Water markets in New South Wales

Improving understanding of market fundamentals, development, and current status

A final report prepared for NSW Department of Primary Industries Water

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AITHER

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Glossary

Allocation assignment	The transfer of water between licence holder allocation accounts as a result of a trade agreement. The assignment becomes part of the receiver's current year allocation account water.
Annual water requirements (or demands)	Refers to the total volume of water required by irrigators or agricultural producers to meet a certain level of production in a given water year.
Available Water Determinations	The process by which water is made available for use and shared amongst water (AWD) users who hold a water access licence. It determines the volume of water that is to be added to an individuals licence allocation account.
Carryover	The volume of share component that may be reserved by a licence holder for use in the preceding year.
Catchment	The areas of land which collect rainfall and contribute to surface water (streams, rivers, wetlands) or groundwater. A catchment is a natural drainage area, bounded by sloping ground, hills or mountains, from which water flows to a low point.
Commonwealth water purchases	Commonwealth water purchases refer to water entitlements purchased by the Commonwealth Government under the *Restoring the Balance in the Murray-Darling Basin Program*, sometimes referred to as 'buyback'.
Dealings	A water dealing refers to a change that can be made to a licence, in particular, those arising from trading including the sale of all or part of an access licence or account water. May also include a change in location, licence category or consolidation/subdivision of licences.
Entitlement on issue	The total volume of Water Access Licences (entitlements) issued to holders of water in a water system at a specific point in time. This volume is determined through arrangements in the relevant Water Sharing Plan.
Individual daily extraction limit (IDEL)	The volume of water that may be extracted, by an individual access licence, from an unregulated river, on a daily basis from a particular flow class.
Intervalley Trade limit (IVT)	Trade of licence holder allocation account water, via allocation assignment, from one catchment to another catchment (or state).
Management zone	An area within the water source to which daily extraction limits are defined. Management zones are designated only where the water source to which the plan applies is divided into areas and daily extraction limits are defined for each area.
Production bore	A water bore that is used for the purpose of taking water from a groundwater water source
Regulated river	A river system where flow is controlled via one or more major human-made structures e.g. dams and weirs. Within a regulated river system licence holders can order water against a held entitlement.
Reliability	A measure of how frequently an entitlement holder is likely to receive 100 per cent of the water stipulated in a water access licence. The reliability of different entitlement types is based on modelling assumptions and history records.

Share Component	The volume on an access licence, usually expressed as a unit share. Available water determinations are made to unit shares.
Supplementary Water	Unregulated river flow available for extraction under a supplementary licence. Specific arrangements and definitions may vary between water systems.
Sustainable Diversion Limit (SDL)	The volume that can be sustainably extracted from a catchment, as determined by the Basin Plan.
Trading zone	A defined area within which trade between users can always occur, or can always occur subject to a few set conditions. Trade between trading zones are also possible, but are subject to conditions defined in the trading rules of a Water Sharing Plan.
Total daily extraction limit (TDEL)	The volume of water that may be extracted under access licences from an unregulated river on a daily basis from a particular flow class.
Unregulated river	A river system where flow is not controlled by releases from a dam or regulated via the use of weirs and gated structures.
Volume-weighted Average Price	The volume-weighted average price (VWAP) calculates the average price weighted by the volume traded at each price.
Water allocated to all entitlements	The total volume of water allocated by state governments to water entitlement holders during the water year (1 July to 30 June) – including water entitlements held by environmental water holders. Measured as an aggregate volume at the end of the water year (30 June).
Water allocated to Commonwealth water purchases	The total volume of water allocated by state governments to water entitlements held by the Commonwealth associated with the water purchases in the southern Murray-Darling Basin. Measured as an aggregate volume at the end of the water year (30 June).
Water allocation	The specific volume of water allocated to water allocation accounts in a given season defined according to rules established in the relevant water sharing plan.
Water availability	Refers to the total volume of water available to all water users in a given water year, which includes both water allocated to all entitlements and rainfall in growing regions.
Water entitlement	Water entitlements are ongoing rights to receive an annual share of available water resources in a consumptive pool as established in a specific river system, catchment, or aquifer. Entitlements are generally secure, tradeable, divisible and mortgageable in the same way as land. In NSW, water entitlements are known as Water Access Licences (WAL).
Water markets	Water markets are regulated markets where formalised transactions of water entitlements and allocations can occur between parties. There is no single national water market, but rather a number of individual (but in some cases connected) markets. Where hydrological connectivity exists, such as in the southern Murray-Darling Basin trade between these markets is possible.
Water price	The cleared and contracted transaction price reported of allocation and entitlement trades between parties. It does not account for fees or charges and is importantly distinct from urban water prices.
Water sharing plan	A water management plan that defines the rules for sharing of water within a region under the *Water Management Act 2000*.

Water year	Refers to the period between 1 July and 30 June of the following year. It is the same as a standard financial year.

Executive summary

Summary of key findings

- Water markets are a fundamentally important tool for irrigated agricultural producers in New South Wales and are an increasingly important tool for regional urban water suppliers, environmental water managers, and investors as well. They are critical to driving improvements in productivity and efficiency in the NSW economy.
- Trade is observed in all systems analysed in this report, with substantial levels in many systems. Trade has grown from modest levels in the mid-2000's, to over 100 gigalitres of entitlement trade and several hundred gigalitres of allocation trade during peaks in the early to mid-2010's.
- This growth was enabled by a range of reforms made by the New South Wales Government, including the introduction of Water Sharing Plans (WSPs). It is also driven by underlying demand for trade by willing buyers and sellers, and the benefits it provides to agriculture, communities, and the economy.
- Trade outcomes observed can be explained by the fundamentals of supply and demand, including water availability; and the scale, nature, and distribution of crop types – as well as trade rules and regulations, and hydrology. Water markets in NSW are working as we would expect.
- Water markets have enabled successful responses to climatic variability and drought, and facilitated the return of water to the environment:
    - Over the last 15 years, there have been two extreme wet periods and two extreme dry periods – water markets have been very successful in managing these extremes and will continue to help water users manage variability, including minimising the impacts of drought.
    - Between 2008 and 2013 entitlements were purchased for the environment, making significant progress towards targets in the Murray-Darling Basin Plan. Reduced water available for irrigation has further reinforced the importance of water markets in dealing with this change.
    - There is an ongoing need for adjustment in irrigated agriculture to adapt to changing conditions. Water markets are not the cause of this adjustment, but help to ensure it happens in a more orderly and manageable way, providing important options and opportunities for all.
- There is a need to further improve the water market in New South Wales to keep pace with new and changing demands. During development of this report, the authors and stakeholders identified various policy and implementation issues, including in information provision; education; data; assessments and approvals; groundwater trade; trade rules and unregulated trade.
- Improvements in these areas can improve productivity and efficiency in the NSW economy and help ensure the resilience and sustainability of the irrigation sector and regional communities. We understand that the NSW Government is embarking on a program of work to address specific opportunities for improvement and realise associated benefits in the near future. We support this work being undertaken and encourage stakeholders to engage constructively with it.

Background, purpose, and scope

Water markets help to ensure the efficient allocation of scarce water resources. Water users benefit from markets, not least because water trade provides flexibility to adapt to changing conditions, providing a critical tool for managing water supply, production, and risk.

The purpose of this report is to improve understanding of water markets in New South Wales (NSW). This includes explaining how markets work, documenting their development and growth over time, and highlighting what drives market activity and results. The report does this by describing the underlying factors that drive water trade, including key supply and demand factors, as well as supporting characteristics and enabling mechanisms.

The report includes detailed analysis of surface and groundwater systems in different regions across New South Wales (see Appendix A)[1] which is used as the basis for providing observations at an aggregate level, including for the southern Murray-Darling Basin (southern MDB), northern Murray-Darling Basin (northern MDB), and coastal and unregulated systems. It explains the various factors that drive differences observed in water market activity and valuations across different water systems and product types.

In NSW, water markets are now heavily relied upon by an increasingly broad range of water users and market participants. In turn, the use of water markets provides beneficial outcomes for the NSW economy, including contributing to improvements in productivity. They have assisted greatly in managing the impacts of drought by reallocating water based on the needs of users and assisted in enabling growth in new industries by providing access to water.

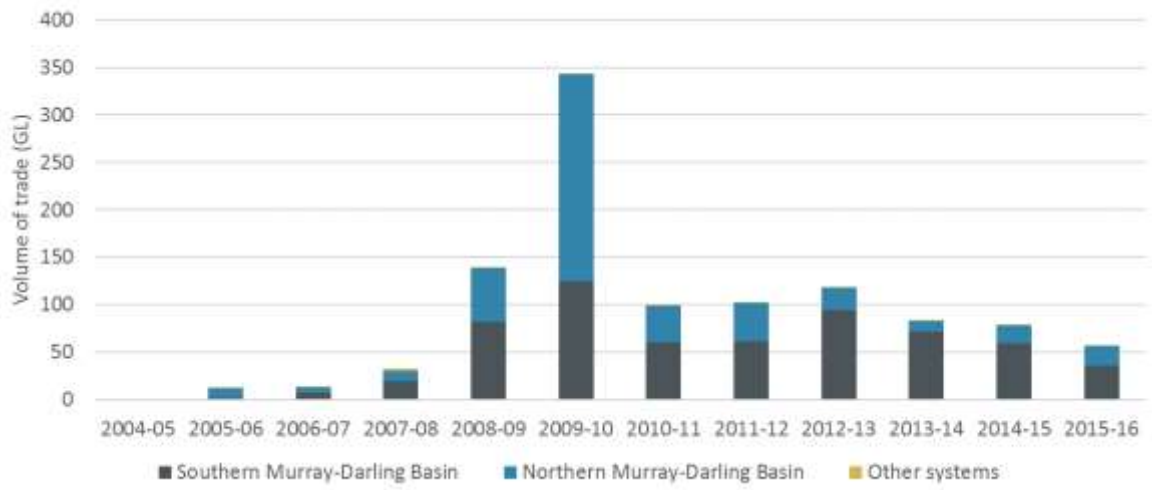
Water market information helps to ensure markets are working as intended, including by providing current or potential participants with the confidence and tools required to participate in the market. Sound market information reduces transaction costs and helps to drive participation, which is beneficial for all water users, and for the economy more broadly.

