Chapter 5

A robust framework for the allocation of water in an ever-changing world

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Abstract

In an ever-changing world with an increasing demand for water, and with the emerging possibility that climate regimes may change, there is a need to put in place arrangements to enable the water resource system to adapt and support itself no matter what the future may bring. Irrigation could be expected to come and go, rivers and the associated environment must be expected to change and the expectations and attitudes of communities and societies will also change.

This chapter focuses on the nature of water allocation regimes that are designed to cope with adverse shifts in water supply, with changing input and product prices, with changing demands for water, and to facilitate adjustment through the adoption of new technologies and management approaches. In essence, we seek guidelines for the development of an allocation and associated administrative regime that is robust—robust in the sense that the regime can be described confidently as likely to withstand the test of time, no matter what climatic and economic future arrives. A robust allocation regime for a regulated river system is defined that first allocates water to enable the maintenance of functioning river sufficient to allow water to be extracted for use, then allocates the available water as unit shares between consumption and environment entitlements. A key feature is the need to give careful attention to water accounting arrangements to ensure hydrological integrity of the system and to arrangements that encourage smart and innovative management of environmental water.

Keywords: Water allocation; Climate change; Robust systems; Water accounting; Environmental entitlements; Water markets

1 Introduction

Change is an enduring process without beginning and end (McColl & Young, 2005). There is nothing more constant than change. Prices change, technologies change, populations change and they all want access to water. Moreover, in recent times, the challenge of coping with such pressures for change
and adjustment has been exacerbated by the emergence of the possibility that climatic regimes may change. The need to put in place arrangements to enable the water resource system to adapt and support itself no matter what the future may bring is becoming increasingly urgent. Irrigation could be expected to come and go, rivers and the associated environment must be expected to change, and the expectations and attitudes of communities and societies will also change.

Water users around the world and in Australia, in particular, are learning about the severity and speed with which adverse climate change can impact on water supplies. The top half of Figure 1 presents rainfall data from the weather station that best describe the sudden shift in rainfall that occurred in 1994 in the region that supplies Perth’s dams. The regime appears to have become drier, much drier. The bottom half of Figure 1 illustrates the dramatic impact that this drier regime has on stream inflow into the dams.

As a crude general rule, for every 1% reduction in mean rainfall there is at least a 3% reduction in stream inflow. Careful inspection of Figure 1 reveals that since 1974 this region has never received that which was thought from historical records to be its mean stream inflow.

Figure 1: Change in rainfall and inflows into water storages near Perth, Western Australia.
In fact, the situation can be worse than this, especially in regulated river systems that are used to convey water to users and facilitate navigation. In such systems, a relatively large proportion of water is needed simply to maintain the river in a regulated state. As a result, and as shown in Figure 2, when the mean amount of water flowing into a system is halved, the amount available for use can be reduced by two-thirds. Changes of this magnitude continue to surprise policy makers.

In this chapter, we focus on the nature of water allocation regimes that are designed to cope with adverse shifts in water supply, with changing input and product prices, with changing demands for water, and facilitate adjustment through the adoption of new technologies and management approaches. In essence, we seek guidelines for the development of an allocation and associated administrative regime that is robust—robust in the sense that the regime can be described confidently as likely to withstand the test of time, no matter what climatic and economic future arrives (Young & McColl, 2005).

2 Outcomes, principles and concepts

The outcomes sought are a suite of arrangements that will maintain the health of a river and the communities that depend on them. One of the main features of robust systems is that they facilitate autonomous adjustment as and when change occurs.

Robust systems have a demonstrated ability to recover gracefully from the whole range of exceptional inputs and situations in a given environment. They tend to be one step below bulletproof. They endure without the need to change

Figure 2: Illustration of the impact of a shift to a drier regime on the amount of water that can be made available for use in a regulated river system.
their foundations. They inspire confidence and are capable of producing efficient, politically acceptable outcomes in an ever-changing world.

Robustness is a concept that has received little attention in the literature. When searching for guidelines to assist with the design of robust allocation systems, however, several Nobel Prize-winning principles are worth careful consideration (Young & McColl, 2002).

The first of these principles is the Tinbergen principle which observes that if we are interested in dynamically efficient resource use through time, at least as many instruments should be used as there are objectives. That is, we should never try to use the same instrument to achieve, for example, both equity and efficiency in resource use. In Australia, appreciation of the importance of this concept has resulted in the unbundling of most water entitlements. In such a system, the arrangements used to define water entitlements are kept separate from those used to define allocations and both of these are kept separate from those used to manage the environmental impacts associated with the application of water on land. In the most sophisticated of these systems, separate instruments are also used to manage water delivery and salinity.

