Water Allocation Issues in the Fitzroy Basin

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Abstract.

Irrigated agriculture is an important source of economic activity in the Fitzroy Basin. The issue of what water is still available for development in the basin and how it might be allocated between different interests groups in the region remains topical. The Water Allocation and Management Plan for the Fitzroy that has been drafted by the Department of Natural Resources and Mines caps overall water extraction from the basin, but allows further development to potentially occur in most of the sub-catchments. In this paper the options for allocating the water resources and the mechanisms by which they might be allocated are discussed. The values that society might have for reserving water resources from development are estimated from a Choice Modelling experiment, and compared to the net production costs available from different development options.

Keywords: Water allocation, social values, choice modelling

1. Introduction

The water reform process in Queensland has been in progress for several years following the 1994 Council of Australian Governments (COAG) agreement on a national agenda for water reform. A key legislative component of the reform process in Queensland was the *Water Act 2000*, which provides for water resource plans (WRP) and resource operations plans (ROP). Some key components and issues surrounding the reform process can be illustrated in relation to the Fitzroy basin in central Queensland (Figure 1). This catchment is the second largest externally draining catchment in Australia (after the Murray-Darling), and supports a substantial irrigation industry focused on cotton, horticulture and other crops (Loch and Rolfe 2001).

The water resource plan for the Fitzroy basin is the Water Allocation and Management Plan (Fitzroy Basin) 1999 (WAMP) which was approved by the government in 1999. This provides the strategic framework for water allocation and management in the Fitzroy basin. The Fitzroy WAMP confirmed existing allocations of water, together with additional authorisations for an 880,000 megalitre (ML) dam and a 6,000 ML weir on the Dawson, and the raising of two weirs on the Mackenzie River.

Queensland is in the fortunate situation of not having already over-committed water resources in the Fitzroy basin. The Fitzroy WAMP also identifies additional water supplies that are potentially available at further locations within the basin. These include:

- Up to 300,000 of additional mean annual diversions on the Isaac/Connors/lower Fitzroy River systems,
- Up to 40,000 ML of additional mean annual diversions in the Comet/Nogoa/Mackenzie River system, and
- Up to 11,500 ML of mean annual diversions from the upper Dawson River.

Demand for water in the Comet/Nogoa/Mackenzie River system is strong, as this region supports profitably cotton and horticulture industries that rely on irrigation supplies. There has been keen public interest in the method by which the remaining supplies might be allocated between competing interests in the basin. While economists recommend market mechanisms on theoretical grounds, many industry groups and non-economists argue for other systems of allocation. Water allocations are often tied to infrastructure projects, so the cost and source of funding for infrastructure become part of the debate over water allocation issues.

There are two key issues explored in this paper. The first is the question about how water should be allocated between competing productive uses in the basin. Questions arise about whether economic theory can adequately address equity issues and stakeholder involvement in the distribution process The second is the question about whether water should be reserved (for environment protection or future use) instead of being allocated now. Identifying whether the WAMP process has achieved the appropriate level of protection for environmental factors, and if there are public values for reserving additional amounts of water are the key issues to address.

The upper Fitzroy basin is used to demonstrate these issues, but the conclusions should be generally applicable across the catchment. The paper is organised in the following way. In the next section, an overview of the water resources and development options are given for the upper Fitzroy catchment. Arguments for allocating water using market mechanisms are given in section 3, and community attitudes to some of these issues are summarised in section 4. A summary of a Choice Modelling application is given in section 5. The two key issues are discussed in sections 6 and 7, and conclusions are drawn in the final section.

Figure 1. The Fitzroy basin

2. Scenarios for dealing with unallocated water in the upper Fitzroy catchment

The upper Fitzroy catchment comprises the Comet and Nogoa rivers, and the Mackenzie River upstream of the Tartrus weir storage (just upstream of the junction with the Isaac River). The catchment area covers 52,300 square kilometers. Rainfall is highly variable, averaging 550-650 mm across the catchment. Stream flows are also highly variable. The mean annual streamflow out of the catchment (lower end of the Mackenzie River) was 1,305,429 megalitres (ML) between 1971 and 2000.

The existing regulated supplies in the system comprise of the Fairbairn Dam near Emerald (1,228,890 ML of storage), and four downstream weirs on the Nogoa and Mackenzie rivers (total of 38,900 ML of storage). A section of the Nogoa and Mackenzie river system is also regulated where there is irrigation development along the floodplain. Unregulated supplies also support irrigation in some areas. Water is harvested under licence from streams in the region, or is captured onsite from smaller channels (referred to as overland flows). The cost of infrastructure involved in assessing unregulated supplies is normally borne by the irrigator, whereas the cost of infrastructure associated with regulated supplies is typically provided in the short term by an intermediary body. SunWater, a state government corporatised body, is responsible for regulated supplies in the upper Fitzroy catchment.

Water supplies are the major limiting factor on further irrigation development in the region. McCarroll (1997, 1998) identified over 110,000 hectares of suitable soils for irrigation within a 5 kilometer wide strip on each side of the major rivers. This area included areas already under irrigation, as well as potential areas. A summary of the land suitable for irrigation is shown in Table 1.

Table 1. Areas of land suitable for irrigation in the Comet/Nogoa/Mackenzie system

Crop	Area of suitable land types (ha)			
	Comet River	Lower Nogoa R.	Upper Mackenzie R.	Total
Cotton	33,715	13,300	35,787	82,802
Cotton/peanut/citrus			3,746	3,746
Peanut/citrus	8,061	1,116	14,997	24,175
Total	41,776	14,417	54,530	110,723

Currently, only about 33,500 hectares of land is irrigated in the system. Most of this is used to grow cotton, with typical application rates of 3.5 – 4.0 ML/ha. Approximately 70,000 hectares of land would be available for further irrigation development if water was available. Demands for irrigation water in the catchment were assessed through a water demand survey carried out in 1996 (Rolfe and Teghe 1997). The results of a “Pessimistic” outlook, where demands were scaled downwards on such factors such as irrigation experience, still showed total demands much higher than potential supplies (see Table 2).

