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# High turbidity: Water valuation and accounting in the Murray-Darling Basin

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ABSTRACT

Australia's sophisticated and advanced water market legislation has allowed direct investment by non-landholder stakeholders in water ownership, which over time has increased the volume of water entitlements owned by government, non-governmental organisations and non-landholder investors (e.g. superannuation companies, trade speculators). The growing market value of Australian water entitlements, driven by increased water scarcity and international commodity prices, has meant that water is now one of the most valuable assets owned by many irrigators. However, to date, there is no standard practise of financial water valuation and accounting, nor is there an understanding of the most common methods used by various stakeholders. We report information from 63 in-depth expert interviews with bankers, environmental water holders, financial investors/agri-corporates, property evaluators and water brokers in the Murray-Darling Basin to establish the current practices employed. The most common valuation methods used current market prices based on water register and water broker data. Water entitlements were valued with historical cost or fair value water accounting, depending on the stakeholder. However, given the lack of standardised methodology, evaluator discretion and fast moving (or thin) markets can lead to considerable divergence in water valuation values. Recommendations are made for the need for greater transparency and standardised water valuation methods.

## 1. Introduction

Much of the world's agricultural systems and regions face a drier future with increased frequency of extreme events, such as droughts (IPCC, 2019). This is especially true for Australia's Murray-Darling Basin (MDB), a region already experiencing a highly variable climate. Much of south-eastern Australia has been experiencing drought from 2017 onwards, leading to a rapid increase in permanent and temporary water prices (albeit temporary prices have still not reached the heights of the Millennium drought time-period from 2001-02 to 2009-10) (DELWP, 2019a). The rapid rise of water prices means that sometimes water is one of the most valuable commodities owned by an irrigation farmer.

In the MDB, water ownership has been separated from land, allowing non-landholders like financial investors and environmental water holders (EWHs) direct ownership of water rights via water markets (Grafton and Horne, 2014a). With MDB water markets routinely recognized as the most advanced water markets globally (Grafton et al., 2011), their challenges and best practice solutions are highly relevant for other water market systems world-wide. Water markets have existed formally in the MDB since the 1980s but developed more rapidly since water entitlement (otherwise known as rights) ownership was separated from land from 2004 onwards (COAG, 2004), the further unbundling of water rights in use and delivery rights (NWC, 2011b), and the stepwise reduction in trade limits and barriers across the MDB (ACCC, 2010). Although there now is a large variety of tradable water rights (e.g. more than 150 different tradeable entitlements (MDBA, 2019a)), trade concentrates in two main products: 1) water entitlements (permanent water – a right to extract water from a watercourse/body); and 2) water allocations (temporary water – the seasonal allocation received by a given water entitlement from a watercourse/body) (Wheeler et al., 2014a). Water entitlements come in three main forms: high, general and low security, reflecting the probability of receiving a full water allocation. For example, a high security entitlement is meant to yield, on average, a full allocation in 90–95 out of 100 years (Zuo et al., 2016). MDB water markets seek to allocate water to its highest and best use, and have historically provided significant economic and drought adaptation benefits (Grafton and Horne, 2014b; Kirby et al., 2015). Yet a number of rights, such as water use licences, are still tied to land-ownership and not fully unbundled. Similarly, trading rural water for urban use is restricted, although with some exceptions, such as irrigation infrastructure organisations and water utilities purchasing water entitlements to support country towns' or Adelaide's water supply, during the Millennium Drought (NWC, 2012). From 2007 onwards, an organisation can buy

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water rights in the southern MDB[1] on the market place without owning any land, and achieve a return by selling water through the market to end-users like irrigators (NWC, 2011b; Seidl et al., 2019; Wheeler et al., 2016). Water market development in the MDB is now very advanced. Fig. 1 illustrates water entitlement and allocation trade over time in the southern MDB (sMDB), and high reliability entitlement and allocation prices in Victoria's 1A Goulburn, one of the most active water trading regions in the southern MDB.

Combined with the removal of barriers to ownership (e.g. 10 % limit on entitlement ownership not tied to land in Victoria (ACCC, 2010)), non-landholder ownership (e.g. superannuation companies, trade speculators and arbitragers, NGOs) of water entitlements in the MDB has been growing. This has been shown by DELWP (2019a) as increasing ownership of entitlements held by the "non-user" group – estimated at around 12 % in Northern Victoria. Water also attracts international investment, with 9.4 % of MDB water entitlements held by companies with a level[2] of foreign ownership (ATO, 2019). However, without publicly available non-landholder ownership data (Seidl et al., 2019), and with a significant proportion of entitlements in the "non-user" group held by irrigators (i.e. in self-managed superannuation accounts), discerning the volume of entitlements owned by non-landholders is challenging.

farm with average water entitlement ownership in 2015-16 held land and water assets worth about AUD$2,285,000 - with water entitlements representing around 41 % of the combined land and water value.[3] The same water portfolio would be worth AUD$1,315,000 under 2018/19 prices, almost the same as their land value. The importance of water and its financial value, combined with the emergence of non-landholder water entitlement owners, such as financial investors or EWHs, has led to the following issues: 1) how irrigators can borrow against their water entitlements and the credit for corporates versus family farms[4] (Australian Property Institute, 2016); 2) how there is different access to information for various irrigators[5] ; and 3) how water assets are valued by different stakeholders. The lack of standard practice and consistency in valuing water can have many financial and political ramifications.

In conjunction with this reform in water property rights, there has been a large-scale effort to achieve environmental sustainability in the Basin to deal with issues such as water scarcity (drought), water over-allocation and severe environmental degradation. The *Water Act 2007* (Cwlth) and the MDB Plan 2012 (Basin Plan) aimed to return 2750 GL of water from consumptive to environmental use by mid-2019. The existence of water markets and the unbundling of water from land allowed the Australian Federal Government (Commonwealth) to pur-

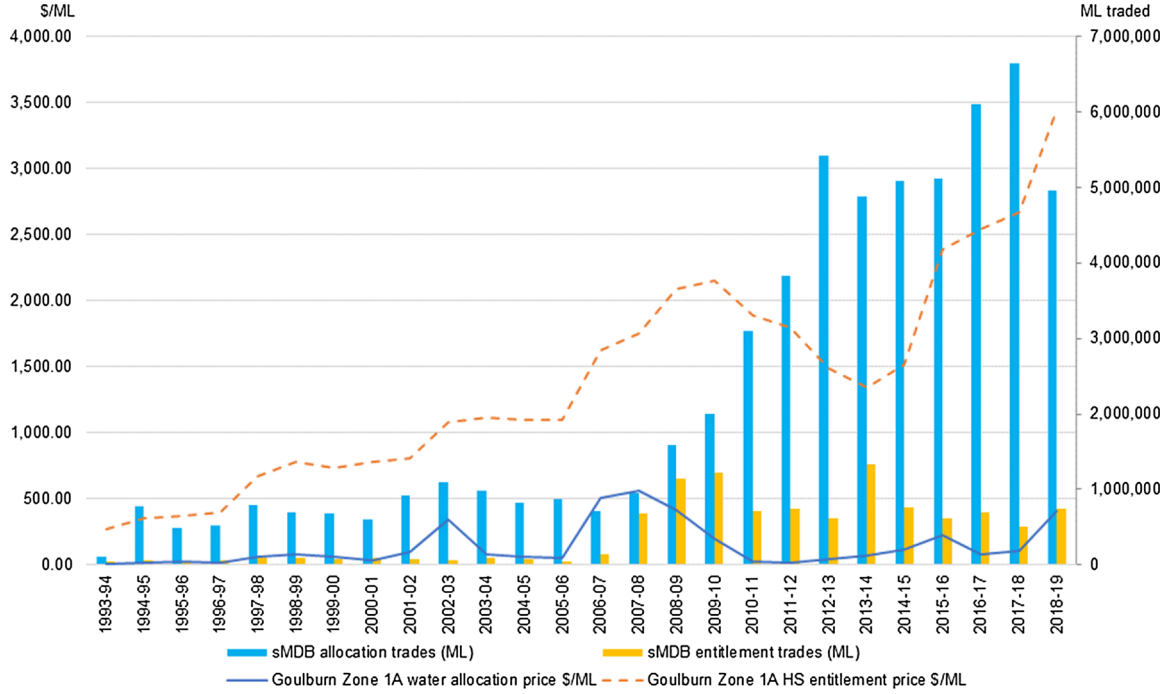


**Fig. 1.** Temporary and permanent water prices in the Goulburn and southern MDB water trade volumes from 1993-94 to 2018-19.
Sources: Historical water prices (based upon nominal average annual prices for Goulburn 1A Zone allocation and high security entitlement trade) datasets held by University of Adelaide, and Victorian water state registry (DELWP, 2019b). Southern MDB trade volumes were sourced from NWC (2011a) and BOM water market dashboard (BOM, 2019b).

