NSW are modelled to be significantly lower with trade.

- The state-contingent scenario permits a more realistic assessment of the impact of SDLs given that natural variability in water supply is expected into the future.

2.6 Wittwer (2010)

Synopsis

Wittwer (2010) models the regional economic of SDLs using the Monash University's Centre of Policy Studies dynamic regional economic TERM-H2O model. The model includes buyback compensation: the buyback occurs between 2011 and 2022; it is suspended for 2 years of modelled moderate drought (2015 and 2020). The inclusion of buyback compensation provides an estimate of the net-effect of the proposed Basin Plan on regional economies. The net impact of the 3500 GL SDL by 2026 is modelled to reduce national real GDP by 0.009%, employment by 0.7% or 500 jobs, and GVIAP by $800 million, while dryland output is estimated to increase by $400 million.

The cost of the program rises with the SDLs: the 3000 GL target is modelled to cost $3 billion, the 3500 GL target $4.1 billion and the 4000 GL target $5.3 billion (all in 2010 dollars). The non-linear increase results from increased water scarcity and consequent higher water prices.

The model estimates changes in agricultural output in the Basin. Output of rice is estimated to decline by 15% more than the baseline by 2026. Smaller declines are modelled for dairy/cattle, cotton, and grapes. Vegetable production is estimated to increase marginally and there is not much change for cereals, other livestock, and fruit. This pattern in part explains why some areas do worse than others in terms of employment losses and real GDP. The results suggest that Border, Moonie, Condamine-Balone fare the worst followed by Paroo and Gwydir. Some areas see growth, such as the Murrumbidgee.

Commentary

The paper is well written and the assumptions and economic rationale for the assumptions are well explained.

Model assumptions and implications

For an explanation of the assumptions embedded in the TERM-H2O model, please see Section 2.3.

- Buybacks are assumed to be voluntary with willing irrigators selling their water entitlements to the Commonwealth Environmental Water Holder: water sales are part of the irrigator's planning process.
- Buybacks are compensated at market prices and prices are expected to rise with large purchases by the Commonwealth Environmental Water Holder (irrigated land rentals are forecast to decline): full compensation reduces the net impacts on irrigators and irrigator communities.
- The buyback is not completed until 2022: the process evolves slowly allowing irrigators time to adapt to less water through crop switches, irrigation efficiency and other measures.
- SDLs of 3000 GL, 3500 GL and 4000 GL: target SDLs incorporate the 796 GL of entitlements already sold to the Commonwealth Environmental Water Holder by end of the January 2010: this ensures only net-environmentally-targeted water is modelled.
- Farmers spend only the percentage of the buyback payments that maintain the real value of payments over time. After 2022 when the buyback ends farm investment declines.
- The SDLs will increase farm output prices, e.g. the price of rice is forecast to rise 7% more than the baseline by 2026.
- Rainfall is modelled: this affects irrigation demand and dryland productivity.
- Water trading is permitted between users, including between the environmental water manager and other users.

Concordance with economic principles

- TERM-H2O and the analysis provided are consistent with economic principles.

Reliability and representativeness

- The magnitudes of economic effects are modelled to be small; they are in line with the ABARE–BRS (2010a; 2010b) results.

Accuracy of the data

- There are no concerns about the accuracy of the data used in the model.

Overall assessment on the study's conclusions

The same concerns with the TERM-H2O model outlined in Section 2.2.3 apply. Overall the paper is well written and the results are in line with other CGE research.

Wittwer (2010) concludes that the regional economic impacts of a gradual introduction of SDLs, with full market-based buyback compensation, will be small, −0.009% less than the baseline by 2026, but that some regions within the MDB will experience greater declines in income and employment. The model suggests that SDLs will increase dryland farming and vegetable production in the MDB: other crops, such as rice, will experience large declines in output, particularly in drought years (a similar result is found in Mallawaarchchi et al., 2010). The author notes that drought years worsen the economic impact of SDLs – two are modelled in 2015 and 2020. The author modelled the severe drought of 2006–07 and 2008–09 and noted that it had a much more severe regional economic impact than that forecast for the SDLs. This is because drought negatively impacts dryland farming and increases irrigation demand as well as reducing water availability (SDLs only reduce water availability).

2.7 Judith Stubbs and Associates (2010)

Synopsis

Stubbs and Associates assesses the socioeconomic impacts of reductions in irrigation water on employment and other socioeconomic indicators. This work predicted a loss of 6000, 14,000 and 28,000 jobs for a 10%, 25% and 50% reduction in water allocations, respectively for an annual cost of lost productivity of $0.6 billion, $1.4 billion and $2.7 billion, respectively. These estimates were made assuming reductions in irrigation water were equally distributed amongst irrigated uses and in the absence of water trading (Judith Stubbs and Associates, 2010, p. 64). The Stubbs report was not adequately referenced and the methodology used to arrive at these figures was not presented. Identifying the grounds upon which Stubbs and Associates based their estimates, it is assumed that a simple linear relationship between GL and employment by agricultural sector was established whereby '…one GL of water employs around 2.3 people if used for cotton, and around 38.0 people if used for vegetables' (Judith Stubbs and Associates, 2010, p. 18). Since employment effects were estimated in the absence of water trading, results were severely biased and therefore unreliable.

Commentary

This report has been negatively critiqued by economists. Some of the issues raised by Professor Grafton regarding the report are listed below (Grafton, R. Q. 2011 personal correspondence).

Model assumptions and implications

- Assume no water trade though 30% of allocations were traded in 2008–09.
- Equi-proportional cuts in water use across the Basin: other modelling shows this is unlikely.
- Labour and land and water are in fixed production: there is substitution between factors of production meaning that jobs lost will not be proportion to reduced water.
- Permanent job losses are assumed even though the Australian job market is dynamic. Many job losses will be temporary.
- Assume costs from reduced employment equal $83,000 per worker. Should use average wage in agricultural sector, which is lower.
- Assume that without SDLs current irrigation diversions are sustainable but they are not, thereby exaggerating losses from SDLs.
- Do not account for buyback compensation offsetting regional economic impact of SDLs.
- Assume benefit of increased environmental flows = losses in agricultural output. This is not how environmental benefits are valued; see Morrison and Hatton MacDonald (2010).

Concordance with economic principles

- Many of the assumptions made are not in line with economic principles. See above.

Reliability and representativeness

- The report is neither reliable nor representative.

Accuracy of the data

- The results of this work cannot be taken as accurate. The estimated employment impacts do not concur with reality. ABS data shows that with an approximate 30% decline in water use in the MDB from 2000–01 to 2005–06 that GVIAP (in nominal terms) rose by 9%.

Overall assessment on the study's conclusions

The methodology and results from this study have been negatively critiqued by other economists.

2.8 Summary and key implications

It may be useful to contextualise the results presented above with ongoing trends and projections for the Basin and for Australia overall. The largest decline in Basin employment between 2001 and 2006 was in agriculture, forestry and fishing (–11.9% or 13,300 employees; MDBA, 2010b, p. 27). Between 1996 and 2006, the number of people self-identified as a farmer or farm manager dropped from 74,000 to 67,000. In the 10 years leading up to February of 2009, employment in agriculture, fisheries and forestry declined by 1.6% per year. Interestingly, this experience is in somewhat of a contrast with industry projections. At a national level, the Australian Farm Institute reported a labour shortage in the agriculture sector on the order of 100,000 in 2008 while AgriFood Skills Australia claimed that an additional 10,000 to 20,000 new farm workers would be required each year to meet growing demand (MDBA, 2010b, p. 220). These trends and projections are much greater in magnitude than those expected to arise with the implantation of SDLs.

