# FINAL REVIEW REPORT

# FOR THE MURRAY-DARLING BASIN AUTHORITY (MDBA)

## AN INDEPENDENT REVIEW OF THE SOCIAL AND ECONOMIC MODELLING INPUTS TO THE NORTHERN BASIN REVIEW



## RFQ Nos: MD3480 & MD003604

12 October 2016

Prepared by Dr Boyd Blackwell<sup>1</sup>, Mr Jim McFarlane<sup>1</sup>, & Mr Richard Stayner<sup>2</sup>

1. UNE Business School, University of New England

2. Institute for Rural Futures, University of New England





The University of New England respects and acknowledges that its people, programs and facilities are built on land, and surrounded by a sense of belonging, both ancient and contemporary, of the world's oldest living culture. In doing so, UNE values and respects indigenous knowledge systems as a vital part of the knowledge capital of Australia. FINAL NORTHERN MURRAY DARLING BASIN SOCIO-ECONOMIC MODELLING REVIEW 12 OCTOBER 2016



#### © 2016 Blackwell, McFarlane and Stayner University of New England, Armidale NSW 2350

Sources of figures front page: From top right clockwise

www.mdba.gov.au/basin-plan-roll-out/northern-basin

MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Final Report, 27 Sep 2016. Canberra: MDBA.

MDBA. (2015). Fish and Flows in the Northern Basin: Responses of Fish to Changes in Flow in the Northern Murray-Darling Basin. Canberra: MDBA. Retrieved from http://www.mdba.gov.au/kid/files/2555%20-

%20Fish%20and%20Flows%20in%20the%20Northern%20Basin%20Stage%203%20Final%20Report%20August%20201 5%20-%20Executive%20Summary.pdf

Bettles, Colin. (2015, 29 September). Counting Basin Plan's Social Costs. *The Land*. Retrieved from http://www.theland.com.au/story/3388655/counting-basin-plans-social-costs/?cs=4963

A suitable reference for this report is:

Blackwell, Boyd, McFarlane, Jim and Stayner, Richard (2016). *Final Review Report For the Murray-Darling Basin Authority (MDBA): An Independent Review of the Social and Economic Modelling Inputs to the Northern Basin Review, 12 October 2016.* Armidale: University of New England.





## Table of Contents

1.	Executive Summary	4
	Overall view of modelling	4
	Social and economic modelling	4
	Community Consultation Report	6
	Lower Balonne floodplain graziers modelling report	9
2.	Introduction	11
	Background and context	11
	Materials provided and implications for review	12
	General approach to undertaking modelling review	13
	Outline of report	16
3.	Literature Review	17
	Global assessment of river basin water productivity	17
	Critique of traditional water efficiency	17
	Water productivity in the Australian cotton context	17
	Work undertaken by MDBA	18
	Regional economic resilience, commuting, and technological shifts	22
	Australian water policy specific studies	23
	International economic assessment of water reductions	24
	Summary and conclusion on literature review	25
4.	Comments on General Approach to Modelling	28
4.	Comments on General Approach to Modelling Introduction	<b> 28</b> 28
4.	Comments on General Approach to Modelling Introduction General approach and factors of production	<b> 28</b> 28 28
4. 5.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling	28 28 28 31
4. 5.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies	28 28 28 31
4. 5.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data	28 28 28 31 31
4. 5.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling	28 28 28 31 31 31 33
4. 5.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling Relationship between hectares and jobs	<b>28</b> 28 31 31 31 33 33
4. 5.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling Relationship between hectares and jobs Longer period for data	<b>28</b> 28 31 31 31 33 34 34
4. 5.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling Relationship between hectares and jobs Longer period for data Referencing of data sources and assumptions	<b>28</b> 28 31 31 31 33 34 34 34
4.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling Relationship between hectares and jobs Longer period for data Referencing of data sources and assumptions Clear and explicit presentation of the econometric results	<b>28</b> 28 31 31 33 34 34 34 35
4.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling Relationship between hectares and jobs Longer period for data Referencing of data sources and assumptions Clear and explicit presentation of the econometric results Correction for omitted variable bias	<b>28</b> 28 31 31 31 33 34 34 34 35 35
4.	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling Relationship between hectares and jobs Longer period for data Referencing of data sources and assumptions Clear and explicit presentation of the econometric results Correction for omitted variable bias Other reviewer comments	<b>28</b> 28 31 31 31 33 34 34 34 34 35 35 35
<ol> <li>4.</li> <li>5.</li> <li>6.</li> </ol>	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling Relationship between hectares and jobs Longer period for data Referencing of data sources and assumptions Clear and explicit presentation of the econometric results Correction for omitted variable bias Other reviewer comments	28 28 31 31 31 33 34 34 34 35 35 36 37
<ol> <li>4.</li> <li>5.</li> <li>6.</li> </ol>	Comments on General Approach to Modelling	28 28 31 31 31 31 33 34 34 34 35 35 35 35 37
4. 5. 6.	Comments on General Approach to Modelling	28 28 28 31 31 31 33 34 34 34 35 35 36 37 37
<ol> <li>4.</li> <li>5.</li> <li>6.</li> <li>7.</li> </ol>	Comments on General Approach to Modelling Introduction	28 28 28 31
<ol> <li>4.</li> <li>5.</li> <li>6.</li> <li>7.</li> </ol>	Comments on General Approach to Modelling Introduction General approach and factors of production Comments on Specific Aspects of Modelling Broader consideration of sectors for regional and local economies Use of ABS employment data The linear relationship used in MDBA water (ML) to land-use modelling Relationship between hectares and jobs Longer period for data Referencing of data sources and assumptions Clear and explicit presentation of the econometric results Correction for omitted variable bias Other reviewer comments Community Consultation Over Modelling Brief review Lower Balonne Floodplain Grazier Modelling Introduction	28 28 28 31 31 31 34 34 34 35 35 35 36 37 37 37 37 37 37





### **1. Executive Summary**

#### Overall view of modelling

The MDBA is reviewing the water recovery targets for the Northern Basin and to inform their decisionmaking, in our independent view, they have undertaken an extensive series of works on modelling the social and economic impacts of water recovery from the communities of the Northern Basin. They bring this together in an interim summary report<sup>1</sup> that allows the reader then to see the extent of work and the key assumptions and results, while at the same time if required, being able to drill deeper into the detail of the accompanying reports.<sup>2</sup>

Undertaking this modelling work is no easy task, given data limitations and methodological hurdles, however we are confident that through our review process, the MDBA have shown a willingness to refine and enhance their modelling by taking on board the majority of our improvement recommendations, if not in the short term due to time constraints, then as part of their medium to longer term planned work program.

We are also in agreement with the MDBAs overall approach to the use of the modelling work, and refer to Feldstein's quote that "a useful model is not one that is 'true' or 'realistic' but one that is parsimonious, plausible and informative".<sup>3</sup> Because of this inherent limitation in all models, the MDBA has a broad range of supporting social, economic, contextual and local information that is presented and should be duly considered along with the modelling outputs in reaching any given decision.

Similarly, no rural community exists in a 'stable state' of perfect predictability, but is a dynamically complex system that is in a continual state of adjustment to some socio-economic change or another. Having a healthy appreciation of this complexity, such as by understanding that each community has a different adaptive capacity to change, shows that the MDBA's modelling and supporting information are together critical to making decisions over water withdrawals.

#### Social and economic modelling

The MDBA have progressed their social and economic modelling work for the Northern Basin communities by using the key indicator for social and economic wellbeing for communities: employment. As part our independent review we have made 14 recommendations (noted in the main text of this report as Recommendation # and in yellow highlights) where in our opinion the MDBA was able to improve its modelling work. These recommendations should be tempered by our three caveats or findings (also noted in the main body text as Finding/Caveat# in blue highlights). Table 1 summarises our recommendations and documents how the MDBA, in conjunction with KPMG, have followed up on the majority of these recommendations as noted in the final two columns in red or subsequently in green.

Table 1: Summary of recommendations and findings or caveats, and response period (Source and notes: see
Recommendation # or Finding/Caveat # in text; * means important matters to address)

Recommendation	or rinding/ cuvcut in in text	, means important matters to data ess,	
Recommendation # • Finding/Caveat #	Detail	Short term MDBA response and subsequent response, subsequent response	Medium to long term MDBA response and subsequent response, subsequent response
R1	Consideration of water withdrawal impacts on other factors of production	<ul> <li>✓ At least to be discussed</li> <li>✓ <sup>4</sup> ✓ and addressed on pp. 8-9,</li> <li>19 of 27 Sept MDBA report.</li> </ul>	<ul> <li>Ongoing work program could incorporate the technical inclusion of factor</li> </ul>

<sup>&</sup>lt;sup>1</sup> MDBA. (2016). Northern Basin Review: Technical Overview of the Socioeconomc Analysis, Draft Interim Report, 27 Sep 2016. Canberra: MDBA.

<sup>&</sup>lt;sup>3</sup> Feldstein, Martin. (1982). Inflation, Tax Rules and Investment: Some Econometric Evidence, The 1980 Fisher-Schultz Lecture of the Econometric Society, <u>*Econometrica*</u> 50(4), 825-862, p. 829. <u>http://www.jstor.org/stable/1912766</u>



<sup>&</sup>lt;sup>2</sup> For example, KPMG. (2016). Northern Basin Community Modelling: Economic Assessment of Water Recovery Scenarios, 16 August 2016 Draft Report. Sydney: KPMG.

#### FINAL NORTHERN MURRAY DARLING BASIN SOCIO-ECONOMIC MODELLING REVIEW 12 OCTOBER 2016



Recommendation # • Finding/Caveat #	Detail	Short term MDBA response and subsequent response, subsequent response	Medium to long term MDBA response and subsequent response, subsequent response
	to labour, like land and capital		impacts and substitutability. ✓ Responsive wage data may help capture substitution effects <sup>5</sup>
R2	The need to attach monetary values via impacts on returns to factors of production or the asset values of these factors	<ul> <li>✓ At least to be discussed ✓ as above – asset values not explicitly addressed though mentioned e.g. p.17 KPMG report</li> <li>✓ and addressed on pp. 8-9, 19 of 27 Sept MDBA report.</li> </ul>	✓ Ongoing work program could incorporate the inclusion of monetary values for factor impacts ✓ as above – asset values not explicitly assessed though mentioned e.g. p.17 KPMG report,
• F/C1	Exogenous factors may have a greater influence on factor impacts, substitutability, returns and assets values	<ul> <li>★ If such a case can be proven, Nil; MDBA have captured the nub of the issue <i>ceteris</i> paribus ✓ Addressed in MDBA report e.g. p. 2, 27 Sep 2016 version</li> </ul>	? Influences could be temporally controlled for and monitored
• F/C2	Jobs only captures part of the social and economic impact picture	See R1&2 above	See R1&2 above
R3	Incorporation of relative employment measures into the modelling	<ul> <li>Currently as % of total employment sufficient) ✓</li> </ul>	<ul> <li>A review to identify most desirable relative employment measures e.g. employment concentration, utilization combined with Stenekes et al.<sup>6</sup></li> <li>noted on p. 33 of KPMG report</li> </ul>
• F/C3	Job losses likely to be overestimated <sup>7</sup> due to impacts of technology (e.g. GM cotton) and substitution of labour with capital	✓ Can be noted as such ★ not explicitly addressed: substitution discussed p. 19 of KPMG report, though discussed as driver of change on p. 20 of MDBA report. <sup>8</sup> ✓– counter reasons for underestimation now included in 27 Sept MDBA report, pp. 18-19	<ul> <li>Could be explicitly addressed in ongoing monitoring and evaluation</li> <li>(Need a section like in KPMG report about future work) </li> <li>– future work section now included</li> </ul>
R4	Greater explicit breakdown of employment impacts by 720 industrial subsectors for each community	<ul> <li>✓ Will better inform agreement making by helping stakeholders with focusing adaptation responses ✓ noted results based on 720; MDBA, p. 15 and ¥ MDBA breakdown could be provided where requested by community.</li> </ul>	
R5	Mapping of spatial impacts	? Though very useful in helping reach agreement, timeframes likely to be too short	✓ ★ recommendation still stands to be addressed. Could be included in possible future work
R6	Identify spatial employment impacts through various types of employment (local, inbound, and outbound, micro subsector sources)	? See R7 where insufficient time to do this, though doing so could ease decision/agreement-making	<ul> <li>recommendation still stands to be addressed.</li> <li>Could be included in possible future work</li> </ul>
R7	Source of ABS employment data and how it was	<ul> <li>important to provide an early indication of spatial consequences of job losses, or to</li> </ul>	

<sup>5</sup> KPMG. (2016). p. 33.

<sup>6</sup> Stenekes, N, Kancans, R, Randall, L, Lawson, K, Reeve, I, & Stayner, R. (2012). Revised Indicators of Community Vulnerability and Adaptive Capacity Across the Murray-Darling Basin: A Focus on Irrigation in Agriculture. Canberra: ABARES. <u>http://www.mdba.gov.au/kid/files/1715-Revised-indicators-of-community-vulnerability.pdf</u>

<sup>&</sup>lt;sup>8</sup> MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Report, 2 Sep 2016. Canberra:





<sup>&</sup>lt;sup>7</sup> See previous footnote about cases where jobs may also be overestimated.

FINAL NORTHERN MURRAY DARLING BASIN SOCIO-ECONOMIC MODELLING REVIEW 12 OCTOBER 2016



Recommendation # • Finding/Caveat #	Detail	Short term MDBA response and subsequent response, subsequent response	Medium to long term MDBA response and subsequent response, subsequent response
	extracted needs to be discussed	provide caveats on degree of over or underestimation  ★ not yet discussed in MDBA or KPMG reports. ✓ – now identified as Place of Usual Residence e.g. p. 19 of 27 Sept MDBA report	
R8	Relationship between water use and yield	✓ As per below ✓ now explained though our view is that the underlying series is time dependent	
R9	Relationship between hectares and jobs needs a suitable transformation and a lag of dependent variable as explanatory variable	✓ Standard statistical practices with time series (or panel) data ✓ now explained in MDBA report though our view is that the underlying series is time dependent	
R10	Obtain a longer period for the data, i.e. larger number of observations	<ul> <li>(to improve the statistical power of the modelling)          now explained in KPMG report         p. 5 that limited by very small number of         observations</li> </ul>	
R11	Referencing of data sources and assumptions in modelling spreadsheets and 'groundtruthing' data with stakeholders e.g. industry	✓ ✓ now detailed and have undertaken community consultation (MDBA, p. 8) – it is not within the review's scope to verify the veracity of this consultation	
R12	Clear and explicit presentation of statistical results of modelling including standard diagnostic testing	✓ ✓ now detailed in reporting, including autocorrelation as a time series diagnostical test with explanation given <sup>9</sup>	
R13	Inclusion or results of potential omitted explanatory variables in regressions	✓ Otherwise results could be misinforming or insufficiently documented. ✓ reporting now explains process undertaken to check for omitted variables	
R14	Other reviewer comments	✓ Have not checked for these; these are left to MDBA to address. These are not within the scope of our terms of reference	

As shown in the table, a number of opportunities exist for the MDBA to better present results to the affected communities as part of their ongoing work program, including as part of their monitoring and evaluation framework, particularly through the addition of a section in their summary report of planned future work (F/C3) as KPMG have in their draft report. This future work could include spatial mapping of impacts and better accounting for leakage in the employment impact analysis. The reports have been immediately improved by providing a brief description of the type of source of employment data primarily used, that is, place of usual residence is used rather than place of work or place of enumeration (R7). While we would like to see a more detailed breakdown of impacted industrial sectors to help with community adaptation and economic planning we are satisfied with how the MDBA or KPMG have addressed our prior concerns.

