TRADING WITH THE ENVIRONMENT
using water options to meet environmental demands

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- In an unregulated river, water reaches floodplain and wetland environments during high flow events that usually occur in wetter years. Managed flows that replicate the timing of these naturally occurring events have the potential to deliver desired ecological benefits at the lowest cost.

- An options contract written against irrigators’ announced allocations could be used to provide water for the environment at a substantially lower cost than government purchase of general security entitlements.

- Further, irrigators can retain their permanent entitlement as a hedge against the risk that the pool of water resources available to irrigators will decline in the future.

Introduction

The Intergovernmental Agreement on the 2004 National Water Initiative sets out three desired objectives for the management of environmental water (Commonwealth of Australia 2004). These are to:

- identify the actions and associated benefits sought within the riverine environment,
- empower managers with authority and resources to achieve these actions and benefits, and
- provide these benefits cost effectively.

One of the key actions in the southern Murray Darling Basin is to reconnect river systems with the wetland environments of the flood plains in a manner and with a frequency to deliver a number of ecological benefits. Some of these benefits include maintaining native floodplain vegetation, promoting waterbird breeding and providing nutrients to maintain fish populations.

The natural link between these environments was through flood events that now occur much less frequently in this highly regulated river system. One means of reconnecting the floodplains with the river is through the use of targeted releases to create or augment high natural flow events. These events would have occurred naturally in seasons with above average inflows in winter and early spring.

While the volume of releases required to inundate wetland environments will depend on the desired frequency and duration of the event, the opportunity cost of those water resources will be lower in seasons with above average winter or spring inflows. In high flow years, both the volume of releases required to supplement inflows and the value of lost agricultural production will also tend to be lower.

This seasonal difference in the costs of diverting water between agricultural and environmental use is why trading is seen to be an important aspect of cost effectively managing environmental flows. While the primary focus has been on the temporary transfer of water from environmental allocations to irrigation use in periods where water supplies are relatively scarce, these is also the potential for irrigators to transfer water to the environment in periods of relative abundance.
Trade in water entitlements between irrigators can have an important role in mitigating the costs faced by irrigators if water is sourced from consumptive use for environmental management (Goesch and Heaney 2003; Heaney et al. 2002).

In this article, the benefits of trade between irrigators and the environment are examined in the context of the timing of environmental and irrigation demands. The results draw on a case study of the Murrumbidgee River. A model of the Murrumbidgee River system was developed at ABARE as a part of the Pratt Water Initiative (Pratt Water 2004) and was used to explore how the timing of providing environmental water affects both the volume and the cost of the transfer.

The environment as a water trader

The transfer of water from irrigators to the environment could take the form of an option. Irrigators could enter a contract to sell the part of their allocation that is in excess of a specified level. For example, an irrigator holding a licensed annual entitlement of 100 megalitres could write an option to sell any allocation announced above 90 megalitres. In years with limited water resources, this threshold may never be reached but in other years, up to 10 per cent of their entitlement may be transferred to the environment.

The timing of the option within the season also needs to be considered. The timing of the option will affect the timing and volume of water available for environmental management, the cost and the demand for storage infrastructure. For example, an option written at the start of the irrigation season could provide water to meet current environmental objectives. Alternatively, an option written late in the season could be carried over in storage for use in a subsequent season.

This approach offers two advantages. First, there is no need for the environmental manager to hold a permanent water entitlement if the water is only required in wetter than average years. The outlay required to gain access rights to water for the environment is the price of the option, which will be substantially lower than the capital cost of a permanent entitlement. Second, irrigators retain their permanent water entitlements. A permanent water entitlement is a natural hedge against the risk that the pool of water resources available to irrigators will decline in the future. Such a decline might result from a longer term reduction in rainfall and catchment runoff, or the sovereign risk that government will reallocate water resources to the environment, for example. Those irrigators holding a permanent entitlement will at least be partially compensated for reduced water access by an increase in the average value of their remaining entitlement.

Murrumbidgee River options model

The Murrumbidgee River options model (MROM) was developed at ABARE to evaluate a range of investment and management options to increase the natural and productive value of irrigated agriculture and the riverine environment. A key purpose of the framework was to provide a better understanding of the tradeoffs between consumptive and environmental water demands in the Murrumbidgee River.

MROM has four integrated components or modules. The first component is a hydrological representation of flows in the Murrumbidgee River and its principal tributaries. The second component simulates the physical operation of storage and delivery infrastructure to meet irrigation and other consumptive requirements, as well as environmental objectives. The third component is an agronomic representation of crop water requirements, yields and production. The fourth component allocates available land and water resources to irrigated agricultural production enterprises to maximise expected returns.

In addition to the main model components, there are environmental demand nodes to represent environmentally important wetlands and billabongs along the Murrumbidgee River flood plain. Natural and induced flood events can connect these wetland environments to the river system to support a range of ecological processes. While these processes are not explicitly represented in the model, the frequency and the duration of these events can be specified as flow management objectives (Hillman 2004). The comparative environmental benefits of different flow regimes, however, are outside
the scope of this model. A schematic diagram of the model is provided in figure A. More detailed information on MROM can be found in Beare, Heaney and Hafi (2004).