Market development and reform

In NSW, water markets today are the result of a range of reforms implemented over the past two decades. While informal trade was possible and observed earlier, markets have grown substantially since the introduction of the NSW *Water Management Act* (the Act) in 2000. The Act provided a more sustainable and efficient approach to water management, including the framework and supporting requirements for trade.

This included the development of WSPs. These are a key enabler of water trade, helping establish the arrangements to ensure trade can occur in an efficient manner while protecting the environment and avoiding third party impacts from trade. As is shown in the data in this report, substantive trade in most systems was only observed after the introduction of WSPs, which have been progressively implemented across NSW since the introduction of the Act. Different water systems have had their WSPs implemented at different times, but as Figure ES1 shows, trade has grown substantially in aggregate since 2004.

[1] Due to scope constraints, it was not possible to analyse all water systems in New South Wales. Section 1 further explains the rationale for the inclusion of the systems analysed.



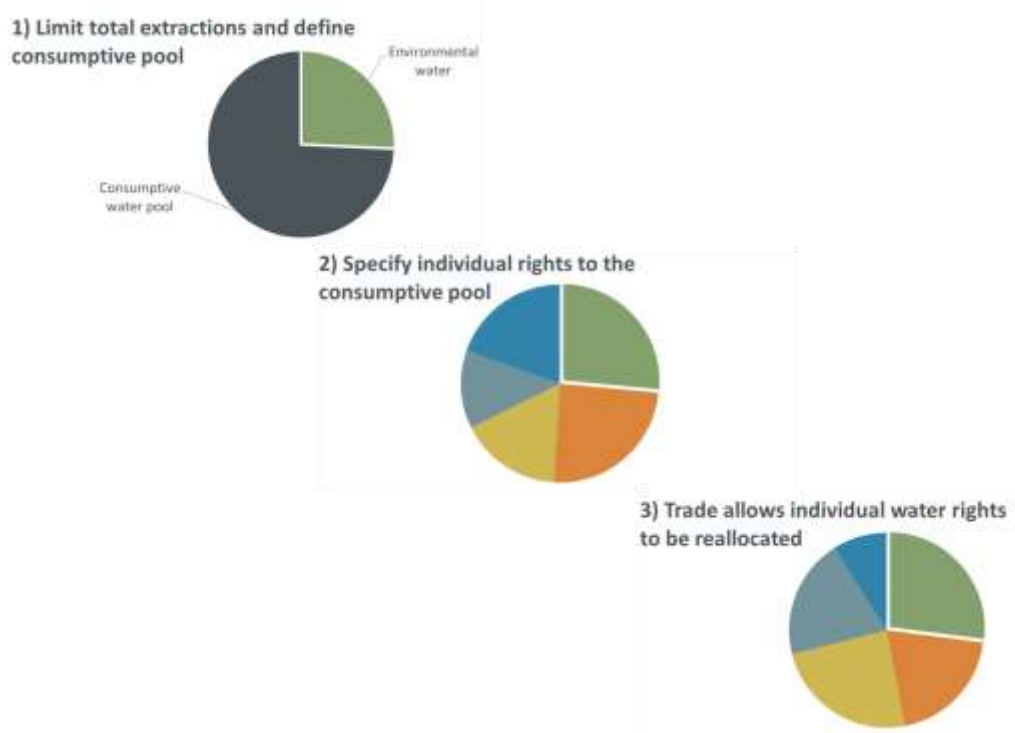
Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Excludes entitlement trades in water systems that are outside of the project scope. Also excludes trades with $0 and outlier prices.

Figure ES1 General Security entitlement trade volumes for major New South Wales surface water zones, 2004–05 to 2015–16

Market fundamentals

Water markets reflect a cap and trade approach. In simple terms, the amount of water required to be set aside for the environment is determined through the water planning process, along with water available for consumptive use. Once the total water available for consumptive use is limited, water trade allows for the reallocation of water between uses and users across space and time.



Source: Aither.

Figure ES2 Cap and trade and the consumptive pool

The right to access water from the consumptive pool is established by water entitlements (these are held as part of 'water access licences' or 'WALs' in NSW). These rights exist in perpetuity and can be traded, depending on the needs and circumstances of different water users and others.

Water allocation is the volume of water allocated to entitlements during the water year, which depends on total water availability. This is water available for use; analogous to a commodity and able to be extracted from water courses and applied as inputs to production. These water allocations are frequently traded amongst water users within and between years.

There are various types of entitlements with different characteristics, including the reliability with which they receive water allocations. This translates to their different value to water users. A range of different types of dealings are possible in NSW related to the trade of both entitlements and allocations.

Features that support trade

Various features result in conditions conducive to water trade. These include the scarcity of available water; variability in water within and across years and regions; connectivity of different water systems; number and type of water users or market participants; whether water demand is increasing, and; if there is pressure for change within industries. Some of these features are threshold requirements for markets and help explain why different trade activity is observed in different locations across New South Wales.

Factors explaining observed differences

Differences in trade results and valuations observed across NSW can generally be explained by supply and demand factors, as well as the characteristics of different products and regions. These include:

- The amount of water rights available (entitlement on issue) in different systems
- Water availability within and between years – i.e. actual amounts of water allocated to entitlements
- The reliability of different entitlement classes, such as General and High Security
- The nature and extent of different crop types within and between regions
- The availability of and reliance on groundwater
- Connectivity of different water systems with one another, and market depth (number of potential participants)
- Trade rules, such as those that enable or prohibit trade within or between systems
- The nature of infrastructure in different systems.

Observed activity and drivers

The water systems analysed in this report have been aggregated into southern MDB (MDB), northern MDB, and other areas. This aggregation is largely spatial, but also reflects differences in market development and size between the different water systems. Water markets in the southern system are larger and more developed, northern system markets are less connected and smaller in size but some are well developed, and in other areas (or system types, such as unregulated) markets may be less developed. The latter results from a variety of factors, some of which may be outside the control of government and present no particular concern – for example, some regions do not exhibit the features required to drive trade, and there is no 'correct' amount of trade.

Southern Murray-Darling Basin

The southern MDB systems considered in this report include the Murray, Murrumbidgee, and Lower Murray-Darling. These systems can generally be considered as having well developed and highly active markets for both water entitlements and allocations.[2]

Entitlement markets are well developed in these systems, with substantial volumes of surface water trade occurring for a range of product types (refer Figure ES3). Trade levels were modest early in the study period (from 2004–05), following the introduction of WSPs, but increased significantly from 2006–07 to 2009–10. There is frequently a greater volume of General Security entitlement trade than High Security, and volumes traded in the Lower Darling are consistently more modest than in the Murray and Murrumbidgee. Groundwater entitlement markets are also active but with much smaller volumes of trade.

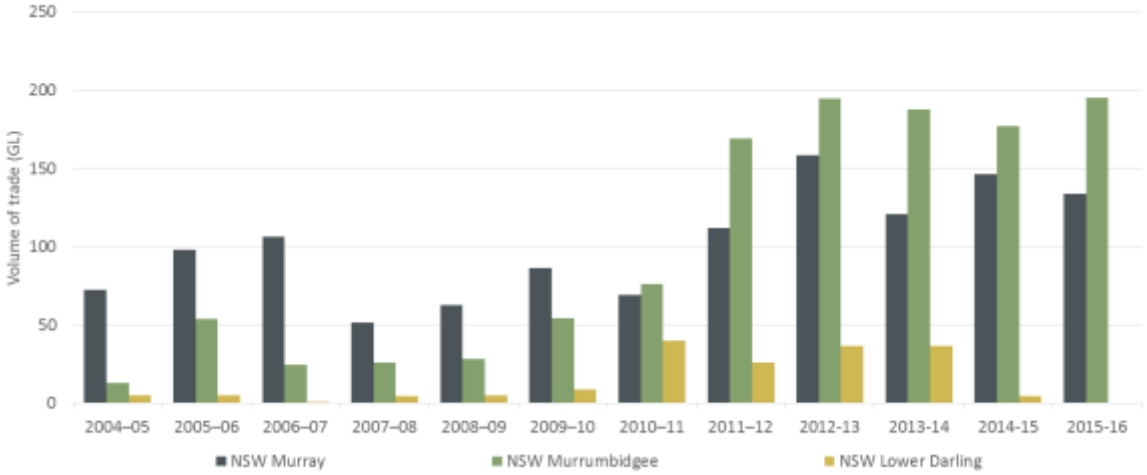
Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Only includes 71Q trades. All $0 trades are removed in calculating both volumes and prices.

