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Comment on “Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments”

This report was prepared for the Murray Darling Basin Authority

June 2012

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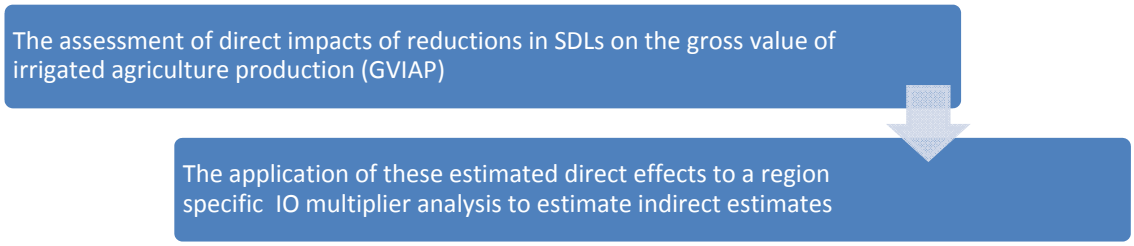
Key Findings

Arche were engaged by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and the Murray Darling Basin Authority (MDBA) to undertake economic analysis of the short-run impact of policy changes in the Murray Darling Basin at a fine level of regional detail. The objective of the project was to develop case study assessments to determine the net impacts of policy changes at a local community scale[1]. This type of analysis faces a number of challenges, namely:

- obtaining appropriate data for small regions (e.g. LGAs) is difficult; and
- capturing the economic and hydrological linkages between regions is complex.

Broadly, the method employed by Arche involves two steps:



To measure the direct impact of the reductions in SDLs for each local government area, Arche relied on information from the ABARES WTM. Percentage reductions in SDLs were applied to each LGA based on the reduction in the broader Sustainable Yields Region.

The second stage of the analysis involved construction of an IO table for each LGA. The regional tables are based on an Australian IO table disaggregated to the LGA level using employment data derived from the 2006 ABS Census.

Given the limitation in data availability, a number of assumptions and adjustments were necessary to undertake the analysis at the LGA regional level. A number of approaches could have been adopted by Arche in making these assumptions and adjustments. The following table outlines alternate approaches to model development and assumptions that could potentially enhance the efficiency and usefulness of the analysis.

Table 1: Alternate approaches to Arche method for estimating economic impacts (modelling and assumptions)

Method/Assumption	Alternate Approach
IO modelling framework	Consider duration of adjustment period given short-run nature of modelling method.
Direct impact estimation based on ABARES-WTM	Incorporate regional variation in water use intensity in regional disaggregation. Use of WTM results under water trade assumptions may be more appropriate.

[1] ARCHE Consulting, 2011, *Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments: An Assessment of the Short-Term Impacts at a Local Scale*, report prepared for DSEWPaC and MDBA, November.

Method/Assumption	Alternate Approach
Baseline development	• Adjust employment baseline to account for changes in regional population over time. • Adjust size of agriculture sector to reflect "business-as-usual" decline over time. • Ensure baseline and scenarios are specified for the same year (or results adjusted accordingly).
General assumptions	• Manual allocation of land use substitutions potentially results in an overstatement of negative impacts. Allowing optimal production substitution based on marginal value of water may be more appropriate and consistent with other economic modelling approaches. • Could allow land and labour ratios to vary to allow for sensitivity to water prices. • Consider accounting for difference in timing of infrastructure spending (short-term) and productivity impacts (long-term).

Source: KPMG analysis

It is noted that a number of these approaches are beyond the scope of the Arche report. Additionally, a number of these approaches would require resources and data beyond that available to Arche in undertaking their analysis.

The IO modelling approach used by Arche is within the scope of the analysis. However, IO modelling tends to overstate the adverse impacts of the SDL reduction. IO modelling results can be viewed as an upper bound.

Arche note that the approach adopted in their study required a significant number of assumptions due to the specific project requirements and data limitations. Arche conclude that, due to the approach adopted, the results of the analysis are likely to overestimate the negative impact of the Basin Plan and underestimate the positive impact of Water for the Future[2].

Overall, given the scope and purpose of the analysis and various limitations outlined above, the approach adopted by Arche is reasonable.

[2] Ibid.

