The evolution of water markets

*Development, implementation and outcomes of water markets in Victoria, focusing on northern Victorian regulated surface water markets*

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Executive summary

In recent years, shifts in water market conditions and drivers, including prices, entitlement ownership, and supply and demand for water, have focused interest on water market arrangements.

This report, prepared in 2016, responds to trends in water market outcomes, and the underlying supply and demand factors that have influenced those outcomes. These include shifting prices for water and changes in the location of water use, as well as climatic variability and changing conditions in different agricultural commodity markets.

After a sustained and severe drought for much of the 2000s during which prices for water entitlements and allocations set record highs, floods and extremely wet years in the early 2010s saw some of the lowest water allocation prices ever recorded. From around 2011 to 2016 allocation and entitlement prices rose substantially – allocation prices increased from around $20-30 per ML in 2010-11 to over $300 per ML in 2015-16. Similarly, there has been a major increase in entitlement prices, particularly from 2014 to 2016.

Previous studies have highlighted that drying climatic conditions have been the prime driver of increases in allocation prices and that the responses observed are to be expected. However, there have also been changes in demand side factors that have influenced outcomes. These include volumes of water being purchased by governments for the environment, as well as new irrigation developments and increased development of crop types not previously grown in certain regions.

Major shifts in supply or demand, and resulting market outcomes (such as changes in price and the location of water use) can create pressure on industries and communities. In recent years, there has been some concern expressed in the media by stakeholders regarding the ability of different industries or communities to adapt to the pace and distribution of change.

In this context, it is useful to consider the development of water markets and reforms implemented, as well as the impacts of water markets to date. Victoria’s water markets are the product of a long evolution in water management, and address the inadequacies of many previous approaches. They provide opportunity to more flexibly adapt to changing circumstances and can complement work in other government policy areas to manage structural change.
1. Introduction

The Department of Environment, Land, Water and Planning (DELWP) engaged Aither to undertake research and analysis to improve information and understanding regarding the development of water markets, their impacts, and the drivers of recent changes.

Scope of this report

DELWP requested that Aither prepare a report that documented:

- what outcomes the water market has achieved for Victoria, including examining the history of water reform, performance in drought, and comparisons with non-market approaches
- the potential implications of recent changes in water demand, including what factors have influenced changes in water prices, and how changes may be affecting industry.

The report is focused on Victoria, and mainly northern Victoria given this is the location where markets are most active and well developed. However it draws on a broader evidence base and examples, including information about national water reforms, and water markets and trade across the southern Murray-Darling Basin. This reflects the scope constraints of this study, which relied on the existing evidence base rather than undertaking any new primary research.

Structure of this report

This report provides a narrative around water market development, including evolution in the approaches to water management, impacts and outcomes of markets during drought, and more recent analysis of contemporary changes and implications for irrigated agriculture. It also briefly considers potential alternatives to markets and provides a comparative case study, and reflects on the impact of certain barriers to water trade that have now been removed.

- Section 2 provides a brief overview of the fundamentals of water markets.
- Section 3 documents the evolution of water markets, their implementation in Victoria, key reforms, and summarises the extent of trade.
- Section 4 outlines the impacts resulting from water markets during the millennium drought, drawing from previous studies.
- Section 5 outlines recent changes in market outcomes and the influence of different supply and demand factors, and highlights the implications for irrigation industries.
- Section 6 provides an overarching summary and conclusions.

There is also further detail on certain topics in appendices. Appendix A considers alternatives to markets and provides a case study of water management in California. Appendix B discusses artificial barriers to trade that have previously been implemented in Victoria but subsequently removed.
2. The basic features of water markets

Water markets are one part of a broader system to sustainably and efficiently manage competing demands for water. They are based on the concept of ‘cap and trade’ and are supported by a range of other measures, including water planning, regulation, and an entitlement and allocation framework.

2.1. Overview of markets as a cap and trade system

Water markets are based on the concept of a ‘cap and trade’ system, which are often used by policy makers to address natural resource management challenges or environmental problems.

In applying such an approach to water quantity management a cap is established that limits the total extraction of water. This is aimed at ensuring environmental and productive sustainability – it defines exactly what water can be used for productive purposes, and ensures some water (that is outside the cap) is reserved for the environment. Water inside the cap is sometimes called the ‘consumptive pool’, however, as noted below, in some cases the environment also has access to this water. Caps on water extraction are an important precursor for enabling the scarcity value of water to be revealed.

Water availability in Australia is highly variable. When water is plentiful there may be enough for all users, but when it is dry, it is not possible to meet all users’ needs. As a result, the cap must be defined in a way that reflects this variability. This is done by defining shares to water that is available within the consumptive pool, with actual volumes varying from year to year.

In parts of Victoria where markets are well developed, the water within the cap is allocated amongst different users using water shares, which are rights to receive a share of the available water. Water within the cap can then be reallocated by trade between holders of water shares, depending on their needs and circumstances. This enables new entrants without undermining the sustainable limits of the system, and allows water to move between competing users and users in response to a myriad of external factors. In some water systems, some water within the cap is also held by the environment, following purchases from other users. Where this is the case, the environment represents an increased demand on the consumptive pool and is treated the same as all other users (including being allocated water in the same way as other users).

1) Limit total extractions from water resource
2) Shares issued to water in the cap
3) Trade reallocates water between users

Source: Aither.

Figure 1 Concept of a cap and trade approach
Environmental water in Victoria

Water for the environment is protected as the environmental water reserve, which is the legally recognised amount of water available for the environment under the Water Act 1989. The objective of the environmental water reserve is to preserve the environmental values and health of water ecosystems. The environmental water reserve is provided in three ways:

Environmental entitlements
These are secure rights to water for environmental outcomes. Environmental entitlements represent the amount of water authorised to be stored, taken and used to meet specific environmental needs. Environmental entitlements are legal rights to water and provide for a share of the water in a river. They may originate from environmental purchases from users in the consumptive pool. This is the case in the Murray-Darling Basin where the Commonwealth Environmental Water Holder now holds a large volume of water shares (see Figure 15).

Obligations on consumptive entitlements
Include the passing flows that water corporations or licensed diverters are obliged to provide to a river.

‘Above cap’ water
Includes water that is available after upper limits on sustainable levels of diversion have been reached and unregulated flows, which cannot be kept in storage. ‘Above cap’ water is considered a part of the environmental water reserve and may be groundwater or surface water.

Much of the water available to the environment is ‘above cap’, which can be a very unreliable source of water and is susceptible to climate change.


2.2. Key concepts

Water shares and seasonal determinations
The total volume of water shares on issue is the same as the maximum amount of water that can be allocated to users in that system during years of full water availability. In this document this is referred to as the consumptive pool. Because volumes in storages, rainfall, and inflows all vary from year to year, the total volume of the consumptive pool may not be available to users in all years. This is why the Water Shares provide a right to a share of the water that is available in the consumptive pool, rather than guaranteeing water in all cases.

When storages, rainfall and inflows are above average, 100 per cent of the consumptive pool may be available. In years where there is less than normal rainfall or inflows, less than 100 per cent of the water share volumes may be available. In Victoria, the delegated ‘resource manager’ makes determinations about how much water can be made available, in accordance with defined rules. This process provides annual allocations, which indicate the volume of water available for water share holders to extract.

As previously noted, some water shares that provide a right to water in the consumptive pool are now held by environmental water holders, who are arguably not consumptive users in the traditional sense. However, the principle of setting the total volume of available shares equal to the total volume of permissible use remains the same. In setting a cap, water is reserved for the environment, but in addition the environment can own shares to water within the cap. This has generally occurred to address past over allocation of water systems (i.e. too many shares being issued to consumptive users).
**Victorian water share, allocation and seasonal determination definitions**

**Water share**
A water share is a legally recognised, ongoing entitlement to a share of the water available in a defined water system. It gives the owner a right to a share of water in the dams. The volume of a water share is defined as a maximum amount of allocation that can be made against it each year. Features of a water share include its water system, such as the Goulburn, Murray or Macalister; its reliability, which can be high or low, and the volume, e.g. 100 megalitres (ML).

**Allocation**
Water that is actually available to use or trade in any given year, including new allocations resulting from a seasonal determination and carryover.

**Seasonal determination**
The percentage of water share volume available under current resource conditions determined by the resource manager for northern Victorian regulated river systems. For example, in a dry year a 50 per cent allocation to your 100 ML water share gives you 50 ML of water available to use or trade. A 100 per cent allocation means that you have your full water share volume available. Since 1 July 2012 the resource manager has used seasonal determination instead of the previously used term, seasonal allocation. This is to distinguish between water available under current resource conditions and the water customers have available because of carryover.

Source: Victorian Water Register.

**Water share and allocation trading**
Both water shares and annual allocations can be traded. Water shares are a type of property right and are somewhat similar to land property rights. Trade of the share means the ongoing right to receive a share of water in the consumptive pool is transferred from the seller to the buyer. In Victoria, trade in a water share can mean a change in ownership, a change in location, or both.

Trade of water allocations mean that a specific volume of water is transferred from a seller to a buyer. It is similar to trading other commodities or physical goods. Once a trade is complete, the buyer of the allocation is able to extract and use the volume of water purchased if they also have appropriate delivery entitlements. The seller receives financial payment based on a price that is agreed with the buyer without any influence of government. Allocation trade can be for almost any volume, subject to the seller having that volume available to sell.

**Victorian water trading definitions**

**Water share transfer**
The transfer of ownership of a water share. When you buy water share you are not also buying the allocation. The buyer only receives new allocation announced to the water share after the Water Registrar has recorded the transfer. Previously this was known as a ‘permanent trade’ and this term is sometimes still used.

**Allocation trade**
The transfer of a volume of allocation water between a seller and buyer. Water is traded within a current irrigation season. Previously this was known as temporary trade and some people still use this term.

Source: Victorian Water Register.
3. Evolution of water markets

Water markets have been developed progressively over the last 30 years in response to scarcity. They have also been developed in response to shortcomings in other approaches to water management and have been trialled and refined over many years. Water users have been closely involved in the development and refinement of water markets in Victoria. This chapter provides a history of water market evolution in Australia, focusing on Victorian examples where possible.

3.1. Objectives for use of Victoria’s water resources

From the late 19th century through to the present day, the drivers for development and use of Victoria’s water resources have evolved, and been driven by different philosophies. From federation in the early 1900s, water resources were used to support regional economic development, including supporting population growth, expanding agricultural production, and supporting soldier resettlement. However, towards the end of the 20th century a substantial shift occurred in objectives for water resources aimed at the dual objectives of sustainability and economic efficiency. These were to be achieved through a reduced role of the state in funding water infrastructure and were part of the shift towards a more open, market oriented economy.

Early visions for development

Early approaches to developing water resources in Victoria were guided by Alfred Deakin’s vision, which included encouraging the greatest possible utilisation of water on the largest possible area (Deakin 1885). This was viewed as important for promoting economic and social development of the regions through closer settlement and increased agricultural production (NWC 2010).

Large-scale irrigation in Victoria has its origins in the irrigation trusts which began after the 1877-81 drought and which were supported by the Victorian Irrigation Act 1886 and associated government loans for developing distribution works (DNRE 2001). This reflected a desire to use irrigation water to create communities of property-owning independent small farmers as a foundation for democratic society (Connell 2007), including a focus on populating the north of the state.

During this period, national and regional development was seen as a strategic social objective, and the provision of water supply infrastructure was considered by government to be a public good. The desire for economic development and regional employment resulted in government investment in water infrastructure (Ward 2009).

Infrastructure expansion and state management and control

From around 1918 through to the 1970s, there was significant expansion in government investment in irrigation activities, including major infrastructure. After World War I, soldier settlement schemes helped returned servicemen gain employment in the rural sector. These generally involved small property sizes and emphasized intensive horticulture and mixed cropping and grazing (NWC 2011).

Development generally involved application of engineering based solutions, with state bodies responsible for planning their design and construction. State agencies were also responsible for supplying the irrigation water, and controlled patterns of rural settlement, including farm sizes and crop types.
In Victoria, the Northern plains had some of the largest and most important developments, including the Goulburn system around Shepparton, but later moved north to the Murray River, including around Mildura, where the Sunraysia districts of Red Cliffs, Merbein, Robinvale and the First Mildura Irrigation Trust were established as small block horticultural enterprises (NWC 2011).

The development focus and associated agricultural, water resources and infrastructure policies led to major growth in intensive irrigated agriculture. However, during this period there was little consideration of the potential negative consequences of the development philosophy (Ward 2009).

**Shifting from development to sustainability and efficiency**

From around the 1970s and by the 1980s the approaches that had dominated most of the century were beginning to change, partly due to government’s unwillingness to fund infrastructure – new developments and replacement or renewal of existing assets was increasingly costly (Musgrave 2008). The assumption that all development was in the public good was being increasingly challenged (NWC 2011), as were assumptions that more infrastructure could drought-proof the country and that the establishment of small farms was appropriate (Davidson 1969, Musgrave 2008).

Another driver was concern about the environmental impacts of water-related developments in the MDB (Musgrave 2008). Blue-green algae blooms and irrigation induced salinity were a major concern, as were impacts on the health of aquatic ecosystems (NWC 2011), and it was becoming evident that many water systems in the MDB were over allocated (Bjornlund and O’Callaghan 2003). Major events such as closure of the Murray Mouth from 1981 to 1983 also contributed to this (MDBA 2010).

By the early 1990s water management had moved further away from regional development objectives and engineering solutions towards resource efficiency and sustainability (NWC 2011). Management of shared resources such as the Murray River was increasingly incorporating environmental factors into decision making. The 1992 National Strategy for Ecologically Sustainable Development also contributed to change in thinking about water management (NWC 2011).

In the 1990s, the national microeconomic reform agenda also placed increasing pressure on the need for more efficient and sustainable approaches to water management. The aim was to improve economic efficiency, particularly in publicly owned industries (NWC 2011). Finally, in the 2000s, the millennium drought further reinforced a need to move to more robust arrangements for water allocation and use. During this period, there were significant further reforms to improve efficiency and flexibility in water allocation and use, while returning water to the environment.

### 3.2. Changes in management approaches

As with the evolution in objectives, the approach to allocating and managing water resources has been evolving. Management approaches applied have often responded to the objectives or issues of the day, including the desire for economic development, or need to respond to environmental issues.

**From common law and riparian rights to centralised state control**

The earliest systems of water rights were based on English common law, known as riparian rights. This gave rights to water in rivers and streams to the adjacent landholders. However, the extreme variability of water supply in Australia meant the system was not effective, including because of the need for large scale storage to enable water to be used when and where it was required (NWC 2011).

In the late 19th and early 20th century, governments sought to limit riparian rights by vesting rights to ‘the use and flow, and to the control of water resources’ in the Crown. This was due to the influence of Alfred Deakin, and commenced with the Victorian Irrigation Act in 1886, and allowed state
governments to centrally control and administer systems for allocating water rights (NWC 2011). This supported the development objectives of governments by enabling greater state control over resource distribution and allocation.

Licensing and permits

Throughout much of the 20th century state governments employed statutory licencing systems, which granted privileges (such as licenses or permits to take water) rather than property rights in the legal sense (Tan 2002). Potential water users generally applied to state agencies for licences, which in Victoria were granted by State Rivers and Water Supply Commission based on the area of irrigable land and crop needs (DNRE 2001), with government administrators making judgements about crop suitability and water needs (NWC 2011).

Water licences or permits were tied to use on specific areas of land. Another philosophy guided by Alfred Deakin, who viewed it as a desirable for farmers to have perpetual use of water to irrigate their land (Deakin 1885). Even in the mid-1980s it was still the case that water was locked to particular pieces of land. Even if a farmer had spare water, they were not officially allowed to transfer it even temporarily to a neighbour who may have had a great need for it such as finishing a crop during a hot period (DNRE 2001).

