

# Defining Tradable Water Entitlements and Allocations: A Robust System

Mike Young and Jim McColl

**Abstract:** Robust systems are characterized by a capacity to recover gracefully from the whole range of exceptional inputs and situations in a given environment. They have a connotation of elegance. This paper will highlight the importance of separating the different elements of any tradable property entitlement and allocation system into its component parts. The result is a constellation of institutional arrangements that can be expected to last, to withstand the test of time. Often, considerable reform is required to put in place robust systems. Using examples from Australia, this paper will highlight the importance of sequencing implementation of the reforms necessary to put robust systems in place. Robustness is achieved by using three instruments rather than one instrument to allocate water and control use, and coupling these three instruments with three separate planning instruments.

**Résumé :** Les systèmes robustes se caractérisent par la capacité de se remettre progressivement d'un éventail complet de situations et d'entrées exceptionnelles dans un contexte donné. Ils possèdent une connotation d'élégance. La présente communication soulignera l'importance de la division, en parties constituantes, des différents éléments de tout droit de propriété négociable et du système de répartition. Il en résulte une constellation d'arrangements institutionnels qui en temps normal devraient s'avérer durables et résister à l'épreuve du temps. Souvent, la mise en place de systèmes robustes demande des réformes considérables. S'appuyant sur des exemples de l'Australie, cette communication fera ressortir l'importance de la mise en séquence de l'adoption des réformes nécessaires à la mise en place des systèmes robustes. La robustesse s'obtient grâce au recours à trois instruments plutôt qu'à un seul instrument pour l'affectation des ressources en eau et pour le contrôle de l'utilisation de l'eau, et par le couplage de ces trois instruments avec trois instruments de planification distincts.

## Introduction

Tradable permit and allocation systems, and other market-based instruments, are being used around the world to help deliver environmental and natural

resource policy outcomes at less cost than has previously been the case. The focus of this paper is not on the case for and against the use of these instruments. Rather, it is about the design of such instruments to deliver maximum benefits:

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- across heterogeneous landscapes;
- through time as circumstances change; and
- when several “objectives” are being pursued and several “problems” are being managed simultaneously.

Essentially, the paper aims to set out the design characteristics of tradable permit and allocation systems that will deliver maximum benefits and are likely to stand the test of time because their foundations are robust. Although these robust systems apply to all forms of resource use, this paper focuses on water management issues, such as climate change, land-use change, groundwater connectivity, and the need to promote investment; issues that conventional systems find difficult to deal with.

## Robustness

Robustness is defined in the jargon dictionary as a system that has “demonstrated an ability to recover gracefully from the whole range of exceptional inputs and situations in a given environment.” The dictionary goes on to observe that robust systems are one step below bulletproof, and that they carry “the additional connotation of elegance in addition to just careful attention to detail” (Anon., 1992).

Robust systems endure without the need to change the foundations upon which they are built. They inspire confidence. They persist, are adaptable and can stand the test of time (Young and McColl, 2003a). Reform or revision of them is not normally on any political agenda. They have an architecture that can be expected to produce efficient and politically acceptable outcomes in an ever-changing world (Jen, 2003).

## Language

The first observation made is that, at least in Australia, it is wiser to describe such water systems as tradable permit, entitlement or allocation systems and not describe them as tradable property right systems. The words “property rights” have different connotations in different audiences and disciplines. Communication is easier if one uses terms that have the same meaning to

all involved in a discussion. In most cases, the debate is really about the nature of peoples’ “interests” in a resource or an “opportunity”.

The second observation is that greater progress is possible if such instruments are described as *market-based* rather than *economic* instruments. The key characteristic of market-based instruments is that they involve buying and selling. The establishment of such a trading market, however, is heavily dependent upon complex legislative and administrative arrangements. Often, instrument design also relies on a considerable amount of ecological science. When one replaces the word “economic” with the word “market”, lawyers, ecologists and other professionals do not feel disenfranchised. After all, these instruments are as much legal as they are economic.

While these observations may seem trivial, it is this attention to detail that often makes the difference between consignment of a proposition to academic libraries or adoption and use in the real world.