#### **Community Consultation Report**

In addition we reviewed the MDBA consultation report and summarise the outstanding issues in Table 2. The full review can be read in section 6 of this report. Of note, real estate value changes, accounting or planning for lag times for new industries to start-up, costs being greater than benefits, significance of impacts on towns and businesses from buybacks, and the fact that local irrigators do not want to sell their water need to all be addressed in the MDBA's (or KPMG) modelling reporting.

<sup>&</sup>lt;sup>9</sup> MDBA. (2016). Northern Basin Review: Technical Overview of the Socioeconomc Analysis, Draft Interim Report, 10 Oct 2016. Canberra: MDBA, pp. 14-15.





lssue No.	Issue	Detail	MDBA response	Our response (subsequent)
Data ai	nd Information			
CCI1	Data paucity	MDBA asked how handing data gaps post 2011.	Constrained by ABS census years – 2011 most recent (2016 in progress, available mid 2017 & will be included in future reports) yet supplemented through (i) annual ABS ag and (ii) ABARES farm surveys and (iii) Australian Collaborative Land Use and Management Program May 2016 update as well as Townsend (iv) talking with local farmers, businesses and people in the community.	✓ MDBA response valid, except (iv) while providing context can not, as presented, be validated as representative ★
CCI2	Job numbers	Preference for actual job numbers rather than percentage change	Incorporated into analysis	<i>v</i>
CCI3	Full-time equivalents (FTEs) versus employment levels	Employment has low correlation with FTEs: Peaks and troughs not captured by FTEs.	Variability taken into account in analysis	~
CCI4	Real estate value changes	Why not included in the analysis?	(No response provided)	<ul> <li>Should be addressed by MDBA, similar to our comment in regards to accounting for substitution between factors of production: Land, Labour and Capital.</li> <li>now addressed on p. 19 of 27 Sept MDBA report.</li> </ul>
Impact	lag time			
CCI5	Impacts from previous buybacks still flowing through communities	Dirranbandi used as a an example	See below	See below
CCI6	Lag time for new industries to start-up	Temporal nature of impacts and consequences for closures and start-ups needs greater consideration	Lag time likely to be 2-5 years for adaptation or adjustment to water recovery shock. Where towns are looking to new industries and innovation, they should discuss broad range of issues including: credit, supply, and farm-town connections.	✗ The analysis should incorporate at least some discussion of temporal impacts – at least short term and intermediate to longer term.
Manag	ement of Busines	s and Community I	Diversity and Connectivity	
CCI7	Community boundaries	Why did they use those different to ABS?	Because boundaries were established based on taking account of the diverse economy and community context for each Broken lines indicate connectivity between	✓ but note difficultly for third party to reproduce results without conversion of standard data to new boundaries

## Table 2: Issues raised through Community Consultation Phase 2 <sup>10</sup>

<sup>10</sup> This table provides a summary of MDBA. (2016). Northern Basin Review Phase 2 Engagement Program: Community Meetings, July 2016. Canberra: MDBA.





lssue No.	Issue	Detail	MDBA response	Our response (subsequent)
			communities and more broadly – demarcation always difficult.	
CCI8	No ag and ag business relationship	Are not all industries connected and dependent on ag in small ag towns?	Non ag includes: hairdressers, retail and accommodation. Appreciate these aren't unrelated to ag esp. in small towns. KPMG modelling designed to account for these relationships.	✓ again, sometimes demarcation difficult but has to be done.
CCI9	Structural changes in St George	Resulted in is less diversity of businesses	(No response provided)	
Buybac	ks versus additio	nal infrastructure i	nvestment	
CCI10 (i)	Buybacks –v- infrastructure have different impacts	These need to be understood by MDBA	(No response necessary – see below.)	NA
(ii)	Costs to communities greater than what presented	Why not a full cost-benefit analysis?	(No direct response provided)	★ Needs to be explicitly addressed. ✓ Now addressed on p. 7 of MDBA 27 Sep report: limited information to do so, would require value judgments, and monetization may obscure social and economic relationship outcomes.
(iii)	Significant impacts on towns and businesses from buybacks	How is MDBA responding to this?	(No direct response provided)	Needs to be explicitly addressed
(iv)	Local irrigators do not want to sell their water	Reason why Australian Government is prioritizing infrastructure spending over buybacks <sup>11</sup>	Implicit reference to Australian Government Water Recovery Strategy?	✓ While strategy sets out Government's strategy does this address community concerns and ideological divide between saving water for the environment through buy-backs and creating more water for growers through infrastructure investment? There is a cap on water buy-backs and plan for investment. ★
Climate	variability and c	hange		
CCI11	Impact of drought	Discussed	Modelling through scenarios takes a long-term view to take account of a range of pressures, incl. drought, which communities need to manage. MDBA presented shifts in decline in casual labour, change in age structure, impacts on business resulting from drought over time	
CCI12	Climate change impacts on community	Have these been included?	Hydrological modelling does not incorporate climate change scenarios rather incorporates a range of historical climate conditions <sup>12</sup> that more than adequately captures average climate	~

 <sup>11</sup> Department of Environment. (2014). Water Recovery Strategy for the Murray-Darling Basin, June 2014. Canberra: Commonwealth of Australia. Retrieved from <a href="http://www.environment.gov.au/system/files/resources/4ccb1c76-655b-4380-8e94-419185d5c777/files/water-recovery-strategy-mdb2.pdf">http://www.environment.gov.au/system/files/resources/4ccb1c76-655b-4380-8e94-419185d5c777/files/water-recovery-strategy-mdb2.pdf</a>
 <sup>12</sup> MDBA. (2012). Hydrological Modelling to Inform the Proposed Basin Plan, February 2012. Canberra: MDBA. Retrieved from <a href="http://www.mdba.gov.au/sites/default/files/pubs/Hydrologic\_Modelling\_Report.pdf">http://www.mdba.gov.au/sites/default/files/pubs/Hydrologic\_Modelling\_Report.pdf</a>





lssue No.	Issue	Detail	MDBA response	Our response (subsequent)
			change impacts on water availability. Referred to MDBAs approach to climate change <sup>13</sup>	
Moving	; forward			
CCI13	Qld Murray- Darling Committee	Complimentary about work to date and need to work with Universities on impacts for fish and birds	(No response required)	NA

#### Lower Balonne floodplain graziers modelling report

Finally, we reviewed the modelling of impacts for the floodplain graziers in the Lower Balonne. Overall the modelling appears thorough being contextualized by consultation and discussion with graziers to better interpret the results; the modelling has been prepared in a sufficiently complex way yet grounded by inbuilt rules that mirror practical grazier decision-making. Our concerns with the modelling centre on that done for grazier earnings as summarized in Table 3 but we believe these have been responded to by the MDBA as noted in the table. If necessary, further MDBA modelling work in the longer-term could include these suggestions.

#### Table 3: Summary of review items

lssue No.	Issue	Detail	MDBA response (where relevant, our suggestion)
GI1	Earnings modelling – inclusion of full costs	Overhead or fixed costs could be included in the earning estimates to provide net earnings (to ensure graziers take account of land taxes, capital assets, manager income – noted on p. 15 – and forgone income to themselves), however, only considering the marginal costs is an economically valid approach and fixed cost and wealth effects are explicitly noted as not included in the modelling in Appendix B, p. 43 and as a limitation.	✓ Floodplain modelled as a single unit rather than for individual business – too great a variation (10-20 times size difference, smallest to largest) to model a typical business plus modelling complexities (changes in business structure/processes) from water changes) outside scope of project. <sup>14</sup>
GI2	Earnings modelling – inclusion of relevant marginal costs	Establishing whether floodplain grazing is viable should include consideration of all relevant marginal costs (as noted above) but also forgone income to graziers themselves – to ensure they earn enough to pay themselves for their efforts), otherwise these co-benefits of environmental flows should be seen as co-costs/non-benefits of water for the environment.	✓ Labour costs (variable) explicitly included in modelling, though not 'for sell-offs' or 'agistment which mostly involve loading and unloading' stock. <sup>15</sup>
GI3	Yearly earnings estimates – incorporation of time value of money	As noted by author on p. 32, these need to be summed overtime because they are typically earned at points in time. Has the author considered time value of money in their earnings models and if not, it may be better to convert annual benefits to net present values to account for the mismatch of costs and benefit flows overtime.	✓ Yes was considered though results to be interpreted as what is expected next year under the different scenarios, NPV may confound some of important messages about sequence of flows because volumes not randomly distributed through time, it does not include costs and benefits for cotton reduced upstream and is only a partial analysis, and results relate to whole floodplain and not individual

<sup>&</sup>lt;sup>13</sup> Neave, I, McLeod, A, Raisin, G, & Swirepik, J. (2015). Managing water in the Murray-Darling Basin under a variable and changing climate. *Water*, *42*(2), 102-107. Retrieved from

www.mdba.gov.au/sites/default/files/pubs/Managing%20water%20in%20the%20murraydarling%20basin%20under%20variable%20and%20changing%20climate.pdr

<sup>14</sup> Wakerman-Powell (2016) Pers. Comms (Email), 16 Sep 2016, MDBA, Camberra.

<sup>&</sup>lt;sup>15</sup> Ibid. Wakerman-Powell provided spreadsheet model that includes 'working costs' as sheep and pricing variables.





lssue No.	Issue	Detail	MDBA response (where relevant, our suggestion)
			businesses. (Recommend the inclusion of these complexities in future modelling)
GI4	Model driven by water input rather than commodity prices	Other factors may drive grazier decisions more than environmental flows, such as commodity prices and exchange rates. Wakerman-Powell specifically notes this on p. 43 of Appendix, particularly where after drought restocking is as significant to decision making as return of water.	Not necessary





## 2. Introduction

#### Background and context

This report provides an independent review of the socio-economic modelling undertaken by the Murray-Darling Basin Authority (MDBA) for a range of water scenarios for the 21 communities of the Northern Basin as shown in Figures 1 and 2.





This report follows that which we have prepared for the MDBA's socio-economic modelling undertaken for the St George and Dirranbandi (Hebel) communities.<sup>17</sup> By building on this previous report, the current report includes some necessary duplication including the literature review and some general review comments from the previous report which remain relevant to modelling the 19 other communities.

<sup>&</sup>lt;sup>17</sup> Blackwell, Boyd, McFarlane, Jim, & Stayner, Richard. (2016). *Independent Review of MDBA Dirranbandi (& Hebel) and St George Socio-Economic Modelling for the Northern Basin: Final Report 23 June 2016*. Armidale: University of New England.



<sup>&</sup>lt;sup>16</sup> Update from Bradley, J. (2016) Pers. Comms (Email), 12 Oct, Canberra: MDBA of MDBA. (2016). *Social and economic change – Bourke, 10 Aug 2016*. PowerPoint Presentation. Canberra: MDBA.







Copies of the terms of reference in preparing this report are provided in Figure 3.

#### Materials provided and implications for review

We have been presented with initial and final drafts and descriptions respectively of:

- 1. the 21 community profiles and descriptions as well as
- 2. the community 'narratives' prepared by Amanda Barwick
- 3. KPMG modelling report<sup>18</sup>
- 4. MDBA's 'Documentation for the hydrology-landuse modeling report' and two supporting

<sup>&</sup>lt;sup>18</sup> Various drafts including KPMG. (2016a). Northern Basin Community Modelling: Economic Assessment of Water Recovery Scenarios, 16 August 2016 Draft Report. Sydney: KPMG; and KPMG. (2016b). Northern Basin Community Modelling: Economic Assessment of Water Recovery Scenarios, September 2016 Draft Report. Sydney: KPMG.





modelling sheets entitled 'NBR hydro-landuse model' and 'NthBasin rain allocn ag'19

- 5. MDBA's Presentation, 'Triple Bottom Line Assessment of SDLs for the Northern Basin'<sup>20</sup>
- 6. MDBA's community consultation report<sup>21</sup>
- 7. MDBA's Lower Balonne floodplain graziers report<sup>22</sup>
- 8. MDBA technical summary report<sup>25</sup>
- 9. University of Canberra report<sup>24</sup>

the final versions of which we have not yet seen but we believe 1 and 2 provide essential context and additions to the main modeling work done through 3 and 4 from qualitative as well as quantitative perspectives. The marrying of qualitative and other quantitative contextual information to the modelling means that the MDBA is not relying on the modelling solely, though this has the potential to add to evidence in supporting their decisions. For example, the MDBA is applying the Triple Bottom Line (TBL - 5) approach to its decision-making, as depicted in Figure 4.

The community consultation that has been undertaken (6) is critical to help address community concerns over water withdrawals. Water withdrawals would rarely be acceptable to regional, rural and remote communities. However, a great deal of angst and stress can be reduced if a fair approach used to determine the allocation of withdrawals amongst communities (though this is complicated by the hydrological and physical constraints within the basin as well as environmental flow requirements) – that is if procedural justice<sup>25</sup> is followed – distributional justice is what communities maybe most concerned about but we have not been commissioned to comment on this directly – rather we have been asked to comment on the social and economic modelling, how it can be improved and whether the MDBA approach is reasonable.

The MDBA technical summary report is a key to communicating to the people of the 21 communities the modelling approach used by MDBA and synthesising the findings from the various reports and elements to their modelling approach for the Northern Basin.

#### General approach to undertaking modelling review

Our general approach to assessing the modelling is presented in Figure 5 and entails assessing the reliability and validity of the key links or drivers between various water scenarios, allocations to environmental assets and production, and how these water inputs are then used in production (such as through the land use model for Dirranbandi and St George), and the resulting benefits that result like employment, profit and social benefits or costs. Employment offers an ideal initial measure of the social and economic consequences of water allocations and this is the key indicator of socio-economic impact that the MDBA has focused on in its modelling.

As part of this final report we focus on:

- whether the approach and the results obtained can be used by the MDBA to help reach a decision about the effects of changes in water availability by interpreting the model outputs (i.e. hectares used in production and employment impacts)
- 2. limitations in this regard and
- 3. considerations for future work.

<sup>21</sup> MDBA. (2016). Northern Basin Review: Phase 2 Engagement Program, Community Meetings, July 2016. Canberra: MDBA.

<sup>&</sup>lt;sup>25</sup> Lukasiewicz, Anna, & Baldwin, Claudia. (2014). Voice, power, and history: ensuring social justice for all stakeholders in water decision-making. *Local Environment*, 1-22. Retrieved from <u>http://dx.doi.org/10.1080/13549839.2014.942261</u>



<sup>&</sup>lt;sup>19</sup> Received from Townsend, Phil (2016). Pers. Comms (Email), Canberra: MDBA, 26 August 2016.