The potential economy-wide and employment impacts of the SDLs described in the Guide are well supported by the underpinning socioeconomic analysis undertaken by ABARE–BRS (2010a; 2010b) and Dixon et al. (2010a; 2010b) as well as the literature review performed by Banerjee and Connor (2010). Table 1 provides a comparative snapshot of these studies. ABARE–BRS (2010a; 2010b) and Dixon et al. (2010a; 2010b), taking into account some differences in methodologies and scenarios, report similar economy and region-wide impacts and employment effects – the impacts of the Plan on the regional economy and on employment are very unlikely to be large. Although in the public arena, some contend that job loss would be massive and agricultural production would be significantly reduced, the most robust, state-of-the-art economic modelling evaluated here has provided a strong and compelling argument to the contrary. With low unemployment in Australia overall, potential jobs lost in one industry will translate into jobs found in another. Agricultural output is also unlikely to decline significantly, given some time for restructuring.

Although the potential economic costs of SDLs appear to be well accounted for in the underpinning socioeconomic analysis, the accounting of market and non-market benefits of improved environmental flows is largely absent. With regards to evaluating regional and economy-wide impacts as well as employment effects, further modelling along the lines of Dixon et al., (2010a) is recommended where SDLs and greater environmental flows are linked to environmental benefits and estimates of the economic value of these benefits. Finally, sensitivity and scenario analysis would facilitate understanding how robust this modelling is to specific assumptions such as those surrounding future water allocations and expectations of future climate.

Table 1. Core economy-wide socioeconomic studies, key results, assessment of reliability and potential issues

Study	Scenario	Methodology	Key Results	Reliability	Potential issues
ABARE–BRS (2010a)	Simulated 3,500 GL reduction in water diversions in the absence of compensation for environmental water acquisition.	Water Trade Model used to derive estimates of impacts on GVIAP; results input into the static AusRegion Computable General Equilibrium (CGE) model.	Estimated: 1.3% drop in GRP, 0.13% reduction in GDP, 0.10% decline in employment in MDB. For Southern MDB, GRP and employment estimated to fall by 1.5% and 0.03%, respectively. Estimated 800 to 1000 jobs lost in the MDB.	Medium to high	-Reliability of results directly related to Water Trade Model (WTM) output. Some issues with the WTM identified in section 2.1 of this report. -Compensation for environmental water not modelled. -Water sector not modelled. -Capital treated as sector-specific. -Environmental benefits of Sustainable Diversion Limits (SDLs) not considered.
ABARE–BRS (2010b)	All scenarios: simulated 3,500 GL reduction in water diversions for the 2007/8 to 2020/1 period. Scenario two considers: compensation for environmental water and $4.4 billion Water for the Future (WftF) infrastructure investment. Scenario one does not consider compensation for environmental water nor WftF investment.	Water Trade Model used to derive estimates of impacts on GVIAP; results input into the dynamic AusRegion CGE model.	Scenario one- estimated: 0.7% decline in GRP, MDB employment reduced by 0.1% and by 0.03% at the national level. Scenario two- estimated: 0.1% increase in MDB employment; 0.04% decline in employment at national level.	Medium	-Reliability of results directly related to Water Trade Model (WTM) output. Some issues with the WTM identified in section 2.1 of this report. -Water sector not modelled. -Sector-specific capital. -Environmental benefits of SDLs not considered. -Mechanism for simulating environmental water acquisition in the model unclear. -Price of environmental water not reported. -Difference between water volume acquired through WftF and 3,500 GL target not explicit.
Dixon et al. (2010a)	Commonwealth purchase of permanent water rights from the southern portion of the Basin to an annual allocation of 187.5 GL in 2009 and another 187.5 GL in 2010 for a total of 1500 GL by the year 2016; reduction in consumptive water of almost 23%.	Application of the Centre of Policy Studies' dynamic TERM-H2O model with a water sector and detailed irrigation/dry-land sectors.	Estimated: GDP declined by −0.0059%; Farm output declined by 1.3% for southern portion of the Basin and by 1.1% for Murray Lands. Household consumption estimated to increase by 0.34% for the southern portion of the Basin and by 0.39% for the Murray Lands.	High	-Modelling assumes water allocations will return to 100% for the next 8 years. -The flexibility by which irrigated agricultural land may be converted to dryland production merits further investigation. -Water purchases were modelled uniformly across rights holders; water prices also uniform -Where compensation monies are spent is exogenous (in or outside region). -Environmental benefits of SDLs not considered.
Dixon et al. (2010b)	Simulation of Commonwealth water purchase of 187.5 GL per year over an eight-year period for a total of 1500 GL. Enables evaluation of effect of where compensation monies spent.	Application of the Centre of Policy Studies' dynamic TERM-H2O model with a water sector and detailed irrigation/dry-land sectors.	Estimated- Central Murray region, aggregate consumption increases by 1% when compensation monies were spent inside the region. When compensation monies spent outside the region, consumption estimated to drop by 1.5%. Employment impacts for the MDB estimated to vary between 0.025% and 0.2%.	High	-The flexibility by which irrigated agricultural land may be converted to dry-land production merits further investigation. -Where compensation monies are spent is exogenous (in or outside region). -Environmental benefits of SDLs not considered.

Study	Scenario	Methodology	Key Results	Reliability	Potential issues
Judith Stubbs and Associates	10%, 25% and 50% reduction in water diversion. Assumes reductions in irrigation water equally distributed amongst uses and in the absence of water trading	Methodology not reported and report is inadequately referenced. It appears that a linear relationship between GL and employment was established where 1 GL of water employs around 2 people if used for cotton and 38 people if used for horticulture.	Estimated job loss of 6,000, 14,000 and 28,000 jobs for a 10%, 25% and 50% reduction in water diversions.	Very Low	-Methodology not reported. -Linear relationship between GL of water and jobs is completely inadequate. -Adjustment process not considered. -Compensation for environmental water acquisition not considered. -Environmental benefits of SDLs not considered.
Mallwaarchchi et al. (2010)	SDL: 3,746 GL. Model water supply variability	Risk and Sustainable Management Group water allocations model: allocates water optimally according to profitability	GVIAP −$1.445 B (−16%) Water trading reduces economic costs to regional economies	Medium	-the water allocation model cannot consider buyback compensation so overestimates negative economic impacts - Environmental benefits of SDLs not considered.
Wittwer (2010)	SDLs 3,000 GL, 3,500 GL and 4,000 GL by 2026. All scenarios take into account the 796 GL already secured for the environment.	Application of the Centre of Policy Studies' dynamic TERM-H2O model with a water sector and detailed irrigation/dry-land sectors.	Estimated: −0.009% GDP; employment 0.7% or 500 jobs, and GVIAP −$800 M, but dryland output +$400 M. Household consumption estimated to increase by 0.19% for the MDB and by 0.19% for the SA portion of the Basin.	High	-CEWH makes purchases between 2011-2022 with suspension in modelled drought years of 2015 and 2020. -The flexibility by which irrigated agricultural land may be converted to dry-land production merits further investigation. -Water purchases were modelled uniformly across rights holders; water prices also uniform -100% of compensation monies are spent in region. -Environmental benefits of SDLs not considered.