Table 2. Indicative Water Demands 2000 & 2005 – Comet/Nogoa/Mackenzie system.

Year/Scenario	Comet River	Lower Nogoa R.	Upper Mackenzie R.	Total
2000 – “Pessimistic”	41,235	18,625	34,420	94,330
2005 – “Pessimistic”	66,351	21,464	61,975	149,790

Prices for irrigation water have already been set at high levels in the basin. In 1997, sales of water from the Bedford weir achieved between $800 and $1000/ML for medium security water, and $1600/ML for the high security water. Rolfe (1998) estimated agricultural water demand schedules for the Fitzroy basin. At an additional supply of 40,000ML, the predicted price in the Nogoa and Mackenzie system is approximately $970/ML[1]. This confirms that water supply is likely to be profitable for cotton at infrastructure costs of up to $1000/ML, although current low prices for cotton will depress this level. For other crops, such as horticulture, supply options may be profitable at higher costs.

Because demand for irrigation water would be excess of potential supply, particularly if allocations were simply distributed as water harvesting licences or other non-price distribution methods, the Department of Natural Resources and Mines (NR&M) has been exploring appropriate mechanisms for allocating further water resources in the basin. The Department has been exploring the use of planning mechanisms to identify water supply development options and consult with the community about which options might be preferred. A regional planning body, the Central Highlands Regional Resource Use Planning Project (CHRRUPP) has been involved with NR&M for this purpose.

The planning approach adopted by the department has two key elements. The first is to develop a number of water allocation scenarios and water development options in consultation with regional communities. These scenarios would have to be modelled using the Departments Integrated Quantity and Quality Model (IQQM) to determine the net water requirements and water yields of each scenario and to test if scenarios meet with WAMP objectives. The scenarios would also need to be costed to determine the opportunity costs associated with different alternatives.

The second element in the planning approach was to engage the community and various sector groups to identify the impact of various scenarios on regional aspirations, and identify environmental, social and equity consequences of different water allocation scenarios. Ideally this engagement process (facilitated through CHRRUPP) should have identified preferred strategies and water development options. A number of workshops have been held to involve different sectors in this approach.

The options for further water allocation that have been identified can be classified into three broad areas, being instream developments, private diversions, or no future development. Another option of allocating 373 ML (mean annual diversion) for the town water supply for Rolleston from the Comet River is likely to be incorporated within any of these broad areas. The various instream developments that were identified and modelled are reported in Table 3 (Bullpitt 2001).

The results of the NR&M planning exercise show that many of the potential instream developments that have been proposed by the regional community have very high costs relative to the predicted annual yield of water. While the Bingegang and Comgoa Weir proposals have yield costs that are likely to be acceptable to the irrigation industry, it appears that private diversions may be able to access water even more cheaply at least at suitable locations.

The range of private diversion schemes including water harvesting and capture of overland flows that could be considered is extensive. There have been a number of these schemes constructed along the mid-reaches of the Comet River. Many of these are innovative in the way that they capture and store water at minimum cost. Modelling by NR&M staff indicates that the annual cost of providing medium security water to one of these schemes would be upwards from $270/ML provided to crop, depending on its location (Roberts 2001).

[1] This allows for $12.50/ML in operating costs, and amortises annual returns over 40 years at a 10% discount rate.

Table 3.

Development option	Storage Volume (ML)	Mean annual diversion (ML/yr)	Yeild (ML/yr)	Monthly Reliability	Demand Type	Capital Cost ($)	Capital Cost/ ML ($)
Bingegang Weir Raising	5,770	4,214	4,800	88.2%	Irrigation		
• Excluding fish lock						2,140,000	446
• Including fish lock						3,559,000	741
Comgoa Weir							
• With Fabridam	10,080	39,700	41,192	88.3%	Irrigation	15,040,000	335
• Without Fabridam	5,060	27,441	31,160	88.8%	Irrigation	13,326,000	428
Lower Comet Weir	600	38	60	88.2%	Irrigation	1,440,000	24,000
Upper Comet Weir	2,630	2,152	2,435	88.2%	Irrigation	6,250,000	2,567
Theresa Creek Dam No 2	198,000						
• Fixed demands		68	70	100%	Fixed		
• Írrigation Demands		256	300	88.2%	Irrigation		
		324	370			91,400,000	247,000

However, each successive development reduces available supplies for downstream harvesters. The successful development of private diversion schemes is partly reliant on future water extraction in the basin being capped. The newly formed Fitzroy Basin Food and Fibre Association moved to recommend a moratorium on new overland flow developments as a way of protecting the viability of private diversion schemes of existing irrigators. A Moratorium Notice was published in September 2001.

The regional planning exercise illustrated the diversity of viewpoints of the different stakeholder groups. Participants from the environmental sector argued that water should be preserved for environmental purposes rather than being allocated to further development. Many participants argued that water should be shared equitably between users. This equity issue covered goals such as allocating water among many landholders along the river systems, supporting family farms, and supporting landholders that are struggling financially. Some participants argued for regional development goals to be met, so that water allocations were distributed on a geographical basis to ensure that all areas had opportunities for prosperity. There were some concerns raised about water being commodified, and about water being concentrated in the hands of a few large irrigators.

3. The use of market based instruments to achieve allocation goals

Economists generally favour the use of competitive market processes to allocate resources and send signals to market participants about supply and demand needs. There are many reasons why competitive pressures generate higher returns to society than production processes managed by government. These include greater flexibility, clearer signals about changed supply and demand conditions, and fewer information and governance requirements. Most importantly, competition allows resources to flow to highest value use (Chang and Griffen 1992). While government involvement is still required to guard against market failure, maintain natural resources, and establish appropriate market and institutional settings, government should not necessarily be a direct player in the use of water for productive purposes.

These principles underlie the development of the COAG agreement about water use reform. The key reforms were to:

- Establish pricing based on principles of full-cost recovery and transparency,
- Specify resource entitlements and property rights,
- Allow and facilitate exchange or trading of water entitlements,
- Reform of regulatory agencies and water-service utilities, and
- Involve users of irrigation water in the water reform process and in water management.

