# Water reform, property rights and hydrological realities

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## Abstract

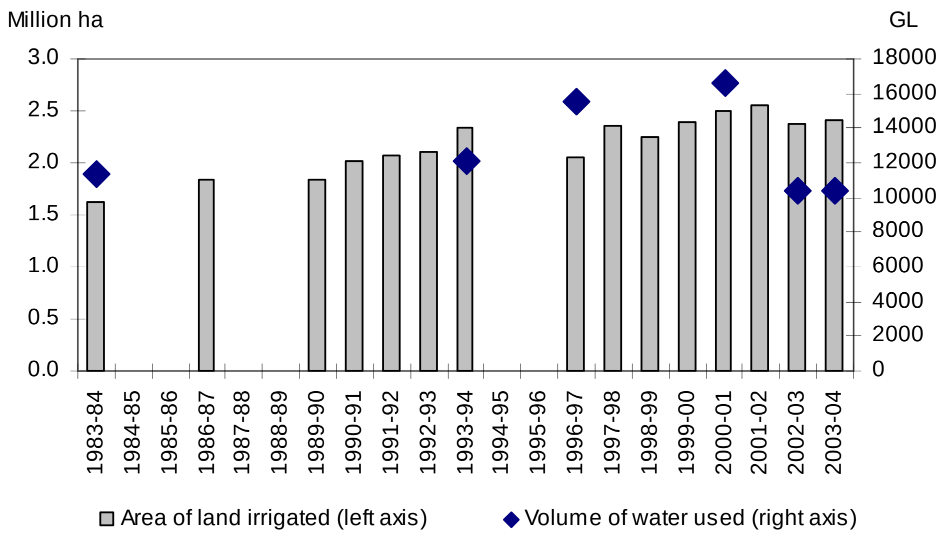
Water reform has led to important improvements in how water is used, with net gains for society as a whole. More flexible water trade arrangements, for example, are enabling irrigation water to move to higher value uses at the margin and making the opportunity costs of use more transparent. Greater recognition is also being given to the environmental consequences of water allocations and patterns of use; more efficient mechanisms for addressing these externalities are evolving. However, water reform has been compartmentalised; some water resources and users are the focus of more robust and effective reform than others. In particular, property rights arrangements for water resources and users are such that it has been very difficult to implement effective reform without affecting the water availability of other users. Consequently, water reform has not yet been as beneficial as it could be — while there is much to celebrate, there is still much to be done. Greater recognition needs to be given to the distributional and efficiency consequences of the current property right arrangements. Further clarification and reform of property rights, for example, will be needed to better reflect hydrological realities and the integrated nature of water resources and use. This will raise important equity questions and require careful consideration of the definition and extent of property rights for water.

## Introduction

Water reform is part of a broader suite of microeconomic reforms that have brought significant changes to the Australian economic landscape. Since the mid 1990s, an increasing focus has been given to reforming rural water policies and management and, to a much lesser extent, the urban water sector. In 2004, this led to the establishment of the National Water Initiative (a joint agreement between the Australian government and jurisdictions). But we will argue that this is not the endgame – a good start but Australia still has some way to go in water policy reform.

Recent water reform has coincided with generally drier climatic conditions, particularly in eastern Australia. Together with limits on surface water extractions and the adoption of markets where water property rights can be traded, this has led in some regions to increases in the demand for irrigation water and increases in the area of land irrigated (for reasons behind this see Appels Douglas and Dwyer 2005) (figure 1).

Figure 1 **Water use in agriculture and irrigated land areas1983-84 to 2003-04**[a]




[a] Data on the quantity of water applied or used are collected on an opportunistic basis. Estimates prior to 2002–03 are generally based on reported areas irrigated and average application rates. These estimates may therefore overstate extracted water use in high rainfall years and understate extracted water use in low rainfall years. Estimates for water use in 2002–03 and 2003–04 do not include use of water on farms for purposes other than irrigation (eg the cleaning of dairy sheds).

*Data source:* ABS and Productivity Commission 2006

While water reform has brought economic benefits, it has also resulted in tradeoffs and costs that aren't always readily apparent. There are important distributional consequences to the reforms that have been undertaken to date. There are also likely to be some efficiency losses due to effects on third parties. Heaney et al. (2006), for example, identified some of the key third-party effects associated with water trade including effects on supply reliability, timeliness of delivery and water quality. Over and above water trade, there are also likely to be other third-party effects where water use by one party affects water use of another. This is because while many water resources are hydrologically linked and substitutable, the application of markets has been largely compartmentalised to certain water resources and specific users. Some water sources and users have not been fully incorporated into water markets because of poorly specified property rights. Some consequences of this are readily observable in relatively short time frames, while some impacts (perhaps even more serious) are yet to be felt.

