issues insights

10.5

Adapting to water scarcity

Orion Sanders, Tim Goesch and Neal Hughes

March 2010

abare.gov.au

© Commonwealth of Australia 2010

This work is copyright. The *Copyright Act 1968* permits fair dealing for study, research, news reporting, criticism or review. Selected passages, tables or diagrams may be reproduced for such purposes provided acknowledgment of the source is included. Major extracts or the entire document may not be reproduced by any process without the written permission of the Executive Director, ABARE.

Australian Bureau of Agricultural and Resource Economics

Postal address	GPO Box 1563 Canberra ACT 2601 Australia
Location	7B London Circuit Canberra ACT 2601
Switchboard	+61 2 6272 2000
Facsimile	+61 2 6272 2001

ABARE is a professionally independent government economic research agency.

ABARE project 3219

Introduction

Irrigators' future access to water is likely to be affected by a combination of climatic factors and new policy initiatives. In particular, it is expected that future average water availability will decline and that the frequency of extreme events such as the current drought will increase.

In 2008 the CSIRO released projections for long-term water availability in the Murray–Darling Basin under a number of climate change scenarios (CSIRO 2008a). The projections were based on extensive Basin-wide hydrological modelling as well as historical data from 1895 to 2006. In all, 15 global climate models were used to predict future water availability for the year 2030. While the CSIRO emphasised the uncertainty in its predictions, it predicted an 11 per cent reduction in surface water availability (from the long-term average) across the Basin by 2030 under a median climate change scenario. Under current water sharing rules, this reduction in surface water availability was estimated to lead to a 4 per cent reduction in consumptive diversions.

Water sharing rules in the Basin are currently in the process of being reformed. On 15 December 2008 amendments to the Water Act 2007 commenced, giving effect to the Intergovernmental Agreement (IGA) on Murray–Darling Basin reform. The IGA provides for the establishment of the Murray–Darling Basin Authority (MDBA) as the agency responsible for developing a Basin Plan that will establish sustainable diversion limits (SDLs) and an Environmental Watering Plan by 2011. Currently, surface water diversions for irrigation are limited by a cap on river diversions within the Basin, which was determined on the basis of historic use rather than sustainability (MDBA 2009a). The new sustainable diversion limits will come into effect as existing water sharing plans expire—beginning in 2014 in Queensland, New South Wales and South Australia, and in 2019 in Victoria. While it is currently uncertain exactly how new SDLs will be defined, it is expected that irrigation water availability will fall as a greater priority is given to environmental water use.

In addition to lower average surface water availability, it is expected that the variability in supply is likely to increase in the future with an increased number of extreme events. CSIRO (2008b) mentions that scenarios of climate change indicate substantial reductions in mean river flows and higher flow variability. Results from some climate change models project up to 20 per cent more droughts in Australia by 2030 and up to 80 per cent more droughts in eastern Australia by 2070. The CSIRO analysis (2008a) also states that drought conditions such as those currently facing the Murray–Darling Basin will become more common in the future.

This paper explores the potential for irrigators to respond to these risks by drawing insights from how irrigators responded to the recent drought under current water policies. First, the effect of drought as an extreme climatic event is demonstrated. This is followed by identifying major policy reforms in recent years. This provides the context within which irrigators have responded to drought. Next, the range of options available to irrigators to respond to a lower and more variable water supply is identified, followed by a discussion of adaptation options that have been observed during the current drought period. The paper concludes with a discussion of the success of current policies in aiding adaptation, and identifies other policy options that may further facilitate irrigators adapting to lower and more variable water supplies.

Drought

The current drought in the Murray–Darling Basin (MDB) is an example of an extreme climatic event, both in its extent and duration. The drought has been highlighted by significantly reduced rainfall and above average temperatures since 2001-02. As a result, Basin inflows have been much lower than average and allocations to irrigators have declined, resulting in an irrigation drought (table 1).

1 Irrigation water allocations in major areas of the southern Murray–Darling Basin, 2000-01 to 2009-10

	Allocation (%)					
System	2000-01	2005-06	2006-07	2007-08	2008-09	2009-10 (as at 4 Jan 2010)
South Australian Murray	100	100	60	32	18	48
Victorian Murray (high security)	200	144	95	43	35	60
Victorian Goulburn (high security)	100	100	29	57	33	50
NSW Murray (high security)	100	97	69	25	95	97
NSW Murray (general security)	95	63	0	0	9	10
Murrumbidgee (high security)	100	95	90	90	95	95
Murrumbidgee (general security)	90	54	10	13	21	14

Source: State water authorities (NSW, Victoria, SA).

