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Assessing demands for irrigation water in North Queensland

John Rolfe
Faculty of Business and Law, Central Queensland University
Email: j.rolfe@cqu.edu.au

Abstract

Irrigation underpins approximately one-third of the value of Queensland's agricultural production. There have been calls for further development of water infrastructure in northern Queensland to enhance the production of sugar cane, horticulture, aquaculture and other crops. One of the steps in assessing potential new developments is to establish which groups have demands for additional water, and how sensitive they are to price. Surveys are one mechanism that can be used to gauge this information. Surveys to assess water demands have been carried out in the Mackay and Atherton Tablelands regions and the results are reported in this paper.

1 Introduction

Growth in rural industries along the eastern coast of Queensland has been accompanied by demands for increased supplies of agricultural irrigation water. These demands stem from both established and emerging industries. Sugarcane is the dominant industry in many regions, but horticulture, tree crops and aquaculture are other key industries. On the Atherton Tablelands, sugarcane has been developed in the late 1990s as the major irrigation crop as tobacco and other small crops have become less viable.

Increased demands for water may be met in two main ways. The first is by reallocating existing supplies of water. The elimination of un-utilised, or under-utilised water supplies through such mechanisms as allocation of licenses or trading of water allocations are important ways of achieving this. Particularly in relation to the latter, increased prices for water supplies help to signal where shortages might occur and where highest value usage might exist.

The second way of meeting increased demand is to establish new sources of supply. In the past, most water supplies were provided through large infrastructure developments that have been funded by Governments. While these are still possible, other mechanisms, such as the development of smaller off-stream storages or the treatment of urban effluent water are also becoming more commonplace. However, the principles underpinning the COAG agreement mean that future investments in water infrastructure should only proceed if the projects meet economic viability (and ecological) criteria.

In Queensland there is still significant interest in many regional areas in water infrastructure as a means to improve local economies through increased agricultural production. The Borbidge National-Liberal Government established a water infrastructure task force in 1996, which subsequently made a number of recommendations for potential irrigation projects. In March 2003, the Beattie Labour Government announced that the Burnett River Dam would proceed, with the bulk of the additional water supplies to be used for the production of sugar cane. There have been a number of other proposals for water storages and delivery systems to be developed in Queensland.

The outcomes of the ongoing water reform process and the tighter assessment rules for new projects means that there is increased interest in the economic assessment of the water industry. A key item in any planning for changes in water allocations or new infrastructure development is to establish existing and future water demands. If demands for water from a sector or geographic area are substantial, they will tend to be translated into higher prices at limited levels of supply. These higher prices provide a mechanism for signaling transfers of water in an open trading system, or the possible viability of providing new supplies of water. One stage in planning for new developments then is the assessment of likely future demands.

In this paper, the results of two water demand case studies in North Queensland are reported. The water demand studies were conducted in the Mackay region and on the Atherton Tablelands. The approach used in the case studies was to ask existing irrigators in the regions what their existing and future demands for irrigation water might be. The challenge in this approach is to ensure that results are not subject to various forms of bias, and this is the primary focus of this paper.

At the time the surveys were conducted, (1998 and 2000), sugar prices were low, but farmers were generally optimistic about future market conditions and prepared to consider expansion. Since January 2003, a sharp fall in the world sugar price and a rise in the Australian dollar have precipitated a major slump in the sugar industry, and the demands expressed for water in those surveys would not be repeated five years later. However, the interest in the late 1990s in water infrastructure to service the sugar cane industry can be evidenced from the commitment by the Queensland Government to the Burnett River dam in southern Queensland, where most of the planning was completed in 2001 and construction started in 2003.

The paper is structured as follows. The next section contains some discussion about the use of stated preferences to estimate demands for agricultural water supplies. In section three, the design of three surveys into water demands are outlined, and section four contains an overview of their performance and some results. An analysis of demand information available from the survey data is presented in section five, and conclusions follow in section six.

2. The use of stated preferences to assess demands

The assessment of water demands is not necessarily straightforward, as they have to be estimated in many cases ex ante, that is, before the event. In some cases the demands for water, and associated prices, can be established from market trading information in schemes that are already established. In many areas though, demand information is not available because little or no market trading occurs. This is the situation in the sugar cane areas of Queensland, where there is little water trading data to directly allow the assessment of demand information. In these situations where there is no existing market data to draw on, there are two broad options that can be pursued.