<sup>&</sup>lt;sup>20</sup> MDBA. (2016). *Triple Bottom Line Assessment of SDLs for the Northern Basin, 1 August 2016*. Canberra: MDBA.

<sup>&</sup>lt;sup>22</sup> Wakerman-Powell, Kai. (2016). *Lower Balonne Floodplain Grazing Model Report - Draft, September 2016*. Canberra: MDBA.

<sup>&</sup>lt;sup>23</sup> MDBA. (2016). *Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Report, 2 Sep 2016*. Canberra: MDBA.

<sup>&</sup>lt;sup>24</sup> Tanton, Robert, Vidyattama, Yogi and Peel, Domonic. (2016). MDBA Community Profiles data extraction. May, Canberra: NATSEM, University of Canberra.



#### Figure 3: Terms of Reference (Source: MDBA Executed Contract MD3480, pp.26-27)

sc	HEDULE 2 STATEMENT OF REQUIREMENTS
1	BACKGROUND
	The Customer requires the Services of an independent review of the social and econo inputs to the Northern Basin Review.
2	SERVICES
	The Northern Basin Review will examine the social, economic and environmental effere recovering water for the environment. Two social and economic projects are being undertaken to inform an assessment of potential social and economic outcomes from range of water recovery scenarios. One project will provide a modelling capability for estimating the economic effects of recovering water on irrigated production and employment in 21 communities across the Northern Basin. The second project required development of a modelling capability for estimating changes in production for floodpl graziers of the Lower Balonne floodplain who may benefit indirectly from increased environmental flows.
	Outputs from these modelling projects will be used with other qualitative and quantitat data when describing the effects and differences between the scenarios of recovering water for the environment. In designing these projects, the MDBA took into account th findings from a review by KPMG of the social and economic work undertaken in support developing the Basin Plan.
	The key question to be addressed by the social and economic projects:
	What are the community-level social and economic consequences of recovering wate the environment, estimated for each of the water recovery scenarios examined in the Northern Basin review?
	The social and economic information prepared from these analyses will be used in conjunction with the results of environmental sciences projects to inform an assessme water recovery scenarios by the Murray Darling Basin Authority. From this information Authority will recommend whether to retain or alter the sustainable diversion limits for catchments of the Northern Basin.
	The Contractor will examine and report upon the:
	<ul> <li>economic and social datasets compiled to support the assessment of Norther Basin Review water recovery scenarios;</li> </ul>
	<ul> <li>modelling capabilities developed to undertake the social and economic assessment; and</li> </ul>
	<ul> <li>additional information collected to contextualize the outputs of the modelling v</li> </ul>
	In assessing the social and economic analyses undertaken for the Northern Basin re- the Contractor is required to specifically comment upon:
	1. The overall modelling approach used to estimate the economic and social effects
	recovering water at the community level; 2. The suitability of the baseline data sets developed to support the modelling approximately and the support the modelling approximately appro
	including the rationale and method underpinning their development;
	<ol> <li>The relevance and suitability of the approach and assessment methodology for addressing the question (identified above):</li> </ol>
	<ol> <li>The limitations of such an approach when using the outputs derived;</li> </ol>
	<ol> <li>I ne input and feedback from stakeholders and how it has been used to inform the development of the modelling canability:</li> </ol>





MD <b>3480</b> :	Murray-Darling Basin Authority: Contract for Services Independent Review of the Social and Economic Modelling Inputs to the Northern Basin Review
	<ol> <li>How the differences between communities are taken into account;</li> <li>The sensitivity of the modelling outcomes to the assumptions used in building the models and to the different scenarios of recovering water for the environment; and</li> <li>The datasets and modelling approach used to assess the economic and social benefits of environmental water recovery for floodplain graziers in the Lower Balonne.</li> <li>In commenting on these matters, the Contractor should consider how the information used in the modelling approach and the outputs from social and economic work are presented in an over-arching social and economic technical report.</li> </ol>
	The Contractor will, where possible, recommend further improvements to the methods for modelling and estimating the potential social and economic consequences of recovering water for the environment.
	In the first instance, the Contractor will be provided with the data and models for the Dirranbandi and St George communities to reflect upon the approach being taken to assess the potential effects of water recovery on irrigated production. The Contractor should consider and provide advice on the method used to examine how those changes work their way through the respective communities.
	In undertaking this review, the Contractor will need to:
	<ul> <li>Consider the 2011 and 2012 social and economic review findings from KPMG (documents to be provided by MDBA);</li> <li>Appraise the landuse models developed by MDBA for the respective communities (developed from the outputs of the hydrology models used by the MDBA and data on annual area irrigated with respect to each of the 21 communities);</li> <li>Consider the structure, design and data used to develop the community-level models for assessing how changes in water availability may lead to changes in social and economic conditions;</li> <li>Examine the design and data used to assess the effects of recovering water for the environment on floodplain graziers in the Lower Balonne; and</li> <li>Reflect upon the contents and findings of the over-arching report for the social and economic assessment of water recovery scenarios considered in the Northern Basin review process.</li> </ul>
	The findings in the final report from the Contractor will be considered by the Murray Darling Basin Authority during its decision-making processes.
	All data sets and models used to estimate the effects of water recovery in relation to the 21 communities examined and reports prepared from this information, and advice from KPMG to the Murray Darling Basin Authority on areas for improving the social and economic modelling of water recovery for the environment will be made available to the Contractor. The Customer will provide the Contractor with advice and information on the sources of data, model design, model testing and rationale for the modelling approach used to inform the analysis of social and economic change in northern Basin communities.







Figure 5: Building Block Approach to Assessing Modelling (Source: Blackwell 2016)



#### Outline of report

As an outline of the remainder of the report, in regards to items 2 and 3 we identify elements of the modelling which we believe might be considered by the MDBA as areas where improvements can be made in general in **Sections 4** through to **Section 7**. In sections 4 and 5, we distinguish between those pieces of work that can be done relatively quickly and easily in the short-term and those that might become part of the MDBA's ongoing work program in the **medium to long term**. Prior to doing this we present a rapid review of the relevant literature in **Section 3** to help identify what modeling has been done previously and lessons learned for improvements.

<sup>&</sup>lt;sup>26</sup> MDBA. (2016a). 'Triple Bottom Line assessment of SDLs for the Northern Basin'. PowerPoint presentation. MDBA Canberra: provided by Phil Townsend via email 1 August 2016.





### 3. Literature Review

#### Global assessment of river basin water productivity

Cai et al. undertook a water productivity assessment in 10 river basins across Asia, Africa and South America, reflecting a range of socio-economic and agro-climatic conditions.<sup>27</sup> They found that intensive farming in the Asian basins gives much greater agricultural output and higher water productivity than the largely subsistence agriculture in Africa. They modelled water productivity as the output derived from water use divided by the water input with crop yields measured as tonnes per ha. They used kg/m<sup>3</sup> or \$/m<sup>3</sup> as measures of water productivity for rice. These findings mean that water productivity is important for increased food security and farmers' livelihoods, though considerations of the cost of improving water productivity, including environmental trade-offs, need to be considered within context and analysed carefully. Importantly, the authors note that current large-scale assessment of whole basins 'relies overwhelmingly on statistical data, which are variable in quality, the spatial scale is often poor and does not correspond to hydrological boundaries<sup>28</sup> These are similar limiting factors for the socio-economic modelling work done by the MDBA. However, Cai et al. do point to remote sensing for estimating crop production and water consumption combined with basin-scale hydrological modelling to understand water cycling, to examine existing interventions and better understand processes on the ground (Literature insight 1, LI1). This reinforces the approach taken by the MDBA in its current social and economic modelling work.

#### Critique of traditional water efficiency

Gleick, Christian-Smith, and Cooley (2011) critique traditional approaches to water efficiency such as through a whole of basin efficiency approach<sup>29</sup> which, though helping clarify issues around the scale and scope of water efficiency, is flawed by:<sup>30</sup>

- excluding or discounting unproductive consumptive use, called 'wet' water, a major component of inefficient water use
- only valuing 'new' water and not using a broad measure of water productivity and
- failing to account for many co-benefits of efficiency such as improved water quality, increased production, greater reliability, decreased energy demands (i.e. impacts on other factors of production), and reduced or delayed infrastructure investments.

What this means for the MDBA is that assessing water productivity, how many goods and services can be produced by water use, rather than efficiency, or how much water is used relative to total amount of water available, is important to account for in the modelling (LI2). For example, crop yield, GDP or households served per unit of water rather than simply the proportion of total water used. Measuring the marginal changes in jobs (through land area under cropping via changes in water availability), in part, takes account of these developments in measuring water productivity *vis-à-vis* efficiency.<sup>31</sup>

#### Water productivity in the Australian cotton context

Water is critical to the cotton industry in the MDB to maximise crop yields and fibre quality. Roth, Harris, Gillies, Montgomery, and Wigginton (2013) found that 80% of Australian cotton-growing area used surface-irrigation systems with 6-7ML/ha applied to cotton crops (dependent on the amount of rain

<sup>&</sup>lt;sup>31</sup> See our comments in the next section about additional measures of social and economic change resulting from water



<sup>&</sup>lt;sup>27</sup> Cai, Xueliang, Molden, David, Mainuddin, Mohammed, Sharma, Bharat, Ahmad, Mobin-ud-Din, & Karimi, Poolad. (2011). Producing more food with less water in a changing world: assessment of water productivity in 10 major river basins. *Water International*, *36*(1), 42-62. doi:10.1080/02508060.2011.542403.

<sup>&</sup>lt;sup>28</sup> Cai et al. 2011, p. 59-60.

<sup>&</sup>lt;sup>29</sup> This approach involves measuring how much of the water that enters a basin is recovered and used.

<sup>&</sup>lt;sup>30</sup> Gleick, Peter H., Christian-Smith, Juliet, & Cooley, Heather. (2011). Water-use efficiency and productivity: rethinking the basin approach. *Water International*, *36*(7), 784-798. doi:10.1080/02508060.2011.631873.



received) and 729mm of seasonal evapotranspiration over 23 years, and in the decade ending 2013, water-use productivity increased 40% for Australian cotton growers (due to whole farm irrigation efficiency gains of 57-70% and a crop water use index of >3kg/mm.ha (high by international standards)) (Roth et al. 2013, p. 1033).<sup>32</sup> They also found that in many Australian cotton-growing regions, crop water demand exceeds the rainfall supply so water-use performance is highly variable between cotton growing regions. These findings reinforce the necessity of site-specific measurement or studies, as being undertaken by the MDBA with the modelling of 21 communities beginning with St George and Dirranbandi (Hebel) to capture the relationship between water uses, hectares irrigated and the social and economic consequences (L13).

#### Work undertaken by MDBA

Since 2009, the MDBA has undertaken an extensive program of research, including those into the social and economic implications of the draft Basin Plan (LI4). The extent of analysis is so significant that MDBA has also undertaken to synthesise the work-to-date at certain points in time, e.g., see its synthesis that accompanies the Plan.<sup>33</sup> The following provides a selection of their research program.<sup>34</sup>

- Irrigated Agriculture in the Murray-Darling Basin: An Economic Survey of Irrigators, 2012-13 to 2014-15 (ABARES) presents key farm performance measures for irrigated horticulture, dairy, cotton ('mostly located in the Northern Basin' p. 19) and rice farms in the Basin, including data on water trading, use of irrigation technologies and with an emphasis on results from 2012-13 to 2014-15.35 Because of the severe drought, incomes of horticulture, dairy, rice and cotton farms were relatively low for the first three survey years from 2006-07 to 2008-09 with record low river inflows and irrigation water allocations. Incomes improved in 2010-11 following improved conditions and water allocations. However from 2012-13 to 2014-15 average farm cash income of cotton growers declined (still significantly higher than other industries at around 2014-15 \$0.5m (p. 9), while horticulture and rice growers' remained even and dairy farmers earned record high levels in real terms since 2006-07. Average returns to capital since 2006-07 was highest for cotton growers at 4.9% (3.5%-8%, p. 16) (horticulture 1.8%, diary 2.2%, rice 1.5%, p.1), reflecting greater variability in cotton prices or risk of return than those for other irrigated industries (p. 5). During the drought, water trading provided irrigators with an important tool for managing low water allocations, with horticulture being the largest net buyer of water allocations, irrigated broad acre and dairy being largest net sellers. As conditions improved, trading declined. Cotton farms had the smallest proportions of farms selling permanent water entitlements. 90% of dairy, rice and cotton growers used flood or furrow irrigation systems and 19% of cotton farms and 28% of dairy farms used travelling irrigators (p.1). Average water use per farm for cotton remains high ranging from 1250-2750ML per year, though for all industries water use increased significantly from 2010-11 (p. 21). Cotton water application rates at around 4.5-7ML/ha (LI5, p. 24) were average compared with vegetables, citrus, stone fruit, prome fruit, rice (significantly higher at 10.5-15ML/ha), dairy pasture and wine grapes.
- Condamine-Balonne Sustainable Yield Regional Profile (MDBA) provides information on the region as defined by CSIRO's Sustainable Yields, and includes data on population, employment, agriculture, and community characteristics. The profile was produced to allow meaningful comparisons between regional characteristics and populations and between those populations over.<sup>36</sup>
- Lower Balonne Community Profile: Irrigation Region (MDBA) provides a brief socioeconomic profile of the Lower Balonne irrigation region in the Murray-Darling Basin. It includes responses from regional stakeholders to

MDBA. (2012b). Socioeconomic Analysis and the Draft Basin Plan Part B - Commissioned and Non-Commissioned Reports Which Informed The MDBA's Socioeconomic Analysis. Retrieved from MDBA Canberra:

http://www.mdba.gov.au/kid/files/2129-social\_economic\_analysis\_part\_b.pdf <sup>34</sup> The full list of social and economic analysis can be found here: <u>www.mdba.gov.au/publications/archived-</u> <u>information/basin-plan-archives/socio-economic-analysis</u> (as at 16 June 2016).

http://data.daff.gov.au/data/warehouse/9aas/2015/IrrigatedAgMDB/IrrigatedAgMDBEconSrvy\_v1.0.0.pdf <sup>36</sup> MDBA. (2009). Condamine-Balonne Sustainable Yield Region Regional Profile. Retrieved from MDBA Canberra: http://www.mdba.gov.au/kid/files/1366-ABS-Revised-Regional-Profile-Condamine-Balonne.pdf



<sup>&</sup>lt;sup>32</sup> Roth, Guy, Harris, Graham, Gillies, Malcolm, Montgomery, Janelle, & Wigginton, David. (2013). Water-use efficiency and productivity trends in Australian irrigated cotton: a review. *Crop and Pasture Science*, *64*(12), 1033-1048. doi: 10.1071/CP13315, p. 1033.