## Factors affecting water availability — ‘risks to shared resources’

A number of factors are eroding the longer-term availability of water in streams. These factors undermine efforts to achieve environmental objectives and to improve the efficiency of water markets and, in some cases, affect the availability and reliability of water for other uses.

The most significant factors (sometimes referred to as ‘risks to shared resources’) that may diminish water availability in rivers over the longer-term include:

- climate change that reduces rainfall and increases evaporation;
- groundwater extractions;
- farm dams and interception of overland flows;
- land-use change (including afforestation, revegetation after bushfires , and even hobby farmers allowing grazing lands to revert to trees); and
- changes to irrigation water management and return flows.

van Dijk et al. (2006) examined such factors for the Murray–Darling Basin, but most of these effects will also occur in other regions. Others, such as broader land management may be more important locally. The effects of native vegetation management and cropping practices on dryland farms in response to changes in climate and commodity markets, for example, may be a significant issue in some catchments.

John Scanlon (an MDBC Commissioner) has argued that the management of ‘surplus’ or unregulated flows is a significant additional factor to the ‘risks to shared resources’ identified by van Dijk et al. (2006). Pressure on these unregulated flows has increased over time as other components of the water system have increasingly been brought within the regulatory framework. The Independent Audit Group (IAG 2006) noted that altered surplus flows was the most significant risk to the achievement of the overall objectives of The Living Murray.

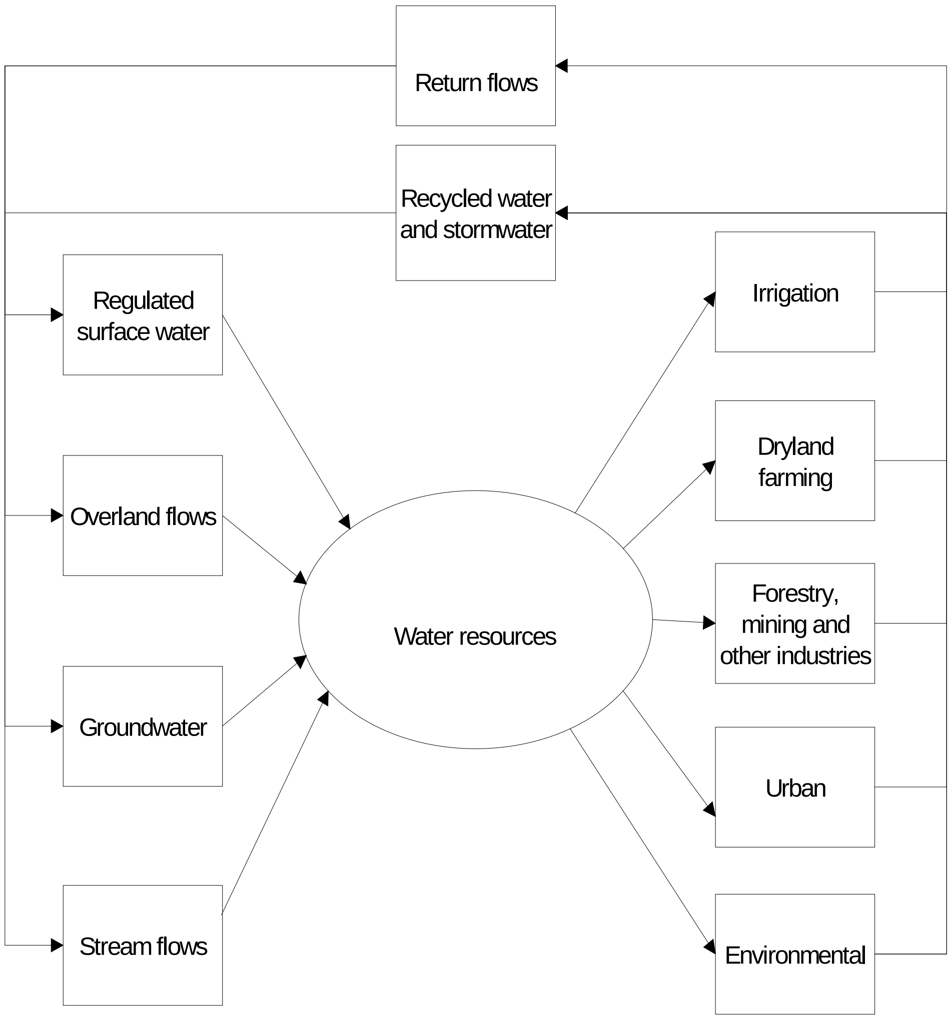
Some of the reductions in water availability for environmental purposes occur because of increases in water used by others, such as owners of tree plantations, groundwater bores and farm dams. Other reductions, such as those due to climate change, occur because of reduced rainfall and increased evaporation. In connected hydrological systems, the consumption of water by one user ultimately affects the availability of water to another (box 1, figure 2).