In the early years of the drought (2002-03 to 2005-06), mainly allocations attached to general security water entitlements were reduced, with allocations in the major southern Basin irrigation regions (NSW Murray and Murrumbidgee) averaging around 40 per cent during this period. However, most farms also faced reduced rainfall and high temperatures, thus increasing the evapotranspiration demand for crops and pastures. While allocations for some high security entitlements were also reduced during this period, this didn't occur until 2006-07 for a majority of high security water entitlements across the Basin. While table 1 indicates allocations to high security entitlements in NSW have been relatively unaffected, the majority of entitlements across the Basin suffered reduced allocations. It is worth noting that prior to the current drought declines in high security water allocations to this extent were unprecedented.

As a result of reduced water allocations, irrigated agriculture across the Basin has been substantially affected, with reductions in water use, land use and production. Unfortunately, consistent data on land use since 2001-02 are not available. However, even for the limited period between 2005-06 and 2007-08, irrigated land use in the MDB fell from 1 654 000 hectares to 958 000 hectares, which was a decline of 42 per cent (table 2). It is likely that a majority of this land would have reverted to dryland agriculture as water availability declined.

The major crops which have been affected by drought are annual crops such as rice, cotton and cereals. Perennial crops such as wine grapes and fruit trees have been affected to a

2 Irrigated land use, Murray–Darling Basin

	Area irrigated	
	2005-06	2007-08
Activity	'000 ha	'000 ha
Pasture/cereal (excl. Rice)	1 045	655
Rice	102	2
Cotton	247	53
Other broadacre crops	38	33
Fruit trees, nut trees, plantation or berry fruits	75	71
Vegetables for human consumption or seed	32	28
Nurseries, cutflowers or cultivated turf	2	2
Grapevines	106	106
Total	1 654	958

Source: ABS 2008, 2009.

lesser degree, as irrigators strived to maintain plantings which have little salvage value and considerable start-up costs for reestablishment.

Previous reforms

A major step in Australian water policy occurred in 1994 when the Council of Australian Governments (COAG) agreed to a water reform framework focusing on recovering the costs of irrigation infrastructure services, allocating water to the environment, and separating land and water property rights to enable effective trading of water rights (Adamson et al. 2007).

Subsequent to the COAG agreement, the Murray–Darling Basin Ministerial Council implemented a cap on river diversions within the Basin. Prior to this, Basin diversion levels had steadily increased as water managers had put in place water allocation systems to encourage the development of Basin water resources (MDBC 1998). However, this was found to have had adverse effects on the environment, with significantly reduced end of system flows and a number of problems with river health. The cap effectively limited water use in the Basin to 1993-94 levels, with some allowances for additional water use.

While policy reform continued at differing speeds throughout the Basin, a method for effectively implementing the principles from the original 1994 COAG water framework took place with the signing of the National Water Initiative (NWI) in 2004. The NWI is an agreement between the federal and state and territory governments on water reform with an overarching goal of optimising the economic, social and environmental benefits that can be derived from water. Among other things, the parties to the NWI agreed to: create water access entitlements for consumptive water that are separated from land; give statutory recognition to environmental water; adjust overallocated and/or overused water systems to more sustainable levels of use; and implement water trading arrangements that facilitate the efficient operation of water markets (Commonwealth of Australia 2004).

The cap and trade system introduced in the Basin has effectively created a value for irrigation water based on its opportunity cost in use. This opportunity cost is its market price, and it is this price that creates the incentives to increase the efficiency of water use. It is in this policy environment that irrigators have had to adapt to the recent drought in the MDB.

Available adaptation options

Irrigators have a number of options to limit the effects of lower and more variable water supplies on their farm business. These options range from short-term and flexible techniques such as engaging in temporary water trade to more extensive and long-term techniques such as upgrading irrigation infrastructure and technology. The extent of the uptake of these options ultimately depends on whether irrigators view the expected benefits of a method as outweighing its expected costs. These depend on individual irrigators' circumstances and expectations regarding future water supply; while one option might be favourable for one irrigator, the same option may not be favourable to another because of differing circumstances or expectations.

In general, the options available for lessening the effects of a reduced and more variable supply of irrigation water all work toward increasing the allocative or technical efficiency of water use across the Basin and within the farm unit. Allocative efficiency refers to whether water is allocated to those activities for which it generates the most value. Changes to the distribution of water across activities or users to those which value it most, for example by trading temporary water, will improve allocative efficiency. Technical efficiency refers to the efficiency with which water is used in the production process of a certain good. Options that decrease the amount of water needed to produce a particular output, such as improvements in technology, increase technical efficiency.