A related but equally important concept is Mundell’s assignment principle which requires that each instrument be assigned to the objective where it generates the most leverage and that once assigned to that objective the instrument not be used to help achieve any other objective. In Australia’s River Murray system, for example, allocations—the amount of water that an entitlement holder may use in any one period—are managed separately from the entitlement—the instrument used to define each entitlement holder’s share of the any water likely to be made available for use. Allocation policy is used to enable efficient resource use and entitlements used to ensure that the allocation processes used are equitable.

A third concept of equal importance is the Coase theorem which stresses the importance of keeping market transaction costs to a minimum so that adjustment is possible in a timely manner and all participants in a water allocation system are able to negotiate with one another. If the cost of trading seasonal allocations is low and trades can be completed quickly, then water use will be much more efficient than it otherwise would be.

3 Defining a robust allocation regime for a regulated river system

For any river system, it is common to begin by stating that the first allocation priority should be to allocate water to the environment. In practice, we think this approach is inadequate in that it fails to differentiate between the water needed to maintain a functioning river and that needed to enable water to flow periodically over a bank and into the surrounding landscape. The first priority should be the allocation of sufficient water to support the maintenance of a regulated river at
the minimum level required to enable water to be extracted for any use, including the over-bank environment.

As summarised in Figure 3, we propose that the next tranche of water should be shared between consumptive users and the environment. Differing from convention, we recommend this approach because it ensures that the environment always gets some water. With formal shares issued to this environment water and defined in the same manner as for consumption, it is administratively impossible to allocate water to consumptive water users without allocating some water to the environment for use beyond the river.

The third and last tranche of water is floodwater. As a general rule, formal entitlements to floodwater should not be issued. The main reason for this is to ensure that no one is liable for the damage caused by floodwater.

When assigning entitlements to water in the shared tranche, we like to describe this tranche as a variable pool of water. Drawing on the well-established and well-tested mechanisms used to define ownership in companies, entitlements should be defined as unit shares rather than proportional shares. The main reason is that this makes it possible to surrender shares and to move shares from one system to another without having to change every share in the share register. In essence, the entitlement regime should be fully specified in the sense that the sum of all entitlements to water that is available for sharing totals 100%.

Figure 3: A robust water allocation regime. The first priority is to allocate the minimum amount of water necessary to maintain the system. The second priority is to allocate water to the environment for over-bank use and to consumptive users.
4 System bulk allocations

When designing a water allocation regime, it is important to differentiate between the bulk allocation rules designed to manage allocations at the system level and those designed to manage use by individuals.

The simplest bulk allocation system that one can imagine establishes a single entitlement pool and allocates unit shares to those interested in holding an entitlement to access any water allocated to that pool. If the costs of trading entitlement shares and/or allocations made to shareholders are zero, this will produce efficient water use. In practice, however, adjustment costs exist and in most systems it is more efficient to partition the shared water pool into a number of priority classes.

Usually, the highest priority entitlement pool is given to providing water for critical human needs, and then one or more entitlement pools of varying reliability are established.

In the River Murray system, for example, special rules have been put in place to ensure that once conveyance or minimum maintenance water requirements have been met, the next priority is to supply the minimum amount of water needed to meet critical human needs. Once critical human needs have been met, two bulk entitlement pools are normally established—a high security pool and a general and lower security pool. The general rule is that the maximum volume that may be assigned to the high security pool is defined and once this volume has been assigned to that pool and allocations made to high security entitlement holders, allocations are then made to those who hold shares in general and low security pools.

In the more sophisticated systems, arrangements are now being put in place to ensure that the high security pool is climate change adjusted so that all water users receive an early warning about shifts in water availability. Advocating this approach, Young and McColl propose that the volume of the high security pool should be adjusted using a long-run moving average of inflows into the system (Young & McColl, 2008a).

As mentioned earlier, it is necessary to differentiate between water needed to cover evaporative and in-stream losses and that needed for over-bank purposes. In many management systems, this water is simply described as environmental water. In practice, however, the two types of water are quite different and it is misleading to describe them using the same term. In regulated river systems, in-stream water is needed by all consumptive users so that water can be conveyed to them. We call this water “maintenance water”. In Australia’s Murray–Darling System, this is now being described as conveyance water.

