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Climate Change, water scarcity and water markets - Implications for farmers' wealth and farm succession

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Abstract

Large areas of Australia are in the midst of the worst drought period in white man's history; it is potentially the worst drought in a thousand years. The socioeconomic impacts within irrigation communities are detrimental. The Federal and State Governments are offering drought assistance to affected irrigators and businesses that are dependent on them.

This paper provides a discussion of how water markets have been used by irrigators over the last 16 years to manage scarcity and structural adjustment. It then uses analysis of prices paid over the last 16 years within the Goulburn Murray Irrigation District in Victoria, Australia (GMID) to discuss how water markets could continue to be used to serve this purpose as scarcity worsens due to climate change and policy reforms. The analyses show strong and consistent increases in prices, with a strong relationship between the fluctuations in the two market prices. The price of allocations leads the price of entitlements. These findings have important implications for how markets can be used to assist irrigators to adapt to the impact of water scarcity and to protect the value of their total assets, either as part of an exit strategy or a succession strategy. Providing opportunities to deal with these processes in the best possible way will not only be most beneficial for the irrigators themselves but also for the communities servicing, and dependent on, the irrigation industry.

Introduction

Large areas of Australia are in the midst of the worst drought period in white man's history and it is potentially the worst drought in a thousand years. The socioeconomic impacts within irrigation communities are detrimental. The Federal and State Governments are offering drought assistance to affected irrigators and businesses that are dependent on them.

This drought arrived at a time when discussions about water reforms in Australia were already intense, with a growing recognition that (even before the drought) many water resources were overcommitted and, therefore, some water currently allocated to consumptive use need to be reallocated to the environment. This reallocation process commenced prior to the drought and had already generated considerable anxiety within irrigation communities, especially in New South Wales, where some catchments and groundwater aquifers suffered considerable reductions in existing entitlements without any form of compensation. When the drought set in, the NSW government suspended the operation of the water sharing plans to ease some of the socioeconomic pain within irrigation communities. At the same time, the Federal Government, State Governments and the Murray-Darling Basin Commission commenced buying water entitlements from irrigators to secure water for the environment. Part of this program was targeted at small block owners to help them exit irrigation while staying on the land and within the community. This current season started out with a similar pattern to the past years but by October allocations had been increased to around 30%, and by mid January to 63% and 55% respectively for the two main systems within the GMID, easing some of the concerns of irrigators.

Politicians are struggling to find ways to deal with this situation in the light of long-term climate change and increases in demand from non-irrigation sectors. Desalination and water recycling plants are being established in several major cities to boost secure supply. However, these efforts are of little consequence to the irrigation sector. The National Water Initiative (NWI) is relying on water markets to encourage more efficient use of water with the aim of negating the socioeconomic impact of reduced water allocations within irrigation communities. Water markets have been beneficial for irrigators by allowing them to achieve the highest possible return from their declining seasonal water allocation during any given season and protect the value of their asset. However, when the latest drought hit and coincided with a depressed farm economy resulting from low commodity prices and very low demand for some key commodities, an increasing number of farmers, by now farm more than half, have no expectation of family succession of the farm.

This paper explores how water markets could potentially assist farmers in adjusting to the new water regime or enable them to carry through the current drought. The second part provides a very brief overview of the policy context; this is followed by a section outlining the water availability for consumptive use since the onset of the drought and the acceleration of the use of water markets. The fourth section discusses how the water market until now has assisted farmers in dealing with this reduced access to water and some of the hardship and challenges associated with this. The final section analyses prices paid in the allocation and entitlement market within the greater Goulburn Region of the GMID. This case study illustrates how these two water products have been traded in the market and provides a discussion of the implications of the markets for farmers' ability to adapt to ongoing water scarcity.

The Australia Policy Context

Serious water policy reforms in Australia commenced in 1994 when the Council of Australian Governments agreed on a new water policy framework (CoAG, 1994). This represented a formal change in policy paradigm away from managing supply to managing demand. The new policy framework included: i) a pricing reform, moving toward water users paying for water based on full cost recovery; ii) a separation of the water right from the land to which it traditionally have been appurtenant; iii) an introduction of water markets in all jurisdictions; iv) a formal recognition of the environment as a legitimate user of water; and v) a devolution of water management processes. All of these elements of the policy framework represent a reversal of past policies.

At the same time, concern over water use within Australia's largest water source, the Murray-Darling Basin, became a focus of attention in the media. An audit of water use found that it was excessive and that, unless drastic action was taken, the problems would continue and even increase in the future (MDBMC, 1995). This would have a detrimental impact on the river environment and potential adverse impacts on water quality, challenging both the environmental and economic use of the water. The Audit resulted in a "cap" on water use within the basin (MDBMC, 1996). This capped total water use at the 1993/94 levels but the cap was not implemented until 1997. The decision of how to keep water use within the cap was left to the States and they all decided to accept existing rights even if they were not currently in use.