Box 1 **Integrated nature of water resources**

Irrigators and other rural water users rely on a number of water sources to supplement rainfall, including surface water (stored and distributed via natural and constructed infrastructure), groundwater, and to a lesser extent, reuse (or recycled) water. These water sources are supplied to the user either though self-extraction or via mains water supply (also extracted from the environment). About 82 per cent of extracted water is sourced from surface water stocks across Australia, while the remaining 18 per cent comes from groundwater stocks (NAPSWQ 2001). The relative dependence on groundwater and surface water differs between states and territories. For example, Western Australia and the Northern Territory rely predominantly on groundwater extractions while all other states and the ACT mostly use extracted surface water (NLWRA 2001).

The linkages between various water resources and water users are stylised in Figure 2.

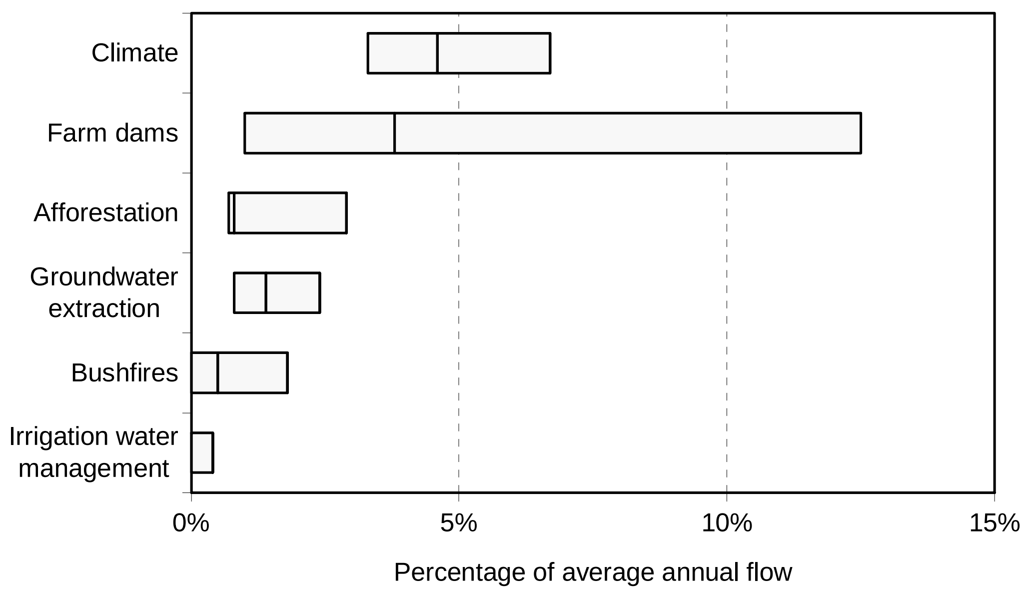
Figure 2 **Linkages between water users and water resources**




*Sources:* NAPSWQ 2001, NLWRA 2001

Recent estimates of potential reductions in average annual stream flow in the Murray–Darling Basin due to each factor are summarised in figure 3. A primary concern resulting from potential changes in water availability due to these factors is the reduced water flows to achieve environmental objectives. However, the factors might not only affect water volumes but also water quality. The impact of these factors on river salinity, for example, is the net result of changes in salt mobilisation and changes in stream flow. If farm dams intercept fresh overland flows, they may increase stream salinity (van Dijk et al. 2006).

Figure 3 **Estimated potential reductions in stream flows in the Murray–Darling Basin by 2020 due to six 'risk' factors**[a]




**a** van Dijk et al. note that these estimates are not forgone conclusions', and that 'understanding of how the risks might impact upon the Basin is by no means complete' (van Dijk et al. 2006, p. 6). The estimates are not additive and the total reduction in water availability is likely to be less than the sum due complex interlinkages between the factors. The estimates for each factor are presented as a possible range with a 'best estimate' intersecting the range. Van Dijk et al. note that '[i]n most cases, a rather wide range of estimates has been derived in different studies, for different assumptions, and for different levels of likelihood. For example, the range shown for farm dams probably covers the entire possible range of impacts, whereas that for bushfires shows the likely range'. (van Dijk et al. 2006, p. 37).