3 Environmental valuation

3.1 Morrison and Hatton MacDonald (2010)

Synopsis

People hold values for environmental, social and commercial consequences of changing water allocations and water management. This report summarises the available non-market valuation studies undertaken inside and outside the Basin. Values from 15 survey based estimates of willingness to pay for improved MDB environmental outcomes (contingent valuation and choice modelling studies) were evaluated and used in the calculation of the benefits associated with incremental changes in environmental attributes that are likely to be improved through implementation of SDLs.

Values estimates for each region of the Basin were prepared to allow assessing how the affected population values each incremental 1% improvement from the baseline for up to five attributes: recreation, healthy native vegetation, native fish, frequency of waterbird breeding, and waterbirds and other species. The environmental values estimated could be used to estimate the benefits of a SDL and compared to estimated potential forgone agricultural production. To achieve this, a set of functional relationships linking a changed flow regime resulting from an SDL to quantitative estimates of the change in resultant environmental indicator would be required. Given this additional information, the estimates could also provide information on the relative value of water for different environmental goals, including providing water to different riverine attributes (e.g., waterbird breeding vs native vegetation), providing water to different locations (upstream vs. downstream) and to different asset classes. One important conclusion of the study is that the aggregate value of improving the Coorong from poor to good quality was estimated at a $4.3 billion Net Present Value (NPV) over 10 years using some conservative assumptions about discounting and affected population (these assumptions are summarised below in the commentary section).

Commentary

Morrison and Hatton MacDonald (2010) was peer reviewed by Professor John Rolfe, Central Queensland University and Professor Quentin Grafton, Australian National University.

This report reviews the literature and then undertakes a benefit transfer to assemble metrics for estimating the non-market values associated the Guide to the proposed Basin Plan that could be incorporated into a BCA framework with the additional step of developing functions that relate flow regime changes to quantitative changes in key ecological indicators.

Assumptions and implications

- Values from 15 existing studies were used, though there are methodological differences between the studies
- A 28% discount rate was used in calculating present value of values elicited through taxes/levies with 5 to 10 year time frames. This was assumed appropriate to reflect the tendency for respondents to severely discount future payments.
- 30% of non-respondents were assumed to have values similar to respondents and all other nonrespondents have zero values.
- For the base case analysis, that respondents outside of the state of the environmental asset did not value the asset (apart from the case of the River Murray).
- The existing studies provided an adequate guide to the underlying community values for the whole Murray-Darling Basin.
- That the values for each region were not affected by the supply of resources (environmental quality) in other regions.

It is recommended that sensitivity analysis is conducted to test the effect of the first three key assumptions and that a pooled model be estimated in future research to enable adjustment for methodological differences across studies.

Concordance with economic principles

Assumptions were based on the economic literature and calculations from well documented studies. For example, the 28% used in calculation of the present value was drawn from field and experimental trials (Kovas and Larson 2008; Bond et al. 2009; Harrison et al., 2003).

Reliability and representativeness

All studies were undertaken in Australia. Values used in transfers were from rivers and wetlands in the MDB or in similar areas outside the MDB. Short of undertaking new primary data collection, this is a suitable approach.

Accuracy of data

Existing studies provide patchy coverage of the different types of environmental assets across the Basin. Some of the early studies from the northern Basin are overly conservative in nature. Very recent studies which focus on the River Murray and the Coorong use a ten year payment vehicle and perhaps more realistic scenarios.

Overall assessment of the study's conclusions

The report outlines a package of improvements and calculates an overall benefit. The study findings suggest that the economic values of environmental improvements resulting from plan implementation are likely to be large in dollar terms, likely of similar order of magnitude to estimated costs to irrigated agriculture. All the key assumptions are outlined for the calculation of aggregate benefits. A critical assumption is that the existing studies provide an adequate guide to the underlying community values for the whole Murray-Darling Basin. Existing studies provide patchy coverage of the different types of environmental assets. Some of the early studies from the northern Basin are overly conservative in nature. Very recent studies which focus on the River Murray and the Coorong use a ten year payment vehicle and perhaps present a more realistic scenario.

Key implications for South Australia

An interesting recommendation in BDA Group, Grafton and McGlennon (2010) is to link, and where appropriate, integrate existing models and methods to quantify the trade-offs of different SDLs by catchment and across the Basin. For SA, where benefits which are quantity, quality and flow related, modelling processes that allow for iterating back and forth between hydro-economic models and hydro-ecological models, possibly linking to non-market valuation studies, would allow for a much more thorough quantification of the costs and benefits of different levels of water available for use and non-use values. Alternatively, 'a range of different water diversion limits could then be used as inputs into regional economic impact models and existing social impact assessments to assess the broader community and regional impacts of water diversion alternatives. The broader regional effects could then, in turn, be used to re-evaluate the water allocation trade-offs through a further iteration of the hydro-economic and hydro-ecological models.'

4 Social survey-based vulnerability assessments

In 2004–05 irrigated agriculture accounted for four-fifths of consumptive water use in the Basin. Just 2% of agricultural land is irrigated in the Basin but this sector generates almost two-fifths of the Basin's total Gross Value of Agricultural Production. The agricultural sector accounts for 9% of the Basin's economy by value and 10% of total employment. The MDB is home to 2.1 million people, of which 22% live in rural economies (2006 ABS data). The Basin is experiencing population growth but at a slower rate than the overall rate for Australia. This growth obscures intraregional trends: in the period 2001 to 2006, rural areas recorded population declines while medium and large towns/cities in the basin experienced robust growth. The dependency of some rural communities on irrigated agriculture and its downstream and upstream industries is high. The livelihoods of people in these communities are likely vulnerable. The Basin is also the home of many Indigenous communities. Because some communities may be highly impacted with the implementation of SDLs in ways that may not be well represented with economic modelling, the MDBA commissioned a report from Marsden Jacob Associates to supplement the ABARE–BRS modelling. The methodologies of the two reports employed are very different but both address different aspects of the terms of reference to: assess the likely impacts of implementing SDLs on irrigated agriculture; associated industries; and the coupled socio-demographic impacts. Both assessments identified those communities most at risk and include recommendations on how to mitigate adverse socioeconomic outcomes.

4.1 Marsden Jacob Associates (2010)

Synopsis

The *Water Act 2007* mandates the MDBA to 'act on the basis of the best available scientific knowledge and socioeconomic analysis' in developing the Basin Plan (*Water Act 2007*, s 21 ss 4(b)). Marsden Jacob Associates were commissioned by the MDBA to develop economic and social profiles of irrigation communities in the Basin in order to assess the socioeconomic impacts of changes in water availability with the setting of the SDLs. The synthesis report (MJA, 2010a) is accompanied by a series of other reports, including one describing irrigator surveys (MJA, 2010b) and one that pertains specifically to SA (MJA, 2010c). The Marsden Jacob Associates reports complement the ABARE–BRS modelling results reported above by providing detailed information on the diversity of the farm-level irrigation sector and farmers, plus dependent communities.

