Treating water markets like stock markets: Key water market reform lessons in the Murray-Darling Basin

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Abstract

Water markets are well known in improving the efficient use and reallocation of water, and the southern-connected Murray-Darling Basin water market is recognised as the most advanced water market globally. In recent years, the market has matured considerably with new water ownership and trading strategies emerging, along with increased participation from non-landholders (i.e. environmental water holders and financial investors, such as pure traders and superannuation companies). This study draws on a quantitative survey of 1,000 southern Basin irrigators plus qualitative interviews with 63 water experts from banks, environmental water holders, investors/agri-corporates, financial investors, property evaluators and water brokers to illustrate the different water ownership and trading strategies employed. Findings suggest that many stakeholders, including non-landholders, prefer to own most of their water needs in higher security water entitlements and use temporary trade to mitigate water supply shortfalls. However, some own no water entitlements (or land) at all, while financial investors and large agri-corporates are more likely to use/supply highly sophisticated temporary trading products, such as water forwards and parking contracts. In addition to the need to reinforce the fundamentals of water institutions in the Murray-Darling Basin (i.e. robust accounting of water extraction and use, and continual monitoring, compliance and enforcement of water extraction/trades), we suggest three major reform areas: 1) data reform: improving the quality and availability of trade and water data plus standardised water market and water forwards terminology; 2) rules and regulation reform:

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increased transparency of trade and allocation/carry-over restrictions plus increased water market regulation and enforcement; and 3) new water market institutional development: a central exchange and clearing house.

Keywords: water investment; water markets; permanent trade; market maturity; temporary trade; non-landholders.

1. Introduction

Water scarcity and climate change are two of the biggest global strategic risks faced by humanity. Many countries will have to deal with both a drier and more volatile climate in the future, requiring substantial adaptation in agricultural systems and production (IPCC, 2019). Continued increase in water extraction and decline in quality and quantity of water resources requires the production of more crops with less water (Perry et al., 2017) without compromising ecosystems. Increasingly, water markets are seen as a key demand management strategy to address water scarcity (Rey et al., 2019), and Australia plays a leading role in this space given it has the most advanced water market system in the world in the Murray-Darling Basin (MDB) (Grafton et al., 2011).

Since their inception a number of decades ago, MDB water markets have been continuously evolving and maturing, and in recent years new water market products such as forwards and parking have emerged (Bayer and Loch, 2017; ABARES, 2018). The separation of land from water – known as unbundling – has allowed for new market participants, such as Environmental Water Holders (EWHs) and non-landholder financial investors (such as superannuation companies and trade speculators) to own and trade water. The reason financial investors have increasingly invested in water is because of the long-term increase in water asset values – to diversify their investment portfolios with water assets which share little correlation with other asset classes (Roca et al., 2015; Wheeler et al., 2016), and the fact that variability in water market prices presents significant opportunities for investment trade returns. In other words, there has been a significant increase in various stakeholders treating the water market like a stock market over the past five to ten years. Although investment in water

entitlements by corporate non-landowners is still relatively small, it is increasing – estimated at around 12% in some areas in 2018[1] (DELWP, 2019b). Additionally, 9% of MDB water entitlements are held by companies with some level[2] of foreign ownership (ATO, 2019). The Commonwealth of Australia is the largest EWH water owner in Australia, currently owning over 2,000GL (gigalitres) of long-term average annual yield (LTAAY – see Appendix A for a glossary of terms) in water entitlements, which it has been recovering from consumptive use since 2007-08 (Zuo et al., 2019a).

With large parts of south-eastern Australia currently experiencing the most severe drought in 120 years (Doyle, 2019), and high water allocation and entitlement prices, increasingly questions have been raised regarding water market functionality and equity issues. In particular, questions surround the role that non-landholders and EWHs play in influencing water market prices, along with their water ownership and trading behaviour (Miller, 2019). Public concerns culminated in the Australian Government commissioning a current review of MDB water markets. Although recent academic evidence (Zuo et al., 2019a) shows water market prices are driven primarily by water scarcity rather than government water recovery, there are still considerable knowledge gaps around water corporate and non-landholder (namely EWH and financial traders/investors) water market strategies.

This study seeks to understand the water ownership and trading strategies used by MDB stakeholders, both landholders and non-landholders. We draw upon 1,000 telephone interviews with irrigators in the southern Basin and 63 in-depth interviews with water experts in banks, large agri-corporates, environmental water groups (generally non-landholding), financial investors (non-

[1]The Commonwealth minister for water resources stated in an interview on 09/09/2019 that 14% of all southern MDB entitlements are owned by entities "that don't have land attached to it". This figure is based on 2018 internal Department of Agriculture and Water Resources (DAWR) estimates of non-landholder ownership of 7-14%. DAWR advised that this estimation is no longer used due to physical variations and changes in water investment strategies in 2019 (DAWR, personal communication, 2019).

[2]The ATO (2019) defines companies with a level of foreign ownership as: 1) owned by an individual not ordinarily an Australian resident; 2) owned by a foreign government or government investor; 3) a company or trust where an individual not ordinarily resident in Australia, a foreign corporation or government holds a substantial interest of at least 20%; or 4) a company or trust where two or more foreign persons hold an aggregate substantial interest of at least 40%.

landholding), property evaluators and brokers. In particular, our study sought to answer three research questions in regards to water ownership, trade and water market improvements:

1) What motivates land-holders and non-landholders to own water entitlements in the MDB and what ownership strategies are employed?
2) What are the water market trading strategies employed by various stakeholders in the MDB and is there a difference in trading strategies between land-holders and non-landholders?
3) What do various stakeholders think are the key lessons for water market improvement?

We conclude with our recommendations for MDB water market design reform and a number of key insights for the development of water markets in other countries.

2. Background of MDB Water Trading

The benefits from introducing water ownership rights (otherwise known as entitlements and licences) and water trading markets have been well established, both in theory and in practise (Bjornlund, 2006; Pujol et al., 2006; Grafton et al., 2016). Water markets have been adopted in a number of countries, such as Spain, Mexico, Chile and the United States, however the most advanced water market operates in Australia's MDB – routinely serving as the exemplar of best-practice (Grafton et al., 2011; Leonard et al., 2019; Rey et al., 2019).

Informal water markets have been operating in the MDB since the 1960s, with water swapping even known during the World War II drought, but were more formally established from the 1990s onwards, and driven by the cap of water diversions implemented in 1995, with the annual permitted extraction from watercourses and regulated rivers set at 1993–94 levels of development (although Queensland was set at 1999-2000 levels (AAS, 2019) and South Australia where the Cap was set at an average use of 90% of entitlements which was considerably above its 1993-94 levels of use). The 2000s saw the separation of land and water ownership (e.g. Victoria unbundled water from land in 2007), which allowed non-landowners to own water for the first time. Water markets developed from the late 1980s and early 1990s onwards. Trade generally occurs through two main products: 1)

96 water entitlements (permanent water – a right to extract water from a watercourse/body); and 2)
97 water allocations (temporary water – the seasonal allocation received by a given water entitlement)
98 (Wheeler et al., 2014a). Water entitlements come in three main forms within the southern system:
99 high, general and low security (reliability in Victoria), reflecting the probability of receiving a full
100 water allocation. For example, a high security entitlement is meant to yield, on average, a full
101 allocation in 90-95 out of 100 years (Zuo et al., 2016). Other relatively common trade products
102 include water delivery shares (right to deliver water in an irrigation network (Crase et al., 2015)),
103 parking (right to use carry-over[3] space owned by a different entitlement holder), water leases, water
104 forwards and water options.[4] For a Glossary of important water market products and expressions,
105 see Appendix A.
106 Over 150 different types of water entitlements currently exist in different parts of the Basin
107 (MDBA, 2019b). Table 1 illustrates the main types of water products traded, along with some price
108 examples of what each product traded for in recent water seasons.

[3]Carry-over allows water owners to store allocation in dams for future use, minus 5% loss for storage evaporation losses.
[4]To date only "call options" were traded, giving the contract buyer the option, but not the obligation, to buy an agreed volume of water for an agreed price and timeline. It seems "put options", giving the contract buyer the option to sell an agreed volume of water for an agreed price, have not yet been transacted (H2OX, personal communication, 2019).

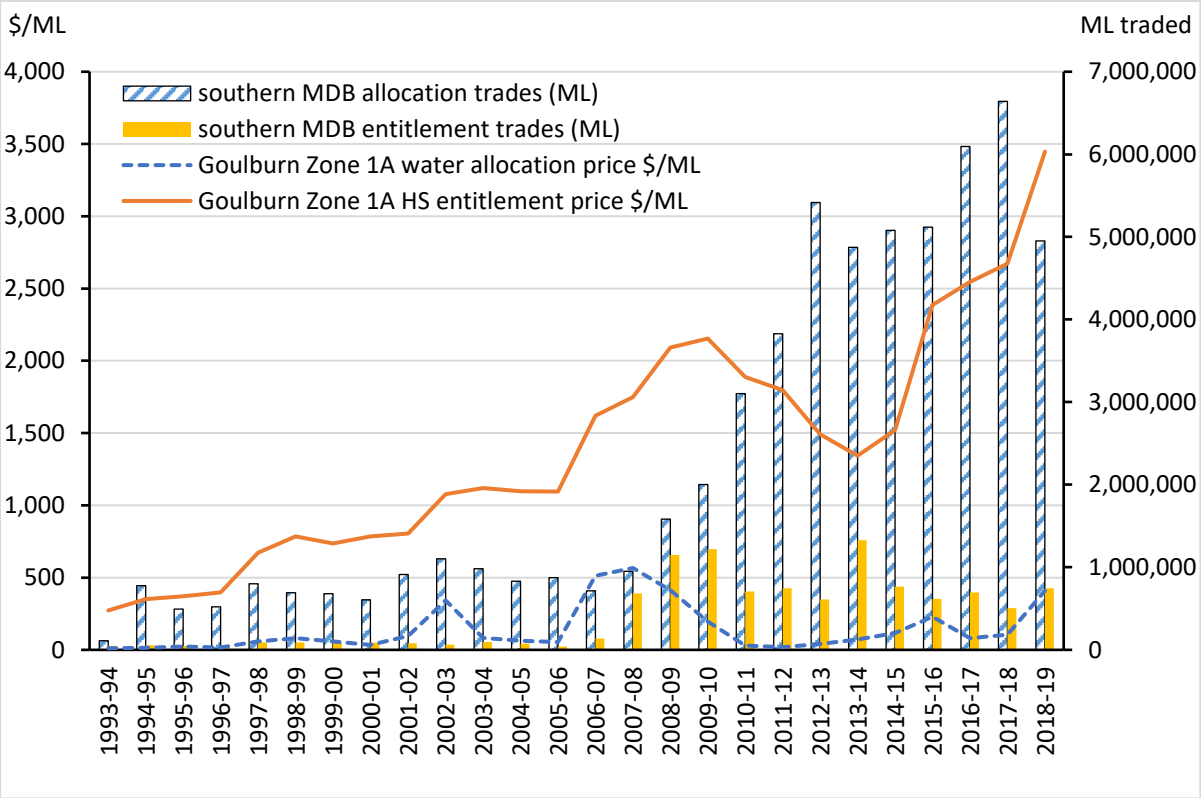
Table 1: Overview of the main MDB water market products