The COAG agreement was partially directed at removing government subsidisation of water supplies and management of water resources. This marks a final break from previous government policy that associated water infrastructure development with regional development and closer settlement goals and used public funding to achieve them. The COAG agreement was also aimed at increasing reliance on market mechanisms for sorting out allocation issues between competing interests. As water resources become increasing scarce and valuable, such a system of allocating resources to highest value users and with socially optimal outcomes is to be preferred (Challen 2000).

In April 1995, the COAG agreement on Water Resource Policy became a component of the National Competition Agreement. Incentive payments linked to maintaining the reform process has helped to bind states to the agreement (Crase et al 2000). The flow-on effects of the COAG reform process should help guard against special interest groups having policy and funding directed in their favour, reduce calls on the public purse, and see water transferred to highest value users. The specification and trade of property rights over water allows reallocation of resources and wealth in the community and encourages water to flow to highest value use (Crase et al 2000). In some cases water may be accumulated by growers to allow large scale production of particular crops. Freeing up water transfers will also encourage specialisation and diversity, and should maximise production and wealth creation in regional areas.

The water reform process has not been without its difficulties in Australia. Unclear or poorly defined rights to access and use water resources, and thin trading numbers have not encouraged market development (Crase et al 2000). Concerns about externality problems involved in water transfers and allocations have tended to restrict trade and slowed the reform process (Brennan and Scoccimarro 1999). Many rural and regional communities have not welcomed micro-economic reform and view water titles, water trading and full cost pricing with suspicion. The complexity of water resource issues makes it difficult to establish appropriate property rights (Quiggan 2001, Crase 2000).

Quiggan (2001) underscores the complexity issue by outlining the proposed hierarchy of rights over water use in New South Wales as proposed by the Independent Audit Group. The categories are ordered by legal status, then by history of use, as follows:

1. statutory rights with a history of use,
2. ‘sleeper’ statutory rights with no history of use,
3. non-statutory rights with a history of use,
4. non-statutory rights with no history of use,
5. formal promises of future access, and
6. expectations of access based on past practices.

The economic arguments for recognising rights over water use by legal status are that clear property rights are an essential component of market systems. Recognition of rights according to prior use takes account of the capital costs that may already be invested in productive enterprises. It also recognises another precedent for water allocation that is much more common in the United States (eg Chang and Griffen 1992), and may be an implicit form of property rights in Australia.

Economic principles would indicate that unallocated water should normally be distributed according to some competitive process, such as an auction or tender system. However, there are three key areas where arguments might be mounted against the simple application of economic principles in this form. These are that competitive processes for allocating water might have unfair equity outcomes or might generate outcomes that involve non-market losses. Each of these arguments is outlined in turn.

Economic tools such as cost-benefit analysis are not particularly well-equipped for dealing with equity issues (Griffen 1998). Welfare economics is useful for indicating that projects and policy changes might be desirable when the sum of benefits, to whom they ever may accrue, outweigh the losses. This concept can be easily applied when the gains from the project or policy change are used to compensate those adversely affected. In many cases though this is not feasible. Particular problems arise when the losses are felt by particular groups, such as those that are already disadvantaged in some way (eg poor communities). In these cases, economic policy may exacerbate equity issues. If the process of water allocations causes major equity issues, this would be an argument to choose other mechanisms for the allocation process.

The second reason why competitive allocation processes may not be desirable is that they generate other social losses. These might occur when water ownership is concentrated in a few large irrigators, or is transferred out of particular regions, leading to a reduced number of irrigators or reduced viability of landholders in a particular region. Some of the losses may be more intrinsic, where a redistribution of allocations generates perceptions of unfairness or inequity in the wider community (Syme and Nancarrow 1997). These losses can be classified as non-market impacts, where social welfare is diminished because of the negative impacts of equity concerns. Note that it is the wider community as well as the particular groups bearing equity impacts that may suffer social losses.

Welfare losses may also occur if there are concerns about the procedural issues used to achieve change in water allocations. Many issues of fairness and equity are related to the process of managing change (Syme and Nancarrow 1997). Perceptions about procedural and distributive justice have links to economic value in three key areas. The first is where perceptions of "unfairness" help to generate social losses, which may offset the benefits of production gains. The second is where procedural change may impact on the structure of property rights that exists. If people lose confidence in the property rights that they hold over water, (eg they fear future arbitrary changes) this will reduce the potential development of market processes. The third is where perceptions of unfairness increases transaction costs and delays involvement in market processes. If participants are unhappy about the process of change, this can divert attention from the real goals of finding allocation and market systems that allow maximum production and wealth creation in rural communities.

These reasons identify that there is real economic benefit to be gained in achieving a smooth transition process between the previous set of allocation rules (or ethos about development and allocation) to the new set of allocation rules. As well, there is economic benefit in choosing reform pathways and new allocation settings that cause minimum disruption. These are some of the reasons why the COAG Water Reform Policy recommends that stakeholders be involved in the reform process and in water management.

Stakeholder involvement in this sense is a two way street. Stakeholder involvement helps to convince stakeholders that reforms should generally enhance productivity and benefit rural communities. The involvement should also ensure that new management and allocation rules are designed to suit local and regional circumstances, and are framed in ways that encourage greater takeup of market trading mechanisms.

Stakeholder involvement and planning processes also generate costs. These include the physical costs of money and time for participants in meetings, planning processes and other activities. It also the time involved in making and delaying decisions, and the opportunities for stakeholders to pursue different agendas. Many stakeholders have fond memories of public expenditure being used finance water infrastructure and regional development, and search for innovative ways of arguing for more of the same. Other stakeholders seek to solve all environmental and other externality problems with public funding.

4. How the community views some of these issues

A series of questionnaires about water development issues in the Fitzroy basin were collected in Brisbane, Rockhampton and Emerald in late 2000[2]. Households were invited at random to participate in a drop-off/collect approach. A total of 913 surveys were collected: 495 from Brisbane, 156 from Emerald and 262 from Rockhampton. The surveys all had a standard section of attitudinal questions (eg please rank the following issues), and questions about the respondents (eg age, education).