<sup>&</sup>lt;sup>33</sup> MDBA. (2012a). Socioeconomic Analysis and the Draft Basin Plan Part A - Overview and Analysis. Retrieved from MDBA Canberra: <u>http://www.mdba.gov.au/sites/default/archives/proposed/social\_economic\_analysis\_part\_b.pdf</u>

<sup>3&</sup>lt;sup>3</sup> ABARES. (2015). Irrigated Agriculture in the Murray-Darling Basin: An Economic Survey of Irrigators, *2012-13 to 2014-15*. Retrieved from MDBA Canberra:



a series of water availability scenarios, including the impacts they believe those scenarios will have on agriculture, the agricultural value chain, and local businesses and services.<sup>37</sup>

- Integration of Socioeconomic Assessments of the Murray-Darling Basin (Nous) seeks to distil and synthesize key findings and conclusions arising from the following two studies commissioned by the MDBA: 1 "Environmentally Sustainable Diversion Limits in the Murray-Darling Basin: Socioeconomic Analysis" (ABARE); 2 "Delivering the Basin Plan: Economic and Social Profile and Impact Assessments in the Murray-Darling Basin" (Marsden Jacob Associates-led consortium).<sup>38</sup>
- Report to the Murray Darling Basin Authority on the Liaison between the MDBA and the Banking Sector on the Draft Basin Plan (MDBA). This was a 2012 report commissioned by the MDBA and prepared by The Hon. Dean Brown AO. It reports on a series of consultative meetings and briefings arranged by the MDBA for the Banking Sector on the draft Murray-Darling Basin Plan at which the modelling of the economic and social impacts of the draft Basin Plan was presented.<sup>39</sup>
- Reviewing The Scientific Basis of Environmental Water Requirements in the Condamine-Balonne and Barwon– Darling: Summary Report. The MDBA engaged a panel of independent scientists to consider the science underpinning the environmental water requirements for the Condamine-Balonne and Barwon-Darling systems, as a starting point for more work on surface water sustainable diversion limits (SDLs).<sup>40</sup>
- People and Place in Australia: The 2014 Regional Wellbeing Survey (University of Canberra). This report compares the experiences of people living in different regions, and of people of different ages, gender, and who are and aren't engaged in farming. In total, 12,125 people took part in the 2014 Regional Wellbeing Survey, an increase of almost 3,000 compared to the 9,135 who took part in the 2013.<sup>41</sup>
- Review of the MDBA's Socio-Economic Impact Modelling (KPMG). The MDBA commissioned a report to determine an assessment of the (CGE) socio-economic impact modelling undertaken for the Basin Plan which included the work of Wittwer, ABARES BRS and UQ RSMG.<sup>42</sup> KPMG found that the three groups of independent researchers produced a set of informative studies that serve to '(a) provide important insights into particular components of the problem and (b) highlight the need for a larger scale, more integrated approach to the socio-economic modelling... ... (through a) more coordinated and cooperative approach... ...that includes agreement on scenario analysis and the appropriate foundation of model baselines'.<sup>43</sup>
- Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments: An Assessment of the Short-Term Impacts at the Local Scale – Final Report. Arche Consulting and Gillespie Economics were engaged by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and the MDBA to undertake input-output analysis of the short-run impact of policy changes in the MDB at the local community scale using 12 representative Local Government Areas (LGAs).<sup>44</sup> Moree Plains (NSW Border Rivers SDL region) and Balonne (Condamine-Balonne SDL region – i.e. St George and Dirranbandi, Hebel) LGAs were included, each encompassing multiple communities relying on different types of water. The analysis provided compressed results for the 7 years to 2018-19 in a single year which allowed for water trading, Commonwealth buybacks to date, Water For the Future infrastructure upgrades, and commodity prices from 2005-06. With a 19.6% and 8.6% withdrawal of water for irrigation respectively for Balonne and Moree Plains Shires, impacts on irrigated production (-49, -37 jobs), potential offsetting increases in the value of dryland or cereal production (+3, +6 jobs), net impacts on farm employment (-46, -31 jobs), and flow-on employment impacts for the local community (-59, -41 indirect jobs, with -4.9%, -1.3% of total jobs) were

http://www.mdba.gov.au/kid/files/1280-Integration-of-Socioeconomic-assessment-report.pdf

<sup>43</sup> KPMG. (2011), pp. 9-10.

<sup>&</sup>lt;sup>44</sup> Arche Consulting, & Gillespie Economics. (2012). Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments: An Assessment of the Short-Term Impacts at the Local Scale – Final Report. Retrieved from Sydney: <u>http://www.mdba.gov.au/sites/default/files/archived/proposed/Arche-Basin-Case-Studies-final-report.pdf</u>



 <sup>&</sup>lt;sup>37</sup> MDBA. (2010). Lower Balonne community profile: irrigation region. Retrieved from MDBA Canberra: <u>http://www.mdba.gov.au/kid/files/1296-Community-Profile-Lower-Balonne-Irrigation-Region-May-2010.pdf</u>
 <sup>38</sup> Nous. (2010). Integration of Socioeconomic Assessments of the Murray-Darling Basin Retrieved from Canberra:

<sup>&</sup>lt;sup>39</sup> MDBA. (2012c). Report to the Murray Darling Basin Authority on the Liaison between the MDBA and the Banking Sector on the Draft Basin Plan. Retrieved from MDBA Canberra:

http://www.mdba.gov.au/kid/files/2499\_Report\_to\_MDBA\_Banking\_Sector\_on\_the\_Draft\_Basin\_Plan.pdf <sup>40</sup> MDBA. (2014). Reviewing the Scientific Basis of Environmental Water Requirements in the Condamine-Balonne and Barwon-Darling. Retrieved from MDBA Canberra: <u>http://www.mdba.gov.au/sites/default/files/pubs/NBSR-Synthesis-</u> accessible-summary-report.pdf

 <sup>&</sup>lt;sup>41</sup> Centre for Research and Action in Public Health, Health Research Institute. (2015). *People and Place in Australia: The 2014 Regional Wellbeing Survey*. Retrieved from University of Canberra. Canberra: <u>https://www.canberra.edu.au/research/faculty-research-centres/ceraph/regional-wellbeing/survey-results/2014-survey-results/2014-Regional-Wellbeing-Survey.pdf</u>
 <sup>42</sup> KPMG. (2011). *Review of the MDBA's Socio-Economic Impact Modelling*. Retrieved from MDBA Canberra: http://www.mdba.gov.au/kid/files/1719-ReviewOfTheMDBAsSocioEconomicImpactModelling.pdf



assessed (for Balonne and Moree Plains LGAs respectively). Losses in cotton and cereal production amount to \$48.89m, \$37m (19.9%, 9.9%) in GVIAP and local value added of \$27.9m, \$19.4m (11.4%, 3%) for Balonne and Moree Plains Shires respectively (pp. 20, 23, 24, 27).

- Comment on "Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments". KPMG reviewed the work of Arche and Gillespie <sup>45</sup> as encompassing a reasonable approach but that their methodology would overestimate the impact of the Basin Plan (and underestimate impacts of infrastructure upgrades) (LI6) as Arche and Gillespie noted themselves. This is because of the inherent limitations in available data and the methodology itself, and the modelling could be improved by including likely inherent adjustment processes (including employment for falling populations and agricultural sector, automated (rather than manual) adjusted land-use based on marginal value of water, and adjustable labour and capital ratios, likely lag in infrastructure spend and productivity gains) over the period and incorporating regional variation in water use intensity (pp. 1-2).
- Revised Indicators Of Community Vulnerability And Adaptive Capacity Across The Murray-Darling Basin: A Focus On Irrigation In Agriculture. Stenekes et al. were commissioned to measure the vulnerability, resilience and adaptive capacity of Basin communities to changes in water availability due to a range of factors in order to inform MDBA planning and decision-making.<sup>46</sup> In particular, '(t)he indices could... ...be used as a baseline of information to measure future socioeconomic changes and as part of a potential framework for measuring effects of the Basin Plan on communities', that is, the social and economic monitoring and evaluation framework of the Plan (see Figure 6). Of note are a series of comprehensive maps in Appendix B (pp. 31-41) that are geospatially explicit for the Lower Balonne including location of St George and Dirranbandi. Results include:
  - St George and Dirranbandi relative vulnerability to changes in water availability *prior to the Basin Plan* read as medium (~0.5) and high level (~0.75) respectively (1.0 is the highest ranked index)
  - $\circ$  subindex of relative sensitivity to water availability, similar results
  - higher average adaptive capacity results (~0.75 for both locations),
  - o lower (~0.5) for relative community vulnerability for 2800 GL water recovery scenario,
  - around 12.5% water reduction (relative to maximum of 25%) for exposure required to meet 2800
     GL SDL after modeled water trade and using 2005-06 commodity prices,
  - o similar results for average 2006-07 and 2010-11 commodity prices,
  - a relative impact subindex ranking of approximately 0.5 for both locations (max 1.0) using 2005-06 commodity prices (higher than most surrounding locations but not compared with the area west of these abutting the border),
  - similar results for variation with 2400 to 3200GL SDL scenarios, and for community vulnerability with these scenarios and latter commodity prices.
  - most striking is for SLA irrigation intensity (ML applied/no. of irrigated farm establishments) with St George and Dirranbandi falling into the highest category (5242-6551ML) in the basin.
  - employment in agriculture as a percentage of total employment varies widely for the SLAs and because St George and Dirranbandi abut various SLAs, the percentage range is from 30%-75% but again, the region to the west and on the border has the highest category at 90%.

The results point to the need for nuanced and specific (rather than generalized) local information on the social and economic consequences of water withdrawals and provide a useful starting point for comparison across SLAs and contribute to a baseline for ongoing monitoring and evaluation of the Plan's implementation (LI7).

• Effects of Change in Water Availability on Indigenous People of the Murray-Darling Basin: A Scoping Study. This report considers the impacts of the Basin Plan on Aboriginal and Torres Strait Islander people drawing on a review of the literature, case study analysis from the Murrumbidgee, Barwon-Darling or Murray River Regions, descriptive characterization of impacts based on case studies and literature, and recommendations to enhance or mitigate the impacts from the plan including future research. Some of the key findings are that impacts for Aboriginal and Torres Strait Islanders are least well known of the social and economic impacts and this is because of a paucity of information, limited water reforms and institutions to strategically capture these people's aspirations, and the need for an MDBA ongoing work program to address this paucity.<sup>47</sup>

<sup>&</sup>lt;sup>45</sup> KPMG. (2012). Comment on "Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments". Retrieved from MDBA Canberra: <u>http://www.mdba.gov.au/kid/files/2015-KPMG-Review-of-Arche-Method-</u> <u>Final Report.pdf</u>

<sup>&</sup>lt;sup>46</sup> Stenekes, N, Kancans, R, Randall, L, Lawson, K, Reeve, I, & Stayner, R. (2012). Revised Indicators of Community Vulnerability and Adaptive Capacity Across the Murray-Darling Basin: A Focus on Irrigation in Agriculture. Canberra: ABARES.

<sup>&</sup>lt;sup>47</sup> Jackson, S, Moggridge, B, & Robinson, C J. (2010). Effects of Change in Water Availability on Indigenous People of the Murray-Darling Basin: A Scoping Study. Retrieved from MDBA Canberra: <u>http://www.mdba.gov.au/publications/archived-information/basin-plan-archives/socio-economic-analysis</u>





Figure 6: Social and economic monitoring and evaluation framework for Basin Plan<sup>48</sup>

Of the work undertaken on social and economic impacts of the Basin Plan, Wittwer (2011) used the TERM-H2O CGE (computable general equilibrium) model to assess the long-term impacts of an SDL target entailing purchases of 2800 GL of water from farmers between 2008 and 2029 on GDP and employment within the MBD.<sup>49</sup> There is little change in overall economic activity (LI8). At a basin scale and given limiting long term view assumptions of CGE, GDP is expected to fall by about 0.3 per cent and employment falls by 0.1 percent or 600 jobs because 'given that the process of environmental water purchases involves willing sellers who are paid a market price, this is not surprising' (Wittwer, 2011, p. 1).

Wittwer (2011) also regressed irrigation water prices in the southern basin against water availability, drought and output prices and found that price is more responsive to drought than changes in irrigation water availability (LI9) and it is sensitive to the farm producer price index.

Furthermore and related to the next subsection heading, MDBA engaged EBC et al. (2011) to assess the community (and regional including Queensland and Condamine Balonne) impacts of the guide to the plan and one interesting finding is the high risk levels for water withdrawal identified for Dirranbandi and St George, given both have relatively small populations and are dependent (35-40% and 25-30% respectively) on employment in agriculture, processing, transport and storage (see Figure 1.1 Risk Factors for Social Catchments (by town) on p. 13 of *Volume 3: Community Impacts*). Prior to this more detailed local analysis, in their *Synthesis Report*, Marsden Jacob Associates et al. (2010, p. 11) found that as a

<sup>&</sup>lt;sup>48</sup> MDBA. (2016b). 'Our social and economic evaluation methodology'. MDBA Canberra: <u>http://www.mdba.gov.au/socio-</u> economic-profile-murray-darling-basin

<sup>&</sup>lt;sup>49</sup> Wittwer, Glyn. (2011). Basin Plan CGE Modelling Using TERM-H20. Report to the MDBA. Retrieved from MDBA Canberra: http://www.mdba.gov.au/sites/default/files/archived/basinplan/1718-BasinPlanCGEModellingUsingTermH20.pdf



whole (i.e. Balonne) these communities had the smallest gross value of irrigated agriculture of 12 regions, yet the highest measures of socio-economic condition, and with irrigation product accounting for 50% of total gross agricultural product. Again, these examples of differing spatial scales of economic and social analyses point to the importance of local conditions differing from regional and the need for the localized analyses (L110).

#### Regional economic resilience, commuting, and technological shifts

Measuring socioeconomic conditions is a way of gauging a region's economic resilience. The economic structure of labour market areas has long been a staple of regional and urban analysis. For example, recently Han and Goetz modelled and mapped the economic resilience of all counties in the United States during the global financial crisis using employment as a measure of economic activity by comparing the drop in economic activity and subsequent rebound that follows.<sup>50</sup> For the MDBA and their social and economic modelling, we note that Han and Goetz used employment data as a starting point but recommended in their discussion (p. 146) that future studies should include consideration of personal income which provide more nuanced qualitative changes of changes in job types rather than numbers alone and make for useful comparison with employment (L111). We are informed that the MDBA has used wage income to convert part-time work to full time equivalent (FTE).

Commuting in and out of regions for work has expanded over time, and there has been a recent shift for Australian regions from an agricultural to mining base.<sup>51</sup> Studies show that network degree and entropy measures explain variations in county per capita income growth patterns.<sup>52</sup> Also higher in and out-commuting entropies are associated with lower per capita income growth, but their interaction enhances economic growth in places simultaneously open to both in and out-commuters.<sup>53</sup> Accounting for commuting and work-migration will be important in modelling the impacts on jobs from water withdrawals in the MDB (L112).