Permanent water products	***Murrumbidgee $AUD/ML price 2018-2019****	***Goulburn (1A) $AUD/ML price 2018-2019****	***Temporary water products***	***Murrumbidgee $AUD/ML price 2018-2019****	***Goulburn (1A) $AUD/ML price 2018-2019****
Entitlements (regulated and unregulated)			Allocation		
• High security (HS)	4850-7000	3000-4000	• Surface water	250-550	230-540
• General security (GS)	1600-2200	not available (n/a)	• Groundwater	200-250	n/a
• Low security (LS)/ supplementary/ conveyance	310-2575	400-550	Water lease • 1 year	n/a	LS: 20-30 HS: 250-350 (p.a.)
			• Multi-year (mostly up to 5 years)	GS: 80+ (p.a.) HS: 350+ (p.a.)	LS: 25-35 (p.a.) HS: 250-350 (p.a.)
• Unregulated	175-800	n/a	Carry-over space (parking)	21-33	5-15
• Groundwater	4000-4500	n/a	Water forwards		
			• 1 year	160-385	140-350
Water delivery shares**	150-250	37 **(seller pays)**	• Multi-year (up to 5 years)	n/a	n/a
			Water options	n/a	n/a

Notes: *Water allocation and entitlement prices are based on monthly median prices, excluding prices of AUD$0/ML, and are sourced from BOM (2019) for Murrumbidgee and DELWP (2019c) for 2018-19 Goulburn water season. H20X water trading platform data provided values for groundwater, delivery shares, leases, parking and forwards. **One delivery share in the Murrumbidgee allows the delivery of 1.2 ML and can be traded annually (MI, 2015). One delivery share in the Goulburn delivers 270 ML (1ML per day per irrigation season (270 days)) and are valid indefinitely. Licencing fees amount to $2,925–5,333 per year per share, with a termination fee of $29,250–53,333 (GMW, 2018). Therefore, sellers in the Goulburn pay the buyer around $10,000 per share, or $37/ML, to take on the ongoing liability.

Figure 1 illustrates the development of water allocation and entitlement volume traded from the early 1990s in the southern MDB, and also displays nominal annual water allocation and high security (HS) entitlement prices for the Goulburn system of Victoria, one of the most active and mature trading regions.

Figure 1. Figure 1. Temporary and permanent water prices in the Goulburn and southern MDB water trade volumes from 1993-94 to 2018-19



Source: Adapted from Seidl et al. (forthcoming).

Under an entitlement lease, the buyer gains the right to extract water allocated to the seller's entitlement for a given time-period. Water forward/options contracts deliver a predetermined volume of allocation at a set date and price to the buyer. Forward delivery is mandatory, whereas under option contracts the buyer can choose not to acquire the water. In contrast to forwards and

options, where the seller bears (part of the) supply risk and guarantees physical delivery, these risks are borne by water lease buyers.

From 2007 onwards, an organisation can buy water entitlements on the market irrespective of land-ownership, and achieve a return by selling temporary water through the market to agriculturalists (Wheeler et al., 2016). As a result, non-landholder ownership (i.e. superannuation companies, trade speculators and arbitrageurs, NGOs, EWHs) of water entitlements in the MDB has been growing (DELWP, 2019b).

Market participation by irrigators in general has also grown over time with 52% and 78% of irrigators in 2015-16 having conducted at least one entitlement or allocation trade respectively (Grafton and Wheeler, 2018). Corresponding to the increase in market use, water market transaction costs and trade barriers have reduced over time (Loch et al., 2018), although a number of legal barriers, such as inter-valley trade restrictions (IVTs – see glossary in Appendix A), and physical barriers (e.g. the 7,000 megalitres per day (ML/day) Barmah-Choke flow constraint[5] (MDBA, 2019a)) remain. There is also evidence that regulations are improving market conditions. For example, there is some quantitative evidence that insider trading potentially declined after the introduction of relevant legislation in 2014 (de Bonviller et al., 2019). At the same time, market participants have become more sophisticated and willing to speculate in the past decade, which can have both benefits and costs for various stakeholders in the market.

Although reasons for water market participation vary markedly between stakeholders, they can be associated with two broad themes: 1) water trading and ownership to mitigate shortage and secure water supply; and 2) water trading and ownership for direct financial gain (from water use). A dominant strategy for many irrigators (both past and present) is to own more water than needed in order to achieve a buffer. Trading surplus water can be dependent upon prices and/or output prices (Wheeler and Cheesman, 2013). Another recent strategy is to diversify water ownership, e.g.

[5]Note that the official maximum flow per day capacity figure can be 7,000 ML/day or 9,500–10,600 ML/day, depending on the source and the point at which it is being measured (MDBA, 2019a; MDBBOC, 2019).

owning entitlements across different securities and regions (Leroux and Martin, 2016). Carry-over has also allowed stakeholders to mitigate future scarcity. Water scarcity is often mitigated using temporary water trading (although irrigators also employ many other farm strategies (Gaydon et al., 2012; Kirby et al., 2014)). The simplest approach is to buy water allocations to supplement water supply during times of scarcity (Loch et al., 2012). Generally, at higher water allocation prices, dairy irrigators are usually the first to switch from buying to selling allocations, followed by broadacre irrigators; whereas perennial horticulturalists continue to purchase allocations even at higher prices to avoid capital loss (Wheeler et al., 2014c; Zuo et al., 2015a; Adamson et al., 2017). In the last few years, derivative-type temporary water trading products such as water forwards, options, and parking have emerged (Bayer and Loch, 2017).

Water entitlement trading is often used by irrigators to restructure existing water portfolios, increase supply security and relocate farm enterprises (Haensch et al., 2016). Water entitlements are also sold when an irrigator wishes to exit farming, restructure farm finances or retire farm debt (Zuo et al., 2015b; Wheeler and Zuo, 2017). For some, having buffer/surplus water enables irrigators to sell unused entitlements to the government and therefore maintain farm production (Wheeler et al., 2014b; Wheeler et al., 2014c).

However, stakeholder trading strategies can vary significantly. For example, the Commonwealth Environmental Water Holder (CEWH) owns a large and diverse portfolio of water entitlements, but only rarely trades this water (CEWO, 2019). Also, some irrigators and financial investors treat water trading similar to trading on stock markets. Trading returns from temporary trade can result from the change in price when selling one's own allocation, but also from the price difference between seasons or catchments when the allocation was purchased – by selling in a different catchment or water year (Loch et al., 2012). Financial gain from selling parking or lease contracts can be seen as a service fee for using the seller's water entitlement/carry-over space and usually takes the form of a nominal price per megalitre. The water forward price includes a risk premium (above the allocation price when entering the contract) as the seller bears the risk for the buyer. The risk premium for

options is higher than that for forwards, as the seller bears the additional risk if the buyer chooses not to exercise the contract at the due date.

Revenue from water ownership is derived from temporary trading and capital appreciation, for example, Zuo et al. (2019a) highlight that water entitlements are driven by temporary prices and hysteresis – plus it has been shown that MDB water ownership has often had higher internal rates of returns than stock markets (Wheeler et al., 2016). Furthermore, some investors choose water entitlements as another avenue to invest in agriculture, with the advantage of non-depreciation (ISA, 2017). This increasing investment, especially by non-landholders, has raised issues of undue influence in water markets.

One issue in seeking to investigate this question of non-stakeholder trading strategies is that there is a lack of publicly available water market/ownership data across all stakeholders. Water register transaction data only encompasses entitlement and allocation trades, and provides no information on other products such as leases or forwards (MDBA, 2019c) or who conducts such trades. Hence this is one reason why, to date, there has been little research on agri-corporates or non-landholder water market trading strategies. This study seeks to extend the literature through a mix of qualitative and quantitative research, to provide a detailed analysis of non-landholder and landholder water ownership and trading strategies, as well as identifying areas for water market reform.

3. Material and methods

We employed a mix of qualitative and quantitative methods to explore the questions surrounding water trade and water ownership in the MDB by type of stakeholder (landholder versus non-landholder). For an overview of data sources used and corresponding analysis, see Appendix A.