Since there were a large number of unused rights, the potential total water use was above the cap. As unused rights were sold and buyers activated them, the only way to stay within the Cap was to lower the seasonal allocations. Hence, traditionally active water users saw their seasonal access to water decline, forcing them to buy more water allocations in order to maintain production. This raised concerns, as it was viewed as a wealth transfer from those who had developed their water rights for irrigation to those who had never invested in using their rights; many water buyers saw this as inequitable.

In the late 1990s, most states within the Murray-Darling Basin (MDB) introduced new water acts reflecting the 1994 CoAG framework and the implications of the MDB Cap. These Acts introduced water markets, separation of land and water rights, and a water planning regime to formally recognize the environment. The 2000 NSW Act for the first time gave the environment first priority to water. Water Sharing Plans (WSP) were to be developed within all NSW Catchments that defined how much water was needed for the environment and to decide how to share what remained for consumptive uses. This process started in 2001 with considerable conflict and resulted in substantial reductions in irrigators' entitlements, without any compensation. The process resulted in frustration, confusion and uncertainty within many irrigation communities (Kuehne and Bjornlund, 2006). This process stalled leading up to the National Water Initiative (NWI) in 2004 (CoAG, 2004a) and was rolled into the planning process imbedded in the NWI.

Nine years after the 1994 CoAG policy framework, CoAG took the next step in pushing the reform agenda. The 2003 Communiqué (CoAG, 2003) announced the launch of a new National Water Initiative (NWI). It was acknowledged that good progress was being made in the reform process but that three main issues needed to be addressed to speed up the process: (i) uncertainty over the long-term access to water was still hampering investments in higher-valued and more efficient production systems; (ii) current water market arrangements were preventing markets from reaching their full potential; and (iii) serious concerns were still prevalent over the pace of securing adequate environmental flows and adaptive management systems to ensure the health of riverine ecosystems.

To overcome these concerns two new Intergovernmental Agreements (IGAs) were signed in 2004. The National Water Initiative (CoAG, 2004a) included the need to establish: i) nationally compatible water access entitlements defined as a perpetual share of the consumptive pool of a resource; ii) a statutory-based water planning process defining the consumptive pool of a resource; iii) statutory provisions for environmental and other public benefit outcomes; iv) clarity about the assignment of risk arising from future changes in the availability of water for the consumptive pool, v) nationally functioning water markets and the progressive removal of barriers to trade in water; and vi) returning all currently overallocated or overused systems to environmentally sustainable levels of extraction. Under the second agreement, Addressing Water Overallocation and Achieving Environmental Objectives in the Murray-Darling Basin (CoAG, 2004b), \$500 million was set aside to purchase water entitlements to secure environmental icon sites on the Murray River.

The planning processes which had commenced under State legislation were now continued under the new NWI guidelines. In many catchments, this process resulted in substantial reductions in water entitlements without any compensation. This problem was clearly most severe in NSW. In some cases, (e.g. Queensland) these Water Sharing Plans (WSP) have been able to provide adequate environmental water, but in other cases (e.g. NSW) some of the WSPs have been suspended due to drought, or environmental priorities have been overlooked in favour of consumptive needs (Wallace, 2009).

After the failure of the regulatory process to achieve adequate environmental flows, increased emphasis has been placed on buying water in the market; this was initiated in the 2004 IGA on addressing overallocation. The Australian government has recently announced a \$12.9 billion *Water for the Future Plan* (Wong, 2008) to recover from irrigators, through a variety of means, up to 1,500GLs of water for the environment (1GL = 1 billion litres of water).

As part of the federal government's program to purchase water for the environment the 'Small Block Irrigators Exit Grant Package' was introduced (Prime Minister of Australia, 2008). This project aimed to encourage small irrigators to sell their water to the

government and was particularly aimed at the owners of small horticultural blocks that were struggling due to water scarcity, oversupply and declining commodity prices.

It is becoming increasingly evident that irrigated farming has been put under sustained pressure for a number of reasons and that this has had significant negative economic, social and environmental impacts within the basin and its communities.

Declining water availability and the accelerated use of water markets

Even though Australia's Murray-Darling Basin experiences regular droughts, the depth and intensity of the drought experienced since the turn of the century has been unprecedented. *For the 2008-09 water year (June 2008 to May 2009) Murray system inflows were the third driest in 118 years of records. This follows the seventh driest year in 2007-08 and the driest on record in 2006-07. Murray system inflows have been below average for nine out of the last ten years* (Murray Darling Basin Authority, 2009, p.1). Some suggest that in addition to the drought, Australia has entered a new drier regime (Young and McColl, 2008).