## Two Principles and a Theorem

The critical building blocks for the design of the robust instruments of natural resource and environmental management consists of two principles and a theorem.

### *The Tinbergen Principle*

Tinbergen was able to show that there is a need for at least as many instruments of control as there are goals or important dimensions to a problem. Jan Tinbergen was awarded the Nobel Prize in Economics (1959) partly for developing this concept (Tinbergen, 1952).

The Tinbergen Principle is usually talked about by those interested in macro-economic policy. A separate instrument must be used to address each policy goal, objective or target. The Tinbergen Principle suggests that the answers to the design of tradable property entitlement, allocation and resource use management systems lie more with robust separation arrangements than they do with the development of integrated (fuzzy) natural resource management systems (Young and McColl, 2002; 2003c).

If a system is to be robust in the sense that it will withstand the test of time, it must be Tinbergen consistent. That is, there must be as many instruments of control as there are important dimensions to a

problem. Another way of expressing this important concept is to state that “the variables in any workable solution must match the number in the problem” (Krehm, 2001).

### ***Mundell’s Assignment Principle***

The second principle of particular relevance to the design of tradable entitlement and allocation systems is Mundell’s principle of effective market classification. Developed by Robert Mundell — another Nobel Prize winning economist (1999) — this principle states that if outcomes are to remain optimal through time, instruments need to be paired with the objectives “on which they have the most influence”. If this is not followed, there will develop a tendency either for a cyclical approach to equilibrium or for instability (Mundell, 1960; 1962). Mundell’s principle is perhaps more effectively described as an “assignment principle”.

### ***The Coase Theorem***

The third building block in the development of a robust entitlement, allocation and management system comes from another Nobel Laureate (1991), Robert Coase. The much debated Coase Theorem stipulates that if the transaction costs associated with the transfer of property from one person to another are very low, or effectively zero, then an efficient outcome can be achieved irrespective of the initial distribution. The clue from this theorem is that it is very important to design a system so that the transaction costs of trading are very low. If the constellation of instruments used to deliver trade-offs involves low transaction costs then they should be able to produce dynamically optimal outcomes as values, costs, technology and understanding change. The lower the cost of each adjustment (each transaction) the greater the probability that the system will prove to be robust.

### **Management Goals, Objectives and Targets**

Goals or objectives typically associated with almost any natural resource management or environmental problem include:

- Distributive Equity – arguments about how the cake should be cut up and distributed among people;
- Economic Efficiency – arguments about how to enable exchange so that the opportunities created produce the greatest quantity of market benefits for distribution according to rules developed elsewhere; and
- Management of externalities – arguments about how to manage the impacts of resource use on those people not involved directly in the transaction or the activity that causes these impacts.

### ***Instrument Design***

The Tinbergen Principle requires that there be a separate objective for each goal, objective or target. Thus, for “goals” or “problems” for which there are no externalities, commitment to robustness necessitates that there be, at least:

- A wealth management instrument associated with ensuring the equitable distribution of the benefits associated with the opportunity;
- An exchange instrument associated with attainment of efficient processes; and
- A third instrument enabling the management of any externalities.

As a general rule, there must be at least one set of these instruments for each significant natural resource management problem, especially when one is operating in an environment where the landscape is not homogeneous. The art lies in determining which objectives are significant enough to justify the use of a separate instrument to manage them and then arranging the detail so that minor problems can be dealt with efficiently.

To make matters more complicated, both individual irrigator and aggregate system irrigation impacts and issues need to be managed.

In summary, for many if not most natural resource and environmental management issues, robust allocation and management arrangement systems will involve the use of at least three instruments. To manage both individual and aggregate system impacts will require a minimum of two by three instruments (see Table 1).