The importance of the value of water entitlements to irrigators can be illustrated with an example. An average sized Victorian irrigation

chase water entitlements from willing sellers. As a result, the Commonwealth now owns a large amount of environmental water

[1] Unbundling has been slower in the northern MDB, with some systems/entitlements still linked to land. However, greater institutional and regulatory reform is required before increased trade can occur without causing additional negative externalities.

[2] The ATO (2019) defines companies with a level of foreign ownership as: 1) owned by an individual not ordinarily a resident of Australia; 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%.

[3] Average farm-land value (AUD$1,360,000) and average water holding (370 ML of high security and 160 ML of low security) was based on Centre for Global Food and Resources 2015-16 survey data for a Victorian farm (see Wheeler et al. (2018) for detail on survey). Water value (AUD$925,000) was based on revenue of selling entitlements (before costs and fees) at 2015-16 median entitlement prices for Zone 1A Goulburn (DELWP, 2019b).

[4] Family farms are said to be disadvantaged in comparison to corporate actors when borrowing against their water entitlements (Waterfind, 2019).

[5] Loch et al. (2018) found irrigators on average spent 5.2 hours per transaction searching for trade opportunities. Intuitively, smaller (non-corporate) farms have less time available, disadvantaging them when water trading.

entitlements (Grafton and Wheeler, 2018), estimated at around 20 % at mid-2019. There are three main ways the Commonwealth has acquired water entitlements for the environment under the Basin Plan: 1) through open reverse-auction tenders buying water entitlements directly off willing sellers in various regions (from 2007-08 to 2012-13); 2) through subsidising upgrades of irrigation and supply infrastructure, both on and off-farm (from 2008 onwards); and 3) through closed tenders (strategic purchases) buying water entitlements (and occasionally land) from large sellers (mainly from 2013-14 onwards) (Grafton and Wheeler, 2018). The Commonwealth states that strategic purchases target water entitlements with substantial ecological or hydrological importance for the MDB that are difficult to acquire with buybacks or infrastructure upgrades (DAWR, 2018). However, many strategic purchases have been heavily criticised for being inefficient and costly, with little environmental water received for the dollars spent (Productivity Commission, 2018; Slattery and Campbell, 2019; The Senate, 2018). For example, water recovered through one such strategic purchase from a Queensland property in 2017, Kia Ora, has come under public scrutiny, receiving significant media attention regarding the fair value of the recovered entitlements (e.g. Davies (2019)). As non-landholder water investment is increasing and with strong public interest in Commonwealth water investment activities, the methods used to assess and report water value are therefore highly relevant. While improvements in physical water accounting was a key requirement under the National Water Initiative (NWI) (COAG, 2004), there has been very little work done to date on ensuring consistency in how different stakeholders assess and account for financial water value in practice (Tingey-Holyoak, 2019). Indeed, there is a lack of understanding about what water market valuation practices are actually used by organisations such as banks, brokers, governments, non-governmental organisations, superannuation companies and large corporates.

Water accounting and valuation is especially relevant as governments around the globe spend considerable resources to improve irrigation efficiency with the aim of reducing water consumption, with the need to demonstrate value for money on the expenditure. However, without comprehensive physical water accounting, increased irrigation efficiency can actually lead to more water consumption (Grafton et al., 2018), whereas flawed financial water accounting can lead to overpayments for water licences and budget blowouts. With Australia at the forefront of both water commodification through water markets, and extensive resources spent on water recovery through irrigation infrastructure efficiencies (Grafton and Wheeler, 2018), learnings from Australian water accounting and valuation practices have valuable insights for the approaches in other countries.

This study identifies the valuation methods and accounting practices used for MDB water entitlements, drawing on 63 in-depth interviews with bankers, environmental water holders, investors, property evaluators and water brokers. In particular, it seeks to address the following research questions: 1) what accounting practices and valuation methods are used by different MDB stakeholders; and 2) how does the employment of various valuation methods significantly impact water entitlement actual values?

We provide lessons for water accounting and water entitlement valuation in the MDB. The lessons learned from the MDB can provide key insights for water accounting and water valuation in other countries.

## 2. Water accounting and valuation principles literature

This background literature section is structured in three parts: 1) a review of international water accounting systems and frameworks; 2) a discussion of water financial valuation methods; and 3) an overview of the current practice of water valuation and accounting in Australia.

### 2.1. International water accounting systems

Water accounting systems or frameworks report water-related data for a number of different purposes and areas. There are a variety of water accounting frameworks used globally, all differing in purpose and scope (Godfrey and Chalmers, 2012). The majority focus on physical water accounting, the reporting of volumes and quality of water, on different scales. Each framework has a particular purpose, for example: the *System of Environmental-Economic Accounting for Water* and the *International Water Management Institute Water Accounting Framework* report on water flows, water stocks, water use and consumption, and water quality on the basin scale (Karimi et al., 2012; Vardon et al., 2012). On the company or product level, water footprint accounting shows the water volume necessary to manufacture a unit of product and water management accounting aims to increase businesses' water management by illustrating water use and associated costs in production and supply chains (Christ and Burritt, 2017a; Hoekstra, 2012).

A common trait of water accounting frameworks is their limited capacity to incorporate financial/monetary water data. The *System of Environmental Economic Accounting for Water* attempts to include monetary flows that correspond to water flows by linking into a country's system of national accounts, mainly for delivery and treatment cost, and by having dedicated water valuation accounts. However, due to data limitations, water valuation accounts remain experimental and unimplemented (Vardon et al., 2012). *The International Water Management Institute Water Accounting Framework* attempts to capture water value by relating water use to agricultural output, yet this is of minor consideration in the framework and seldom implemented (Godfrey and Chalmers, 2012). Additionally, in this framework, water is only valuable as a function of agriculture, ignoring the potential value to non-agricultural water users (Karimi et al., 2012). Water value in water management accounting is highly dependent on the costs of water supply and wastewater treatment. These are determined by water utilities' tariffs, often set low for political reasons in many countries (Mungatana and Hassan, 2012), limiting the benefit of financial water management accounting and its implementation.

Water accounting frameworks describe what data ought to be reported, but rarely provide guidance on how this data should be measured and compiled. This is particularly true for data concerning monetary/financial valuation of water assets.

### 2.2. Financial valuation for water assets

In the absence of international agreement on how to value water resources, the *System of Environmental Economic Accounting for Water* suggests water valuation methods commonly applied in economics (e.g. residual methods, revealed and stated preferences, production functions) should act as the default approach. Alternatively, asset valuation methods from finance and accounting could also be used. Economic tools based on the concept of total economic value can be applied to the valuation of water resources based on their direct, indirect and non-use value (United Nations, 2012).