Figure ES3 Southern Murray-Darling Basin surface water entitlement trade volumes, 2004–05 to 2015-16

Surface water allocation markets are also well developed (refer Figure ES4). Trade has occurred consistently throughout the study period, increasing from 2004–05 to 2006–07, then at lower levels in 2007–08 to 2010–11, before increasing again from 2011–12 through 2015–16. Groundwater allocation trade is also active, beginning in 2006-–07 and increasing to 2009–10 before dropping sharply in 2010–11 and then trending upward to 2015–16. The Lower Murrumbidgee Deep Groundwater source consistently trades greater volumes than the other southern MDB groundwater systems considered.

[2] Less so in the Lower-Darling which is often not connected to the other systems for the purposes of trade.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Total volume of trade in a zone is defined as all trades within that zone, plus all trades into that zone, but excluding trades out of the zone (to avoid double counting). Trade within irrigation corporations is not included.

Figure ES4 Southern Murray-Darling Basin surface water allocation trade volumes, 2004–05 to 2015–16

Some of the reasons that greater volumes of trade and more active and deep markets are observed in the southern MDB include these systems having:

- Substantially greater volumes of water available for productive use than other systems
  - The southern MDB systems considered here have more total water available for use than all the other systems combined
- Greater numbers of water users, and larger or more intensive irrigation industries
  - the southern MDB systems have many times the numbers of licensees than other systems, and the gross value of irrigated agricultural production is much larger
- A range of diverse crop types, spread across geographic regions, with variability in water demand
  - almost all the possible irrigated crops are evident in different locations within the southern MDB, including rice, pasture, fruit trees, nuts, wine grapes, citrus, other cereals, and now cotton
- Variability in water supply including in crop rainfall, given the geographic spread
  - the southern MDB covers a very large area east to west which can result in differences in rainfall
- Connectivity for trade between systems both in NSW and interstate (Victoria and South Australia)
  - Murray, Murrumbidgee, and Lower-Darling water users can trade with one another, to many Victorian systems that are tributaries to the Murray River, and also with South Australian Murray water users, subject to various constraints

These factors contribute to both the significant opportunity and strong demand for trade in entitlements and allocations and drive the larger market size and trade levels observed.

The main determinants of entitlement prices in the southern MDB are the reliability of the different entitlement classes and the willingness of different irrigation industries to pay to secure medium-to-long-term water supply. Changes in the type and extent of crop types planted, as well as downstream

processing, has had an influence on entitlement prices in recent years, as has the entry and exit of governments purchasing water for the environment and broader economic conditions.

Allocation prices are largely driven by inter and intra-year water availability – mainly allocations to entitlements, but also in-crop rainfall, carryover, and water held in storages. Allocation prices in the southern MDB generally equalise across a wide geographic area because water systems are connected and it is possible to trade allocation water across the system.[3]

Overall, water markets in the southern MDB are performing as would be expected given observed trends in supply and demand factors that drive water market activity. Further gains from market development in this region are likely to result from efficiency gains at the margins, including around improving transaction speed and costs, market information, trade rule refinement, and groundwater trade enhancements, rather than wholesale changes.

Northern Murray-Darling Basin

The systems considered in this report grouped as northern MDB include the Lachlan, Macquarie, Namoi, Peel, Gwydir, and Border-Rivers.[4] These systems can vary in the extent of their development and how active water markets are in each. Overall, they do not exhibit the same extent of trade as southern MDB systems.

By volume, the most active surface water entitlement markets are in the Gwydir, Lachlan and Macquarie (refer Figure ES5). General Security products are traded more than High Security. The most trade occurred in 2009–10, but trade has been observed since 2005–06. Compared to southern MDB systems there is less trade by volume, with most products trading at less than 10,000 ML per annum, compared to southern MDB where certain products trade between 40,000 and 50,000 ML per annum. Groundwater entitlement markets are also active, with the Lachlan dominating by volume.

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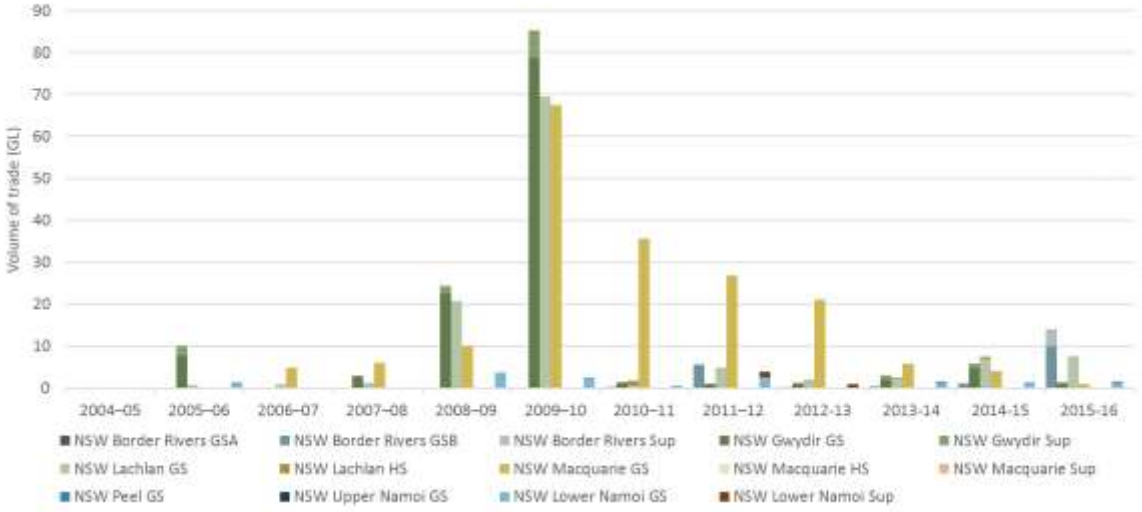
[3] In some instances, this equalisation does not occur when particular trade rules, such as the as the Murrumbidgee IVT, are binding.

[4] The Barwon-Darling is considered as part of other systems given it is an unregulated system.

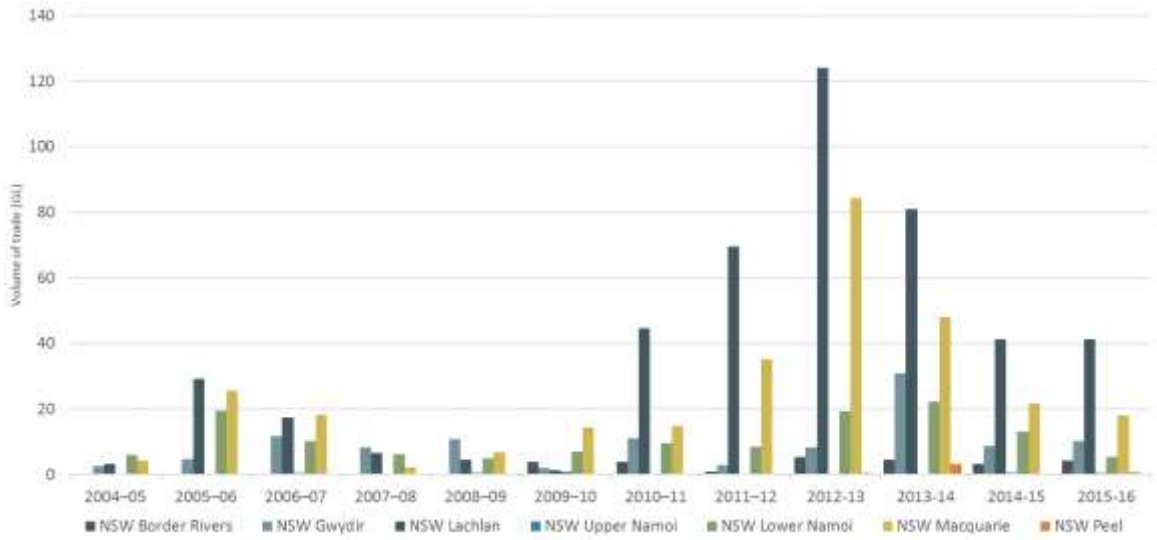


Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Only includes 71Q trades. All $0 trades are removed in calculating both volumes and prices.

Figure ES5 Northern Murray-Darling Basin surface water entitlement trade volumes, 2004–05 to 2015–16

Surface water allocation markets are well developed in the northern systems (refer Figure ES6). Trade has been observed since 2004–05, with significant volumes in 2005-06, before declining through to 2009-–10. Allocation trade volumes increased substantially to peaks in 2012–13, before declining to 2015–16. By volume, the Macquarie and Lachlan have tended to experience the most trade. Similar to entitlement markets, northern systems experience smaller volumes of allocation trade than southern systems. Groundwater allocation markets are active, with trade observed since 2006–07. Trade levels were at their lowest in 2011–12 but increased to among the highest overall levels in 2015–16. The Lachlan has tended to display the greatest volume of groundwater allocation trade.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Total volume of trade in a zone is defined as all trades within that zone, plus all trades into that zone, but excluding trades out of the zone (to avoid double counting).