Commentary

Marsden Jacob Associates reported on the exposure, sensitivity, adaptive capacity, impact mitigation and residual vulnerability of 12 sub-regions. The assessment utilized community profile data and published analysis of the economic impacts of irrigation water reduction from ABARE, ABS and BRS. In addition they conducted 250 in-person interviews with irrigators and their suppliers plus with local and community leaders. A larger group of farmers (1500) was surveyed by telephone. The surveys provide data to: determine sensitivity to resource change; characterize socioeconomic profiles in the basin; and also measure personal wellbeing and community values. At the time of writing the actual SDLs were unknown; therefore to assess the impacts of reduced water availability in the Basin, Marsden Jacob Associates examined three scenarios: a 20%; 40%; and 60% reduction in diversions. The higher end of these scenarios would, if implemented, require more drastic cuts in consumptive uses of water than those envisaged by the Guide to the proposed Basin Plan (MDBA, 2010a) and those modelled by ABARE–BRS.

The survey results include information on the intentions of farmers with respect to the three water reduction scenarios in the in-person interviews and for the first two scenarios in the telephone-based interviews. The telephone survey results (1021 completed surveys) show that under the 20% reduction scenario, 25%, 32%, and 38% of rice, horticulture, and dairy farmers surveyed, respectively, indicated that they would change their farming practices (e.g. adopting dry land farming and less intensive use of water). Under the 40% reduction scenario these percentages changed to 36%, 25%, and 30%, respectively. A fifth to 30% of farmers surveyed reported that they would exit the industry under the 20% scenario, while 30% of dairy, nearly two-fifths of horticulture, and half of all rice farmers surveyed said they would exit with a 40% cut in water. The study reports that farmers are more likely to exit if they are: middle-aged; highly dependent on irrigation water; experiencing financial stress; and have low feelings of personal wellbeing and optimism. The study also identifies those communities that are reliant on agricultural processing for employment; these regions may require additional community assistance in the transition period.

Assumptions and implications

- Three scenarios: 20%, 40% and 60% cut in SDLs.
- The sampling methodology resulted in a sample response that is representative and unbiased.
- No water buy-backs even though compensation has been part of earlier programs, i.e. the WftF program. This assumption is contrary to provisions in the Water Act 2007 that water entitlement holders be compensated at market rate for loss of entitlement (s. 77) or erosion of water right reliability (s. 77 and s. 83) as a result of the plan. This omission likely affects the reliability of the survey results.
- Stated intentions (e.g. to exit farming) are good indicators of actual actions that irrigators would take if confronted with the actual water supply reduction scenario.

Concordance with economic principles

This study is qualitative in nature and relies on data from other sources, surveys, and socio-demographic assessments. The econometric analysis of farm decisions seems over-specified (MJA, 2010b).

Reliability and representativeness

The Nous Group (2010) cautioned that the response bias in the surveys may overstate the intentions of irrigators in the Basin to exit. In reading a companion report to the synthesis report (MJA, 2010b) the response rate to the survey is reported. Of 1,500 telephone surveys 1,021 were completed: a response rate of 68% (MJA, 2010b). Of the total surveys completed 808 were irrigators and 213 dryland farmers. Of the 808 irrigators, 391 completed the 20% reduction survey and 417 the 40% reduction survey (MJA, 2010b).

Perhaps of equal concern is that the survey asked interviewees their intentions with regards to the 40% cut in diversions which is higher than the reductions envisaged by the Guide to the proposed Basin Plan (MDBA, 2010a) and in the ABARE–BRS report (ABARE–BRS, 2010a). This level of reduction, coupled with the statement that there is no compensation, is emotive. Furthermore, given the community connectedness reported in the study, some of the survey respondents may have heard about and discussed the surveys, including the in-person interviews where 60% cuts to SDLs were included.

This companion report argues that the respondents' demographics are representative of Basin farmers more generally, but the data are not always easy to compare. Wellbeing was measured using the Deakin Wellbeing Index and results are reported as broadly consistent with published research. Optimism is measured on a 5-point scale but the report provides no information on the confidence of this measure. Social capital is measured by four questions on a five-point scale. The report identifies that responses to one of these questions, on community connectedness, are consistent with previously published work.

Accuracy of data

Response bias with the survey dataset may be problematic.

Overall assessment on the study's conclusions

The study is a qualitative socioeconomic assessment of the Basin community. Consideration of socioeconomic challenges in the design and implementation of the Basin Plan may ease structural adjustment and mistrust. The report recommends measures to reduce the impacts of SDLs on communities by: reducing exposure and sensitivity; strengthening adaptive capacity; provisioning communities with structural adjustment programs; and addressing residual vulnerability. Some specific recommendations are to: sequence implementation; provide compensation; secure environmental water from those tributaries where socioeconomic costs are lower; invest in non-water options to improve the resilience of ecological assets; and manage a wider portfolio of water to meet environmental water requirements, such as shorter-term leases and options contracts. The report agrees with the Productivity Commission's recommendations that actions be taken at the state and federal levels to reduce barriers and transaction costs to water trades. The report stresses the importance of rolling out policies on buybacks and any structural adjustment programs in tandem with the Basin Plan to allay affected communities and therefore smooth implementation. In addition they suggest thoughtful management of the dissemination of information on the entirety of the Basin Plan and connected policies.

Key implications for South Australia

The study reports that the SA Murray below Lock 1 and the Riverland have high levels of social disadvantage which indicates that these areas may be less able to cope with regional adjustment. These reports state that the SA government could probably target programs to improve essential services to increase the resilience of these communities. The study suggests that more water in the Lower Murray and the Lower Lakes would have important socioeconomic as well as ecological benefits. Specifically, nature-based and flow-based tourism and commercial fishing would benefit from higher water levels and reduced salinity, with expectations of enhanced community levels of well-being and optimism. The SA specific report adds that urban development based around marinas might grow with the implementation of SDLs (MJA, 2010c).

4.2 Indigenous values: Jackson, Moggridge and Robinson (2010)

The MDBA commissioned CSIRO to undertake a scoping study on the impact of SDLs on Indigenous peoples in the Basin. The background for this report is that national water policy initiatives should give regard to Indigenous issues (National Water Initiative of 2004). The *Water Act 2007* requires the MDBA, to 'maximise the net economic returns to the Australian community from the use and management of the Basin water resources' (s. 3(d)(iii)). Furthermore, in developing the Basin Plan, the MDBA has to have 'regard to the following ... social, cultural, Indigenous and other public benefit issues' (s. 21 ss. 4(c)(v)). Note that the *Water Act 2007* does not incorporate concrete requirements for water volumes specifically allocated to Indigenous nations. It also does not require the MDBA to consult with Indigenous nations (*Water Act 2007*, s. 42 ss. 1) though it can (*ibid* s. 42 ss. 3). In 2006 a Memorandum of Understanding was signed between a confederation of Indigenous nations (the Murray Lower Darling Rivers Indigenous Nations) and the predecessor to the MDBA.

Synopsis

Jackson et al. (2010) provide a literature review on Indigenous socioeconomic status and demographics, water rights, uses and values, and engagement in the Basin Plan process. In order to identify the potential impacts from the setting of SDLs they draw on three case studies, none of which is in SA, that catalogue Indigenous access to water, water management, and the spectrum of inter-connected Indigenous water values. These case studies also provide information on data gaps and a future research agenda. The report provides a framework for incorporating Indigenous water values in a full socioeconomic analysis. The authors assert that Indigenous communities have a role in co-managing environmental flows for the dual purpose of enhancing environmental *and* Indigenous values.