3.1. Qualitative information

A total 64 semi-structured interviews were conducted with key stakeholders across the MDB. As water register data on agri-corporate and non-landholder investor ownership is not publicly available, we chose the method of targeted qualitative expert interviews to understand these stakeholders' trading strategies. To specifically target prominent agri-corporate and non-landholder organisations with a "large" holding of southern MDB water entitlements, we used publicly available information[6] to first identify relevant organisations (and individuals within), and employed a chain referral approach to recruit additional interview participants (Biernacki and Waldorf, 1981). We also approached large organisations with expert knowledge in water entitlement valuation, water trading and agri-business lending in the southern MDB, such as banks, evaluators and water brokers. Consequently, the qualitative interviews focus on the views and behaviours of large and corporatised organisations, rather than the typical irrigator. Overall, we approached 83 eligible individuals or organisations for interview and hence obtained a response rate of 77%. The stakeholders interviewed included: 20 investors and agri-corporates (very large landholders owning and/or trading water but generate their main income from farming); 15 EWH and NGO employees[7] (public or private entities, owning or delivering water entitlements or allocations for environmental purposes); 10 water evaluators (consultants etc. specialised in water valuation); 7 financial investors (non-landholders trading water for financial gain[8]); 6 bankers (employees from financial institutions who were the key individuals responsible for significant lending portfolios in water entitlements); and 5 water brokers (who earn commission-based revenue from water market transactions).

[6]This included reviewing stakeholders' annual and financial reports before interviews.
[7]Note we interviewed a few respondents who worked for the same organisation. This was because some EWHs operate across multiple states with water management decisions made at the local level, making it necessary to interview a variety of local representatives. While some EWHs own land, their primary function is water management so they are classified as non-landholders. Three respondents from environmental NGO organisations are not included in our data analysis as their NGO did not own water.
[8]Investment and ownership structures of financial investors are complex. Some own agricultural land in other investment funds. Generally financial investor respondents manage an exclusive water asset portfolio, therefore are classified as non-landholders.

224 The interviews were mostly conducted face-to face during 2018-19, at times and locations
225 convenient for respondents across the MDB. A quarter of interviews were undertaken by phone and
226 two provided written submissions. The incompleteness of one written submission meant it was
227 excluded, hence only 63 responses are included here. The interviews had a median length of 60
228 minutes, with interview recordings and transcripts compiled into Nvivo11 and coded into major
229 themes. A range of open-ended questions were asked on topics of water ownership, trading, water
230 accounting, water markets and valuation. 84% of our respondents were male, while 70% of our
231 female respondents worked for EWHs. This gender balance is (unfortunately) reflective of the
232 industry in general.
233 This study focuses mainly on understanding water ownership and market strategies by land-
234 holders versus non-landholders, hence, it uses information from a range of quantitative sources plus
235 our interviews with 1) investors and agri-corporates, and 2) EWHs and financial investors. Hence,
236 most of the analysis is focussed on 38 of our interviews[9], however we also use responses from the
237 full set of 63 interviews in the final section to explore suggestions for water market design
238 improvements.
239
240 **3.2. Quantitative data**
241 This study also used quantitative data to illustrate stakeholder water entitlement ownership, along
242 with allocation, entitlement, carry-over and forward trading behaviour. We utilised data from a
243 representative telephone survey of 1,000 southern MDB irrigators[10] undertaken in 2015-16 (see
244 Wheeler et al. (2018) for further detail) to supplement the personal interview information and
245 establish general MDB water ownership and trading behaviour. We also analysed transaction data

[9]12 EWHs, 19 investors/agri-corporates and 7 financial investors. One investor interviewed was not included in our data analysis as they owned no water in the Basin, but were interviewed originally as they were considering it.
[10]Includes 419 NSW, 209 SA and 372 VIC irrigators.

made available by one of the MDB's leading water trading platforms[11] to illustrate the extent of water forward and parking trading.

4. Results

The results are presented in three sections: 1) an overview of water market participation using the survey of 1,000 irrigators and interviews with 38 landholder/non-landholder investors and EWHs; 2) qualitative data on 38 water investors' and EWHs' trade strategies and motivations; and 3) qualitative data on all 63 interview expert participants' beliefs about water market improvements.

4.1. Water market participation and strategies – quantitative data

About 65% of Victorian (VIC) irrigators own a diverse water portfolio of at least two types of entitlements, with diverse ownership less common in New South Wales (NSW) (28%) and South Australia (SA) (7%) – where ownership is mostly concentrated in general and high security surface-water entitlements respectively (Table 2).[12] These ownership patterns are mainly because of historical factors of water ownership by states.

[11]H20X had a market share of 11% of all non-zero MDB allocation trade volume in 2018/19.
[12]While all SA water entitlements are high security, stakeholders could decide to own different security entitlements in other states.

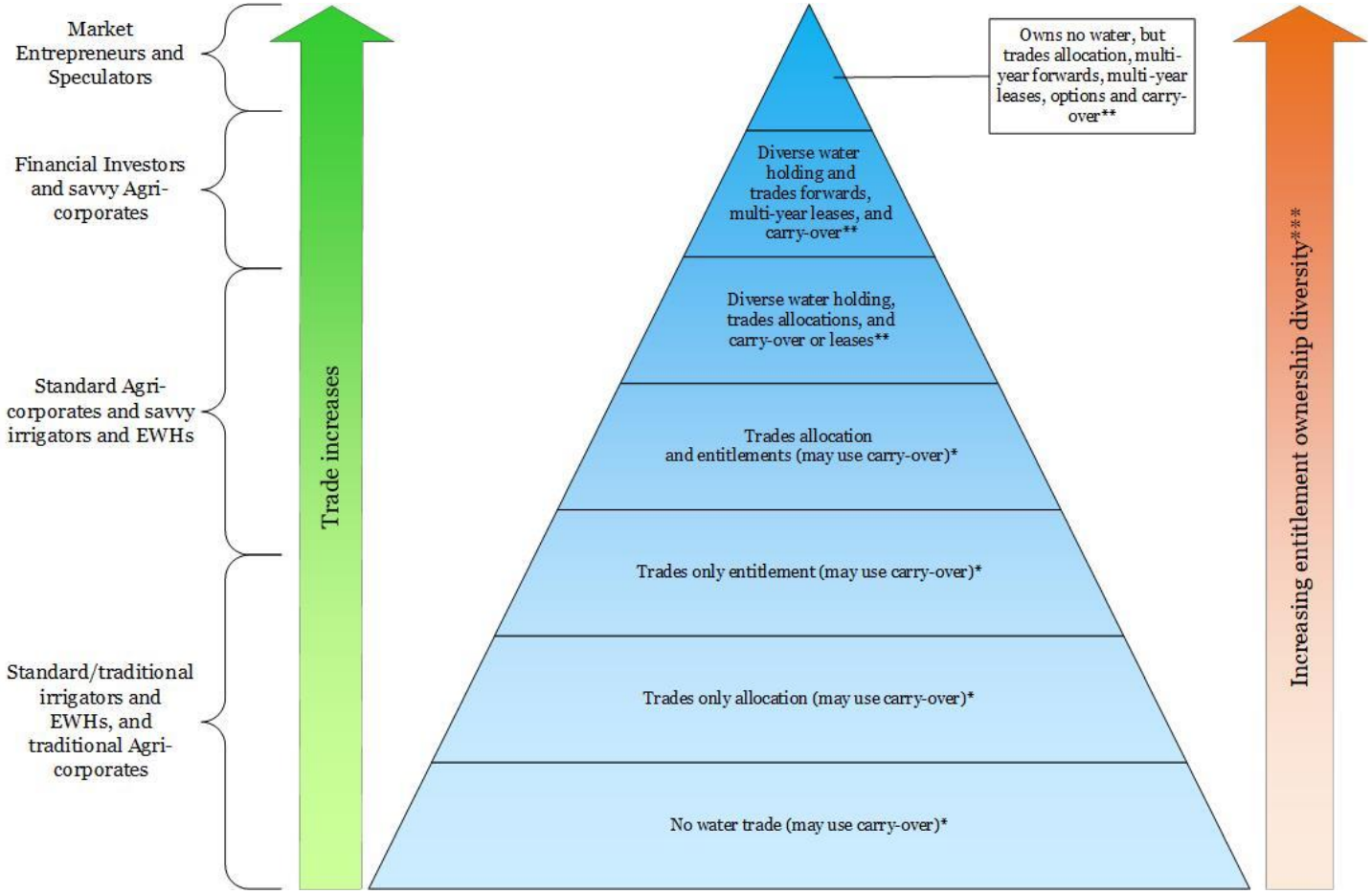
Table 2: Surface-water entitlement ownership and carry-over for MDB irrigators and landholder/non-landholder interview participants

Method	***State/ stakeholder***	***Own surface-water entitlements? (% answering yes)****				***Diverse entitlement ownership (% owning more than one security type)****	***Used carry-over? (% answering yes)******
		High	*General*	*Low*	*No ownership*		
2015-16 Irrigator survey – southern MDB	NSW (n=419)	37%	65%	12%	4%	28%	67%
	VIC (n=372)	94%	3%	62%	2%	67%	84%
	SA (n=209)	81%	9%	5%	8%	7%	11%
2018-19 landholder and non-landholder interviews	EWHs (n=12)	100 %	75%	42%	0%	83%	67%
	Financial Investors (n=7)	86%	86%	72%	14%	86%	78%
	Investors/agri-corporates (n=19)****	95%	26%	37%	0%	58%	39%

Notes: *More than one type of water entitlement can be owned.
**Does not include delivery share ownership
***Question asked for the 2014-15 water season in telephone survey. Carry-over was not available on SA entitlements in 2014-15, but some South Australians own water elsewhere with carry-over availability.
****Investors/agri-corporates own land, EWHs and financial investors generally do not.

Synthesised and created from both our qualitative and quantitative data, Figure 2 illustrates the overall different water ownership and trading strategies employed by southern MDB stakeholders. The majority of southern MDB stakeholders have established water trading and ownership strategies to secure water for production, such as using their own carry-over and trading allocation. Entitlement trade was less common. Table 2 and Figure 2 both illustrate that standard irrigators own less diverse surface-water portfolios than larger agri-corporates, with non-landholders' surface-water ownership the most diverse. Between 58% and 86% of our interviewed respondents had a diverse water entitlement portfolio across stakeholder groups.