Young and McColl (2010) emphasise the relationship between declining precipitation and the resulting decline in runoff into dams supplying consumptive users on regulated streams - a relationship which has hitherto not received much attention. Figure 1 shows that since 1974 Perth has not received the rainfall they would expect based on historical records. It also shows that while rainfall declined by 20%, the resulting reduction in inflow to storages was as much as 66% lower. This suggests that predicted changes in precipitation due to climate change might have even greater influence on the availability of water for consumptive use, as most of the initial precipitation is absorbed by the soil and lost to evaporation, leaving little to become effective inflows.

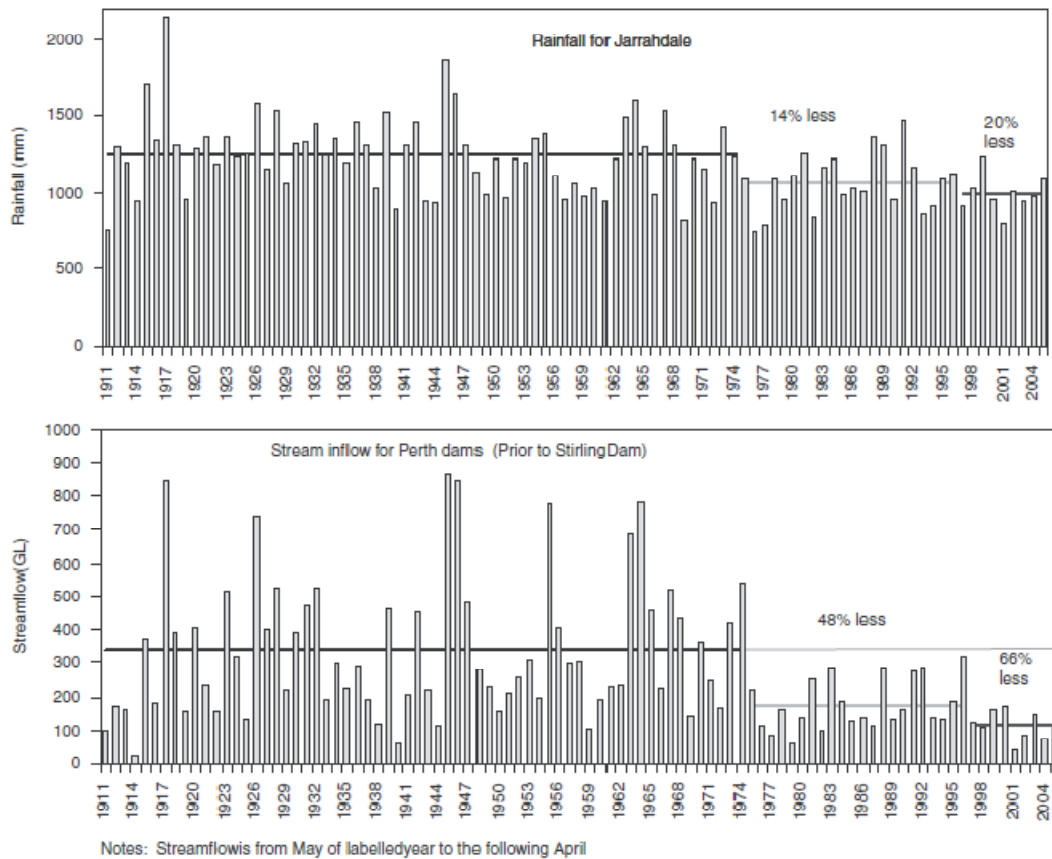


Figure 1: Rainfall and inflow into water storages near Perth, Western Australia (Source: Young and McColl, 2010)

While the combination of the drought and policy change has reduced allocation levels across the Murray-Darling Basin, it varies significantly from State to State due to the legacy of past allocation practices. Historically, irrigators in NSW have suffered seasonal allocations well below 100% in most years, with an average of 70%. By comparison, irrigators in Victoria have historically enjoyed allocations well over 100% in almost all years, with an average of 160% and dropping below 100% only in extreme situations estimated to occur only twice in 100 years. Irrigators in South Australia had never experienced allocations below 100% until 2006. Given the permanent nature of plantings in South Australia, irrigators showed little interest in allocations in excess of 100%. In 2006 allocations reached only 60%, dropping to 32% in 2007 and 18% in 2008. The current 2009/10 season opened with an allocation of a few percent but had increased to 30% by mid-October due to late winter and early spring rains. Having never experienced any previous reduction, the last four years have turned the world of irrigators in South Australia upside down.

Irrigators in the main systems of the Goulburn-Murray Irrigation Districts in Victoria have moved from receiving 200%+ in seasonal allocations on a regular basis to levels significantly lower (Table 1). Since 1998, the Goulburn system has not seen allocations above 100% and five out of the last eight years have been below 100%. It can also be noted that 1998 saw a change in allocation policy so that much lower opening allocations were announced. This resulted in a transfer of the risk associated with variable inflows during the season from the water authority to the irrigators.