Commentary

Jackson et al. (2010) undertook a literature review and surveyed three Indigenous communities to: catalogue Indigenous water access and involvement in the Basin Plan process; identify interconnected Indigenous water uses, values, and priorities; illuminate probable impacts, both negative and positive, of SDLs on Indigenous people; highlight data inadequacies; and frame a future research agenda. The description and cataloguing of Indigenous water use is a necessary first step in describing 'the uses to which the Basin water resources are put (including by Indigenous people)' which is mandated in the *Water Act 2007* (s. 22 ss. 1(b)). It is also an essential step in incorporating Indigenous values in a full socioeconomic analysis of the Basin Plan.

Assumptions and implications

- Indigenous participation in the development of the Basin Plan has been constrained by institutional, legal, economic, and knowledge barriers
- The three case studies provide a representative sample of Indigenous water access and water values.
- Enhanced environmental flows will likely benefit Indigenous communities. To a significant extent Indigenous ‘cultural’ water interests overlap with environmental values. However, the correspondence is not exact because Indigenous people may have ‘their own knowledge of the river and indicators of floodplain ecosystem health’ which differ from indicators currently used (Jackson et al., 2010, p. 138) and because cultural values encompass more elements than environmental flow values per se. For some Indigenous communities, water values include water for irrigated agriculture. Therefore, if entitlements are reduced, agricultural income, both from Indigenous farms and from Indigenous leased land, may decline impacting Indigenous livelihoods and employment opportunities. Mitigating these impacts are irrigator adaptation and compensation money.
- High security entitlements held by Indigenous communities, might, if the priority of other entitlements with the implementation of SDLs erode, rise in value
- The changes in water management inherent in the Basin Plan may provide opportunities for Indigenous natural resource stewardship and the payment for ecosystem services provisioned.

These assumptions underpin the authors’ proposal that the benefits for Indigenous communities from the introduction of SDLs could be enhanced if, the management of environmental water and flows, and state environmental watering plans, are mandated to be ‘more inclusive of Indigenous water values, use and priorities’ (Jackson et al., 2010, p. 154). To this end they recommend: shared water governance and environmental water co-management with Indigenous communities; the setting of accreditation benchmarks for Indigenous water needs, values and priorities in state environmental water plans; and assisting resource managers to engage Indigenous communities in new opportunities for stewardship and the provisioning of ecosystem services.

Concordance with economic principles

Given data paucity the report does not attempt to measure net benefits accruing to Indigenous communities from implementation of SDLs. However, the authors implicitly set out a framework for the application of economic principles to undertake this quantification. They identify: a range of Indigenous water values and priorities and the probable costs *and* benefits of the Basin Plan to Indigenous communities. They propose strategies to increase net benefits accruing to Indigenous communities in the design and implementation of SDLs and report that Indigenous participation in water governance and environmental water management is viewed as valuable by Indigenous communities.

Reliability and representativeness

This scoping study is limited by the lack of descriptive data on how SDLs and state environmental watering plans will be implemented as well as the paucity of data on current Indigenous water use, values, and priorities. The report is neither comprehensive nor representative of all Indigenous communities — three case studies are reported — the Nari Nari and Ngemba in NSW, and the Yorta Yorta in NSW/Victoria. Despite these limitations, it provides important insights into Indigenous access to water, water management, and the spectrum of inter-connected Indigenous water values. The authors are all knowledgeable and well-respected in their disciplines.

Accuracy of data

The report is qualitative rather than quantitative. This is because the spatial, temporal, and flow impacts of the SDLs are still unknown, and foundational level quantitative data on Indigenous water use, values and priorities is also lacking. The authors provide a framework to incorporate Indigenous water values in a full socioeconomic analysis.

Overall assessment on the study’s conclusions

The authors do not provide a definitive answer on how SDLs will impact Indigenous communities. As a scoping study, it provides a roadmap for cataloguing and accounting for Indigenous water rights and water values in a full socioeconomic analysis of the Basin Plan. Utilising a review of relevant literature and case study information, the authors identify data limitations and a diverse range of Indigenous water values. The authors provide insights into how SDLs might positively (increased environmental flows watering culturally-important sites) and negatively (reduced commercial/agricultural water entitlements) impact Indigenous livelihoods. The *Water Act 2007* requires the Basin Plan to have regard for Indigenous issues and the authors provide a proposal for fine-tuning the Basin Plan to increase Indigenous benefits. They propose that Indigenous communities have a role in co-managing environmental flows for the dual purpose of enhancing environmental *and* Indigenous values.

Key implications for South Australia

From a SA perspective the scope of the report is limited; the sample of three does not include key regions in SA. However, the broad conclusions of the report likely extend to SA's Indigenous communities. There are a number of sites in the SA Lower Murray that are of cultural significance to Indigenous communities, for example the icon sites of the Coorong and Lower Lakes. In a full socioeconomic analysis these sites, plus others, and cultural values more generally would be estimated and provide further economic-based rationale for sustainable water management in the Basin. Other recommendations in the report may apply to SA, to: collect baseline socio economic and demographic data on Indigenous peoples; quantify current Indigenous water uses as well as Indigenous water requirements and priorities; and build capacity in Indigenous communities in water management and governance.

5 Concluding summary

In a 3500 GL reduction in water diversion scenario, ABARE–BRS (2010a) reported a 15% decline in the Gross Value of Irrigated Agricultural Production (GVIAP). In the absence of compensation for environmental water purchases, ABARE–BRS estimated the Gross Regional Product (GRP) and Gross Domestic Product (GDP) would fall by 1.3% and 0.13% respectively. Employment estimates saw a decrease of 0.10% for the Basin. More robust modelling undertaken by Dixon, Rimmer and Wittwer (2010a) evaluated a 1500 GL reduction in diversions by 2016 for the southern portion of the Basin. GDP was estimated to fall very slightly by 0.0059%; farm output declined by 1.3% for the southern portion of the Basin, since compensation for environmental water was considered, household consumption in fact was estimated to increase by 0.34%. Nonetheless, some issues were identified with both studies including a need for more thorough documentation with regards to technical parameters and functional forms used in the model runs and greater clarity in the assumptions used.

The Guide considers the potential environmental values in the Basin through the study by Morrison and Hatton MacDonald (2010). A significant conclusion of this study was that the aggregate value of improving the Coorong from a poor to a good condition was estimated as $4.3 billion Net Present Value over 10 years. Next steps in this area of inquiry involve linking river flow regimes with environmental outcomes and their associated economic values.

Work conducted by Marsden Jacob Associates (MJA, 2010) shed light on the socioeconomic profiles of irrigator communities in the Basin. Extensive surveys were conducted to gauge farmers’ responses to various water diversion reductions. Marsden Jacob Associates identified communities and farmer profiles that may be particularly vulnerable to the structural adjustment that SDLs could require. Insight into what characteristics render farmers more likely to exit the industry facing a specific SDL was also gained. Jackson et al. (2010) evaluate what SDLs may mean for Indigenous communities specifically. The authors draw on three case studies which catalogue Indigenous access to water, water management and Indigenous water values. There is clearly more work to be done in understanding Indigenous water values. Jackson et al. (2010) made progress in this direction, providing a framework for incorporating Indigenous water values in a more complete socioeconomic analysis.

Clearly, a significant body of work on the potential socioeconomic impacts of SDLs has been assembled. As identified in this report, however, there is a good deal of opportunity to refine this analysis further. A number of recommendations to this end are provided in Report 2 in this compilation. Limited consideration for the potential benefits of SDLs was a feature common to all but one of the studies evaluated. A deeper treatment of the benefits of SDLs and their quantification and inclusion in a benefit cost framework is recommended.