Figure 2: An Overview of Southern MDB Water Ownership and Trading Strategies



Notes: Diagram is not drawn to scale, and classifications of irrigators into groups (e.g. standard irrigators, standard agri-corporates etc are approximate only).
*Based on trade results for 1,000 irrigators in the southern Basin in water season 2014-15: irrigators conducted no water trades=38%; traded only allocations=51%; traded only entitlements=4%; traded allocations and entitlements=7%.
**Based on 38 landholder and non-landholder interviews: 55% trade carry-over and/or allocations/leases; 29% trade forwards, multi-year leases and carry-over; and 3% own no entitlements but trade carry-over, multi-year leases, multi-year forwards, and options.
***The exception to this trend is the top of the pyramid: speculators own no water entitlements.

Various stakeholders undertake differing levels of sophisticated trading strategies. A "standard/traditional" irrigator, EWHs, and "traditional" agri-corporate (which represent the majority of MDB irrigators at the base of Figure 2) use their own carry-over, and trade allocation to either supplement water supply or to earn income from surplus water. Note this typology relates to water trading and ownership strategy sophistication, is indicative and not to scale. A significant number own all or an excess of their water needs under one type of regional entitlement. More "savvy" irrigators, EWHs, and "standard" agri-corporates (a smaller proportion of irrigators in the MDB) own diverse portfolios of entitlements, occasionally trade entitlements, and make regular use of their own carry-over, allocation and lease trading for farming. "Savvy" agri-corporates and financial investors (which note represent a very small proportion of MDB stakeholders), own diverse entitlement holdings, and frequently trade sophisticated temporary products such as water forwards and parking, not just for water supply but also for price arbitrage differences.

Finally, there is an even smaller number of highly "sophisticated" market entrepreneurs and speculators who, while not owning water, trade and arbitrage daily across the whole diverse range of temporary products, often developing and trading new temporary derivative-type water products.

4.2. Water Ownership rationale and strategies – participant qualitative data

The qualitative data provided rich information on participants' views of water assets and their surface-water ownership strategies. Table 3 classified rationales for water ownership into eight broad reasons: historic; supply security; asset investment; diversification; proximity to (agricultural) operations; price; deliverability; and liquidity. Rationale for water ownership varies between and within our landholder/non-landholder stakeholder groups.

Table 3: Water asset characteristics and rationales for surface-water ownership strategies

Water Asset Characteristics	***Sub-total (n=38)***	***EWHs (n=12)***	***Financial Investors (n=7)***	***Investors/agri-corporates (n=19)****
Do you view water entitlements primarily as a financial/investment asset? *(% of yes responses)*	79%	75%	100%	74%
How do water entitlements compare to other financial/investment assets? *(% of respondents believing entitlements represented an unique asset)*	50%	33%	57%	58%
Answers to the open-ended question: "Reasons why you own the water portfolio that you do?"*				
Historic (e.g. water bundled with land)	21%	21%	4%	32%
Supply security (e.g. high security)	17%	21%	13%	18%
Strong investment (e.g. expected value appreciation)	16%	13%	25%	12%
Diversification (e.g. different entitlements across regions)	13%	13%	17%	12%
Proximity to operations (e.g. entitlements in the farm region)	12%	13%	8%	15%
Price (e.g. "cheap" purchase price opportunity)	11%	8%	13%	12%
Deliverability (e.g. can trade allocation to most other MDB catchments)	9%	13%	17%	0%
Liquidity (e.g. entitlements in active trading zones)	1%	0%	4%	0%

Notes: *Investors/agri-corporates own land, EWHs and financial investors generally do not.
**Multiple answers were allowed.

Around four-fifths of investor/agri-corporate, EWH and financial investor respondents (79%) saw water entitlements as an (investment) asset, with half perceiving water entitlements to be an extremely attractive, but unique asset class.

> *"There is no depreciation, there's no goodwill, there is no maintenance and repairs. There is really very few costs in the ownership of it. There are not many asset classes that are that good." (Investor/Agri-corporate)*

Although 75% of EWH respondents regard water entitlements as an investment asset, they found it challenging to compare water to other assets. Since EWHs typically do not own water entitlements

for financial gain, entitlement risk and return characteristics are of little relevance:

> *"It is completely different because we are putting water out there for environmental purposes, so it depends on how you end up valuing the environmental benefit which is associated with that." (EWH)*

Unsurprisingly, all financial investor respondents saw water entitlements as an investment asset, particularly pointing to their unique risk profile, good returns, non-depreciation and non-correlation to other assets:

> *"That is the attraction, it does not trade in the same pattern as real estate or infrastructure assets, it has different drivers of return. Probably 10% return per annum: we derive that from 4-6% income yield and 4% capital appreciation over the longer term. Your yield can be pretty volatile, which would demand a higher return and we do get that. Often real estate has some material financial leverage, whereas we are acquiring water at 100% equity basis, which de-risks it again." (Financial Investor)*

However, some respondents highlighted that water entitlements are a statutory asset, subject to regulatory changes[13] and are therefore legally very different from property and consequently has less protection:

> *"[legal] Accuracy around the entitlements comes from the bipartisan nature of water policy. Commonwealth and states, through agreement and through practice over the last 25 years, really reduced the sovereign risk in the water market to an extent where people are prepared to invest in it. As if it were a solid property right, what it is not." (EWH)*

Despite the legal status of entitlements as non-property as determined by the high court (Fisher, 2010), our findings suggest that most market participants treat water entitlements as property.

[13]States can change the security of an entitlement, rules regarding use and access to allocation, or the overall allocation volume to a catchment based on sustainable diversion limit considerations (*Water Act 2007 (Cwlth)*, pt2 d4 sdA s77). For example, a change in the Barwon-Darling water sharing plan allowed entitlement holders to extract water at lower river levels, with increased extraction (and drought) substantially contributing to a mass fish-kill event in 2018-19 (AAS, 2019).

344 The most frequently cited motivation for water ownership strategies was historic reasons, as
345 water entitlements were acquired with agricultural land prior to unbundling and had not been
346 traded since. Many EWHs had their water portfolio legislated into existence. Water supply security
347 was identified as the second-highest motivation. This related both to the strategy of owning
348 excess/buffer water and the preference for more secure entitlement classes or large carry-over
349 capacity. Other important factors highlighted in Table 3 include the need for proximity of water
350 entitlement holdings to the relevant farm/environmental asset; the ability of a particular
351 entitlement class to trade allocation into different catchments (deliverability); diversification of
352 water holdings across regions and entitlement classes; and entitlement price.
353 When considering the motivations of non-landholder stakeholder groups: historic reasons and
354 supply security were the most important factors for EWHs, whereas financial investors ranked strong
355 investment, diversification and deliverability the highest. Similar to EWHs, landholders' ownership
356 strategies were largely influenced by historic reasons, supply security and agricultural proximity.
357 Financial investors saw water entitlements as a growth asset due to increasing high-value
358 horticultural production and climate change:
359 *"We often see dramatic changes in the commodity mix that is being produced throughout*
360 *the Basin, to much more horticulture and higher value crops. We think that over time, not*
361 *only do those crops need more water, but they become more inelastic to pricing. They will*
362 *have to water their permanent crops and they have higher margins so they can support*
363 *higher prices." (Financial Investor)*
364 Overall, there appeared to be three major themes influencing the ownership of water entitlements:
365 1) supply and operational factors; 2) water trading and delivery; and 3) financial factors.
366 Owning water close to operations is seen as a strategy that reduces the need for water trading,
367 exposure to trade restrictions and transaction costs.[14] On the other hand, concentrating

[14]While subject to negotiation, it is convention that the allocation buyer shoulders transfer and register fees (Elders, 2019; H2OX, 2019; Waterexchange, 2019; Waterfind, 2019a; Wilks, 2019).

entitlements in one region increases exposure to localised climate uncertainty.

Another strategy as already highlighted is diversification: owning a variety of highly tradable water entitlements (e.g. see MDBA (2010a)) across different regions. For example:

> *"The portfolio was very focused on the southern MDB, we want the interconnectivity, that is what attracted us to start there. The portfolio focused on the tradability of water and the movability of water around [trading] zones, the maturity of the market, and the liquidity it provides. In terms of the portfolio construction, we want a mix of high security, general and low." (Financial Investor)*

This strategy maximises water trading and reduces the impact of localised climate, at the cost of more exposure to trade restrictions and transaction costs.

Some respondents discussed the impact of IVTs on ownership and water markets, particularly the Barmah-Choke trade restriction. As water portfolio structure was influenced by historic factors, so is landholders' exposure to IVTs. Interestingly, only a few respondents, mainly non-landholder financial investors, stated that they diversified their entitlement portfolio around minimising the impacts of IVTs. An exception is the Barmah-Choke constraint, with most respondents preferring entitlement ownership below the choke:

> *"Five years ago, we would have bought NSW Murrumbidgee. Now with the difficulty of getting out of the 'Bidgee, first to the Murray, and then from the Murray, down to here. That is our strategy, to now only look at Victoria below the Choke." (Investor/Agri-corporate)*

Water entitlements below the choke (i.e. unaffected by constraints), such as Victorian Murray trade Zone 7, are seen as more desirable. While respondents identified the Goulburn system and the Mulwala canal (10,000 ML/day capacity (GMW, 2019)), which is part of the Murray Irrigation area, as important to mitigate the choke constraint, they acknowledged the limits of these mitigations due to the Goulburn-Murray IVT and the higher cost of delivering water through Murray Irrigation infrastructure. IVTs and in particular the Barmah-Choke trade restriction disproportionately affect EWHs, as one EWH stakeholder explained:

"So whenever we do an inter-valley transfer, we have got a watering action that we are doing, and we have moved some water from below the choke to above the choke. Our water is included as water going through the choke and it opens up the choke for water going the other way, when in fact we have moved the water up there so that we can bring it back to fill the choke up. IVTs are something we have to keep a very close eye on. If you could move 1GL of water between valleys A and B, we have probably got that gigalitre of water. We choose not to do it because it would choke the industry out and good neighbour policy means that you do not do that." (EWH)

Larger and more sophisticated agri-corporates often mix strategies of concentration and diversification: they own a diversified portfolio of water entitlements but use them to run operations in the corresponding catchments. This approach would reduce the exposure to IVTs. Financial investors' lack of land ownership means their main strategy is to sell temporary water to producers, requiring a highly deliverable, diversified water portfolio capable of mitigating the effects of IVTs.