*Source:* van Dijk et al. 2006.

Many of the factors are already having impacts on water availability, but it is crucial for policy responses to recognise the importance of lags. Some of these effects are likely to become a pressing problem in the coming year or two as water scarcity increases due to the abnormally dry winter and spring in eastern Australia. However, it is imperative to also seek longer-term solutions, and recognise that while short-term and long-term problems are both vexing, the solutions could look very different. Our short-term ‘crisis management’ must be consistent with, and work towards, long-term solutions rather than exacerbate the problems.

## The role of property rights

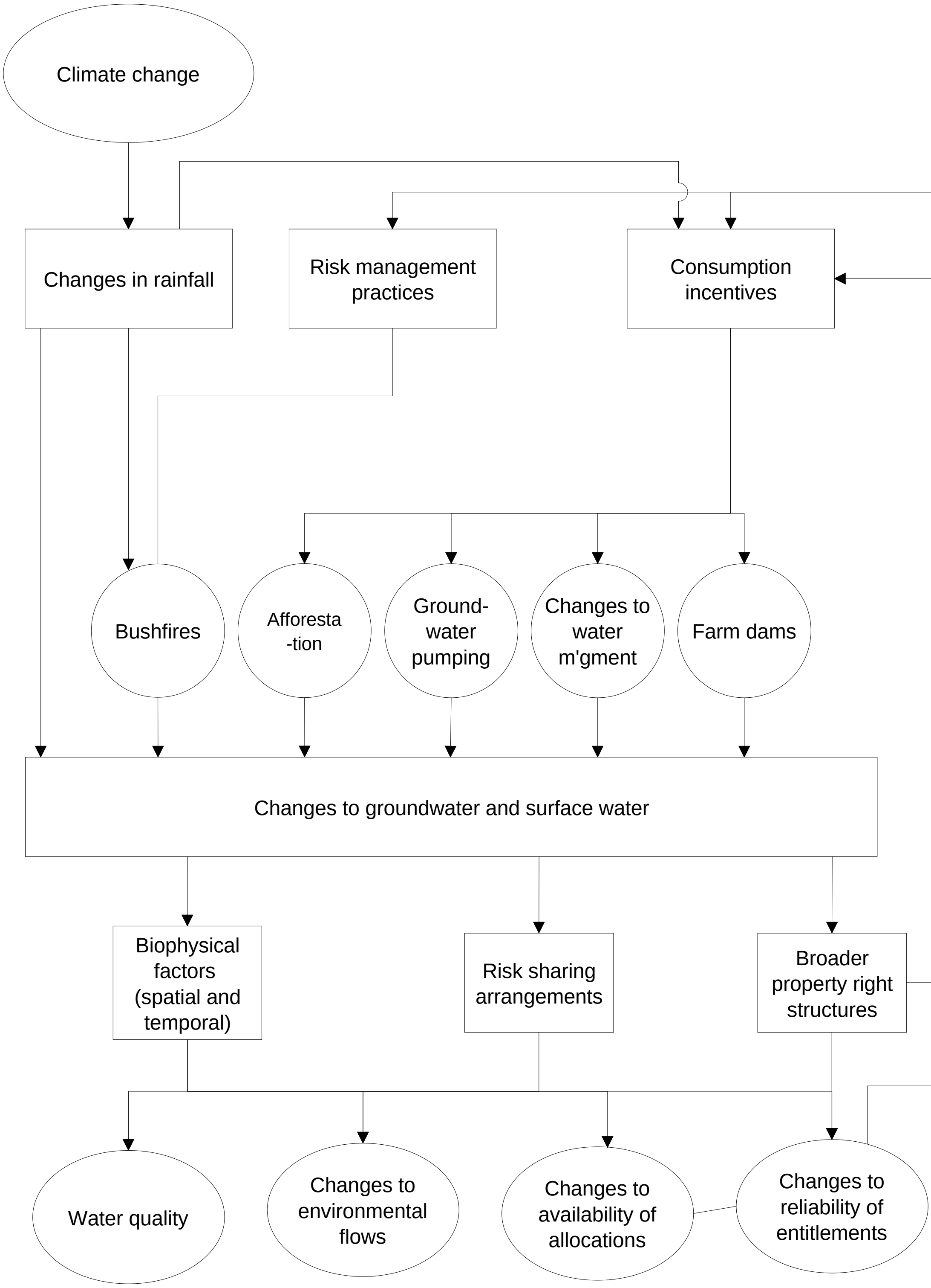
Property rights are a key driver of land-use changes and reactions to changes in climatic conditions. Property rights will influence the choices available to water users and the extent to which the impacts of water use on third parties will be taken into account. The action taken to limit water extracted through groundwater bores and intercepted by farm dams, for example, in order to protect the integrity of the system and water security/reliability for other uses and the environment, will impinge on some landholders’ rights in order to protect others’.