As the aforementioned water accounting frameworks focus mostly on direct water use, water as an investment asset receives no mention and therefore no corresponding water valuation technique is discussed. However, a mainstay of finance and accounting is the valuation and reporting of asset value, therefore financial asset valuation techniques could be applied for water rights. Financial asset valuation follows three approaches: 1) discounted cash-flows (e.g. ascertains value based on an asset's fundamentals such as associated cash-flows; expected growth of the asset; associated risk to cash-flows; and the asset's terminal value); 2) value of comparable assets (relative valuation - price of comparable assets in the market place, adjusting for difference in asset characteristics, or cost of replacing the asset); and 3) option pricing models (contingent claim valuation - dependent upon the occurrence of a particular event) (Damodaran, 2012b, 2012c).

In contrast to financial valuation, accounting determines the value of an asset as the historical cost of the asset less its accumulated depreciation, or fair value. If historical cost accounting is used, this can result in significantly different book and market values for an asset, especially for assets such as water which can move in value very quickly (Damodaran, 2012a). If fair value is used, water market prices need to be readily available. Hence, although possible, financial water valuation and financial water accounting in the absence of readily available water market prices is difficult.

### 2.3. Water accounting and valuation in Australia

Although Australia has employed continuous water accounting since 1983 (Connell, 2007), water accounts were primarily used for internal agency management purposes. From 2004, the *National Water Initiative* (COAG, 2004) required a water accounting framework to be developed, which provides information for internal and external stakeholders to facilitate planning, monitoring, trading, and environmental and farm management. This led to the *Australian Water Accounting Standards* for "*General Purpose Water Accounting*" (GPWA) currently used at the basin scale around Australia, including in the MDB (Water Accounting Standards Board, 2012a). GPWA employs water accounts to report physical levels of water assets, water liabilities, net water assets, changes in water assets, and changes in water liabilities, with application mainly on the catchment/basin/country scale, although the framework was intended to be used also by companies/businesses (Water Accounting Standards Board, 2012b). On the basin/catchment scale, these water accounts underpin water sharing plans and water market activity in the MDB, providing transparent information on how much water is managed, how much is extracted, and how much is traded (Chalmers et al., 2012). The implementation of GPWA remains challenging; the definition of relevant water assets is not standardised and often left to practitioners, leading to inconsistencies between regions. Another significant methodological challenge is poor quality and lack of hydrological data (Tello and Hazelton, 2018). Due to this lack of data, GPWA assumes water extraction equals consumption. This approach ignores return flows back to the river, and hence has the potential to overestimate consumption and underestimate negative externalities, which has been widely canvassed in the international literature (Grafton et al., 2018; Perry et al., 2017). Reflecting global practice, GPWA also focuses on physical water accounting and does not incorporate economic/financial data[6] (Godfrey and Chalmers, 2012).

While basin-level physical water accounting has dramatically improved with GPWA, monetary water accounting is still underdeveloped. The only monetary data readily available is water market data, either an abridged version of the trade in state water registers and the Bureau of Meteorology water dashboard or analysed in report form (ABARES, 2018). However, reviews have highlighted a number of issues with water register data (Deloitte, 2019; MDBA, 2019b). First, there is no mandatory price reporting, leading to a large number of trades without price, or with a price of zero. Second, entitlement transactions as a part of a land transaction are not always identified, potentially skewing reported prices, and this is a particular problem in the Queensland water register. Third, even if reporting errors have been identified, they are either not corrected, or a correct transaction gets inserted into the data, without removing the erroneous transaction record (MDBA, 2019b). Additionally, and in contrast to land registers, water ownership registers are not accessible publicly. Individual water licence information is often behind a pay-per-record paywall, making it difficult to discern the size and value of various water holdings. This is complicated by the fact that authorities often require stakeholders' permission to share water licence information, even in case of paid requests.

[6] The framework theoretically allows for monetary values to be used if appropriate for users' information needs. This is not implemented in practice.

At the individual business level, water accounting is voluntary and not standardised (Christ, 2014; Tingey-Holyoak, 2019). For financial reporting, the Australian Accounting Standards Board (AASB) recommends treating (unbundled) water rights as intangible assets with an indefinite lifespan. Water rights get valued at initial cost, or purchase price, less impairment. Contingent upon an active market, a fair value assessment is undertaken at revaluation (AASB, 1995, 2019b, 2019c). The AASB (2019a) recommends three techniques for fair valuation: 1) market (namely relative valuation); 2) replacement cost (amount required to replace the asset); and 3) income (discounted cashflow). However, it does not provide a detailed valuation method for water entitlements, nor does it recommend any of the fair valuation techniques.

There is also no industry-recommended water valuation method. Although the Australian Property Institute (2017) touches on water valuation in its guidelines for rural and agribusiness property valuation, and runs water evaluator courses, it only advises evaluators to understand water trade and budget issues. Similarly, how to value water entitlements is only sparsely addressed in legislation, if at all. The *Water Act 2007* (Cwlth) mentions the "market value" of entitlements and that methods to establish this value are subject to "regulations". These regulations seem not to exist on the Commonwealth level. On the state level, there is a similar but nuanced picture. Prior to unbundling, water entitlements were valued as part of the land and governed by the relevant acts in every basin state and the Australian Capital Territory (ACT) ((*Rates Act 2004* (ACT); *Valuation of Land Act 1916* (NSW); *Land Valuation Bill 2010* (QLD); *Valuation of Land Act 1971* (SA); *Valuation of Land Act 1960* (VIC)). Since unbundling, no state in the MDB has passed a legislative instrument dedicated to financial water valuation. While some states refer to land valuation in their water legislation, others make no mention of the issue. NSW excludes water entitlements as part of land valuation but prescribes no methods for valuation in the *Water Management Act 2000* (NSW). The Queensland *Water Act 2000* (QLD) mentions the market value of entitlements for compensation purposes, but does not identify a corresponding valuation method. It seems that the Victorian *Water Act 1989* (VIC) addressed financial water valuation the most comprehensively, requiring water entitlements to be valued by a certified valuer, and exit fees in irrigation districts should represent the present value of all future fees payable. But, while the Act prescribes discounted cash flow valuation for exit fees, it provides no guidance on water entitlement valuation. In contrast, the ACT and SA have no provisions for water valuation in their legislation (*Water Resources Act 2007* (ACT); *Natural Resources Management Act 2004* (SA)). For an overview of relevant water valuation legislation see Appendix Table A2.

Hence, in the absence of dedicated guidelines in the MDB, the choice of water valuation and financial water accounting practice lies with the evaluator, and raises the research question of what methods are stakeholders applying, and what are the potential consequences that arise from various valuation methods.

## 3. Data collection and analysis

A mix of qualitative and quantitative methods were employed to explore a variety of water trade, water ownership, strategic risk management, water valuation and accounting methods issues in the MDB.

This paper reports the findings from 64 semi-structured interviews conducted with bankers, evaluators, EWHs, investors and water brokers across the MDB. Given the fact that there are 1) no standard industry and legislative valuation methods; 2) no publicly available register of water entitlement valuations; and 3) the commercial in-confidence practise of valuations, we chose a qualitative method of data collection to understand these stakeholders' water valuation strategies. To

specifically target large and prominent organisations with expert knowledge in water entitlement valuation, water trading and agribusiness lending in the southern MDB, such as banks, evaluators and water brokers, we used publicly available information to first identify relevant organisations (and individuals within), and as a second step, a chain referral approach to recruit additional interview participants (Biernacki and Waldorf, 1981). Consequently, the qualitative interviews focussed on the views and valuation approaches of large and corporatised organisations. Given that the common approach to valuation employed both by government and industry is to contract large evaluation firms to undertake water entitlement valuations, then our method of recruitment was aimed at understanding the methods by these firms. The interviews were conducted mostly face-to face in mid to late 2018 at times and locations convenient for respondents (with 25 % of interviews undertaken by phone and two respondents provided written submissions). Overall, we approached 83 eligible individuals or organisations for interview and hence obtained a response rate of 77 %.

