Land and Water

Quantifying and valuing land use change for Integrated Catchment Management evaluation in the Murray-Darling Basin 1996/97 – 2000/01

Stage 2 Report to the Murray-Darling Basin Commission

Brett Bryan[1] and Steve Marvanek[2]

[1] Policy and Economics Research Unit

[2] Spatial Technologies Unit

CSIRO Land and Water

Urrbrae, South Australia

CSIRO Land and Water Client Report

November 2004

Quantifying and valuing land use change for ICM evaluation in the Murray-Darling Basin 1996/97 – 2000/01

Stage 2 Report to the Murray-Darling Basin Commission

Brett Bryan[1] and Steve Marvanek[2]

[1] Policy and Economics Research Unit

[2] Spatial Technologies Unit

CSIRO Land and Water

Private Bag 2, Glen Osmond

South Australia 5064

ISSN 1446-6171

Folio Number - S/04/1696

CSIRO Land and Water Client Report

November 2004

Executive Summary

This study provides a broad scale assessment of the distribution and dynamics of agricultural land use and the economic returns to agricultural use of land and water resources from 1996/97 to 2000/01 in the Murray-Darling Basin (MDB), Australia. The aim of this study is to provide a spatially explicit, comprehensive, integrated, basin-wide summary as baseline data for informing Integrated Catchment Management policy in the MDB.

To assess the changes to agricultural land use and the economic returns to agricultural use of land and water resources from 1996/97 to 2000/01 we extend the methods used in the National Land and Water Resources Audit Theme 6 (Hajkowicz and Young 2002). Land use maps constructed by the Bureau of Rural Sciences (BRS) are combined with Australian Bureau of Statistics (ABS) agricultural statistics data to map the spatial distribution of irrigated and dryland versions of 48 agricultural commodities in the MDB. Spatially-explicit data on the value, production, area, water requirements and costs of production of each commodity in the MDB is assembled for input into a profit function. Price and yield data for each commodity is derived by Statistical Local Area from the agricultural statistics and the spatial distribution of yield is refined using satellite data. Spatially explicit data on cost parameters for each commodity are assembled from Gross Margin Handbooks and data on water costs for each commodity are derived from irrigation benchmarking data. Data on government support to agriculture is derived from Trade and Assistance Review data. A profit function is used to calculate the returns to agriculture in terms of gross revenue, profit at full equity, and net economic returns to each agricultural commodity type in the MDB.

To quantify the economic returns to water of different irrigated agricultural land uses in the MDB and the changes between 1996/97 and 2000/01 we use estimates of crop water requirements. Water requirements are an estimate of the typical application rates of water in ML/ha rather than actual water application rates. Typical water requirements for each irrigated land use are derived from irrigation benchmarking data. Water requirements vary by crop type and by region with crops grown in moister climates requiring less water than those grown in drier climates. We estimate the total water requirements of irrigated land uses by applying water requirement estimates for different irrigated land uses to the mapped land use areas. For this study the same crop water requirements rates were used for both 1996/97 and 2000/01. We have not considered the effect of possible increases in water use efficiency resulting from improvements in irrigation technologies and management techniques (e.g. re-use etc.) on crop water requirements. Hence, our estimates of total water requirements in 2000/01 are likely to be higher than the actual water used for irrigation.

Results are presented in terms of the total returns, returns per hectare, and returns per megalitre of irrigation water used. Results are summarised by the 20 Catchment Management Regions (including the ACT) in the MDB. The spatial distribution of these economic measures is mapped and changes are assessed from 1996/97 to 2000/01.

This analysis attempts to synthesise all of the biophysical, agronomic and geographic complexities of agricultural activity in the MDB and provide a comprehensive and integrated summary based on the best available data and techniques. However, to achieve this goal,

significant spatial and agronomic detail has necessarily been generalised and assumptions have been made at many stages of the analysis. Also, limited on-ground verification of results has been undertaken. As a result, the outputs from this study should be considered as *estimates* only. The uncertainty surrounding various estimates, particularly livestock and irrigation areas, and water requirements statistics, may at times be significant. The uncertainties are quantified and discussed in the report. Spatial data layers are available from the MDBC or from the authors. Selected results from the study are summarised below.

With regard to the agricultural use of land and water resources:

- Over 100 different individual agricultural products are produced in the MDB;
- The total area of land under agricultural production in 1996/97 was 87 million ha, which increased slightly to 89 million ha in 2000/01;
- Dryland agriculture occurs across the MDB such that Sheep, Beef Cattle and Cereals account for over 95% of all agriculture by area in the MDB;
- There has been large scale conversion of pasture areas from Sheep grazing to other land uses between 1996/97 and 2000/01 especially Beef grazing following recovery of beef cattle prices;
- Overall, Dairy has experienced a 19% increase in area between 1996/97 and 2000/01 with significant conversions from rainfed pastures to irrigated pastures;
- The area of Oilseeds (led by Canola) has expanded in area nearly 1.5 times and Grapes, Coarse Grains, Fruit, Cotton and Rice have also increased in area substantially;
- The irrigated agricultural land use of largest areal extent is Dairy, followed by Cotton, Cereals and Rice;
- The total area of irrigated agriculture reported was 1.5 million ha in 1996/97 and 1.8 million ha in 2000/01 – an increase of 22%;
- The modelled estimate of the total water requirements of irrigated agricultural land uses in 1996/97 was 9,346 GL which increased by nearly 29% to 12,050 GL in 2000/01, due to the increase in the total area of irrigated agriculture and a shift towards more intensively irrigated land uses. The MDBC Water Audit and Monitoring Reports show a decrease in surface water diversions for irrigation between 1996/97 and 2000/01 from 11,825GL to 11,369GL. Figures on groundwater diversions for the MDB have only been available since 1999/00 and show an increase between 1999/00 to 2000/01 from 1,052GL to 1,240GL.