**Table 1. Generalized framework for the selection and assignment of instruments for the management of natural resources.**

Scale	Policy Objective		
	Distributive Equity	Economic Efficiency	Externality Management
Individual	Entitlement	Access Allocations	Use licences
Total System	Water Allocation Plans	Trading Protocols	Catchment Plans

### Instrument Assignment

The next principle relevant to the design of robust instruments is Mundell's principle of effective market classification or assignment. Mundell's principle suggests that as well as paying attention to instrument separation, one must also assign (pair) instruments to issues for which they have the greatest leverage. For insights as to the most effective instrument assignment, Young and McColl (2002; 2003a; b; c) turn to history and experience. The essential test they propose is that the instrument must have withstood the test of time and be characterized by low transaction costs. Casting the net widely, they identify:

- the unit share structure used since 1862 to distribute entitlements among a group of people and the Torrens title system used to register entitlements and legal interests in them (Abbott, 2004) — assigned to distributive equity;

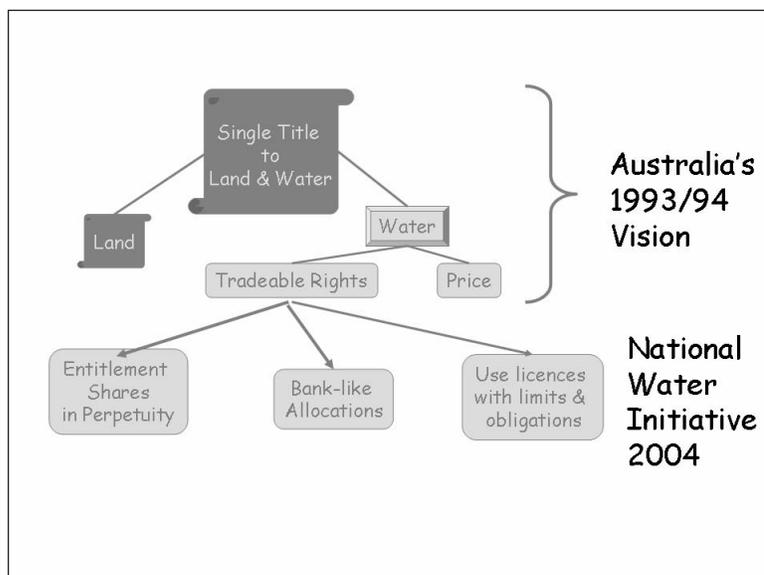
- the accounting system used by banks to track holding of money and the transfer among people — assigned to economic efficiency; and
- periodically-reviewable conditions on individual use licences as an effective way to manage externalities caused by site-specific actions — assigned to externality management.

The result is a three part structure that is quite different from the single licensing or permit systems in use in many countries (see Figure 1). Separate instruments are used to achieve each policy objective. The result is a structure that, because the attributes can be managed independently, can be expected to remain robust.

Clues to the detail necessary to ensure that each instrument is able to respond to changes as they occur come from a wide variety of sources and from the rich gallery of experiences derived from the analysis of the reasons why previous systems had to be changed (Young and McColl, 2002).

### Application to Water Resources Management

Applied to the management of water resources, the above framework reveals a series of policy recommendations now being developed in Australia.



**Figure 1. Generic elements of a robust entitlement, allocation and use management framework.**

On the recommendation of the Council of Australian Governments (COAG) in 1994, titles to land were to be separated from water entitlements and water allocations were to be supplied at full cost, including the cost of externalities (see Figure 1).

The unexpected result of implementing these 1994 reforms was the emergence of many new problems. Essentially, the existing licensing systems were not designed for exposure to market processes. In particular, the extent of water entitlement over-allocation became apparent and arrangements to deal with groundwater and surface water interconnectivity and the effects of water use efficiency and land use change were not in place (Murray-Darling Basin Ministerial Council, 2002). Water traded into some regions has resulted in environmental problems, and, in particular, significant salinity problems have emerged. Trading has also been accused of causing significant adverse economic and social impacts, although there is little available evidence to suggest that this may be the case. To address these problems, a system redesign based on a robust separation was clearly required (Young and McColl, 2002).

First, drawing on the experience of the way investors in companies define the size of their stake in a business, the system should involve the introduction of unit shares underpinned by registers organized so that interests in them can be recorded on an indefeasible register.