Figure ES6 Northern Murray-Darling Basin surface water allocation trade volumes, 2004–05 to 2015–16

Drivers of these outcomes include that:

- There are lower volumes of water available for productive use than southern systems, and there is variability of water available amongst the different systems
  - The Murrumbidgee has 1,833,631 ML of surface water on issue, whereas the Peel has 29,975 ML, the Namoi has 250,716 ML, and the Lachlan has 493,325 ML
- Northern systems are isolated from one another for the purposes of trade (i.e. not connected)
  - No trade is possible between the northern systems considered here, and no trade is possible between the northern and southern systems
- There tend to be fewer water users, and they have similar water demands
  - The southern MDB is estimated to have had nearly 4,000 separate access licences involved in allocation trade from 2004–05 to 2015–16. This is estimated to have been 144 in the Peel, 187 in the Gwydir, 393 in the Namoi, and 689 in the Macquarie over the same period.

These factors mean that the opportunity for, and demand for trade, can vary substantially amongst the different northern water systems. The overall lower volume of water available for productive use and the fact that systems are not connected are the key determinants of there being lower volumes of trade than southern systems.

Entitlement prices in the northern MDB are driven by the same fundamentals as southern systems – that is their reliability, and the willingness to pay of different irrigation industries. Importantly, there are different industries, or combinations of industries amongst the northern systems, which can influence differences observed in prices for similar types of entitlement. For example, some northern systems are dominated by a single high-value crop that requires High Security of water supply which may sustain higher entitlement prices in that system.

Allocation prices in the north also respond to inter and intra-year water availability, as in the south. However, because systems are hydrologically isolated from one another, and they experience differences in water availability, allocation prices can differ substantially between systems. Some northern systems also have differences in their storage capacity, which can also influence prices.

While water markets in the north experience lower volumes of trade, their intensity of trade may not be substantially less than southern systems (i.e. the amount of available entitlement or allocation that is traded). As a result, they are not necessarily less 'developed.' Importantly, the lower volumes may also be more a function of the fundamentals of these systems,[5] rather than suggesting policy or market failures. That said, groundwater tends to form a more major part of irrigated agriculture in some northern systems, and there is evidence to suggest that groundwater markets could operate more effectively and efficiently.

Coastal and unregulated systems

The systems considered under this grouping were the Barwon-Darling (unregulated) and the Hunter, which are not similar but are distinct from the southern and northern systems (the Hunter because it is coastal, and Barwon-Darling because it is unregulated). Trade has only been possible in the Barwon-Darling since 2012, while trade has been possible in the Hunter for a longer period (in both cases this is driven by when the relevant water sharing plans were implemented).

For entitlement trade, relatively greater volumes were observed in the Hunter in 2005–06 and 2006–08, with particularly low volumes in 2013–14 and 2015–16. In the Barwon-Darling, there was a

[5] Such as connectivity, number of potential users or participants, homogenous versus heterogeneous demand, and any pressures for change within industries.

substantial volume traded in 2015–16 with a much smaller amount traded in 2014–15. In the Barwon-Darling, unregulated class B has had most of the trade volume. In the Hunter, there has been a mix of General and High Security water traded, but very little High Security water has traded since 2010–11. Trade volumes are modest compared to MDB systems.

For allocation trade, this mostly occurred in 2004–05 to 2006–07 and 2012–13 to 2014–15 in the Hunter. Peak years in the Barwon-Darling were in 2012–13 and 2015–16. Trade volumes in the Hunter are modest compared to MDB systems, but the Barwon-Darling volumes are somewhat comparable.

Some observations about the different results observed in these systems include that:

- The Hunter is a substantially different catchment in terms of its water available for productive use, nature and diversity of water uses, and its climate and water availability
  - It has a modest volume of water available for productive use compared to many MDB systems (around 150,284 ML compared to the Murray's 1,385,468 ML[6])
  - It has fewer industries in it than many other systems and has unique demand characteristics driven by the presence of mining industries, which have a very high willingness to pay for water and require high reliability and security of supply
  - Its climate has not followed the same drought, flood, drying sequence as many MDB catchments over the past decade, but trade observed does appear to respond to observed changes in supply and demand fundamentals
- Unregulated systems are substantially different to regulated systems in terms of the product characteristics, and the ways in which water can be stored
  - In the Barwon-Darling there is no shared infrastructure to store and subsequently order water from, and licences are based on pumping rules and river height restrictions. Water users tend to have very large on-farm storages which can be used to store water for individual use
  - Licences may permit more water to be taken than can be stored in on-farm storages, which is likely to influence demand for allocation trade and trade patterns
- The Barwon-Darling also has a much smaller number of water users, most of which have very large individual water holdings
  - This reduces the number of counterparties for trades, which may lead to more infrequent trade, but the much greater size of the holdings can mean individual trades are for very large volumes.

On face value, these markets appear to be working as would be expected. The Hunter appears to respond to the different supply and demand characteristics that the catchment exhibits (relative to MDB systems). Similarly, the infrequent and large volume trades in the Barwon-Darling reflect its unique physical and licencing characteristics. Unregulated trade is relatively new, and there may be room for improvement in or further development of unregulated markets, but this needs to be balanced with demand for unregulated trade, which could be lower than for other systems and product types due to the differences in the underlying characteristics required to support trade.

Opportunities for the future

As a result of government reforms – such as the NSW *Water Management Act 2000* and the introduction of WSPs – and the underlying demand for and benefits of trade, water markets are

[6] Both figures only include high and General Security surface water.

operating across large parts of NSW and delivering benefits to the farming and irrigation sectors, regional communities, and the economy. As an exchange between willing buyers and sellers, the trade results reflected in this report provide evidence of market participants' recognition of the gains from trade, in northern, southern and coastal systems.

While this is the case, there is room for improvement. As part of the development of this report, the authors and stakeholders identified a range of issues associated with development, implementation, and operation of water markets in New South Wales. These relate to refining and improving existing markets, as well as facilitating the development of emerging markets. Addressing these could bring important productivity and other benefits to the agriculture sector and the NSW economy.

Areas for consideration identified and separately reported on to the NSW Government include:

- Information provision, such as the accessibility of water availability and water trade related information, especially how information is presented and accessed on the DPI Website.
- Education, such as on the fundamentals of water trade, how to undertake a variety of trade related actions in NSW, on trade rules, and on topical issues of concern to market participants such as speculators or concentration of market power.
- Data issues, such as the quality and timeliness of price information, and the presence of related party transfers in reported data.
- Assessment and approvals processes, such as the need to clarify assessment criteria and processes, clarify embargoes, improve feedback to applicants, and reduce assessment times, particularly for Groundwater trade.
- Trade rules, including the potential need to refine the operation of certain rules, and improve information on key rules (including their rationale & operation).
- Unregulated trade, including investigating the demand for trade in areas where it is not possible or only emerging, and investigating the case for investing in new trading products or changes to rules or processes to facilitate trade.

The authors understand that NSW water authorities, including DPI Water, have a good understanding of these issues and are in the process of prioritising further market improvement and development efforts by looking at the incremental benefits and costs of specific actions in each of these areas.

1. Introduction

1.1. Project context

1.1.1. About this report

Purpose of this report

The purpose of this report is to improve understanding of water markets in New South Wales through the provision of relevant market information. The report aims to explain observed trade outcomes and activity, such as volumes and prices of trade, including over time and across different regions. It does this by exploring the underlying factors that drive market participants to trade water, including key supply and demand factors, as well as supporting characteristics and enabling mechanisms.

Report structure

The report is structured to start broad and move towards greater levels of detail. It does this by first explaining key concepts related to water markets, then providing an overview of observed trade across New South Wales, then exploring trade observations and underlying drivers at a more detailed level. Regional analysis is undertaken with respect to southern Murray-Darling Basin (MDB), northern MDB and coastal system aggregation, with selected individual water systems analysed and presented in appendices.

Report scope

The focus of this report is trade in entitlements and allocations. The data and analyses presented are contained to certain representative systems, rather than all systems, due to scope constraints. The timescale for analysis is also constrained, to align with available trade data. Reliable and complete trade data for all the systems included is only available from the 2004–05 water year onwards. For alignment, supporting data and analysis is generally presented over the same period, except in some cases where only a shorter time series is available.

1.1.2. Background and context

The NSW Government has a strategy to grow the State's primary industries sector for future generations and to ensure the industries within the sector are best-placed to capitalise on rising demand for agricultural products. The primary industries sector in New South Wales is estimated to contribute around $12 billion to the NSW economy, and is the foundation for rural and regional communities, directly providing 100,000 jobs.[7] It is estimated that in 2014–15 the gross value of irrigated agricultural production in NSW was over $3 billion.[8]

The NSW DPI Strategic Plan defines the department's purpose as being to *increase the capacity of primary industries and communities to drive economic growth across NSW.* One of the department's **strategic priorities** is to create a positive business environment, which is supported by a **goal** to

[7] NSW DPI Strategic Plan 2015-19.

[8] Australian Bureau of Statistics: *4610.0.55.008 - Gross Value of Irrigated Agricultural Production, 2014-15.*

support government decision-making for infrastructure, regulation, and priorities with information about economic opportunities and challenges. This in turn is supported by **outcomes** that include:

- Economic growth by ensuring sustainable use of and access to natural resources.
- Risks to community and industry confidence mitigated and managed.

DPI is managing a range of programs to deliver these outcomes, including in relation to the sustainable access to and use of water, and increasing the capacity of the agricultural sector to respond to risks and adapt to change. DPI Intends to measure its progress against the target of a 30 per cent growth in the value of NSW primary industries by 2020.