Improved water use efficiency benefits irrigation businesses by putting them in a better position to deal with a reduced or more variable water supply. The benefits of improved water use efficiency come directly from increasing expected farm income during periods of low water supply and also indirectly by managing the risk of reduced water availability (Hardaker et al. 2004). These risk management benefits are mostly derived from reductions in the variability of farm income, which is important for some irrigators. Of course, improvements in water use efficiency involve costs, so that the overall value of increasing water use efficiency for an individual irrigator is derived from a comparison of these costs and benefits. As costs and benefits can differ significantly between irrigators, some irrigators may prefer to greatly increase their water use efficiency while others might not do so at all.

Water trade

One of the more flexible adaptation options available to irrigators is engaging in water trade, in either the temporary or permanent market. Temporary water trade involves trading yearly allocations of water and is a short-term method used to respond to short-term variability in supply. Because of the natural variability in the Australian climate, the value of water to individual irrigators varies between seasons and years. Temporary water trade provides irrigators flexibility in managing their water use and allows irrigators with higher value uses to source water from irrigators with lower value uses. This increases the allocative efficiency of water use within the Basin.

Permanent water trade involves the sale or acquisition of water entitlements that yield water each year. This is a more permanent means of adjustment toward a reduced or more variable water supply. While this trade also allows water to move to higher value activities, a significant proportion of the value of an entitlement may be derived from the security of future water supply that is provided by owning it. As the price of seasonal allocations can exhibit large fluctuations while the price of entitlements is relatively stable, risk averse irrigators can seek to insure themselves against price risk by holding some water entitlements (PC 2009). As such, trade in entitlements allows irrigators to manage water supply risk or financial risk, with the value of an entitlement comprised of both the expected stream of income that can be earned from allocations attached to these entitlements and a risk premium.

Groundwater access

While surface water allocations are generally correlated with inflows so that a reduction in rainfall and inflows results in a reduction in surface water allocations, groundwater allocations are usually not affected to the same extent. As such, when surface water becomes scarce and the price of water rises, irrigators are more likely to substitute toward groundwater usage, where this is possible. While groundwater is usually more expensive to access because it involves extra pumping costs, these costs may be worth bearing as water becomes scarce and its value increases.

Intertemporal water management

The Australian climate is naturally highly variable between years and seasons. The ability to manage water use between years provides irrigators with an extremely useful means of both reducing production risk and ensuring water is used during periods when it is more highly valued. In some annual accounting water systems, carryover water has become an integral part of some irrigators' risk management strategies. Carryover allows water users to carry a percentage of their allocation into the next year, providing some security for the availability of water in the next season.

Altering mix and level of production

One predominant method irrigators may use to respond to a reduced and more variable water supply is to alter their mix and level of production. By altering their mix of production, irrigators can adjust from water intensive crops toward less water intensive crops during periods of low allocations, and vice versa during periods of high allocations. While this option is more suited to annual cropping activities where farmers have the capacity to quickly switch between irrigated and dryland crops given the short life cycle of these crops, there is the potential for this to occur in other activities. For example, in dairy this may take the form of reducing perennial pasture and increasing annual pasture, or in the case of horticulture, by replanting existing stands with new drought tolerant varieties or alternatively by grafting these varieties onto existing rootstocks.

In addition to altering the mix of production, irrigators may simply reduce production. This option may be attractive to some in dairy and perennial horticulture irrigation. In the dairy industry, reduced production may take the form of culling herd size or reducing feed and maintaining cows in a less-productive or non-productive state. In perennial horticulture, this may be achieved by abandoning less productive plantings, decreasing the volume of irrigation water applied, or by pruning trees.

Farm management practices and technology

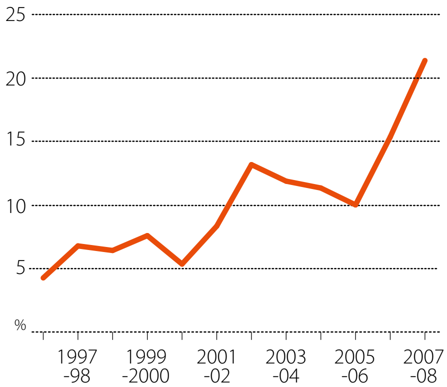
Changes to farm management practices and irrigation technology provide a large range of options in adapting to a more variable or reduced water supply, usually by improving the technical efficiency of water use at the farm level. These can be short-term options ranging from relatively low cost methods such as the adoption of night irrigation to conserve water evaporation losses to more expensive options such as buying in feed to supplement on-farm feed supplies (for dairy and other livestock). More extensive and longer term adaptation options consist of upgrading irrigation technology such as moving from furrow and overhead sprinkler to drip irrigation (perennial horticulture) or implementing water recovery and reuse systems.