The first is to do an economic assessment of the existing resources, market opportunities and crop production economics. The broad assumption that is made under this approach is that if commercial potential is identified, and resources such as water supplies are made available to industry, participants will take advantage of the opportunities. An economic analysis would focus on the commercial viability of expanded or new agricultural opportunities if new water resources were made available.

Linear programming methods are often used to model water demands in the short and long term, where resource constraints, production, management and market information are combined to predict what the response of farmers would be to changes in the price and/or supply of different factors. Briggs-Clark (1986) and ONECG (2001) provide demonstrations of this type of approach. For example, ONECG (2001) estimated for the Bundaberg region that the gross margin of irrigation water supplied to sugarcane was $156/megalitre.

In the Burnett River project, construction of a new dam and four new or augmented weirs on the Burnett will deliver an additional 174,000 ML of water per annum (ONECG 2001). Capital costs of the project are just over $200 million, giving a capital cost of approximately $1,150/ML. In the economic analysis performed by ONECG (2001), it is assumed that the bulk of the additional water supplies are applied to existing irrigation areas to increase application rates, particularly for sugar cane. By assuming that sugar cane growers across the region would find it profitable to increase application rates by 1 - 2 ML/ha, high levels of demand from agriculture were implied.

The second option is to approach the potential users of new water resources and ask them directly what their demands for additional water supplies might be, what they would use the water for, and how sensitive their demands might be to variations in price. The advantage of this approach is that it helps to identify actual demands in a region, identify the potential users of new water supplies, gauge the speed of takeup of new water supplies, and estimate sensitivity to price.

Both approaches to estimating water demands are useful because they offer different snapshots of how regional planners/economists/industry leaders and existing irrigators view the potential for development. When the two approaches give very different results, it sometimes indicates that either or both groups do not have access to accurate information, or that structural adjustment (with associated social costs) will be necessary to achieve projected development targets. Differences may also indicate that one (or both) of the methods have biased results.

Traditionally though economists have only employed the first option in assessing the viability of water infrastructure schemes and the potential demand for water. For example, the economic analysis of the Burnett River developments provided by ONECG (2001) outlines only the linear programming approach to demand estimation. In some cases there are good practical reasons for this. It is not always possible to identify the potential users (e.g. when new irrigation areas are established), and potential users may not always have sufficient information to make informed choices (eg when supplies allow new crops to be grown).

However, traditional economic analysis of water infrastructure options has not always proved very accurate. Smith (1998) outlines the process by which the Burdekin Dam was approved in 1980. The scale of the project ($260 million) meant that the funding had to be shared between the Commonwealth and the State governments. The decision process was conducted at a time when projects needed to meet more rigorous economic criteria, and a review conducted in 1978 concluded that the Burdekin Dam would enable some 45,000 hectares of land to be irrigated and a return on investment to be at least 10%.

The economic analysis conducted for the Burdekin was the most thorough that had ever been carried out in Australia for an irrigation scheme. In hindsight, the analysis was super-optimistic, poorly framed, and lacked definitions on what should and should not be included (Smith 1998). Although the Burdekin Dam was completed in 1986, the available water from it has still not been fully utilised, some of the land envisaged for agriculture turned out to be unsuitable for that purpose, and the sale of new farms by auction has been a slow process. The Industry Commission (1992) estimated that the state could not expect to recoup its investment for a period of 70 years (allowing for the Commonwealth contribution of $130 million to be written off). It is clear that the initial projections of a 10% return on capital were wildly optimistic.

The Burdekin Dam example highlights one aspect of economic forecasting that is difficult to perform accurately in analysis of water infrastructure projects - the estimated rate of takeup of new supplies. Water infrastructure schemes have large up-front capital investment costs, followed by long term revenue streams less the associated operating costs. The present value of those revenue streams are usually very sensitive to how quickly water supplies are taken up and paid for. In practice, take up rates are often very slow [1] , partly because the associated private costs of developing land suitable for irrigation and the low real rates of return and capital accumulation in many agricultural industries. The result is that even when economic analysis might predict the total amount of potential development, any delays in the takeup of new water supplies can seriously impact on the profitability of potential developments.