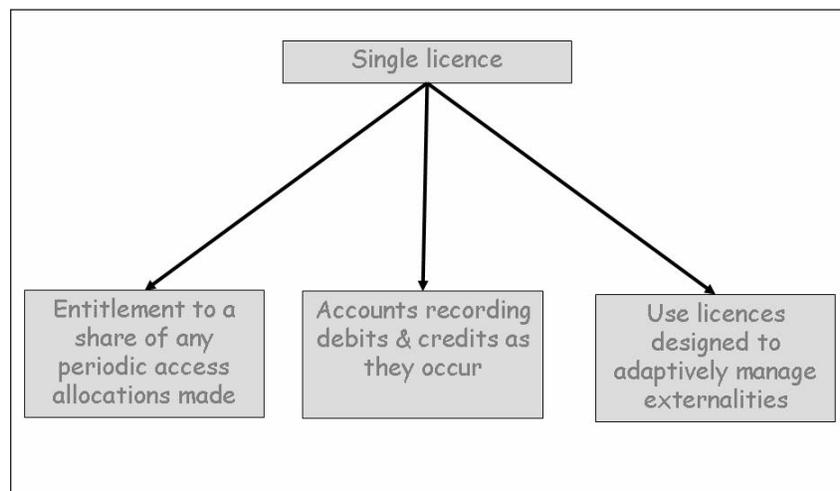
Second, under the above framework, entitlements provide a share of allocations made in proportion to the number of shares held. Casting the net for the most cost-effective way to manage allocations, one option is to use the accounting systems that banking systems around the world rely on. The key characteristic of these systems is that the cost of any single transaction is very low. One of the reasons for this is the simple accounting discipline that requires that for every credit there is a corresponding debit (see Figure 2).

The third element of any separated system is the design of instruments for the management of externalities. Classically, licences are used to define water entitlements and to manage the way this water is used. By using this single instrument to do both tasks, inefficient outcomes occur. Drawing upon the insights offered by Mundell's assignment principle, it can be

<b>Account Name: Aussie Irrigation</b>			
<b>Statement No: 24</b>			
<b>Date</b>		<b>Debit</b>	<b>Credit</b>
1/07/2001	Balance brought forward		400
1/09/2001	Periodic allocation 1000 shares translates to 2000 ML of water that may be consumed		2000
12/10/2001	Transfer from XYZ Pty Ltd Cheque No. 1234 5678		500
3/11/2001	Use from 1/9/01 to 1/11/01 (Pumped 1000 ML and deemed to have used 50%)	500	
3/11/2001	Transfer from AB&CD Smith @ 0.9 ML per ML from South Australia Electronic RN 9876543		300
30/04/2002	Use from 2/11/01 to 30/4/02 (Pumped 1320 ML and deemed to have used 50%)	660	
30/05/2002	Unused water not available for carry forward to 2002/03 season	420	
5/09/2002	Credit for removal of forested area 10ha at 1.5 ML per ha		15
5/09/2002	Debit for establishment of 50 ha of forest at 1.5 ML per ha	75	
			1560

**Figure 2. Example of a robust accounting system for the management and trade of water allocations.**

seen that use licence conditions are most appropriately assigned to externality management. The three essential building blocks for a robust management of water entitlements, allocations and use is summarized in Figure 3.



**Figure 3. A robust structure for the management of water entitlements, allocations and water use.**

Having separated licence components, a process is needed to enable the periodic revision of these conditions and other planning and regulatory arrangements. The main challenge is to find a fair and efficient way to conduct and complete reviews without discouraging investment. There is still considerable debate about the most effective way to conduct these reviews and when they should be conducted. The emerging view is that it is most efficient to allow water users time to plan for and adjust to a new set of conditions. When advance warning is given of a change, existing equipment and infrastructure can be replaced in an orderly manner. Announcing changes to be implemented say five to seven years later provides plenty of time for adjusting to the new regime.