An interesting new policy development has been a recent change in the way it is planned to define the environment’s right to access shared water. Australian water legislation typically has stated that the environment should have first claim to any water allocations and once this need has been met, the remaining
water may be allocated. In practice, however, this approach has not worked. As a result, governments are now moving to a regime where entitlements to water for over-bank and other non-conveyance purposes is being defined by issuing the environment with a formal entitlement to a share of the water allocated to each security pool. In fully or over-allocated systems, the approach taken is purchase entitlements from existing users and transfer ownership to an environmental water holder. In the Murray–Darling Basin, for example, A$3.1 billion has been allocated for the purchase of water entitlements and A$5.8 billion for investment in water savings projects that will enable the transfer of existing entitlements to a Commonwealth Environmental Water Holder (Water Act, Parliament of Australia). It is proposed that this program will be implemented over the 10 years to 2016/17.

5 Individual interests

Having established a framework for the system bulk allocation regime, we can now turn to the nature of arrangements necessary to ensure that individual water use is efficient, that allocations are equitable and that the arrangements can cope with sudden as well as gradual changes. Young and McColl have argued the case for the definition of all entitlements using unit shares recorded on a central register (Young & McColl, 2005; 2002).

The case for issuing shares rather than volumetric entitlements is predicated primarily on the need to make it clear that investment in water use is risky and that there can be no guarantee that a specific volume of water will always be available. Sharing systems also put in place a suite of arrangements that make it clear how the available water is to be shared. In essence, the requirement is that allocations be made to a defined pool and every shareholder is then entitled on a pro-rata basis to a proportion of those allocations to the pool. No guarantee is made about reliability.

As stated earlier, it is important that shares are defined as unit rather than proportional shares so that additional shares may be issued and shares transferred to another part of the system without the need to change every share in the system whenever, for example, administrative boundaries are changed or investments that increase water availability are made.

Similarly, administrative efficiency can be increased by establishing and using a share register to define ownership. In these systems, the register defines who owns what. The transfer of ownership from one person to another is then implemented by contracting to change the register. This Torrens title system or property registration, as it is called, is much more reliable than any system that defines ownership by issuing a certificate. When a share register is used to define entitlement, arrangements that allow the registration of mortgages, etc. are easily added to the system. The entire system can be managed electronically and efficient settlement procedures established.
6 Water accounting

One of the key features of any robust water entitlement and allocation system is the need to give careful attention to water accounting arrangements that ensure that all transactions and allocation arrangements have hydrological integrity. Allocation systems that have hydrological integrity are characterised by the fact that allocation policies take full account of system interconnectivity—especially ground–surface water interconnectivity, processes that intercept flows which otherwise would have reached the river, and water use practice changes that reduce the return of “inefficiently” used water to the river system. The essential rule is that whenever one person or process is allowed to take more water, someone else in the system understands that as a result of this action they will have to take less water (Young & McColl, 2003).

The most common error in Australian water accounting has been the failure to properly account for return flows and to define entitlements in gross rather than net terms. Under a gross entitlement allocation system, increases in water use efficiency reduce return flows to the system (Young & McColl, 2003; Crase, 2008). Under a gross allocation system, an entitlement holder can improve the efficiency of water use and, by reducing the volume of water that is returned to the system, increase the total volume of water they use, and decrease the volume available for others to use. In contrast, net entitlement systems only allow water users to keep real savings that result from a reduction in the volume of water that has been returning to the system either via a surface drain or through accession to groundwater.

Robust water entitlement systems also have to account for connectivity between surface and groundwater systems. The first step in such a process is to define all water within a short distance of a river as river water rather than groundwater. Beyond that area, the entitlement regime needs to specify the relationship between the river and the groundwater system in a way that changes in one resource influence the management of the other. Taking this concept to its logical conclusion, Young and McColl recommend that groundwater entitlement systems that contribute to river flow be defined so that the river holds shares in the groundwater allocation system (Young & McColl, 2008b). The river should also be required to contribute a minimum volume of maintenance water to the groundwater system before any allocations are made to those who hold shares in the groundwater system. Where this cannot be done, an alternative equally robust approach is to require that groundwater depth be kept within a narrow range.

The reverse applies in the case of groundwater systems that gain water or are recharged by a river. In this case, robustness requires that the nature of this relationship be fully specified by allocating shares in the river system to the groundwater system.