Recruitment continued until saturation was reached, namely when no new information and themes were identified. The incompleteness of one written submission meant it was excluded, hence only 63 responses are included here. Interview recordings and transcripts were compiled into Nvivo11 (a qualitative data analysis software package) and manually coded into major themes. The interviews had a median length of 60 min and comprised three main stakeholder groups, namely: 1) 15 EWH employees; 2) 27 water market investors (financial investors and agri-corporates); and 3) 21 bankers (6), water brokers (6) and water evaluators (10)[7] . EWHs are public or private entities, owning or delivering water entitlements or allocations for environmental purposes. Investors own and or trade water to generate non-commission income from water trading or revenues from growing crops. The majority (e.g. 20) of these were investors and agri-corporates (very large landholders owning and/or trading water but generated their main income from farming), while 7 were financial investors (non-landholders trading water for financial gain). Bankers represent financial institutions with significant portfolios in agribusiness (and water entitlement) lending. Water brokers generated commission-based revenue from water market transactions. Evaluators are specialised in rural, agribusiness and water valuations. The socio-economics were that 84 % of our respondents were male, with 70 % of the female respondents working for EWHs, and 75 % of respondents have had experience in their current or a similar previous role for more than 10 years. However, our analysis suggested responses were mainly driven by the stakeholder group rather than by job experience or gender.

In addition, this study applied a quantitative case study methodology to illustrate the monetary impact of using different water valuation methods. The case study was the strategic water purchase by the Commonwealth from Kia Ora, a Queensland property owned by Eastern Australian Agriculture, for the purpose of returning water from consumptive to environmental use. We collected relevant water register data and used various water valuation methods to illustrate the differences in water values from different techniques applied.

## 4. Results and discussion

The results are broken down into two main themes: water valuation methods and water accounting methods. Over two thirds (68 %) of all participants discussed water valuation and water accounting in detail during the interviews, with most comments respectively provided by bankers, evaluators and water brokers, investors and then EWHs.

### 4.1. Water valuation methods

Table 1 summarises the valuation methods and data sources considered by respondents (43 respondents commented on water valuation methods). Relative valuation methods based on current water market entitlement prices and transaction data were most commonly used. Other methods included adopting the broker price/purchase price or using volume weighted average prices based on different lengths of data (6–18 months). Respondents explained that only transaction data between non-distressed, at arms' length counterparties[8] is considered, excluding transactions resulting from liquidation or bankruptcy,[9] and 19 % of respondents mentioned other valuation methods. These alternative methods included: 1) valuations based on historic and future allocation volume; 2) associated production; 3) long-term average annual yield (LTAAY) (e.g. see Cheesman and Wheeler (2012, p. 68)); 4) statistical and time-series analysis; and 5) capital asset pricing type valuation models.

In the stakeholder interviews, respondents discussed in-depth some water valuation challenges. In particular, comments were made in regards to thin water markets —also called illiquid markets —which refers to areas of trade with only a small number of market participants or very few trade transactions over multiple years (Tisdell, 2011). The biggest challenge with thin markets was the absence of high quality data. Stakeholders addressed this gap by using water trade data from comparable water products in other regions (based on reliability) or property sales data. For example, evaluators consulted stock and station agents for the water value proportion of a property transaction:

> *"We take out the value of the land, structures, apportion value to all those things and then work back to what an in-situ value of water might be. But it can be very difficult in those instances and people can have a wide variety of opinions as to what they think it might be worth"(Evaluator)*

Only very rarely is a competing valuation undertaken by a different company to negotiate a valuation outcome, or an entitlement valued at a discount to the market in an attempt to adjust for scarce or biased data. There is a fair amount of discretionary space to choose data sources and methods for valuation, but strong personal contacts in the real estate sector and to other evaluators are considered paramount to improve data availability.

On the other hand, in a highly liquid water market, respondents rate data quality and availability less of a concern for water valuation:

> *"There are components of the water market that are still immature, but largely across the southern connected system, I think it's a very dynamic, very well informed market."*(Evaluator)

However, Table 1 highlights there is still an element of discretion even for liquid markets, particularly around data cleaning and data sources used. Another area of discretion is the time-period. All participants used entitlement trade data from the relevant state water registers, but problems with data reported meant the need to clean datasets. For example, there are a large number of zero-priced transactions

[7] Note we interviewed a few respondents who worked for the same organisation. This was because some EWHs and evaluators operate across multiple states with water management or valuation decisions made at the local level, making it necessary to interview a variety of local representatives. We grouped bankers, water brokers and water evaluators together in the analysis as they do not own water and base their income on water-related services, rather than primary production.

[8] There is no standard legal definition of non-distressed counterparties. Rather, evaluators apply an economic definition, similar to the definition in *Land Valuation Bill 2010* (QLD), meaning a transaction under reasonable terms without time pressure. This is a core principle of commercial valuation.

[9] This stems from land valuation practices, where transactions from liquidation are significantly discounted. The NSW water register tracks water trades as a result of liquidation as "71X" trades, but they are unidentified in other state registers.

**Table 1**
Water valuation method and data sources mentioned by respondents who discussed water valuation and accounting (n = 43).

| | Answers to: 1) What method do you use to value water entitlements? and 2) What data sources do you use? | Banks % (n = 6) | Evaluators & water brokers % (n = 15) | Financial Investors/Agri-corporates % (n = 19) | EWH % (n = 3) |
|---|---|---|---|---|---|
| Methods Used* | Current market price | 50 | 53 | 16 | 67 |
| | Volume weighted average | 33 | 27 | 0 | 33 |
| | Original purchase price | 17 | 0 | 0 | 0 |
| | Other | 17 | 13 | 32 | 0 |
| Data sources* | Water registers | 67 | 73 | 16 | 67 |
| | Water brokers | 67 | 80 | 11 | 33 |
| | Own data | 67 | 20 | 0 | 0 |
| | Property sales | 0 | 27 | 0 | 0 |
| | Other evaluators | 17 | 7 | 0 | 0 |
| | Test listing** | 0 | 7 | 0 | 0 |

Note: *Multiple mentions of methods and data sources per interview possible.
** Where a water broker offers an entitlement for sale to collect bidding data, but then does not go through with the sale.

(representing either trades without a valid contract (e.g. EWH trade or transfer) or price not reported), low and high outlier prices, and data reporting lags of up to a few months (de Bonviller et al., 2019; MDBA, 2019b). It is common practice to exclude zero price trades from valuation, or use median prices, but adjustment for outlier values is less straight forward, especially in less liquid markets. Abnormally high prices for water entitlements can appear for a number of reasons. In NSW for example, there is incentive to over-value the water component of a bigger land transaction in order to minimise stamp duty fees given water's exempt status (Revenue NSW, personal communication, 11/11/2019). The ACT, NSW, Queensland and SA water registers currently do not contain information on combined land-water transactions, allowing inflated water prices to enter unrecognised (MDBA, 2019b). Water registers also do not contain information on whether an entitlement transaction included allocation or carry-over volume (Deloitte, 2019). These are called "dry" and "wet" water sales, with "wet" sales containing allocation or carry-over volume. Prices of wet entitlement sales are higher as a portion of the value is in the form of water allocations. Some respondents adjust their valuation by referring back to a dry entitlement price, others implicitly assume that entitlements are wet/dry at certain times of the year and this reflects in market prices:

> *"I try and go back to a dry value if I can, but obviously our evaluations are at a certain period of time, we're taking it as at that date and if you're selling water that's got a bit of temporary water included then you're going to get a little bit of a premium."*(Evaluator)

The scale of a particular water entitlement transaction can also lead to outlier prices, referred to as "scalability" by respondents. The issue arises from water entitlements trading at a premium (or discount) corresponding to its transaction size. Some respondents' argued that larger parcels of water trade for a premium, with the buyer paying for the convenience and lower transaction costs of not having to aggregate the volume from smaller parcels.[10] A single large transaction can also incur a premium due to perceived less reputational risk and backlash in rural communities compared to many small transactions:

> *"I think a continuing trend that's witnessed is that we typically see a premium of some sort for a larger parcel when compared to a smaller parcel."*(Evaluator)

On the other hand, some respondents noted that smaller parcels of water trade at a premium, because they are more affordable and attract a bigger pool of buyers:

> *"Smaller parcels have the higher premium. Someone has got 100 ML and they buy this 10 ML parcel for $4,100/ML, all they've done is made the average cost of their water go from $2200/ML to $2300/ML and the addition of throwing in 10 ML. And they slowly accumulate on the basis of being able to afford it."*(Investor)

Bankers, evaluators and water brokers pointed to water broker data as an important source of information to mitigate shortcomings in the water registers, particularly to address time lags. While some respondents rely on a single broker, many consult a number of water broker platforms in order to get a comprehensive market picture. Evaluators use property sales data, sourced from real estate agents or the parties involved, to identify the value apportioned to water in land-water transactions. Some organisations also maintain internal databases on transactions or valuations undertaken:

> *"Our best evidence is what our clients are actually selling and buying…I see every formal valuation that's done so we have a big database of what other valuers are putting on water."* (Banker)

Respondents also discussed the time-period used to value water entitlements. While some include data from the last month only, others consider up to the previous 18 months of data. Investors seem to prefer more recent data, whereas bankers and EWHs use longer periods:

> *"We tend to have a rolling benchmark, so that looks back 18 months, what the price has been doing…Another way in which we look at it, we look at the last six to twelve months."* (Banker)

While most MDB water valuations use relative valuation methods in liquid markets, discretion is exercised around what periods of data and what data sources to draw upon, and around water value assumptions. This often makes it difficult to compare different valuations, as assumptions and methodology are often scarcely documented or commercial-in-confidence. Although some valuations contain explanatory footnotes, these likely do not attract much attention as managers fixate on the valuation number as the main source of information (Briers et al., 1997).

While variations in valuations based on different approaches might be minor in liquid markets and where water values are not rapidly increasing, it can have a substantial impact for thin markets as demonstrated in the following case study.

#### *4.1.1. Case study: strategic purchase of water from Eastern Australian Agriculture*

The strategic purchase of water from Eastern Australian Agriculture by the Commonwealth Department of Agriculture and Water Resources (DAWR and now titled the Department of

[10] Entitlement transactions require on average 13.2 hours per trade to finalize, can include trading fees of on average AUD$24-1064/transfer when crossing Irrigation Infrastructure Operator boundaries, and water broker commission of 1.5% or 3.0% of transaction value for sellers and buyers respectively (Loch et al., 2018).

Agriculture), as part of the Basin Plan to return water from consumptive to environmental use, illustrates the impact of different valuation methods, assumptions and evaluators' discretion. The DAWR acquired 28,740 ML of overland flow water entitlements in the Condamine-Balonne region from Eastern Australian Agriculture's properties Kia Ora and Clyde via a strategic purchase in August 2017 (DAWR, 2018). For a definition of overland flow licences and their difference to unbundled water entitlements, see the glossary in Appendix Table A1. The purchase included the condition that Eastern Australian Agriculture must decommission levee banks and structures which allowed it to harvest the overland flows for the licences in question. The publicly available documents state that this removal is done by the company "at no cost" (The Senate, 2018, p. 412). Of the purchase value of AUD$78.9 million, AUD$38.95 million was apportioned to 14,190 ML of unsupplemented Condamine-Balonne water entitlements - overland flow licences - from Kia Ora. While the purchase received initial attention in the Senate in 2018 (Slattery and Campbell, 2018; The Senate, 2018), it attracted major public interest in the 2019 Federal election campaign (West, 2019; Wroe, 2019).

One key issue was whether the price paid by strategic purchase (namely in negotiation with the company, not on the open market) was value for money for the type of water entitlements acquired (Davies, 2019), given the relevant water valuation documentation was not publicly available (DAWR, 2019; The Senate, 2018). Grafton and Williams (2019) have argued that the Kia Ora purchase in particular was an example of rent-seeking behaviour by vested irrigation and corporate agriculture interests, seeking to benefit from unduly high water entitlement valuations.

Although government policy regarding strategic purchases is meant to give regard to socio-economic impacts[11] (DAWR, 2018), a government commissioned assessment by NCEconomics deemed the Kia Ora water purchase to have negligible socio-economic impacts for the region[12] (The Senate, 2018). In 2017, an evaluator estimated a value for Kia Ora water entitlements based on: 1) historic sales evidence; 2) an estimation of the LTAAY based on 1922–1995 data; and 3) the difference in property value with and without water, leading to a negotiated price of AUD$2745/ML. The government's competing valuation by NCEconomics reduced the estimated LTAAY of Kia Ora water from 14,190 ML to 12,983 ML, based on 1985–2009 data, leading to a 9 % difference in purchase cost (The Senate, 2018). To illustrate the impact of an evaluator's discretion and the implications for water prices, we undertook a relative valuation of comparable water products, such as unregulated water licences in the Gwydir, the Barwon-Darling and the NSW intersecting streams, and the more reliable[13] water entitlement of regulated high security (HS Reg) 1A Goulburn in Victoria for the given time-period (Fig. 2).

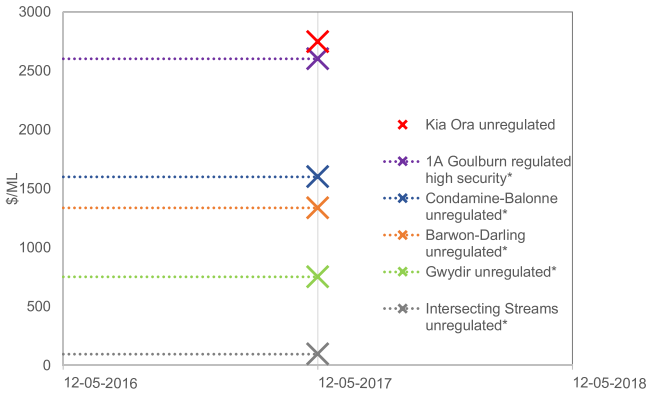


**Fig. 2.** Median price and purchase price for unregulated Kia Ora, Condamine-Balonne, NSW intersecting streams, Gwydir and Barwon-Darling, and Goulburn HS Reg licences as at 12/05/2017.
Notes: *Median price based on previous 12 months, from BOM (2019a) and The Senate (2018).
Median price of 1A Goulburn HS Reg is stable for last 12, 6, and 3 months.

It would have been within the evaluator's discretion to value the water at the median of Condamine-Balonne or comparable overland flow licences, as it was also in their discretion to choose 1922–1995 or 1985–2009 as the LTAAY base.

Given the lack of transparency and information regarding the purchase price of Kia Ora, it is not possible to state why the value seemed higher than what could be expected. However, what can be verified is that if the Commonwealth paid the median market price, the purchase cost would have been around 42–97 % less, depending on the unregulated reference licence (see Table 2). While Kia Ora water could have traded at a premium due to its size (14,190 ML – given government does prefer larger parcels to decrease its transaction costs per water transfer), other aspects of its unregulated nature arguably do not warrant a price premium, to the extent of making the water more expensive than the more reliable entitlement of Goulburn high security.