Surveys of grower intentions can be used to gain information about potential demands and rates of takeup. This information can be used to crosscheck the results of case study economic analysis and provide updates of demand intentions. However, assessment of demand intentions in this way has not been very common. Perhaps the closest examples come from water user associations and other irrigator cooperatives which have been useful in countries like Chile to provide local management of irrigation schemes and insights into local supply and demand patterns (Hearne 1998).

There has been reluctance by many agricultural economists to use stated preferences as an instrument for estimating demand patterns or values. This helps to explain why surveys of demand intentions have not been commonplace in Australia. Stated preferences refer to those that people state they have in a survey instrument, while revealed preferences refer to those that can be obtained from market transactions. This reluctance to use stated preferences stems in part from the controversies surrounding the Contingent Valuation Method (CVM) (Bennett 1996). This is a non-market valuation technique which uses stated preferences to estimate values for changes in the provision of (usually) environmental goods.

Strategic behaviour is a potential concern with water demand surveys. Australia has a long history of water infrastructure being constructed for political rather than economic reasons (Smith 1998). Many large water infrastructure projects appear to be been justified more on regional development and social equity grounds than economic criteria (Smith 1998). Landholders and irrigators would normally expect to be better off when governments build new water infrastructure, and so there is potential for strategic bias to influence results of any surveys about projected demand.

The demand surveys reported here were designed to minimize these potential problems of strategic behaviour as well as those associated with realistic preferences and informed choices. The steps involved in this process are outlined below.

3. The performance of the surveys

Two separate case studies were carried out. The studies were performed in association with a variety of agencies, including the Department of Natural Resources (now Natural Resources, Mines and Energy), Cane growers, and the Tablelands Economic Development Corporation. The case study areas were:

- Mackay - almost exclusively sugarcane, and
- Atherton Tablelands - sugarcane, tobacco, tree crops, horticulture.

The main purpose of performing the demand studies was to ascertain if there was sufficient demand for additional water supplies in a region to warrant investigation of new water storage or distribution infrastructure.

3.1 The Mackay Study

The Mackay study was performed in 1998 to ascertain demands for water in the coastal region between Camilla in the south and at St Helen's Creek in the north. The dominant crop in the region is sugarcane. While some of the sugarcane is rain-grown, some is irrigated from underground water and some is irrigated from water storages (Kinchant and Teemburra Dams). There are about 1,400 cane farms in the region, of which about 400 draw water from the two major storages. Nearly 25,000 hectares of cane were grown under irrigation in 1998-99 in the Eton Irrigation Area and the Pioneer River Project schemes. There have been a number of proposals for more water storages in the area.

At the same time that there have been demands for more water supplies, the usage of available supplies of water in many years is below available levels. For example, in the Eton Irrigation Area in 1997-98, 37,799 megalitres of water were delivered to farms when announced allocations of water (available supplies) were 51,700 megalitres (DNR 1998). The following year, only 1,832 megalitres of water were delivered out of the available 51,569 megalitres (DNR 1999). These situations arise from the fact that in the Mackay district, irrigation water provides an insurance policy for many cane growers. In the wetter years, little irrigation water is needed, but it may become vital to keep crops alive and maintain yields in drier seasons. By contrast, most of the sugar cane in the Burdekin region further north relies heavily on the use of irrigated water.

Other issues surrounding water reform in the region and the need for information on water demands include the development of salinity in some regions from salt water intrusion, and the possibility of treating effluent water from the city of Mackay for agricultural purposes. The survey was thus designed to provide general information about demands in the region rather than demands relating to any specific projects. The survey was distributed and completed at Cane growers meetings and shed meetings in the region. About 1,400 surveys were distributed, and 700 responses were received.

3.2 The Atherton Tableland study

The Atherton Tableland study was performed in 2000. On the tablelands, the irrigation industry is centered around Mareeba, where water from the Tinaroo Dam services over 900 irrigation farms in the Mareeba- Dimbula Irrigation Area (MDIA). This region has been going through a substantial restructuring phase as irrigators in the region have moved away from tobacco and other small crops into other industries. Most growth has occurred in sugarcane, tea-tree and tree crops (eg mangoes).