1 Introduction

Arche Consulting (Arche) were engaged by the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) and the Murray Darling Basin Authority (MDBA) to undertake an analysis of the potential short-run socio-economic impacts of the Murray-Darling Basin Plan and the Water for the Future program. The specific objective of this project was to develop case study assessments to explore the net impacts from the implementation of reduced Sustainable Diversion Limits (SDLs) at a local community/regional level. The report focuses on the short-run impacts at a relatively fine level of regional detail[3]. The project was commissioned, in part, to complement the MDBAs socio-economic modelling undertaken at a higher level of regional aggregation by Monash University and ABARES.

1.1 Scope

The MDBA has commissioned a brief third-party assessment of the method employed by Arche in their report "*Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments: An Assessment of the Short-Term Impacts at a Local Scale"*[4]. In this assessment, the validity of specific results is not addressed; rather, commentary is provided on the efficacy and utility of the method employed.

The level of detail included in this review reflects the availability of technical detail included in the Arche report. The comments contained in this review are, therefore, restricted to the data and assumptions used and general observations on the use of IO multipliers in regional economic analysis.

It is acknowledged that the Arche report was prepared within scope, timeframe, data availability and budget limitations. Many of the issues raised in this review are a function of the limited resources available in undertaking the analysis. A more detailed, sophisticated and expensive technique could provide solutions to some of the issues raised in this review, and additional time and personnel could potentially increase the quality of the data used.

This review does not seek to be critical of Arche consulting.

In undertaking this review, the issues identified primarily focus on:

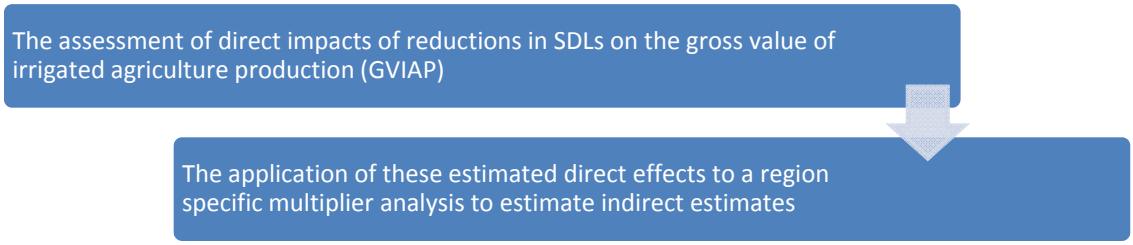
- data and techniques employed for establishing the baseline and direct impacts; and
- the validity of IO modelling for estimation of wider economic impacts.

1.2 Overview of Arche Method

Arche were engaged to undertake short-run analysis at a fine level of regional detail. Data for this type of analysis is notoriously scarce and unreliable. Arche note in their report that obtaining appropriate data at a small area (LGA) level is a challenge. In addition, economic modelling that seeks to capture inter-sectoral linkages at such a fine level of regional detail is generally very difficult to undertake in a robust way.

Broadly, the method employed by Arche involves two steps:

[3] ARCHE Consulting, 2011, *Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments: An Assessment of the Short-Term Impacts at a Local Scale*, report prepared for DSEWPaC and MDBA, November.
[4] Ibid.



This is a common approach applied by economists to estimate the regional economic impacts of policy changes.

Direct impact assessment

Arche estimated the direct impacts of SDL reductions in terms of GVIAP[5]. Estimates for baseline GVIAP at the regional level were constructed from various data sources including statistics on:

- irrigated crop areas;
- commodity prices; and
- regional-level farm gross margin budgets.

Arche assessed the characteristics of a particular region's irrigated agriculture sector using data on enterprise type, product mix, employment and regional profit. The SDL reductions imposed to generate the modelled results were based on information on estimated diversions and government interventions (such as the Water for the Future program's investments in irrigation infrastructure).

The estimates used by Arche to generate the SDL reduction scenarios were derived from the ABARES[6] Water Trade Model (WTM).

The ABARES – WTM

The WTM is a comparative static, partial equilibrium, hydro-economic model. Irrigated agriculture production is modelled using a Cobb-Douglas production function with two inputs, water and land. Water networks are modelled using a nodal framework, in which water flows between hydrologically connected regions are accounted for at specific points (or "nodes") in the system linked (or not linked, as the case may be) to other nodes. At any given point on a watercourse, water availability is given by the sum of local surface water run-off, surface water run-off from hydrologically connected regions upstream and local groundwater.