It is also becoming apparent that the costs of periodic reviews and the uncertainty associated with them can be reduced by:

- conducting reviews on a regional basis and rotating them between regions so that the review process is predictable and users can see the nature of changes that are being phased in elsewhere; and

- providing for a secure review closure mechanism that requires advance warning of the nature of a proposed change and provides for the use of an independent arbiter if the review process is not finalized within, say, five years before the current arrangements expire.

### National Water Initiative

In response, and as a result of much of the research reported in this paper and other deliberations, Australia's leaders agreed to pursue a National Water Initiative (NWI) that will seek to "implement a robust framework for water access entitlements" (COAG, 2003).

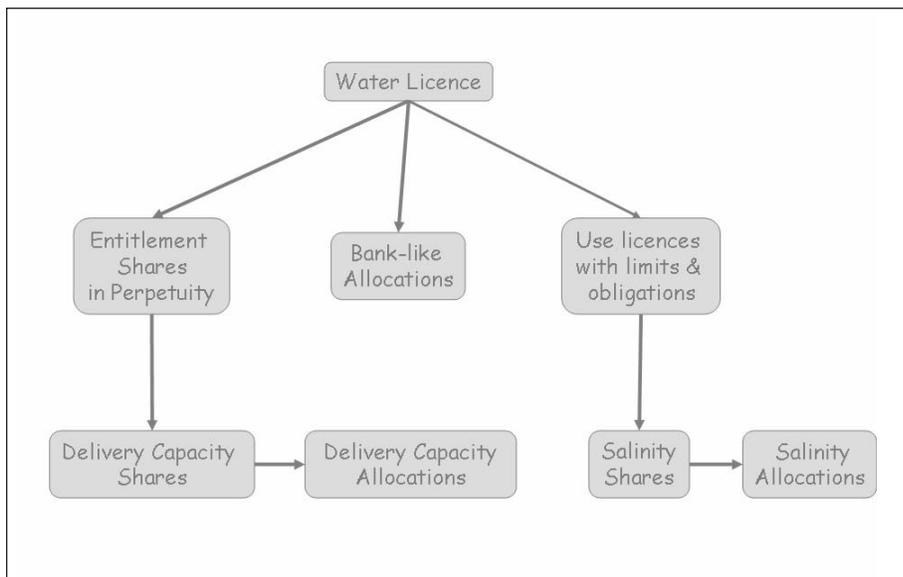
Subsequently (COAG, 2004), there has been agreement to a National Water Initiative (NWI) that contains actions to be implemented with "the objective of achieving a nationally compatible, market, regulatory

and planning-based system of managing surface water and groundwater resources for rural and urban use, that optimizes economic, social and environmental outcomes, and is able to adapt to future changes in the supply and demand for water".

This new framework defines water access entitlements as providing perpetual access to a unit share of a defined water resource, and specifies and assigns risk between water users and governments. Robust registry and accounting systems that take full account of the water cycle and of hydrological processes are to be established. These will take into account interactions between surface water and groundwater systems, and the effects of significant land-use changes, such as forestry, that can decrease the quantity of water otherwise available to water users. In addition, regulatory approvals enabling water use at a particular site for a particular purpose will be specified separately to the water access entitlement. A key feature of such systems are mechanisms in water allocation plans, trading protocols and catchment plans that encourage periodic review of deeming rates, exchange rates and

assessments of the impacts of land use changes (see Figure 3).

There is also interest in setting up the system in a manner that will enable the introduction of separate entitlement and allocation systems to allow people to trade in peak demand period delivery capacity and to also enable salinity entitlement and allocation trading. If all these foreshadowed policy changes occur then a framework similar to that set out in Figure 4 could emerge.



**Figure 4. A separated system designed to enable independent management of salinity and delivery capacity in peak demand periods.**

**Sequencing**

The final issue for this paper to consider is the question of the sequencing of any reforms. The transition from a standard water allocation and use control system to a robust one can involve many complex processes and it can be tempting to implement the easiest ones first. This, however, may not be the wisest choice of action, especially if market-based processes are to be used and if the available resource is over-allocated. In such cases, implementation in the wrong order is likely to increase the costs of adjustment.