Observed adaptation

The available evidence indicates that the range of options identified above has been widely utilised by irrigators as they have responded to reduced allocations during the drought. For instance, water markets have been a critical tool in allowing irrigators to respond to varying levels of water supply, while carryover water has allowed greater flexibility in managing intertemporal water use, allowing irrigators to better manage risk and ensuring water is used when it is valued most. Survey results also indicate that the extent of improvements in farm management practices and technology across the Basin has been significant.

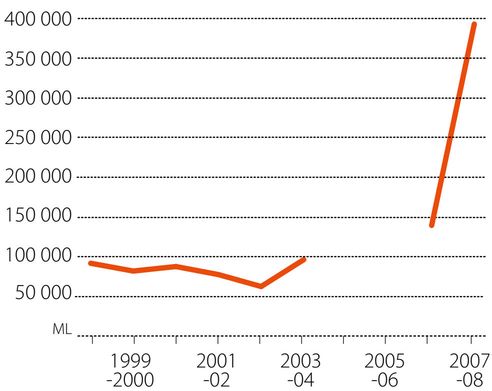
Because of limited availability of quantitative data on the extent and type of adaptation being undertaken at the farm level, the analysis has been supplemented by information gathered in a series of interviews with irrigators in the southern Basin. This involved interviewing seven irrigators in the Murrumbidgee, Murray, Goulburn, and South Australian Murray irrigation regions involved in a range of industries (dairy, wine grapes, citrus and irrigated broadacre). Irrigators were asked about the effects of drought on their business, the options they had taken in response and their expectations for the future. The information gathered in the interviews suggested that significant adaptation had taken place in recent years. Moreover, the individual stories tended to support other studies, such as Mallawaarachchi and Foster (2009)

a Allocation trade as a proportion of irrigation diversions, Murray-Darling Basin, 1996-97 to 2007-08



Source: MDBC 1997-2008, MDBA 2009b.

b Permanent entitlement trade, Murray-Darling Basin, 1998-99 to 2007-08 a



a Data incomplete for 2004-05 and 2005-06.
Source: MDBC 1997-2008, MDBA 2009b.

and Topp and Shafron (2006), and are consistent with behavioural expectations from general economic theory.

Water trade

Water markets have been highly successful to date in both allowing irrigators to manage risk and to ensure water is put to its highest value use. Data indicate there has been a large increase in water trade and that it has played a critical role in enabling irrigators to adjust to a change in water availability (Mallawaarachchi and Foster 2009).

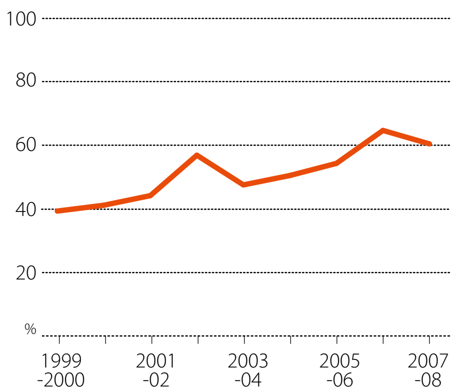
The volume of temporary trade as a proportion of irrigation water diversions is shown in figure a. This measure of trade has risen dramatically since the beginning of drought as irrigators respond to a more variable supply of irrigation water. While an increase in trade has been facilitated by the maturing of water markets within the MDB, this is unlikely to account for the full increase. Further data from the NWC (2009) indicate there was a 41 per cent increase in the volume of temporary trade within the southern connected MDB between 2007-08 and 2008-09.

Trade of permanent water entitlements has also recently shown a significant increase, albeit from a low base (figure b). While trade in water entitlements was relatively flat until 2004-05 (unfortunately the data series is incomplete), since 2006-07 trade volumes have increased dramatically. In addition to the data presented in figure b, NWC (2009) indicates that between 2007-08 and 2008-09 there was a 75 per cent increase in the volume of entitlement trade within the southern connected MDB. However, some of this increase is attributable to the entry of the Australian Government into the water market as part of the Restoring the Balance program. The increase in entitlement trade also corresponds with the years in which allocations for high security entitlements began to decline. With reduced security of entitlements, irrigators with a need for a secure supply of irrigation water may have sought to purchase additional entitlements.

Irrigators interviewed saw water trade as an extremely useful tool to manage the effects of drought on their business. A majority of the irrigators interviewed indicated that they had recently engaged in temporary trade. Those irrigators who faced reduced water allocations used water trade as a tool to supplement their supply of irrigation water. For example, water trade was vital for a Goulburn wine grape grower who would have lost the majority of his vines to water stress in 2006-07 (when high security water allocations fell from 100 per cent the previous year to 29 per cent) if he had not been able to purchase temporary water. Although this carried a large financial cost ($1000 per megalitre), the loss of his plantings would have affected him severely. Another irrigator from Coleambally purchased temporary groundwater opportunistically in order to continue growing relatively water intensive crops, including rice. Those irrigators who did not engage in temporary trade—one each from the rice, dairy and perennial horticulture industries—indicated that the price was too high to be beneficial for their individual farming enterprise. They noted that purchasing temporary water is not a viable long-term strategy for businesses in a similar position to theirs.