The main focus of the surveys were a series of choice questions which asked respondents to choose between different scenarios involving environmental factors, socioeconomic factors, and the level of rates that might be paid by households. These questions provided data for a Choice Modelling analysis, which is described further below. Many of the other questions in the survey focused on what people thought about different issues relating to the environment and the Fitzroy catchment. Here, some of the results from these questions are described.

Respondents were normally asked to rank a series of issues for a particular topic, with the number 1 being used to indicated highest rank. Therefore, the lower the mean of ranking scores to an option within a question, the more highly that respondents have viewed that particular item. In almost all questions there was little difference in ranking from the three population groups. Emerald is a township in the heart of the irrigation region in the Fitzroy, where the local economy has substantial involvement with the irrigation sector. Rockhampton is the regional centre at the mouth of the Fitzroy catchment. Its residents would expect to gain some regional benefits from economic development, but also feel any downstream effects of irrigation activities. Brisbane is the major urban centre in Queensland, some several hundred kilometres away from the Fitzroy catchment.

In Question 3 of the survey respondents were asked to rank a set of reasons why more water could be allocated to the irrigation industry. The lower the average score, the more importantly the reason is viewed. The results show that *developing the economic base of the region* was consistently viewed as the most important reason for allocating more water to irrigation. *Developing new industries*, *reducing unemployment*, and *spreading wealth creation across small towns* also ranked highly in some communities. *Allowing the most efficient irrigators to produce*

[2] This project is aimed at estimating environmental values associated with further potential irrigation development in the Fitzroy basin in Central Queensland. The project involves collaboration between Central Queensland University, the Queensland Department of Natural Resources, and Australian National University. A copy of the questionnaire used is available from the lead author on request.

more was consistently ranked last by the communities, even though this may be the most logical way of developing the economic base of the region.

Table 4. Average response to reasons for allocating more water to irrigation from river systems.

	Brisbane	Emerald	Rockhampton
To develop the economic base of the region	2.50	2.84	2.88
To reduce unemployment in the region	3.45	3.21	3.48
To develop new industries in the region	3.54	3.01	3.13
To allow many of the landholders along the river systems to diversify by gaining access to irrigation water	3.66	3.84	3.60
To allow the most efficient irrigators to produce more	4.31	4.65	4.53
To spread wealth creation across all the small towns in the region	3.47	3.57	3.16

In Question 4 of the survey, respondents were asked to rank a set of reasons why more water should not be allocated out of the river systems. Again, the lower rankings (see Table 5) represent more favoured alternatives. The communities were very consistent in the responses given to the reasons why more water may not be allocated. The environment issues were ranked first, second and third by each community, while future *development, preserving the entitlements of current irrigators*, and *recreation use* all ranked much lower.

Table 5. Average response to reasons for not allocating more water from the river systems.

	Brisbane	Emerald	Rockhampton
The known impacts on ecosystems and the environment	2.10	2.60	2.56
The risk of unknown possible impacts on ecosystems and the environment	2.38	2.38	2.53
Possible downstream effects on coastal estuaries and the Great Barrier Reef	2.63	3.18	2.54
Reserving water for possible future development	3.97	3.67	3.93
Guaranteeing the entitlements of current irrigators	4.75	4.62	4.65
Maintaining water quality for recreation use	4.96	4.49	4.62

In another question in the survey, respondents were asked to rank four key goals of the water reform process. Results are shown in Table 6, and indicate that respondents thought that *meeting the requirements of basic/natural river flows* was the most important factor, followed by *distributing water allocations in a fair and just manner*. The Brisbane and Rockhampton populations ranked *impact of water trading on local towns and communities* as the next most important, and *maximising farm income* as least important. The Emerald community, which is a local town and community in an irrigation area, ranked the *impact of water trading on local towns and communities* last. For this community, *maximising farm income* was seen as more important.

Table 6. How people feel about the importance of four aspects of water reforms.

	Brisbane	Emerald	Rockhampton
Maximise farm income, given available water supplies	3.27	3.33	3.29
Distribute water allocations in a fair and just manner	2.02	2.02	2.13
Meet the requirements of basic/natural river flows	1.77	1.94	1.76
Account for the impact of water trading on local towns and communities	2.84	4.29	2.77

The results of these questions show that environmental considerations and equity issues are important for outside communities. For all of the communities surveyed, these issues ranked ahead of production goals. These preliminary results indicate that adverse equity outcomes have the potential to impact on social welfare in the same way that environmental losses might (although probably to a different extent). Just as non-use values for environmental losses are now routinely considered in economic evaluations such as cost benefit analysis, so might non-use values for adverse equity outcomes.

5. The Choice Modelling Study

The Choice Modelling (CM) technique has been applied to estimate values for environmental and social factors associated with additional water allocations in the Fitzroy. In this case study, people from Brisbane have been surveyed to ascertain their preferred choices about resource allocation in the Fitzroy basin and the upper Fitzroy basin.

CM is a stated preference technique. This means that the information about values is gained by asking people to state their preferences for particular resource use changes, rather than by inferring values from market transactions. Stated preference techniques are an important way of capturing what people think about environmental resources. This is because people often have values for environmental and social outcomes that do not necessarily involve their direct use. For example, people may place value on the protection of an ecosystem or continued prosperity of a small country town without ever going to visit either. These values (termed non-use values) are difficult to capture, because they are not revealed in market transactions. It is only stated preference techniques that can put estimates on their value. Generally, stated preference techniques operate by estimating all the environmental and social outcomes together as a package. This avoids double counting and simplifies the estimation procedure.

A CM application operates by surveying a number of households at random from the population of interest. In the surveys, respondents typically answer a number of questions, as well as being given background information about the issue of interest. The core of the survey is a series of tradeoff questions that involve choices between a status quo option (the current situation) and some alternatives. The alternatives, usually involving an improvement in environmental conditions, come at a cost in the form of higher taxes or rates. Because respondents answer a number of these questions, enough data is gathered to be able to draw a statistical relationship between the changes in environmental attributes and the amount of money that people are prepared to pay.