Limitations of licensing and supporting management arrangements

For most of the period up to the 1970s where development was the primary objective, licences to water were available on demand. Irrigators could generally use as much water as they like but only on a specific area for irrigation. While this contributed to development, it did not incentivise efficient use of water resources. In some cases, licences did specify volumetric constraints, such as a certain number of acre feet of water per acre, but were not effective in controlling use (NWC 2011).

Supporting arrangements, such as accounting and metering, were generally inadequate, leading to a poor understanding of total extractions and licensed volumes on issue at any one time. This, in addition to the bulk of licences being issued at a time when the MDB was in a 50-year ‘wet period’, contributed to the over allocation of resources (NWC 2011). Licences were able to be amended or cancelled, but there was an expectation of automatic renewal, and over time it became increasingly difficult for governments to establish caps on use (McKay 2008).

Capping diversions and allowing for reallocation

Overallocation was a key driver of the shift from a development philosophy to sustainability and efficiency. To address this, steps were taken to cap diversions and allow water to be reallocated between irrigators, rather than continually issuing more licences (NWC 2011). Increasing demand also meant that available water could not be put to additional uses without compromising the security of existing licence holders (Sturgess and Wright 1993).

In Victoria, licences to pump from unregulated streams during summer ceased to be generally available after the 1967–68 drought (DNRE 2001). However, this did not prevent ongoing environmental degradation (DLWC 1999) and ongoing environmental impacts of irrigation in northern Victoria led to two major investigations in 1975. Reports concluded that water supply was largely committed and no new licenses should be issued, and that markets should be used to facilitate reallocations of water between irrigators (Bjornland and O’Callaghan 2003).

As is discussed further in Section 3.5 below, some key policy reforms were important in capping extractions and allowing for reallocation. The 1989 Victorian Water Act established bulk entitlements which helped to clarify previously poorly defined water rights, and explicitly recognised the
environment’s right to water. The landmark 1997 Murray-Darling Basin Cap limited the amount of water that could be diverted for consumptive use in the Basin.

Changes to the 1989 Victorian Water Act as part of the Our Water Our Future reforms in 2004 facilitated change to the current system, where water shares were granted as a share of the water resources available in a given year. This approach only allows users to extract the total volume in years of high (or ‘full’) water availability. In years of lower availability, allocations are reduced in proportion. This approach was viewed as more equitable and fair, as it removes third party impacts from use, and is more environmentally sustainable. It is also the substantive enabler of effective water markets. Under these reforms, rights to water were also unbundled from land property rights into three separate rights; a water share, a delivery share or extraction share in a works licence, and a water use licence. The environmental and third party impacts of water use are managed through the water use licence.

3.3. Objectives of water markets

In broad terms, the objective of water markets is to efficiently manage the allocation and reallocation of water amongst competing users, given scarcity and increasing demand, and in the context of a cap on total water extractions. However, they were also intended to deliver on a number of other objectives as well.

Managing water within a cap on total extractions

Introduction of total cap on water extractions means that competition would increase for the available resource. In order for water to be reallocated between users, there must be a mechanism to do so. Limiting the issuing of new rights to water meant that the only way to acquire water was to obtain it from other holders. Because rights to water were tied to land, there were no easy mechanisms to transfer water. Obtaining more water would require obtaining more land, which added considerable cost and delays and was not conducive to reallocating water easily (NWC 2011).

Water markets were seen as the most effective way for allowing reallocation between users, as it allowed water users to make decisions about the value of water based on their intended uses. In the absence of a market, there would be no opportunity for reallocation, or government would need to assess and reallocate water, something it is not well placed to do. In order for markets to function effectively, the limitation of entitlements being tied to land had to be removed.

Flexibility to respond to new or changing conditions and industry needs

With a cap on available resources, and in the absence of any mechanism to trade, there was no ability for new participants to enter irrigation, or for existing participants to easily exit. This was a major barrier to driving improvements in efficiency and productivity, and to providing flexibility to individual enterprises. It would also not allow for growth in new industries or decline in others, something that is necessary is responding to commodity prices and changes in consumer sentiment, as well as maintaining economic benefits for Victoria.

In addition, after a sustained ‘wet’ period in the mid-20th century, it had become clear that Victoria’s water systems were highly variable, and there were increasingly diverse industries with different water needs. This pointed to the need to not only transfer rights to water, but for ‘temporary’ trade of parcels of water between users within the irrigation season. Similarly, with caps in place, there needed to be a mechanism to enable new development, which pointed to the need for entitlement trade separate from land transactions.
Environmental sustainability, economic efficiency and fairness

The introduction of water markets was concerned with achieving both economic efficiency and environmental sustainability. During the period in which water markets were more fully developed and formally implemented in the 1990s and 2000s, there was significant interest in microeconomic reform to improve the efficiency and productivity of the economy, and in environmentally sustainable development, including achieving development objectives in a more socially and environmentally sustainable way.

Australia’s commitment to its National Strategy for Ecologically Sustainable Development (NSESD) meant that it was required to consider the increased use of economic measures to deal with environmental problems, including externality pricing and tradeable entitlements. Governments committed to develop economic instruments, such as tradeable rights, in the management of resources, monitor and assess economic instruments already in place, and establish pilot programs within natural resource sectors to testing different market and regulatory mechanisms (COAG 1992). This reflected the need to drive more efficient and higher-value water use by signalling the value of water — historically, with no price signal to indicate the value of water, there was no incentive for efficient use, which was critically important with increasing demand and variable supply.

Water markets were also generally seen as fairer than other approaches, such as government attempting to make decisions about reallocating water within the cap, which would require it attempting to pick winners amongst different industries – something governments have a notoriously bad record of success in doing (see Aither 2014). The water market placed decision making in the hands of individual enterprises and users, and by design required there be gains from trade for both buyers and sellers in order for any relocation (trade) to occur. With the presence of appropriate rules to manage third party impacts, trade was seen as a more fair and equitable approach, as well as being more efficient (NWC 2011).

Microeconomic reform and the changing role of government

Microeconomic reform, such as in the National Competition Policy reforms, aimed to use competition to improve efficiency and community welfare, and responded to concerns about Australia’s economic performance and productivity compared to other OECD countries. This led to water sector policies intended to improve pricing of water storage and delivery services, institutional reform of government owned water utilities (that had traditionally managed irrigation policy and assets), and further develop water markets to facilitate water moving to its highest value use. For example commitments were made such as in relation to water allocations or entitlements (NCC 1998):

(a) the State government members of the Council, would implement comprehensive systems of water allocations or entitlements backed by separation of water property rights from land title and clear specification of entitlements in terms of ownership, volume, reliability, transferability and, if appropriate, quality; (b) where they have not already done so, States, would give priority to formally determining allocations or entitlements to water, including allocations for the environment as a legitimate user of water;

and in relation to trading in water allocation or entitlements (NCC 1998):

(a) that water be used to maximise its contribution to national income and welfare, within the social, physical and ecological constraints of catchments; (b) where it is not already the case, that trading arrangements in water allocations or entitlements be instituted once the entitlement arrangements have been settled. This should occur no later than 1998; (c) where cross-border trading is possible, that the trading arrangements be consistent and facilitate cross-border sales where this is socially, physically and ecologically sustainable; and (d) that individual jurisdictions would
develop, where they do not already exist, the necessary institutional arrangements, from a natural resource management perspective, to facilitate trade in water, with the provision that in the Murray-Darling Basin the Murray-Darling Basin Commission be satisfied as to the sustainability of transactions;

The introduction of water markets was also driven by a changing view of the role of government and the public sector in resource management. Smaller government, more involvement of individuals in making decisions in their best interests, and regulating only where necessary to avoid market failure were increasingly favoured (NWC 2011). There was a lessening in the degree of discretion left to water authorities and an increasing requirement to accommodate economic instruments and market based approaches in water allocation and use (Pigram 1999).

### Alternatives to markets

The preceding discussion highlights that there have been a range of different approaches applied to managing the allocation and use of water resources. As is further expanded on in Appendix A, and is substantiated in NWC 2011, this journey demonstrates that many of these alternatives to markets have inadequacies:

- Riparian rights were ineffective due to variable rainfall, which meant passing flows could not be relied upon.
- Individuals are better placed than governments to decide if, when and how to undertake agricultural development and allowing them to do so leads to better outcomes for society as a whole.
- Without a cap on total water use, use by one user erodes the rights of others, and environmental degradation occurs to a point where economic and environmental sustainability is compromised.
- In the absence of markets, governments would need to favour certain industries, creating equity issues and uncertainty, reducing overall investment, and impacting on business planning.

Water markets have evolved and been progressively implemented to address the shortcomings of these previous management approaches, which have ultimately proven to be both inequitable and unsustainable in economic or environmental terms. This is reflected in comparisons with other major economies such as California (also see Appendix A) which is currently looking at water markets in Australia and seeking to implement similar reforms there.

### 3.4. Progressive implementation of water markets in Victoria

Water markets started slowly, with trade being introduced in particular districts and only temporarily. This expanded gradually, with trials of entitlement trade and interstate trade occurring later. In part this owed to supply and demand factors, but also institutional arrangements. Under early licencing systems irrigators could use as much water as they liked, and new licences were readily available. Infrastructure was also built to mitigate supply constraints, and demand for water was not sufficient to drive the need for markets until later in the 20th century.

**Early examples of trade and gradual introduction of markets**

Some of the earliest examples of water trade in Victoria occurred when there were acute shortages such as in the 1940s droughts when there were stories of short-term, unofficial trade between farmers (DNRE 2001). Further examples of trade occurred in the drought of 1966–67, and in a restricted version over the period from 1982–83 to more general introduction in 1986–87 (DWR 1986). The 1982–83 drought drove some of the recognition of the need for water trading in Victoria. In addition,
policy makers and academics were increasingly advocating for the introduction of market reforms around that time (AWRC 1986).

Introduction of trade was initially limited to specific defined locations or types of users and types of trades which meant some market segments developed before others. There was greater willingness to allow trading within irrigation districts than between districts because intra-district trading reallocated water within a district rather than a loss of water from the district. Initially, there was more acceptance of allocation trading rather than entitlement trading which was associated with exits from irrigated agriculture with longer term regional implications (NWC 2011).

### Legislative change and formalisation of trade

Securing the legislative changes required in Victoria, and implementing administrative processes took time. There was a gap of some years between imposing embargoes on new water rights and enabling transfers of water rights between users. Many of the required mechanics of trading were developed in the 1980s, and debates had over the perceived impacts of trade (NWC 2011).

It was not until 1989 that a new Victorian Water Act enabling formal trade came into force, after a lengthy public review process and several major reports (Babie 1997). Temporary trade was possible from 1987 but gained more momentum following the introduction of the new legislation in 1989. Intradistrict entitlement trading was allowed in 1991, and interdistrict entitlement trading commenced in 1994 (DNRE 2001, Pigram et al. 1992, Martin 2005). However land and water were still bundled together throughout this period.

### Concerns about trade and initial take up

Some initial concerns and uncertainty about water trading underpinned the gradual and incremental approach to trading, including initial restrictions or constraints on trading, particularly entitlement trades out of irrigation districts. In 1994, when interdistrict trading was made possible, the Victorian Government imposed a 2 per cent limit on entitlement that could be traded out of an irrigation district in any one season (NWC 2011). The justification was around attempting to control the initial rate of structural change in an area, and impacts on the community including attempting to provide comfort that regional areas would not rapidly collapse (DNRE 2001).

Take up of trade was modest even once some of the major administrative and legislative barriers were overcome, which may have reflected a lack of understanding and experience in water trading and the relatively high availability of water in the late 1980s and early 1990s (NWC 2011). In the first seven years of allocation trading, less than 1 per cent of total water use was facilitated through trade (DNRE 2001). Allocation trading was tested in in 1994–95, when water availability was much lower than in previous years, and trading activity increased dramatically (NWC 2011).

### Further reforms and refinement

There were more substantial reforms undertaken associated with Victoria’s Our Water Our Future policy in 2004, and the National Water Initiative of the same year. Following these developments, there was completion of unbundling of land and water rights, significant investment in water registration and trading systems, as well as accounting and metering, and refinement to trade rules. This included changing the 2 per cent limit on out of district trade to 4 per cent, but a 10 per cent limit remained on non-water user ownership. The 4 per cent rule was eventually removed. All of these developments contributed to major increases in trade activity in the late 2000s and early 2010s (see later sections for more details).
Using artificial barriers to trade to manage change

Victoria has previously experimented with two specific constraints to water trade in an attempt to manage or mitigate particular issues of concern that were raised during the implementation of water markets. These included a rule to limit the scale or pace of structural adjustment within irrigation districts by limiting how much water could trade out of districts, and a rule to address the perception that ‘water barons’ would buy up significant amounts of water and influencing prices or other outcomes, by restricting water that could be owned by non-water users. As is further expanded upon in Appendix B, both of these rules were eventually removed in a response to their lack of effectiveness, lack of need (i.e. initial concerns were unfounded), or evidence of perverse outcomes.

- The 4 per cent rule, as it was commonly known, was initially set at 2 per cent, but later revised, was designed to limit the net amount of water entitlement (by volume) that could be traded out of a particular irrigation area in one year. It was designed to limit potentially negative economic and social impacts on regions or communities that might emerge with rapid movement of water to different locations. The rule was disbanded with the introduction of the Basin Plan Trading Rules in 2014.

- The 10 per cent non-water user limit was introduced in conjunction with the unbundling of entitlements from land in 2007 and 2008, which meant that a maximum of 10 per cent of the amount of water shares in any water supply system could be owned without being associated with land. This was designed to prevent non-irrigator ‘water barons’ from buying up large amounts of water and excluding it from productive use. Data on the limit suggests that it was generally not binding, (i.e. demand by non-water users did not generally exceed 10 per cent), and in 2009 the rule was removed, at which time the Victorian Water Minister confirmed that fears of water barons had proved unfounded. Today, many irrigators choose to disassociate water shares from land to increase flexibility of water supply access.

3.5. Major reform achievements

There have been a number of state and national level policy reforms that were required to implement water markets successfully. This section outlines the major reforms at both the national and Victorian level that have been instrumental informed water market development and implementation in Victoria.

Victorian Water Act 1989

The Victorian Water Act 1989 (the Act) implemented major reforms to entitlements, and explicitly recognised the environment’s rights to water. The Act converted existing, poorly defined rights to water to clearly defined entitlements, and established the basis for sharing the resource with the environment. The framework for specifying bulk entitlements provided many of the key principles underpinning the 1994 COAG Water Reform Framework.

In Victoria, water planning was used to balance consumptive water use and the needs of the environment. In the 1990s, Victoria had begun converting bulk entitlements established under its 1958 Water Act to entitlements under the 1989 Water Act and established groundwater management plans (NWC 2011). The objectives of the bulk conversion included providing a basis for sharing limited

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water resources while protecting the entitlements of other users and protecting in-stream values (PC 2003).

1994 COAG Water Reform Framework

The 1994 COAG Water Reform Framework shifted water allocation arrangements away from administrative allocations by government towards a market-oriented approach based on clearly defined and tradeable property rights. It included agreement that systems of water allocations and entitlement be established, backed by separation of water rights from land title, with clear specification of ownership, volume, reliability and transferability. It also included agreements regarding facilitation of cross-border trade, and allocations of water for the environment.