Appendix A Determining environmental water requirements

The *Water Act 2007 (*s. 22) requires the Basin Plan to include long-term average sustainable diversion limits (SDLs) which are the amount of water that may be used for consumptive purposes (drinking water, industry and irrigated agriculture among others) after meeting environmental water requirements concordant with the Water Act. Consumptive use is not to compromise key ecosystem functions or assets, the productive base of the water resource and key environmental outcomes.

The MDBA determined environmental water requirements in four main steps. First, a baseline was established by calculating, in the absence of development, the amount of water that would flow through the Murray Mouth (12,500 GL/year on average). This was compared with the long-term modelled average volume of water flowing out of the Murray Mouth (5100 GL/year). Next, the MDBA established that a healthy Basin requires the maintenance of *key ecosystem functions* which include river flow regimes (and the benefits that stem from these flows), and maintenance and enhancement of key environmental assets.

The four key ecosystem functions identified by the MDBA were: creation and maintenance of habitat; transport of nutrients and other matter; connectivity along river and across flood plains; and wetlands for foraging, migration and colonisation. In identifying key environmental assets, the MDBA reviewed 20,000 assets, assessing water-dependent ecosystems against five criteria, namely the ecosystem:

- does or is it capable of supporting species in international agreements
- is at least near natural and rare or unique
- provides vital habitat
- supports listed threatened species or ecological communities
- supports or could support significant biodiversity.

Sites that met one of the five criteria above yielded 2442 assets, 477 of which are located in the Murray region of the Basin (MDBA, 2010a, p. 63).

According to the MDBA (2010a, p. 67), end of system flows - the flows that reach the end of a Basin – may be used as a measure of the water available to maintain key ecosystem functions and therefore, key environmental assets. Determining the environmental water requirements for 2,442 assets is a formidable task. To address this challenge in a timely manner, the MDBA considered that many ecosystem functions and assets are hydrologically connected and interdependent and therefore ensuring water reaches one particular asset will ensure maintenance of ecosystem functions and assets at various locations (MDBA, 2010a, p. 69). As such, the MDBA developed a methodology for defining a subset of these assets, naming them the *Basin's* hydrologic indicator sites - 106 in total. The watering of 88 of these sites is to ensure the maintenance of key ecosystem functions while the watering of an additional 18 sites is to ensure maintenance of key environmental assets.

The basis upon which the 88 key ecosystem function sites were selected was that they: provided reliable water flow measurement over time; were geographically representative; and were representative of river types in the Basin. The 18 key environmental asset sites were chosen based on the criteria that the asset:

- contained water dependent ecosystems requiring flows at the high end of the flow regime
- was located in a valley with a natural flow regime that was significantly affected by development
- contained ecosystems with large volumetric water requirements
- was geographically representative
- avoided overlap and repetition in water requirements (MDBA, 2010a, p. 69).

Next, the MDBA considered flow targets for the 88 ecosystem function sites as a proportion of without-development conditions, rating them as good (80−100%), moderate (60−80%) and poor (less than 60%). For example, a rating of good implies that the catchment exhibits 80−100% of without-development flows (MDBA, 2010a, p. 72). Flow regimes to maintain the 18 hydrological indicator sites' watering requirements were also developed as long-term average volumes, specific flow thresholds or volumes for a period of time, and in some cases, for a specific time of year. The MDBA's analysis determined that the amount of additional surface water required for the environment is between 3000 GL/year and 7600 GL/year over the long-term. Currently, the average volume of environmental water is 19,100 GL/year indicating that environmental water requirements are between 22,100GL/year and 26,700 GL/year (MDBA, 2010a, p. xix).

In the second to last step, the MDBA considered the effect of the range of additional environmental watering (3000 GL/year to 7600 GL/year) on catchment health using the good, moderate and poor rating scheme described above. Interestingly, the 3000 GL/year scenario would leave the Condamine-Balonne, Gwydir, Loddon, Lower Darling and Murray regions in the poor ranking (MDBA, 2010a, p. 74). This scenario clearly does not represent a favourable environmental outcome for South Australia.

The environmental outcomes of various environmental water allocation scenarios were assessed by the MDBA in a relatively robust and transparent fashion. The decision to concentrate on the 3,000 GL/year to 4,000GL/year range is where the determination of an environmental water regime loses methodological rigour. Based on irrigation-sector socioeconomic analysis, the MDBA '…believes reductions that exceed 4,000 GL/y will not meet the requirements of the *Water Act 2007*. Indeed, reductions of this size would not represent an optimisation of the economic, social and environmental outcomes under the *Water Act 2007*. The Authority therefore determined that it would only examine scenarios with reductions of between 3,000 GL/y and 4,000 GL/y' (MDBA, 2010a, p. xxi).

Interestingly, from the documentation that is publicly available, the MDBA has not conducted any economy wide or overall employment impact analysis for scenarios above 4000 GL/year. While the MDBA states 'Based on the available social and economic information, the Authority has made a judgement to only examine scenarios for increasing the amount of water available for the environment to between 3,000 GL/y and 4,000 GL/y' (MDBA, 2010a, p. xxii), this judgement was made *without* having commissioned economy-wide and overall employment impact studies of scenarios that consider reductions beyond 4000 GL/year.

Appendix B Revealed preference approaches to environmental valuation

As previously discussed, the Guide focuses on the costs of SDLs and does not compare in any rigorous way, the potential market and non-market benefits that may be expected to arise with increased environmental flows. Fortunately, there is significant opportunity to build on the non-market valuation work conducted by Morrison and Hatton MacDonald (2010). Looking forward, Morrison and Hatton MacDonald have identified a number of information gaps with regards to environmental benefits in the Basin. Wetlands, given their importance as icon sites, present a significant opportunity for increasing our understanding of the environmental benefits of improved flows. In addition to the choice modelling approach, a stated preference technique, revealed preference methods can also move us towards a more complete valuation of environmental benefits.

Travel cost is a revealed preference method that provides a rigorous framework for valuing tourism and amenity values. Damage cost, replacement cost and substitute cost are also revealed preference methods. The damage cost method uses the value of an environmental service that is being protected, or the cost that may be incurred to avoid damage to the service, to approximate the value of the environmental benefit. The replacement cost method estimates the value of replacing a specific environmental service. The substitute cost method identifies the least costly alternative to providing an environmental benefit. These methods deliver conservative estimates since they do not provide a measure of total economic value, rather, they approximate the benefit of one, or a few environmental services, valued by an individual and/or society. The maintenance of water supply and water quality are benefits that may be readily valued with these revealed preference methods. Reduced water supply, for example, can require significant investment to secure alternative supply sources and enhance system reliability.

Additional revealed preference methods include averting behaviour and defensive expenditure approaches. These methods depart from the premise that households can protect themselves from non-market 'bads' by taking action at a cost. Protection from a bad may come in the way of investment in goods and services traded in the market to substitute for a non-market service. There are numerous examples of this in the Basin, such as the conveyance infrastructure that was constructed to supply consumptive water to communities of the Lower Lakes, salt interception schemes, and the extension of ferry landings for river transportation. Similar to damage, replacement and substitute cost methods, the values generated by these approaches may be considered as a lower bound for the value of an environmental benefit.

The Commonwealth and South Australian governments have incurred significant costs in mitigating environmental damage caused by the recent drought. Based on these costs, and those anticipated should the current drought continue, a lower bound for the value of environmental benefits generated by regular (non-drought) river flows may be estimated. Table 2 is a first-take in cataloguing the environmental values affected by low flows, the related mechanisms of impact, and the data sources required to generate value estimates. Currently, CSIRO's Natural Resource Economics and Decision Science group is engaged in this work.