Globalisation has changed the outlook of economic activity in regions across the globe.<sup>54</sup> Also technology has changed production techniques in many industries<sup>55</sup>, such as in the case of genetically modified cotton requiring less spraying and associated labour. Studies around the world reflect favorably on the

<sup>54</sup> McCann, Philip, & Acs, Zoltan J. (2015). Globalisation: Countries, cities and multinationals. *Global Entrepreneurship, Institutions and Incentives: The Mason Years, 45*, 371. doi:10.1080/00343404.2010.505915

<sup>&</sup>lt;sup>50</sup> Han, Yicheol, & Goetz, Stephan J. (2015). The Economic Resilience of US Counties During the Great Recession. *45*(2), 131-149. <u>http://journal.srsa.org/ojs/index.php/RRS/article/view/45.2.2</u>

<sup>&</sup>lt;sup>51</sup> McFarlane, Jim A, Blackwell, Boyd D, Mounter, Stuart W, & Grant, Bligh J. (2016). From agriculture to mining: The changing economic base of a rural economy and implications for development. *Economic Analysis and Policy, 49,* 56-65. doi:10.1016/j.eap.2015.11.012

<sup>&</sup>lt;sup>52</sup> Hussain, R, Maple, M, Hunter, SV, Mapedzahama, V, Reddy, P, & Hunter, Sally. (2015). The Fly-in Fly-out and Drive-in Driveout model of health care service provision for rural and remote Australia: benefits and disadvantages. *Rural and remote health*, *15*(3068), 1-7. <u>http://www.rrh.org.au/articles/subviewnew.asp?ArticleID=3068</u>

Storey, Keith. (2010). Fly-in/fly-out: implications for community sustainability. *Sustainability*, *2*(5), 1161-1181. doi:10.3390/su2051161

<sup>&</sup>lt;sup>53</sup> Goetz, Stephan J, Han, Yicheol, Findeis, Jill L, & Brasier, Kathryn J. (2010). US commuting networks and economic growth: Measurement and implications for spatial policy. *Growth and Change*, *41*(2), 276-302. <u>www.blackwell-</u> <u>synergy.com/doi/abs/10.1111/j.1468-2257.2010.00527.x</u>

<sup>&</sup>lt;sup>55</sup> Feldmann, Horst. (2013). Technological unemployment in industrial countries. *Journal of Evolutionary Economics*, 23(5), 1099-1126. <u>http://link.springer.com/article/10.1007%2Fs00191-013-0308-6#page-2</u>

Loi, Michele. (2015). Technological unemployment and human disenhancement. *Ethics and Information Technology*, 17(3), 201-210. http://dx.doi.org/10.1007/s10676-015-9375-8



industry nonetheless<sup>56</sup> and the broader community can expect a deskilling in labour in those regional areas and an associated lessening of labour demand.<sup>57</sup>

When measuring the social and economic impacts of irrigated cotton in the MDA, resilience, migration and commuting, globalisation and technological advancements and associated falls in labour demand, should be considered. All these facets have been considered in the MDBA social and economic modelling and analysis to date except for commuting and this is discussed in the more detail in the next section of this report (LI13)

#### Australian water policy specific studies

There have been many studies covering a wide range of aspects in Australian water policy and decisionmaking with a selection demonstrating the range of issues considered:

- modelling the economic effects of the plan on the southern basin<sup>58</sup>
- a review of relevant environmental economics applied to developing an eclectic policy reform framework including taxing polluters, creation of new forms of communal property rights, and regulation to achieve environmental sustainability<sup>59</sup>
- modelling of water use efficiency uptake in the Namoi catchment, amounting to around 100GL, resulting in more water for irrigation and income, bringing into question the necessity of government support<sup>60</sup>
- modelling of irrigator decision making over water use using mind mapping<sup>61</sup> and
- a review of historical and future hydrological changes in the MDB.<sup>62</sup>

Dixon, Rimmer and Wittwer used their TERM  $H_2O$  dynamic multiregional CGE model to find that water buybacks increased water asset values and had little effect on aggregate farm output in the southern basin as farms reallocated resources between activities (L114).<sup>63</sup> Because the effects of the basin plan play-out with time, these types of forecasts can be tested.

Banjeree used TERM  $H_20$  to model the economic impacts of investment in irrigation infrastructure using a case study of the Murrumbidgee sub catchment (Southern Basin).<sup>64</sup> This public investment results in an

Irrigation Water. *Economic Record*, 87(276), 153-168. doi:10.1111/j.1475-4932.2010.00691.x <sup>64</sup> Banerjee, Onil. (2015). Investing in recovering water for the environment in Australia's Murray-Darling Basin. *International Journal of Water Resources Development*, 31(4), 701-717. doi:10.1080/07900627.2014.979398



<sup>&</sup>lt;sup>56</sup> Bennett, Richard, Kambhampati, Uma, Morse, Stephen, & Ismael, Yousouf. (2006). Farm-level economic performance of genetically modified cotton in Maharashtra, India. *Applied Economic Perspectives and Policy, 28*(1), 59-71. doi: 10.1111/j.1467-9353.2006.00273.x

Qaim, Matin, & Zilberman, David. (2003). Yield effects of genetically modified crops in developing countries. *Science*, 299(5608), 900-902. <u>http://science.sciencemag.org/content/299/5608/900</u>

<sup>&</sup>lt;sup>57</sup> Bennett, Richard, Morse, Stephen, & Ismael, Yousouf. (2006). The economic impact of genetically modified cotton on South African smallholders: yield, profit and health effects. *The Journal of Development Studies*, *42*(4), 662-677. http://www.tandfonline.com/doi/abs/10.1080/00220380600682215

Stone, Glenn Davis. (2007). Agricultural deskilling and the spread of genetically modified cotton in Warangal. *Current Anthropology*, *48*(1), 67-103. doi:10.1086/508689

<sup>&</sup>lt;sup>58</sup> Dixon, P, Rimmer, M, & Wittwer, G. (2011). Saving the Southern Murray-Darling Basin: The Economic Effects of a Buyback of Irrigation Water. *Economic Record*, 87(276), 153-168. doi:10.1111/j.1475-4932.2010.00691.x

<sup>&</sup>lt;sup>59</sup> Quiggin, John. (2001). Environmental economics and the Murray–Darling river system. *Australian Journal of Agricultural and Resource Economics*, *45*(1), 67-94. doi:10.1111/1467-8489.00134

<sup>&</sup>lt;sup>60</sup> Ticehurst, Jenifer L., & Curtis, Allan L. (2015). Can existing practices expected to lead to improved on-farm water use efficiency enable irrigators to effectively respond to reduced water entitlements in the Murray–Darling Basin? *Journal of Hydrology, 528*, 613-620. <u>doi:http://dx.doi.org/10.1016/j.jhydrol.2015.06.055</u>

<sup>&</sup>lt;sup>61</sup> Douglas, Ellen M, Wheeler, Sarah Ann, Smith, David J, Overton, Ian C, Gray, Steven A, Doody, Tanya M, & Crossman, Neville D. (2016). Using mental-modelling to explore how irrigators in the Murray–Darling Basin make water-use decisions. *Journal of Hydrology: Regional Studies, 6*, 1-12. doi:10.1016/j.ejrh.2016.01.035

 <sup>&</sup>lt;sup>62</sup> Leblanc, Marc, Tweed, Sarah, Van Dijk, Albert, & Timbal, Bertrand. (2012). A review of historic and future hydrological changes in the Murray-Darling Basin. *Global and planetary change*, *80*, 226-246. doi:10.1016/j.gloplacha.2011.10.012
 <sup>63</sup> Dixon, P, Rimmer, M, & Wittwer, G. (2011). Saving the Southern Murray-Darling Basin: The Economic Effects of a Buyback of



increase in regional output, income and employment, while nationally there is a small negative impact (L115) resulting from the transfer of resources to the basin and a crowding out of private investment. They also note that '(w)hen water-balance modelling for a catchment does not account for return flows (reduced return flow from water saving infrastructure upgrades), the water savings maybe overstated' and where the infrastructure results in water-use efficiency, return flows are reduced, with the possibility of 'no real effect on water savings' (p. 72) (L116). However, the higher geographical scale of this work is different to the local geographical scale of social and economic impact being considered for St George and Dirranbandi (Hebel).

Wheeler, Zuo and Bjornlund found a weak to no impact for Commonwealth water sales on lagged net farm income from selling water entitlements in the southern MDB (LI17) across the period 2008 to 2012.<sup>65</sup> This was used as evidence to suggest that irrigators used the proceeds from these sales to reduce their debt and interest payments, restructure and invest on farm. Interestingly, on farm consequences from the sales included greater existing use from entitlements, implying that irrigators simply sold their surplus or buffer water. These authors advise selling irrigators to undertake further incremental adaptation, water management or on-farm changes, to not risk regular water shortages given the advent of climate change. The authors point out also that their study focused on farm related impacts, rather than those on communities which might also be negative and positive, though the time period and location of sales is different to that of the current work. (LI18)

Wittwer and Dixon, using TERM H2O, found that public spending on health, education and other services in the basin were superior regional economic management options to infrastructure upgrades, creating between three and four jobs relative to the one created from upgrades.<sup>66</sup> The authors therefore see jobs, and the relative impact on jobs, as important social and economic measures of wellbeing in regional development analysis (LI19).

Loch, Wheeler and Adamson highlight the importance of people and place in river-based management of the MDB in Australia. Historically there has been a focus on people (social and economic objectives) but more recently an emphasis on place (through environmental objectives). While jobs alone insufficiently represent an appropriate assessment of 'people and place' in the Northern Basin, the MDBA are aware of this limitation and have undertaken a survey of Aboriginal and Torres Strait Islanders to identify the social and cultural values for the basin as well as a regional well-being survey, both noted above and part of their ongoing monitoring and evaluation framework (LI20).<sup>67</sup>

#### International economic assessment of water reductions

Bekchanov and Lamer assessed the economic effects of upstream infrastructure developments and reduced river run-off on downstream countries in central Asia using a CGE model.<sup>68</sup> They found that a 10-20% water supply reduction caused the irrigated areas in Uzbekistan to be reduced by 241,000 to 374,000 ha, with employment losses of 712,000 to 868,000, resulting in a national income loss of 3.6 to 4.3 per cent (p.1).

<sup>67</sup> Jackson, S, Moggridge, B, & Robinson, C J. (2010). Effects of Change in Water Availability on Indigenous People of the Murray-Darling Basin: A Scoping Study. Retrieved from MDBA Canberra: <u>http://www.mdba.gov.au/publications/archivedinformation/basin-plan-archives/socio-economic-analysis</u>; Centre for Research and Action in Public Health, Health Research Institute. (2015). *People and Place in Australia: The 2014 Regional Wellbeing Survey*. Retrieved from University of Canberra, Canberra: <u>https://www.canberra.edu.au/research/faculty-research-centres/ceraph/regional-wellbeing/surveyresults/2014-survey-results/2014-Regional-Wellbeing-Survey.pdf</u>

<sup>68</sup> Bekchanov, Maksud, & Lamers, John P. A. (2016). Economic costs of reduced irrigation water availability in Uzbekistan (Central Asia). *Regional Environmental Change*, 1-19. doi:10.1007/s10113-016-0961-z



<sup>&</sup>lt;sup>65</sup> Wheeler, Sarah Ann, Zuo, Alec, & Bjornlund, Henning. (2014). Investigating the delayed on-farm consequences of selling water entitlements in the Murray-Darling Basin. *Agricultural Water Management, 145*, 72-82. http://dx.doi.org/10.1016/j.agwat.2013.10.015

<sup>&</sup>lt;sup>66</sup> Wittwer, Glyn, & Dixon, Janine. (2013). Effective use of public funding in the Murray-Darling Basin: a comparison of buybacks and infrastructure upgrades. *Australian Journal of Agricultural and Resource Economics*, *57*(3), 399-421. doi:10.1111/1467-8489.12001



Liu, Hertel and Taheripour reviewed the incorporation of water into CGE modelling at the global scale. Importantly for the MDBA, they found that ignoring sub-national hydrological boundaries in global economic analysis of water scarcity maybe sufficient when considering national-scale trade, production and welfare changes, but for assessing the 'distribution of inputs and outputs within a region, preserving the river basin and sectorial detail in the model brings considerable added value to the analysis'.<sup>69</sup> (LI21)

Zhong et al. assessed the economic effects of the 2000 drought in China using a CGE model which accounted for the dichotomy between irrigation (including 16 provincial irrigation water supplies and their subsidies) and piped water and parallel pricing arrangements.<sup>70</sup> Similar to the analysis undertaken by Wittwer of the Basin Plan in Australia<sup>71</sup>, the effects of the drought on the Chinese macro economy were found to be negligible (noting that CGE models the effects in the long-run) (LI22). However, they found significant effects on agricultural production mainly undertaken in the northern areas of China where more capital and labour were used to ameliorate the effects of the drought (LI23). Labour moved from non-farming agricultural production sectors into farming. Urban and rural households suffered severe losses in food consumption and welfare, despite receiving additional income (LI24). Rural households in the northern and southern regions suffered the worst losses.

#### Summary and conclusion on literature review

The MDBA has already undertaken an extensive range of social and economic modelling to inform the development and implementation of the Plan. We have identified 24 insights from the domestic and international literature which required consideration in undertaking the social and economic modelling of impacts for withdrawals in the Northern Basin. A summary of these is provided in Table 4 which shows that most of these are already incorporated in the modelling or provide impetus to the current modelling, noting that most of our comments have been addressed, at least through explanation, in the latest draft reports as noted in the Table's final column in red. Only one insight has been overlooked and could be done as part of the MDBAs ongoing work program rather than immediately. To gain further details for each insight simply go to the coding (Ll#) and yellow highlight in the above text. Overall, these 24 insights reinforce our recommendations in regards to the modelling which are provided in the following section.

LI#	Insight	Relevance to MDBA modelling	Whether incorporated ( V OR *) by MDBA modelling/processes (suggested inclusion timeframe) Subsequent incorporation by MDBA ( V OR *)
1	Remote sensing can be combined with basin-scale hydrological modelling to better understand water cycling and local processes	Not directly relevant but reinforces current locally nuanced approach taken	ΝΑ
2	Water productivity should be measured through impact on goods and services rather than focused on amount of water used	Assessing impacts on jobs goes some way to doing this.	✓ Previous modelling incorporates impacts for local communities on jobs, value added and regional output (Arche and Gillespie). But, more nuanced impacts could be assessed for communities by building smaller local economy models
3	Site or locale specific studies necessary for establishing	Reinforces MDBA current approach	V

Tabla A. C							(A
lable 4: Summary	y of ilterature insi	gnus (LI)	, relevance,	, and incorpora	ation (S	Source: see L	i# in text)

 <sup>&</sup>lt;sup>69</sup> Liu, Jing, Hertel, Thomas, & Taheripour, Farzad. (2016). Analyzing Future Water Scarcity in Computable General Equilibrium Models. *Water Economics and Policy*, *2*(2), 1650006:1650001-1650030. doi:doi:10.1142/S2382624X16500065, p. 1650006-1.
 <sup>70</sup> Zhong, Shuai, Shen, Lei, Sha, Jinghua, Okiyama, Mitsuru, Tokunaga, Suminori, Liu, Litao, & Yan, Jingjing. (2015). Assessing the Water Parallel Pricing System against Drought in China: A Study Based on a CGE Model with Multi-Provincial Irrigation Water. *Water*, *7*(7), 3431.