With increased scarcity of water and resulting higher water prices, those irrigators with more secure water supplies engaged in selling temporary water where they otherwise wouldn't have. One Murrumbidgee citrus farmer interviewed owned solely high security water entitlements, which only experienced minor reductions in allocations in recent years. Water trade has allowed him to obtain additional income from selling temporary water, while also allowing irrigators who purchased this water to access supplies they would not have otherwise had access to.

C Groundwater use as a proportion of allocation, Murray-Darling Basin, 1999-00 to 2007-08



Source: MDBC 1997-2008, MDBA 2009b.

Groundwater

Available data indicate that groundwater use intensity has increased over the course of the current drought. This is expected as irrigators substitute to groundwater when the availability of surface water declines. The Groundwater Technical Reference Group provided estimated data for inclusion in the Water Audit Monitoring Reports on groundwater usage and allocation across the MDB. In most areas of the Basin, groundwater usage is not allocated by explicit allocation percentages, but rather by other rules and regulations such as limits on pump size. Nevertheless, estimates were provided on the effective allocation of groundwater in the Basin. Figure c indicates an increasing trend in the use of groundwater as a proportion of this allocation, and suggests that irrigators have begun utilising groundwater more intensively as surface water availability has declined. However, it should be noted that there are a number of deficiencies in the data, so this analysis must be treated with caution.

While access to groundwater was limited to a small number of those irrigators interviewed, it played a significant role in enabling those who had access to ease the effect of reduced access to surface water. Those irrigators with access to groundwater stated that it was a major factor in allowing their business to remain viable during the drought. For one rice farmer, groundwater access was the result of a bore built during drought in the 1960s. This had mainly gone unused, as pumping costs were more expensive than surface water costs. However, during the drought he began to utilise this water to compensate for reduced access to general security surface water. Another dairy irrigator reported that access to groundwater had specifically been set up before the drought as a form of risk management. In his view, other irrigators in the area had the possibility of accessing groundwater, but chose not to. These irrigators had expected to buy temporary water in times of scarcity rather than face the high setup costs associated with installing a bore. With the onset of drought, and consequent high temporary surface water prices, many of these irrigators have faced high costs for accessing additional water.

Carryover

Carryover has been used in New South Wales for a number of years and was recently introduced in Victoria. Evidence indicates that this water use management tool has been widely utilised by irrigators. For example, in the Murrumbidgee, carryover for the past 10 years has averaged 10 per cent of total entitlement volume and peaked at 16 per cent in 2008-09 when the cap was raised from 15 per cent to 30 per cent of entitlement volume. Carryover was introduced in Victoria in 2006-07. The initial carryover limit was 30 per cent. It proved highly successful, with almost 10 per cent of total entitlement volume in Victoria estimated to have been carried over from 2007-08 to 2008-09. The cap has since been raised to 50 per cent for 2009-10.

Farm management practices and technology

Unfortunately, quantitative data on farm management practices and irrigation technologies across the Basin are limited. ABARE's irrigation survey provides useful information across the whole Basin, however data points are only available for recent years (2006-07 and 2007-08). Additional survey data mostly concentrate on small areas of the Basin for a limited number of years. Nevertheless, those data that are available and the qualitative interviews suggest that some irrigators across the Basin may have undertaken significant adaptation in response to reduced water availability and the risks posed by more frequent extreme events by upgrading irrigation technology and altering farm management practices.

Giddings (2008) examined the change in irrigation technology and performance within selected districts in the lower Murray–Darling, specifically, Coomella, Curlwaa and Pomona, and found that between 1997 and 2006 there were significant changes in irrigation technology. He found that the percentage of farms utilising drip irrigation, a relatively efficient irrigation application technology, increased from around 6 per cent to around 33 per cent. Conversely, the proportion of farms utilising furrow and overhead irrigation was found to decline significantly. In addition he found that average application efficiency of irrigation water steadily increased from 1998 to 2003, the period for which data were available.

Topp and Shafron (2006) analysed two surveys dealing with drought preparedness, management and adaptation. The first was conducted by the Queensland Government Department of Primary Industries and Fisheries in 2004 and covered all major agricultural regions in Queensland. The second survey was conducted by ABARE in 2005 and targeted horticultural producers in four drought affected regions in New South Wales and Victoria.