7 Interception

A related accounting challenge is the question of how best to account for the interception of water before it reaches a river or storage. Examples of processes
that intercept water include the expansion of plantation forestry, the construction of farm dams and the construction of levy banks designed to prevent overland flows from reaching a river.

Conceptually, the impact of interception is similar to that of a shift to a drier climatic regime. This form of water use, however, can be managed, and if it is, investment will be more efficient than it otherwise would be (Young, 2009). To illustrate this point, consider the likely impact of the introduction of a carbon emissions trading scheme on water users. Stimulated by the opportunity to earn emissions trading permits, landholders have an incentive to plant trees and as a result decrease the amount of water available for use by irrigators. The plantation forestry sector gets access to water that irrigators were previously entitled to use. To manage this process, plantation forestry and all other forms of land-use change that intercept water need to be bought into the allocation system.

As the amount of water taken by most interception processes is not and cannot be metered, an alternative approach is needed to account for the impact of these processes. In recognition of the proposition that “it is better to be approximately right than comprehensively wrong”, Young and McColl (2009) recommend that an assessment be made of the expected long-term impact of an interception process, and interceptors be required to surrender entitlements whose expected water use would be the amount that is expected to be intercepted. Recognising that under such an arrangement, the interception process is protected from the adverse effects of climate change, they go on to recommend that the amount surrendered could include an adverse climate change premium.

8 Allocation management

In many systems, there is pressure on system managers to make allocations in a manner that gives confidence to water users. One of the more serious mistakes made in Australia in recent times was to assume that the supposed “drought” would end and it could not get worse. In the Murray–Darling Basin, for example, until very recently it was assumed that the minimum volume of water available for use would always be greater than the sum of the minimum inflow received in each month. As summarised in Table 1, in 2006/07 inflows into the River Murray system were less than the minimum monthly inflow for 11 months in succession with the result that allocations had to be reduced after they had been announced. As a result, it has now been decided to shift to a more robust arrangement that only allows allocations to be made when delivery can be guaranteed. The result is much more robust and makes it clear to users that they are responsible for managing supply risks and uncertainty.

9 Facilitating adjustment in an ever-changing world

A related issue is the question of how to proceed down the pathway of water reform in a way that facilitates change and adjustment in an ever-changing world. In a dramatic change to policy and as part of the development of a National...
Competition Policy in 1993/94, Australian governments agreed to separate water licences from land and make these licences—which became known as entitlements—tradable.

The first step in the process was to introduce arrangements to enable water licences or water rights to be held separately for land titles, thus enabling water to be traded separately from land. Having achieved that goal, as part of a National Water Initiative agreed in 2004, it was decided that to improve the efficiency of water trading arrangements, water licences, or water rights as irrigators prefer to call them, should be unbundled. Under such an arrangement, entitlements, allocations and permissions to apply water to land could be managed separately. Importantly, as part of these reforms and in the search for a more robust way to define entitlements, it was decided that entitlements should be defined as shares and that no implicit reliability guarantees should be given. It was also made clear that the responsibility for managing climatic risks and uncertainty should be assigned to entitlement holders and not to government.

In a similar manner, allocations are to be managed separately, and in the search for a robust management system, they are being registered on accounts which, like bank accounts, are accessible over the Internet. Under such an arrangement, whenever a trade occurs, one account is debited and simultaneously

Table 1: Recorded minimum inflows into the River Murray system before 2006/07 and in 2006/07.

<table>
<thead>
<tr>
<th>Months</th>
<th>Previous lowest monthly inflow before 2006</th>
<th>2006 inflow</th>
<th>Previous minimum inflow (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>110 GL in 1967</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td>July</td>
<td>150 GL in 1967</td>
<td>130</td>
<td>87</td>
</tr>
<tr>
<td>August</td>
<td>130 GL in 1902</td>
<td>100</td>
<td>77</td>
</tr>
<tr>
<td>Sept</td>
<td>180 GL in 1902</td>
<td>120</td>
<td>67</td>
</tr>
<tr>
<td>October</td>
<td>140 GL in 1914</td>
<td>80</td>
<td>57</td>
</tr>
<tr>
<td>November</td>
<td>60 GL in 1914</td>
<td>70</td>
<td>117</td>
</tr>
<tr>
<td>December</td>
<td>60 GL in 1982</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>January</td>
<td>50 GL in 1983</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>February</td>
<td>60 GL in 2003</td>
<td>50</td>
<td>83</td>
</tr>
<tr>
<td>March</td>
<td>50 GL in 1915</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>April</td>
<td>70 GL in 1923</td>
<td>40</td>
<td>57</td>
</tr>
<tr>
<td>May</td>
<td>80 GL in 1902</td>
<td>110</td>
<td>138</td>
</tr>
<tr>
<td>Total</td>
<td>1140</td>
<td>970</td>
<td></td>
</tr>
</tbody>
</table>

A Robust Framework for the Allocation of Water in an Ever-Changing World

Figure 4: Evolution of water reform in Australia and the progressive separation of water licences from, and subsequent unbundling into, separate components.

another account is credited. As illustrated in Figure 4, the third element of this unbundled arrangement is an approval to apply water to land which is usually subject to an array of local conditions.