The first key stage in designing a CM experiment is to define the issue in question into a number of key attributes. For the purposes of making the choices clear to respondents, and minimising design complexities, a smaller number of key attributes is preferred. Each is allowed to vary across a set number of levels.

For the study on the Fitzroy basin, a small number of attributes were selected to represent the wide range of issues and complexities involved in floodplain development and conservation. The attributes were selected following a series of five focus groups, and meetings with stakeholders. The key attributes selected were as follows:

- Amount of healthy vegetation left in floodplains (% of original)
- Kilometers of waterways in good health (kms)
- People leaving country areas each year
- Amount of water in reserve (% above the WAMP limits).

While the attributes relating to vegetation, waterways and people specifically related to factors that people associated with conservation and development choices, the reserve attribute was designed to signify something different. Reserve was described as the amount of unallocated water, being the gap between the amount of water already committed to industry and the 50% of median flows that was identified under WAMP as essential to ecological processes. In the background information, reserve was likened more to an insurance policy, where water remained available for a number of reasons, including:

- Uncertainty about future demands
- Uncertainty about accuracy of current scientific knowledge
- Future demands for growth or environmental purposes.

The purpose of describing the reserve attribute in this way was to try to measure values for changes in reserve according to the option value and quasi-option value concepts. Option value refers to the values that people might hold for avoiding irreversible decisions and maintaining future options (Weisbrod 1964, Bishop 1982). Preserving the environment is usually associated with option values, as the choice between development and preservation remains open. In contrast, development decisions are usually not associated with option values, because environmental losses are normally non-reversible.

Quasi-option values refer to the value that people have for improving the knowledge about particular tradeoffs so that more accurate choices can be made (Arrow and Fisher 1974). In relation to the Fitzroy, there is some potential value associated with holding water in reserve until more certainty exists about ecological thresholds and the accuracy of current modelling. Once better knowledge is available, water may then be allocated for development or the environment.

The key attributes were combined with a payment option to form the alternatives that people might choose between. In the surveys, three options were given to respondents in each choice set. One option was a constant ‘status quo’ situation, which represented the likely state of the Fitzroy system in 20 years time, given the existing state of resources and current trends. The other two options in the choice sets were potential improvements (in environmental conditions) on the status quo choice that would involve an annual contribution (in the form of higher rates) from respondents. These options were varied slightly by changing the levels associated with each attribute. The levels used for the base and the alternative options are shown in Table 7, and an example of a choice set used is shown in Appendix 1.

In order to determine how respondents viewed different conditions, another survey was run that focused on the Comet-Nogoa-Mackenzie sub-catchment of the Fitzroy basin. The purpose of running these surveys concurrently was two-fold. First, it allowed the researchers to test how values for a larger basin (the Fitzroy) could be disaggregated into smaller components. Second, it allowed a test of how values for specific attributes changed when different quantities were involved.

This was particularly relevant for the reserve attribute. Under the Fitzroy WAMP, substantial water reserves remain to be allocated in the Lower Fitzroy and Isaac/Connors systems. In contrast, only 40,000 megalitres of additional water was available for allocation in the Comet-Nogoa-Mackenzie (CNM) system. This was achieved at the cost of setting some environmental flow indicators below the Environmental Flow Limit for parts of the Mackenzie River under the WAMP process. To reflect these factors, different levels were chosen for the CNM system. These are indicated in Table 7.

Table 7 – WTP Base and Attribute Levels for the Fitzroy and CNM Surveys

Attribute	CNM Survey		Fitzroy Survey	
	Base Levels	Choice set Levels	Base Levels	Choice set Levels
Payment ($)	0	10, 20, 50	0	20, 50, 100
Healthy Vegetation in floodplains (%)	25%	30%, 40%, 50%	20%	30%, 40%, 50%
Kilometers of Healthy Waterways (km)	400	500, 650, 800	1500	1800, 2100, 2400
People leaving country areas (#)	0	0, 25, 50	300	275, 325, 350
Amount of water in reserve (%)	0%	-2%, 2%, 4%	0%	5%, 10%, 15%

The surveys were administered in the form of a small booklet, with five choice sets in each. Surveys were collected on a drop-off/pick-up basis in Brisbane in November and December 2000. Brisbane was chosen as the population base because of its size in relation to the state population. 130 surveys were collected for the Fitzroy sample and 87 surveys for the CNM sample. The returned surveys were coded into an Excel spreadsheet so that the data could be analysed with the Limdep statistical software.

Survey results.

The results of the CM questions were analysed by fitting a logistic regression model to the answers given. The choices made were regressed against the levels involved in each option, as well as the socio-economic characteristics of the respondents. In this way the probability that an individual would choose between a particular option would be a function of the attributes and levels of the option, the characteristics of the individual, and other factors (represented by a constant term).

For behavioural interpretation and statistical modelling purposes, a two stage decision model was adopted. Under this model, respondents were assumed to initially make a choice between the status quo and protection options, and this choice could be largely explained in terms of the characteristics of the individuals (e.g. age, gender). For those choosing to support protection, the second stage was to choose between the two options (B and C) on offer. The structure is depicted in Figure 1. Attribute labels used in the models are described in Table 8.