As a general rule, those reforms that add the greatest value should be implemented last and only after over-allocation issues have been resolved. Reforms likely to add value include definition of entitlements as

perpetual shares and the guarantee of an entitlement register. Consideration of these issues has led Young and McColl (2003a) to recommend that reforms begin with the introduction of robust bank like accounting arrangements for allocations and arrangements to manage hydrological interactions well before unit share access entitlements are introduced and entitlement registers guaranteed. In particular, land-use impacts on water yield need to be managed, ground and surface water interactions need to be accounted for, and the impact of increases in water use efficiency on the quantity of water available to others needs to be built into the system.

**Concluding Comments**

Australian and other experience reveals the likely benefits of building a robust entitlement system from the outset. Moreover, the administrative costs of building a robust entitlement, allocation and use management system are not significantly more than the costs of starting with a less sophisticated system.

The main costs of establishing any system are determined by the number of water users not how many pieces of paper are issued and the detail associated with each entry. In the longer run, if a robust system is put in place, further costly reform and adjustment will not be necessary. If a government implements a separated system, then many such problems can be avoided and the long-term costs to industry and the environment avoided. The approach is also particularly relevant for those interested in setting up emission trading systems, forest harvesting systems, fish harvesting systems, etc.

In any environment where there is uncertainty and these uncertainties cannot be avoided, entitlements should be defined as shares and periodic allocations made in proportion to the number of shares held. If the transaction costs associated with allocation trading are low, then almost all efficiency benefits can be

secured through the use of robust accounting practices. Conceptually, most of the remaining efficiency gains can be realized through the introduction of arrangements for the efficient management of externalities.

## Acknowledgements

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## References

- Anon. 1992. *The Hackers' Dictionary of Computer Jargon*. <http://www.worldwideschool.org/library/books/tech/computers/TheHackersDictionaryofComputerJargon/chap44.html>.
- Abbott, D. 2004. *Encyclopedia of Real Estate Terms*. Delta Alpha, London.
- Council of Australian Governments. 1994. "Water Resources Policy." *Communiqué*, February 1994.
- Council of Australian Governments. 2003. "National Water Initiative Water Resources Policy." *Communiqué*, August 2003.
- Council of Australian Governments. 2004. "National Water Initiative." *Communiqué*, June 2004.
- Jen, Erica. 2003. "Stable or Robust? What's the Difference?" Working Paper, Santa Fe Institute, Santa Fe.
- Krehm, W. 2001. *The Other Lower Manhattan Disaster: A Policy Kit for the Cleanup*. <http://www.comer.org/Manhattan.htm>.
- Mundell, R.A. 1960. "The Monetary Dynamics of International Adjustment under Fixed and Flexible Exchange Rates." *Quart. Jour. Econ.*, 74: 227-257.
- Mundell, R.A. 1962. *The Appropriate Use of Monetary and Fiscal Policy for Internal and External Stability*. International Monetary Fund Staff Paper.
- Murray-Darling Basin Ministerial Council. 2002. *The Living Murray: A Discussion Paper on Restoring Health of the River Murray*. Murray-Darling Basin Commission, Canberra.
- Tinbergen, J. 1952. *On the Theory of Economic Policy*. Amsterdam, North Holland.
- Young, M.D. and J.C. McColl. 2002. "Robust Separation: A Search for a Generic Framework to Simplify Registration and Trading of Interests in Natural Resources." CSIRO Land and Water, Adelaide, Australia.
- Young, M.D. and J.C. McColl. 2003a. "Robust Reform. The Case for a New Water Entitlement System for Australia." *Australian Economic Review*, 36(2): 225-34.
- Young, M.D. and J.C. McColl. 2003b. "Robust Reform: Implementing Robust Institutional Arrangements to Achieve Efficient Water Use in Australia." *CSIRO Land and Water*, Adelaide, Australia.
- Young, M.D. and J.C. McColl. 2003c. "Robust Separation: A Search for a Generic Framework to Simplify Registration and Trading of Interests in Natural Resources." *Agricultural Science*, 15(1): 17-22.