The WTM is based on Sustainable Yield Regions. These are broader than the LGAs defined in the Arche analysis. Accordingly, the subsequent stage of the analysis involved disaggregating Sustainable Yield Region water reductions into LGAs level reductions. The Arche analysis assumes that the water reductions would apply based on relative water use in each LGA within the broader Sustainable Yield Region.

A reduction in water availability generally results in a reduction in production of irrigated crops and the land from this irrigated crop production is converted to dry land agriculture. Assuming

[5] GVIAP is the wholesale-level value of recorded production, measured at market prices.
[6] ABARES(2010) Environmentally sustainable diversion limits in the Murray-Darling Basin: Socio-economic analysis, ABARES report prepared for the Murray-Darling Basin Authority, Canberra.

constant ratios of water, land and labour to GVIAP (based on gross margin budgets sourced from state government) for each crop type, Arche used the change in dry land and irrigated agriculture production mix to estimate changes in the expenditure of the irrigation sector. These expenditure impacts formed the inputs to stage two of the project, estimation of the indirect economic impacts.

Indirect economic impacts

The second stage of the analysis involves construction of an IO table for each LGA. The regional tables are based on an Australian IO table disaggregated to the LGA level using employment data from the 2006 ABS Census[7]. The changes in expenditure patterns of the irrigation sector (the direct impacts derived in stage one) were then applied to IO multipliers to estimate indirect regional economic impacts.

Arche constructed an IO table for each region that reflects a snapshot in time. These tables were used to estimate IO multipliers and assess the "backward linkages" (also known as "upstream effects") between sectors impacted and the broader regional economy.

Usefulness of the IO framework

Arche's approach involves the use of an IO table for each region and the application of multipliers to assess the short-run regional economic impacts of implementing SDL reductions. Given the scope of the Arche analysis, this is considered a reasonable approach.

When interpreting the Arche analysis, it is important to consider the underlying assumptions of the IO modelling employed and the assumed changes in the use of land from irrigated agriculture to dry land farming The IO framework assumes there is no limit on the supply of production factors available in each region. This limits its application to large-scale and/or long run events or policy changes. However, IO analysis is effective in assessing the short-run impact of an event in a narrowly defined region. Considering the potential impacts arising from a change in land use (or an adjustment of factors), potentially involves a medium to long adjustment period. The Arche analysis assumes the transition from irrigated agriculture to dry land farming. This is considered to require a medium to long run period of adjustment[8]. Accordingly, the appropriateness of the IO approach for this analysis may be diminished.

The IO approach would be most suited to estimating the short-run impact of a reduction in irrigated agriculture without assuming that irrigated agriculture could be converted to dry land farming. However, such an analysis would likely overstate the negative impacts of the policy change.

Efficacy of the direct impact calculation

To assess the direct impact of the SDL reductions, Arche estimated the water reduction for each LGA region. The availability of data regarding the likely reduction in SDLs by LGA is limited. Accordingly, Arche disaggregated ABARES-WTM results at the Sustainable Yield Region level to the relevant LGA level. In undertaking this disaggregation, Arche assumes equal proportional reductions. This assumption relies on water use intensity being consistent across

[7] The IO tables used in the Arche analysis were based on ABS 2006 Census data and were derived specifically for the purpose of their analysis.
[8] A discussion with ARCHE report author indicated the adjustment period required is about 5 to 6 years.

LGA regions within each relevant catchment area. The composition of irrigated agriculture production is different in each LGA region and there would likely be differences in water use intensity. Accordingly, the appropriateness of the proportional disaggregation method may be diminished.

Efficacy of the IO modelling:

The WTM results used in the main Arche analysis assume no water trade. This can be justified from a short-term perspective, however, water trade is an essential element of the overall SDL reduction program over the policy reform period. Accordingly, the use of the WTM results under water trade assumptions would be more appropriate. A sensitivity analysis was included in the Arche report that modelled the impacts with water trade, however, these results were not reported as key findings.