There is about 22,000 hectares irrigated in the MDIA, with 158,000 megalitres of water being available allocations in the 1997/98 and 1998/99 years (DNR 1998, 1999). In the 1998/99 year, sugarcane was responsible for the bulk of water use (53%), followed by mangoes (14%), tea-tree (10%) and tobacco (4%). Total water usage has been low for many years, ranging from 69,795 megalitres in the 1995/96 year (less than half the nominal allocation) to 120,184 megalitres in the 1997/98 year. For sugar cane, there is less reliance on rainfall than in the Mackay region, so supplies of irrigation water would be expected to be an integral production input.

Water trading has been trialed in the MDIA over the past two years, with open trading allowed after the 1 st of July 2000. However, there has been little activity in water trading in the region. Some of the reasons may related to depressed economic conditions, with the downturn in the sugar markets since 1998, adverse seasonal conditions in 2000, and the collapse of the tea-tree market in 2000.

A survey to assess water demands was developed in 1999, and collected on the tablelands during the first half of 2000. Two collectors were used to identify a random sample of irrigators in the region and then approach them to complete a survey form. A total of 116 surveys were successfully completed, representing about 28% of the irrigated area in the Tablelands. The time of the survey performance coincided with some of the most adverse economic and weather conditions over the past decade, and collectors reported low levels of interest in expansion or future water demands.

4. The design of the surveys

The surveys were designed explicitly to minimize problems of strategic bias and other potential biases associated with stated preference surveys. While both surveys differed in some respects according to specific information needs and the circumstances of particular regions, the underlying structure to ascertain demand information was consistent.

One of the major issues that emerged from planning stages and focus group exercises was that many irrigators have very limited knowledge about actual levels of water usage, which made it difficult for them to ascertain their potential demands. For example, licenses for water extraction from streams or bores are often framed in terms of the size of the pump that is allowed, rather than the amount of water that is extracted.

The surveys thus started with a series of questions that explored the potential for further irrigation to be developed, helping respondents to frame the issues involved in additional water demand. For example, respondents were asked to indicate their farm size, the amount of irrigation that they had, what crops they grew, and what area they had that could be potentially irrigated. These were relatively easy questions for respondents to complete, and helped them to consider their potential development options.

Other questions in each survey focused on the different uses that farmers had for irrigation water. The types of questions that were asked of the irrigators were whether they were satisfied with their current supplies, how supplies could be improved, and what uses they would have for additional water supplies. The latter question was important in some areas because additional water supplies are not always needed to expand production area, but may also be used to increase production on existing fields, or as an insurance against dry times. These questions helped respondents to compartmentalize their potential demands, as well as aiding in the subsequent statistical analysis. For example, respondents were asked to indicate their potential uses of more irrigation water in terms of crop type, area to be developed, and application rates.

The final section in the survey focused on collecting information about the potential demands for water. In the key question, irrigators were asked to indicate how much water they might demand at certain price levels. In the Mackay and MDIA surveys, four price levels were given, and irrigators were asked to indicate demands at each price level. These are discussed in more detail in section 5.

4.1 Addressing issues of possible bias

In collecting stated preference data, there is always potential for respondents to mis-represent their true demands in order to achieve some strategic outcome. If respondents were to engage in strategic behaviour, they would be expected to overstate their true demands for water. Farmers were well aware that if the expressed demands for water in the region were very low, there would be little likelihood that additional infrastructure would be built. There was no strategic advantage for farmers in understating their demands.

The potential for strategic bias was addressed in two main ways. Firstly, the surveys collected the names and addresses of respondents, as well as real property descriptions. This meant that the answers could be verified. The second main way of addressing strategic bias issues is to check the internal validity of survey responses. One way of validating survey results are to compare responses to general industry knowledge. For example, irrigators in the Mackay survey indicated on average that their annual application rate on to sugarcane was 2.52 megalitres per hectare, which matched closely the opinions of local farm leaders.