Table 2. Reduced river flow impacts on ecosystem services

Impact	Mechanism of Impact	Costing
Irrigated agriculture	Greater and less variable/less saline water supply increases food output.	Lower Murray Economics, ABARE, TERM. Drought packages and exit grants SA government purchase of water allocations for permanent plantings. SA water purchase of entitlements for secure allocation to meet critical human water needs. Re laser levelling of dairy areas. Cracked levee banks can result in 25-30 GL annual water loss. LMRIA- millions in cost sharing grants to irrigators to improve infrastructure; optional and mandatory works- much of this investment has been damaged due to drought.
Municipal and industrial water quantity and quality	Allocations and sufficient conveyance water provide M&I water quantity; Adequate flows at off-takes provide water quality attributes desirable for M&I use like salinity and algae, acid sulphate and heavy metal risks with wetland and lake bed drying.	SA Water, University of Adelaide (Maier), CSIRO (Kandulu) urban water economics. Quantity: water restriction cost studies and alternate supply costs. Quality: treatment costs and infrastructure damage cost.
Bank stability	Less than normal conveyance flow resulting in reduced bank stability, desiccation below lock 1, flood plain damage, landslides, loss of access to water/dwellings and loss of real estate. Lake front houses now 30 meters from lake.	Costs incurred by state/local government for impact mitigation; repairs to levy banks; Riverbank collapse (has claimed vehicles and roads); hotspots have been identified. 1400 shacks and holiday homes valued at an average of $400,000 each are within 50 metres of the river. Risks also to boat ramps, marina services, pumps and sheds, utilities, roads and residences. Large trees contribute to collapse while their removal may be up to $5,000/tree. Riverbank collapse information program valued at $400,000/year.
Recreational/tourism/amenity use values - *weir pool based*	Regulated, relatively constant weir heights (enough to avoid blue green algae) create conditions safe for human contact.	Travel cost, hedonic price models, visit times visit value.
Recreational/tourism/amenity use values - *natural flow based*	Near natural flow patterns sustain healthy ecosystems and biodiversity, floodplain forests, bird populations and fish population.	Morrison (CSU) & Hatton MacDonald (CSIRO) Australia wide surveyed values (willingness to pay) studies. Bird watching visitation rates. Lower levels will require construction of new dry dock. Potential displacement of 475 houseboats below lock 1 (at −1.5 m AHD). Property values in Meniningie, Clayton Bay and Milang were reduced by up to 30%. Goolwa Township economic impacts to tourism and recreation activity. Businesses directly connected to water and tourism declined by up to 80%. Houseboating in the CLLMM and beyond has been reduced by over 50% in the last 5 years. 800 boats were removed from the Goolwa region due to low flow resulting in local business losses of up to $2 million/year.

Impact	Mechanism of Impact	Costing
Lower Lakes and Coorong level- salinity and acid sulphate soils impacts.	Low flows reduce levels and raise salinity in Lower Lakes and Coorong and uncover acid sulphate soils. Lake level maintenance required to keep salinity levels and acid sulphate soils in check. Proliferation of tubeworm.	Various estimates of costs of treatment (liming, infrastructure such as SE drains, new barrages, new freshwater pipelines, local desalinization. Lost tourism, reduced real estate values. Cost of plantings and bioremediation trials. Research in use of sea water to avert lake acidification and amount of fresh water required at site to avoid catastrophic acidification. Dredging cost. Water purchases for the environment and infrastructure upgrades. Major research project involving key national research bodies. Bioremediation trials. Seeding of over 10,000 ha. Planting over 1 million wetland plants on exposed soils. Acid sulphate mitigation via liming: 3,000 tonnes were applied to the Goolwa Channel, Currency Creek and Finnis River. Research into cost of seawater to avert lake acidification. Research into cost of use of freshwater requirements to avoid large-scale catastrophic acidification event. Pumping of hyper saline water from the South Lagoon to the sea. Translocation of key aquatic plants. Water purchases for critical human needs and the environment: 50 GL plus an additional 120GL in 2009-2010. Lakefront habitat restoration at Lake Meningie.
Commercial and recreational fisheries	Flows sufficient to maintain lakes fisheries productivity.	Restoration of fish passages, lost revenues from commercial and recreational fisheries. Fish freeways.
Carbon	Flows sufficient to inundate floodplain forests support continued carbon sequestration.	Value of carbon sequestered.
Transportation	Low flows render ferry landings inaccessible; river impassable due to shallow water; difficulties for emergency vehicles.	Trip cancelations and cost of moving ferry landings. Unusable marinas. Modifications to enable ferry crossing. Further drops in river levels could require dredging to maintain a navigable channel.
For all of the above	Research, planning and monitoring of mitigation and adaptation measures.	Investment in research, planning and monitoring.

Appendix C Meeting critical human needs – key issues

The *Water Act 2007* (Cwlth) states that the Basin Plan needs to take into account critical human water needs. Section 86A(2)(a) of the Act defines taking account of critical human water needs as delivering the minimum amount of water, that can only reasonably be provided from Basin water resources, required to meet core human consumption requirements in urban and rural areas. The way that Basin water resources are managed will impact water quantity available from the Murray, and potentially quality attributes of this water that make it more or less suitable for human consumption requirements in South Australia's (SA; and other states') urban and rural areas. The Guide to the proposed Basin Plan (MDBA, 2010a) states that a new Schedule for Water Sharing is being developed in parallel with the Basin Plan provisions for critical human water needs. This schedule will provide some of the key mechanisms to set aside, deliver and account for the critical human water needs and conveyance reserves. The objective of this section is to outline findings from previous studies on key water quantity and quality impacts associated with changes in River Murray flow regimes to SA's urban and rural areas. The Basin Plan needs to take these impacts into account to ensure that critical human needs in SA's urban and rural areas, especially during low flow periods, are met.

State governments have the responsibility of ensuring supply and quality reliability to meet the basic human water needs of individuals and communities reliant on the rivers of the Basin. Decisions on: how water from each state's share is used; which water uses will be treated as 'critical' for specific communities; and how risks associated with the provision of critical human water needs are managed are left to state governments. Under the Murray-Darling Basin Agreement, SA received a minimum annual water allocation of 1850 GL (entitlement flow) to satisfy community demands (Jacob, 1990). The Basin Plan will outline a graduated or tiered approach to sharing water in the River Murray system that is linked to water availability. This allows additional water sharing rules and contingency measures to be invoked during periods of extremely low water availability. When critical human water needs cannot be met or delivered by the arrangements of the current tier, a change to a higher tier is triggered.