The majority of EWH, financial investor and investor respondents generally own their complete water needs (for a typical year) in entitlements. A fifth of our investor participants chose not to own their entire water needs in entitlements for capital reasons, supplementing their entitlement ownership with temporary trading, while other investors own only a small fraction of water in entitlements and trade frequently, be it for farming purposes or for making money from delivering forwards and options.

"Our standing position is generally not to own water. That is about capital sheet efficiency, and not tying up a lot of capital." (Investor/Agri-corporate)

A few respondents commented on owning water delivery shares, and utilised a strategy of owning more delivery shares than water entitlements – or even owning most of the delivery shares within an irrigation system, in order to guarantee priority of water delivery.

4.3. Temporary trading strategies: carry-over, parking, forwards – Qualitative data

Figure 2 illustrated that the majority of MDB stakeholders have used allocation and carry-over. We found that our interviewees with more diverse water portfolios employed more sophisticated trading strategies (Table 4). Table 4 illustrates that many employ lease and forward contracts, and use carry-over opportunistically (e.g. parking trade, carry-over allocation for price gains between years).

Table 4: Temporary trade strategies by landholder/non-landholder stakeholders

Trade product	***Use***	***EWHs/Financial Investors/investors with diverse portfolio (n=27)***	***EWHs (n=12)***	***Financial Investors (n=7)***	***Investors/agri-corporates (n=19)****	***Sub-total (n=38)*****
Carry-over	Do not use	19%	50%	0%	42%	37%
	Farming/environmental use	41%	42%	0%	37%	32%
	Parking trade	37%	8%	100%	16%	29%
Leases	Do not use	56%	100%	0%	42%	53%
	One year	0%	0%	0%	11%	5%
	Multi-year	41%	0%	100%	37%	37%
Forwards	Do not use	41%	83%	0%	53%	53%
	One year	41%	17%	57%	26%	29%
	Multi-year	15%	0%	43%	11%	13%

Notes: * Investors/agri-corporates own land, EWHs and financial investors generally do not.
**A few stakeholders did not answer these questions; hence not all totals add up to 100%.

Land-owning stakeholders (investors/agri-corporates) use temporary products such as leases, forwards and carry-over primarily as tools to manage water supply risk. Water lease contracts seem to be a standard tool and are well established; whereas only more sophisticated agri-corporates employ a mix of parking, forwards and lease contracts. This approach aims to minimise the capital cost of water ownership, while maintaining supply security.

> *"We take a portfolio approach, we own some, we lease some, we have got forward positions, we use carry-over, and we use the spot market. We have got half of the water needs covered with forward positions, 10% with leasing and 30% is in the spot market. Moving forward, we see ourselves building more exposure with leases and forwards." (Investor/Agri-corporate)*

Carry-over was the most employed strategy by stakeholders. EWHs and investors/agri-corporates use carry-over mainly for their own surplus water, however at least one EWH sells parking contracts to generate extra revenue:

> *"We also use carry-over as a market-based mechanism, essentially carrying over dollars but in water, but also as a product we can offer to sell. We use the carry-over capacity on our licences to offer space to irrigators." (EWH)*

All financial investors use carry-over opportunistically; employing parking for extra allocation to supply forward arrangements, or to speculate on temporary prices. In addition, more sophisticated investors/agri-corporates employ parking contracts to expand their carry-over capacity, or use carry-over to substitute between different water sources:

> *"We might have carry-over capacity on our accounts and [when] the price in the temporary market is acceptable, we buy-in to carry-over. Or we have got a mix of water types…where we might turn off the bores, buy temporary river water for production and carry-over allocation volume on the bore water account" (Investor/Agri-corporate)*

Financial investors and investors/agri-corporates use and sell multi-year leases. Financial investors explained that they prefer a large part of their water portfolio to be leased long-term (up to five years) as this provides stable income with less risk, whereas investors/agri-corporates often employ leases to avoid water entitlement ownership:

> *"We have the long-term view that we lock at least 70-80% of the portfolio into leases which gives us a nice steady, climatic risk free, return." (Financial Investor)*

> *"Water is so expensive to buy…so it is a lot of capital you need to put up-front when you are doing a development. We have had a strategy of putting in place some long-term leases, at least five years, and as we start producing almonds and generate some cash flow, then we will buy entitlements." (Investor/Agri-corporate)*

Financial investors and investors (along with one EWH) are also regularly using forwards – namely one-year contracts. Analysis of private water trading platform data shows that 92% of forwards

464 traded since 2016 have been one-year contracts. Given that water forwards have only been
465 commercially available since 2014, and participants are still learning about the product, multi-year
466 forward supply is limited by the small number of vendors willing to bear the extra risk. Although
467 financial non-landholding investors only own around 10% of MDB water entitlements (DELWP,
468 2019b), they trade a significant proportion of forwards (37% of forwards sold since 2016 based on
469 our analysis of private water trading platform data). Many of the interviewees see forwards as a
470 valuable risk management tool, but also cited a number of dangers in relation to reputation,
471 counterparty and market immaturity. For example, EWHs currently do not trade forwards due to
472 reputational and political risk issues:

473 *"EWHs use [forward trading] very cautiously because there is just as much risk around their*
474 *social licence to operate as there is around portfolio management…And it is a huge political*
475 *risk. They [public EWHs] are at the whims of the government and need to be seen as not*
476 *skewing the market, so they have got to be above board like you would not believe." (EWH)*

477 Counterparty risk occurs where the forward seller has incentive to default during times of high
478 temporary prices, whereas the buyer has incentive to default at low prices. Another aspect of
479 counterparty risk is non-delivery:

480 *"Parties that only own about 100-200ML write a 400ML forward, hoping they can buy the*
481 *allocation on the market and deliver against it on a multi-year basis. If we get a really dry*
482 *year they are not going to deliver." (Financial Investor)*

483 Due to the fact that respondents are cautious who they trade with and that often 20% of contract
484 value is required as a down payment, counterparty default was described as rare. However, greater
485 water market institutional reform was called for, such as standardised forward contracts, a
486 regulatory body, and a central exchange and clearing house:[15]

[15]In financial markets, the clearing house is the counterparty for all trades, guaranteeing delivery in case of counterparty default (Pirrong, 2011).

"The issue with forwards in the water markets is, it is a semi-sophisticated product in a very unsophisticated market…. We are trying to move into these more sophisticated products but we have not got the underlying infrastructure in the market to do that, a central exchange and clearing house for example." (Water Broker)

Forwards are seen as more expensive than using temporary allocation plus carry-over fees (or parking), and less secure due to counterparty risk. Carry-over and forwards have different cash-flow implications for the buyer: the full costs of temporary trade combined with parking need to be paid immediately, whereas forwards only require an initial deposit, with the remaining costs paid at delivery. Some respondents argued that carry-over and forwards are essentially identical – to guarantee delivery, the forward seller has to store the contracted temporary volume in carry-over (adjusted for spill risk and evaporation). A few financial investors underwrote forwards with other temporary products, abstracting forward delivery from entitlement holdings and carry-over.

4.4. Water market design improvements – Qualitative data

Finally, respondents were asked an open-ended question to nominate and comment on any aspects they would like changed or improved in relation to the MDB. 59% of the total 63 surveyed participants responded to this question with comments relating to water market reform and ownership (Table 5).

505 **Table 5: Stakeholder views on improvements to MDB water markets and ownership**

*Improvements suggested (self-nominated)**	*Total participants naming water market improvements (n=37)***	*Banks (n=4)*	*Evaluators (n=7)*	*EWHs (n=6)*	*Financial Investors (n=4)*	*Investors/agri-corporates (n=12)****	*Water Brokers (n=4)*
Water trading and storage data and standardisation (e.g. more complete and transparent water register data)	25%	40%	62%	0%	44%	11%	14%
Relaxed catchment trade restrictions (e.g. IVTs)	13%	0%	0%	33%	14%	22%	0%
Greater transparency in allocation and inter-valley trade restriction announcements (e.g. better explain reasons behind decisions)	12%	0%	0%	0%	0%	16%	44%
Change legal status of water (e.g. reverse unbundling; make water property)	12%	20%	0%	50%	0%	11%	0%
Introduce regulation and accreditation for intermediaries (e.g. water broker licence)	10%	20%	0%	17%	14%	6%	14%
Simplify carry-over arrangements (e.g. SA carry-over access)	8%	0%	25%	0%	0%	6%	14%
More public EWH trading capabilities (e.g. sell environmental allocation)	8%	0%	0%	0%	14%	16%	0%
Better understanding and regulation of agricultural development (e.g. limit on permanent planting area)	4%	0%	13%	0%	0%	6%	0%
Decrease water trade transaction costs (e.g. faster processing)	4%	0%	0%	0%	14%	0%	14%
Environment to contribute to water delivery costs (e.g. delivery fees for environmental transfers)	4%	20%	0%	0%	0%	6%	0%

506 Notes: *Some respondents addressed multiple topics in one interview.
507 **Responses based on those 37 respondents in the total 63 interviews that named water market/ownership reform issues.
508 ***Investors/agri-corporates own land, banks, evaluators, EWHs, financial investors and water brokers generally do not.

The primary issue identified by all stakeholders concerned the quality of dam storage and water trade data. Consistent with the findings of Grafton and Wheeler (2018) about lack of consistency in MDB water data, many participants argued that MDB storage volumes differ depending on the data source, and that water market data via registers was outdated and of poor quality.