#### 4.1.2. Water valuation summary

This study is limited by its focus on primarily qualitative data, which hinder attempts at quantifying the impacts of different valuation methods. Future studies should analyse a dataset of real water valuations (which was not available for this study[14]) to quantify the monetary impacts of different assumptions and methods, data cleaning and evaluators' discretion on water entitlement valuations.

Nevertheless, our results provide a useful illustration of water valuation practices and their challenges. While water valuation follows similar processes to the valuation of agricultural land (i.e. market value of the asset at valuation date), which may be due to continuation of the practice of irrigated land valuation prior to unbundling, the assets are arguably very different. Water entitlements are more volatile than land, and in many cases extremely liquid, traded routinely in large volumes on active markets. Despite these differences, a dedicated water

[11] The government has stated it prefers strategic water purchases over voluntary water buybacks, as they are believed to have less socio-economic consequences (DAWR, 2018). Part of a strategic purchase application is to demonstrate that the purchase has no or negligible socio-economic impacts (The Senate, 2018, pp. 369-371). However, socio-economic impacts (on a farm level) are then used to justify a particular water price by evaluators, based on the in-production value of water and its impact on farm viability (if the farm is less viable, a higher price is seen as justified) (The Senate, 2018, p. 389).

[12] The NCEconomics assessment established that the strategic purchase: 1) has a negligible impact on regional production and employment; 2) would reduce Eastern Australian Agriculture's land under irrigation by only 9% in higher-flow years and less in normal years, without adverse impacts on farm viability; and 3) would constrain regional peak production (higher-flow years) by 2-3%, or 14,900 – 19,100 bales of cotton, and 8-10 seasonal labour positions, offset by alternative dryland cropping (The Senate, 2018).

[13] Goulburn high security water yields a full allocation 95 years out of 100, with this allocation supported by storage infrastructure. It also provides access to carry-over. A Gwydir general security entitlement yields a full allocation 36 years out of 100, a Kia Ora unregulated overland flow licence 12 years out of 100, and are not supported by storage infrastructure. This makes Goulburn HS Reg a more valuable entitlement (Cheesman and Wheeler, 2012; Hargraves et al., 2013; The Senate, 2018).

(*footnote continued*)

[14] Water entitlement valuations are often commercially in-confidence and not publicly available. If available, valuation methodology and assumptions sections are usually redacted. There is no register containing water valuations. While a public central register for land and property valuations exists in some states, it contains only the final value but not the actual valuation report. However, having access to the valuation report, in particularly the valuation methods and assumptions sections, is necessary to quantify the impact of evaluators' discretion.

**Table 2**
Comparing Kia Ora water purchase price and transaction value for 14,190 ML with similar area unregulated water entitlements.

| | Water price/median price (AUD$/ML) | Total cost (AUD$m) | % Difference compared to Kia Ora Price Paid |
|---|---|---|---|
| Purchase price Kia Ora (in Condamine-Balonne) | 2,745 | 38.95 | n.a. |
| Condamine-Balonne unregulated | 1,600 | 22.70 | −42% |
| NSW Intersecting Streams unregulated | 95 | 1.34 | −97% |
| Gwydir unregulated | 750 | 10.64 | −73% |
| Barwon-Darling unregulated | 1,337 | 18.98 | −51% |
| 1A Goulburn HS Reg Victoria | 2,600 | 36.89 | −5% |

valuation methodology has yet to emerge: the current legislative and valuation industry's guidelines are fairly inconclusive on the treatment of water assets, leaving much to evaluators' discretion. There is a lack of clearly defined methodologies and guidelines in the current practice of water valuation and accounting in the MDB, confirming the findings of other studies (Christ and Burritt, 2017b; Tingey-Holyoak, 2019). Insights from the case study and respondents' water valuation comments highlight how the valuation process can be sensitive to bias, as it relies heavily on secondary data that is not always reported correctly, nor transparent. This is particularly pronounced in thin markets, where data scarcity and quality arguably require the use of longer time-periods and multiple data sources.

In addition, commercial valuation relies on the notion of non-distressed counterparties. An interesting application of this involves government water recovery. With environmental water recovery targets for each catchment and the corresponding deadline, in form of the requirements of the Basin Plan, public knowledge, this condition is arguably violated: hence the government could be seen as a distressed buyer. Under a strategic purchase regime, particularly in thin markets with a high concentration of water entitlement ownership/market power and a significant portion of the environmental water recovery still to recover, various interests may be able to extract unduly high water entitlement prices due to "government distress". Similarly, evaluators' method choices and assumptions could drive valuation outcomes, and hence provides opportunities for rent-seeking.

### 4.2. Water accounting systems

The other major theme identified by our respondents was how water value was reported in accounting systems, with distinct practices identified for banks, EWHs and investors.

#### 4.2.1. Accounting by banks: water as collateral/security

Bankers explained a MDB water entitlement can be accepted as a security for a loan or mortgage. The value of this security is a function of the entitlements' market value, established by water valuation, and a risk adjustment[15] (otherwise known as an "internal lending margin" or "extension rate"). Some banks undertake water valuation in-house, others contract external valuation services due to conflict of interest. Larger or more complex valuations tend to be done externally, whereas simpler valuation tasks stay in-house. Most banker respondents conceded that experience with water as a security is limited, and banks therefore employ a more conservative extension rate for water than for land. In addition, some banks reduce the valuation amount by 10 % before applying the extension rate. Most also prefer to mortgage against a mix of water and land assets, leading to a higher extension rate for water as part of an asset mix, and to not lend against water entitlements alone.

It is known that water entitlements are less protected than land in legal terms. First, water entitlements are a statutory property right, making them less protected from regulatory change than a land title (Fisher, 2010). Second, banks can directly access the money from a land sale to satisfy their mortgage, whereas such a provision does not exist in every state for water entitlement sales as the money can go straight to the seller.[16] There are cases where the water owner took the money, defaulted on the mortgage and disappeared, leaving it to the bank to chase the money through litigation. Although one-third of the bankers interviewed accepted water entitlements as security by themselves, they are subject to lower extension rates, ranging between 50–70 %, representing a 10–20 % discount as compared to agricultural land extension rates. Note that banks still negotiate the terms of the mortgage, and extension rates only determine securities' value:

> *"If it's part of a wider transaction that involves farming land, so dirt and water, and water being used on the land, then we'll lend up to 70% of the water value. If it's a transaction where it's not being used specifically by the owner or a related party of the owner for farming purposes, so it's more of a speculative investment type purchase, then we reduce that to 50%."* (Banker)

Once a mortgage has been negotiated, banks do not adjust the value of the water asset until revaluation. Again, revaluation periods depend on the bank: they may, for example, be yearly, every three years, or only for intended re-mortgage.

#### 4.2.2. Accounting by EWH: water as environmental asset

EWH respondents account for the value of their water assets at historic cost less impairment (AASB, 2019b). The relevant cost is heavily influenced by the way water was initially acquired: purchase price if the water was bought on the market; or the value apportioned to water recovered as part of a strategic purchase or infrastructure upgrade (DAWR, 2018). For strategic purchases, the water value relies heavily on external valuation. For water entitlements acquired through infrastructure upgrades, they can cost a premium of up to 7.1 times the market price once transaction program costs are taken into account (Productivity Commission, 2018). Finally, for water entitlements transferred from another entity for free (e.g. gift of environmental water entitlements by the Victorian Government to the Victorian Environmental Water Holder (VEWH, 2018)), the cost is AUD$0/ML.[17]

These costs remain unadjusted in EWH accounts, save annual impairment testing, until revaluation (which only occurs in active markets). However, EWH respondents often argue that there is no active market for environmental water since it is never to be sold. In practice,

[15] Banks adjust for: the risk of the mortgagor defaulting; the liquidity; and collateral "security". Bankers explained that standard lending risk metrics such as debt-equity ratio, historic income and cash-flow are considered, as well as the agribusiness banker's expertise and judgement about the farm enterprise.