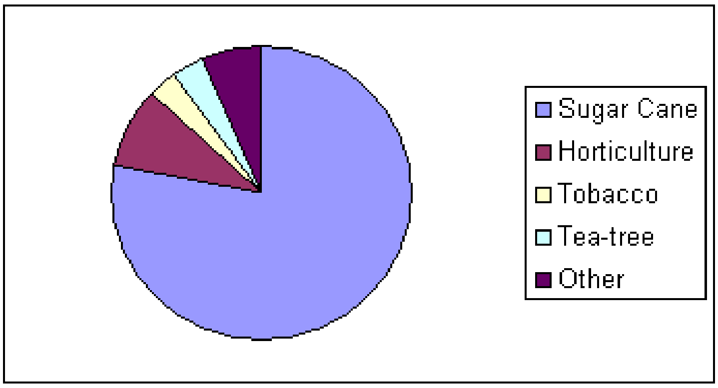
As well, respondents to the surveys showed a strong degree of internal consistency in their answers. In the Mackay survey, respondents were asked to estimate directly their demands for water according to different potential methods of supply. The average additional annual demand was 113.18 megalitres per respondent. This amount of demand could also be estimated indirectly by calculating the amounts of water needed to irrigate current dryland sugarcane, to expand new ground, and to increase application rates on irrigated cane using the areas and desired application rates nominated by respondents. The average implied demand per respondent came out to 112.43 megalitres, a difference of less than 1%.

4.2 Indications about demands for water

The results of the survey questions provide useful background information about demands for water in the different regions. For example, 62% of respondents in the Mackay survey indicated that they were not satisfied with the amount of water that they had for their current irrigation activities. This reflects the fact that many cane growers in the region do not have access to channel or regulated stream supplies. In contrast, only 28% of irrigators in the MDIA described their supplies as 'inadequate' or 'very inadequate'.

It is clear from the survey results that additional development of irrigation at that time would be largely concentrated on sugarcane. In the Mackay region, about 98% of additional water demands were for sugar cane. The potential expansion area for irrigation in the MDIA can be shown by crop type, as in Figure 1 below. When the estimates are translated in potential water demands, approximately 84% of additional water would be used to grow sugarcane in the region.

Figure 1. Potential expansion of irrigation by area of crop type in the MDIA



5. Estimating demand relationships

The key question in each of the surveys was one where irrigators were asked to indicate their potential demands at several different price levels. Responses at the different price levels were needed to be able to calculate demand relationships. To ensure that responses were accurate, the questions were framed in each survey according to the existing water marketing structure in each region. For example, respondents were told that the questions did not relate to any particular storage proposals, that the actual price of supplying additional water was still unknown, and that responses did not commit growers to taking nominated amounts of water.

In the Mackay survey, irrigators were asked to nominate their desired additional supplies of water at four annual price levels, being $40, $70, $100 and $150 per megalitre. They were reminded in the preamble that the current cost of water ranged from approximately $30/megalitre from a regulated stream to approximately $70/megalitre from a pumped pipeline system.

In the MDIA survey, irrigators were asked to give their responses at five price levels representing once-off capital costs for purchasing the water. Respondents were reminded that there would still be annual operating charges to meet, assumed to be $25 per megalitre. Responses were invited for two time frames, being short term demands by 2005, or longer term demands by 2010. The capital costs nominated were $250, $300, $500, $750 and $1,250 per megalitre.

Responses to the surveys were analysed using multiple regression techniques. The regression function sought to explain the quantity of water demanded in terms of the price indicated and the other data collected from the survey results. Across the surveys, the relationships between Price and Quantity demanded were generally found to be strongest when at least one variable (Price) was estimated in logarithmic form.

The water demand question was not always answered fully by survey respondents. Some respondents only indicated the quantities that they would demand at the lowest price levels, while others did not answer the question at all. The results of the regression were affected according to how these partial respondents were treated, and meant that different regression models could be calculated. The best fitting regression models were calculated when the respondents who did not indicate demands at more than one price level were excluded.

5.1 Results from the Mackay study

The regression equation for the group of respondents in the Mackay survey who indicated demands at more than one price level is reported in table 1. A number of other variables generated from answers to other survey questions have been identified as significant variables in the model.

Table 1. Regression model of average quantity demanded with price in log form for Mackay Area.