1997 Murray-Darling Basin Cap

The Murray-Darling Basin Cap, while interjurisdictional, was important for water market development in Victoria because it helped to set the cap in the ‘cap and trade’ approach, and covered most of major water systems in which major irrigated agriculture occurs. The Cap limited the amount of water that could be diverted for consumptive uses in the Basin, and was developed following an audit of water use in 1995 (MDBMC 1995) which addressed issues such as previously unused or partially used licences, and incomplete cover of moratoriums on new licences. In Victoria, the Cap was implemented through bulk entitlements, which had been established under the Water Act 1989.

The National Water Initiative

The National Water Initiative (NWI) built on the 1994 COAG agreement, and reflected concerns about the state of progress of implementing the 1994 agenda. The NWI was more specific and comprehensive, and included a range of new commitments that were to be implemented by the states, including in relation to water planning, regulation, and water markets. The NWI proposed a nationally compatible system of water access entitlements to improve the security of entitlements through defining them as perpetual or open-ended shares of the consumptive pool of a specified water resource (as determined by a relevant water plan) (NWC 2011). Actions in related to markets included reinforcing the need for unbundling land and water rights, and a range of items related to rules for trade, including removal of artificial barriers to trade.

Victoria’s 2004 Our Water Our Future policy paper

Coinciding with the NWI, the Victorian Government also launched the Our Water Our Future White Paper (OWOF) in June 2004 (Victorian Government 2004). This reflected priorities established in the NWI and built on the Water Act 1989. The policy paper set out 110 actions with irrigation, water allocation and entitlements, and institutional reform forming key priorities.

Following Our Water Our Future, entitlements were referred to as a ‘water share’, are expressed as the maximum volume of seasonal allocation that may be made against the water share, and provide a right to a share of available water, rather than guaranteeing a specific amount. Two new water entitlements were created as part of Victoria’s 2004 Our water, our future White Paper reform process: high-reliability water shares were conversions of existing licences, and previously available ‘sales water’ was converted into low-reliability water shares (Victorian Government 2004).

Further reforms

Since the NWI and OWOF, there has been ongoing work to implement existing reform commitments, and undertake further work that supports or reinforces water markets. Nationally key areas include the full implementation of unbundling for major surface water systems (in Victoria this includes the southern connected urban system), major investments in water registration, improvements in administration and trade processing, and improvements in the availability of market information. Some
changes have been made in response to the requirements of the water trading rules in the Murray Darling Basin Plan, including the removal of the four per cent limit of trade out of irrigation districts.

The Victorian Water Register has been central to many key improvements and has contributed significantly to information availability as well as the speed and convenience of trade processing and broader water information and management. The Register was implemented for northern Victorian regulated systems in 2007 and in southern Victoria in 2008. The Register contains all water entitlements and water trade information, as well as water allocations, and has involved substantial investment.

### 3.6. Extent and utilisation of trade

Since its formative beginnings in the 1980s, water trade in Victoria has grown substantially. In northern regulated systems it is now widely available and extensively utilised by a range of different water users and market participants. This includes extensive number and volume of trade in both allocations and entitlements, within and between different water systems.

**Entitlement markets**

The entitlement market is largely used by irrigated agricultural producers, but is increasingly being used by investors (as an alternative or ‘non-correlated’ asset class, often utilising allocation sales or a leasing arrangement with water users), water utilities (including urban suppliers) and environmental water holders (also refer to section 5.5). These users use the market to modify their long term arrangements for facilitating production, or meeting environmental requirements or urban demand. Trade in entitlement is often also driven by the need to manage risk associated with securing supply, and may also occur due to changes in business strategy or structure (such as retiring debt).

Data for northern Victoria shows that entitlement trade was relatively modest for most of the 1990s including because major enabling reforms (including unbundling) had not been implemented. Trade increased in the early 2000s coinciding with drought, and substantially increased in 2007-08 following completion of unbundling in the northern regulated systems and implementation of the Victorian Water Register (Figure 2).
The evolution of water markets

Allocation markets

The water allocation market is mainly used by irrigated agricultural producers (including rice, dairy, horticulture, cotton and others), and environmental water managers, but investors and others also participate by selling allocations received against entitlements they hold to producers. Producers can use the market to sell water excess to requirements, or buy additional water in during dry periods or when temporarily expanding production.

Data for northern Victoria is similar to that for entitlement trade (Figure 3), with relatively modest volumes of trade prior to key enabling reforms. Allocation trade is now a widely used tool in periods of both higher and lower water availability.
Water markets have been shown to facilitate adaptation by individual participants and irrigation industries. They have similarly allowed urban water users, and the environment to adapt to and manage the impacts of drought. Studies undertaken during the Millennium drought showed that beneficial adaptation has been particularly pronounced during periods of extremely low water availability. This section draws on evidence from studies up until 2012 as there has been limited research on this topic since then.

4.1. Overview

The introduction and subsequent expansions of water markets was based on the premise that trading provides economic benefits to buyers and sellers, and to society as a whole, by reallocating scarce water resources to higher valued uses (NWC 2010). The conclusion of a series of National Water Commission studies that finished in 2012 was that water trading significantly benefited individuals and communities across the southern Murray-Darling Basin (NWC 2010).

The impacts of water markets are multifaceted and occur to different stakeholders, and at different time and geographic scales. There are high level economic impacts, to the nation, to different states, to the Murray-Darling Basin and to different regions. However, all benefits essentially begin with individuals or enterprises, based on trades that occur between buyers and sellers. These are then reflected in broader impacts to industries, and at the regional and state level, as well as impacts on the environment.

Benefits have been particularly apparent during times of water shortage, including drought, due to the ability to move water to locations or industries where it is valued most. However, water trade has had some certain flow on impacts on communities, such as where there is large and rapid trade of water into or out of a region. This section outlines the nature and scale of impacts of water trade for: individuals; industries; urban suppliers; regions and Victoria, and; the environment. It concludes with a discussion regarding adjustment and water trade,

How trade impacts buyers and sellers

Buyers and sellers only engage in trade if they believe they will both gain from that trade. For sellers, gains may simply be the monetary proceeds which can be put to use in other purposes. For buyers gains may involve mitigating impacts or risks such as from drought, or expanding production. This can be demonstrated by a worked example.

Imagine two irrigators who farm different types of crops. These different crops have different costs to produce, different water requirements, profit margins, risks, and capital investments. Given this, each irrigator values water differently, and would be willing to pay different amounts for water to use in producing their crops.

The first may value water at $800 per megalitre, as they may still be able to profit from producing a crop at that amount, whereas the second may only value water at $200, as any amount beyond this would mean that selling water is more profitable than producing their crop.
If supply and demand in the market are such that the price of allocation water is $300 per megalitre, and these two irrigators agree to trade at that price, this creates total benefits of $600 per megalitre – distributed as $500 per megalitre to the first and $100 per megalitre to the second.

In this scenario, the seller receives more money in selling water than they would have expected to generate from using it. The buyer uses the water to generate expected addition returns that should exceed the cost of the water purchase. Trade is voluntary. It occurs when there are benefits to both the buyer and seller.

4.2. Individuals

4.2.1. Overview

Water trade allows water to be reallocated to those that value it most – by revealing a price for water, it encourages users who place a lower valuation on their water at a particular time, to sell to those that have a high valuation (NWC 2012). In deciding to transact, trades provide benefits to both buyers and sellers. As noted in the Box above, trade can mean greater returns than using water for sellers, and additional returns to buyers in excess of the cost of acquiring more water.

A 2010 assessment by the National Water Commission (NWC 2010) found that water trade helps individual irrigators manage and respond to external drivers by allowing more flexible production decisions, leading to improved cash flow, debt management, and risk management. Water allocation trade helped irrigators manage seasonal conditions, including maintaining permanent plantings, while entitlement trading facilitated longer term change, including allowing sellers to restructure, or buyers to develop new activities or improve supply.

4.2.2. Water allocation trading

Water allocation trading is frequently used as a mechanism to manage seasonal variations in water availability, but can also be used to temporarily contract or expand production, or is used to access carryover provisions (noting that carryover is limited, see comment below), or by third parties to offer particular services. In some cases, enterprises have been established that do not hold entitlements and rely solely on allocation trade to meet water requirements.

For the most part however, water allocation trading is used extensively by irrigators as a farm management tool. Data published by the National Water Commission in 2012 suggested 47 per cent of respondents to a survey at that time had traded water on the allocation market. The same survey suggested almost all irrigators consider the ability to trade allocations as beneficial to their farm business (NWC 2012).

Impacts of water allocation trading

The major impacts of water allocation trading to individual irrigators can be summarised as:

• Generating additional income – water allocation sales can generate income to help pay off debt, cover costs, or fund new on farm investments. In periods of low water availability sales can provide income where there would otherwise have been none (as allocations were too low to

3 It should be noted that there are limits on carryover provisions in Victoria designed to avoid third party impacts and other issues. See: http://waterregister.vic.gov.au/water-entitlements/carryover/carryover-rules
produce crops). For some irrigators, they may have entitlement in excess of production needs, so can sell surplus water. There is evidence of wide spread use of sales to generate income across many different farm and crop types.

- **Minimising input costs** – trade allows irrigators to minimise input costs and optimise performance, particularly in the dairy industry. The price signal provides the ability to make decisions on trade-offs between buying feed versus growing it, and allocation trading allows them to optimise inputs to achieve the lowest cost.

- **Maintaining production in dry periods** – not irrigating certain crops in dry periods can have very high costs and consequences. Some irrigators may need to maintain operation at a certain size, may have committed to long term output contracts, can incur significant start up or shut down costs to change production, or may lose future revenues. Allocation trading mitigates these risks or impacts.

- **Improving production and productivity** – allocation trading allows irrigators to expand production at favourable times, such as in response to improved commodity prices, or to make up for lean years. At certain times of the year, not watering could result in loss of a crop, so additional purchases can cover critical shortfalls.

- **Using trade to access carryover** – Carryover can be used to manage water availability risk across seasons. Allocation trading supports carryover strategies by allowing water to be transferred to entitlements that have carryover available, and using this water in the future. Strategies may include hedging against low season opening allocations by buying water later in the season and carrying it over. However the ability to mitigate water availability risk using such strategies is limited by carryover limits that Victoria has in place.

**4.2.3. Water entitlement trading**

Similar to allocation trading, National Water Commission data suggests entitlement trading is widely seen by irrigators as beneficial to farm management (NWC 2012). While a lot of entitlement sales were to the Commonwealth for water recovery for the environment in the late 2000s and early 2010s, this has generally not been occurring in Victoria or elsewhere more recently (see also section 5.5). There is now entitlement trade amongst irrigators and a range of other participants (such as urban users, investors, or third parties offering lease or forward contracting services for water).

Entitlement trade has often been associated with risk management and longer term adjustment in the scale of enterprise activity. Irrigators buying entitlements may do so to manage the risk of supply shortfall, particularly for high value permanent crops. However, they may also buy to expand production for new investments. Sellers may do so to improve access to capital for different reasons.

**Impacts of water entitlement trading**

The major impacts of water entitlement trading to individual irrigators can be summarised as (NWC 2012):

- **Expansion and new investment** – irrigators can trade entitlements to manage risk while expanding or developing new investments. As structural changes occur in the economy, irrigators can trade entitlement to take advantage of opportunities by expanding. In the Victorian Murray, significant expansion and investment in horticulture would not have been possible without

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4 See previous note regarding carryover limits.
entitlement trade, and similarly, it would not have been possible for wine grape growers to respond to structural change in that industry effectively without entitlement trade.

- **Accessing capital** – entitlements can be sold to access capital, which can then be used for purposes such as reducing debt that may accumulate in drought or lean years, to make more efficient use of available capital, to make investments, supplement income, exit the industry, adapt holdings to better meet circumstances, or invest in more property or plant and equipment.

- **Facilitating more efficient use of capital** – many irrigators have sold entitlements to access capital, but chosen to continue producing based on sourcing water from the allocation market, as it can be more efficient to use the capital in others ways, depending on the price of water. Conversely some investors have purchased entitlement to gain long term exposure to a diversified asset class that has a low level of correlation with other investments.

- **Changing the scale or nature of irrigation activities** – many irrigators use entitlement trade to adjust the scale or nature of activities, including in response to climate, product market conditions, or changes in personal circumstances.

### 4.3. Industries

#### 4.3.1. Overview

Impacts to industries are an extension of the impacts to individual irrigators, and can be revealed by trends at the industry level, such as in relation to water use and production. The nature of production in different industries also reveals the way in which they can benefit from trade. For example (see NWC 2012):

- **Perennial horticulture** benefits from trade because water demand in this industry is highly non-interruptible. Horticulturalists can hold entitlements to manage supply risk, but can also buy and sell allocations, including if they have been relatively more or less conservative with entitlement holdings.

- **Rice and mixed farming enterprises** benefit by being able to alter the area under irrigation depending on water availability. Substitution can also occur for dryland production systems, and production can also expand during periods of higher water availability. Mixed farmers and rice can easily change production depending on access to water, and prices, while maximising income.

**Dairy farms** are semi-interruptible production processes. Production is not as easily varied as for rice and mixed farming, but there are some substitutes for irrigation of annual pasture such as purchased feed or cattle agistment (NWC 2012). Allocation purchases can maintain short term productive capacity, while selling allocation or entitlement can allow for substitute input purchases such as feed. Community impacts are further discussion in Section 4.7 below.

#### 4.3.2. The dairy industry

The National Water Commission’s 2012 Impacts of trade report identified three main areas of benefit for the dairy industry:

- optimising feed costs during drought
- facilitating industry adjustment
- improving overall capital efficiency of the industry.
Optimising feed costs

The 2002-03 drought had particularly severe impacts for dairy farmers in the Goulburn region, due to low water availability. This resulted in the build-up of substantial debt, but water trading in 2006-07 to 2009-10 was used to help minimise the cost of feeding herds and contribute to maintaining income.

The dairy industry now increasingly responds to water allocation prices, fodder prices, and milk prices, to optimise costs. The dairy industry now understands the price threshold in the market at which switches should be made from buying to selling water. When downstream horticulturalists demanded large volumes of water in 2007-08 and 2008-09, allocation sales by dairy farmers generated good income due to high water prices which helped maintain production.

Structural adjustment and debt reduction

The 2002-03 drought and extended dry conditions from 2006-07 in both the Goulburn and Murray, as well as falling milk prices in 2009, had major impacts on the northern Victorian dairy industry (NWC 2010). There were many sales of entitlement to the Commonwealth or other producers as a result, and declines in the number or size of dairy farms, or changes in the extent of production. However water sales substantially mitigated the overall impacts, and resulted in there being more income available than would otherwise have been the case. This helped to pay down accumulated debt, and helped recovery in subsequent years. While this is the case, in some circumstances sales may not have been the preferred strategy (see further discussion in Section 4.7 and 5.7).

Improving capital efficiency

As outlined in Section 4.2.3 water entitlement trading can increase the efficiency of capital deployed, and has been the case in the dairy industry. Water trading has become more central to its operation, including short and long term decision making. Many irrigators rely on carryover and water allocation trading to meet water needs, after having sold entitlements which has freed up capital to be used for other purposes. There is also greater use of carryover and low-reliability entitlements to facilitate carryover (some lower reliability entitlements only receive allocations infrequently, but do have carryover associated with them so water is often traded onto them to carry water over).

Impacts on industry production

The National Water Commission also investigated industry level statistics as part of its 2012 assessment. During the worst years of the millennium drought, milk production declined substantially. However, water trade was determined not to be a substantial driver of reduced milk production, but rather the drought itself, and commodity prices.

4.3.3. Horticultural industries

The National Water Commission’s 2012 Impacts of trade report identified a number of areas of benefit for horticultural industries:

- enabling growth
- responding to seasonal conditions
- facilitating structural change.