Some of the interrelationships between the key factors reducing water availability, and property rights are introduced in figure 4. Property right specifications can have efficiency and distributional implications for the availability of water for some entitlement holders. The significance of these threats to water availability, and the appropriate policy response, will vary within and across catchments.

Climate change is the only factor affecting total water availability that is effectively exogenous to (outside the influence of) those making decisions related to water and on land management in the irrigation areas and in the catchments that are the source of their water. There are complex interrelationships between the endogenous factors — some of them mutually reinforcing. Increasing groundwater extraction, for example, may drive physical water use efficiency as the pumped groundwater will be more suited to pressurised water delivery systems.

Reductions in rainfall, and increased evaporation, will influence the impact of all the other key factors. Drier conditions, for example, will be more conducive to bushfires. Lower rainfall will reduce seasonal allocations and entitlements for surface water and drive substitution to other water sources, such as groundwater and farm dams. Water scarcity will also increase water prices thereby enhancing the viability of adopting new technology, which may further reduce return flows to streams. Lower rainfall also may limit or change the nature and location of the development of afforestation in catchments.

Figure 4 **Interrelationships of factors affecting instream water availability**




Source: PC 2006, p.19.

Of the key factors considered by van Dijk et al. (2006), only climate change directly reduces the total water available for instream use (changes to evaporation excepted). With the exception of any effects on evaporation (which can be significant for some factors, such as farm dams), the other factors change the *distribution* of water rather than the *total amount*. Nevertheless they can also lead to important temporal effects on water availability. The intertemporal effects can vary significantly — some maybe very short and others very long. The loss of vegetation from bushfires can increase water availability immediately, for example, but rapid regrowth of vegetation then reduces in water availability for many decades (Duguid et al. 1990).

Property rights and planning arrangements play a critical role in determining the impacts as all of these factors change and interact. Under the current operation of the Murray–Darling Basin Cap, for example, surface water diversions are capped to prevent further reductions in stream flows. By defining the Cap in terms of diversions, however, reductions in total water availability (due to climate change) or increases in water interception or abstraction not fully covered by the Cap, reduce the amount of water for environmental purposes and for 'downstream' entitlement holders.

There are no *water* property rights solutions that can prevent the occurrence of climate change. All other factors are endogenous and reflect the competing uses for the water resource. Some will have legacy effects that can not be altered by property right solutions. Alterations to water property rights, however, can change the distributional impacts of legacy effects.

### *Farm dams*

Farm dams are an important source of water for many landholders (including those with recreation and lifestyle blocks), especially during periods of low rainfall. Farm dams are used to store water for stock and domestic purposes (in the case of smaller dams), or for irrigation (usually requiring larger dams). Farm dams harvest and store water by capturing overland flows, irrigation runoff, or water from a stream. As farm dams intercept water that would otherwise have continued to flow to become part of the water system — either as runoff to surface water, or recharge to groundwater — failure to incorporate farm dams into water resource management and accounting will affect other water users and the community. While the effects of an individual farm dam may be small, the cumulative impact of thousands of farm dams will be significant. The timing and volume of water extracted, rates of evaporation, and the location of the farm dam in relation to the landscape, will all affect the likely impact.

In general, the impacts are likely to increase as the number and cumulative volume of farm dams increase. Using computer modelling, van Dijk et al. (2006) estimated that the likely effect on stream flow was a reduction of 0.84 megalitres for each megalitre stored in the farm dam. However, it is difficult to estimate the cumulative effect into the future given that farm dam regulations are being imposed progressively in the jurisdictions — a case of some jurisdictions amending traditional property rights of landholders to achieve environmental outcomes and protect the rights of other water users.