[16] NSW, QLD and VIC legislation rule that caveats can be placed on water entitlements, entitlements can only be transferred if agreed by the mortgagee, and in the case of default - proceeds of water sales need to satisfy mortgages first (*Water Act 1989* (VIC); *Water Act 2000* (QLD); *Water Management Act 2000* (NSW)). In contrast, SA legislation allows for caveats to be placed on water entitlements, but does not provide mortgagees with veto powers, nor does it dictate the use of proceeds from water sales in case of default (*Natural Resources Management Act 2004* (SA)).

[17] This is generally the case for EWHs when no cost (purchase price or cost of infrastructure efficiency program) can be attributed to a particular water entitlement, e.g. bulk water entitlements outside of the MDB.

this leads to environmental water assets being massively undervalued: most water entitlements have appreciated considerably from the time the majority of EWHs acquired their portfolios, and impairment adjustment cannot exceed the initial cost.

The practice of claiming no active market to avoid revaluation has likely evolved within public EWHs with the aim to avoid Treasury calls for revenue from water assets. Although most public EWHs are not required to recover costs or create revenue, but rather manage their water for environmental benefit (O'Donnell, 2013, 2018), this is not the case for all, and subject to regulatory change. One respondent explained that as water entitlements are listed on a state's asset register, they reported that the Treasury argues that water assets are contributing to a state's bottom line and need to be valued at market value. There is then perhaps an argument that they should therefore recover the associated costs of holding and using the asset (licencing and trading fees), requiring EWHs to create a monetary return through allocation sales. However, EWHs prefer to manage water for environmental benefits, not cost recovery:

> *"The model where government absorbs the costs in some other mechanism and the EWH just has to go about their business as managing the water is the preferred model."* (EWH)

There are some EWHs that employ a market valuation approach for entitlements acquired through direct purchase, although water recovered through infrastructure upgrades remains at cost. This approach allows EWHs to represent water ownership value closer to the current market, better informing water portfolio rebalancing decisions.

#### 4.2.3. Accounting by Financial investors and Agri-corporates

All businesses list their water portfolio value in their balance sheets but the accounting framework differs for entitlements held for production or as part of an investment asset portfolio. When water entitlements govern water held for production, water entitlements are treated as intangible assets with an indefinite life-span, accounted for at historic cost less impairment, with the purchase price as the historic cost (AASB, 2019b). In contrast to EWHs, investors/agri-corporates revalue their entitlements at fair market value. However, this often occurs infrequently. For example, family farms tend to account for entitlements at cost for multiple years without revaluing, and only revalue if required by their bank. While some investors revalue their water assets annually, this was not standard process amongst our respondents.

Non-landholder financial investors hold water entitlements as part of a real asset investment portfolio. They value water entitlements at current market prices and revalue at a high frequency, sometimes every month, making sure the market asset value is represented at all times. This provides transparency and enables shareholders to make swift decisions about portfolio restructure:

> *"We are an investment fund, we have to hold water at its fair market value based on AASB13 (Fair Value Measurement) in our books, rather than historic cost. That's important for us because our members can trade in and out of our product daily. We need to have an up-to-date market valuation so that we can ensure they're trading in and out at fair market value."* (Financial Investor)

Historical cost accounting has implications for investors/agri-corporates: having a significant part of their asset value not reflected in financial statements can make communication with shareholders difficult, as well as not reflecting the true value of the company:

> *"My previous employer had water that was at about a tenth of its value on the books. That just suggests that the accounting standards are back to front."* (Investor)

By accounting for water at fair value (AASB, 2019a), financial investors have stronger balance sheets, which is advantageous when trying to attract investor interest and credit opportunities. However, one banker respondent claimed that the balance sheet value of water has no bearing on credit decisions:

> *"Financial institutions take no notice of the value in the balance sheet when it comes to property, and that's why they do valuations on water. And at the end of the day, the bank manager and the customer know the true value of the asset."* (Banker)

One potential reason for this may be the difference between the market value of water as represented by comparative valuations versus the value of the water used by the business. All businesses will have differing marginal values of water (e.g. see Wheeler et al. (2014b) estimates for differing buy and sell water trade values for various irrigation industries). The "true value" the respondent refers to is likely the marginal value of water for a particular business, which can be different to the book value[18] and different to the current market value.

#### 4.2.4. Accounting framework summary

Financial water accounting practice in Australia broadly follows historical cost or fair value accounting practices set out by the AASB (AASB, 2019a, 2019b). However, as AASB standards only have to be used by "reporting entities", such as ASX200 listed or companies with significant external stakeholders, water accounting by smaller businesses is not impacted. This leads to a wide variety of water values being reported, without much transparency about assumptions or the accounting framework used. This is exasperated by the sometimes poor quality of water entitlement ownership data, misreporting the location and security of stakeholders' water entitlement ownership. Consequently, comparing different water asset portfolios is challenging at best. Historical cost accounting particularly has been criticised as obscuring real performance, providing largely irrelevant information, and leading to poorer business decision-making (Argilés Bosch et al., 2012; Barlev and Haddad, 2003). This resonates with the concern that smaller businesses are disadvantaged in accessing capital since an important part of their asset base, namely water entitlements, are often undervalued due to historical cost accounting and infrequent re-evaluation. Given the maturity of southern MDB water markets, fair value accounting for water assets is possibly more transparent, more reflective of economic realities, and arguably easier than historical cost accounting. More transparent water accounting frameworks, reflecting the current value of water, provide important information for stakeholders and may enable better water management. Transparency in accounting can also build trust in the water market system (Wheeler et al., 2017).

The MDB case points to important aspects for water valuation and accounting globally. Current water accounting initiatives on the business scale are not standardized, they focus mainly on physical water information and water use, but do not pay attention to water asset values (Burritt and Christ, 2017; Tingey-Holyoak, 2019). Future studies should pay more attention to financial water values and attempt to incorporate these values better into existing accounting frameworks. With water increasingly becoming a sought-after investment asset with increased non-landholder ownernership, plus being an important part of irrigators' assets, water accounting needs to adequately reflect the fair value of the asset, rather than its historic cost, or just the cost of provision and physical volumes. While some basin-scale water accounting frameworks envision financial water accounting conceptually, they provide little instruction on best practice water valuation methods. Clear standards and methodologies for both accounting and valuation

[18] However, due to accounting treatment under AASB138 (Intangible Assets) (AASB, 2019b), book value is impaired when water prices fall below the initial purchase price. Therefore, the current market value can only ever be equal or larger than the book value.

are necessary to enable transparent and comparable assessment of financial water asset value for diverse stakeholders. To underpin the hydrological integrity and financial water asset values, physical accounting considering net water consumption on a basin-scale (Grafton et al., 2018), and financial fair value accounting of water rights, reflecting current market values, are paramount. Transparent valuation of water resources should follow a standardised approach in regards to data cleaning, data sources considered and valuation methods employed. In addition, governance, regulation and corruption have been identified as important issues for water markets globally (O'Donnell and Garrick, 2019). Therefore, when water valuations concern government expenditure, we suggest that methods, data and assumptions used should be publicly available, rather than commercial in-confidence, to: 1) increase accountability; 2) demonstrate "value for money"; 3) discourage rent-seeking by vested interests; and 4) engender trust in government processes (Grafton and Williams, 2019; Wheeler et al., 2017). Furthermore, in situations where the government is perhaps classified as a "distressed buyer" to recover water, standard commercial valuation methodology might not be appropriate to discern the value of water rights.