The use of WTM results under the no trade assumption avoids some complications arising from potential changes in agriculture prices due to water trade. However, any adjustments requiring a change in land use would have long-run implications, and therefore, the Arche modelling analysis could be enhanced by incorporating water trade impacts into the direct impact calculation.

2 Baseline and Direct Impact Estimation

2.1 Baseline

The precise method used in the development of the baseline is unclear. However, there are a number of issues that warrant further consideration, namely:

- the alternate baseline used for comparison of employment and the size of the agricultural sector; and
- the establishment of the baseline allocation of regional SDL reductions to LGAs.

2.1.1 Employment and the agriculture sector

The regional employment impacts are based on the assumption that agricultural employment levels are static and equal to the base year. The employment results show that LGAs with larger declines in employment are generally those expected to experience the largest fall in population in the future. Static baseline regional employment levels (i.e. that do not take into account trends in regional population growth/decline) results in bias in the negative employment impacts into areas with a declining population.

In the baseline, the size of the agriculture sector remains static and consistent with that specified in the regional IO tables. There is potential that a decline in the agricultural sector will occur in a business-as-usual baseline scenario. From the point of view of comparative static analysis, this issue is more to do with the baseline assumptions regarding the relative size of the irrigated agriculture sector in each LGA economy.

It is not clear whether the base year of the regional IO tables in the Arche study represents a particular point of time in the future or in the past. The latest published detailed IO tables available from the ABS are for 2004-05. If the tables have not been modified to reflect a forecast economy once the full impact of the Basin Plan is implemented, they reflect the 2004-05 structure of the local economy. If this is the case, in the context of a LGA with a declining agricultural sector and population (and therefore employment) pool, a shock to the number of jobs would translate to an inflated percentage of the smaller future regional population. This means that the impact on jobs and agricultural production would be overstated for these LGAs and may be understated for LGAs with increasing population (if agricultural production were also growing).

The Arche study assumes that all of the reforms occur in the final year of the implementation of the policy (i.e. the year when the full impact of the Basin Plan is implemented). The selection of the base year may not be so critical in the comparative static analysis provided that both the baseline and scenario are specified in the same year. However, caution would be needed in interpreting employment results reported as numbers employed. It is unclear which is the base year to which the final year reform effects are applied. The short-term effects in the final year or earlier might be quite different as the levels of the fixed factors will be significantly different.

2.1.2 LGA level water use

Baseline diversions for each LGA are taken as a portion of the broader catchment baseline and are apportioned based on ABS data on diversions at the LGA level for 2005-06. The use of a

single point in time these apportionments over the long run may misrepresent water diversions in each LGA. Diversions are likely to vary significantly year-to-year and are sensitive to a number of factors, including:

- total rainfall and location;
- water quality;
- previous water capture;
- intraregional water trade;
- evaporation;
- agricultural production;
- crop composition and quality;
- technology;
- commodity prices;
- exchange rates; and
- wages.

The use of water diversions for a single year (2005-06) in establishing the baseline LGA allocation of regional water use may not be representative of medium to long-term water use. This method of allocation may also bias the results when apportioning water reductions under the scenario (discussed further in the next section).

2.2 Direct impact estimation

As discussed previously, to determine the direct impacts of a water reduction scenario, Arche used the outputs of the ABARES WTM model. Local level data, such as farm budgets, were also used to establish the change in expenditure for each agricultural product. There are a number of issues associated with this method that warrant consideration, namely:

- the compatibility of the WTM with an LGA level model; and
- the assumptions relating to the reallocation of previously irrigated land, fixed factors ratios and water trade.

2.2.1 ABARES WTM compatibility

Arche developed an LGA level model using a regional IO model for each of the selected LGAs. This approach is, in some ways, similar to the ABARES (2010 and 2011) modelling approach[9], however, these analyses were based on more aggregated regional definitions. Arche used the Sustainable Yield Region level outputs from the WTM model and applied these to LGA level regional IO models.

[9] ABARES (2010 and 2011) interfaced the WTM results with a CGE model, AusRegion, allowing the inclusion of resource constraints.

The development of single-region LGA IO models reflects the expectation that SDL impacts would vary across LGA regions. The individual regional models enabled Arche to apply different "Water for the Future" infrastructure investment in each LGA.