### *Plantation forestry*

Plantation forestry is an expanding dryland activity. As well as the obvious timber production, it can offer benefits for the wider community, including carbon sequestration and, depending on the location, ameliorating dryland salinity and reducing inundation in low-lying areas. The National Water Initiative (NWI) lists large-scale plantation forestry as a activity that has the potential to 'intercept significant volumes of surface and/or groundwater' and notes that it presents a 'risk' if it's not made subject to 'some form of planning and regulation' (clauses 55, 56).

### *Groundwater extraction*

Connectivity between groundwater and surface water varies across systems. In some systems, groundwater and surface water are highly connected and are essentially a single source, while in others systems the sources appear quite separate. In addition, the level of connectivity can differ significantly between reaches of a river (Sinclair Knight Merz 2004). Resource management in many areas of Australia has failed to sufficiently integrate and account for these links. This has resulted in some systems being highly over-allocated, and others being managed under considerable uncertainty (Evans 2005).

Evans (2004) estimated that, on average, in the Murray–Darling Basin, for every 100 megalitres of groundwater extracted, surface water will be reduced by 60 megalitres. Based on these estimates, between 1993-94 and 1999-2000, Evans considers the growth in groundwater extraction eroded the Murray–Darling Basin Cap by an average of 2 per cent per year. The erosion is likely to increase over time because many groundwater management units are currently only partially developed and demand for groundwater is growing.

The lack of integration of surface water and groundwater systems in how water resources are allocated and regulated, can create perverse incentives for water users and undermine water resource management. Due to the substitutability of these two sources of water (where water quality issues such as salinity are not prevalent), reducing access to one can increase the use of the other. As noted above, extracting groundwater in close proximity to a river can sometimes have the same impact as directly diverting from the river. This substantially reduces the effectiveness of water management policies that address only surface water or only groundwater.

### *Bushfires*

As noted earlier, bushfires have both short-term and long-term effects on water availability. Immediately after a fire, water availability in a catchment will increase substantially but as vegetation regenerates water yield gradually declines until eventually (typically more than fifty years) returning to pre-fire levels as vegetation matures. There do not appear to be any property rights to water that encourage the better public management of native vegetation to reduce the risk of significant losses (due to bushfire) of future water yields.

### *Changes in irrigation management*

When water is applied on-farm, some proportion of that water returns to the water system through seepage or runoff. This return flow can then be used downstream by other water users or to achieve environmental outcomes. Existing water entitlements in most jurisdictions are based on some expectation of return flows. When return flows are less than the assumed amount, third-party effects and problems of over-allocation can occur downstream. Water Resource Plans in Queensland, however, are very conservative in that they assume no return flows in determining water plans (from which entitlements are provided).

A potential problem with most existing entitlement specifications is that there is little formal consideration of changes in return flows, such as from increasing physical water-use efficiency (through water-saving technologies and management practices). The impact of increases in physical water-use efficiency on return flows can be significant. Like off-farm infrastructure 'savings' which have been a focus of water recovery programs, on-farm water savings can be 'illusory' in the sense that they reduce water available to other users, including other irrigators and water for environmental uses. 'Taking from Peter to give to Paul' may be rational if Paul is paying more for it or has higher prior claims, but we should not delude ourselves that delivering more water to Paul means we have found or created 'new' water. In addition, in dry years, such as this irrigation season, how much water will be 'saved' for environmental flows from infrastructure works, if rivers and channels are operating nowhere near their peak capacity? The 'water-saving' approaches to sourcing water for the environment can be expensive and it can be simply more economic to purchase the water required from willing sellers.

## The NWI and water reform

The National Water Initiative (NWI) has made a number of important steps toward improving social well being from water use. The objective of the NWI is:

> … a nationally-compatible, market, regulatory and planning based system of managing surface and groundwater resources for rural and urban use that optimises economic, social and environmental outcomes … (COAG 2004, clause 23).

Among others it established risk-sharing arrangements to help address the potential impacts of climate change and bushfires. The NWI risk-sharing framework outlines how several risks to water availability for consumptive use (including those from bushfires and climate change) will be shared between governments and entitlement holders under the Cap (box 2).

### Box 2 Risk sharing under the NWI

The National Water Initiative (clauses 46–51 and attachment A) provides a framework for managing many of the risks associated with future changes in water availability for water entitlement holders under their entitlements. The risk of future reductions in water availability have been assigned such that:

- risks of reductions arising from ‘bona fide improvements’ in the knowledge of water systems’ capacity to sustain particular extraction levels are to be borne by water users until 2014, after which time risks are to be shared between users and governments;
- risks associated with natural events, such as bushfires, drought and climate change, are to be borne by users; and
- risks of reductions resulting from changes in government policy (for example, new environmental objectives) are to be borne by governments.