Under such an arrangement, entitlement and allocation markets have rapidly emerged and grown in sophistication, efficiency and robustness.

In the early stages in the development of these markets, water allocations were only tradable within a season. In essence, the rule was to use it, or sell it, as you cannot save it (Young & McColl, 2007a). It soon became apparent, however, that if an efficient outcome is to be achieved then markets have to allow the management of water supply both within and between seasons (Brennan, 2007a; 2007b).

Having established these foundations for the development of entitlement markets and allocation markets, the last step in the development of efficient markets is to introduce a suite of rules that prevent markets from being used to protect water users from competition. Whilst progress has been slower than one would expect, it has now become clear that this requires a suite of arrangements that

- Assign ownership of entitlements to individual water users and not to irrigation districts so that any entitlement holder is free to choose whether to sell their entitlement either within or outside an irrigation district;
- Regulate the setting of fees and charges associated with supply and delivery contracts so that any person who decides to sell their water outside an irrigation district is not charged an inequitable fee for deciding to do this (ACCC, 2006; 2008);
- Require trades to be completed within a reasonable amount of time;
- Prevent districts from placing limits on the proportion of entitlements and/or the quantity of water that can be traded out of a district.
In summary, under a robust arrangement it should be possible for the application of trading rules and processes associated with trades to be completed instantaneously for allocation trades and within two days for unencumbered entitlement trades (Young & McColl, 2008a).

10 Managing environmental water

In the allocation system set out, we make a clear distinction between conveyance or maintenance water and water needed for the maintenance of the environment on either side of a river. Differing from conventional practice, we have recommended that this latter form of water be defined in exactly the same way as all other shared water entitlements are defined. Under such an allocation regime, whenever an allocation is made to the shared water pool, some water must be allocated to the environment. Environmental managers must then decide whether to use this water, save it for future use or sell it in the market for allocation water.

In passing, we note that under such an arrangement the optimal environmental water management strategy may sometimes be to engage in what Australians describe as counter-cyclic trading. Counter-cyclic trading involves the sale of water to consumptive users in the peak of a dry period or a drought (long dry
period)—when prices are high. This money can then be used subsequently to buy back a lot more water when water is cheaper. According to Kirby et al. (2006), in a regime where supplies are variable, this can be an extremely profitable strategy for an environmental manager to pursue.

In large river systems, like Australia’s River Murray, one of the more interesting challenges to resolve is the question of whether to assign environmental entitlements to regional environmental management trusts or to hold these titles centrally. Having considered the question, we conclude that the most robust approach is a mixed one. A considerable proportion, say 70%, can be assigned to regional trusts and a much smaller amount needs to be held centrally to enable the pursuit of systemwide opportunities at the margin. This approach to the assignment of environmental water entitlements allows local catchment boards and communities to plan and manage with confidence. It can also be expected to encourage the development of smart and innovative environmental water managers.

11 Concluding comment

At the start of this chapter, we set out to specify the main characteristics of a water entitlement and allocation regime that could be confidently described as robust—robust in the sense that the regime could be expected to withstand the test of time and not require modification as conditions change. We emphasise that the need is to put in place arrangements to enable the water resource system to adapt and support itself no matter what the future may bring is becoming increasingly urgent. Irrigation could be expected to come and go, rivers and the associated environment must be expected to change and the expectations and attitudes of communities and societies will also change.

One of the main features of the model proposed is that regime gives first allocation to maintenance of the river, but not the over-bank watering priorities. In recognition that governments, while willing to commit to giving first priority to the environment, are not willing to do so when the system is under pressure, a much more secure sharing approach is recommended. Under such a regime, the property right is fully specified and commitments to make a proportion of water available for the environment must be honoured. As would happen in a natural system, if the system gets drier, the environment gets less water.

References


Water Act 2007 (as amended), Parliament of Australia.