Enabling growth

Water entitlement trading has been closely linked to expansion of horticultural industries in Victoria’s Sunraysia region. The ability to purchase water underpinned development, and allowed irrigation of...
new areas of land, as well as enabling existing irrigators to shift to new crops. A key driver for this has been responding to profitability incentives in horticulture. Previous investment and expansion in Victoria’s wine grape industry around Mildura would not have been possible without water entitlement trading (see also Facilitating structural change below).

Responding to seasonal conditions
Trade of allocations was essential for the horticulture industry in Sunraysia in years of historically low levels of water allocations. The horticultural industries purchased large volumes of allocations from rice growers, as well as dairy and mixed farmers. Wine grape and almond growers purchased additional allocation to keep almond trees alive and maintain production. Without the market, it is likely that many trees would have died, which would have significant consequences for the industries as a whole, including flow on effects.

Facilitating structural change
The wine grape industry was significantly impacted on by changes in structural conditions from the boom years of the 1990s, to the 2000s where oversupply and commodity price impacts put significant pressure on the industry overall. The ability to trade entitlements was a significant contributor in allowing the industry to adjust, and also to facilitate growth in other areas, or in returning water to the environment. In the absence of entitlement trade, the process of change would have been substantially more difficult given the revenues that entitlement sales generated.

Impacts on horticultural industry water use and production
The National Water Commission’s assessment found that water trade contributed to enabling horticultural industries to manage through the worst impacts of the millennium drought. This was evidenced by water use being maintained during low water availability years, as supported by allocation trade. This contributed to maintaining production, which was relatively steady for wine grapes from 2004-05 to 2009-10 and increased substantially for almonds (which was also supported by entitlement purchases).

4.4. Urban supply and users
Water markets can provide benefits to urban water suppliers, including for water supply security in regional towns such as Bendigo and Wodonga. Impacts can also be provided around balancing supply and demand at least cost, including drawing on lower cost sources of supply to delay large capital investments.

4.4.1. Examples of rural-urban water trade in Victoria
During the 2000s, several urban water suppliers in the MDB purchased entitlements or seasonal allocations from irrigators to improve supply security, including Victorian regional water authorities Coliban Water (Bendigo), Central Highlands Water (Ballarat), North East Water (Wodonga), and Lower Murray Water (Mildura) (NWC 2012).

Large urban water customers in northern Victoria also bought seasonal water allocations from irrigators through pilot trading schemes facilitated by regional water authorities (NWC 2012). However, Goulburn Valley Water sold up to 9000 ML of allocations to other water authorities and irrigators as its annual volume of water available from its bulk entitlement exceeded that required (NWC 2012).
Changes in conditions from 2010 onwards saw shifts in trading decisions, including reduced entitlement and seasonal allocation purchases or more sales of seasonal allocations. In 2010–11 Coliban Water did not purchase any seasonal allocations or access entitlement, Goulburn Valley Water increased allocation sales and there was little or no trade through pilot trading schemes in Victoria or by local councils along the NSW Murray River (NWC 2012).

4.4.2. Impacts on urban users

Two key impacts of water trading to urban water users includes the avoided cost of water restrictions, and minimising impacts on urban supply costs and prices.

Avoided costs of water restrictions

During drought in the 2000s, many regional water suppliers would have needed to implement water restrictions if allocation trade was not available. Allocation trade avoided a number of potential costs associated with restrictions, such as damage to sports fields, park, gardens and commercial plantings.

The NWC estimated that in a regional urban area such as Bendigo or Ballarat the costs of restrictions to consumers alone may total around $9,560,000 per year (in 2003 dollars). In the case of Bendigo, the NWC suggested the avoided costs attributable to water trading in the case of Bendigo and Ballarat, may have been the difference between extreme levels of restrictions (due to the risk of running out of dam water) and comparatively moderate restrictions. Rural-urban trade can also have a longer term benefit in reducing the incidence of restrictions over time; entitlement purchases can support existing bulk entitlements to support longer-term security.

Impacts on urban supply costs and prices

Feedback from pilot trading programs in Victoria also suggests trading has provided low cost options for urban water suppliers. During the Millennium Drought, North East Water highlighted the cost of trucking 1 ML of water at $8,500 whereas purchasing that through the trading program cost $1,316, and bore construction for 2 ML was $16,000, whereas via trade the cost was $2,638 (NWC 2012).

4.5. Regional and state level impacts

At the regional, state, and even national level, water trading provides aggregate economic benefits, because it encourages water to move to higher value uses, thereby increasing the value derived from water resources, and benefiting the overall economy.

Similar work undertaken by the National Water Commission through the Millennium drought as referred to in previous sub sections provides some quantification and other evidence of how water trading impacts the state and regions. While this work focused on impacts in the southern MDB, similar principles apply to other regions where there is the ability to trade between locations and that have heterogeneous demand.

4.5.1. Aggregate irrigated agricultural production

As noted above in relation to individual and industry level impacts, water trading can help to ensure ongoing (and higher value) production, where it might not otherwise have been able to occur. One
method, which has some important caveats, to demonstrate this is to compare the gross value of irrigated agricultural production and water use. In severe drought years, water use will generally have to fall, even with trade because of reduced water availability. However, the value of production can potentially be maintained (or losses minimised) by reallocating water. While many other factors affect gross value of production (e.g. commodity prices, exchange rates), the comparison does suggest that water trading may be contributing to minimising negative impacts on the value of irrigated agricultural production in periods of drought (Figure 4).


Figure 4  Gross value of irrigated agricultural production and water use in the MDB (2005-06 to 2008-09)

Earlier studies, including a 2010 study by the National Water Commission (NWC 2010), also point to production impacts at the aggregate level. CGE modelling for that study estimated that water trading contributed $270 to $370 million to southern MDB production during each of the very dry years from 2007-08 to 2008-09.

4.5.2. Economic impacts of trading between irrigators

Updated modelling undertaken of the Millennium Drought for the NWC’s 2012 assessment provides evidence of economic benefits of trade between irrigators. While the gross domestic product (GDP) of the southern MDB is reduced substantially during drought years, the impact is much less when there are opportunities for inter and intra-regional trade. This is because water trading alleviates drought-induced output and job losses.

In each of the most extreme 2007-08 and 2008-09 years more than $200 million can be attributed to inter regional water trading. Over the period 2006-07 to 2010-11 the NWC modelling suggests southern MDB production was $845 million higher than it would have been in the absence of interregional trading (NWC 2012). Overall, water trading and on farm factor mobility resulted in gains of $1.05 billion and $1.2 billion in 2007–08 and 2008–09. Over the five years from 2006–07 to 2010–11, sMDB production was $4.3 billion higher than it would have been without water trading and on farm reallocation of water between irrigation activities (NWC 2012) (see Figure 5 below).
Regional and state level impacts

The same work completed by the National Water Commission (2012) demonstrated the regional and state-level economic benefits. Their extent depends on whether a region tends to be an importer or exporter of water during dry conditions. For the period 2006-07 to 2010-11 Victoria was a net importer of water, and as a result of full trading, there was $885 million in benefits compared to a situation of no trading. Over the same period, production benefits at the basin scale were positive.

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</table>


The environment

The environment has benefited from water trading mainly due to the ability for government water recovery programs to purchase water and return it to environmental assets. Some impacts have also been provided due to the net movement of water downstream during drought periods due to trade.

4.6.1. Government buyback of water rights

To achieve sustainable diversion limits, governments have been returning water to the environment through different recovery mechanisms. This has been occurring throughout the MDB, and has also been contributing to achievement of sustainable diversion limits under the Basin Plan. To date, the
most of water recovery to meet Basin Plan requirements has been recovered through market mechanisms, under a number of different programs, but primarily under the Commonwealth’s Restoring the Balance in the Murray Darling Basin program. Purchasing has mostly occurred over the period 2008 to 2012.

To date, approximately 1,000GL of water entitlements has been returned to the environment from the southern MDB via market mechanisms (also see section 5.5). This has resulted in substantial volumes of water being directed to improving the condition of environmental assets by environmental managers who now receive annual allocations against their resulting entitlement portfolios. This has also provided benefits to willing sellers who have received market prices for their water entitlements, using proceeds for investment, capital restructuring, debt management and other purposes.

However, as discussed further below, there have been concerns about the industry and local community level impacts of water purchases by the Commonwealth.

Table 2  Cumulative water entitlements purchased by Commonwealth Government – registered at start of water year (GL)

<table>
<thead>
<tr>
<th>Entitlement type</th>
<th>07-08</th>
<th>08-09</th>
<th>09-10</th>
<th>10-11</th>
<th>11-12</th>
<th>12-13</th>
<th>13-14</th>
<th>14-15</th>
<th>15-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vic 1A Greater Goulburn HRWS</td>
<td>-</td>
<td>1</td>
<td>54</td>
<td>96</td>
<td>182</td>
<td>187</td>
<td>187</td>
<td>188</td>
<td>188</td>
</tr>
<tr>
<td>Vic Murray HRWS</td>
<td>-</td>
<td>6</td>
<td>75</td>
<td>138</td>
<td>222</td>
<td>228</td>
<td>229</td>
<td>229</td>
<td>229</td>
</tr>
<tr>
<td>Vic 1A Greater Goulburn LRWS</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Vic Murray LRWS</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
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<td>11</td>
</tr>
<tr>
<td>SA Murray HS</td>
<td>-</td>
<td>1</td>
<td>39</td>
<td>67</td>
<td>93</td>
<td>96</td>
<td>96</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>NSW Murray HS</td>
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<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>NSW Murrumbidgee HS</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>NSW Murray GS</td>
<td>-</td>
<td>8</td>
<td>171</td>
<td>195</td>
<td>218</td>
<td>248</td>
<td>253</td>
<td>253</td>
<td>253</td>
</tr>
<tr>
<td>NSW Murrumbidgee GS</td>
<td>-</td>
<td>14</td>
<td>64</td>
<td>99</td>
<td>152</td>
<td>184</td>
<td>189</td>
<td>189</td>
<td>189</td>
</tr>
<tr>
<td>Total</td>
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<td>32</td>
<td>424</td>
<td>618</td>
<td>895</td>
<td>978</td>
<td>995</td>
<td>996</td>
<td>996</td>
</tr>
</tbody>
</table>

Source: Aither 2016a.

4.6.2. Management options for environmental water holders

Water trading also impacts the managers of the environmental entitlement portfolios that exist as a result of water recovery programs. Trade has enabled such users to move water between different locations to ensure water is able to reach the environmental assets in most need (it is the primary mechanism by which this is achieved, with substantial volumes being transferred to delivery partners or locations every year). Where an environmental holder deems it appropriate, such as being able to deliver greater environmental outcomes, they may be able to sell allocation water. This can provide financial benefits to environmental holders which can be put towards other aspects of environmental management and improvement, while also benefiting buyers of the allocations.
4.7. Localised adjustment pressures

Water trading provides flexibility for irrigators and their communities to respond to change. Overall, including at the state and national level, this movement of water is generally economically beneficial, as water is moving in response to changes in supply and demand, and generally moving to higher value uses. However, where large volumes of water move in or out of a region, or do so rapidly, this can be challenging for some individuals and businesses.

Even though water trading may have little net impact on aggregate water use within a large region, smaller areas within the region may experience larger proportional changes in the amount of water used due to trading (NWC 2010). Local reductions in water use can have community impacts through direct, indirect and flow-on effects on local economic activity. Examples include reductions in local income generated by industries such as agricultural services and farm supplies, and food processing (NWC 2010).

Issues related to adjustment were investigated by the NWC in the context of drought in both its 2010 and 2012 assessments on the impacts of water trade. In its 2010 assessment, the NWC observed that water trade may have accelerated certain underlying trends, but was not the sole or primary driver of the need to change or adapt – i.e. water trade was not the cause of water moving between regions, but did facilitate it. For example, the NWC found that (NWC 2010 p. 67):

This is strong evidence that other factors (for example, drought) are more significant drivers of changes in the indicators, and that changes in regional water use due to trading did not play a significant role in influencing overall socioeconomic outcomes at the regional level in the sMDB over the study period.

The NWC also concluded that there is not a strong relationship between patterns of regional water trading and socioeconomic outcomes, based on analysis of a range of data and socio-economic indicators. This supported the view that there is much complexity surrounding and a range of drivers of adjustment. For example, the NWC concluded that regional water trading patterns do not explain:

- relative changes in employment in agriculture among regions
- changes in average incomes across regions
- changes in population across regions
- changes in unemployment across regions.

The NWC also undertook detailed regional case studies in its 2010 report, many of which focused on Victorian regions. These concluded that there were a range of drivers, and mixed results, with respect to socio-economic indicators or change. Some regions experienced population declines, while others increased, in some cases net movement of water correlated with such trends, while in others it did not. For example, the NWC noted outward trade may have played a role in accelerating the ongoing process of change in the Pyramid Hill and Boort communities, which experienced population declines over the study period, but outward trading in the area was largely a response to underlying land and water management factors. Conversely population in Rochester was similar over the study period, while water use was generally higher due to inward allocation trading. While localised changes in water use in the Shepparton and Central Goulburn irrigation districts were small, particularly in comparison with changes due to drought (NWC 2010).

In its 2012 assessment of the impacts of trade, the NWC reached similar conclusions to its 2010 assessment, including that drought and other factors were the primary drivers of change, but that water trading could contribute to adjustment pressures. For example, the assessment found:
Reduced irrigated agricultural production as a result of outward water allocation trading during the drought may have contributed in some cases to declines in local economic activity and employment and increased pressure on human services. However, drought was the dominant factor driving those impacts, and it is not possible to attribute specific changes to the impacts of water trading.

While both of the NWC’s assessments generally concluded that water trading was not a primary driver of adjustment pressures and local community impacts, it is important to note that that the net movement of water between regions – whether entitlement or allocation, can have impacts on local regions and communities. It is also important to note that when negative impacts occur, positive impacts are likely to occur in another region, including growth of new industries and increased economic activity in regions where water is moving to. It is also important to note that this movement is necessary to ensure irrigated agricultural industries can adapt to changing environmental and economic conditions and ensure longer term economic sustainability.

Analysis of more recent data with respect to water movement and ownership in northern Victoria is further explored in the following chapter.
5. **Recent changes in water markets**

Since major flood years in the early 2010s, there has been another drying cycle with declining water availability resulting in water allocation prices increasing. At the same time, there have been other drivers of change, including in the nature and location of demand for water. In combination, these and other factors have been intensifying the need to adapt and change.

5.1. **Overview**

While water markets are now very well developed and utilised (in the southern MDB), compared with other markets they are relatively young. Since the major step change in market participation that occurred following key reforms in 2007 there has been one extremely severe drought period (2007-08 and 2008-09), an extremely wet period (2009-10 and 2010-11), followed by a drying phase to the present. This effectively means one major cycle in water availability, and correspondingly one major cycle in prices.

Most recently there has been a significant strengthening in prices for water allocations and entitlements, broadly corresponding with the return to dry conditions. However, other factors have been influencing prices, on both the supply and demand side. Given the substantial and rapid rebound in prices there has been significant concern amongst stakeholders and communities.

A number of recent reports have highlighted both supply and demand side drivers that have contributed to price movements, as well as resulted in significant changes in use and ownership of water. This section explores these changes and their implications for irrigation industries.

*Allocation markets are reflecting the fundamentals of supply and demand*

As per any other market, water markets are primarily driven by supply and demand. An increase in supply or reduction in demand tends to result in lower prices, whereas a reduction in supply or increase in demand tends to have the opposite effect. While the determinants of supply and demand are extremely complex, depending on individual decisions by thousands of market participants, even relatively simple statistical models of supply and demand can be very successful in explaining and predicting aggregate market outcomes, such as trends in water allocation prices (Aither 2016a).

