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Droplets explore ideas and propositions, which if developed further, might improve water use. They develop ideas and search for the fundamental concepts and building blocks that one might consider if not constrained by prior decisions.

Shepherding water: Unregulated water allocation and management

"Careless shepherd make excellent dinner for wolf." Earl Derr Biggers

In regulated water supply systems like the River Murray, when you want to use some of a seasonal allocation made to your entitlement, you order it. In the meantime, the balance of the water allocated to you is stored for you in one or more large dams.

In unregulated water supply systems, however, there are no large dams and access to water is reliant on capturing water as it flows past your place and storing it in your own dam. In addition to river flow, significant amounts of water can sometimes be obtained by capturing overland flows – especially in extremely episodic systems like those found in Australia's Darling River system.

Apart from a few licences to take water from waterholes or weirs, when the flow rate is low no-one is allowed to take water. As the flow rate increases and defined flow-rate thresholds are passed at a defined point, progressively more and more licence holders are allowed to extract water from the river and/or allowed to harvest overland flows.

To prevent over-harvesting, flow-rate threshold announcements are usually made on a daily basis and, for each threshold, entitlements specify a maximum daily volume that may be diverted or taken while the river flows above that rate. In some systems, maximum storage volume limits are set.

The resultant management regime can be extremely complicated. In Queensland's Lower Balonne system, for example, most entitlements or licences, as they are often called, contain two or three flow-rate thresholds. Larger licences may contain more than 20 flow-rate thresholds.

As a general rule and given the rate at which new technologies and new markets have emerged, there is no logical reason to assume that the current assignment of these opportunities to take water from an unregulated system is optimal. Thus in most systems, there is a case for allowing people to trade their licence from one location to another.

In unregulated systems and when the flow is episodic, how can trading be facilitated? If one wanted to reduce the take of water from one part of the system or "shepherd" water to the end of the system, what administrative arrangements would need to be in place? What is the best way to deal with the effects of shifts to a drier climatic regime and/or preference for environmental outcomes?

Sharing the available water

When setting up an unregulated entitlement and trading system, careful consideration must be given to the likely impacts of each trade on downstream wetlands, downstream entitlement holders and the interests of landholders whose animals graze on floodplains that have traditionally been wetted by overland flows.

The interests of towns may also need to be taken into account. In some New South Wales systems, for example, river managers are required to take into account both the flow rate at a defined point and the amount of water in the Menindee Lakes, from where Broken Hill's water supply is drawn.

To fulfil these downstream requirements and obligations, managers need to be able to time announcements in a way that enables water to be shepherded past licence holders otherwise entitled to take this water.

Trading

Whilst it is very easy to recommend trading, in practice, one has to recognise that the place where water is taken affects both the downstream flow rate and where water flows over the land. Moving the point where water is taken from is especially a problem when entitlements are defined solely by the flow rate at the pump or diversion structure. When this is the case, if you try to trade your water downstream, the first thing that happens is that the flow rate increases and, assuming no change to the management regime, other entitlement holders will be allowed to capture "your" water as it passes "their" pump and diversion structures. Under such circumstances, trading is not a very good idea!

If, however, a river system is divided into a number of reaches and each entitlement is defined by the flow rate at the top of the reach, the maximum amount that one licence holder can take within the reach is not changed by the actions of all other entitlement holders in the reach. Under such as regime, and with appropriate adjustment to account for downstream interests, within-reach trading is possible. But to trade from one reach to another, it has to be possible to raise or lower the flow rate at which the announcements are made.

Accounting for transmission losses

In most unregulated systems, especially those that spread out over large areas, transmission losses can be high. This means that whenever an entitlement is traded, the main factors that determine how much water can be taken – like the maximum pumping rate – may need to be adjusted. In most systems, computer models have been developed and used to estimate the changes that are likely to occur and make an appropriate adjustment to the maximum pumping rate. In practice, however, such models are

far from perfect. In the short-term, the easiest way around this problem is to set a conservative exchange rate.

An alternative approach is to allow tagged trading. Under a tagged trading regime, the purchased entitlement retains all of its characteristics at its original location. The amount that can be taken at the new location is then adjusted periodically to take account of changes in conditions at the original location and knowledge about the behaviour of the system. Tagged trading systems are designed to protect the long-term interests of third parties. They do this by assigning the exchange rate risk to the buyer.

We think that the development of a tagged trading system for unregulated system management has merit – especially when the volumes involved are so large that they may change the pattern of water flow across the landscape. Tagged trading in unregulated systems has particular merit when river managers are uncertain about the impact of a trade on the direction of water flow across a landscape. With further development and improvement of modelling, eventually normal transfer of a purchased entitlement to another location should be possible.

When one moves the pumping or diversion point upstream, the interests of other pumpers, landholders who benefit from grazing floodplains and the environment need to be taken into account. If you want to give 100 per cent protection to the floodplain and grazing interests, then only allow trading downstream! But remember that, the further water is traded downstream, the greater are the losses.

Shepherding water downstream

Imagine what would need to happen if a Queensland entitlement was purchased with the view to increasing river flow in South Australia. To effectively shepherd any water to South Australia, every announcement threshold and every monitoring point along the way would need to be changed, but changed only for each shepherding circumstance. Possible, but development of such a system would require a considerable degree of co-ordination and communication among river managers and jurisdictions. Some refinement of interstate water sharing agreements may be necessary.

Without a shepherding arrangement that allows announcement threshold variation, a decision to increase river flow in downstream states by purchasing a Queensland entitlement to may be a questionable investment. CSIRO estimates that when there is a maximum flow at the St. George weir in Queensland's Condamine Balonne System, one megalitre of water will deliver only 0.18 megalitres to the Murray Mouth.

Dealing with adverse climate shifts

The last question to consider is the effect of adverse climate shift on the health of an unregulated river system. If there is an adverse shift to a drier climatic regime, then one would expect a reduction in the total flow and in the number of high flow events. In most unregulated systems, however, entitlement holders get access to a larger proportion of the volume of low flow events and to a smaller proportion of high flow events, with most of the environmental water coming from high flow events.

If it gets drier, however, under current entitlement conditions the amount that may be taken during low flow events will remain the same. This means that the environment may lose out. If one was concerned about this happening, then a possible solution would be to define flow-rate thresholds as a function of a long-run moving average (adjusted for any lag effect) so that the impact of the emergence of a shift to a drier regime on the health of an unregulated system is minimised. Note also that if there is a shift to drier climatic regime, all downstream users will get fewer opportunities to harvest water.

Where to from here?

As we write this Droplet, the Murray Darling Basin Authority is starting work on a new Plan for the Basin that will need to address these issues. Amongst other things, this will require the development of ways to raise and lower announcement thresholds on an event by event basis. If this were done, then river managers would be able to shepherd water through several reaches. They should also be able to manage the effects of adverse climatic shifts on downstream users and the environment.

If the intent is to find ways to shepherd water over long distances, and if required, to move it through different jurisdictions, then considerable refinement of existing interstate water sharing agreements may be necessary.

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References (Access them by clicking on the links embedded in this Droplet.)

Department of Natural Resources (2007) Condamine and Balonne Draft Resource Operations Plan, Brisbane