Water markets play a very important role in facilitating the contribution of the irrigated agricultural sector to NSW productive output. They have assisted greatly in managing the impacts of drought by reallocating water based on the needs of users and assisted in enabling growth in new industries by providing access to water. They support growth while mitigating risks, and facilitate adaption to changing circumstances. In this context, they will be critical to NSW achieving the types of goals it has set for agriculture in the state, including its 30 per cent growth target.

Providing information about water markets to current and potential market participants can assist greatly in improving the efficient and effective operation of markets. Improving both understanding of and confidence in markets can enhance participation, and therefore reallocation of water. This reallocation amongst different users and uses can help to take advantage of new opportunities and generate greater returns from water and lead to growth in the value of primary industries.

As a result, there is a strong case for improving the availability of market information, and an important role for DPI Water in this context, not only to deliver against key elements of its strategic plan but for NSW to capitalise on important economic opportunities and deliver improved outcomes

It is in this context that this report has been prepared.

1.2. Fundamentals of water markets and trade

1.2.1. Fundamentals of a market-based approach

Water planning and cap and trade

Water planning

Water planning is a process for determining how water is allocated at the highest level, including between water users, and the environment. It is intended to be a participatory process used by governments and communities to make water management and allocation decisions, including regarding trade-offs. Water plans sit within broader systems of management, including regulations and market structures that also guide water use.

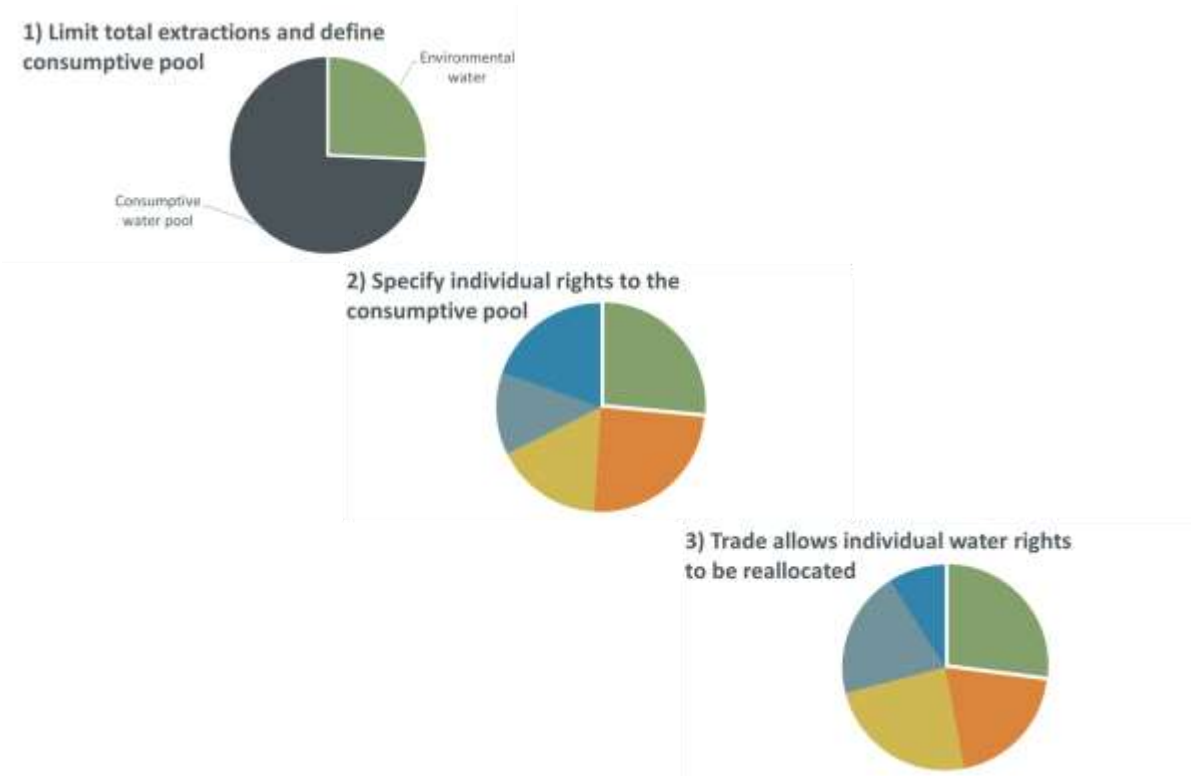
In New South Wales, Water Sharing Plans (WSPs) are the main water planning mechanism, and are enabled under water management legislation.[9] They set aside certain volumes of water for critical human needs and stock and domestic uses, for the environment, and establish the volume of water available for productive or other consumptive uses. They enable the use of entitlements owned by various users, and they also contain various rules about how water is managed, as well as rules governing water trade within and between water sources.

[9] As part of national water reforms, NSW (along with other states) is in the process of moving towards Water Resource Plans, of which Water Sharing Plans are only one subcomponent.

Cap and trade approach

Water markets are based on the concept of a 'cap and trade' system. A cap is established that limits the total extraction of water, with water inside the cap often called the 'consumptive pool.' The cap defines what water can be used for productive purposes (e.g. agriculture and industry), ensures some water is reserved for use by the environment (for the benefit of ecosystems and communities) and enables the scarcity value of water to be revealed. Having a cap in place indicates that the extractive limits of a system have been set (as determined in a water plan)[10] and is a key precursor to facilitating trade. The cap is an estimate of the total sustainable water use and is usually generated based on actual and modelled data over the long-term.

Because water availability varies from year to year, the cap needs to be defined in a way that reflects this – the total amount of water in the cap cannot be guaranteed to all the different water users in all years. Since the early 2000's, this has been achieved by defining shares to the water that is actually available within the cap from year to year (as reflected in the amount of rainfall and inflows that actually occurs in each year). In this way, governments do not attempt to guarantee the provision of water that cannot be made available.



Source: Aither.

Notes: The slices of the pie in the charts are not intended to represent the actual size of the allocations, which vary from system to system. It is important to note that environmental water exists both within and outside of the consumptive pool, and environmental water within the pool has the same priority as other holders of the same class of entitlement. The diagram is simplified for illustrative purposes.

Figure 1 Cap and trade and the consumptive pool

Entitlements and allocations

Rights to water in the cap is granted to users via entitlements. Water in the cap can be redistributed amongst water users by trading the entitlements, depending on their different needs and

[10] It is possible to firstly cap a system, recognising the total limits to extraction, and continue to issue entitlements or allocations up until that cap is reached. The cap denotes an upper limiting amount, or scarcity.

circumstances. Trade in entitlements allows water users to enter or exit without compromising the sustainable limits of the system and allows water to move between different uses or users in response to external factors.

The approach to sharing water in New South Wales follows a similar conceptual approach implemented in most water systems across Australia, including the use of entitlements and allocations, which are designed to manage the year to year variability in rainfall and inflows.

Entitlements – Water Access Licences

A water entitlement is a generic term for an ongoing right to receive a share of available water resources in a consumptive pool. An entitlement specifies a maximum annual volumetric share of available resources in a given catchment or water system, which the holder will receive as water allocations, depending on annual rainfall, inflows, water held in storage and other factors.

Entitlements are analogous to a land property right, are generally secure and mortgageable in the same way, and have substantial value. Each catchment typically has a small number of entitlement 'classes,' and generally all entitlements within a given class are homogenous. In New South Wales, the two major surface water classes are known as High Security (more reliable water) and General Security (less reliable water).

In New South Wales entitlements are known as **Water Access Licences**. Water access licences (WALs) entitle licence holders:

- to specified shares in the available water within a particular water management area or water source (the share component), and
- to take water at specified times, rates or circumstances from specified areas or locations (the extraction component).

WALs may be granted to access the available water governed by a water sharing plan under the *Water Management Act 2000.*

Source: DPI Water.

Allocations – Available water determinations

Water allocations are the volumes of water allocated to entitlement (WAL) holders during the water year (1 July to 30 June), which depend on water availability, and are not guaranteed. They are a physical good similar to a commodity, and are extracted from water courses and applied as inputs to production or the environment. Allocations are made periodically and cumulatively throughout the year, reflecting any improvements that occur to water availability (e.g. rainfall and runoff) Their value varies within and between years.

In New South Wales, a water allocation informs licensed water users of how much water they can extract in a season (along with specific rules associated with each entitlement type), and is a type of announcement known as an **Available Water Determination** (AWD). An AWD is given effect by a statutory water order. AWDs and their associated orders are issued on 1 July and periodically throughout the year.

Each order authorises WaterNSW to incrementally credit the accounts of licensed water users with the volume of water specified, and allows licensed users to then take that additional water in accordance with their account balance and license conditions.

Trade operation and mechanisms

Water markets are enabled and operated by government agencies, state-owned water utilities, and in some locations, private irrigation corporations. Governments or their delegated entities effectively operate the market, including by establishing the trade framework, and approving and processing trades subject to relevant rules and regulations. Governments also manage and maintain water registers which contain records of all trades and a variety of other information.

However, a range of third parties play a role in facilitating both entitlement or allocation trade, including in connecting buyers and sellers, negotiating prices, completing due diligence, handling documentation, registration and other transfer processes. These include water exchanges, brokers, conveyancers, real estate agents, and legal representatives.

In New South Wales, DPI Water makes Available Water Determinations and is responsible for setting trade and other water management rules (such as for conveyance and losses) through WSPs. As the main rural water ulility, WaterNSW processes allocation trades, while Land and Property Information complete entitlement (WAL) transfers and trades.