Interfacing the WTM outputs with the LGA level Arche models creates a number of challenges. For example, the application of the Sustainable Yield Region water reduction percentages from the WTM to the derived LGA level water use estimates may not reflect the different levels of water intensity generated from the different agriculture mix between LGA regions within a catchment area.

As noted by Arche, significant intra-regional trade is likely to result in asymmetrical distribution of water reductions between LGAs within a Sustainable Yield Region. This trade ensures that LGAs, where the agriculture industry comprised of commodities with the highest marginal returns to water (profitability), are allocated a smaller water reduction than those with lower marginal returns.

The application of a single water reduction percentage across these LGAs potentially creates an artificially large water reduction. This will potentially result in overstated negative impacts by implying a greater than optimal shift from irrigated agriculture to dry land agriculture (which may be less efficient in production). Conversely, LGAs within the region that are more inclined to sell water rights (due to a lower marginal return to water and a greater relative efficiency in dry land agriculture), will be artificially over-supplied with water at the prevailing market price, forcing an overproduction of irrigated agricultural products in which they lack a comparative advantage. Overall, the negative impact across the whole region is potentially overstated.

The WTM accounts for dry land agriculture and it is not clear how the replacement impacts of dry land agriculture are estimated. Arche have indicated that a manual adjustment was made to land allocation. It is assumed that Arche allocated the previously irrigated land to dry land production and have allocated other fixed factors in fixed proportions (issues with this method are discussed below).

2.2.2 Assumptions

Land use substitution

The Arche method focuses on the irrigated agriculture products most likely to be impacted by water use reductions and the dry land agriculture products most likely to replace them. While the selection of products appears to be reasonable, they do not capture product interaction within the region. Arche selected the crop to be impacted in each LGA using a number of methods, including:

- the dominant irrigated crop; and
- crop that has been affected historically by water reductions.

Generally, in economic modelling, the decision to sell water rights and reduce production is driven by the relationship between the marginal value of water and the market value of the water right. The displacement of irrigated agricultural production will initially be in the least profitable irrigated agriculture products. For example, when the availability of water is reduced farmers might reduce their irrigated wheat production before they reduce rice production (assuming the former is less profitable than the latter in terms of return to water use). The key

underlying substitution behaviour assumed in the Arche paper is that the reduction in production of one irrigated product and associated reallocation of irrigated land to dry land products. This substitution may not reflect the likely outcome under optimal substitution behaviour. In the Arche analysis, an overstatement of the negative impacts of water reductions potentially arises due to the manual allocation of a specific crop type that will decline under the water reduction scenario.

Example of potential overstatement of negative impacts

In the Balonne region, Arche assumes that cotton and wheat production will decline in response to SDL reductions and the land converted to dry land grazing. However, this allocation is made without reference to the value of other crops in the area and may impose an inefficient production mix on the region. One implication is that the direct employment declines may be overstated. Optimal production substitution is likely to result in a shift at least in part to production of less water intensive irrigated products that have a greater labour input than dry land grazing.

Direct employment impacts

For the direct employment impact estimation, Arche assumes fixed employment per unit of land for each of the agriculture products. Such fixed ratios may not hold in practice even in the short run. The land/labour mix could be very sensitive to the change in water prices. These ratios were also determined according to base year data that represents a single year, as opposed to a long-term average. This factor adjustment is particularly relevant when considering a change in the use of land.

Buybacks, infrastructure investment and trade

The Arche study highlights that the flow-on impacts of infrastructure spending, buyback and trade are significant. Although these flow on impacts are relatively small compared to the impacts of SDL reductions in isolation and without such additional offsetting measures. Infrastructure spending is accompanied by productivity improvements in water use, which is reflected in the WTM results. In addition to these productivity impacts, Arche incorporates the impact of additional spending on infrastructure construction in the local economy. While the fiscal impacts of the infrastructure spending do not overlap with the productivity effects, the timing of these two impacts is quite different. That is, the infrastructure spending is transitory while the productivity improvement has lasting impacts. If the base year of the model was adjusted to the final year of implementation of the policy, the transitory impacts of the infrastructure spending will have already dissipated, but the productivity impacts will persevere.