> *"Accessing current information is very challenging. All that information exists but the quality of it is very poor. For example, if you want to know how much water is in Lake Hume at any one time, I can go to GMW, I can go to NSW water and I can go to the MDBA, and I will get three different figures, which is absurd. Likewise, if I want to know the states' share of water in the Murray system storages, the MDBA releases that information once a month, two weeks after the end of the month, at best." (Water Broker)*

Additionally, standardised water market terminology and a central water register containing all trading information was seen as needed, with others suggesting a central water exchange and clearing house, similar to the ASX. This reflects findings from other studies, suggesting insufficient water trade and ownership data quality and access. Current data capturing processes are ill-equipped to support emerging temporary products such as parking, forwards and options.

Another important issue raised was the transparency of trade restrictions and allocation announcements. Respondents advocated both for more transparency in announcing allocations and IVTs, a particular issue in the Murrumbidgee, and for relaxing restrictions in general. For example:

> *"Farmers have zero idea of what the allocation is going to be, particularly in NSW. And it seems that that information is almost made up. It is often nonsensical, it often has errors in it and people are trying to make investment decisions, not only around trading water but also around growing crops." (Water Broker)*

> *"[The Goulburn IVT] limits that region to become just a regionalized trading region rather than sit across the whole southern connected MDB. NSW does the same in the Murrumbidgee. Effectively, they stop water being traded across the basin and make life difficult." (Financial Investor)*

There is no clear pattern of landholders or non-landholders advocating for relaxing trading restrictions and IVTs. Rather, respondents owning diverse water portfolios and personally affected by IVTs suggested this improvement.

A significant number of bank, EWH and investor/agri-corporate respondents desired the reversal of unbundling, or alternatively restricting non-irrigator ownership of entitlements, believing it would decrease speculation and lower water market prices. This view was not shared by financial investors and water brokers. EWH respondents argued that unbundling has put a price on biodiversity via the cost of allocations needed to achieve environmental outcomes and led to calls for EWHs to pay water licencing and delivery fees. The lack of market intermediary regulation and its implications for misconduct was also raised. For example:

> *"You need some rules around the way brokers operate. I know brokers who have interest-bearing accounts and they keep the interest from customers' acquired funds that sit there. In theory you should have an allocation trust account which holds water on behalf of the clients which you never touch. There are situations where that water gets traded by the brokers for their own profit. I also know brokers that are the counterparty to their client, they are not intermediary, they are actually the principal. They see a really good deal and instead of passing that on to a seller, they sell it themselves." (Financial Investor)*

While the Australian Water Broker Association provides a voluntary code of conduct for its members (AWBA, 2019b), an industry-wide legally binding code of conduct does not exist, leading to some industry calls for more regulation (Waterfind, 2019b). Claims of intermediary misconduct are contested (Miller, 2019), but difficult to show quantitative evidence for without corresponding reporting and regulatory requirements.

Other less common responses included issues surrounding more accessible, greater and standardised carry-over. Some respondents advocated for a more proactive role of public EWHs in water trading, especially during drought. The least discussed topics included faster and more efficient water trade processing; the size and impacts of MDB permanent plantings; and the financial

561 contribution of EWHs to water delivery and storage operations. EWH respondents rejected making
562 monetary contributions to the delivery of environmental water based on their limited ability to raise
563 funds:
564 *"The environment cannot make a return in order to pay those fees. So where does this return*
565 *come from? It can only come from the taxpayer." (EWH)*
566 In regards to the issues concerning increases of MDB permanent plantings, a few respondents
567 worried whether there was enough water to satisfy the existing and future needs of plantings, and
568 the ability to physically deliver the water to these areas:
569 *"There will be a risk of delivery failure. They cannot get water to certain parts of the system.*
570 *They have all the trees being planted downstream in the Basin and there is a lot of trade*
571 *restrictions. Do they expect to get water from all of the tributaries upstream?" (Financial*
572 *Investor)*
573 Some respondents called for a restriction on permanent planting area until the impacts have been
574 fully assessed. Indeed, the Victorian government recently stopped processing applications for water
575 extraction permits until delivery concerns have been assessed (Neville, 2019b).
576
577 **5. Discussion**
578 While MDB irrigators have become more sophisticated in their water ownership and trading
579 strategies, the majority still own all or most their water needs under one type of entitlement (in one
580 region) and use the temporary market to supplement supply. While a typical irrigator in the
581 southern Basin owns mainly high or general surface-water security entitlements and use this as their
582 main water source (Wheeler and Garrick, forthcoming), non-landholders and investors/agri-
583 corporates tend to own a variety of entitlements across different regions. Hence, there appears to
584 be two broad philosophies underpinning water entitlement ownership strategies: 1) concentrate
585 ownership in one catchment; and 2) diversify water ownership across multiple entitlements and
586 catchments. Groundwater entitlements are also playing a role in this diversification by many agri-

587 corporates (Davies and Burns, 2019). Interestingly, most landholder respondents diversify around
588 water entitlement security and carry-over capacity - with the exposure to trade restrictions, apart
589 from the Barmah-Choke constraint - rarely stated as a driver for diversification. The two strategies
590 are not mutually exclusive: some respondents source water for farming locally but own operations
591 across different catchments, potentially to limit the exposure or impact of trade restrictions.
592 Financial investors prefer the second of these strategies, owning large and diverse water portfolios
593 with significant proportions of high and low security entitlements and the capability to mitigate
594 trade restrictions. As the larger part of their portfolio is leased out on a long-term basis, having a
595 diverse portfolio of attractive high security entitlements is paramount, while low security
596 entitlements provide the carry-over capabilities to supply forwards or sell parking. In contrast, some
597 stakeholders, particularly agri-corporates, own little to no water entitlements, relying on temporary
598 trading. Although this strategy can have capital outlay benefits, particularly for industries pairing
599 high upfront capital requirements with delayed revenue, it is susceptible to high temporary water
600 prices.

601 Most respondents see water entitlements as an investment asset, with some pointing to the
602 unique characteristics of the asset class. The vast majority of respondents ignore the legal status of
603 water entitlements as a statutory asset (Fisher, 2010), potentially leading to an illusion about the
604 legal security and protection of water assets in practice.

605 Forwards, leases and parking are only used by small number of MDB stakeholders, with parking
606 mostly used by financial investors and some investors/agri-corporates. This reflects some landholder
607 respondent comments that they prefer plant-based management strategies (e.g. mulching,
608 improved irrigation scheduling – see Wheeler and Marning (2019) for more detail) over managing
609 their water portfolio to address water shortage. Forwards are recognised as an important risk
610 management tool, but questions remain around counterparty, reputational risk, and market
611 maturity. Although trade to date has been limited, the forward and options market is likely to grow
612 given its capability to reduce supply risk and guarantee physical delivery.

613 Respondents identified a need to improve water data quality and accessibility, which has been
614 well documented previously (Grafton and Wheeler, 2018; de Bonviller et al., 2019; Seidl et al.,
615 forthcoming). However, standardised water product contracts, intermediary regulation, market
616 integrity rules and a water market central exchange and clearing house have yet to receive much
617 attention (although Leonard et al. (2019) discusses advantages of a central exchange and clearing
618 house for western US water markets). Currently, publicly available water market data is unable to
619 identify and support transparent reporting of parking, water forwards and options trading – which
620 will require increased attention in a maturing water market. Indeed, the call for more transparent
621 data is now also backed by the water broker peak industry body (AWBA, 2019a) and the Australian
622 Competition & Consumer Commission (ACCC, 2019), while the Commonwealth Government recently
623 invested over AUD$1 million to develop the Waterflow app to improve water storage and trade
624 information (Business.gov.au, 2019). Respondents saw a need for intermediary regulation to provide
625 minimum quality standards and address conflicts of interest (such as intermediaries owning and
626 principally trading water, and unethical handling of customer accounts). While the intermediary
627 industry seems to regard self-regulation, rather than standardised and enforceable rules for code of
628 conduct, as sufficient (AWBA, 2019a), the recent findings of the Royal Commission into Misconduct
629 in the Banking, Superannuation and Financial Services Industry cast doubts on the effectiveness of
630 such approaches (Hayne, 2019). Indeed, with the water market increasingly behaving like a financial
631 derivatives market, regulation may be especially relevant in the MDB. Particularly with regards to
632 conflict of interest and insider trading, the Australian Securities & Investment Commission (ASIC)
633 market integrity rules could provide guidance (ASIC, 2018).
634 Issues also surround different terminology and allocation, IVTs, and carry-over announcements.
635 Increased transparency in allocation, carry-over and IVT rules may address some implementation
636 issues, which we suggest may increase trust in water market institutions (Wheeler et al., 2017a;
637 Wheeler et al., 2017b). Arguably, addressing water accounting issues, particularly around water use
638 versus water extraction and consumption accounting (Young, 2014); water valuation and

methodology issues (Seidl et al., forthcoming) and addressing issues in current water resource plans (Productivity Commission, 2018), could contribute to improved decision-making. Given the prevailing criticism of hydrological water accounting in the MDB (Walker, 2019; Williams and Grafton, 2019; Wheeler and Garrick, forthcoming), it seems unlikely that rule transparency can be forgone due to improved accounting.

Further, we share the view that an examination of the appropriateness of IVTs and trade restrictions would be beneficial (ACCC, 2019). While a necessity of the hydrological realities of operating in the MDB, some IVTs arguably tend to isolate particular catchments (and industries) from the water market system, keeping water prices low and preventing the politically undesirable exodus of water licences and industry from catchments. In particular, respondents often claimed the Goulburn-Murray IVT is a protectionist measure for the Goulburn dairy industry, albeit that potentially increased flow levels in the Goulburn river associated with the removal of the IVT could lead to increased river bank erosion. Generally, it is possible that trade restrictions and IVTs can lead to price distortions in the rest of the inter-connected water markets and to distorted trade patterns as stakeholders scramble to trade water out of/into a catchment while the IVT is open. In particular, investors/agri-corporates and financial investors, often with the help of water brokers, seem to have a comparative advantage (as compared to smaller operators) to act upon an IVT opening, pushing large volumes across catchments and subsequently closing the IVT often in a matter of hours.