Predictor	Units of measurement	Coefficient	Sig.	Average of response
Constant		529.76	0	
Water application rates for non-sugar crops	ML/ha	18.931	0.013	0.026
Area of current dryland to be irrigated	Ha	-0.385	0.027	25.4
Demands from regulated flood harvesting	ML	0.275	0.000	15
Demands from unregulated flood harvesting	ML	0.493	0.000	9.92
Demands from channel or pipeline	ML	0.389	0.000	100.17
Demands from licensed ground water	ML	0.394	0.000	13.17
Demands from unlicensed ground water	ML	0.49	0.007	3.55
Demands from farm dams	ML	0.111	0.000	15.37
Demands from other sources	ML	0.381	0.000	11.17
Intend to buy aluminium flood pipes	Dummy coded (1 = intention)	-0.691	0.000	2.4
Intend to buy winch equipment	Dummy coded (1 = intention)	0.343	0.002	21.05
Intend to buy trickle irrigation	Dummy coded (1 = intention)	-0.836	0.003	1.64
Intend to irrigate dryland at preferred rate	Dummy coded (1 = intention)	0.158	0.001	89.95
Ln Price		-117.83	0.000	

Dependent Variable: Quantity of water demand

r 2 = .587

The model can be simplified to:

Quantity of water demanded = 599.75 - 117.83 x LN PRICE. (1)

The model predicts that maximum expenditure on water would have occurred at an annual price of $59.74/ML, where the average farmer would have taken 118 ML. Below that price level demands would be expected to be inelastic, and above that price level the demands should be elastic. Some measure of the price elasticity can be gained from a simple double-log function, as shown in Table 2. The estimated price elasticity from this function is - 2.777, indicating that demands are very sensitive to price.

Table 2. Double log regression model for short term water demands in the MDIA area.

Variable	Unit of measurement	Unstandardised Coefficients	Standard error	Significant
Constant		15.308	0.531	.000
LN_PRICE	$	-2.777	0.120	.000

Dependent Variable: Natural log of quantity of short-term demand

r 2 = .371

LN Quantity (short term) = 15.308 - 2.777 * LN Price (2)

The model results indicate that demand would be low at higher price levels. If annual delivery charges are estimated at $40/ML, the difference from full prices is the amount available to pay for infrastructure. For example, if annual prices were set at $100/ML (allowing $60/ML to be allocated to infrastructure funding), the average quantity demanded per farmer would be 57 ML. At a price level of $140/ML (allowing $100/ML to be allocated to infrastructure funding), the average quantity demanded would be only 17.5 ML. These average demands can be multiplied across the 226 survey respondents indicating their willingness to pay for water at higher prices to estimate total demands in the region.

5.2 Results from the MDIA

A regression model of quantity demanded for a sub-group of respondents in the MDIA survey is reported in Table 3 below. Respondents had been asked to indicate at four different price levels (representing the capital costs for a permanent trade) how much water they would demand.

Table 3. Regression model of average Quantity demanded (Short term) with Price in Log form for the MDIA area

Variable	Unit of measurement	Unstandardised Coefficients	Standard Error	Significant	Average Value
Constant		779.735	147.846	.000	
LN_PRICE..	$	-117.344	23.438	.000	
Area of cane irrigated	Ha	4.046	.453	.000	19.86
Need more water for current irrigation area	Dummy coded (1=needs water)	292.500	42.738	.000	.1429
Area of horticulture currently irrigated	Ha	-4.986	1.111	.000	13.52
Potential area of horticulture irrigation	Ha	11.495	4.819	.020	1.2857

Dependent Variable: Quantity of short-term demand

r 2 = .734

From this table, the regression equation for short term demands can be expressed in this way:

Quantity of water demanded = 779.735 - 117.344 x LN PRICE + 4.046 x (current ha of sugarcane irrigated) + 292.5 x (need more water for current irrigation) - 4.986 x (current ha of horticulture irrigated) + 11.495 x (potential ha of horticulture irrigation). (3)

These results show that the larger cane growers, those that needed more water for their existing area of cane production and those that had potential for further horticultural production are the farmers most likely to have demands for additional water. Maximum expenditure on water would have occurred at a price of $511/ML, where the average farmer would have taken 117 ML. This represents the point of unit elasticity. Some measure of the price elasticity can be gained from a simple double-log function, as shown in Table 4. The estimated price elasticity from this function is - 1.739, indicating that demands are very sensitive to price.