Figure 1. The Nesting Structure Adopted in the Statistical Models

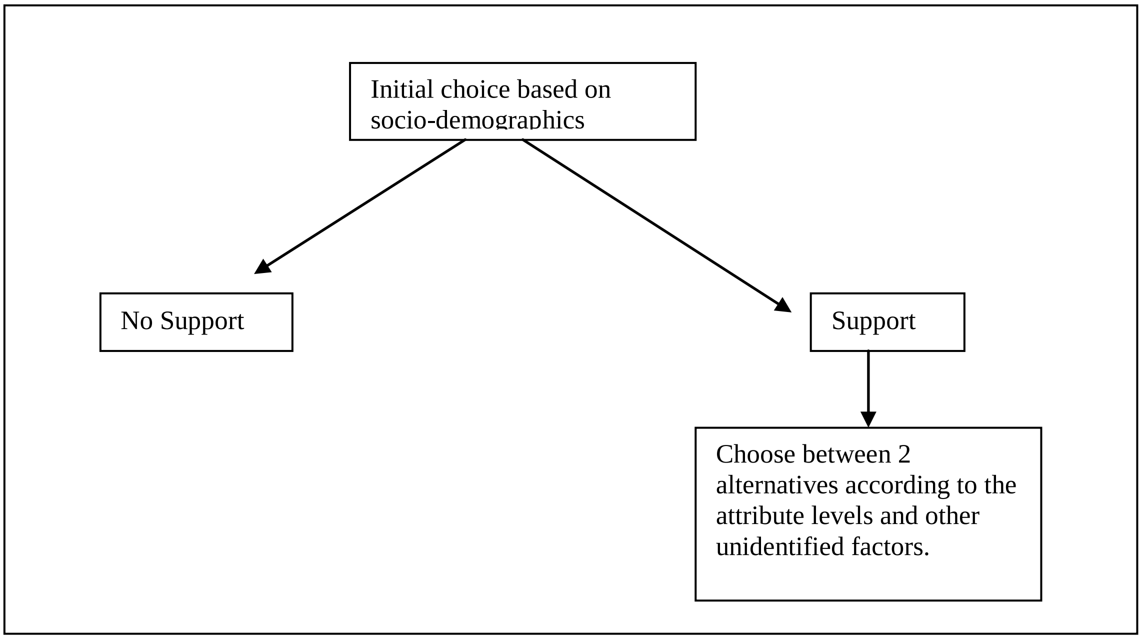

Table 8. Variables used in the CM application

Attributes of branch choice equations	Indicates the reasons why people choose between support/no support branches in the models
Age	Age of respondent (in years)
Occupation	Occupation (1 = employed, 2 – 5 = other categories)
Education	Education (ranges from 1 = primary only to 5 = tertiary degree)
Income	Income of household in dollar terms
ASC	Constant value – reflects influence of all other factors on why people choose between support/no support branches
Attributes in the utility functions	Indicates the reasons why people choose between the 2 alternatives
Cost	Amount that households would pay in extra rates (or rent) each year to fund improvements
Vegetation	% of healthy vegetation in floodplains remaining
Waterways	Number of kilometers of waterways in catchment remaining in good health
People Leaving	Number of people leaving country areas each year
Reserve	% of water resources in catchment not committed to environment or allocated to industry/irrigation/urban
ASC1	Constant value – reflects influence of all other factors on why people choose between different choice profiles
IV parameter	Provides the statistical link between the two levels of the nested model

The survey results are summarised in Table 9. Robust models were identified for each catchment, with all attributes signed as expected. The negative coefficients for the *Cost* and

People Leaving attributes indicate that higher levels of these attributes were not preferred. In contrast, the positive coefficients for the *Vegetation, Waterways* and *Reserve* attributes suggest that higher levels of these attributes were preferred. The negative sign on the income coefficient indicates that people with a higher income were less likely to support the *No Support* option. In a similar manner, the negative coefficient on Education in the Fitzroy and CNM samples indicates that respondents with higher levels of education were less likely to support the *No Choice* option.

Table 9. Nested Models for Fitzroy and CNM surveys.

	Fitzroy	Comet-Nogoa-Mackenzie
Attributes in the utility functions		
Cost	-.0214***	-.0233***
Vegetation	.0348***	.0333***
Waterways	.0006**	.0020***
People Leaving	-.0067***	-.0156***
Reserve	.0043	.1544***
ASC1	.2016*	.0587
Attributes of branch choice equations		
ASC	1.2325***	.8978
Age	-.0010	-.0068
Occupation	-.1164	.0359
Education	-.2951***	-.2842**
Income	-.0001**	-.00001***
IV parameter	.7462***	.8884***
Summary Statistics		
Number of Choice Sets	650	435
Log Likelihood	-603.37	-378.13
Adjusted R-squared	.23268	.31114

*** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

6. How should water allocations be made between competing production interests?

The results of the attitudinal questions indicate the equity concerns are important issues when determining water allocations. The results of the CM study indicate that in all catchments, increased water allocations that help to create jobs and keep people in rural areas provide social benefits. At the same time, increased water allocations that cause environmental losses to waterways and vegetation create social losses.

Economic principles indicate that highest social values will be achieved when water is allocated on a competitive basis. This is the thrust of the COAG Water Reform process in this area. The key question to consider is whether concerns about equity, procedural and environmental issues are substantial enough to influence or override this broad policy setting. There are three areas of relevance to the Comet-Nogoa-Mackenzie region, being:

- Allocations via instream or offstream storages,
- The geographical distribution of allocations, and
- The method of allocation.

Instream vs offstream storages

The assessment of construction costs relative to water yields for instream and offstream storage options reveals a wide range of costs/ML, with some offstream storage options on the Comet River appearing to have the lowest infrastructure costs. From an economic perspective, the offstream storage options would be likely to generate the maximum profits and economic wealth. There is an additional benefit in that public funds do not have to be committed for infrastructure purposes. In relation to environmental issues, offstream storages are often favoured over instream storages because there is not the same level of disruption to river flows and other natural processes. However, reliance on offstream storages may generate both equity and procedural concerns.

Equity concerns might arise because offstream storages are usually large scale operations. Therefore the potential allocation in the basin may be taken up by a very small number (<10) large irrigators. In contrast, instream storages may make water available to a larger number of irrigators. These equity concerns are balanced though by three considerations. The first is that irrigation activities in the basin are tending to consolidate to large scale operations in any case. The second is that smaller parcels of water will still be available from regulated supply areas, which comprise the bulk of water supplies in the basin. The third is that the larger, most productive enterprises will tend to generate the most wealth and the bigger flow-on effects in terms of spending and employment in the region. Therefore the smaller number of jobs at the irrigation enterprise level may be balanced by the larger number of jobs in the agricultural service and other input sectors.