Accounting, metering and enforcement

To ensure confidence in water markets, and water management arrangements more broadly, water needs to be appropriately accounted for, and water use effectively metered. Limits on water use or compliance with other controls or regulations also need to be enforced.

In New South Wales, DPI Water is responsible for water resource accounting and reporting, including the provision of annual water accounting reports in accordance with Australian Water Accounting Standards. Metering is undertaken by WaterNSW, as are compliance activities that help water users understand their rights and obligations and how to comply with rules, monitoring, and investigations into breaches.

1.2.2. New South Wales products and dealings

New South Wales licence types and characteristics

There are a variety of different entitlement (licence) types on issue across New South Wales, many of which can be traded. One of the key defining characteristics of the different entitlements is their level of reliability (or in another sense, their priority). This level of reliability provides a broad indication of how frequently the entitlement holder is likely to receive all of the water the licence stipulates in a given year. Because entitlements define access to a *share* of available water resources in a given year, it is not guaranteed that the full amount of the entitlement will always be available. Levels of reliability mean that some entitlements are more likely than others to receive the full share.

There are generally two major classes mainly used for irrigation purposes – High Security, and General Security, but these are not the same products across different water systems (they are homogenous within a water system however). High Security is higher priority and therefore more reliable than General Security, but there are frequently more General Security licences on issue in most systems (by number and volume). Water access licences for town water supply and domestic and stock purposes have priority over other types of licences. Reliability is determined by WSPs, which provide detailed rules about the process for allocating the available water amongst the different licence types. The key general types of entitlements (licences) on issue include:

- Regulated river (High Security) access licence
- Regulated river (General Security) access licences
- Supplementary water access licences

- Regulated river (conveyance) access licences
- Aquifer access licences
- Major utility access licences
- Local water utility access licences
- Domestic and stock access licences

General Security and some High Security entitlements have access to uncontrolled flow, which is non-debit water accessible during supplementary flow events in periods of low allocations. Rules in water sharing plans, linked to allocation levels, define access to uncontrolled flow.

Floodplain harvesting licences are another important class of licence in certain areas of New South Wales. Floodplain harvesting is the capture and use of water flowing across a floodplain that is not covered by another extraction category such as an access licence, harvestable right or capture of irrigation runoff in tailwater return systems.[11]

Carryover

An important characteristic of different licence types is the ability to carryover water. Carryover is the volume of share component that may be reserved by a licence holder for use in the subsequent year. In practice, this generally means an entitlement holder may be able to store a portion of unused allocation water provided in one season, for use in the following season. Carryover rules and can differ substantially between different entitlement classes and water systems, including some having very generous provisions, and some having no provision at all. Similarly, some systems use an annual accounting system for carryover while others use a continuous system. Carryover is a very important management tool for many irrigators, including as it can mitigate water supply risk and 'smooth' water availability over seasons. Given this, it can also drive trade activity and decisions, including allocation trade from licence types that do not allow carryover, to those that do.

Types of dealings in New South Wales

The *Water Management Act 2000* and WSPs define what types of 'dealings' are possible. These are the primary enablers of what types of trade are possible. The Act establishes the dealings, and the WSPs provide more specifics about whether and which types of dealings are possible in different catchments. Not all types are always possible in all catchments. The major dealings include:

- Water licence transfer – change in ownership of the licence from one person another (71M)
- Assignment of share component – sale of all or part of the entitlement of the licence (71Q)
- Assignment of water allocations – sale or transfer of all or part of the water held in the licence holder's annual account under a trade agreement (71T)
- Term transfer of a water access licence – lease of a licence to another person for a period of time (71N)
- Change in location where a water access licence can be used – movement of the licence to another water source or part of the water source (71R and 71S)
- Conversion of a water licence from one category to another (i.e., from General Security to High Security) (71O)

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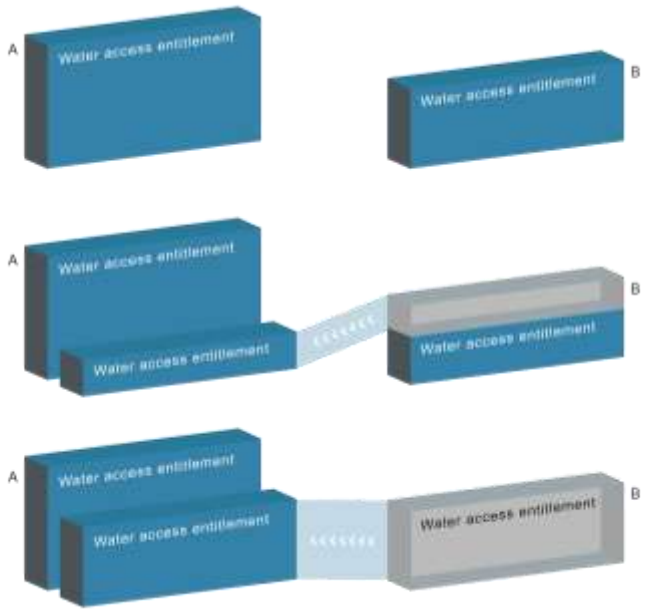
[11] The NSW Government has finalised the NSW Floodplain Harvesting Policy. The Floodplain Harvesting Policy will be applied state wide to bring floodplain harvesting activities into a statutory licencing and approvals framework under the *Water Management Act 2000.*

- Subdivision of a water access licence – division of the licence usually so a portion can be sold (71P)
- Consolidation of water access licences – amalgamation of licences (71P)
- The exit of a co-holder from a water access licence – allowing one of the holders of a licence to sell their co-holding (74).
- Interstate transfer of access licences – cancellation of access licences in one state for the purpose of granting a licence in another state (71U)
- Interstate assignment of allocations – sale of all or part of the water held in the licence holder's annual account to an interstate water source (71V)
- Nomination of water supply works – amendment of the licence for delivery of water from an alternative water supply work or group of works (71W)

The following two figures provide simplified illustrations of the two most common types of dealings in New South Wales (and in water markets in general) entitlement trade (71M and 71Q), and allocation trade (71T and 71V).



Source: Aither.

Notes: In this example, user A purchases part, or all, of user B's entitlement.

Figure 2 Simplified illustration of entitlement trade

Source: Aither.

Notes: In this example, user A purchases all of user B's current water allocation.

Figure 3 Simplified illustration of allocation trade

1.2.3. Uses, users, and drivers of markets

Water entitlement markets

The entitlement market enables the transfer of the ongoing right to receive water allocations, rather than the water allocations themselves. Entitlements can generally be held by any entity in any location, but water use is tied to site-specific regulatory controls, and intervalley or interstate entitlement trade depends on hydrologic connectivity and other factors. The nature of entitlements differs significantly between those catchments with large amounts of water storage infrastructure (called 'regulated' systems) and those without ('unregulated' systems).

The entitlement market is largely used by irrigated agricultural producers, but is increasingly used by investors, water utilities (including urban suppliers) and environmental water holders. These users use the market to modify their long-term arrangements for facilitating production or meeting environmental requirements or urban demand. Trade in entitlement is often driven by the need to manage the risk associated with securing supply and may also occur due to changes in business strategy or structure.

Key drivers of market outcomes

The value (and price) of water entitlements is largely determined by their reliability characteristics – e.g. are they High Security or General Security. High Security provides more water allocations over the long-term, and more consistently provide water allocations each year, and are always valued (and priced) higher than other types. This reflects the increased allocations and the premium certain industries place on this reliability.

Trade in entitlements is driven by longer term production decisions and the characteristics of different industries or users, including their risk tolerance. Producers expanding or contracting production drive market activity, as do investors, who may hold entitlements but facilitate other users' farming based on selling annual allocations.[12] Purchases of water on behalf of the environment have also driven market activity in recent years.

[12] Allocation trade is only possible between the same categories of licence unless otherwise specified within the relevant plan.

Water allocation markets

The allocation market enables transfer of physical water between parties for use, further trade, or carryover. Allocation trade can generally only occur between parties that are hydrologically connected such that water can be delivered between them (or substituted by other water from a shared storage).

The allocation market is mainly used by irrigated agricultural producers, and environmental water managers, but also investors. Producers use the market to sell water excess to requirements or buy additional water during dry periods or when temporarily expanding production. Environmental water holders may similarly buy or sell if they have water that cannot be delivered or used or they need additional water (although examples of these types of trades are more limited). In some cases environmental holders may trade to generate revenue to meet portfolio costs or for associated environmental purposes or projects. Another key (and much more common) reason that environmental water holders trade allocation water is to initiate delivery of water to environmental assets.[13] For example, the Commonwealth Environmental Water Holder (CEWH) may trade water to the NSW Office of Environment and Heritage (OEH) to deliver water on their behalf, or trade to consumptive users for delivery to an environmental asset via their works. Investors may trade for a variety of reasons, but frequently they manage entitlement portfolios and trade allocation water to farmers for use in production.

Key drivers of market outcomes

The amount of water allocated to entitlement (WAL) holders each year, as well as in-crop rainfall, are key drivers of allocation market outcomes (including prices and volumes traded). Allocations influence the total amount of water available for use or trade – when allocations are low, water is scarce, and prices are high, and the opposite is true when allocations are high.

Allocation levels reflect broader water availability, including rainfall and inflows in relevant catchments, and volumes held in storages. Allocations in surface water systems can also impact trade activity in groundwater markets – when allocations in surface water markets are high, activity in associated groundwater markets may be low. Similarity, groundwater markets may be more active when allocations in associated surface water markets are low. Other key drivers in allocation markets include conditions in markets for irrigated agricultural products and conditions in substitute input markets.