Table 1: Opening and closing allocations 1991 to 2008

Year	Goulburn System		Murray System	
	Closing allocation	Opening allocation	Closing allocation	Opening allocations
1994/95	200+	200	200+	200
1995/96	150	150	200	150
1996/97	200	200	200	200
1997/98	120	120	130	130
1998/99	100	40	200	95
1999/00	100	35	190	100
2000/01	100	48	200	200
2001/02	100	55	200	200
2002/03	57	34	129	129
2003/04	100	0	100	18
2004/05	100	0	100	42
2005/06	100	0	142	82
2006/07	29	0	95	76
2007/08	57	0	43	0
2008/09	33	0	35	0
2009/10	55 ¹	0	63 ¹	0

Prior to 1994 allocation were persistently at 200 percent or more. ¹ as of 15 January 2010

In response to declining allocation levels, water market activities have picked up considerably (Table 2). Entitlement trading initially accounted for less than or just over one percent of the total volume of entitlements per annum for the first 12 years of trading within the GMID, and increased to more than 4 percent. Allocation trading increased from under two percent per annum for the first five years, to close to 20 percent. Taking low allocation levels into account, entitlement trading has a considerably bigger impact on total water use with more than one-third of all water applied in the field being purchased in the market (Bjornlund and Rossini, 2008). Similarly, market participation has increased substantially from only a few percent of

irrigators being active in the market in any given year to more than 60% trading in water during any given season (Bjornlund, 2006).

Table 2: Allocation and entitlement trading within the Goulburn-Murray Irrigation District, Victoria, Australia

Season	Entitlement base ¹	Allocation market		Entitlement market	
		Volume trade ²	% traded ³	Volume traded ²	% traded ³
1989/90	1907145	21927	1.15	0	0.00
1990/91	1907145	31955	1.68	0	0.00
1991/92	1907145	32148	1.69	2715	0.14
1992/93	1907145	22829	1.20	8100	0.42
1993/94	1907145	29961	1.57	6369	0.33
1994/95	1907145	206872	10.85	9941	0.52
1995/96	1907145	132955	6.97	8230	0.43
1996/97	1907145	102924	5.40	10573	0.55
1997/98	1906763	245773	12.89	16349	0.86
1998/99	1905668	208069	10.92	23283	1.22
1999/00	1895578	215794	11.38	18173	0.96
2000/01	1893769	193335	10.21	16851	0.89
2001/02	1896718	259493	13.68	23834	1.26
2002/03	1883761	286418	15.20	19697	1.05
2003/04	1882806	338088	17.96	51335	2.73
2004/05	1852233	337707	18.23	44302	2.39
2005/06	1793637	332131	18.52	48914	2.73
2006/07	1764870	309189	17.52	60494	3.42
2007/08	1720705	230048	13.37	76954 ⁴	4.47

Produced on the basis of data provided by Goulburn-Murray Water and available in annual reports

¹total volume of water entitlement within the GMID at the beginning of each season; ² total volume of water traded each season; ³ volume traded as a percentage of total entitlement

Given the level of activity in the entitlement market, the Federal Government's objective of buying 1,500 GL of water entitlement for the environment is daunting. It has been estimated that it will require the purchase of 100% of the average entitlement trades for the next 14 years (WaterFind Pty Ltd, 2008). This suggests that the government will completely dominate the entitlement market for the foreseeable future and potentially cause market prices to rise. There are great fears that this might

interrupt the market's ability to assist irrigators in managing the increased level of water scarcity.

How markets have so far assisted irrigators to adapt to low allocations

When water markets were introduced there was no scarcity and they were relatively inactive and mainly used in an opportunistic manner. Allocations were purchased if there was an opportunity for a marginal increase in crop production and entitlements were sold by irrigators who did not need the water (Bjornlund, 2004). Entitlement trading did facilitate new developments for some buyers, as well as the expansion of existing operations, since it was no longer possible to apply for new licenses. This was especially the case in South Australia, where 90% of the water was used to expand the irrigated area in horticulture. In Victoria, where a decrease in seasonal allocations started prior to 1995, most water entitlements were purchased to maintain existing production (Bjornlund and McKay, 2002). Hence, in the early years of the water market there is evidence of a moderately positive adjustment impact on the buying side. For those selling unused water it seems that they were well rewarded by the price paid, as they did not suffer any production losses. There is, however, evidence to suggest that this dominance of unused water entitlement in the market depressed prices with the result that those selling water on which their current production depended received a lower price than the consequent drop in property value (Bjornlund and Shanahan, 2009). There is also evidence that many of the sellers were under financial pressure to sell and used the proceeds from selling a fixed asset to cover current operating cost or pay short term debt, thus digging them deeper into the poverty trap and widening the gap between water rich and water poor farmers (Bjornlund and McKay, 2000). Hence, irrigators were reluctant to sell their entitlements as they were aware that they would be better off holding on to them and, if necessary, selling the water allocation on an ongoing basis.