Where affected parties — including water access entitlement holders, environmental stakeholders and the relevant governments — agree, on a voluntary basis, to a different risk sharing formula, that will also be considered an acceptable approach.

*Source:* PC 2006

Signatories to the NWI also agreed to assess the significance of interception activities, such as farm dams and bores, intercepting and storing of overland flows, and large scale plantation forestry, on aquifers and catchments. Where necessary, appropriate planning, management and/or regulatory measures will be applied:

> The intention is therefore to assess the significance of such activities on catchments and aquifers, based on an understanding of the total water cycle, the economic and environmental costs and benefits of the activities of concern, and to apply appropriate planning, management and/or regulatory measures where necessary to protect the integrity of the water access entitlement system and the achievement of environmental objectives. (COAG 2004, clause 56)

However, it seems very courageous to rely on planning and regulatory measures to achieve this. There may well be much smarter, more efficient and equitable ways, making more use of market forces and relying much less on planning controls and regulatory prescription.

## Moving away from an over reliance on planning

In some regions of Australia, planning regimes are exclusively used to allocate water for environmental purposes, and in some regions over-allocation is not an environmental concern. Within water plans, administrative arrangements are relied on to allocate portions of the water resource pool to a range of different uses, such as the environment, agriculture and urban activities. These administrative arrangements also allocate water use within various subsets of the water resource pool, such as groundwater and surface water. Insufficient recognition is given to the implications of the integrated nature of water resources and effects of use by one water user on another.

Usually markets are the most efficient mechanism to distribute scarce resources. Administrative arrangements can be used to make initial allocations to water users, and markets can be used to reallocate the rights to this water to where it can yield its highest value. Trade in regulated surface water rights (particularly within major irrigation districts) is well developed, although constraints remain (box 3).

Currently there is very little direct purchasing of water from irrigators (particularly on existing water exchanges) for environmental purposes. But there are signs that this is beginning to change, the New South Wales Government, for example, has established RiverBank and some tendering for water has begun. The Productivity Commission (2006) called for the establishment of environmental managers to enter markets and establish portfolios of water products. Governments have seen this, however, as a last resort option for fear of affecting water markets. Yet other approaches such as infrastructure investment, by definition, also affect markets – the difference is whether the intervention is direct and transparent or not.

**Box 3 Water trade**

Trade in water was first introduced in Australia in 1983 and was further enhanced by the COAG agreement in 1994. The National Water Initiative established in 2004 has since extended these initiatives to aid in expanding water trade at a state, territory and national level. State and territory governments agreed to:

> … progressive removal of barriers to trade in water and meeting other requirements to facilitate the broadening and deepening of the water market, with an open trading market to be in place. (COAG 2004, clause 23(v))

Water trading in Australia was initially restricted to trade between irrigators within the same irrigation district. Over time, trading has expanded to include inter-valley, and more recently, interstate water trading. All states and territories have the potential to trade water as water entitlements are now (or are in the process of being) separated from land rights. Water is generally traded through the buying and selling of water entitlements (also known as permanent trades) or seasonal allocations (also known as temporary trades), although there is a growing number of derivative products, including forward contracts, leasing and options. Water trade is well established in Victoria, South Australia and New South Wales. Trade in seasonal allocations is relatively unrestricted and intrastate trade is generally possible where sources are hydrologically connected. Interstate trade in water entitlements, however, is restricted to regions in the pilot interstate trading project.

*Source:* COAG 2004, PC 2006

Similarly there has also been little trade of water between the rural and urban sectors (see Dwyer et al. 2005). Nevertheless there are surprisingly few restrictions that prevent urban users purchasing rural water property rights (see PC 2006).

There is also very little trade in groundwater (box 4) or among other potential users. While providing a framework and impetus for removing trade constraints, the NWI, was not designed to substantially reform the property rights of existing users or require potential water users to acquire new rights. These property right powers rest with the jurisdictions. Some potential water users are excluded from the markets either because they are not granted initial allocations or because their rights to the water resource pool are not interchangeable with other water users. While there are few limits to who can buy water, a key problem is that some major users are not required to acquire water property rights to engage in activities that affect water availability. In many jurisdictions, converting a dryland grazing enterprise to a tree plantation, for example, requires planning approval but does not require acquisition of an appropriate water property right, yet the implications for water availability can be significant. In South Australia, a management plan was introduced in 2004 that requires a new forestry development to secure an appropriate water allocation if existing forestry in a water resources management area exceeds 59 000 hectares. In most jurisdictions, however, forestry development requires planning approval but not an appropriate water allocation.