Table 4. Double log regression model for short term water demands in the MDIA area.

Variable	Unit of measurement	Unstandardised Coefficients	Standard Error	Sig.
Constant		12.047	1.238	.000
LN_PRICE	$	-1.739	0.198	.000

Dependent Variable: Natural log of quantity of short-term demand

r 2 = .246

LN Quantity (short term) = 12.047 - 1.739 * LN Price (4)

A similar result can be estimated for long term demands, where a summarized linear-log demand model can be represented as follows:

Quantity (long term) = 1227 - 168.5 * LN Price (5)

At the point of unit elasticity, the average farmer would pay $534.80 for 168.5 ML of additional water supply. This shows that over the longer term, prices would rise only slowly, but there would a substantial increase in the quantity used.

However, the overall results show that demands for additional water in the MDIA were quite low, particularly at higher price levels. For example, at a price level of $800/ML, the average farmer interested in more water will only take 65 additional ML in the short term, and 100 ML in the longer term. When these results are extrapolated across all interested respondents to the survey, total demands are 3,100 ML and 4,800 ML respectively. If the results are extrapolated across the rest of the irrigated area in the Tablelands (survey respondents accounted for 28% of the irrigation area), total water demands may be approximately 3.6 times higher. At a price level of $1000/ML, the average farmer interested in more water will only take 39 additional ML in the short term, and 63 ML in the longer term.

In total, the estimated water demands from the survey results are only a small proportion of the annual allocation from the Tinaroo Dam. It is likely that the introduction of water trading and other operating changes would be sufficient to meet these additional demands. There is little indication from the demand models that any investment in new infrastructure is warranted.

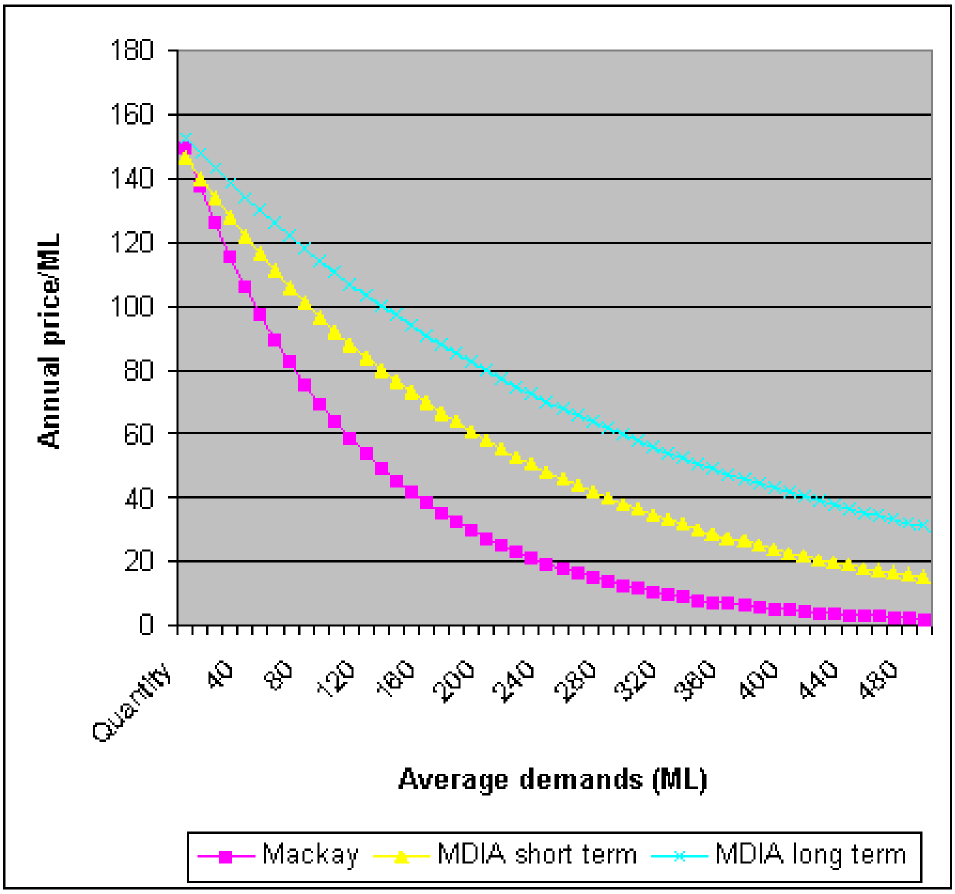
5.3 Comparing demands between the MDIA and Mackay regions