Since then, water scarcity has worsened, which has significantly increased the need for coping mechanisms. In response, the allocation market has become far more mature and farmers have become very businesslike in their decision about whether to sell their allocation during any given season or use it to grow a crop. As the price of water allocations increase in response to lower allocations, many low value producers such as graziers and croppers simply stop irrigating and sell their water allocation every year, enabling them to improve their net income from their farm asset. Surveys of sellers during 1998/99 within the GMID showed that 13% had no irrigation at all while 21% had less than 50 ha. A similar survey during 2003/06 suggested that 21% had no irrigation and 54% had less than 50 ha (Bjornlund, 2008). As a consequence, dependence on off-farm work has increased from 50% to 67% among those depending on selling their water. There has also been an increasing dependence on off-farm work to support household income, with those obtaining 75-100% of household income from off-farm work increasing from 40% to 50% (Bjornlund, 2008). Reflecting this, family continuity of the farm is in doubt, with those certain of family continuity dropping from 39% to 20%

among those selling water allocations, but also dropping from 48% to 22% for those buying water allocations (Bjornlund, 2008).

More recent research conducted with irrigators in the Riverland of South Australia using the photo elicitation technique suggests that the feeling of despair over the drought and associated reforms are increasing. In this region, there is ample evidence of farmers believing that the impact of the drought they feel has been worsened by corporate enterprises and managed investment funds buying water. These corporate enterprises and funds are supported by taxation rules that make such investments tax deductible to them and not to the normal farmer. This tax rule has resulted in an increase in the price of water to a level where it is impossible for the average farmer to compete for water in the market. They find it increasingly frustrating to see new large-scale plantings go in with plenty of water at a time when they can't afford to irrigate, over supply and low commodity prices make it impossible for them to survive, and consequently, many of them watch their plantings die (Kuehne et al, 2009).

Many irrigators in the Riverland are, therefore, seeking a way out. They have no succession in place. Either the children have other careers, or they don't want to encourage their children to take over farming under current conditions. However, many of them are old and don't think they have any skills to take on a new job, or don't want to leave the farm. If they would like to sell their property, there are no willing buyers in the market who will pay a price allowing them to get out, even free of debt. Many are considering the exit grant (as discussed above). Some are actively applying and others are considering it, but don't really think that they will get enough money to continue living on the farm (Kuehne et al., 2009).

If a large number of irrigators exit an area, then the viability of the community is also under threat (Edwards et al., 2007, 2008). There is, therefore, a need for a variety of strategies to enable irrigators to pursue different avenues of dealing with scarcity while retaining their water entitlement and staying within their community. Possible solutions include: i) undertaking farm adjustment to make their farm business long-term viable; ii) enabling succession planning; or iii) ceasing irrigation but staying on the land. These are not only strategies that allow them to manage their response to drought but also to manage, and secure the value of their assets, as beneficially as possible. We have seen evidence of water markets playing an important role in this process, as discussed above. However, the urgency of this need is intensifying. The final section of this paper will offer an analysis of prices paid for water allocations and entitlements to facilitate a discussion of the ability of markets to continue to, and improve their ability to, facilitate these processes.

An analysis of water prices 1993 to 2009

The following discussion is based on analyses of prices paid within the Greater Goulburn Region of GMID in Victoria. Prices of both water products have increased substantially, with an average annual growth over the sixteen year period of 26.6% for allocations

and 12.9% for the underlying entitlements. Allocation prices show great variation in prices both between and within seasons. There is a significant seasonal pattern, with prices being at least 20% above the annual mean during the first 4 months of the irrigation season (August to November). This provides some important guidance for irrigators using the allocation market as a tool to manage the impact of the drought. Fluctuations in allocation prices are strongly related to the allocation levels as well as levels of evaporation (Bjornlund and Rossini, 2005; Wheeler et al, 2008) and show a strong cyclical pattern.