Procedural concerns might arise because offstream storages have already been built along the Comet River while the Fitzroy WAMP has been developed. Those offstream storages have captured overland flows. These were not regulated in the Fitzroy basin until September 2001. This meant that while other potential irrigators were not allowed to make applications for waterharvesting (or had submitted applications frozen), the landholders along the Comet River building offstream storages have essentially captured the last remaining allocations allowed under the Fitzroy WAMP. While the water may have ended up in its most productive use, there has not been open access to the potential allocations through a competitive process.

In terms of categories of water rights reported by Quiggan (2001), landholders with expectations of access based on past practice (applications for licences) have been trumped by landholders gaining non-statutory rights though development and use (building off-stream storages). A 'no regrets' policy tends to favour creation of property rights over natural resources that have prior use, in this case the irrigators with off-stream storages capturing overland flows.

The geographical distribution of water allocations

Interest groups within the basin have raised concerns though the CHRRUPP consultation process and other forums about the possibility that water allocations may be concentrated in particular areas of the basin. This would occur if the production and profitability opportunities are higher in one region relative to others. In contrast, arguments for uniform regional development suggest that methods need to be found to spread the wealth creation across the region. This could be done by supporting instream developments with public funding so that irrigation development was spread across rural shires and towns in the basin.

The equity concerns implicit in this case for regional development are not substantial. First, measures that try to influence the location of irrigation development are often at cross-purposes with the concept that water should flow to highest value use. If water is not being used to maximise production and wealth because of other political and regional development goals, it is the wealth of the overall region that is adversely affected. For the region as a whole, wealth is maximised when water can trade freely. Second, there is little point at the regional level in locating irrigation in particular areas when the water would have to be transferred from other nearby rural locations. There is no benefit in committing public funds to infrastructure development if there is no overall increase in the amount of wealth creation or job opportunities. A third issue is that as water trading is established, water allocations may simply be sold away from less profitable enterprises to areas of high value use.

The method of allocation

There have been arguments made that water allocations should be made to support industry diversification, family farms, and smaller landholders. The essential core of the arguments is that water should be allocated thinly across a large number of landholders. Because these groups would not be able to compete in a market setting against larger irrigators, the water would have to be allocated through some non-market allocation process.

These arguments have little merit. The pattern of farm amalgamation in the region and farm budget models (eg Spackman (1996)), suggest that scale economies are very important in irrigation. Smaller allocations of water are almost certain to be non-viable. The introduction of water trading means that any non-economic distribution of allocations will only be a short term measure. In the medium to longer term, trading will ensure that water flows to highest value use. As well, there is no obvious way of distributing water allocations. Is it only landholders adjacent to a river, or those within 5 kilometres of a river that would receive the benefit.

There will be some concerns about moving from a system of allocation where landholders applied for a license at minimum cost to another system where landholders have to purchase water on an open market. There will be some learning and adjustment (transaction) costs involved in this process, and there may be some wider community concerns about social outcomes. It is possible that irrigation water might be transferred from some areas, and that the number of irrigators contracts.

However, the bulk of water transfers will occur between farmers, and higher water prices simply mean a different redistribution of assets occurs. Most farmers will automatically be compensated through market processes for changed water allocations. Community concerns about any apparent equity issues is likely to be only short term, while production gains from a more efficient allocation of water will be ongoing. In cases where more water is not allocated in a particular region, potential irrigators will not be made worse off, but will not receive the possibility of further development. This contrasts with the situation in the Murray-Darling basin, where irrigators have to give up allocation to ensure that environmental conditions and water security do not deteriorate further.

Summary

In the Comet-Nogoa-Mackenzie system, concerns about the different equity outcomes of allowing market forces to determine water allocation do not appear to be substantial. Any measure to intervene in market processes is costly because it reduces the amount of water that flows to highest value use. Impacts on wealth creation hurt the region. Most measures to direct water allocations to specific groups simply redistribute irrigation activity, and do not advance regional development as a whole. Market processes for allocating water appear to be the most efficient, and are equitable in that they offer open access to water resources.

7. Should water be reserved rather than allocated?

The remaining issue to be addressed is whether the remaining water should be reserved rather than allocated. The value for the Reserve attribute from the CM study is the issue of particular interest here. This is because where smaller amounts of water are involved, it is possible that the impacts on the other social and environmental factors might be slight. For example, allocation of water to larger irrigators may not create many new jobs. The water might be allocated to areas where land is already cleared, meaning that there is little impact on vegetation. And if water is allocated in areas where there is already substantial disturbance of natural stream flows, there may not be large impacts on the health of waterways.

For the Fitzroy as a whole, the reserve attribute did not emerge as significant. This makes sense because of the large amount of reserve available in the Fitzroy system. As a result, people did not place much importance on changes to the amount allocated, and the attribute was not significant in the way that people made choices. This is in keeping with economic explanations about marginal value. When a resource is abundant, the value of one extra unit (marginal value) tends to be very low.

However, for the CNM system, the amount of reserve left was very important in making choices. The coefficient for the reserve attribute is highly significant for this model. The implication is that as the systems become allocated down to the threshold level (or just past it), this has a bearing on how people make the choices. As the reserve water becomes scarcer, people value it more.

For the lower Fitzroy and Issac/Connors systems, the low importance placed on Reserve does not mean that more water allocations are costless. If additional allocations have impacts on floodplain vegetation and the health of waterways, then there will be offsetting environmental values to consider against the benefits of development. In many cases though it could be expected that development would continue to be worthwhile in the lower Fitzroy and Issac/Connors systems.

Marginal values can be estimated for changes to reserve amounts that households in Brisbane might hold for the CNM system. These values (known as part-worths) are estimated by taking the ratio of the *Reserve* and *Cost* coefficients from Table 5, and multiplying by –1, as shown in the equation below:

Part-worth = $-1 \times \beta_{Reserve}/\beta_{Cost}$

For example, the part-worth for each household of each 1% change in *Reserve* in the CNM system is \$6.62 per annum over 20 years.

Values in the CNM system.