<sup>&</sup>lt;sup>71</sup> Wittwer, Glyn. (2011). *Basin Plan CGE Modelling Using TERM-H20. Report to the MDBA*. Retrieved from Melbourne: http://www.mdba.gov.au/sites/default/files/archived/basinplan/1718-BasinPlanCGEModellingUsingTermH20.pdf



LI#	Insight	Relevance to MDBA modelling	Whether incorporated ( VOR *) by MDBA modelling/processes (suggested inclusion timeframe) Subsequent incorporation by MDBA ( VOR *)
	relationship between water use, hectares irrigated and the social and economic consequences		
4	Significant body of work already undertaken by MDBA in its social and economic analysis of the Plan	Large body of background work that has guided the MDBA and reinforces need and approach for current modelling work	V
5	Cotton water application rate of 4.5-7ML/ha	Consistent with current modelling	<b>v</b>
6	KPMG found Arche Gillespie I- O approach reasonable but temporal and transitional processes need to be incorporated	Reason for current modelling	ΝΑ
7	Community vulnerability and adaptability indices provide an important baseline for ongoing monitoring and evaluation framework of social and economic consequences of Plan	MDBA has such a framework	V
8	CGE TERM H2O modelling shows employment impacts across entire basin relatively small due to tradability of water	While the case at macro-level, is not the case at local level and hence need for current work	V
9	Water price more sensitive to drought and producer costs than water availability	This result may be more a function of the CGE modelling approach than reflecting local conditions, reinforcing need for such local modelling	Such modelling at the micro-scale could be undertaken to assess such sensitivity but would be constrained by data availability
10	St George and Dirranbandi (Hebel) identified as high risk areas (proportion of irrigated ag, socio-economic condition) in implementation of the Plan	Reinforces need for current work nuanced to meet local conditions	V
11	Income measures could be incorporated and provide comparison with employment number analysis	We are informed that MDBA used income measures to convert part-time employees to full time equivalent.	Measuring localized employment income impacts could be part of the MDBA's ongoing social and economic monitoring and evaluation framework (medium to long-term) ✓ noted in chapter 5 of KPMG community model report <sup>72</sup>
12	Commuting and work migration will be important to modelling the spatial (i.e. local) consequences for job losses	We believe this is highly relevant given recently emerging literature of its significance not just for mining but for all sectors	(medium to long-term)  noted as a limitation in KPMG community model report 73
13	Resilience, migration and commuting, globalisation and technological advancements and associated falls in labour demand need to be incorporated into any modelling	All these have been incorporated except for commuting and work migration	See literature insight 12 for more detail.

<sup>72</sup> KPMG. (2016). Northern Basin Community Modelling: Economic Assessment of Water Recovery Scenarios, 16 August 2016 Draft Report. Sydney: KPMG, p. 33.

<sup>&</sup>lt;sup>73</sup> KPMG. (2016). Northern Basin Community Modelling: Economic Assessment of Water Recovery Scenarios, 16 August 2016 Draft Report, p. 16.





LI#	Insight	Relevance to MDBA modelling	Whether incorporated ( V OR *) by MDBA modelling/processes (suggested inclusion timeframe) Subsequent incorporation by MDBA ( V OR *)
14	TERM H2O CGE predicted water buybacks increased water asset values and had little effect on aggregate farm output in the SB	This prediction could be tested with time for both the southern and northern basins, though it was done at a macro-scale and not local/micro scale.	¥ (medium to long-term) ¥
15&16	Investment in infrastructure upgrades in SB increased regional output and jobs but could have little effect on water savings	Used TERM H2O CGE and reinforces need for localized understanding of effects of infrastructure investment	<ul> <li>Infrastructure jobs stimulus was incorporated into work of Arche and Gillespie as offsetting gains in jobs though noted as underestimated by KPMG</li> <li>Return flows negating water savings (short term)  discussed Collarenebri, Dirranbandi flow on for Moree, St George <sup>74</sup> and some infrastructure water savings retained for productive uses, netted for current water recovery in relevant communities, <sup>75</sup> and accounted as 30% return of water savings in Wee Waa. <sup>76</sup></li> </ul>
17 & 18	Commonwealth water buybacks in SB (2008-2012) had little impact on farm net income	Proceeds from sale were used to pay- off debt/interest or invest on-farm and resulted in greater use of existing entitlements (and this latter response not sustainable). Community impacts not assessed and could be positive and negative	<ul> <li>Substitution between factors of production needs to be incorporated into jobs impact work</li> <li>(temporal inclusion not yet known) ) </li> <li>discussed in KPMG report.<sup>77</sup></li> </ul>
19	Impact on jobs considered an important measure of social and economic consequence	Foundation for current work. (Infrastructure investment has employment multipliers 1/3 to ¼ of those for public health and education)	<ul> <li></li> </ul>
20	Importance of incorporating 'people and place' thinking into social and economic monitoring and evaluation framework	MDBA conscious of these concerns and have undertaken an identification of cultural Aboriginal and Torres Strait Islander values and has an ongoing program of monitoring community wellbeing	<ul> <li>Where communities believe this is not the case, this could become part of the MDBA's ongoing work program (i.e. medium to long-term)</li> </ul>
21-24	Negligible effects of drought on Chinese macro economy though urban and rural households experienced severe losses in food and welfare due to water withdrawals, especially in northern and southern basins	Farmers substituted capital and labour (moved from non-ag to ag) for water. Distinction between negligible macro and significant regional and community impacts reinforces need for current modelling work. Ability to substitute labour for water hindered by higher wages in Australia, and already increased capitalization from drought.	See insight 17 and 18 above.

<sup>&</sup>lt;sup>74</sup> MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Report, p 1.

<sup>&</sup>lt;sup>75</sup> MDBA (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Report, 2 Sep 2016. Canberra: MDBA, p 26.

<sup>&</sup>lt;sup>76</sup> MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Report, 2 Sep 2016. Canberra: MDBA, p 33.

<sup>&</sup>lt;sup>77</sup> KPMG. (2016). Northern Basin Community Modelling: Economic Assessment of Water Recovery Scenarios, 16 August 2016 Draft Report. Sydney: KPMG, pp. 18-19.



## 4. Comments on General Approach to Modelling

#### Introduction

The MDBA approach to modelling localized social and economic community impact is summarized in their final report with the following figure.



Figure 7 is consistent with our general view of modelling the impacts of changes in water recovery and its impact on land use and employment (see Figure 5 in the Introduction to this report). Key factors are taken into account including the effect of water recovery scenarios on extractions by irrigators taking into account their land use, and use of groundwater and seasonal rainfall. The resulting change in area irrigated then determines the change in employment in agriculture and non-agriculture sectors.

#### General approach and factors of production

We believe the MDBA has focused on the key indicator of the impact on social and economic wellbeing from changes in diversions on communities, that is, jobs or employment. Jobs are fundamental to the wellbeing of communities, provide people with a sense of place and contribution, and provide much needed income to spend on other goods and services in the community, providing further stimulus to the local economy and jobs and wellbeing to other members. Having said that, jobs are only one of the three main factors of production<sup>79</sup>:

- land (and now with water reform, water has been separated as an asset)
- labour and

Accessed 19 Aug 2014 from: http://www.anzrsai.org/assets/Uploads/PublicationChapter/546-BlackwellandDollery.pdf



 <sup>&</sup>lt;sup>78</sup> Update from Bradley, J. (2016) Pers. Comms (Email), 12 Oct, Canberra: MDBA of that provided in MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Report, 2 Sep 2016. Canberra: MDBA, p. 8.
 <sup>79</sup> Blackwell B and B Dollery (2013) Income factor shares from mining in remote Australia: An analysis of the Ranger uranium mine and the Tanami gold mine in the Northern Territory, Australasian Journal of Regional Studies 19(3), pp. 369-395.



capital.

It is the combination of these factors that results in production and supply of goods and services. In comparison with jobs, there are other returns to other owners of factors of production, notably owners of land and water and capital, that will also be impacted through the diversion of water to meet environmental or other objectives. (Recommendation 1) Some discussion of these factors and their likely impacts in addition to the impact on labour or jobs is therefore recommended and we suggest some reasoning as to why these were not included. This has now been addressed in the KPMG community modelling report and MDBA report.<sup>80</sup> For example, as water is withdrawn, the impact on jobs will be complicated (offset or compounded) through substitution between all factors of agricultural production.

Related to these factors of production are 'factor shares' or returns to these factors employed in the production process. From an economic viewpoint, economic measures are usually described in dollars and some quantification in monetary terms of the impacts on jobs (and other factors of production) would be an important addition (though explained to us that local wage and salary estimates are complex and data is not readily and reliably available).

In his Wealth of Nations, Adam Smith observed that "Wages, profit, and rent, are the three original sources of all revenue" and that the disbursement of agricultural revenue to the factors of production, "either as the wages of ['inhabitant's'] labour, profits of their stock (or machinery, genetic material etc.), or the rent of their land" is a key consideration in economic and political analyses.<sup>81</sup> While it is more difficult to attach wage and salary estimates to jobs, we believe there is sufficient data to do so at below the shire scale, at least by transferring values form local government areas or appropriate statistical areas as we have previously done for The Northern Territory.<sup>82</sup> Similarly, losses in rents associated with water and land, and profits from the application of crops, machinery and other equipment to agricultural land will be impacted. (Recommendation 2) The monetary value of these impacts have not been assessed in the analysis and the extent to which these will impact these local economies and communities should at a minimum be discussed (short term) as should a reasoning for their non-inclusion (short term). In the longer term, it would be preferable that local measures of wage and salary income be attached to the job losses. These are now identified on p.33 of the KPMG community modelling report as an area for future work and discussed in the MDBA report.<sup>83</sup>

However, a good point raised by the MDBA in our discussions on 31 May 2016, is the extent to which these changes to the returns to factors of production are impacted by water withdrawals rather separate from other exogenous factors (like changes in commodity prices, reduction in trade barriers etc.), or will be impacted by other exogenous factors as these play out through time. (Finding/Caveat 1) We therefore believe the MDBA has captured the nub of the required analysis here using *ceteris paribus*, all other things held the same or accounted for.

Because the factors of land and water, labour and capital are combined, their respective returns will be impacted by a change in the volume of any given factor (here water applied to crops etc.) as a result of the water withdrawals. Therefore considering the impacts on jobs alone does not foretell the impacts on land and capital (equipment) which are combined with water in producing agricultural output and income, and subsequent consumption and production impacts throughout the local and regional

<sup>&</sup>lt;sup>83</sup> MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Interim Report, 27 Sep 2016, pp. 8-9, 19.



<sup>&</sup>lt;sup>80</sup> MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Interim Report, 27 Sep 2016. Canberra: MDBA, pp. 8-9, 19.

<sup>&</sup>lt;sup>81</sup> Smith, A. (1904). An Inquiry Into the Nature and Causes of the Wealth of Nations, first published 1776, Methuen and Co. Ltd, London. Online version access 18 Oct 2012: <a href="http://www.econlib.org/library/smith/smWN2.html">www.econlib.org/library/smith/smWN2.html</a>

<sup>&</sup>lt;sup>82</sup> See Blackwell B, McFarlane J and S Blake (2014) Local Employment of Aboriginal and Torres Strait Islander Peoples by Local Government Area in the Northern Territory: Red Dirt Employment and Income, Journal of Australian Indigenous Issues, vol. 17, no. 4, pp. 72-90.



economies. (Finding/Caveat 2) Only part of the social and economic impact picture will be represented through jobs.

Are measures of jobs, rather than relative measures of job losses, enough? Such an analytical extension would provide relative measures of impact, particularly where employment is concentrated in industrial subsectors (as in the case of communities with irrigated cotton – important in considering the resilience of communities and their economies to bounce back from shocks such as from water withdrawals. For example, see our work on labour concentrations (relative measure) in Figure 8<sup>84</sup>. (Recommendation 3) We acknowledge that KPMG have incorporated the percentage change in jobs relative to the base case, but in the **longer term** we believe a review of relative employment measures would be worthwhile e.g. location quotients which provide measures of employment concentration, employment to working age population ratios which provide an indication of utilization of community populations in the workforce etc. to identify those of most benefit to the ongoing monitoring and evaluation framework. Integrating this work with that of Stenekes et al.<sup>85</sup> may present the greatest synergy for the MDBA. This addition is now noted on p. 33 of the KPMG Community Modelling report.

(Finding/Caveat 3) Overall job losses may be overestimated due to a number of technological advances (e.g. GM cotton and the need for less spraying and employment) and the general substitution of labour for capital in Australia<sup>86</sup>. The former was discussed on p. 19 of the KPMG report, though discussed as driver of change on p. 20 of MDBA report.<sup>87</sup> These are countered by discussion of valid reasons for underestimates on pp. 18-19 in the Sept 27 draft of the MDBA report.

 <sup>&</sup>lt;sup>86</sup> See Blackwell B and B Dollery (2014) The impact of mining expenditure on remote communities in Australia: The Ranger uranium mine and the Tanami gold mine in the Northern Territory, Australasian Journal of Regional Studies 20(1): 68-97.
 'Accessed 19 Aug 2014 from: <a href="http://www.anzrsai.org/assets/Uploads/PublicationChapter/Blackwell-and-Dollery-final.pdf">http://www.anzrsai.org/assets/Uploads/PublicationChapter/Blackwell-and-Dollery-final.pdf</a>
 'MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Report, 2 Sep 2016. Canberra:



<sup>&</sup>lt;sup>84</sup> Calculation of location quotients is a standard technique in economic geographic analysis, though our particular 4 way geospatial visualization is unique. Other studies using LQ type analyses include: Tonts M., Davies A. and Haslam-Mckenzie F. (2008) *Regional Workforce Futures: An Analysis of the Great Southern, South West and Wheatbelt Regions.* University of Western Australia, Perth; Lawrie M., Tonts M. and Plummer P. (2011) Boomtowns, Resource Dependence and Socio-economic Well-being, *Australian Geographer* **42**, 139-64. Tonts M., Plummer P. and Lawrie M. (2012) Socio-economic wellbeing in Australian mining towns: A comparative analysis, *Journal of Rural Studies* **28**, 288-301. Lehtonen O. and Tykkyläinen M. (2012) Estimating Regional Input Coefficients and Multipliers: Is the Choice of a Non-Survey Technique a Gamble?, *Regional Studies* **48**, 382-99.

<sup>&</sup>lt;sup>85</sup> Stenekes, N, Kancans, R, Randall, L, Lawson, K, Reeve, I, & Stayner, R. (2012). Revised Indicators of Community Vulnerability and Adaptive Capacity Across the Murray-Darling Basin: A Focus on Irrigation in Agriculture. Canberra: ABARES. http://www.mdba.gov.au/kid/files/1715-Revised-indicators-of-community-vulnerability.pdf



## 5. Comments on Specific Aspects of Modelling

#### Broader consideration of sectors for regional and local economies

We appreciate that the modelling has considered the job impacts for water withdrawals and aggregated impacted sectors in specific groupings (4 in total: farm and farm supplies, agricultural processing, nonagricultural private, government services), which is based on 720 subsector job categories aggregated to 11 industrial categories however we believe inclusion of this mirco-level analysis of job impacts will reveal impacts more specifically for communities and therefore focus their attention on adaptive or responsive strategies (Recommendation 4, short term). This recommendation still stands to be addressed. Where communities request, the 720 industry subsector data could be provided. For example, in our tracking and mapping of mine expenditure in remote Australia – we use the 720+ industrial subsectors like MDBA and aggregate these to 111 subsectors of the economy and present average employment concentration graphs for each LGA (see Figure 8A for Western Australia and Figure 8B as an example of geospatial jobs concentration impacts). Furthermore and along with the regional profiling and descriptions, mapping the geospatial impacts might help communities, governments, and industry visualize the likely impacts (Recommendation 5). This recommendation still stands to be addressed and could be included in the future work program. This mapping would form an ideal negotiating instrument in the short-term for various jurisdictions but the timeframes for decision-making may be sufficiently short to mean these maps are prepared in the medium to longer term.