Despite the fact that many irrigators call for water to be linked again to land-ownership, driven by the perceptions about the negative impacts of non-landholder entitlement ownership (Hunt, 2019b), and the view that increased demand by non-stakeholders has led to higher water entitlement prices[16] and gauging behaviour by some operators, it is also true that unbundling has brought material benefits for irrigators. It enabled drought adaptation through water trading (Kirby et al., 2014), allowed irrigators to reduce debt by selling water to the government (Wheeler et al.,

[16]It is important to note that increases in water market prices benefit water allocation sellers and water entitlement holders, but disadvantage water market buyers. Issues often surround who is benefiting and who is losing.

663 2014b), and saw water entitlement values increase significantly (Seidl et al., forthcoming). Our
664 results also indicated that non-landholders can be beneficial for the water market: new water
665 market products are often developed/called for and first used by non-landholders, and financial
666 investors and EWHs are major sellers of forward and parking contracts. This view is shared by the
667 Australian Water Brokers Association, pointing out that restricting non-landholders in owning and
668 trading water could have detrimental consequences for the water market (Testa, 2019). While water
669 market speculators exist – generating revenue from temporary price differences without owning
670 entitlements – their current small numbers suggest limited market impact, however this impact is
671 dependent upon: a) the liquidity of the local water market they operate within; and b) the volume of
672 their trade or any insider information knowledge. Although non-landholder entitlement ownership
673 and speculative trading in general is rising, and there are calls for increased regulation of this type of
674 investor in the market, we suggest that growth is likely limited by the required financial investment
675 and derivative trading skills, and consequently the opportunity cost of trader involvement given the
676 lower annual turn-over of water markets as compared to financial derivative markets. However,
677 monopolistic concentration of entitlement ownership and market power can lead to price gauging
678 by landholder and non-landholder actors alike, particularly in illiquid markets or when combined
679 with insider information (de Bonviller et al., 2019). As a clear example of this, some respondents
680 claimed that information available in regards to regulatory and water delivery consultation (e.g. such
681 as being part of a relevant water steering committee) enables a range of insider trading to take
682 advantage of changed rules. Therefore, and given the material data challenges for quantifying their
683 water ownership and trading, non-landholder regulation should be delayed until more quantitative
684 evidence (such as linking both ownership and trading register data) has been collected and analysed.
685 Although some respondents expressed the desire for EWHs to sell their allocation in drought to
686 support irrigation, there is evidence that EWHs are disadvantaged during drought[17] (Pittock, 2013),

[17]A substantial part of water for the environment is "rules-based" water: the difference between the total water available and the water allocated for consumption (including conveyance water). In drought, this rules-based water contracts disproportionally more than the consumptive pool (CSIRO, 2008).

687 and current water holdings are insufficient to deliver ecological targets (Walker, 2019). However,
688 proactive temporary trading for environmental purposes may be beneficial for more EWHs to adopt,
689 by extending flood events (Connor et al., 2013) or by sourcing water cheaper (and more socially
690 acceptable by irrigators) than buying more entitlements (Wheeler et al., 2013). Indeed, EWHs seem
691 to be more disadvantaged compared to irrigators in regards to transmission losses associated with
692 delivering water. For example, EWHs have transmission losses associated with environmental
693 watering activities attributed to their water account (MDBA, 2019d), albeit associated return flows
694 are credited (which one may view as surprising given the incomplete crediting of return flows by the
695 Commonwealth government in recovering water through irrigation infrastructure (Williams and
696 Grafton, 2019)). On the other hand, while transmission losses from supplemented water
697 transactions are attributed towards irrigator accounts in the Northern Basin, there is no such
698 adjustment in the Southern Basin; transmission losses are attributed to conveyance water[18] and
699 socialised. While acknowledging that socialising may not be appropriate, the ACCC (2010) argues
700 that transmission losses in the Southern Basin are negligible and difficult to attribute to individual
701 users due to the large number of storages. This topic has since received further attention: the MDBA
702 (2019d) states that while water extractions between regions is shifting, the corresponding impact on
703 transmission losses is too difficult to quantify. However, the unequal treatment of market
704 participants and EWHs and the subsequent impact on water markets deserves further investigation.
705 Another topic that has received limited attention includes tagged trading[19] (DELWP, 2018). While
706 the contingencies of tagged trading (low irrigator uptake, perceived delivery guarantee and high
707 administrative burden) were initially discussed by the ACCC (2010), subsequent discussions highlight
708 a continuing low uptake of tagging and the potential violation of IVTs (Productivity Commission,
709 2018). Current practice in Victoria allows owners of tagged accounts and entitlements to deliver

[18]Conveyance water is set aside by states to ensure the river system connectivity. Conveyance loss can be around 12,000GL in one year, depending on hydrological and climatic factors (MDBA, 2019d).
[19]Establishing an entitlement tag allows extraction and use of temporary water in a different region than the entitlement's system of origin. It is illegal to sell this water (MDBA, 2010b).

710 unlimited allocation volume across the Goulburn Murray IVT, legally arbitraging on price differentials
711 between the zones (use cheap and sell expensive water) (DELWP, 2018), and circumventing the
712 intentions of the *Water Act 2007*. This is also the case across the Southern Basin for tags established
713 before 22nd October 2010, which are exempt from IVTs (MDBA, 2014). There are claims that some
714 operators use this to illegally sell water allocations across IVTs (Hunt, 2017). As the magnitude of
715 tagged trading is hard to quantify,[20] further analysis of this issue may be advisable. As also identified
716 by some EWH respondents, high water levels in the Goulburn river, stemming from high water
717 delivery, caused environmental river bank damage,[21] prompting Victoria to subject all tagged trading
718 to IVT rules, which will begin in December 2019 (Neville, 2019a). At the time of writing, this
719 announcement was said to lead to temporary price increases in the affected trading zones (Hunt,
720 2019a).

721 These findings provide insights into needed water market design reform. It is important to first
722 remember that water markets only exist within institutions and hydrological and scientific
723 knowledge (Wheeler et al., 2017b). There is a continuing fundamental need in the MDB for robust
724 accounting of water extraction and use (at both a catchment and basin scale); continual monitoring;
725 compliance and enforcement of water use; and water market institutional conditions – in order to
726 ensure transparency and confidence in the market – as well as continual adaptation over time (e.g.
727 (Wheeler et al., 2017b; Grafton and Wheeler, 2018). Many commentators (e.g. Productivity
728 Commission (2018); Walker (2019); AAS (2019)) have also made a large number of recommendations
729 on the need for changes in water policy, with some of these relevant for water markets in general.
730 This also includes the need to review river water operations – as changes in where water is being
731 used are having a potentially negative environmental impact. We suggest that there is a great need

[20]Tagged entitlement data is fragmented and reported differently between water registers. For example, Victorian data suggests that allocation delivered under a tag in the Goulburn increased to 120GL in 2017/18 (Neville, 2019a).

[21]Respondents explained that environmental watering in spring may lead to recruitment of native river red gums, while high river levels from delivery of irrigation water in summer through tagged trades regularly drowns young saplings.

732 for further water design reform, using new insights from the economics market design literature
733 (e.g. Bichler et al. (2019)). In particular, our above discussion suggests the need for three key water
734 market design changes: 1) data reform; 2) rules and regulation reform; and 3) new institutional
735 development.

736 Firstly, water register data reform includes the need within registers to identify water forward,
737 lease, option, and parking transactions – including counterparty type – in order to support emerging
738 water market products. Entitlement transactions in conjunction with land must be identified, along
739 with mandatory price reporting and rigorous quality controls of different water register data
740 enforced (MDBA, 2019c). Entitlement ownership by stakeholder type data should be analysed at a
741 catchment level to identify and address concerns of market power and monopolistic behaviour.
742 These issues have also been identified as critical by the ACCC and the Victorian government (ACCC,
743 2019; DELWP, 2019a).

744 Second, improving and making transparent rules and standards for water forwards and options,
745 carry-over access, allocation and IVT determinations would contribute to better decision-making of
746 MDB stakeholders. In absence of clear standards for water forwards and options, product
747 comparability is problematic. Counterparty risk for forwards is significant. Water futures would offer
748 similar risk management benefits for lower risk, as they are standardised and exchange traded,
749 where a central clearing house mitigates counterparty risk through daily cash settlement of profits
750 and losses. However, water futures would require a water market central exchange and clearing
751 house (see glossary in Appendix A). With the increasing use of derivative type products and
752 increasing incentives for counterparty default in times of water scarcity, particularly in drought, the
753 topic of standardisation and counterparty risk requires urgent attention. Unified water market
754 terminology for comparable water products, such as water entitlements or allocations could
755 improve interstate trading by removing confusion and ambiguity; whereas a review of tagging and
756 transmission losses through trading should identify and quantify corresponding third party impacts.
757 Conversely, very careful assessment needs to be given to any change in unregulated entitlements to

allow trading, such as allowing trading in floodplain water harvesting rights. Legal loopholes enabling stakeholders to bypass trade restrictions and extraction embargoes need to be closed. Administrative arrangements and structures minimising insider trading and rent-seeking are key for robust water sharing systems (Young, 2019). Therefore, membership of consultation bodies, such as water steering committees, and standards for water brokers needs to be fully transparent and publicly declared to avoid rent seeking by vested interests.