In both entitlement and allocation markets, policy decisions and announcements can also have impacts on trade, and in some cases, may drive trade. For example, certain restrictions that prevent trade may be lifted or enforced from time to time, which may incentivise trade activity. Entitlement characteristics and other policy decisions (such as changes to carryover for example) can also have a bearing on trade activity and outcomes.

1.3. A framework for explaining trade

To understand variations in the nature or extent of trade across New South Wales and over time, it is useful to consider some of the characteristics required to support trade, as well as prerequisites or enabling mechanisms. Together, these provide a framework to help explain what may be observed in trade data and statistics across different regions.

[13] In this sense it is more akin to a transfer as no money is involved – trade is simply used as delivery mechanism.

Characteristics required to support trade

There are a number of characteristics required to support trade. Such characteristics can have a bearing on whether trade is feasible (a threshold requirement), but also the need for or extent of demand for trade. These include (adapted from NWC 2011):

- **Scarcity** – Water systems need to be at or near full allocation. If water users are able to obtain more water through other means (e.g. issuing of new licences from government) then there is no cap on the available resource, and therefore no demand to trade.
- **Variability** – Variation in water availability within and between water years (seasons), as well as across different geographic areas, or over time, will contribute to the need for water users to trade with others.
- **Connectivity** – Water systems that are connected to others increase the amount of water users that can trade with one another, and can leverage increased differences in both water availability and demand, leading to greater opportunities for trade.
- **Sufficient users/participants** – As with many markets, greater numbers of users can contribute to increased liquidity, greater variation in demand, and therefore greater opportunities to trade.
- **Heterogeneous demands** – Where the demands of all users are the same (homogenous) there may be less demand for trade, as users are likely to have similar water requirements. Different industry types existing in the same area (or connected areas) mean more opportunities to trade as demand profiles can vary.
- **Increasing demand** – A net increase in demand over time, including driven by new investment or activity within water using industries (or new industries), will increase the demand for trade.
- **Pressure for change** – Where there is change in industries, including in response to external drivers such as structural shifts in global commodity markets, there can be increased need to trade as different entities enter, exit, or modify activities.

Scarcity and sufficient numbers of users are likely to represent threshold requirements for a market to exist, whereas most of the other characteristics will influence the extent of trade. Where all these characteristics are present, there is likely to be greater demand for trade than would otherwise be the case.

As will be discussed later in this report, the extent to which these characteristics exist varies across different water systems in New South Wales, and therefore help to explain why we may observe different trade outcomes.

2. New South Wales systems and trade activity

This section provides an overall summary of the water systems included in the analysis and presents a high-level summary of trade activity and outcomes at an aggregated level. This includes a summary of entitlements on issue, the key legislative underpinnings, and summaries of entitlement trade, allocation trade, and water recovery.

2.1. Systems overview

The project scope covers an examination of major New South Wales regulated surface and groundwater water systems. To aid the presentation of analysis and draw insights, we have classified the water systems within the scope of the project into three groups.

1. Southern Murray-Darling Basin
2. Northern Murray-Darling Basin
3. Coastal and unregulated systems

2.1.1. Southern Murray-Darling Basin

Water systems included in the southern MDB grouping are:

- New South Wales Murray Regulated River Water Source
- Lower Murray Groundwater Source
- Murrumbidgee Regulated River Water Source
- Lower Murrumbidgee Groundwater Sources (both deep and shallow)
- Lower Darling Regulated River Water Source

The southern MDB is characterised by the interconnected nature of the major surface water systems, which enable trade across different valleys and interstate, and contains a large proportion of NSW's irrigated agricultural activity. Groundwater also supports agriculture in this region, although not to the same extent as surface water.

2.1.2. Northern Murray-Darling Basin

Water systems included in the northern MDB grouping:

- Lachlan Regulated River Water Source
- Lower Lachlan Groundwater Source
- Macquarie and Cudgegong Regulated Rivers Water Source
- Lower Macquarie Groundwater Source (Zones 1 to 6)
- Upper Namoi and Lower Namoi Regulated River Water Sources

- Upper and Lower Namoi Groundwater Sources
- Peel Regulated River Water Source
- Gwydir Regulated River Water Source
- Lower Gwydir Groundwater Source
- Border Rivers Regulated River Water Source

The systems grouped as northern MDB are often more discrete than in the south because there is little or no connectivity between water systems. There tends to be more reliance on groundwater sources in these regions. There is a wide range of types of irrigated agricultural industries spread across these water systems.

2.1.3. Coastal systems and unregulated systems

Water systems included in this grouping are as follows:

- Hunter Regulated River Water Source
- Barwon-Darling Unregulated River Water Source

These systems do not share similar characteristics and are only grouped this way given they differ more markedly from the other systems (either in physical geography, or the nature of water management in the case of the unregulated system).

Inclusion of water systems in project scope

It was not possible to analyse all water systems in this report due to scope constraints. The rationale for choosing the systems for analysis included:

- Having broad coverage of the state
- Covering the different types of water systems and licence types
- Including some systems with relatively large or small amounts of trade
- Including most of the systems where the bulk of trade occurs
- Including most of the entitlement on issue across the state
- Including some systems with unique or different characteristics regarding markets and trade

Systems are included based on their WSP areas, primarily because these areas define the boundaries for water trade, and the WSP's themselves are the key enabling mechanisms for trade within and between water systems. Consistent with this, trade statistics and analyses are presented based on the different types of products that exist in the different WSP areas.

Table 1 illustrates the total volumes of entitlement on issue for the systems included in this report, grouped by southern MDB, northern MDB, and coastal. The majority of entitlement on issue across the state has been included in the analysis.

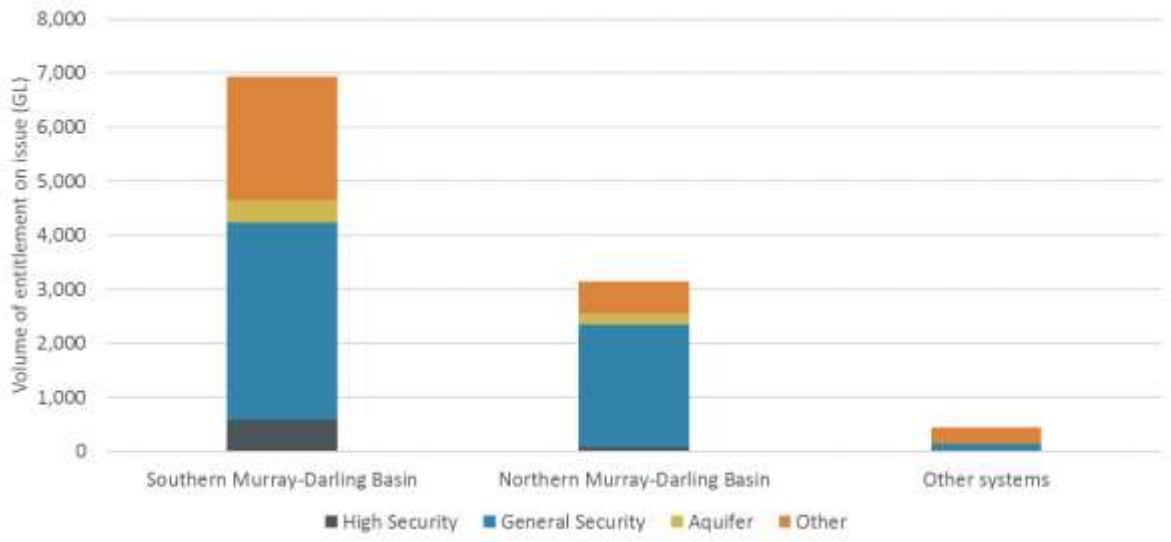
Table 1 Entitlement on issue comparison between water system groupings

Water system	Total entitlement on issue (GL)	Proportion of total entitlement on issue (%)
Surface water		
Southern MDB systems analysed	6,503.7	43.3
Northern MDB systems analysed	2,914.6	19.4
Coastal systems analysed (Hunter)	247.4	1.6
Unregulated systems analysed (Barwon-Darling)	196.5	1.3
All other systems (not analysed)[1]	*3,049*	20.3
Groundwater		
Southern MDB systems analysed	167.7	1.1
Northern MDB systems analysed	230	1.5
All other systems (not analysed)[2]	*1,712.4*	11.4
Total[3]	**15,021.3**	**100%**

Source: Aither 2016. Based on information sourced from ABARE and NWC.

Note: 1) The sum of all surface water systems outside the scope of this report. 2) The sum of all groundwater systems outside the scope of this report. 3) Items may not sum exactly due to rounding.

Figure 1 provides a graphical interpretation of the proportion of key entitlement types across the different system aggregations. This reinforces the concentration of available water in the southern MDB. It also shows there is a relatively small proportion of High Security water, and a relatively large proportion of General Security water, across the included systems.