The results indicated that for dairy farms the single most common farm management strategy adopted was an increased reliance on fodder (75 per cent of farms), both for on-farm stocks and purchased feed. Thirty five per cent of these dairy farms made an early decision not to plant a crop, while 30 per cent of farms planted a different crop than normal and 26 per cent of farms took on extra off-farm work. In the cropping industry, the most common responses were altering the mix of production (47 per cent) or simply reducing production by not planting a crop (60 per cent). Horticulture farms mainly responded to drought by improving the efficiency of their irrigation systems (48 per cent), implementing moisture conserving crop management strategies, and acquiring additional water (20 per cent). Sixteen per cent of farms increased their off-farm employment.

Finally, data from the ABARE irrigation survey indicate that 34 per cent of irrigation farms within the Basin made a new investment in irrigation capital in 2006-07. This includes fixed irrigation infrastructure, irrigation water equipment and permanent water entitlements.

All of the farmers interviewed had undergone some form of adaptation to increase their on-farm water use efficiency. Adaptations taken to improve irrigation technology included laser levelling of paddocks, laying new piping, upgrading from overhead sprinklers to drip irrigation, installation of water recycling systems, channel realignments, replacement of diesel pumps with electric pumps and upgrading delivery systems from open ditch to PVC to supply gravity fed furrows. A number of farm management strategies were also implemented. These included planting inter-row live mulch crops to retain soil moisture, night irrigation to reduce evaporation losses, and choosing to irrigate only flat paddocks from which water cannot run off.

Change in mix and level of production

All of the farmers interviewed also said they had responded to the drought by altering either their level or mix of production, consistent with economically rational behaviour. One broadacre rice farmer altered his crop mix by reducing the amount of (water intensive) rice planted from 49 hectares to 16 hectares, while another completely changed his crop mix from predominantly rice and grain to a less water intensive mixture of rockmelons and pumpkins. In the dairy industry, one farmer decreased his herd size by culling his stock down to the core breeding stock. This, and reduced feed supplements, resulted in lower average milk production as the number of milking cows, yields and quality decreased (they reported around a 50 per cent reduction in milk production). On another dairy farm, while the herd was maintained at original size, the reduced availability of feed grown on farm, as a result of reduced irrigation water, led to a large decline in milk output; during one drought year the cows were not even milked.

Those in perennial horticulture were also affected. On one Murrumbidgee wine grape farm, 10 per cent of total plantings were abandoned to keep the rest of the plantings in normal production by providing the required water. On another Goulburn wine grape farm, which faced large reductions in irrigation water, all of the plantings were kept alive, although with significantly less water. The operator noted that grape yields had been 'significantly reduced'. The operator on this farm was also in the process of changing his production mix by grafting different wine grape varieties onto a small proportion of his land. The new varieties were chosen to better cope with reduced water availability.

Expectations

The interviews also revealed evidence that recent events have affected some irrigators' expectations regarding future irrigation water supplies. For example, a number of irrigators noted that prior to the drought they had never considered the possibility of a drought as long lasting as the current one, but that now they consider it a likely possibility in the future. Furthermore, some operators explicitly stated that their expectations of the likelihood or frequency of future drought had greatly increased. Most irrigators were also clearly expecting reduced average water availability in future. One irrigator mentioned that even though he was unsure whether future supplies would be reduced, as a risk management strategy he had to plan for the worst case scenario.

While many irrigators may have changed their expectations regarding future water availability, the interviews suggest this is not the case for all irrigators. For example, the operators of a Goulburn dairy farm stated that their expectations regarding future drought have remained unchanged. They noted that while other irrigators attribute current drought conditions to climate change, they do not believe this to be the case; instead, they believe the drought conditions are just part of normal fluctuations in weather patterns.

Changes in the expectations of future water availability could lead to changes in the pattern of irrigated activities across the Basin as the risks increase for some industries reliant on stable irrigation water supplies. This may be the case for perennial horticulture. Such industries face large capital losses in years of low water availability if these plantings die because of water stress.

Additional reforms

The available evidence appears to support the case that current water policies have aided irrigators' abilities to adapt to the drought. For example, it appears that the allocation market played a major role in minimising capital losses for horticultural farmers with perennial crops as high security allocations declined. The willingness of these irrigators to avoid these losses was highlighted by the spike in allocation prices at more than $1000 a megalitre in 2007. This trade was mutually beneficial, with sellers receiving high prices for their allocations, helping offset any decline in income associated with a reduction in irrigated production.

It also appears that the high allocation prices in 2007 may have stimulated other forms of adaptation, to the extent that allocation prices fell in 2008-09 despite allocations generally being lower than in 2007-08. This could be expected as many irrigators may not have been in a position to pay the high prices witnessed in 2007 for any extended period.