Aither (2016a) shows that observed allocation prices in the southern MDB have a strong and predictable relationship with total water available for consumptive use and rainfall in irrigation areas (See also Figure 6). This provides strong evidence that water allocation markets are working in a predictable, flexible and therefore efficient manner.
Water markets in northern Victoria are linked to markets in southern New South Wales and South Australia. So changes in both supply and demand in those markets typically affect northern Victoria (see Aither 2016a and 2016b). For example, the expansion of the cotton industry in the New South Wales Riverina has led to increased water demand, and higher water allocation prices in northern Victoria. Another implication is that water allocation prices tend to be similar across the southern Murray-Darling Basin at any given time, notwithstanding occasional differences due to trade restrictions.

5.2. Water market outcomes

The following discussion highlights the nature of changes observed in the market over that period; following sections explain the observations in the data by analysing changes in supply and demand.

5.2.1. Water allocation prices

Water allocation prices have broadly moved in the opposite direction to water availability (compare Figure 7 and Figure 9). Water allocation prices were briefly as high as $1,000 per ML during the worst of the Millennium Drought, before falling to around $20 per ML during 2011-12. In March 2016, water allocations were trading for around $250 per ML.

Prices for allocation are highly correlated to total water availability in the southern MDB, and specifically to water allocations which along with crop rainfall is the primary supply of water to irrigated agricultural production (Aither 2016a).

Over time, there has been a significant decrease in the distribution of prices in the data, indicating improved understanding of the value of water, drivers of prices, and the operation of the market by participants. Figure 7 demonstrates that there has largely been one price for allocations across the southern connected MDB at any one point in time.
The evolution of water markets

Source: Aither Water Market Database.

Figure 7  Price of all water allocation trades in the sMDB (2007 to 2016)
5.2.2. **Water entitlement prices**

While water allocation prices tend to be similar across regions in most years, water entitlement prices differ based on their characteristics. For example, in northern Victoria, VIC 6 Murray high reliability entitlements generally trade at a discount to VIC 7 Murray high reliability and VIC 1A Greater Goulburn high reliability, due to there being marginally less opportunity to trade allocations made to entitlements. Hydrological limitations, such as those associated with the Barmah choke can reduce the extent of opportunity for trading the allocations made to VIC 6 Murray high reliability entitlements. Low-reliability entitlements trade at low values because they only receive allocations in very wet years (so cannot be relied upon to regularly supply water for production), but can be used to carry over water (so have some value because they allow for carryover of water by trading it onto low reliability entitlements from other sources).

Expectations regarding future available water determinations and allocation prices are a key determinant of prevailing water entitlement prices. Water entitlement prices in northern Victoria were generally above $2,000 per ML between 2008 and 2010. Entitlement prices subsequently declined to less than $1,500 per ML in 2013. Since then there has been a period of steady appreciation. In March 2016, VIC 7 Murray high reliability and VIC 1A Greater Goulburn high reliability water shares were trading at around $2,900 per ML.
The evolution of water markets

Source: Aither Water Market Database.

Figure 8  Price of all water entitlement trades for selected HRWS Victorian entitlement types (2007 to 2016)
Higher water prices are neither inherently good nor bad. It is efficient for water prices to adjust to reflect changes in expectations regarding the value of water over time – if water genuinely becomes scarcer, the price should increase. As has been discussed previously, this creates appropriate incentives for efficient water use and avoids shortages. It also ensures water moves to where it is most highly valued at any given point in time. Importantly, entitlement prices are based on expectations for the future. This means that the market can effectively price in the availability and value of water expected in the future.

5.3. Changes in supply

5.3.1. Water allocations

The supply of water allocations depends on the volume carried over from the previous season and the volume announced for the current season. The volume of water allocations announced for the current season depends on water availability, which in turn depends on catchment rainfall. Variability in rainfall over the last decade has resulted in large fluctuations in the volume of water allocations announced across the southern connected MDB (Figure 9).

![Allocations to major sMDB entitlements (1998-99 to 2015-16)](image)

Source: Aither.

Figure 9  Allocations to major sMDB entitlements (1998-99 to 2015-16)

The annual volume of water allocations announced ranged from around 1,900 GL during the worst years of the Millennium Drought (2007-08 and 2008-09) to around 6,900 GL after the Millennium Drought broke (2011-12 and 2012-13). In the last few years, the annual volume of water allocations announced has again fallen as the catchments have dried. By early 2016, some parts of Victoria had experienced serious and severe rainfall deficiencies over the past 20 months (BOM 2016).
5.3.2. Carryover

Reliable data on carryover is not available for all sMDB states, however data is available for Victoria. The volume of water allocations carried over in northern Victoria has varied substantially over time, and has been highly correlated with water allocations as market participants sought to carryover water from relatively wet seasons when water is less valuable to relatively dry seasons (Figure 10). For example, around 2,100 GL were carried over to 2011-12 following an unusually wet season in 2010-11. This substantially increased the supply of water allocations in that season, and reduced irrigation demand. Since then carryover has been drawn down as seasonal conditions have deteriorated. Around 360 GL was carried over to 2015-16.

![Carryover Volume Graph]


Figure 10 Volume of carryover (after spills), northern Victoria (2007-08 to 2015-16)

5.4. Changes in demand

In addition to changes in the supply of water allocations, there have been significant changes in demand by urban water authorities and irrigators.

5.4.1. Irrigators

There has been a substantial change in water demand by irrigators across the southern connected MDB over the last decade. Figure 11 shows changes in water use for irrigation by activity in the sMDB (including groundwater). Water use varied substantially across years for dairy and rice, but was more consistent for fruits and nuts. This will continue to change over time.

The bulk of this variability in water use is due to variability in water allocation prices as a result of changes in seasonal conditions. Separating the effects of seasonal conditions from changes in underlying demand is challenging. One option is to compare water use across seasons with similar water allocation prices, such as 2005-06 and 2013-14, when median water allocation prices were similar at around $75 per ML after adjusting for inflation. This comparison suggests that demand has fallen for dairy, rice and grapes. By contrast, demand has increased for cotton and nuts.

These changes in demand are driven by a myriad of factors, including changes in:
The evolution of water markets

- commodity prices – for example, the prices of many varieties of wine grapes have fallen substantially
- input prices – for example, electricity prices have increased significantly in some regions, increasing the costs of pumping water
- production technology – for example, improved varieties for cotton have allowed production to move further south, while there have been investments in farm infrastructure (Aither 2016b).

Source: Aither (2016a).

Note: Water use also varies with changes in climatic conditions, which should be considered when interpreting this figure, including comparing use between years. For reference, 2005-06 and 2012-13 had similar water availability, and 2008-09 had severe shortages in water availability which influenced use.

Figure 11 Water use for irrigation by activity in the sMDB (2005-06 to 2013-14)

Interstate movements in water use

In recent dry seasons, there has been net trade in water allocations from New South Wales to Victoria (Figure 12). This trend was reversed in 2011-12 and 2012-13 when due to high carryover volumes water availability was high. Net trade from South Australia to Victoria follows a less clear pattern – in the worse years of drought there was small movements into SA, while in two wet years water moved to Victoria, in more recent average to dry years there has been movement into Victoria.

These trends depend on demand, including the composition of irrigation activities and their responsiveness to changes in water prices, and supply in different states. These issues are discussed in detail in Cummins (2016), but include structural adjustment in different industries, including some irrigators exiting particular industries or regions, with other industries being created or growing in other locations. Overall, Figure 12 shows that the expansion of allocation trade across state borders is generally resulting in increased movement of water into Victoria in most years. With increased competition for water within Victoria, this interstate trade in will continue to be important.
The evolution of water markets

Figure 12  Net allocation trade into Victoria (excluding within environment trade) (2007-08 to 2014-15)

Changes in water use in northern Victoria

Table 3 below shows that there has been modest decline in water use in GMW districts but more substantially for GMW diverters in addition to LMW districts, over the last decade. However, there has been a doubling of water use over the same period by LMW diverters.

### Table 3  
Annual water use in Northern Victoria by user group and location

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigator</td>
<td>Central Goulburn</td>
<td>389</td>
<td>140</td>
<td>171</td>
<td>121</td>
<td>289</td>
<td>414</td>
<td>313</td>
<td>347</td>
<td>-11%</td>
</tr>
<tr>
<td></td>
<td>Shepparton</td>
<td>157</td>
<td>64</td>
<td>72</td>
<td>42</td>
<td>103</td>
<td>163</td>
<td>127</td>
<td>128</td>
<td>-19%</td>
</tr>
<tr>
<td></td>
<td>Rochester</td>
<td>199</td>
<td>58</td>
<td>84</td>
<td>52</td>
<td>153</td>
<td>215</td>
<td>163</td>
<td>173</td>
<td>-13%</td>
</tr>
<tr>
<td></td>
<td>Pyramid-Boort</td>
<td>222</td>
<td>70</td>
<td>100</td>
<td>44</td>
<td>152</td>
<td>234</td>
<td>164</td>
<td>204</td>
<td>-8%</td>
</tr>
<tr>
<td></td>
<td>Campaspe</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>11</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-88%</td>
</tr>
<tr>
<td></td>
<td>Murray Valley</td>
<td>283</td>
<td>92</td>
<td>127</td>
<td>92</td>
<td>209</td>
<td>302</td>
<td>222</td>
<td>227</td>
<td>-20%</td>
</tr>
<tr>
<td></td>
<td>Torrumbarry</td>
<td>405</td>
<td>112</td>
<td>173</td>
<td>130</td>
<td>332</td>
<td>423</td>
<td>304</td>
<td>348</td>
<td>-14%</td>
</tr>
<tr>
<td></td>
<td>Nyah, Tresco &amp; Woorinnen</td>
<td>20</td>
<td>17</td>
<td>17</td>
<td>10</td>
<td>18</td>
<td>23</td>
<td>21</td>
<td>23</td>
<td>12%</td>
</tr>
<tr>
<td>GMW districts</td>
<td>GMW districts subtotal</td>
<td>1,686</td>
<td>555</td>
<td>745</td>
<td>495</td>
<td>1,267</td>
<td>1,776</td>
<td>1,316</td>
<td>1,450</td>
<td>-14%</td>
</tr>
<tr>
<td>GMW diverters</td>
<td>GMW diverters subtotal</td>
<td>133</td>
<td>43</td>
<td>33</td>
<td>19</td>
<td>59</td>
<td>104</td>
<td>89</td>
<td>91</td>
<td>-32%</td>
</tr>
<tr>
<td>LMW districts</td>
<td>Robinvole, Red Cliffs, Merbein</td>
<td>86</td>
<td>60</td>
<td>56</td>
<td>33</td>
<td>66</td>
<td>73</td>
<td>64</td>
<td>61</td>
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</tr>
<tr>
<td></td>
<td>FMID</td>
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<td>30</td>
<td>13</td>
<td>28</td>
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<td>34</td>
<td>33</td>
<td>-34%</td>
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<td>LMW districts</td>
<td>LMW districts subtotal</td>
<td>136</td>
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<td>87</td>
<td>46</td>
<td>94</td>
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<td>98</td>
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<td>-30%</td>
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<td>LMW diverters subtotal</td>
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<td>236</td>
<td>270</td>
<td>190</td>
<td>310</td>
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<td>354</td>
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<td>103%</td>
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<td>Irrigator subtotal</td>
<td>Irrigator subtotal</td>
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<td>751</td>
<td>1,731</td>
<td>2,402</td>
<td>1,857</td>
<td>2,033</td>
<td>5%</td>
</tr>
<tr>
<td>Water corporation</td>
<td>Not specified</td>
<td>unknown</td>
<td>79</td>
<td>111</td>
<td>64</td>
<td>73</td>
<td>74</td>
<td>70</td>
<td>73</td>
<td>N/A</td>
</tr>
<tr>
<td>Environment</td>
<td>Not specified</td>
<td>unknown</td>
<td>25</td>
<td>41</td>
<td>224</td>
<td>315</td>
<td>334</td>
<td>659</td>
<td>512</td>
<td>N/A</td>
</tr>
<tr>
<td>TOTAL</td>
<td>TOTAL</td>
<td>2,150</td>
<td>1,028</td>
<td>1,287</td>
<td>1,038</td>
<td>2,118</td>
<td>2,810</td>
<td>2,587</td>
<td>2,618</td>
<td>12%</td>
</tr>
</tbody>
</table>

Source:  
Impact of irrigator demand on prices

Changes in demand by irrigators have affected water allocation prices over the last decade. In the sMDB there has been an increase in demand for allocations by the cotton and nuts industries. On the other hand, there has been a decrease in demand for allocations by the dairy and rice industries (Aither 2016b). These changes in demand are evident when comparing water use by industry across years with similar allocation prices, such as 2005-06 and 2013-14 (Figure 11).

The overall effect of these opposing trends on allocation prices is a potential area for further research, but it is likely that irrigators have contributed towards a firming of demand for allocations. This has been largely driven by the nuts industry, which tends to be less sensitive in terms of water use to high allocation prices than other industries. As a result, the expansion of the nuts industry has contributed towards greater competition for allocations in low allocation seasons, leading to higher allocation prices in those seasons. However, in moderate and high allocation seasons, the increase in demand by the cotton and nuts industries may have been offset by the decrease in demand by other industries, leaving allocation prices largely unaffected.

Potential future scenarios and implications are explored further in Section 5.6.

5.4.2. Environmental water

Government water entitlement purchases

As part of broader initiatives to improve environmental outcomes in the MDB, the Commonwealth Government has purchased around 1,000 GL of water entitlements in the sMDB under the Restoring the Balance Program since 2007-08. As was outlined in Section 2.1, such purchases have been undertaken to address past over allocation of water resources. Because they are purchases of existing water shares they can be considered an increase in demand on the existing consumptive pool, rather than a decrease in the size of the consumptive pool.

The bulk of these water entitlements were purchased before 2012-13 (see Table 2). With growth in the environmental water portfolio, the water allocations associated with the portfolio also increased (as shown by the green bars in Figure 13) – however, the portfolio has not grown since 2012-13. In 2014-15, around 15 per cent of total allocations in the southern MDB, or 785 GL, was allocated to water entitlements purchased under the Restoring the Balance Program.5

5 The size of the allocation to the portfolio in each year is influenced by the total entitlements held but also the proportion of lower and higher reliability entitlements.
The evolution of water markets

Note: The total volume of water allocated to Commonwealth water purchases is reported based on the year to year cumulative portfolio growth (i.e. it is not just purchases in that year).

Source: Aither (2016a).

Figure 13  Total water allocations in the southern MDB to consumptive and Commonwealth environmental entitlements between 2005-06 and 2015-16

Other water recovery mechanisms

In addition to Commonwealth water entitlement purchases, a substantial volume of entitlements has been acquired through other mechanisms, including:

- off-farm efficiency programs (infrastructure investments in irrigation systems and networks to reduce evaporation and seepage losses)
- on-farm efficiency programs (infrastructure investments to upgrade on-farm irrigation infrastructure).

Some of the water acquired through these other mechanisms was not previously allocated to water users, such as water savings associated with preventing losses from certain infrastructure. Because this water was not previously allocated to any user its reallocation to the environment would have no direct impact on the water market. However, a proportion was part of the consumptive pool and could have an effect. To the extent that the entitlements were previously part of the consumptive pool, the recovery of water can create an additional source of demand for water allocations.