The results of the two surveys can not be compared directly because the Mackay study related demands to annual charges, while the MDIA study related demands to up-front capital costs. To be able to compare the results between Mackay and the MDIA, prices used in the MDIA analysis have been converted to annual payments over twenty years at a 10% discount and the $25/ML operating charges added. For example, a $500 capital lump-sum cost converts to $58.73 as an annual payment plus $25 for the operating costs. In this way, the quantities that have been demanded per interested farmer can be related to expected annual costs.

The relevant demand curves are depicted in Figure 2. These show that average demands are more sensitive in the Mackay area compared to the MDIA, and that short-term demands in the MDIA are more sensitive to price than the long-term demands. Higher levels of price sensitivity in the Mackay area are likely to be because sugar cane is effectively the only crop grown in the area, and because of differences in climate and other factors.

Aggregate demand curves can be estimated for each region by extrapolating demands across the relevant number of growers. The aggregate demand curves may not be as similar as the average demand curves. This is because there were more farmers in the Mackay region (226) indicating demands at higher price levels compared to the MDIA (48). As a consequence, total identified demands for additional water supplies were higher at some price levels in the Mackay region than in the MDIA.

Figure 2. Average demands for selected farms in the Mackay and MDIA areas



6. Conclusions

In this paper, the results of two demand surveys of agricultural water needs in north Queensland have been presented. The use of stated preferences to estimate demands in factor markets is not commonplace, and is viewed with suspicion among some economists. Among the reasons for this are the potential for survey respondents to engage in strategic behaviour by overstating or understating their true intentions.

Strategic behaviour problems can be minimized with careful attention to design. This has been shown in the surveys reported here, where the collection of contact information, real property details and other background information all helped to establish an environment where it was difficult for respondents to provide misleading results. In the survey data, the internal consistency of responses appears to be very high, and to match with local expert opinion. For example, in the Mackay survey, stated demands for additional water matched closely with the potential to use it on individual farms for increasing application rates and/or converting more land to irrigation.

The functions that have been estimated confirm that demands for water in the sugar cane industry remain very sensitive to price. For the groups analysed in the MDIA and Mackay regions, the point of unit elasticity occurs slightly above $60/ML. At higher price levels, the predicted demands for water were substantially reduced. These demand relationships indicate that it was unlikely that new infrastructure could be justified in those regions to supply agricultural irrigation water. The continued downturn in the sugar industry since those demand surveys were conducted is likely to have further depressed demands.

These results contrast with the economic analysis performed at a similar time for the expansion of irrigation supplies in the Burnett River area (ONECG 2001). For that analysis, only a desktop analysis was performed, and there was no survey of sugarcane growers to identify their stated intentions to take up more irrigation supplies. The desktop analysis predicted that there would be substantial takeup of additional water supplies to increase application rates on sugarcane, and that the gross margin associated with this additional water use would be approximately $156/ML (ONECG 2001). While the Burnett River case study is in southern Queensland, as compared to Mackay (central Queensland) and MDIA (northern Queensland), the economics of producing sugar cane do not differ greatly between regional areas. The results of the stated demand surveys indicate that the takeup of additional water supplies may be lower than the desktop analysis might suggest.

The use of stated preference techniques to assess demands in factor markets has the potential to help economists make better predictions about market behaviour and demand patterns. Stated preference results can provide a useful cross-check to the results of more traditional linear programming tools for predicting water demands, and may help to better identify price elasticity of such demands.

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[1] Water from the Burdekin Dam, the largest in Queensland , is still not fully allocated fifteen years after completion. In the case of the Fairbairn Dam near Emerald, the next largest dam in Queensland , full allocation of the available supply did not occur until about 20 years after completion.