## 5. Conclusion

This study used qualitative information from 63 interviews with water experts (banks, evaluators, EWHs, investors and water brokers) and case study quantitative information to highlight issues associated with 1) water entitlement valuation; and 2) water accounting frameworks.

The majority of respondents used relative valuation (namely current market value) to value water entitlements, as well as other methods such as purchase price and volume weighted average price. Bankers value water on a longer period of water market data (6–18 months), whereas evaluators largely rely on information within the last six months. Water register and water broker data were the most commonly used data sources. Issues associated with valuation include transparency and accuracy of water market data, larger versus smaller water parcels, transaction costs and fees, and "wet" versus "dry" trades. These are particularly impactful in thin water markets where data availability and quality are poor. We show that the use of different data and methods can have a meaningful impact on valuation values, as demonstrated in the Kia Ora Commonwealth's strategic purchase case study where the same water entitlement could have been valued anywhere between AUD$95-2745 per ML, and it is highly likely that the Commonwealth paid considerably more (up to 97 % more) than they should have due to evaluator discretion.

In the MDB, physical water accounting is limited by its focus on gross-extraction, rather than net consumption of water. Financial water accounting frameworks value water at historical cost (less impairment) or fair value. Bankers stated they applied extension rates between 50–60 % to water valuations, whereas rates between 60–70 % apply to agricultural land, for mortgage and security purposes. On the other hand, financial investors, owning water as part of a real asset investment portfolio, revalue assets monthly at current market prices. EWHs undertake yearly impairment testing, but do not revalue their portfolio, as they claim there is no active market for environmental water. The difference in accounting can lead to a material divergence in reported water portfolio values between stakeholders - making comparisons challenging. The predominant use of historical cost accounting by small businesses could disadvantage them in regards to access to capital.

These findings highlight that there are no clear standards for water valuation and financial water accounting and we illustrated this impact on water asset values. Physical water accounting does not report real availability of water resources as it is based on an assessment of gross-extractions. There is a need for proper water accounting across the whole Basin, accounting for return flows and all water consumed. The processes of financial water valuation and accounting are confusing and potentially obfuscating, enabling rent-seeking by various interests. As illustrated by a series of inquiries, a MDB Royal Commission, and considerable public interest in government water valuation of strategic environmental water purchases, there is a compelling need for transparent and open water management, valuation and financial water accounting. Greater transparency and a standardised water valuation method, clearly identifying assumptions made, would reinforce the development of water markets, both in the MDB and worldwide. Proper accounting practice is important to discharge organisations' responsibilities for water management and purchase against its stakeholders, contributing to greater trust in institutions and governance, which is a vital issue for all water market systems.

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A

**Table A1**
Glossary of key terms.

| *Term* | *Explanation* |
|---|---|
| "Dry" water entitlement sale | Transfer of a water entitlement without any water allocation or carry-over volume as part of the transaction. The price reported to the water register only refers to the water entitlement itself. |
| "Thin" market/ Illiquid market | A market with only a few sellers and buyers, and a limited number of transactions. Water markets are often thin due to hydrological constraints to trade (Tisdell, 2011) |
| "Wet" water entitlement sale | Transfer of a water entitlement which includes some volume of water allocation or carry-over. The price reported to the water register may contain the price of allocation (Deloitte, 2019). |
| Bona fide/non-anxious/genuine seller/buyer and reasonable terms/ ordinary circumstances and arm's length transaction | These expressions mean largely the same. A bona fide transaction is between willing but not anxious buyer/seller, who have a reasonable period to negotiate the transaction with the property reasonably exposed to the market (*Land Valuation Bill 2010* (QLD)). Forced transactions, e.g. from mortgagor default, or transactions between businesses under the same ownership are not bona fide or at arm's length. |
| 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) |
| Impairment of an intangible asset and impairment testing | If the market value of an intangible asset is lower than its book value, this gets accounted for as an impairment loss equalling the difference between the values. If the market value of an intangible asset is higher than the book value, no impairment or adjustment is made (AASB, 2019b). Intangible assets get tested for impairment annually, or when there is indication that the asset may be impaired |
| 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) |
| Overland flow entitlements | Allows water extraction only when there is a flood that goes over the banks of the rivers and brings water onto the properties where the entitlements are held (Grafton and Williams, 2019) |
| Supplementary water entitlement | Supplementary water, formerly known as off-allocation water, is surplus flow that cannot be captured, or 're-regulated', into storages. When storm events result in flows that cannot be captured in storages, and the water is not needed to meet current demands or commitments, then regulated rivers become unregulated for a period of time. Supplementary water entitlement holders can only pump water against these licences during these periods (DPIE, 2019) |
| Supplemented water entitlement | An entitlement to water from major infrastructure that is owned and operated by a Water Supply Provider. Supplemented entitlements have a higher reliability than unsupplemented entitlements (Hargraves et al., 2013) |
| 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) |
| Unsupplemented water entitlement | An entitlement to take water from higher level river flows (i.e. in excess of supplemented water allocation requirements) that is managed by the resource manager (Hargraves et al., 2013) |
| Water allocation | Also called temporary water, the seasonal allocation received by a given water entitlement (Cheesman and Wheeler, 2012) |
| 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) |
| Zero price trade | Trades submitted to the water register with a AUD$0 price. While there are legitimate instances of zero price trades (for example, the transfer of an entitlement between trading zones by the same owner), it seems common practice for sellers to deliberately misreport the price of trades as zero dollars (MDBA, 2019b) |

**Table A2**
Land and Water Entitlement Valuation Legislation.

| Act/Bill | State(s) and relevance for water entitlement valuation |
|---|---|
| *Land Valuation Bill 2010* | QLD: value of rural land is the unimproved value of the land in a "bona fide" transaction, water allocation (entitlement) value is part of the land value. |
| *Natural Resources Management Act 2004* | SA: amended in 2009 for unbundling of water from land, makes no provisions for water entitlement valuation, allows for a caveat to be put on a water entitlement, makes no provisions for forced water entitlement sales. |
| *Rates Act 2004* | ACT: value of rural land is the unimproved value of land in a transaction at "reasonable terms", no separate provision for water entitlements. |
| *Valuation of Land Act 1916* | NSW: value of rural land is the unimproved value from a transaction at "reasonable terms" by "bona fide" seller/buyer, value of water access licence (entitlement) included in land value (not used since unbundling), water access licence value assessed excluding allocation (not used since unbundling). |
| *Valuation of Land Act 1960* | VIC: value of rural land is value of sale by "genuine seller" in "ordinary circumstances" of comparable properties, valuation can include every information the valuer deems relevant to take into account. |
| *Valuation of Land Act 1971* | SA: value of rural land is the unimproved value realised by "reasonable" sale for comparable properties, no separate provision for water, land valuation necessary every five years. |
| *Water Act 1989* | VIC: introduced water trade, determines valuation of water shares (entitlement) needs to be done by a valuer, dictates the order of distributing the proceeds of a forced water share sale between the interest holders, determines the method to calculate and exit fee in an irrigation district, enables mortgages on water shares and defines the rights of the mortgagee. |
| *Water Act 2000* | QLD: mentions market value of water allocation (entitlement) for compensation purposes, makes no provisions for water allocation valuation, allows for a caveat to be put on water allocation, makes no provisions for forced water entitlement sales. |
| *Water Act 2007* | Commonwealth: unbundled water from land, mentions "market value" of water entitlements, method to determine change in "market value" subject to "regulations". |
| *Water Management Act 2000* | NSW: developed water access licences (entitlements), makes no provision for the valuation of water access licences, allows for a caveat to be put on an access licence, determines the order of distributing the proceeds of a forced water access licence sale between the interest holders. |
| *Water Resources Act 2007* | ACT: makes no provisions for water entitlement valuation or security interests in water entitlements. |

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