Impacts of water recovery on prices

The increased water allocated to environmental water holders has increased water allocation prices above what would have eventuated without the increase in demand (Aither 2016a). Increased prices in the short term due to a reduced volume of water available for consumptive use is a logical outcome of increased competition between market participants, the question is the magnitude of the increase. To inform this debate, Aither has previously applied its Water Allocation Price Model to simulate the impact of environmental water purchases, holding all else constant to isolate the effects of environmental water purchases.

Aither (2016a) estimated that annual median water allocation prices were $24 per ML higher in 2014-15 than without environmental water purchases (a change from $88 to $112 per ML). For context, about a quarter of the modelled increase in water allocation prices in the southern Murray-Darling Basin between 2010-11 and 2014-15 was attributable to Commonwealth environmental water entitlement purchases, with drying climatic conditions being the prime driver.
**Allocation trading by environmental water holders**

Sales of water allocations by environmental water holders can also influence the extent to which water available for consumptive use is affected by environmental water holdings. To date, environmental water holders have tended to make only limited use of allocation trade in the sMDB. The only trade undertaken by the Commonwealth Environmental Water Holder was the sale of 20 GL of water allocations in the Victorian Goulburn system in 2015.

The Victorian Environmental Water Holder (VEWH) has also traded water allocations commercially (much of its water deliveries are facilitated using trade as a transfer mechanisms as well, but these involve no financial consideration). In 2014-15 Melbourne Water and VEWH jointly funded the purchase of 629 ML of licence allocation in the Maribyrnong system and the VEWH sold 12,975 ML of water allocation in the Murray and Goulburn systems (VEWH 2015 annual report). The VEWH has also previously purchased 300 ML of water allocation in the Loddon system (2013-14 annual report), and sold 14,000 ML of water allocation on the Murray system from November 2012 to January 2013 (2012-13 annual report).

The VEWH has policies and governance arrangements in place concerning its trading decisions and activity in the market. These include its water allocation trading strategy, published on its website, as well as internal policies and procedures. VEWH’s trading decisions are also linked to their Seasonal Watering Plans which are also published on their website. As an example, the principles that guide VEWH commercial allocation trade activity include:

- Allocation trade is undertaken to optimise use of the Water Holdings for environmental benefits.
- Any proceeds resulting from allocation trade will be used to improve the environmental values and health of water ecosystems in Victoria.
- Potential third party impacts resulting from allocation trade by the VEWH will be assessed prior to implementation, and any significant adverse impacts will be minimised or avoided.

**5.4.3. Urban water authorities**

Urban water authorities have contributed to increased demand for water allocations across the southern MDB, particularly in dry seasons. For example:

- In 2008-09 the South Australian Government purchased 106 GL of water allocations from the River Murray for urban use (NWC 2010).  

- As part of the Tantangara Transfer Project, announced in 2009, the Australian Capital Territory Government purchased around 10 GL of Murrumbidgee High Security Entitlements and 13 GL of Murrumbidgee General Security Entitlements to make Canberra less reliant on local rainfall (ACTEW 2013). Icon Water (who manage the ACT’s urban water supply) may choose to sell allocations to these entitlements to irrigators in wet and average years when the transfer scheme is not required.

- There has also been an increase in urban water demand in northern Victoria, where water corporations have acquired around 62 GL of High Reliability Water Shares to support Bulk Entitlements since 2009 (Tim Cummins & Associates 2016).  

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• Water retailers have not purchased high reliability water shares for the metropolitan area: instead, it invested $300 million in modernising GMW’s irrigation systems in return for 75 GL of the water savings (Tim Cummins & Associates 2016).

Some Victorian water corporations hold high reliability water shares that are in excess of their needs in wet and average conditions. Some of these corporations sell excess allocations in most seasons providing additional water for irrigators. However, in very dry conditions they are more likely to carryover or use allocations to boost supply security.

**Impact of urban water demand on prices**

The increase in demand by urban water authorities has also increased water allocation prices, but the impact has been smaller than the impact of environmental water purchases, because the volume transferred is smaller. And unlike environmental water holders, the demand by urban water authorities, and hence price impact, is largely confined to low water allocation seasons.

### 5.5. Changes in entitlement ownership

Some concerns have been raised about two elements of entitlement ownership:

1. The nature and extent entitlement movement between locations or user groups
2. The nature of the owners of entitlements, and any potential implications of this for prices

**Changes in location of entitlement ownership between users and regions**

There have been increases in the volume of entitlements held by water corporations and environmental water holders as a result of trade. In net terms, between 2001 and 2015 around 175 GL of high reliability water entitlements were traded to private entities in northern Victoria without being linked to land. Tim Cummins & Associates (2016) suggested that much of this is held by farmers (see further discussion below).

Over the same period, around 780 GL of higher reliability water entitlements were traded from irrigators in northern Victoria. While Lower Murray Water (LMW) diverters were largely unaffected, Goulburn Murray Water (GMW) diverters and irrigators in both LMW and GMW districts sold substantial volume of entitlements. In GMW districts, irrigators sold around 40 per cent of their high reliability water entitlements over that period, much from the dairy industry.
The evolution of water markets

The volumes reported for Torrumbarry include water shares in the Nyah, Tresco and Woorinen irrigation districts. The user group ‘water corporation’ includes water shares owned by Victorian urban and rural water corporations. Note that any interstate water corporations that may own Victorian water shares cannot be easily identified and would be classified as ‘Private – not tied to land’. It is assumed that these are not tied to land, however there may be some water shares linked. Volumes at 30 June 2001 reflect the volume of water rights held (since water shares had not yet been introduced).


Figure 14 Comparison of location of ownership of high-reliability water share volumes in 2001 and 2015

Changes in the nature of entitlement ownership

Since 2009 there has been no limit on water shares that can be held without any link to land, however, as at 30 June 2015, 1,497 GL (64 per cent of the total volume) of high reliability water shares in northern Victoria were linked to land, with farmers owning nearly all of these (Tim Cummins & Associates 2016). A further 175 GL (7 per cent) was privately held but not linked to land (but much of this is held by farmers), 62 GL (3 per cent) was held by water corporations and 605 GL (26 per cent) was held for the environment (Figure 15) (Tim Cummins & Associates 2016).
The evolution of water markets


Figure 15  Changing ownership of high reliability water shares, northern Victoria

As is noted elsewhere, these changes in ownership have resulted from:

- purchases on behalf of the environment
- water corporations purchasing water to help address security of supply issues and manage costs
- movement of water between regions in response to changes in industry structure and demand

In relation to the volumes of private water tied to land or not tied to land, Tim Cummins & Associates (2016) asserts that the volume of water not tied to land has been relatively stable for some years, and that a lot of the unlinked water shares are still held by farmers who use allocation trade to shift water to other water shares associated with land for use. In addition, Cummins suggests water shares potentially held by investors are also likely trading allocations to these entitlements to other water shares and locations for use in farms or plantations (held by the investor, or sold to other parties, including farmers).

5.6.  Future drivers and scenarios, and potential outcomes

Water markets in northern Victoria are likely to continue to change in the future. Looking forward:

- **climate change** could reduce the supply of water allocations to all entitlement holders.
- There is also the potential for further [environmental water purchases in the MDB and other recovery measures](http://www.mdba.gov.au/basin-plan-roll-out/sustainable-diversion-limits/surface-water). The Victorian Government has stated its support for meeting any remaining water recovery with neutral or positive socio-economic impacts (Victorian Government 2016). Across the MDB, future environmental water purchases are constrained by a 1500 GL legislative limit on overall environmental water purchases. Whether this limit is binding depends on the volume of water recovered through other mechanisms and adjustments (for more information see the MDBA website).  

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There will also be changes in demand by irrigation industries. In particular, cotton and nuts are likely to continue to expand in the short run, notwithstanding recent fluctuations in almond prices (Aither 2016b, Tim Cummins & Associates 2016). Other industries may have lower or more variable demand for water given changes in commodity prices or other factors (such as availability or price of feed). There is also the potential for infrastructure upgrades to affect water demand, with increases and decreases in demand possible depending on the circumstances.

While there is substantial uncertainty in predicting the future, there is the potential for the factors identified above to interact to generate substantial increases in water allocation prices, especially in low allocation years. Aither (2016b) estimates the impacts of projected changes in demand by cotton and nuts between 2015-16 and 2020-21. These projected changes were developed based on consultation with stakeholders in late 2015. Modelled water allocation prices increased by around 7 per cent in ‘average’ seasons as a result of the projected changes, with larger increases in ‘dry’ seasons. This does not include the effects of the other factors outlined above – including climate change and environmental water recovery.

Increases in water allocation prices will affect water use, although, again, the magnitudes are uncertain. Aither (2016b) estimates that surface water use by dairy could fall by around 9 per cent in ‘average’ seasons over the next five years as a result of increasing competition from cotton and nuts. The combination of further water recovery plus increased irrigation and urban water demand in dry years may have a combined impact on short run allocation prices that is even higher. However, this could also result in industry adjustment that offsets these increases.

5.7. Implications for irrigators and irrigation industries

The observed and potential future changes outlined above have a number of implications for individual irrigators and irrigation industries.

5.7.1. Implications for irrigators that are highly reliant on allocation markets

Some water users are now more reliant on the allocation market. In many cases, this has resulted from sales of entitlement (including to the Commonwealth) to manage debt or for other reasons, with ongoing reliance on the allocation market to meet water needs. This has also occurred as a result of new participants who have developed new agricultural enterprises reliant solely on the water allocation market. In either case, such users are sensitive to shifts in the price of water allocations given they do not receive a stream of allocations from entitlements held. This is particularly the case for individual irrigators in the Victorian dairy, broadacre cropping and wine grape sectors that have limited ability to pay high allocation prices in dry years. Some almond growers may be highly reliant on the allocation market but they have a higher capacity to pay for water.

Anecdotal evidence collected by Aither in consultations with irrigators, brokers, representative organisations and other water market stakeholders over a number of years suggests that many irrigators have been caught out by the strategy of relying heavily on allocation markets. Many irrigators sold entitlement to the Commonwealth between 2009 and 2011. Subsequent to this, rather than exiting the industry some continued irrigation activities due to low allocation prices observed from 2010-11 to 2013-14. The return to drying conditions in 2014-15 placed pressure on those who have continued irrigating, and created concern about water prices. This has led to strong demand for information about the future of allocation prices in the southern MDB as well as questions about the further implementation of the Basin Plan. As demonstrated by Figure 16, for many irrigators, the return to dry conditions has meant substantially increased prices that mean some irrigators are now reconsidering their future in light of the decision made to sell their entitlements several years ago.
The evolution of water markets

Source: Aither water markets database.

Figure 16 Registrations of Commonwealth environmental water and sMDB allocation prices (2007 to 2016)

5.7.2. General movement of water to higher valued industries

In addition to the pressures felt by those irrigators that are highly reliant on allocation markets, water is generally also moving to where it is most valued, particularly during times of water shortages or stress. This includes examples such as rice production declining or ceasing in drought years, with the water being traded to different types of permanent plantings (or cotton). Similarly water in dairy is often traded to permanent plantings when water allocation prices are higher.

While all participants in trade gain from that trade, there can be different impacts for different producers and industries. Those who cannot produce or reduce production (or seek substitutes) are compensated for their water, but those who purchase water and continue to produce may have margins eroded (or productivity may still be impacted). Different industries can also be impacted differently, including because of different sensitivities around interruptions to demand. Such factors have contributed to the net movement of water between regions, and some of the local adjustment pressures as occurred during the millennium drought (See Section 4.7).

As discussed in Section 4.7, changing patterns in the supply of and demand for water, and associated changes in prices or other factors (such as net movements of water between regions), can also lead to structural adjustment pressures. Some industries may be more capable of transition than others, including their ability to pursue short or long term alternatives, scaling up or down in response to changes, or moving in and out with changes in price. In addition, there can be pressure on communities and regions, or in relation to infrastructure, such as when there are large net movements of water out of or into particular districts in response to changing circumstances.

While changes in the price or movement of water do have a bearing on adjustment issues, for the most part, commodity market and other economic factors and broader trends in agriculture have been, and continue to be, the strongest drivers of change. These include demand for different products, commodity prices, the value of Australian dollar and the terms of trade, debt levels, demographic considerations, and other individual farm by farm pressures (see Aither 2014).
For example, prices for wine grapes have fluctuated markedly between 2004 and 2014, from $570 per tonne to $310 per tonne on average, or from around $881 per tonne to $216 per tonne for Chardonnay. Changes in the number of dairy farms in Victoria over the last 40 years have also been significant, which have been in part driven by global factors including the need to compete and the drive for greater productivity and efficiency.
6. Conclusions

Water markets are the product of an extended period developing and refining approaches to water management. They address many shortcomings of previous approaches, are highly valued and utilised, and are being emulated by other nations. Markets have provided flexibility to manage change and adapt to new conditions however recently change has been rapid. In these circumstances, adjustment can be challenging for water users and their communities. There are opportunities to further improve decision making through improved information, and as water use and availability continues to change, there may also be opportunities to improve approaches to helping industry adjust through other policy measures.

6.1. Evolution of markets

Water markets have been implemented as part of a long journey and evolution in the approach to water management. The different approaches that have been applied over time in part reflect changing philosophies and attitudes about the development and use of water resources, including moving from a strong development stance irrespective of costs and impacts, to an approach more focused on ensuring both long term environmental and economic sustainability.

Early management approaches were proven to be unsuitable to managing the significant variation in supply that is inherent to Australia’s climate. Similarly, centralised government control over how water was used was shown to be inefficient, with water users far better placed to determine when and how to use water. The ongoing issuing of rights to water without limitation was also proven to be unsustainable and of negative consequence not only to the environment but on the rights of water holders, and the economic and productive capacity of irrigated agriculture more broadly.

Experience with these approaches over a century led to a realisation of the need to cap total extractions on water, which in turn led to both the ability and the need to implement water markets. Water markets allow water within the cap to be reallocated, provide flexibility to respond to new or changing conditions in the environment or in industry, and support the environmental sustainability, economic efficiency, and equity objectives that society demands and requires in the 21st century.

The implementation of water markets was not without challenges, but their progressive implementation which was driven by irrigators, and the widespread support amongst all stakeholders is reflective of their value and importance to all concerned. Water markets are now extensively utilised and highly valued as a business and risk management tool for many involved in irrigated agriculture. Australia’s water markets are also recognised by other major global economies as a highly effective way of managing scarce water resources, some of whom are now seeking to emulate them.

6.2. Impacts and outcomes during drought

Evidence collected in response to the millennium drought suggests water markets have had a range of impacts or outcomes on different stakeholders or participants, including individuals, industries, urban supply, the environment, and at the state or regional level.

For individuals, water trading has provided water market participants with increased flexibility and options. Water allocation trading has provided the ability to generate additional income, minimise input costs, maintain production in dry periods, improve production and productivity, or manage
seasonal water availability. Water entitlement trading has enabled expansion and new investment, access to capital, more efficient use of capital, and modifications to the scale or nature of irrigation activities.

Industries have experienced impacts that are reflective of the impacts at the individual level and beyond. These include better managing interruptible and non-interruptible demand associated with different crops, substitution, and maintaining of modifying production levels more quickly and flexibly in response to external changes. Water trade also had impacts on adjustment within industries, debt management, capital efficiency, and enabled growth.

At the regional level, water trade during the drought had significant impacts in aggregate economic outcomes. This included minimising the economic impacts that less water use might be expected to result in. For urban users, water trade helped to avoid the costs of water restrictions, and is likely to have reduced the costs of urban water to customers by helping to defer large scale investments. For the environment, water trade resulted in the ability to recover water for the environment that was over allocated through the 20th century and help to ensure water allocation is on a more sustainable footing for years to come.