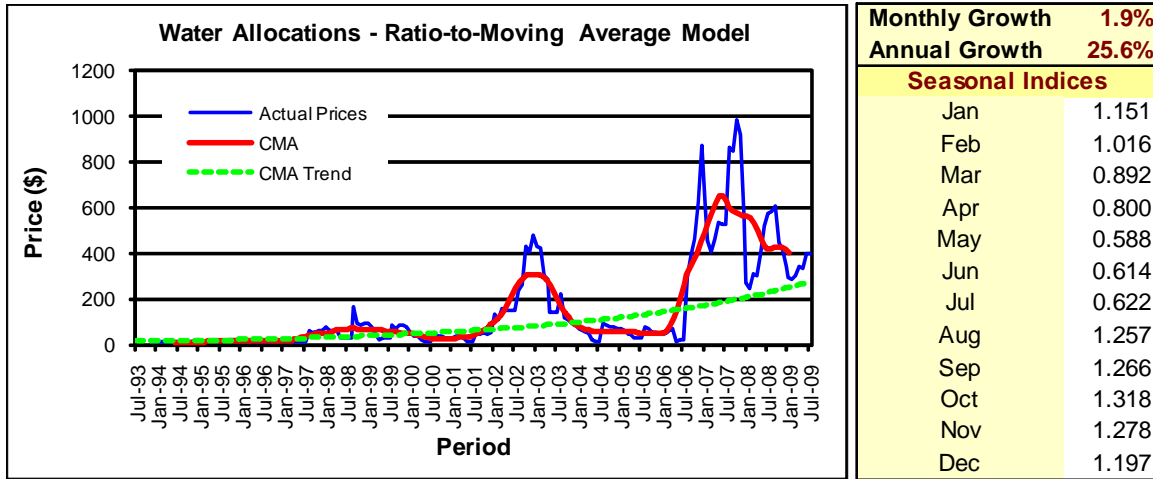


Figure 1: Allocation prices 1993 to 2009

Seasonal indices show that entitlement prices have little seasonal fluctuations and also fluctuate less between seasons. Generally, they have followed a rather steady trend with an annual average growth of just under 13% (Figure 2) and with shallow cycles. Both Figure 1 and 2 strongly suggest that exiting irrigators are better off keeping their entitlements and selling the allocation on a seasonal basis. This secures a steady growth in the value of their asset and provides a steady annual return.

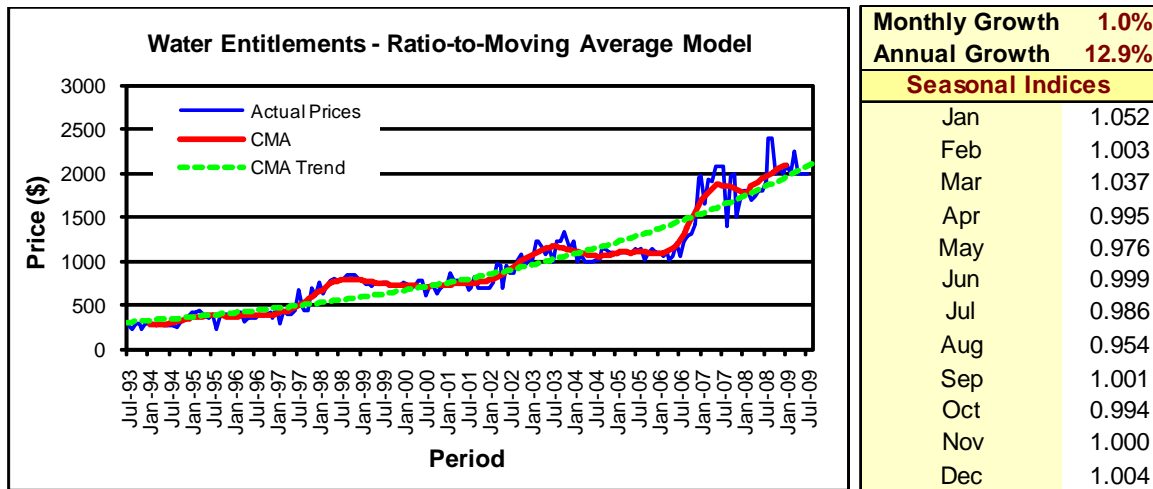


Figure 2: Entitlement prices 1993 to 2009

Comparing the cyclical factors for water allocations and entitlements confirms the above findings that allocation prices fluctuate far more than entitlement prices (Figure 3). It is worth noting the difference between the scales of the entitlement and allocation cycle factors. When the factor for entitlement is 1.2, the allocation factor is about 3.7, or three times as high. The two cycles follow each other quite closely. Initially, entitlement prices seem to lead the cycle; however, since around 1997 the allocation prices seem to lead the cycle as economic theory would suggest. This is particularly the case over the last two cycles, during which entitlement prices seem to react faster to changes in allocation prices. To further support that allocation prices are driving entitlement prices, hedonic analysis shows that the price of water allocations is a strong significant determinant of entitlement prices (Bjornlund and Rossini, 2007), while the price of water entitlements has no significant influence on the price of water allocations (Bjornlund and Rossini, 2005). This suggests a maturing market in which investments in water can be made in a similar way to other investment vehicles.