#### Use of ABS employment data

We have clarified in discussions with the MDBA that the source of employment data from the ABS is place of usual residence (PUR). If this means that all workers, regardless of their place of work but whom live locally are included in the analysis then this data accounts for local residents who work locally but also local residents who work outside the local area and return home and spend their 'outside' wage and salary income locally. In this case, the impact on jobs may be overestimated because people who work outside a given community's area are not likely to be impacted by water withdrawals directly and will no doubt continue their employment after these withdrawals are implemented.

In contrast, if place of work (POW) data was used this would account for local residents employed locally as well as residents commuting in for work but leaving to an outside community to spend their money. In this latter case, the total employment effects of water withdrawals will not be overestimated because it is the locally oriented withdrawals that are likely to impact local jobs, but the location of employment impacts will be mis-specified because some of this employment lives outside the local community.

To provide a general indication of possible mis-estimation of impacts, ABS Tablebuilder<sup>88</sup> indicates that of the 2296 people who are employed anywhere<sup>89</sup> and live in Balonne, 1886 (82%) work locally, 271 (12%) work elsewhere in Queensland [of this 62 (3%) identified a particular LGA, 91 (4%) were in Queensland with 'no fixed address', and 118 (5%) were categorized as in Queensland 'undefined'], and 139 (6%) elsewhere in Australia (of these 56 (2%) from NSW, 3 (0.1%) from WA, 81 (4%) 'not stated'). In other words, 82% of jobs are locally placed, 18% are placed outside Balonne bringing additional income to the local community that does not rely on local jobs and the impacts for job losses will tend to be overestimated for this component, though the MDBA do model for seasonal workers.

In corollary, of the 2096 people who work in Balonne, 1884 (90%) live locally, 155 (7%) live elsewhere in Queensland, and 57 (3%) live elsewhere in Australia. In this case 10% of employment income from Balonne is lost to outside areas or states, lessening the impact locally, but spreading the impact to outside areas.

http://www.abs.gov.au/websitedbs/censushome.nsf/home/tablebuilder?opendocument&navpos=240 <sup>89</sup> The online and spreadsheet ABS notes refer to 'POW geographical area - Place of Work relates to where the person worked in the week prior to Census Night. Applicable to employed persons aged 15 years and over.'



<sup>&</sup>lt;sup>88</sup> ABS. (2016). TableBuilder, accessed 20 June 2016 from:



Figure 8: A. Employment concentrations (LQs) in Western Australia; B. Predicted spatial impacts for possible future Ranger uranium mine closure (Source and Notes: Blackwell, Fischer and McFarlane 2016; AG= agriculture; MI=mining; MA=manufacturing; UT=utilities; BS=business services; PS=public and personal services; LQ= employment location quotient.)







Therefore an improvement in use of the data and presentation of the impacts would be to <mark>identify the</mark> <mark>spatial impacts by breaking down the employment data into its various types</mark> (Recommendation 6<sup>90</sup> ):

- 1. Local employment (PUR cross tabulated with POW for local community)
- 2. Locals employed outside (PUR cross tabulated with POW outside local community)
- 3. Outsiders employed locally (local community POW with PUR outside local community) and
- 4. Industrial subsector (e.g. 2 or 4 digit level) to provide clues as to the specific industrial sources of employment income leakage or gain.

While it would be preferred to better inform negotiation between various jurisdictions and communities that this work is done quickly in the **short term**, the short-time frames may mean this becomes part of the **medium to longer-term** work program.

This refinement would then capture the extent to which local jobs will be impacted (Item 1) and outside jobs (item 2) that will not be impacted by the withdrawals, and employment impacts outside the local area that will be impacted by the withdrawals (item 3). Figure 8B above provides an example of a similar type of spatial analysis for loss of jobs from a potential closure of the Ranger mine in the Northern Territory. While the Northern Territory is renowned for its iterant workforce, there is growing evidence in the literature of the need to account for labour migration and commuting in better understanding the changing economic geography of local and regional communities.<sup>91</sup>

Therefore noting the source of data and how it was extracted from the ABS is important to identify the degree to which commuting and employment migration are accounted for and the spatial effects that then eventuate (Recommendation 7). Recommendations 6 and 7 have not yet been addressed in the MDBA or KPMG reports and could form part of the MDBA's future work program.

#### The linear relationship used in MDBA water (ML) to land-use modelling

This model is simplistic and does not account for time series nature of the data – therefore we recommend the inclusion of lags and transformations, unless some other exception can be discussed (Recommendation 8). We now accept that the reporting has attempted to address our concerns here with a discussion as to why thorough time series diagnostic tests are not employed and with an addition of an F test to provide a test of the overall performance of the model (see I4 in Table 2 below). Further discussion is provided in the 27 Sept MDBA report which outlines the testing done to address these issues.

In addition, we provided a brief and rapid response to the MDBA<sup>92</sup> on this work as outlined in Table 5. The MDBA also co-responded as noted in the table.

#### Table 5: Summary issues (Source and notes: Blackwell, 2016<sup>93</sup>)

lssue No.	Issue	Detail	MDBA response <sup>94</sup>
11	Difficult to model reality – though overall	Approach commendable because there is a model for each community to help	NA

<sup>&</sup>lt;sup>90</sup> A further recommendation around accounting for labour migration may be to incorporate lags to account for when people leave and arrive, again this would be a medium to long term work program recommendation.

<sup>94</sup> Townsend, Phil, (2016). Email received 22 August 2016 in response to Blackwell (2016). Canberra: MDBA.



<sup>&</sup>lt;sup>91</sup> See for example, Nicholas, C , & Welters, R (2016) Exploring determinants of the extent of long distance commuting in Australia: accounting for space. Australian Geographer, 47(1), pp. 103-120. doi: 10.1080/00049182.2015.1090300; and Blackwell B, Fischer A, McFarlane J and Dollery B (2015). 'Mining and other industry contributions to employment leakage in Australia's Northern Territory', Journal of Developing Areas, Special Issue, 49(6): pp. 263-278. Accessed 30 Sep 2015 from: http://muse.jhu.edu/journals/journal\_of\_developing\_areas/summary/v049/49.6.blackwell.html

<sup>&</sup>lt;sup>92</sup> Blackwell, Boyd. (2016). *RE: Update of modelling files.* Email sent to Phil Townsend 22 August 2016. Armidale: University of New England.

<sup>&</sup>lt;sup>93</sup> Blackwell, Boyd. (2016). *RE: Update of modelling files*. Email sent to Phil Townsend 22 August 2016. Armidale: University of New England.



lssue No.	e Issue Detail		MDBA response <sup>94</sup>
	approach commendable	capture appropriate context and nuance	
12	Approach, assumptions and results for each community detailed	Will help communities see how their particular community modelled	NA
13	Approach of modelling reality and then adjusting so performance of model better matches actuality	For example, some dummy variable added to gain a better fit with actual water to land use relationship	NA
14	Presentation of Results should include F statistic	F statistic needed in addition to t and adj. R2 to test overall significance of model in explaining water use	✓ Added to models (though does not appear in current version of drafts in grey coloured results boxes ¥)
15	Some communities' past water use not predicted by models as well as others	While this is the case, we believe its important for MDBA to explain why the models are better at predicting future water use rather than past to provide communities greater confidence.	✓ St George noted as an example: hydrology- modelling outputs for water course problematic. To be documented and clarified.
16	Need for inclusion of time series diagnostic testing	Though explicitly explained in KPMG report, time series nature of data requires standard diagnostic testing to show these inherent biases are accounted for because cross sectional results suggest greater performance than would otherwise be the case	✓ Will explain at front of Document why data not technically time series but cross-sectional and that cotton prices not statistically related to area of production. Users have a development area from 2000 set by water policy, development costs, and water reliability risk. Refer to Chp. 4 and Appendix 4 of KPMG draft report.
17	Greater time spent on modelling one community over another	Explanation of reasons why may provide communities with greater confidence in MDBA approach	✓ Will be explained in Document.
18	While modelling may predicts past water use well, this does not equate to predicting future well	Issue needs discussion in terms of modelling approach as per I5 and I3 above.	✓ Models not intended to be used to predict future because of changing production systems and efficiencies.

#### **Relationship between hectares and jobs**

While taking account of time dependency (through the T variable taking on a value of 1 for each successive year of the model) this relationship needs to be explained explicitly in the KPMG report. Similar to the linear water and land-use model, the hectares to jobs relationship using time series data requires a suitable transformation such as a first difference of the dependent variable, again unless some other reasoning can be provided and regardless of the preferred approach should be explained in the text of the report. (Recommendation 9a). It also requires a lag variable of the dependent variable as an explanatory variable (Recommendation 9b). These issues have now been explained in the reporting.

#### Longer period for data

Currently as we understand, the number of observations used in the regression for labour is relatively small compared with typical times series (or panel data) analysis. (Recommendation 10) This is the most important extension of the current modelling from an econometric perspective because this will add considerable statistical power to the modelling and allow for the incorporation of other possible explanatory variables. We note the data limitations now documented in the KPMG report on p. 5.

#### Referencing of data sources and assumptions

For modelling spreadsheets these should be explicitly stated in the spreadsheets so it is clear to the viewer where the data has been derived (Recommendation 11). While the various sources were verbally explained to us, to the lay reader, he or she will be left wondering what the sources were. Such documentation will also help with interpretation by other MDBA staff new to the project or spreadsheets and by stakeholders reviewing the model. On this latter point we also recommend that stakeholders, particularly industry, verify the data inputs in the model. Referencing of data sources, assumptions and 34



limitations now detailed in the reports and the MDBA has undertaken community consultation (MDBA, p. 8) though it is not within the scope of our terms of reference to verify the veracity of this consultation other than what we have provided in Section 6 of our report.

#### Clear and explicit presentation of the econometric results

This must be provided (Recommendation 12):

- Providing the required standard diagnostic test results for running time series or panel data models, e.g., to test for autocorrelation, endogeneity and omitted variable bias etc.<sup>95</sup>
- *Adjusted R*<sup>2</sup> instead of simply R<sup>2</sup> to account for the number of explanatory variables in the models; this will be important where the number of observations are relatively small.
- Is an appropriate time series modified R<sup>2</sup> used as per Wooldridge<sup>96</sup>, page 366-367, because R<sup>2</sup> for time series data are inherently high regardless of the model's underlying explanatory power?
- All test statistics should be explicitly named correctly in the spreadsheets to ease interpretation.

We are satisfied that these are now addressed through both reports, for example, see pp. 14-16 of the MDBA interim summary report and the detailed results in the appendices of the KPMG Report.<sup>97</sup> However, our view is that the underlying data is times series in nature.

#### **Correction for omitted variable bias**

Currently, with only one main variable included in the modelling, there is likely to be omitted variable bias in the results. This occurs where one variable captures the variation of others variables not included in the model. This results in the coefficient for the explanatory variable (ha or agricultural labour employment) being larger than it otherwise should be and for any given reduction in water, and thus reduction in ha or agricultural labour employment, the predicted loss in employment will be overestimated.<sup>98</sup> (Recommendation 13) We therefore believe a number of other explanatory variables should be included and reported in the results to confirm whether omitted variable bias is occurring. For example, a non-exhaustive list of variables that may impact employment *a priori* (signs in brackets) are:

- Price of labour (i.e. wages rates, -)
- Level of investment<sup>99</sup> (+) as a proxy for capital (see previous points about Labour, Capital, Land and Water substitution)
- Volume of output (+) which should be readily known in an agricultural enterprise (else it can be approximated by the level of value added calculated by subtracting from business volume the value of intermediate output
- Price of output (i.e. Cotton price, +) or to overcome multicollinearity between volume and price of output the value of output

<sup>&</sup>lt;sup>99</sup> For example, see inclusion of investment in the empirical labour market modelling undertaken by Lichter, A, Piechl, A, & Siegloch, A. (2012). Micro-level labour demand estimation for Germany *NEUJOBS Working Papers, April 4*(Working Paper D10.3), 1-49. http://www.neujobs.eu/sites/default/files/publication/2012/04/NEUJOBS\_Working%20PaperD.10.3.pdf



<sup>&</sup>lt;sup>95</sup> The currently very high R<sup>2</sup> for the models suggest some underlying problems that can be identified and corrected through diagnostic testing.

<sup>&</sup>lt;sup>96</sup> Wooldridge, JM (2009) Introductory Econometrics: A Modern Approach, 4e, Cengage Learning, Sydney.

<sup>&</sup>lt;sup>97</sup> KPMG. (2016). Northern Basin Community Modelling: Economic Assessment of Water Recovery Scenarios, 16 August 2016 Draft Report. Sydney: KPMG; MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Interim Report, 10 Oct 2016. Canberra: MDBA.

<sup>&</sup>lt;sup>98</sup> While omitted variable bias is likely to result in an overestimate of impacts of labour, there is also the potential for underestimation through the modelling because not every ML of water recovery has the same effect on the local economy/community. As more and more water is recovered, the marginal impact may vary. Furthermore, the way water is

recovered may have a significant impact on employment, e.g. buying water on a day from the biggest or one of the biggest irrigators in a community.



We are satisfied that The MDBA has gone through a series of processes that test for omitted variable bias as noted in their report on pp. 11-12. <sup>100</sup>

#### Other reviewer comments

While we have read the comments from other reviewers of the Lower Balonne social and economic modelling by the MDBA, we have undertaken our review independently of their concerns in the first instance, that is, we have read these other review concerns after drawing our own opinions.

Firstly, we have reviewed the comments by Mr Jim Binney for the Queensland Government provided by Phil Townsend on Friday 3 June 2016 in marked-up changes on various earlier work undertaken by KPMG<sup>101</sup> and MDBA and have necessarily no disagreement with his general comments – though some of these seem irrelevant to the St George Dirranbandi (Hebel) work given the general approach taken by KPMG since this review (no fault of Mr Binney's) appears to have been to simplify the modelling with a focus on jobs. One point we disagree with is around the assumed immobility of Aboriginal and Torres Strait Islander peoples. CRC REP research suggests otherwise and indeed recent evidence suggests they are recognized as 'highly mobile' – e.g. see Dockery<sup>102</sup> page 4.

Secondly, we have read the comments raised by DNRM of the Queensland Government provided by Ms Sophie Rolls via email on Friday 3 June 2016. Again we do not necessarily disagree with the matters they raise. Instead we have focused our review on those issues that in our opinions are important. This however, is not to say that DNRM's concerns are any less important than ours, and should not also be given due consideration. In this way, our recommendations can be seen as corroborating in some instances, while original and additional in other instances.