Overall, in the face of reduced water availability such as in drought, water markets have provided the much needed flexibility required to manage change. However, water trading can contribute to the rate of adjustment in some communities, in both areas where water is leaving, or where it is entering. Overall, including at the state and national level, this movement of water is generally economically beneficial. However, where large volumes of water move in or out of a region, or do so rapidly, this can be challenging for some individuals, businesses or communities. Nevertheless, such change is primarily driven by factors outside of water markets, and such change is required for different industries to survive over the long term.

6.3. Recent changes in market outcomes and associated drivers

Water markets have only been functioning in an extensive and widely utilised sense for around 10 years. During that time, water availability – a key determinant of water market outcomes including prices and the extent of trade – has moved through one major cycle, from extreme drought, through flood, into a drying cycle. Consistent with this, prices for water have come from record highs, to record lows, back to moderately high levels. With the recent increases in prices has come concern about individual and industry level capacity to manage this.

However, a number of factors related to supply and demand have influenced observed outcomes in the market. These include water allocations to entitlements, which have reflected the overall water availability cycle. Carryover has also had an impact more recently, effectively delaying some of the water availability decreases of most recent years as water has been moved into future years from wetter years – but this water has increasingly now been used.

On the demand side, changes in water use have occurred, which reflect underlying changes in commodity and agricultural markets. These include overall increases in cotton production in the southern MDB, increases in nut production, and more variable use in dairy and rice. In addition, environmental water recovery efforts have contributed to in an increased demand for water. Overall there have been net increases in demand for water.

In response to or in reflection of these changes, there have been changes in the location of water use, and the ownership of entitlement. Changes in the location of use has generally resulted in increased allocation water moving into Victoria from interstate, and more variation between Victorian regions. Ownership of entitlement has tended to move downstream in Victoria (such as out of the Goulburn
and into the Murray) and to the environment, reflecting changes in the nature of demand from different commodities and the need to address over allocation.

6.4. Implications for the future and overall conclusions

In the future, there will be further change in environmental and other conditions that influence water market outcomes. Increased climate variability and change could further reduce water supply, and there will continue to be changes in demand by different irrigation industries as there has always been in the past. Further environmental water recovery in the Southern Murray Basin could also have an impact. In general, changing water availability and demand will mean water prices continue to fluctuate. If the long term trend is towards reduced water availability, prices could be expected to increase.

It is important to reflect on the evolution of markets, the alternatives, and the impacts that they have had in managing change during periods of extremely low water availability. There is a positive series of outcomes that have been achieved, and the increased flexibility markets provide has been shown to have a range of positive impacts for many different stakeholders and participants.

Given the right policy and operational settings, water markets can continue to deliver the important outcomes for which they were implemented well into the future. Central to this is ensuring that when adjustment and change occurs, markets are allowed to continue operating in the absence of any artificial barriers to trade, which have been proven to distort markets, create perverse outcomes and not achieve their intended objectives. Any downside community impacts, if they occur, could be addressed by other policy tools or means.

Markets remain the most flexible and robust tool for managing scarce water resources effectively, and for managing and responding to change in irrigated agriculture. However, recently change has been rapid. In these circumstances, adjustment can be challenging for water users and their communities. Government may have a role in helping to facilitate change (rather than delaying or preventing it) by:

- ensuring markets are operating as efficiently and effectively as possible
- ensuring that quality, timely and relevant information is provided to market participants and others about the operation of markets, the drivers of market outcomes, and adjustment pathways
- allowing water markets to continue to provide flexibility for change, by managing structural adjustment pressures through other policy tools, outside of water markets.
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Appendix A – Alternatives to markets and comparative case study

Alternatives to markets

It is useful to briefly reconsider the past management approaches that water markets have evolved from, and why we are now in a situation where markets are highly utilised.

As is highlighted by the discussion and references provided in Section 4:

- The earliest systems of riparian rights were highly ineffective due to the variable nature of Australia’s rainfall – irrigators could not rely on the presence of passing flows.

- Historically, centralised government investment and control regarding the allocation, distribution and use of water was pursued in order to achieve the economic development objectives of the day. These objectives are no longer considered appropriate by society, nor is this considered an appropriate role for government. Contemporary economic theory and evidence confirms that individuals acting in globally competitive markets such as those for irrigated agricultural outputs are far better placed to make decisions about if, when and how to use resources, and that outcomes for society as a whole will be better if this is the case.

- Without a cap on total water use and the cessation of new licences, the use of water by one user would erode the rights of another, severely affecting the certainty and confidence to invest of all users. In addition, environmental degradation would have continued to accelerate, to the point at which this would impact the ability to deliver water, and would also impact farm sustainably and productivity, given impacts on broader ecosystem health.

- In the absence of a cap and water markets based on defined shares of the resource, governments would need to reduce the rights of all irrigators in dry years, and increasingly so in any year if licences continued to be issued. This could result in governments needing to ‘pick winners’ and favour certain industries, reductions in water would most likely not have been compensated, and there would be no flexibility for users to reallocate water given the cuts in use that were imposed. Such approaches would create significant uncertainty, impact on the ability of any farm business to undertake future planning, and significantly harm investment in irrigated agriculture.

- Water markets have evolved and been progressively implemented to address the shortcomings of these previous management approaches, which have ultimately proven to be both inequitable and unsustainable in economic or environmental terms.

Discussion below describes the situation in California, where a lack of effective markets has contributed to a lack of flexibility for water users to adapt to change, including major drought.
California comparative case study

This case study presents an overview of the water management framework in California and how it has shaped impacts of the recent drought. The case study highlights why the way water rights are defined and the ability to trade these rights is important to underpinning the resilience of irrigated agriculture under drought conditions.

Overview

California is the most populous state in the United States of America (USA). Agricultural production is an important component of the Californian economy. In 2014, California generated approximately US$54 billion in farm output (CDFA 2015). Access to and use of water is an important element in this production. The U.S. Geological Survey (USGS) estimates that irrigated agriculture water use in California totalled approximately 26 million acre-feet in 2010 — which is the equivalent of approximately 31,200 GL of water (CRS 2015).9,10

Californian water management framework

The Californian Department of Water Resources (DWR) is responsible for managing water in California. The State Water Resources Control Board (SWRCB), which sits under the Environmental Protection Agency, is responsible for ensuring proper water resource allocation and efficient use across California. While these state agencies have responsibility for managing water at a state level, in reality, management of water in California is more complicated. A complex web of federal, state and local ownership, accountably and rules have evolved since the 1800s with little central consistency. As described by Grey et al. (2015):

'It is fragmented, inconsistent, and lacking in transparency and clear lines of authority—all problems highlighted during the latest drought'.

Rights to water

A water right in California is defined as the right to divert water from a particular water source and use it for beneficial use (SWRCB 2016a). Water rights are like property rights; however, right holders do not own the water, rather they only have a right to use it based on certain conditions. Under the California Water Code, if certain rights to water are not put to beneficial use for five consecutive years, the owner of that water loses the right to use it.

Water rights exist for both surface and groundwater sources. There are two main types of surface water rights in California:11

Riparian – rights to water based on the ownership of land that borders a surface water source. Riparian rights allow land owners to take natural flows and do not require permits. During periods of

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9 Water use meaning all water extracted from surface or groundwater sources.
10 An acre-foot is the amount of water needed to flood an acre of land one foot deep. 1 acre-foot is approximately equivalent to 1.2 ML of water.
11 There are also other types of water rights such as federal government rights (similar to environmental water in Australia) and pueblo rights (which are water rights retained by municipalities, such as Los Angeles, based on the outcomes of the Mexican-American War in the mid-1800s).
low natural flows, generally no one right holder has a higher priority than another. As these rights are connected to land, they normally cannot be traded to water users in other locations (SWRCB 2016a).

**Appropriative** – rights to surface water but there is no connection to land. There is a major distinction between appropriative rights that were ‘claimed’ pre or post-1914 – with those claimed pre-1914 being subjected to less government oversight. Post-1914 appropriative rights are the most common types of water rights in California and require a government permit.\(^{12}\) Water available against these rights in a given year is governed by a seniority hierarchy. In periods of drought, the newest water rights to a water source must reduce water use first (i.e. water is allocated to the oldest or most senior water rights first). Appropriative rights generally have a lower priority than riparian rights. Most appropriative rights are legally tradeable between water users; however, as explained below, there are factors which limit how easily these rights can be traded in reality (SWRCB 2016a).

Most groundwater sources in California are unregulated. Where groundwater is unregulated there is no formal volumetric based right to water (SWRCB 2016a). Rather, land owners overlying groundwater sources have a right to extract groundwater for beneficial use without the need for government approval.

**Irrigation districts and water projects**

Irrigation districts and water projects play an important role in Californian water management. The majority of appropriative rights to surface water are held by local public agencies which manage irrigation districts. Some local agencies hold contracts with federal or state agencies to manage large-scale water infrastructure projects – but these projects also supply urban water.\(^{13}\) Within these systems, water infrastructure (such as dams, pipes and pumps) regulates water flow and delivery.

Individual irrigators are normally located within irrigation districts and projects. It is uncommon for individual irrigators within these systems to actually own the rights to water themselves – indeed some irrigation districts were established to claim water rights for an area (Sawyers 2013). Rather, individual irrigators generally have contractual or statutory agreements in place with the managing authority of these systems to secure the delivery of water every year. Authorities have discretion as to how water is allocated to individual irrigators within these systems (Sawyers 2013).

**Water trading**

In California, the trade of water between parties is called ‘water marketing’ or ‘water transfers’. Some types of rights to water can be sold permanently or leased for a set period of time (normally annual or multi-year). While the permanent or temporary trade of some types of water trade is legally possible, there are a number of factors that can make the process complex and burdensome.

To trade water, water right holders must be able to prove that the water they are trading exists and the water source that the water is being bought and sold across must be hydrologically connected (Hanak 2012).

**Proving the water exists – ‘paper’ water versus ‘wet’ water**

While water right owners hold the right to a quantified volume of water per annum, in drought conditions, water is not always available to meet the total volume of that right. This leads to the existence of ‘paper’ water where a claim to water exists but there is no official right to that water in a

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12 The Water Commission Act of 1914 established a framework to assign permits for post-1914 water rights which is now administered under the California Water Code. Pre-1914 water rights do not require a permit.

13 For example the U.S. Bureau of Reclamation holds the rights to water in the federally-owned Central Valley Project (CVP) and the DWR holds the rights to water in the state-owned State Water Project (SWP).
given year. To trade water, a water right holder must be able to demonstrate that the water is ‘wet’, meaning that there is water available that can be used or stored by the buyer (Hanak 2012).

Generally, there are only two types of ‘wet’ water available to be traded: 1) surface water that a seller has a right to but does not wish to use in a given year; and 2) groundwater. The trade of groundwater is not covered by the Californian Water Code and thus there is less oversight of these trades (Hanak 2012).

As most individual irrigators do not own appropriative rights themselves (rather a local irrigation district authority holds the right), water is generally traded at a district level. Individual irrigators within these districts may have a say (such as voting) in trading decisions depending on what agreements are in place (Hanak 2012). In cases where managing authorities specifically allocate water to individual irrigators for their own use, individuals (normally large sophisticated agribusinesses) may be in a position to trade this water independently if they choose not to use it for productive purposes (Hanak 2012 and Sawyers 2013).

**Hydrological connectivity**

In the early to mid-1900s, large investment was made into water infrastructure across California. This infrastructure has created hydrological connectivity between many regions which would provide the basis for a California-wide water market (Hanak 2012). Where hydrological connectivity does not exist, water exchanges are sometimes used to ‘substitute’ water in one market for water in another (i.e. physical water is not traded, rather intermediaries trade the value of physical water in one system for the value of physical water in another).

**Approvals**

Some types of water trades are also subject to approval from the SWRCB (SWRCB 2016a). Water trades of post-1914 appropriative rights require approval from the SWRCB. Trades of pre-1914 appropriative rights are not subject to the same level of approvals.

**Water accounting**

The sustainable management of water resources requires that there is a robust, consistent and transparent approach to water accounting (i.e. managing the supply and use of water). The aim of water accounting is to ensure that water is not over allocated in any given system leading to the unsustainable use of that resource. In California there is no consistent state-wide water accounting approach. Water accounting is normally managed by individual local authorities. Historical rights to water have also led to a situation where the volume of rights held to surface water across Californian exceeds the average volume of water available. Because there is no central way to account for the use of water, it is extremely difficult to manage supply and plan for future years.

**Impacts of recent Californian drought**

California is prone to frequently low rainfall and drought conditions. These conditions have made the agriculture sector heavily reliant on applying irrigation water to supply permanent and annual crops. Since 2011, California has experienced a severe drought – with a record-low snowpack (snow melt provides California with most of its water supply), record high temperatures, and the lowest cumulative precipitation since records began (Hanak 2016a). As a result, water availability in surface water sources is below average (in some cases no water being available at all).
The most recent drought in California has impacted the irrigated agriculture sector significantly. A study by UC Davis estimated that approximately 8.7 million acre-feet less in surface water would be available to Californian agriculture due to drought conditions in 2015 (Howitt et al 2015). This is a surface water reduction of close to 50 per cent from assumed baseline conditions. While 70 per cent of this water loss is expected to be offset by groundwater extraction, drought conditions in 2015 are still anticipated to have a total economic impact of $2.7 billion and cause the loss of 21,000 direct and indirect jobs (Howitt et al 2015).

Another study estimates that in 2014 Californian water right holders were allocated approximately 6.6 million acre-feet less in surface water due to drought conditions (Hanak 2015a). This was suggested to have reduced Californian farm output in 2014 by US$2.2 billion (or close to 5 per cent of total farm output for 2014) (Hanak 2015a).

**Relationship between Californian water management framework and impacts of drought**

The way that water rights are defined and are able to be traded under current Californian water management is important to understanding the impacts of the most recent drought and the resilience of irrigated agriculture in California.

**Inconsistent water accounting means unreliable information**

Due to there being no consistent water accounting approach in place in California and the fact that water is generally understood to be over allocated, drought conditions may lead to more severe impacts than would otherwise be the case. Inconsistent water accounting means that in times of drought the agriculture sector is forced to make decisions based on potentially unreliable information about the true state of water availability. This may lead to a situation where an irrigator plants in good faith that water will be available, to then lose a crop because not enough water is available. Similarly it could lead to a situation where irrigators choose to cease production if there is uncertainty about future water availability. Limitations on the ability to trade water compound the risks associated with these decisions.

**Seniority hierarchy means inefficient and inequitable allocation of water between right holders**

The seniority hierarchy governing water allocated to post-1914 appropriative rights means that in times of drought there is potentially an ‘unfair’ allocation of water across water users. The outcome of this is that owners of more junior rights may not be allocated water even if their irrigation activities are highly productive or profitable. The allocation of water in this way is inefficient because it does not incentivise incumbent right holders to improve water use efficiency or productive. Also, limitations on the ability to trade water further compound the inefficiency of this water allocation approach because it is difficult for those not allocated their full amount of water to buy additional water from others.

Furthermore, the seniority hierarchy of water allocation penalises late entrants. This may be a serious barrier to entry for new investment because it creates uncertainty for new entrants about water availability in the future. This investment might otherwise occur if all water right holders were treated the same if they owned the same types of water rights.

**No quantified rights to groundwater leads to unsustainable extraction**

To mitigate against decreased surface water availability, agricultural water users in California have turned to groundwater to supplement water supply for irrigation purposes. Historically, groundwater

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14 6.6 million acre-feet is equivalent to approximately 8,150 GL of water – or just less than double the total volume of water applied for irrigation purposes across the whole of the southern Murray-Darling Basin in Australia in 2013-14.
has accounted for approximately one third of total water use in California (agricultural and urban), but since 2014, this has increased to over 50 per cent by some estimates (Hanak 2015a).