  There is uncertainty surrounding the water requirements estimates modelled in this study. However, it is clear that there has been a substantial increase in the total area of irrigation in the MDB between 1996/97 and 2000/01 whilst surface water diversions have decreased.

  Both 1996/97 and 2000/01 were years of fairly average rainfall in the MDB and hence there is no reason to suggest any significant influence on irrigation demand resulting from climatic variation. An increase in the use of groundwater resources may account

for some of the increase in the area of irrigated agriculture. However, we suggest that significant improvements in irrigation efficiency both on-farm and in the irrigation water supply systems may have also contributed to this effect. Increases in irrigation efficiency may result in lower return flows to the river both through surface and groundwater systems. This effect was predicted by Young and McColl (2003) although these results suggest that the magnitude of the effect may be larger than predicted. These findings have important implications for environmental flows and water policy. More research is required to validate these results, to better understand where irrigation efficiencies are being made, and the implications of these gains in efficiency.

- The largest user of water for irrigation in the MDB is Dairy, followed by Cotton, Rice, Cereals and Grapes;
- Areas of irrigated Cotton expanded by 108,000 ha (36%) and the total water requirements of Cotton increased by 729 GL to a total of 2,856 GL in 2000/01;
- In terms of changes in areas of irrigated land uses, Cereals expanded by around 90,000 ha, Grapes expanded by around 33,000 ha and Rice by some 24,000 ha. Irrigated Sheep pasture contracted by 118,000 ha and Beef pasture contracted by some 23,000 ha;
- Significant new areas have opened up to irrigation. In the southern parts of the MDB, newly irrigated areas are opening up with a variety of land uses including Dairy, Cereals, Grapes and Fruit. In the northern parts of the MDB areas previously used for dryland agriculture are being opened up to irrigation largely for Cotton.
- The Agricultural Land Uses of Sheep and Beef pasture, Oilseeds and Legumes experienced reduced areas of irrigation, saving just over 600 GL in total water requirements of irrigated agriculture in the MDB;
- New South Wales accounts for around 60% of the total water requirements for irrigated agriculture in the MDB, Victoria accounts for 32%, Queensland around 5% and South Australia 3%.
- Geographically, around 65% of the total water requirements of irrigated agriculture occurs in just 4 Catchment Management Regions - North Central (Vic), Goulburn (Vic), Murray (NSW) and Murrumbidgee (NSW);
- The irrigation character of the MDB is such that irrigated agriculture in the lower Murray area is dominated by Fruit and Grapes; in the Victorian CMRs Dairy is dominant; in the Murray and Murrumbidgee CMRs in NSW Rice and Dairy dominate; and in the northern CMRs such as Gwydir, Namoi and Border Rivers Cotton dominates.

With regard to the economic returns to agricultural use of natural resources:

- In 1996/97 the gross revenue from agriculture in the MDB was around $11.7 billion. This increased by 16% to $13.6 billion in 2000/01;
- Total profit at full equity from agriculture in the MDB in 1996/97 was $3.856 billion which decreased slightly to $3.732 billion in 2000/01;

- The total value of government support to agriculture was $665 million in 1996/97 or 17% of profit at full equity. In 2000/01 the total government support to agriculture was $533 million, or 14% of the total profit at full equity;
- The total net economic returns to agriculture in the MDB in 1996/97 was $3.192 billion. This increased slightly to $3.199 billion in 2000/01;
- New South Wales accounts for 49% of the total profit at full equity to agriculture, Victoria accounts for 34%, Queensland 12% and South Australia 5%;
- Most parts of the MDB increased in gross revenue from 1996/97 to 2000/01 except the north-eastern CMRs which suffered from a drop in revenue from Cotton;
- Around 50% of the total profit at full equity occurs in around 1% of the agricultural area and 80% of the total profit at full equity occurs in around 5% of the agricultural area;
- Although irrigated agriculture covers only about 1.4% of the total land area of the MDB, it accounts for around 36% of the total profit generated from agriculture;
- Highest total economic returns are obtained from dryland land uses with low returns per hectare but which cover broad areas such as Cereals, Beef and Sheep;
- Per hectare the highest returns are obtained from Cut Flowers, Fruit, Grapes and Tree Nuts whereas the lowest returns are from livestock grazing and cereals;
- Per megalitre of irrigation water the highest returns are obtained from those land uses that have high to moderate returns and lower water requirements per hectare including Cut Flowers, Vegetables, Fruit, Grapes and Tree Nuts. The large water users Dairy, Cotton and Rice have moderate returns per megalitre. Beef and Sheep pasture, Legumes, Oilseeds etc have low returns per megalitre because although they have low water requirements their returns are very low;
- Geographically, the economic returns to agriculture largely follow the distribution of water from both rainfall and irrigation. High value agriculture is concentrated in the crescentic region stretching from the River Murray in South Australia, curving east around the southern, eastern and north-eastern parts of the MDB. The drier interior of the MDB has very low returns to agriculture per hectare.

Table of Contents