While recent reforms have increased the flexibility of irrigators to adapt to drought, there are areas where additional reform could further increase the flexibility of irrigators to adapt to lower and more variable water supplies as well as aid longer term adjustment within the sector. One of the main goals of water policy reform should be to facilitate autonomous adjustment within the irrigation sector and to adjust any policies that distort market based incentives to enter or exit the industry.

Constraints on trade

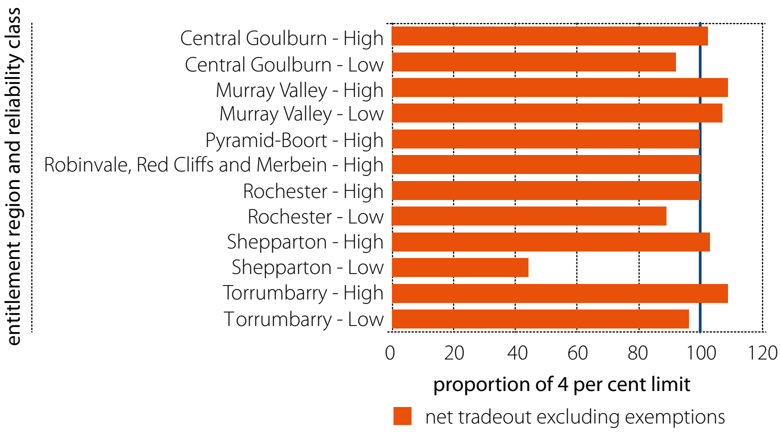
Given this goal, one area in need of reform is the market for irrigation entitlements. While the market for allocation water is relatively unrestricted, there are a number of restrictions on trade in entitlements.

For instance, in both Victoria and New South Wales there is a 4 per cent annual limit on the volume of water entitlements that may be traded out of an irrigation area. This does not apply to entitlement trades into or within a region. Once this limit is reached, further applications to trade water out of a region are rejected. In Victoria this rule applies to small irrigation districts within water authorities, while in New South Wales this applies to entire regions controlled by irrigation cooperatives or corporations (Frontier Economics 2009).

Water entitlements can provide considerable benefits to irrigators in managing risk. As such, restrictions in the trade of entitlements could be constraining investment in businesses which require access to a secure supply of water or have high initial capital costs, such as perennial horticulture. Specifically, Frontier Economics (2009) mention that constraints on entitlement trading undermine the ability of water users to manage their risks efficiently, to undertake long-term investments or to realise the value of their assets in response to pressures facing the industry. However, these effects are realised only when the constraint on trade is binding.

Trade restrictions in Victoria have been relaxed to some extent by the introduction of trade exemptions. These allow for the sale of entitlements to the Australian Government where such sales have been made as part of the Murray–Darling Basin Small Block Irrigators Exit Grant Package, or a result of Australian Government assistance in achieving on-farm efficiencies, or in areas which have been identified as not being a priority for modernisation and subject to volumetric restrictions. However, available data show that these limits on trade have been reached in many regions (figure d). This suggests that the limits may have prevented some mutually beneficial entitlement trades from taking place, or at least delayed these transactions. Frontier Economics (2009) suggest that the 4 per cent limit does not apply to a large proportion of irrigators in New South Wales.

d Comparison of traded water and 4 per cent limit



Source: Victorian water register.

Water property rights

As average water availability declines and variability increases, it becomes increasingly important to have well specified water property rights. In general, well specified water property rights are those that accurately reflect the hydrological realities of the underlying water supply systems. The more accurately water rights are specified the more efficient will be the allocation of water across regions and across users. Well specified property rights will ensure that the gains from trade, including the potential gains from the removal of barriers to trade, are fully realised. While more accurately specified water rights are desirable, property rights reform may involve some costs. Decisions over appropriate reforms need to take into account both the potential benefits and costs. As such, the desirable water rights structures may vary across contexts (regions).

An important area of reform that has the potential to help irrigators, and water users more generally, adapt to lower and more variable water supplies is carryover. Carryover rights have now been implemented in varying forms in most regions across the Basin. However, it has been well established that basic carryover rights systems have a number of limitations (Hughes and Goesch 2009a), including strict volumetric limits and incomplete treatment of storage constraints, spills and losses. The problems with basic carryover rights are likely to become more apparent as demand for carryover increases. For instance, the Commonwealth Environmental Water Holder may want to build up a store of water in order to create a flood. This may entail carrying over large volumes of water in storage. Where carryover rules inadequately account for storage constraints, spills and losses, large carryover volumes could adversely affect the reliability of irrigators' and other users' entitlements.