We therefore believe that the concerns of any other reviewers of the modelling work should be addressed by MDBA in clearly articulated terms. The incorporation or otherwise explanation as to why incorporation would not be appropriate or is impractical should be provided to these reviewers or the agencies for which they act (Recommendation 14 - **short term**). We have not checked for this because this is outside the scope of our terms of reference, but request that MDBA address these concerns separately.

rep.com.au/resource/CW015\_ReconceptualisingMobility.pdf



<sup>&</sup>lt;sup>100</sup> MDBA. (2016). Northern Basin Review: Technical Overview of Socioeconomic Analysis, Draft Report, 2 Sep 2016. Canberra: MDBA.

<sup>&</sup>lt;sup>101</sup> KPMG (2016b) Development of capability to assess effects of water recovery for the environment at the community level in the Northern Basin: Modelling specification brief, March, KPMG, Melbourne; KPMG (2016c) Development of capability to assess effects of water recovery for the environment at the community level in the Northern Basin: Modelling brief, February, KPMG, Melbourne; Townsend, P (n.d.) 'Modelling irrigated agriculture production in the Lower Balonne', (Lower Balonne area yield modelling) Unpublished, MDBA, Canberra; Mainstream (2016) Review of documents outlining models to assess impacts of changes to Sustainable Diversion Limits, Mainstream, Brisbane.

<sup>&</sup>lt;sup>102</sup> Dockery, AM (2014) Reconceptualising mobility for Aboriginal and Torres Strait Islander Australians, CRC-REP Working Paper CW015, Ninti One Limited, Alice Springs. Accessed 8 June 2016: <u>http://www.crc-</u>



## 6. Community Consultation Over Modelling

#### Introduction

As noted in the introduction, we received a report on community consultation as summarized in Table 6. The full process for this consultation has been outlined in the MDBA technical summary report for which we are not commenting – such would be outside the scope of our review – instead we focus on any community concerns over the modelling elements.

#### **Brief review**

Of the 13 identified, five need to be more explicitly addressed by the MDBA to help allay community concerns including: real estate value changes, accounting or planning for lag times for new industries to start-up, costs being greater than benefits, significance of impacts on towns and businesses from buybacks, and the fact that local irrigators do not want to sell their water.

Issue	Issue	Detail	MDBA response	Our response		
No.						
Data and Information						
CCI1	Data paucity	MDBA asked how handling data gaps post 2011.	Constrained by ABS census years – 2011 most recent (2016 in progress, available mid 2017 & will be included in future reports) yet supplemented through (i) annual ABS ag and (ii) ABARES farm surveys and (iii) Australian Collaborative Land Use and Management Program May 2016 update as well as Townsend (iv) talking with local farmers, businesses and people in the community.	✓ MDBA response valid, except (iv) while providing context can not, as presented, be validated as representative ¥		
CCI2	Job numbers	Preference for actual job numbers rather than percentage change	Incorporated into analysis	V		
CCI3	Full-time equivalents (FTEs) versus employment levels	Employment has low correlation with FTEs: Peaks and troughs not captured by FTEs.	Variability taken into account in analysis	~		
CCI4	Real estate value changes	Why not included in the analysis?	(No response provided)	Should be addressed by MDBA, similar to our comment in regards to accounting for substitution between factors of production: Land, Labour and Capital.		
Impact	lag time					
CCI5	Impacts from previous buybacks still flowing through communities	Dirranbandi used as an example	See below	See below		
CCI6	Lag time for	Temporal	Lag time likely to be 2-5 years	The analysis should incorporate at least some		

#### Table 6: Issues raised through Community Consultation Phase 2 $^{\rm 103}$

<sup>&</sup>lt;sup>103</sup> This table provides a summary of MDBA. (2016). Northern Basin Review Phase 2 Engagement Program: Community Meetings, July 2016. Canberra: MDBA.





lssue No.	Issue	Detail	MDBA response	Our response
	new industries to start-up	nature of impacts and consequences for closures and start-ups needs greater consideration	for adaptation or adjustment to water recovery shock. Where towns are looking to new industries and innovation, they should discuss broad range of issues including: credit, supply, and farm-town connections.	discussion of temporal impacts – at least short term and intermediate to longer term.
Manag	ement of Busines	s and Community [	Diversity and Connectivity	
CCI7	Community boundaries	Why did they use those different to ABS?	Because boundaries were established based on taking account of the diverse economy and community context for each Broken lines indicate connectivity between communities and more broadly – demarcation always difficult.	✓ but note difficultly for third party to reproduce results without conversion of standard data to new boundaries
CCI8	No ag and ag business relationship	Are not all industries connected and dependent on ag in small ag towns?	Non ag includes: hairdressers, retail and accommodation. Appreciate these aren't unrelated to ag esp. in small towns. KPMG modelling designed to account for these relationships.	✓ again, sometimes demarcation difficult but has to be done.
CCI9	Structural changes in St George	Resulted in is less diversity of businesses	(No response provided)	
Buybac	ks versus addition	nal infrastructure i	nvestment	
CCI10 (i)	Buybacks –v- infrastructure have different impacts	These need to be understood by MDBA	(No response necessary – see below.)	NA
(ii)	Costs to communities greater than what presented	Why not a full cost-benefit analysis?	(No direct response provided)	Needs to be explicitly addressed
(iii)	Significant impacts on towns and businesses from buybacks	How is MDBA responding to this?	(No direct response provided)	✗ Needs to be explicitly addressed
(iv)	Local irrigators do not want to sell their water	Reason why Australian Government is prioritizing infrastructure spending over buybacks <sup>104</sup>	Implicit reference to Australian Government Water Recovery Strategy?	✓ While strategy sets out Government's approach does this address community concerns and ideological divide between saving water for the environment through buy-backs and creating more water for growers through infrastructure investment? There is a cap on water buy-backs and plan for investment. ★
Climate	e variability and cl	hange		
CCI11	Impact of drought	Discussed	Modelling through scenarios takes a long-term view to take account of a range of pressures, incl. drought, which communities need to manage. MDBA presented shifts in	V

<sup>&</sup>lt;sup>104</sup> Department of Environment. (2014). *Water Recovery Strategy for the Murray-Darling Basin, June 2014*. Canberra: Commonwealth of Australia. Retrieved from <u>http://www.environment.gov.au/system/files/resources/4ccb1c76-655b-4380-8e94-419185d5c777/files/water-recovery-strategy-mdb2.pdf</u>





lssue No.	Issue	Detail	MDBA response	Our response
			decline in casual labour, change in age structure, impacts on business resulting from drought over time	
CCI12	Climate change impacts on community	Have these been included?	Hydrological modelling does not incorporate climate change scenarios rather incorporates a range of historical climate conditions <sup>105</sup> that more than adequately captures average climate change impacts on water availability. Referred to MDBAs approach to climate change <sup>106</sup>	V
Moving	g forward			
CCI13	Qld Murray- Darling Committee	Complimentary about work to date and need to work with Universities on impacts for fish and birds	(No response required)	NA

changing climate. *Water*, 42(2), 102-107. Retrieved from www.mdba.gov.au/sites/default/files/pubs/Managing%20water%20in%20the%20murray-darling%20basin%20under%20variable%20and%20changing%20climate.pdr

<sup>&</sup>lt;sup>105</sup> MDBA. (2012). Hydrological Modelling to Inform the Proposed Basin Plan, February 2012. Canberra: MDBA. Retrieved from http://www.mdba.gov.au/sites/default/files/pubs/Hydrologic\_Modelling\_Report.pdf

<sup>&</sup>lt;sup>106</sup> Neave, I, McLeod, A, Raisin, G, & Swirepik, J. (2015). Managing water in the Murray-Darling Basin under a variable and



## 7. Lower Balonne Floodplain Grazier Modelling

#### Introduction

While we have already provided our independent review report to the MDBA on the modelling done for the St George and Dirranbandi (including Hebel) communities<sup>107</sup> this did not consider the modelling work (through simulation) done by the MDBA on the impacts from increased environmental flows for the floodplain graziers of the Lower Balonne (see Figure 9) as reported by Wakerman-Powell<sup>108</sup>. In this section of our report we address this as per our terms of reference (see section 2 Introduction).

Figure 9: Lower Balonne River Floodplain (Source: Wakerman-Powell <sup>109</sup>, p. 3)



Figure 10 depicts a profile of irrigation systems at play in the Balonne River including the Lower Balonne River Floodplain (green shading). The Figure key also denotes that this floodplain is key environmental asset site of the Basin. Upstream agricultural development on the Condamine-Balonne Rivers has reduced the 'size and scope of large overbank flows' and 'smaller flows which allow for in-channel environmental

 <sup>&</sup>lt;sup>107</sup> Blackwell, Boyd, McFarlane, Jim, & Stayner, Richard. (2016). Independent Review of MDBA Dirranbandi (& Hebel) and St George Socio-Economic Modelling for the Northern Basin: Final Report 23 June 2016. Armidale: University of New England
 <sup>108</sup> Wakerman-Powell, Kai. (2016). Lower Balonne Floodplain Grazing Model Report - Draft, September 2016. Canberra: MDBA.
 <sup>109</sup> Wakerman-Powell, Kai. (2016). p. 3.





benefits and stock and domestic water'.<sup>110</sup> These reduced flows have thus significantly impacted Lower Balonne graziers and the environment over the last 20 years – some graziers have lost as much as a quarter of stock and earnings from lower flows.<sup>111</sup> Therefore returning flows to the floodplain is expected to deliver environmental benefits and improved yields to graziers, contributing to the businesses and economies of Goodooga, Brewarrina (see Figure 9) and Weilmoringle. The MDBA floodplain report in this regard therefore attempts to simulate the extent of benefits that are transferred to graziers as a result of the water scenarios for increased environmental flows to the Lower Balonne Floodplain, and this will help recommend a recovery target 'alongside other detailed studies of environmental, social and economic impacts'.<sup>112</sup>

**Figure 10: Longitudinal Profile of Lower Balonne River Floodplain** (Source: http://www.mdba.gov.au/sites/default/files/pubs/Balonne LP.pdf)



The simulation model, using computational and statistical estimation and consultation with graziers, takes into account 'overbank flows, rainfall and property conditions to estimate grazing productivity on a seasonal basis' as noted in Figure 11.<sup>113</sup> However, opportunity cropping benefits, or geographical impact distribution across the floodplain is not taken into account and more 'work is required to trace the impact of specific flows on the floodplain'.<sup>114</sup> Between 25% and 33% of lost stock productivity and earnings can be returned across the floodplain scenarios considered as mirrored by withdrawals of between 278GL and 390GL in the Northern Basin.<sup>115</sup> Interestingly, greater volumes of water recovery across these scenarios may not necessarily have increasing impacts for graziers, because of the varying distribution of water recovery across valleys and environmental water holder use; there is a non-linear benefit response from increased environmental flows.<sup>116</sup> The modelling uses a 100-year baseline up to June 2009 prior to the Basin Plan as well as taking account of upstream development.

<sup>116</sup> Wakerman-Powell, Kai (2016), p.

<sup>&</sup>lt;sup>110</sup> Wakerman-Powell, Kai. (2016). p. 1.

<sup>&</sup>lt;sup>111</sup> Ibid.

<sup>&</sup>lt;sup>112</sup> Ibid. <sup>113</sup> Ibid.

<sup>&</sup>lt;sup>114</sup> Ibid.

<sup>&</sup>lt;sup>115</sup> Ibid.



#### Figure 11: Lower Balonne Floodplain Grazier Model Structure<sup>117</sup>

The stock in any one period is a function of the current season (4 seasons included), the stock in the previous period, and the overbank flows and rainfall over the previous two years, as derived from grazier consultations, where overbank flows on the floodplain have large lagged effects and are sequence dependent.



#### **Review Items**

Overall the modelling for floodplain glazier impacts appears thorough being contextualized by consultation and discussion with graziers to better interpret the results (e.g. See grazier comment p. 8 about even small flows in dry years following an overbank flow year presents an ideal sequence). We also believe the modelling has been prepared in a sufficiently complex way (using excel sheets, simulations, Monte Carlo results estimation, computationally optimized model variables, seasonality, conditions as rules based, separate estimation of carrying capacity and earnings with the latter estimated seasonally) yet grounded by in-built rules that mirror grazier practical decision making. The full set of modelling assumptions and limitations are outlined in the Appendix B: Model Design of Wakerman-Powell (2016). For this reason, we have no major concerns with the Lower Balonne Floodplain Grazing Model or its report other than those outlined in Table 4, and only one of these may be useful to consider in future modelling work (see GI3 in Table 4) undertaken by the MDBA.

<sup>&</sup>lt;sup>117</sup> Upate via Wakerman-Powell, K. (2016) Pers. Comms (Email), 13 Oct 2016, Canberra: MDBA of Wakerman-Powell (2016, p. 25)





Issue Issue No.		Issue	Detail	MDBA response		
	GI1	Earnings modelling – inclusion of full costs	Overhead or fixed costs could be included in the earning estimates to provide net earnings (to ensure graziers take account of land taxes, capital assets, manager income – noted on p. 15 – and forgone income to themselves), however, only considering the marginal costs is an economically valid approach and fixed cost and wealth effects are explicitly noted as not included in the modelling in Appendix B, p. 43 and as a limitation.	✓ Floodplain modelled as a single unit rather than for individual business – too great a variation (10-20 times size difference, smallest to largest) to model a typical business plus modelling complexities (changes in business structure/processes from water changes) outside project's scope. <sup>118</sup>		
	GI2	Earnings modelling – inclusion of relevant marginal costs	Establishing whether floodplain grazing is viable should include consideration of all relevant marginal costs (as noted above) but also forgone income to graziers themselves – to ensure they earn enough to pay themselves for their efforts), otherwise these co-benefits of environmental flows should be seen as co-costs/non-benefits of water for the environment.	✓ Labour costs (variable) explicitly included in modelling, though not 'for sell-offs' or 'agistment which mostly involve loading and unloading' stock. <sup>119</sup>		
	GI3	Yearly earnings estimates – incorporation of time value of money	As noted by author on p. 32, these need to be summed overtime because they are typically earned at points in time. Has the author considered time value of money in their earnings models and if not, it may be better to convert annual benefits to net present values to account for the mismatch of costs and benefit flows overtime.	✓ Yes was considered though results to be interpreted as what is expected next year under the different scenarios, NPV may confound some of the important messages about sequence of flows because volumes not randomly distributed through time, it does not include costs and benefits for cotton reduced upstream and is only a partial analysis, and results relate to whole floodplain and not individual businesses. Recommend the inclusion of these complexities in future modelling.		
	GI4	Model driven by water input rather than commodity prices	Other factors may drive grazier decisions more than environmental flows, such as commodity prices and exchange rates. Wakerman-Powell specifically notes this on p. 43 of Appendix, particularly where after drought restocking is as significant to decision making as return of water.	Not necessary		

#### Table 7: Summary of review items

<sup>118</sup> Wakerman-Powell (2016) Pers. Comms (Email), 16 Sep 2016, MDBA, Camberra.
 <sup>119</sup> Ibid. Wakerman-Powell provided spreadsheet model that includes 'working costs' as sheep and pricing variables.