Similar to the buyback scheme, the proceeds of water trade should be incorporated into the modelling analysis. It is not clear whether such financial gains from trade are taken into account. The impacts of water trade are not always offsetting. For some regions, such as Murrumbidgee, adverse impacts are larger when water trade is introduced (see Table 53 of the Arche report).

2.2.3 The efficacy of IO multipliers

As mentioned previously, the scope of the Arche analysis was to assess the short-run implications of SDL reductions. No one empirical framework can provide a definitive answer

on such policy matters, IO modelling is of limited relevance to policy making, particularly in the long run. However, it may provide indicative impacts in the very short run, but these short run results would tend to overstate the adverse impacts of the SDLs reductions.

Due to the fixed IO coefficients inherent in IO modelling, the direct impacts of the modelled scenarios are based on a fixed ratio of water to GVIAP. Impacts on resource demands flow from the output effect at fixed prices (for example, changes in the demand for labour without supply constraints and the impact on wages). This assumes that the underlying irrigated agriculture production function has a fixed and linear relationship with water use and implies that all other inputs such as labour, other variable inputs, capital and land, are also fixed per unit of water and in terms of output.

A key behavioural element that is lacking in IO modelling is the change in the mix in irrigated and dry land farming. Such a change can be explained in (for example) a CGE model via the substitution elasticities between irrigated land and dry land and the structure of the production function. Arche have attempted to address this limitation by developing pre and post SDL reduction IO tables that are created with different agriculture sector production structures to reflect the displacement of irrigated farming activities for dry land agriculture. Such an approach is an improvement upon standard IO modelling and it reduces the rigidities in capturing the responses of the farming sector inherent in traditional IO approaches. However, as discussed in the previous section, this method requires a judgement-based manual redistribution of the agricultural sector.

IO models have several limitations, many of which the authors have noted, namely:

- There is no allowance for the substitution effects flowing from changes in relative prices, technological change, productivity or other dynamic production factors.
- There is no accounting for factors such as preference shifts, international trade impacts or resource constraints.
- Output shares are fixed, implying that producers in the multi-product IO table cannot respond to price changes in shifting the types of production they undertake.
- IO models cannot endogenously take into account: efficiency gains in average water use stemming from water trade; production switching to less water intensive agriculture; or the sale of water rights or technological progress over time. This means any variation in these parameters must be introduced into the model exogenously.

Fixed coefficient assumptions of this type are also generally not supported by time-series data. For example, data for land to water ratios vary markedly over years at a regional level.

An inability to allow fixed factors to adjust implies that the estimated adverse impacts of the SDL reductions would be larger; this is theoretically consistent in that the short run results (characterised by fixed factor) tend to be larger than long run results. The absence of price-sensitive substitution behaviour fixes employment/land ratios makes the IO modelling results much larger than if substitution was allowed. Therefore, the IO modelling approach will tend to overstate the adverse impacts of the SDL reduction. However, it is not known to what degree this overestimation occurs. Therefore, the IO modelling results can be used as an upper bound on the adverse impacts resulting from the scenario, or they can be seen as "overnight" effects – that is, immediate, very short run impacts. An IO approach provides a simple framework that quickly produces information that is useful in a very short-run analysis, but this is not a framework ideally suited to long-run policy analysis.

Ideally, a multi-regional bottom-up model with inter-regional trades between the LGA regions would be developed to analyse these impacts, although for several reasons including data availability this is likely to be a difficult and expensive task. Agriculture products produced at the LGA level are likely to be subject to inter-regional trade, particularly as the inputs to the manufacturing sectors and other final users. In this case, a single region modelling approach might result in biased results due to simplification of the responses of the key users in other regions. Arche note a number of these limitations in their report.

The construction of inter-regional trade flows, which is a key to developing a multi-region IO or CGE model, is a formidable task as the relevant data is seldom available in a directly useable form. Furthermore, generally such inter-regional trades are recorded in terms of physical units rather than the values. The Arche modelling approach assumes that within an LGA, any changes in supply would be matched by demand from with the region and from other regions. It would be worthwhile to investigate the likely impacts on inter-regional trades on specific irrigated agriculture products.

Though it would be time consuming, a discussion of the implications of the inter-regional trades on the agricultural commodities between LGA regions on the SDL impact assessment would be useful in understanding whether one adverse regional impact influences other regions.