To assess water quantity and quality impacts of reductions in diversions (MDBA, 2010a) for urban and rural areas in SA, further details on how SA implements Sustainable Diversion Limits (SDLs) to meet critical human needs under low flow conditions is required, including:

- how SA Water, South Australia's government water utility responsible for providing drinking water to 1.5 million people in several municipal centres across SA, shares River Murray water amongst regional municipal centres across SA
- the extent to which River Murray water available to SA Water affects overall reliability of urban and rural water supply system
- minimum service-level water supply and quality requirements (for meeting critical human needs) below which SA water would need to invest in alternative additional supply and treatment infrastructure
- cost and reliability characteristics of available alternative water supply and treatment infrastructure including but not limited to building infrastructure to enable carry over between one water year and the next
- details/criteria on/for (and compliance and enforcement) strategies including flow management, monitoring, assessment and risk management provisions that will 'enable the Authority on behalf of, and in conjunction with, the Commonwealth, New South Wales, Victorian and South Australian governments to assess and mitigate risks to critical human water needs'
- modelling of water quality and salinity trigger points (840 mg/L) at which water in the River Murray system becomes unsuitable for meeting critical human water needs
- details on system level (and localised) emergency response options to adequately address risk of water quantity and quality characteristics exceeding threshold levels through flow management and infrastructure construction and operation (volume, timing, source – Darling, Murray, Lake Victoria, etc).

From previous studies, we consider key water quantity and quality impacts that may be affected by the Basin Plan including water security and water quality. Key water quantity impacts considered include costs of investing in supply augmentation to enhance water supply reliability of urban and/or rural water supply systems, and implementing water restrictions to cope with low water availability in low flow years. Key water quality impacts considered include treatment and damage costs from changes in levels of water quality indicators including salinity, toxins from growth of blue-green algae, sediment and turbidity levels, and occurrence of acid sulphate soils. Below these studies are outlined and key findings discussed in detail.

Supply augmentation

Typically, the decision to invest in water supply augmentation would be necessary if SA Water were unable to meet minimum service-level reliability requirements due to reduced River Murray entitlement. To assess water availability impacts, we would need to understand the extent to which River Murray flows with/without the plan would affect overall reliability of water supply systems in urban and rural areas. If more/less water is available to SA Water with/without the Plan, there would be avoided costs/incremental costs associated with not investing/investing in alternative supply sources to enhance water supply system reliability including:

- engineering set-up and operations and maintenance costs (SA Government, 2005, 2009; Marsden Jacob Associates, 2006; Hughes et al., 2008; Paton et al., 2009)
- environmental damage costs associated with increased energy usage (e.g. higher GHG emissions) (SA Government, 2005; Marsden Jacob Associates, 2006; Hughes et al., 2008; Paton et al., 2009; SA Government, 2009).

Water restrictions

The security of water in SA's urban and rural areas may be affected by the restrictions imposed under the Basin Plan. Without the Basin Plan there is some possibility that in low flow scenarios water of sufficient quantity and quality might not be available for all areas serviced by SA Water to meet usual demand. In the short-run, major capital works to augment supply or treatment may also not be possible. In such circumstances, restricted supply would result.

Several studies have found that there are significant costs from implementing water restrictions in Australian cities (Brennan et al., 2007; Hughes et al., 2008; Grafton and Ward, 2008). In these studies, the cost of implementing water restrictions arises from water consumers' loss of the option to pay higher volumetric prices for their water to satisfy particular uses such as outdoor watering assuming water consumers' are willing and able to pay higher prices. The cost of water restrictions is defined as the foregone benefit resulting from water restrictions.

Water quality

The MDBA considers that the Basin Salinity Management Strategy and the Water Quality and Salinity Management Plan (yet to be released), combined with raw water treatment that is consistent with the Australian Drinking Water Guidelines, will adequately address the risks associated with any other public health issues and impacts associated with drinking water sourced from the River Murray system.

The Plan states that two initiatives, the National Water Quality Management Strategy and the Basin Salinity Management Strategy, are currently guiding development of the Basin's Water Quality and Salinity Management Plan. The objectives of these bodies of work are to manage risk, understand accountability, and deal with water quality and salinity issues in a whole-of-Basin approach.

Changes in flow impact the quality of raw water entering SA Water reservoirs. Depending on how flows are managed with/without the Plan, SA Water may incur low/high treatment costs to treat raw water to the level consistent with Australian Drinking Water Guidelines (SA Water, 2007, 2009, MDBC, 2000). Previous studies have identified key water quality indicators associated with changes in flows in the Murray including salinity (Wilson, 2003; Wilson and Laurie, 2002; CSIRO, 2003, 2006; SA Government, 2005, 2009; MDBA, 2010a and 2010b), blue-green algae (Hotzel and Croome, 1994, 1996; Bormans et al., 1997; Baker et al., 2000; Maier et al., 2001a and 2001b); sediment levels (SA Water, 2007 and 2009; MDBA, 2010), and heavy metals and acid sulphate soils (Fitzpatrick et al., 2008; Simpson et al., 2008). These water quality indicators are generally associated with a range of water quality attributes including salts (hardness), toxicity, turbidity, and acidity/alkalinity which affect characteristics of drinking water such as colour, taste and odour. Furthermore, salinity is associated with damages to various equipment including but not limited to treatment infrastructure, household plumbing fixtures, and industrial equipment (GHD, 1999; Connor, 2006; Connor, 2008). Depending on how flows are managed with/without the Plan, SA Water, and its urban and rural customers may incur salinity damage costs associated with high salinity levels especially during low flow periods.

The Plan states that 'water quality and salinity targets will not impose direct mandatory compliance obligations on government. Instead, at the regional level, water quality management plans will need to be prepared as a part of the water resource plans and will include management actions that, when implemented, will ensure that water quality target values are achieved. Flow management decisions made by operating authorities or infrastructure operators must have regard to any adverse impact on water quality at the Basin level.' There is need for details on compliance and enforcement mechanisms that would be implemented to enhance the effectiveness/likelihood of the Plan to meet critical human needs.

Blue-green algae

Previous studies investigated flow management options for controlling blooms of blue-green algae and found that entitlement flow conditions determine the likelihood of sustained blooms of blue-green algae in the River Murray at Morgan, SA (Maier et al., 2001b). These studies also identified flow management as the most cost effective strategy for combating bloom formation. To assess the risk and costs of blue-green algae data is required on: the management of daily flows in critical months for growth of blue-green algae (December to March) from the National Water Quality Management Strategy; and effective strategies to contain blooms from the Basin Salinity Management Strategy (Maier et al., 2001a and 2001b). The Basin Plan will identify new long-term average annual SDLs, however, details on how daily flow rates will be managed would be more useful in assessing the risk and cost-effectiveness of flow-management strategies for achieving water quality outcomes for SA.

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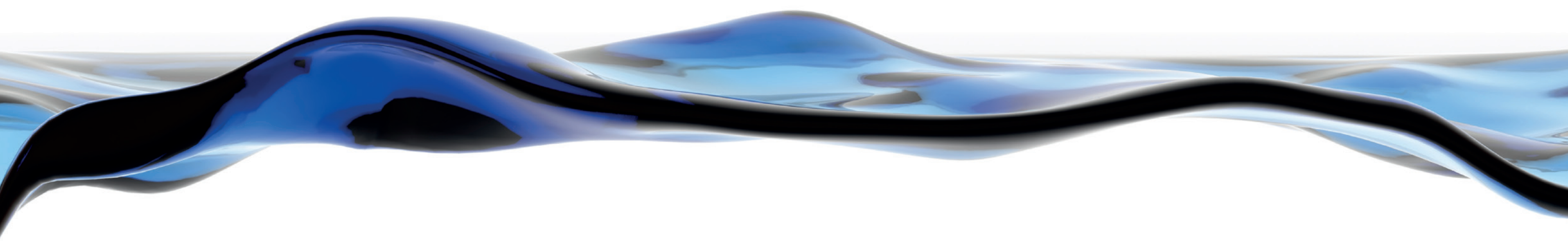

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