The fact that there are no quantified rights to groundwater in most aquifers across California has led to a rapid and potentially unsustainable decline in water levels in some groundwater resources over recent years. Because there is no requirement for most groundwater users in California to report how much water they use, it is very difficult for government agencies to estimate how much groundwater remains in different regions.

Trade barriers prevent maximum gains from trade being realised

During times of drought, water trade allows water to be reallocated among water users based on individual decisions about production, and provides gains for both buyers and sellers. The ability to trade water easily and at minimal cost can limit the impacts of drought on regional economies and improve the resilience of the agriculture sector.

Most appropriative water right holders in California can legally trade water. In the most recent drought, trading has to some extent helped reallocate water between water users. This trading has allowed buyers of water to remain in production while allowing others to sell water and not produce (i.e. generating gains from trade). Hanak (2016b) estimates that in 2015 approximately 3 per cent of all water used is traded in California’s market.

In an efficiently operating water market, it would be expected that the intensity of temporary of water trade would increase during times of drought as water is redistributed – as was observed in Australia during the Millennium Drought. While there are data challenges in in California, volumes of permanent and temporary trade are estimated to have declined rather than increased since 2011 (the beginning of the most recent drought in California) (Hanak 2016b).

Most of the water that is being traded in California is either moving from agriculture to agriculture or from agriculture to urban uses (Hanak 2016b). For example, cities in Southern California now rely on water trades for approximately 10 per cent of total urban water supply per year (Hanak 2016b). Almost all trading occurs within county or regional boundaries, with very little water moving large distances across the state – despite most of California being hydrologically connected.

Despite the fact that some water trade does occur, California’s water management framework creates a number of barriers to trade which significantly limits the intensity of water trading in times of drought. Major barriers include:

- **Complex approval process** – there is a fragmented and inconsistent approvals process for water trades in California which can involve local, state and federal review and can take months or in some cases years to be completed.

- **Few individual irrigators owning rights to surface water** – because most individual irrigators do not own rights to surface water, trading decisions are generally made at more aggregated levels. Decisions at aggregated levels (i.e. by local authorities) can involve more complex negotiation and take longer, limiting incentives to actually participate in such trades.

- **Inconsistent information** – the lack of a consistent and authoritative information repository about water availability and trades that have occurred limits information and price discovery for those wanting to participate in water trading.¹⁵

¹⁵ There is no publically available source of information that provides a comprehensive and timely register of water trades that occur across California. A number of private companies exist that collate fragmented data on trade outcomes through surveys. However, beyond private and academic circles, this information is not widely available to the public.
• **Hydrological choke points** – while hydrological connectivity enables a state-wide water market, there are hydrological choke points which limit trade between some locations (Hanak 2016b).

**Response to recent drought conditions**

**Government responses**

Due to the worsening drought, a state-wide drought emergency was declared in California in January 2014. As a result, the SWRCB enforced water conservation measures which place restrictions on urban water use (Hanak 2015a and SWRCB 2016b). Allocations for irrigated agricultural water use were also reduced to reflect low levels of water held in storage – although these decisions are made at sometimes local levels with no central consistency. In some cases, such as in the federally administered Central Valley Project (CVP), zero water has been allocated to irrigators over recent years.

Industry assistance in the form of cash funding has also been provided to the agriculture sector in California to mitigate the impacts of drought. In 2015, a $1 billion industry assistance package was announced by the Californian Governor to assist the agriculture sector in the short-term, and invest in improved water security in the long-term.

The Californian Government also introduced the Sustainable Groundwater Management Act in 2014. This Act provides a framework for the adoption of local groundwater management plans across California within a 20 year period. Once implemented, these plans should improve the sustainability of groundwater sources and improve the reliance of irrigated agriculture in California (Hanak 2015b).

Another important step by government was the adoption of a Resolution to adopt an Emergency Regulation for Measuring and Reporting Water Diversions in January 2016 (SWRCB 2016c). This resolution introduces requirements for all water right holders (diverting more than 10 acre-feet of water per annum) to report water diversions and use of water annually to the SWRCB. Proposed to be phased in over a period of time, this resolution is an important step towards building a consistent and robust water accounting framework for California.

While structural changes to Californian water management are progressing, government responses to date have primarily focused on limiting the immediate economic impacts of drought on the agriculture sector in California. Where more work is needed is to address the aspects of Californian water management that fundamentally limit the ability for the irrigated agriculture sector to improve its resilience to drought conditions.

**Future reforms**

As the most recent Californian drought has persisted, the limitations of the current Californian water management framework are being increasingly recognised. There is now an active discussion across government, industry and academia about what a more optimal approach to managing water in California might look like. Lessons from Australian experiences are being looked at as possible directions for change.

Commentators have suggested a number of reforms. These reforms generally focus on improving how water rights are defined and water trading is facilitated. The ultimate aim of these reforms is to improve the resilience of irrigated agriculture in times of drought at the same time as securing sustainable environmental outcomes. Suggested reforms include:

• introducing a more consistent state-wide approach to defining surface water rights
• quantifying groundwater rights to limit unsustainable extraction in times of drought
- developing an authoritative state-wide water accounting system to improve understanding about water availability
- improving clarity around the priory of different types of water rights – including federal environmental water
- reducing barriers to water trade (such as accelerating approvals and improving the provision of water trading information).

**Lessons for Australia**

The Californian case study highlights where Australia (and Victoria) has come from, including the limitations of past approaches to management of water, and the benefits that water markets provide. It is instructive that an economy as significant as California’s is looking to emulate Australian reforms in order to improve its approach to water management and lesson the impacts of periods of low water availability. Importantly, Australia has already completed reforms and is realising the benefits of those reforms in many of the same areas that are withholding California.
Appendix B – Using artificial barriers to trade to manage change

Victoria has previously applied policies to water markets in an attempt to slow the rate of change or manage concerns about ownership of entitlements by non-irrigators. These have been progressively removed over time in response to a lack of effectiveness, a lack of need (i.e. initial concerns were unfounded), or evidence of perverse outcomes.

The two examples outlined below focus on the net movement of water entitlement ownership between districts and the potential for non-irrigators to be driving up prices through ownership of water entitlements.

Controls on the rate of movement of entitlement ownership out of irrigation districts

Issue to address

One of the concerns raised during implementation of water markets in Victoria was the potential for substantial volumes of entitlement to rapidly move out of particular irrigation districts. A commonly expressed view at the time was that such trade would result in negative economic and social impacts on regions and communities, due to the immediate and flow on economic activity associated with the water use being moved to different locations.

Another concern was the potential for stranded assets – public and private infrastructure that was no longer required to deliver water after entitlements had moved out, therefore being stranded due to a lack of users remaining. There was a perception at that time (before the unbundling of tariffs) that this could contribute to increasing cost in the area for the remaining users to pay for upkeep, as well as the ‘swiss cheese effect’ which occurs where there is patchy or uncoordinated demand across a district related to the untargeted nature of movement out.

The policy tool applied

The policy mechanism that was implemented to address these issues was a percentage based limit on the net amount of water entitlement (by volume) that could be permanently traded out of a particular irrigation area in one year. This was initially set at 2% of the total volume of entitlements on issue in the irrigation area that was selling the entitlement. The rule was applied to certain irrigation districts or areas, and was later adjusted to 4% following commitments made to the progressive removal of artificial barriers to trade in the National Water Initiative.

The rationale for the rule

Consistent with the concerns that had been raised, the rationale put forward for the rule at the time by the Victorian Government was both the rate of structural change, and the potential for stranded assets. As noted by the Victorian Government in 2001 (Value of Water, p 44):

*The trading regulations include a rule that can be used to curb any rapid exodus of entitlement from an irrigation district (or a part of a district, or a group of districts). One reason for having the rule is to prevent a district’s infrastructure being suddenly stranded without enough customers to afford its upkeep.*
More generally, the rule allows a ceiling to be put on the rate of structural change in an area, and any associated erosion of the community as a whole. For most areas this ceiling is high, its effect nominal. Yet the rule provides real comfort that areas won’t be allowed to collapse overnight, and has been important in achieving local concurrence for trade out of areas.

It has also been suggested that at the time, there was generally a lack of more suitable mechanisms to manage the impacts of trade out on cost-recovery.

Results

In 2001, the Victorian Government noted that the 2% rule had only been invoked once – that is it had only prevented trade from occurring in one irrigation season. Of the 9 areas in which the 2% rule was applied up to 2001, the highest net trade in any year had only approached the limit in two zones. However, as demand for trade increased, particularly after extensive unbundling of land and water rights in 2007, the limit began preventing trade from occurring in more areas. In 2009, the National Water Commission found the limit had prevented trade in many irrigation districts (at which time the limit had been relaxed to 4% rather than 2%), and was critical of the perverse incentives the policy was having.

Outcomes and criticisms

The policy had the effect of preventing trades from occurring that involved willing buyers and sellers – that is, an agreement had been reached that would benefit both parties, but this was prevented from occurring. Some trade would proceed (up to the limit) but others would be restricted, and considerable effort was made in some cases towards managing the demand for trade out of some districts (including ballot systems). In many cases the policy was implemented through a ballot whereby those applicants fortunate enough to be selected first were able to sell outside the district but the remainder were not.

The policy had the effect of preventing sellers from realising full market value for their entitlements, as sales were then restricted to within district sales. It meant that some sellers that needed to raise capital to exit the industry were left selling to buyers within an irrigation district, often at a substantially lower price. In addition, these buyers within districts could then attempt to get through the ballot system at some point in the future, effectively negating any impact of the policy.

Importantly, several commentators recognised that it is water use that drives regional economic activity and ownership controls on water use have no guaranteed impact on water use (i.e. allocation could be sold out each year regardless).

The trade out rule was also argued to be the wrong tool for managing the types of concerns raised, because it constrained necessary structural adjustment from occurring (such as shifting irrigation to more efficient and profitable locations and crop types) and did not specifically address community and individual impacts associated with adjustment. Termination fees were suggested to be more efficient and appropriate tools for managing stranded assets, and a range of alternative measures were suggested to better meet individual and community adjustment pressures (See National Water Commission 2009 chapter 10). Further in 2011 the National Water Commission stated:

The limit has impeded the use of buyback programs to assist in returning overallocated water systems to sustainable levels of extraction, unfairly and arbitrarily penalised willing sellers of irrigation entitlements, distorted patterns of water trade out of irrigation areas (including interstate trade), inhibited desirable and necessary structural change, and complicated interstate collaboration in other areas of water reform.
Removal and current situation
The National Water Initiative required the removal of the 4% limit by 2009, however in 2011 the limit was still in place, at which time Victoria had stated its commitment to its removal by June 2014. The rule was removed by July 2014. In part this was driven by the level of ongoing criticism from the National Water Commission as well as a realisation of the ineffectiveness of the policy. The removal of the 4% limit was also required as part of commitments associated with the Basin Plan following the ACCC’s advice on water trading rules for the Basin Plan, which required that there be no such limit on trade in any jurisdiction. To manage the costs of delivery infrastructure, Victoria has since 2007 introduced delivery shares and termination fees.

Controls over ownership of entitlements by non-water users and non-landholders

Issues to address
Prior to unbundling of land and water rights in 2007 there had been some concerns about the potential for water to be bought up by non-water users, such as investors. There was a perception amongst some stakeholders that water may no longer be available for productive use, that prices would be pushed out of the reach of farmers and irrigators, and that that this could contribute to a range of negative consequences for irrigated agriculture.

The policy tool applied
In response to these concerns, the Victorian Government introduced a 10% non-water user limit in conjunction with the unbundling of entitlements from land. When unbundling occurred (1 July 2007 in northern Victoria and 1 July 2008 in southern Victoria), this rule meant that a 10 per cent limit was placed on the amount of water shares in any water supply system that could be owned without being associated with land. In each water system there were separate 10% limits for high-reliability and low-reliability water shares that could be held as disassociated water shares.

The rationale for the rule
Consistent with the perceived concerns, the rationale stated for the rule was the need to prevent ‘water barons’ buying up large amounts of water and excluding it from productive use. As stated by the Victorian Water Minister at the time of the removal of the rule (NWC BA 2009):

[the] Non-Water User limit was introduced to allay fears among some people that non-irrigators, or ‘water barons’, could buy large volumes of water that had been dissociated from the land and drive up the trading price.

Results
Data published by the Victorian Government for the years the limit was in place suggests that it was not binding, although based on publically available data it is not possible to determine what trades may have been denied in zones that were approaching the limit at a given point in time. However, as at September 2009, only the Victorian Murray had reached its limit, and for many systems there were very low proportions or no entitlements held by non-water users. The average proportion of high

16 This was different to unbundling where a specific parcel of land and a water right had previously effectively been stapled together. The 10% limit required the water be associated with land, but was not specific about which land, so water rights could still generally be freely traded between regions (notwithstanding the 2% and 4% limits that were in place).

reliability entitlement held in an individual system by non-water users at that time was 4%, while the median was 0.8%.\textsuperscript{18} Across all systems, the proportion of high reliability water shares held by non-water users was closer to 9%.

**Outcomes, criticisms and removal**

It is difficult to fully determine if the limit was binding at different points in time, but it appears from the published data that it generally was not, and that the fears about water barons were generally unfounded.

This was confirmed by the Victorian Water Minister at the time of the removal of the rule in 2009, who also confirmed the fact that irrigators had been using water shares not linked to land to more efficiently manage their operations and water needs (as quoted in NWC 2009):

> These fears have proven unfounded. There is no evidence of water barons entering markets in a big way in other jurisdictions that do not have this provision. Recent growth in ownership of water that is not linked to land is being influenced by irrigators themselves, looking for more flexibility in where and when they can use their water …

Further, it was evident that a lot of irrigators converted to non-water user because of the flexibility it provided. Some entitlement holders converted because it meant going through the ballot for the 4% trade out restriction, but once having gone through that, it would not be necessary to do so again, which then meant complete flexibility for selling outside the region.

It is important to note that there is both low feasibility of being able, and little incentive to withhold water from the market to influence prices. There are strong incentives to avoid ‘banking’ of water allocations in perpetuity due to limits on carryover and the risk of spills, and given the cost and risk of attempting to hold water in this way would outweigh the benefits of selling it or using it in production. In addition, water allocated to entitlements has no other value to any holder of it other than for use in irrigation or sale to other users. In order to generate returns on capital tied up in water entitlements, whether held by individual farmers, agribusinesses, or investors, water allocations must be put to use in irrigated agriculture or sold to other users. If water users cannot generate a return on capital invested in water, they will likely invest that capital elsewhere. Given this, even investors who may have purchased entitlements in the expectation of capital gains will still be selling annual allocations (or similar products like long term leases) into the market rather than withholding them, and therefore not pushing up prices. Finally, it is also evident that while major investors may have portfolios that are large relative to other participants, they are not likely to be price setters – that is their market share is of insufficient size to set prices in the market, they must accept prices set by the wider market, and will do so in order to generate annual returns (see Cummins 2016).

**Current situation**

As is illustrated by Figure 15 (Section 6) and the associated discussion, only 7% of high reliability water shares in northern Victoria are currently not linked to land. As is also demonstrated by Cummins (2016), most of these water shares are still used by farmers or agricultural enterprises for irrigation purposes. Many are using water shares not associated with land to more efficiently manage water holdings, capital assets, and production, across farm enterprises.

\textsuperscript{18} Ibid.
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