There are opportunities to use markets to substitute for administrative arrangements to more efficiently allocate water among competing users. This could be achieved for subsets of the water resource pool, but third-party effects observed above would remain. Alternatively, markets could allocate water across the total water resource pools with allocations exchangeable across all users. This would require the purchase of water for public water uses, such as environmental flows.

### Box 4 **Trade in groundwater**

Trade in groundwater is limited for a number of reasons, including:

- groundwater trade is often restricted to trade within a hydrologically connected groundwater system and these tend to cover smaller areas
- little is known about groundwater connectivity and levels of sustainable use in many regions
- entitlements to groundwater are not clearly defined in some regions and there are often significant regional differences in groundwater management
- groundwater is not currently included in the Murray–Darling Basin Cap and increased use of groundwater through trade may exacerbate problems of over-allocation
- however, some progress is being made in this regard, for example, Queensland and New South Wales have reduced or capped groundwater entitlements in the Murray–Darling Basin
- entitlements to groundwater are still tied to land in many regions
- there are often regulatory restrictions on trade in groundwater
- many groundwater sources are not metered.

Despite this, varying degrees of trade in groundwater has occurred in New South Wales, Victoria, Queensland, South Australia and Western Australia. The largest volume of trade in groundwater seasonal allocations has been in Queensland and the largest volume of trade in entitlements has been in South Australia. Several jurisdictions are in the process of investigating trading opportunities between groundwater and surface water stocks and flows, but these measures are being introduced slowly due to poor understanding of groundwater and surface water connectivity.

*Source:* PC 2006

The main types of responses, that governments could consider to better integrate the factors affecting water availability into water policy, include:

- Responses broadly based on property rights/entitlements — this could include incorporating non irrigation forms of water usage into existing water entitlement regimes or creating new entitlements (which may, or may not, be tradeable).

- Offset schemes — these may involve catchment or district level water use caps.
- Separate or integrated water usage caps — for example, the use of separate groundwater caps or integration of groundwater caps into surface water caps.
- Regulatory limits and conditions on water-use and land-use changes which significantly affect water use.

The relevant property right arrangements currently vary across jurisdictions and the implications of these property rights need to be better understood. Efforts to address those factors affecting water availability are likely to raise important equity questions about which water users should gain or lose. Cost-sharing issues will need to be resolved. In many cases, policy choices relate to who should bear the risk of changes to water availability (in other words, who has the primary or priority 'property right'). There are also important issues of policy design which can affect the efficiency of policy choices.

The appropriateness of each approach will depend on (among other things):

- the threat to water availability that is being managed;
- the nature and extent of the risks in the relevant location;
- availability and cost of information and necessary monitoring ; and
- other institutional matters.

In some cases, policy responses can cut across the different factors affecting water availability. Existing arrangements (including existing property rights) can be fine-tuned, and opportunities exist for synergistic benefits by using a mix of instruments. In all cases, the benefits and costs of alternative approaches should be carefully considered including the transaction costs of appropriately specifying property rights.

## Conclusion

In the longer-term, as demand grows and scarcity in one subset of the water resource pool drives substitution to other sources, the need for integrated water markets will become even more pressing. The development of integrated water markets that are open to all and that incorporate, where hydrologically feasible, all aspects of the water resource pool, is a radical departure from the existing arrangements in all jurisdictions. This requires a serious rethink within government and the community of how water is used as a resource in the wider economy and the contribution it makes to society's overall wellbeing. The development of fully integrated water markets is likely to create powerful competitive pressures and spur innovation in water products, enhance on- and off-farm productivity, and foster more sophisticated market-based responses to environmental management.

Governments have a critical role in providing the appropriate institutional and property right arrangements within which integrated water markets can flourish. The competitive arrangements we envision would increase the need to articulate clear environmental objectives, and require a preparedness to place economic values on environmental objectives and a willingness to financially resource them appropriately. Adjustment and equity issues will also need to be addressed. A reliance on markets may require that those who are insufficiently resourced, but require a certain amount of water, gain access to funds to participate in the markets.

More research is required to understand the biophysical and economic relationships that influence the distributional impacts of changing water availability. This then leads to further improvements in water accounting, to understand the spatial and temporal dimensions of the effects, as well as who will be affected. Improved accounting arrangements can also play a key role in helping to refine and clarify underlying property right arrangements that, in turn, determine the distributional consequences.

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