The key features of the model include the following:

- Data from 1976 to 2003 were used to estimate the seasonal patterns, as well as the spatial and temporal correlations in stream inflows, rainfall, and evapotranspiration. These patterns were used to generate stochastic dam and tributary inflows, and crop demands. Droughts were incorporated into the baseline. The annual likelihood of a drought event was assumed to be 10 per cent with a random reduction in unregulated inflows of between 35 and 70 per cent.
- The model hydrology operates on a daily time step where simulated inflows are routed according to travel times between reaches of the river, infrastructure constraints, including storage and channel capacities, operational rules managing releases from Burrinjuck and Blowing dams, offtakes to the main irrigation areas and overbank flows to wetlands.
- Operational rules were developed to prioritise and allocate available resources between competing uses including environmental requirements, irrigation, and urban, stock and industrial use. The rules are intended to reflect water sharing arrangements set out in the catchment management plans for the Murrumbidgee Valley and the Murray Darling cap diversions for consumptive use.
- Within the modeling framework, water allocations to irrigators are announced monthly from August to February. After deducting environmental and nonagricultural water requirements, the balance of water resources held in storage, plus minimum expected future inflows form the basis of the announced irrigation allocation.
- Storage release rules were developed to maximise irrigator returns subject to environmental and other release requirements. The rules minimise the likelihood of a severe constraint on delivery capacity that can arise when storage levels at Burrinjuck Dam are not sufficient to meet peak season irrigation demands.
- Explicit representation of thirteen horticultural, winter and summer crops that are allocated to maximise expected agricultural returns given current land availability and announced surface water allocations, and the uncertainty associated with water allocations, rainfall and crop transpiration demands. Crop yield functions are used to calculate irrigated production and revenue. The timing and level of moisture stress determines any yield losses.
- Each simulation was run over a 50 year time horizon with model outputs recorded as annual averages. Net present values were calculated using a discount rate of 5 per cent.
Evaluating the use of options to trade water to the environment

In the example considered here, an option could be provided whereby the environmental manager (in the case of the Murrumbidgee, the New South Wales Government) could acquire water for environmental management from irrigators at a prespecified price and conditions of access. This contract could take the form of an option to transfer an irrigator’s announced allocation, at a specified time, above a certain defined threshold of allocation percentage.

Here, the contract provides for the transfer of that proportion of an irrigator’s 1 August allocation that is above a threshold, say 85 per cent of the irrigator’s licensed entitlement, at a specified price. The environmental manager could negotiate an option fee (the price for the right to the option itself), which would be paid to the irrigator even if the option was not exercised. For its part, the environmental manager would have the right to exercise the option if the announced allocation exceeded the nominated threshold.

The MROM simulation tool was used to estimate the expected yield and cost of writing the option for a range of thresholds. The expected yield of the option is across the total licensed entitlement for the Murrumbidgee Valley and, as such, represents the maximum volume of water that could be obtained at each nominated threshold. The thresholds under consideration are 80, 82.5, 85 and 87.5 per cent of the total licensed entitlement. The price (or cost) of the option is the opportunity cost of forgoing the water from agricultural use — that is, the amount that the irrigator would need to receive to be at least as well off after the option was exercised. The cost is based on the assumption that the option is exercised in full when the threshold condition is reached. The findings are summarised in figure B.

If announced allocations on 1 August are 80 per cent of the licensed entitlement, the volume of water available for the environment would be around 90 gigalitres at a price of $30 a megalitre. This is equivalent to about 4 per cent of licensed entitlements. Conversely, if announced allocations were 87.5 per cent of licensed entitlement, the average volume of water available for the environment would be 10 gigalitres at a price of around $12 a megalitre. Importantly, this price is well below that of purchasing a general security entitlement of an equivalent yield. This was estimated to be around $46 a megalitre a year.

The distribution of the volume of water transfers under an option with an 85 per cent threshold is shown in figure C. Data are shown for transfer volumes of 0 (that is, beneath the threshold), 50, 100 and more than 100 gigalitres. While the option has an expected annual yield of around 30 gigalitres, the 1 August threshold was not reached in the majority of irrigation seasons. The results indicate that the option could be exercised in about three out of ten irrigation seasons. Of the options that could be exercised,
about half were for transfer volumes that were in excess of 100 gigalitres, with the majority of the balance being between 50 and 100 gigalitres.

Concluding remarks

This case study provides a clear indication that while there are competing environmental and consumptive demands for water, the nature and timing of these demands are, in some sense, complementary. Establishing institutional arrangements that allow water trade between irrigators and an environmental manager when seasonal conditions are favorable can substantially reduce the opportunity costs of sourcing water to meet environmental demands.

The transfer of allocation to the environment during times of relatively abundant water supplies will minimise the value of lost irrigated production as well as any flow on disruptions to the processing and service sectors beyond the farm gate. In other words the opportunity costs of obtaining environmental water will be lowest when the timing of purchases matches the natural pattern of flood events that connect the river system to the flood plains.

An options contract written against irrigators’ announced allocation is only one way to establish trade between irrigation and environmental demands. However, there are two advantages of using this approach to meet environmental demands. The first is that irrigators can retain their permanent water entitlements. Permanent water entitlements are a natural hedge against the risk of a future decline in the pool of water resources and provide a more secure setting for irrigators, and others, to make investment decisions. Second, the purchase of an options contract allows governments to acquire environmental water without having to make the initial capital outlay to purchase entitlements, or to have to manage those entitlements once purchased.

There are other environmental demands for water that do not necessarily match the timing of natural flood events. However, it may still be possible to acquire water though an options contract and then store it for later release. For example, if an options contract were used to source water for the Snowy River, it would be necessary to store purchases, or borrow against expected purchases, within the Snowy Hydro-electric Scheme.

There are, however, a number of questions that need to be considered to design an effective contract. First, a clear understanding of the desired environmental outcomes is needed to assess the expected timing and level of water demand. Second, the conditions and price of the option will need to attract a sufficient number of irrigators or other agent(s) that are willing to write options to meet those demands. Third, there is a need to identify other institutional arrangements required to facilitate or enhance the effectiveness of trade. Again, these arrangements might include infrastructure access rights to store purchases for later release. Finally, the contract specifications and the uptake of the option will have a major influence on how effectively a contract can be used to source environmental water requirements. This is an area for further research.

References