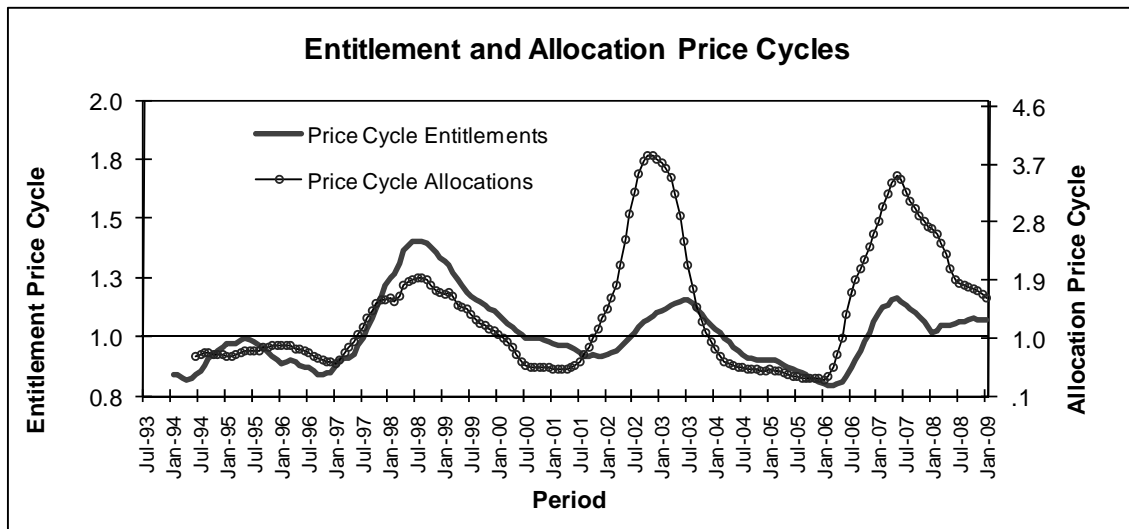


Figure 3: Entitlement and allocation price cycles 1993 to 2009

This conclusion is further supported by cash flow analyses of investments in water entitlements with the intention of selling the annual allocations and realising the entitlement after a five year holding period. This is an extension of the work by Bjornlund and Rossini (2008) and includes a greater period covering the extension of drought conditions and the Global Financial Crisis (GFC). Figure 4 shows returns from investing in water entitlements over a five year period. Both the total return and the return from capital growth are shown. The return from an equivalent 5 year investment in shares is also shown. The analysis suggests that investments in water entitlements consistently outperformed the share market. It also indicates that an increasing proportion of the total return is obtained from operational income rather than capital growth. Only during two very short periods did the share market outperform the water market.

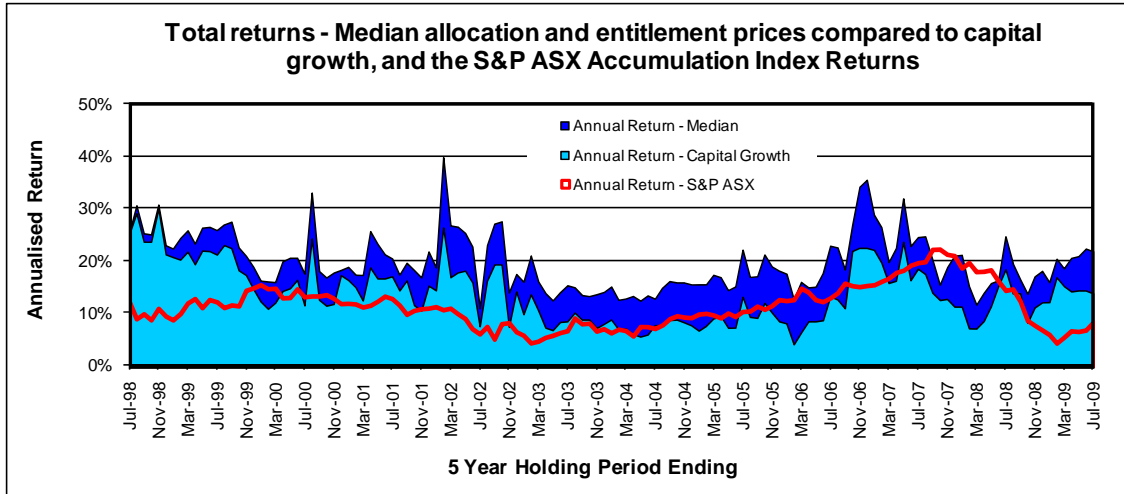


Figure 4: Total return from investments in water entitlement and company shares

It should be noted that the returns in Figure 4 are based on selling allocations at the median price each year, which is conservative. If allocations were sold when the seasonal indices are highest, then return would be higher by at least a couple of percentage points (Figure 5).