In recent times there has been some reform to carryover rights systems across the Basin. For instance, reforms introduced in Victoria for 2010-11 identify specific rules to address storage losses and spills. Under the new rules, users can hold seasonal allocations and carryover water up to entitlement volumes. Any excess water is then carried over in the 'spillable water account' which is debited in the event of a physical storage spill. An annual (5 per cent) adjustment for storage losses is also applied. Other examples of improved approaches to carryover include continuous accounting arrangements, which have been in place for some time in northern NSW.

Another promising development has been the adoption of an even more advanced approach in southern Queensland, based on the concept of capacity sharing described in Hughes and Goesch (2009b). The capacity sharing approach involves the definition of explicit storage capacity rights, inflow rights (effectively replacing centralised water allocations) and individual accounting of both storage and delivery losses. The potential benefits and costs of a capacity sharing based approach are discussed in detail in Hughes and Goesch (2009a).

While there has been some progress in addressing the shortcomings of some carryover systems, there remains scope for continued reform of carryover rights, and water property rights more generally, in a number of regions across the Basin.

References

ABS 2008, *Water use on Australian farms*, 2005-06, http://www.abs.gov.au/AUSSTATS/subscriber.nsf/log?openagent&46180do012_200506.zip&4618.0&Data Cubes&80B73CB98EC7FABFCA25740A000E43AE&0&2005-06&13.03.2008&Latest.

——2009, *Water use on Australian farms*, 2007-08, http://www.abs.gov.au/ausstats/subscriber.nsf/log?openagent&46180do001_200708.xls&4618.0&Data Cubes&54BFDB3FA0BA22CECA2575EE001AEDFB&0&2007-08&10.07.2009&Latest.

Adamson, D, Mallawaarachchi, T and Quiggin, J 2007, *Modelling basin level allocation of water in the Murray Darling Basin in a world of uncertainty*, Australian Journal of Agricultural and Resource Economics, 51(3), 263-81.

Commonwealth of Australia 2004, *Intergovernmental Agreement on a National Water Initiative*, An agreement between the Commonwealth of Australia and the Governments of New South Wales, Victoria, South Australia, the Australian Capital Territory and the Northern Territory, Canberra.

CSIRO 2008a, *Water Availability in the Murray-Darling Basin: A report from CSIRO to the Australian Government*, Canberra, October. Available from: http://www.csiro.au/files/files/po0n.pdf.

——2008b, *An overview of climate change adaptation in Australian primary industries – impacts*, options and priorities, February.

Frontier Economics 2009, *Volumetric restrictions on water entitlement trade*, A report prepared for the ACCC, August.

Giddings, JA 2008, *Improved irrigation efficiency in the Lower Murray Darling region of Australia*, Acta Hort, (ISHS) 792:305-312. Available from: http://www.actahort.org/books/792/792_35.htm.

Hardaker, JB et al. 2004, *Coping with risk in agriculture*, CABI Pub., Cambridge.

Hughes, N and Goesch, T 2009a, *Management of irrigation water storages: carryover rights and capacity sharing*, ABARE report to the National Program for Sustainable Irrigation, Canberra, May.

Hughes, N and Goesch, T 2009b, *Capacity sharing in the St George and MacIntyre Brook irrigation schemes in southern Queensland*, ABARE research report 09.12, Canberra, June.

Mallawaarachchi , T and Foster, A 2009, *Dealing with irrigation drought: the role of water trading in adapting to water shortages in 2007-08 in the southern Murray-Darling Basin*, ABARE research report 09.6 to the Department of the Environment, Water, Heritage and the Arts, Canberra, March.

Murray–Darling Basin Authority (MDBA) 2009a, *The Basin Plan: a concept statement*. Available from: http://www.mdba.gov.au/files/publications/basin-plan-concept-statement.pdf.

—— 2009b, *Water Audit Monitoring Report 2007-08*. Available from: http://www.mdba.gov.au/files/publications/Water-Audit-Monitoring-Report-2007-08.pdf.

Murray–Darling Basin Commission (MDBC) 1997-2008, *Water Audit Monitoring Reports*. Available from: http://www.mdbc.gov.au/nrm/nrm_archives/cap_archives#WAM_reports.

National Water Commission 2009, *Australian Water Markets Report 2008–2009*, NWC, Canberra. Available from: http://www.nwc.gov.au/www/html/2693-water-markets-report---december-2009.asp?intSiteID=1.

Productivity Commission 2009, *Market Mechanisms for Recovering Water in the Murray-Darling Basin*, Draft Research Report, December.

Topp, V and Shafron, W 2006, *Managing Farm Risk: The Role of Preparing for Drought*, ABARE eReport 06.6 Prepared for the Department of Agriculture, Fisheries and Forestry, Canberra, April.