Finally, the more that stakeholders treat water markets like stock markets, then the more that water markets will require sophisticated institutional development to avoid negative consequences/externalities. ASIC market integrity rules could provide guidance for water market changes. Institutional development is particularly important for derivative type temporary products, where consideration should be given to additional water market infrastructure, such as a central exchange and clearing house, along with a well-resourced market regulatory agency with competency in derivative products that monitor and enforce compliance. While a central exchange and clearing house provides benefits in regards to counterparty risk and transparency of trades (Duffie and Zhu, 2011; Pirrong, 2011), it likely will increase the transaction costs of trade initially, both monetary and temporal, and require substantial regulatory reform. Sophisticated derivative type products require comprehensive spot price data, in this case allocation and entitlement data. This data is challenging to provide in a timely manner without a central exchange trading allocation and entitlements. However, this does not necessitate one central exchange for all products; a number of central exchanges, e.g. one for allocation and entitlements and another for derivative products may also be appropriate. In addition, greater water market intermediary regulation is needed, particularly in defining, policing and sanctioning conflict of interests, along with establishing minimal brokerage requirements. Potential regulation is also needed to stop water market intermediaries from commercial water entitlement ownership and principal trading, to avoid conflict of interest. Water market institutions and regulation need to enforce product standards and code of conduct, and limit rent-seeking from privileged information, as well as having prosecution powers to

784 effectively limit counterparty risk in derivative type products and unlawful intermediary behaviour.
785 As the water market continues to evolve, institutions and regulation need to keep pace in order to
786 support an effective and fair market for all stakeholders.

787 Although we suggest that non-landholder and corporate trading behaviour can be beneficial for
788 the water markets, large knowledge gaps remain. In particular the water ownership, trading patterns
789 and potential concentration of market power are difficult to quantify due to lack of publicly available
790 water trade and ownership data. Further research should aim to quantify how much water is held
791 and traded by investors/agri-corporates and non-landholders, and assess whether this has
792 quantifiable impacts for the water market to influence its long-term dynamics (e.g. see Zuo et al.
793 (2019b)), including a consideration of concentration of market power, price gouging or unequal
794 access to carry-over and inter-valley transfers.

795 While the importance of water accounting and data quality for water markets is internationally
796 well-understood, the Australian case draws attention to the importance of water ownership and the
797 use of different trading products by non-landholder stakeholders. Additionally, it exemplifies the
798 need for adaptable institutions capable of designing and enforcing regulation and monitoring of
799 intermediary behaviour, as well as still encouraging innovation within markets. Finally, the Australian
800 case emphasises the ongoing need for assessment and research of any negative externalities created
801 from unintended behaviour in water markets, to enable institutional change as a response.

802

803 **6. Conclusion**

804 This study draws upon key insights provided by 63 qualitative interviews with key water experts and
805 landholder (investors and agri-corporates) and non-landholder (EWHs and financial investors) MDB
806 stakeholders. Combined with market intermediary and large-scale representative irrigator survey
807 data, it highlights issues around major themes of water entitlement ownership, water trading
808 strategies, and water market reform.

We found that MDB water markets have evolved and matured considerably: market participation has increased, and new trading products, ownership and trading strategies have developed with non-landholders actively trading water and fulfilling important market functions. The majority of stakeholders own most or all of their water needs under high/general reliability water entitlements in their region and trade water allocations occasionally to supplement their water supply, although some investors/agri-corporates own little to no entitlements for capital reasons. Diverse water entitlement portfolios are more prevalent for non-landholder EWHs and financial investors. More sophisticated investors/agri-corporates and financial investors use parking contracts, multi-year water leases, and water forwards. However, the market for parking and multi-year forwards is still under-developed. Results suggest non-landholders act as major sellers of leases, forwards and parking to irrigators, potentially having positive market impacts. While current public debate in Australia revolves around the perceived negative impacts non-landholders may be having in the water market (i.e. increased water demand leading to higher prices or market power), without further quantitative research it is unclear if, or to what extent, negative impacts exist and how much these are offset by the benefits from increased diversity of water market products.

Water markets are an important tool to drive efficiency and provide risk-management benefits to irrigators. As Wheeler and Garrick (forthcoming) conclude, water market participation is driven fundamentally by robust government regulation and institutional rules; low transaction costs; and homogeneous marketable products (and heterogeneous market users). There is a continuing fundamental need in the MDB for robust accounting of water extraction and use at both a catchment and basin scale, continual monitoring, compliance and enforcement of water extractions. The MDB experience of market maturity has led to evolving market challenges, and provides important lessons for other countries. Three associated water market reform policy recommendations were made, namely the need for more transparent and cohesive: 1) water market data and terminology; 2) rules and regulation reform; and 3) water market infrastructure and intermediary regulation and standards (such as ASIC market integrity rules, a central exchange and

clearing house and a regulatory and policing organisation). It is important that maturing MDB water markets draw on best practice guidelines and structures from financial markets wherever possible, and continue to adapt their institutions and rules as needs arise. Hopefully such reform will address negative externalities, prevent conflicts of interest and unethical behaviour from market intermediaries, as well as supporting and fostering the development of new derivative type water products to provide greater water market adaptation benefits for irrigators.

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1093 **Appendices**

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1095 **A1 Glossary of key terms**

Term	***Explanation***
Barmah Choke trade restriction	Due to a geo-hydrological phenomenon near the town of Barmah (Barmah Choke), only around 7,000 ML/day can be transferred from the important upstream storages Dartmouth and Hume dam to the lower Murray catchment in New South Wales and Victoria (Zone 10 to 11, and Zone 6 to 7) and the significant horticultural planting areas of Sunraysia and Riverland downstream (MDBA, 2019a)
Carry-over	Arrangements which allow water entitlement holders to hold water in storages (water allocations not taken in a water accounting period) so that it is available in subsequent years (ACCC, 2010)
Counterparty risk	The risk that a counterparty defaults on a contractual agreement (Pirrong, 2011)
Delivery share	The legal, and tradeable, right to have water delivered within an irrigation system, region or trust run by an irrigation infrastructure operator (Wheeler et al., 2014a)
Financial investors	Financial investors are individuals or businesses without land ownership who generate their income through trading or leasing water to other parties. Although most financial investors own large portfolios of water entitlements, some generate their income purely through water trading without owning entitlements.
Inter-valley trade restriction (IVT)	The maximum amount of water transferrable between two catchments, either due to hydrological or legal considerations (MDBA, 2010a)
Investors/agri-corporates	Investors/agri-corporates are individuals or businesses with large water entitlement and/or land ownership, generating their main income (in a normal year) through primary production
Long-term average annual yield factor (LTAAY)	LTAAY is the long-term annual average volume of water permitted to be taken for consumptive use under a water access entitlement. Currently all LTAAY figures are calculated using the long-term diversion limit equivalent factors, with these factors to be accredited in finalised state water resource plans (Cheesman and Wheeler, 2012)
Parking	A contractual arrangement permitting the buyer to store their water allocation on the carry-over of the seller, usually from one water accounting period to the next (ABARES, 2018)
Risk premium	The monetary premium a forward/option seller charges above the spot price to compensate for the extra risk they bear through the contractual arrangement (Gaydon et al., 2012)
Spill risk	The risk of losing carried over water in the event that a water storage is full and needs to release water for storage security purposes (Productivity Commission, 2010)
Spot price	The market price of a given good/commodity on the day. This usually refers to the allocation price in the water market (Bayer and Loch, 2017)
Supply risk	The risk associated with uncertainty in future water supply (Bjornlund, 2006)
Tagged Trading	Water entitlement holders can establish a “tag”, changing the extraction location of allocations associated with an entitlement to a different region/zone than the zone of the entitlement (system of origin). Water

	extracted under a tag can only be used, not sold, and gets delivered through a "tagged trade". This delivery can be exempt from inter-valley trade restrictions (MDBA, 2010b)
Unbundling	The legal separation of rights to land and rights to access water, have water delivered, use water on land or operate water infrastructure, all of which can be traded separately (ACCC, 2010)
Unregulated river system	Rivers without major storages or rivers where the storages do not release water downstream (Wheeler et al., 2014a)
Water allocation	Also called temporary water, the seasonal allocation received by a given water entitlement (Wheeler et al., 2014a)
Water entitlement	Also called permanent water, a right to extract water from a watercourse/body every year, subject to climatic conditions. Some water entitlements provide access to carry-over. Water entitlements come in different securities, with high security yielding a full allocation in 90-95 of 100 years, general security 42-81 of 100 years, and low security 20-35 of 100 years. Supplementary and conveyance entitlements only yield water in flood years. Unregulated entitlements are in unregulated river systems (Cheesman and Wheeler, 2012)
Water forward	A contractual arrangement whereby the seller guarantees to deliver a defined volume of allocation, for a predetermined price, at a predetermined point in time in the future to the buyer. The buyer guarantees to honour the contract (Bayer and Loch, 2017)
Water future	Water futures currently do not exist in the MDB. Futures are similar to forwards in that the seller guarantees to deliver a defined volume of allocation, for a predetermined price, at a predetermined point in time in the future to the buyer. The difference is that futures are exchange traded: the central clearing house collects collateral deposits from the counterparties and guarantees contract delivery in case of counterparty default. For most futures, the difference between the spot price and price agreed in the future contract is credited/debited daily to the counterparties' accounts (daily cash settlement) (Pirrong, 2011)
Water lease	A contractual arrangement whereby the lease taker (lessee) receives all allocation attributed to a leased water entitlement. The entitlement remains property of the lease giver (lessor) (ABARES, 2018)
Water option	A contractual arrangement whereby the buyer has the option, but not obligation, to deliver/have delivered a defined volume of allocation, for a predetermined price, at a predetermined point in time the future to/by the seller (Wheeler et al., 2013)

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A2 Data sources and corresponding analyses

Data source	*Year*	*Observations*	*Analysis*	*Figures/Tables*
Irrigator telephone survey	2015-16	1,000 irrigators	Entitlement ownership, entitlement ownership diversification, carry-over, allocation and entitlement trading	Figure 2 Table 2
Semi-structured qualitative expert interviews	2018-19	63 expert interviews (with mainly 38 of them used in this paper)	Water ownership motivation and strategies, water trading strategies, water market design improvements	Figure 2 Table 2 Table 3 Table 4 Table 5
Water market transaction data	2018-19	BOM trade data (Murrumbidgee allocations and entitlements) Victorian Water Register trade data (Goulburn allocations and entitlements) H2Ox: private register data (forwards and parking)	Water forward and parking trade	Table 1