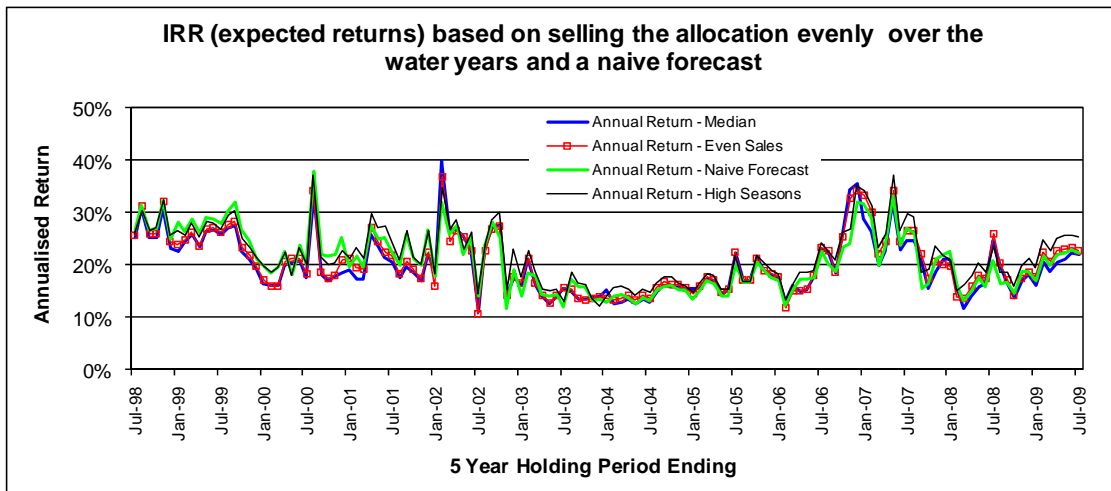


Figure 5: Returns from investments in water entitlements under various scenarios

Discussion and conclusions

The analysis of prices paid over the last 16 years within the GMID show strong and consistent increases in prices with a strong relationship between the fluctuations in the two market prices in which the price of allocations leads the price of entitlements. These findings have important implications for how markets can be used to assist irrigators in dealing with the impact of water scarcity and protect the value of their total assets, either as part of an exit strategy or a succession strategy. Providing opportunities

to deal with these processes in the best possible way will not only be most beneficial for the irrigators themselves but also for the communities servicing, and dependent on, the irrigation industry. An orderly exit, including the capacity for as many of the exiting farmers as possible to remain in the community, will help sustain the population base, local services, social capacity and business activities, and jobs. This will minimize many of the social and community impacts that have been reported following farm closures and population drain, particularly in Victoria (Fenton, 2006; Edwards et al., 2007)

The findings suggest that farmers with the financial means to do so should keep their water entitlement, either to use or to sell the seasonal allocations to supplement off-farm work and/or income from dry land farming. By retaining ownership, farmers will obtain capital gain, receive an annual income and have the most flexible options for the future of their property. These options would include: i) selling it to retire or passing the proceeds on to the next generation; ii) returning to irrigated farming if the financial and/or weather conditions change; iii) passing it to the next generation once they are ready; iv) continuing irrigated farming until they retire or to the time of succession; v) to buy in more water and expand the production to become viable for future generations.

The findings also suggest that the water market can assist farmers who do not have the means to hold on to their water entitlements either because they have too much debt or need additional money to restructure the farm. The maturity of the market and the predicted returns from investing in water entitlements suggest that investment bodies such as super funds and property funds should be willing to invest in water entitlements and make lease-back arrangements which would provide farmers with a cash infusion as well as long-term security over access to water allocations.

The findings also have implications for the government's plans to buy back water for the environment. Maybe more emphasis should be placed on buying long-term options to water allocations rather than buying water entitlements, which have uncertain allocation yields for the environment. Buying long-term options from irrigators opting out of irrigation either indefinitely or until succession issues have been resolved might prove more beneficial and attractive to these irrigators as they retain ownership of the entitlements and certainty of income. A combination of a one-off payment up front and then seasonal payments depending on allocation levels and market prices would be a sensible arrangement. For the environmental manager, this could be beneficial as it would not own uncertain paper entitlements but options to buy real water, only paying for what is actually delivered in any given year. Finally, substantial environmental water is needed during high flow when "over the bank flow" to flood wetlands is most likely. During these periods irrigators, who are currently securing their high value horticultural plantings with secure entitlements, will be willing to sell excess allocations at low prices. This makes it more feasible for the environmental water management to buy options to secure excess water cheaply during these periods.

In conclusion, this paper has documented that water markets have in the past played an important role in allowing irrigators to manage drought. However, in the future the

need for this function will increase and the level of sophistication needed to facilitate this will increase as well. Our analysis indicates that the market fundamentals are there to allow that to happen. But water managers and market operators need to be innovative and be willing to think outside the box.

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