Survey respondents were informed that current reserves in the CNM system (the 40,000 ML identified in the WAMP) equated to about 4% of the system. Thus Brisbane households, on average, would pay about 4 times the amount above, or \$26.48 per annum, to preserve the entire 40,000 ML. This payment stream can be converted to present value terms, and multiplied by the number of households in Brisbane (approx 300,000) to arrive at a total value. At an 8% discount rate, this payment stream grosses up to about $77.99 Million in current value. At a 12% discount rate, the payment stream grosses up to about $59.34 Million. When the rest of Queensland households are counted in, these values for reserving the water in the CNM system would approximately double.

These preservation values can be compared to the production benefits that allocating the water might generate. The production benefits can be conveniently thought of as being captured in the prices that irrigators might pay for the water, as this usually represents the discounted stream of future profits from using the resource. If the whole 40,000 ML's were to sell for approximately $1,500/ML, the net present value of the production benefits can be calculated at approximately $60 Million.

It appears that, on the preliminary figures at least, the preservation values outweigh the potential production benefits from allocating more water in the CNM system. There may be particular situations where further allocations of water has positive social outcomes without many environmental losses, in which case there may be some justification for allocating more reserve. However, some environmental consequences from allocating more water would normally be expected. This means that in most cases there would appear to be more value in reserving the 40,000 megalitres of water in the CNM system than allocating it to irrigation. This does not preclude it from future use; the value expressed is to keep it as a backup so that the options for using it for environmental or development purposes remain open.

Caveats

There are three important caveats to note in regard to the above analysis. The first is that applications of the Choice Modelling technique to issues of water allocation and potential environmental losses remains at an early stage of development. It is likely that as more studies are done, more accurate ways of representing scenarios will be developed, and there will be more available studies to cross-check results. It is possible that the environmental values reported above are slightly inflated because there has been one issue at a time presented to respondents. The values might also be high because of the way that the reserve attribute has been described. However, values are also likely to have been depressed by measuring environmental changes through a Willingness to Pay mechanism, even though it is more accurate to frame the situation in the Fitzroy basin in Willingness to Accept terms. Further research will help to improve the accuracy of the estimates reported above.

The second caveat is that the values for the *Reserve* attribute are unlikely to remain constant over their full range. In both the Dawson and CNM systems, the possibility that the systems could be overallocated (i.e. drawn down past the WAMP limits) was modelled. Because the marginal values for the reserve amounts appear to change quite quickly across systems, it is possible that most of the values expressed above are focused on not letting the system become overallocated. This means that while the losses to households from allocating more water in the system may be $6.69/annum for each 1% loss on average, it is probably lower for initial losses, and higher for subsequent losses, particularly those that take the system below the WAMP median levels. So the marginal values will probably change (get higher) as the amount of reserve falls to zero or becomes negative. The first allocations of water in both the CNM and Dawson systems probably do not have quite as high a value for the environmental losses as the later allocations.

The third caveat is that considerations about the amount of reserve in the catchment systems are likely to be influenced about the types of property rights established. If most property rights are established in favour of landholders, this implies that any future environmental flow requirements might have to be funded by the taxpayers. This is the situation developing in many other catchments of Australia, where the taxpayers are funding remedial works for salinity and other issues relating to previous overallocation of water resources. In this situation, it is understandable that the public are wary about committing all available water to development.

If property rights remained flexible enough to ensure that the taxpaying public did not bear the financial risks of potential overallocation of water resources, public values for holding water in reserve may well be lower. In this situation, industry and irrigation sectors would bear all or most of the responsibility of ensuring that environmental flow requirements were met, and would adjust the amount of allocated water drawn from the system if necessary as better information about environmental flows became available.

Conclusions.

Equity issues are commonly raised in relation to water allocation and irrigation development issues. This is the situation in the Fitzroy basin in central Queensland, where a number of concerns have been raised about the remaining 40,000 megalitres of potential supply in the basin might be allocated. Concerns have been raised that the allocation process will not distribute wealth creation equally across the region, and will favour large scale irrigation enterprises over smaller scale family farms. There are also concerns about whether water should be reserved for environmental or other purposes.

The water reform process, with an emphasis on specifying property rights for water allocations and allowing competition to allocate scarce resources, does not address these equity issues. Under a competitive allocation process, water allocations in the upper Fitzroy basin are likely to be concentrated in a few large enterprises in specific areas of highest productive use. Given that this will maximise the production and wealth generation capacity of the region, it is worth considering whether concerns about equity impacts should be considered.

There are three key areas where equity issues might be expected to impact on an economic assessment of the value of water allocations. The first is where there are major equity impacts, which would not be easily addressed in any cost-benefit analysis. The second is where equity impacts generate social losses in the wider community, and the third is where concerns about procedural issues generate losses and make it difficult to achieve change in a reform process.

The equity impacts of further water allocations in the Fitzroy basin do not appear to be substantial. This is because there are no groups that would necessarily worse off (although lack of development opportunities over time may mean they become relatively worse off). There are substantial opportunity costs associated with some potential water infrastructure developments. If water were to be allocated to achieve regional development and other equity goals, there would not only be a transfer of wealth from one area to another, but a decrease in the overall wealth generating capacity. For the region as a whole, wealth creation will be maximised if water can flow to highest value use, and there are corresponding equity impacts in terms of higher spending and job multipliers.

The issue of whether water should be allocated out of the system now or reserved for future use and environmental purposes can be analysed as a quasi-option value. In this case, there may be some value in reserving water from the system so that better information can be collected about future needs for both environmental and extractive purposes. There is scientific uncertainty about both the modelling of water flows and resources in the basin, and the environmental impacts of further water extractions. Reserving some water is like an insurance policy in case negative outcomes arise from those uncertainties.

A choice modelling study has generated preliminary values held by the Brisbane population for reserving water from the upper Fitzroy system at approximately $26.48 per household per annum for the next twenty years. At an 8% discount rate, this payment stream grosses up to about $77.99 Million in current value. There will also be value for reserving water held by other Queenslanders to consider. In comparison, the productive value of the 40,000 megalitres available in the upper Fitzroy basin is approximately $60 million. The conclusion to be drawn is that there is some value in reserving water from the system for either use or environmental purposes in the future.

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