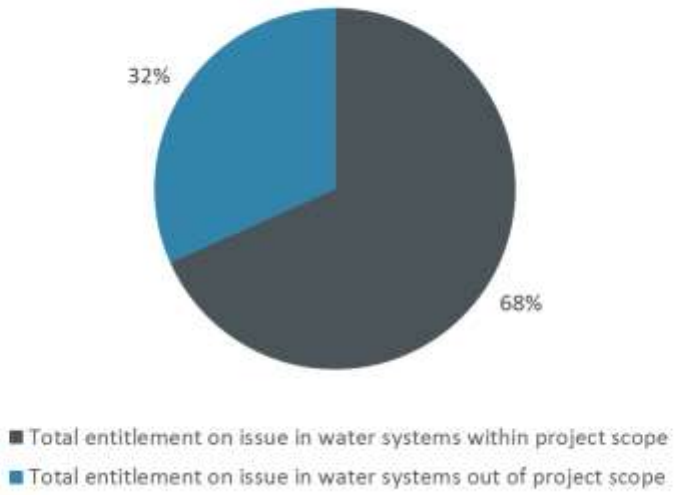


Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Please note that 'Other' includes both surface water and groundwater entitlement types. Excludes entitlement on issue in water systems that are outside of the project scope.

Figure 4 Entitlement on issue comparison between entitlement types and water system groupings

Figure 5 reinforces that the majority of water in New South Wales is in the water systems that are within the scope of the project.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Figure 5 Entitlement on issue comparison between water systems within and out of project scope

2.2. Policy and legislative arrangements

The current water management framework in New South Wales is enabled by the *Water Management Act 2000*. The Act was introduced to provide a more sustainable and efficient approach to water

management and included a completely new statutory framework for managing water based on ecologically sustainable development.

Before the introduction of the Act, New South Wales was at the limit of its available water resources. New licences could no longer be issued across most of NSW and a cap had been placed on total water extractions in the Murray-Darling Basin (MDB). These were important drivers of the need for water markets, and the Act was a key enabler of trade.

The Act enabled the separation of water licences from land, and introduced the widespread use of water sharing plans, which determine the share of water between users and the environment, and establish rules for trading within and between water sources. Since the introduction of the Act water sharing plans have been progressively implemented, and trade has increased substantially.

The state government legislative and regulatory arrangements also interact with Commonwealth arrangements, principally associated with the Commonwealth Water Act 2007. That Act covers interstate arrangements and agreements associated with the MDB, including for water planning, and water trading. The Murray-Darling Basin Authority has a role in overseeing trade rules in the MDB, including ensuring they are consistent with requirements of the Act.

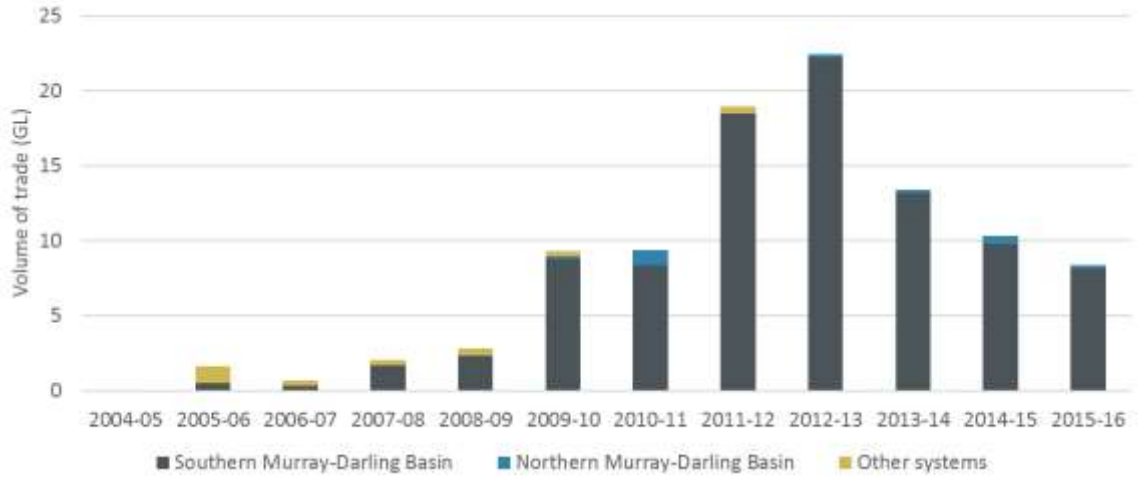
2.3. Entitlement trade summary

Trade in entitlements was substantially enhanced by the reforms that were introduced with the passage of the Act. The roll out of WSPs following the Act were a major contributor to the growth in entitlement trade that occurred after 2004–05.

2.3.1. Surface water

Figure 6 shows that there was substantial growth in trade in High Security surface water entitlements from 2005–06 to 2012–13 and that the clear majority of this trade has been in the southern MDB systems.

As is explored later in this report, some of the peaks in trade volume for these types of entitlements is likely to have been driven by efforts to recover water for the environment, which has generally not occurred through on market purchases since 2012–13.

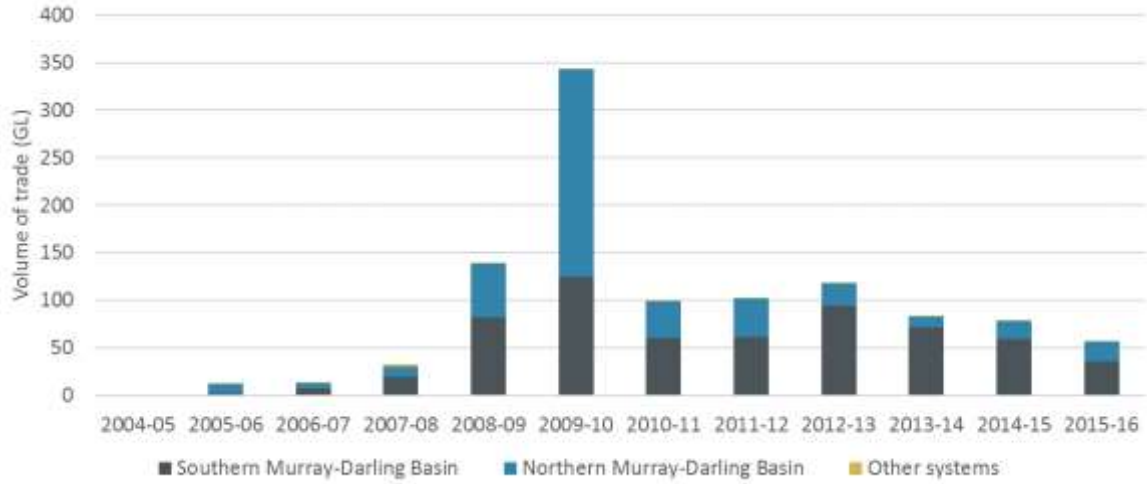


Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Excludes entitlement trades in water systems that are outside of the project scope. Also excludes trades with $0 and outlier prices.

Figure 6 High Security entitlement trade volumes for major New South Wales surface water zones, 2004–05 to 2015–16

Figure 7 also shows growth in trade for General Security entitlements from 2005–06 but with a peak in trade earlier, in 2009–10, and a more stable level of trade since 2010–11. It also shows that the total volume of General Security trade is more balanced across southern and northern systems and that the volume of trade in General Security is far greater than for High Security (compare scales for Figure 6 and Figure 7). Similar to High Security entitlements, the peaks in General Security entitlement trade (in terms of volume) are likely to have been driven by water recovery efforts and to a lesser extent, water availability.

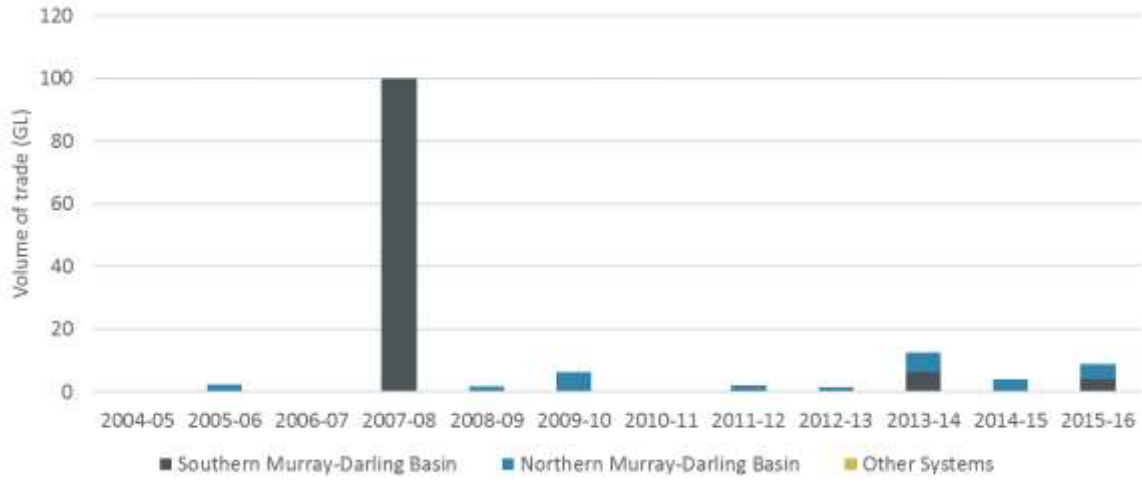


Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Excludes entitlement trades in water systems that are outside of the project scope. Also excludes trades with $0 and outlier prices.

Figure 7 General Security entitlement trade volumes for major New South Wales surface water zones, 2004–05 to 2015–16

The volume of trade in supplementary water has been variable from year to year but is generally very low (Figure 8). Supplementary water is traded in both northern and southern systems. The large volume in 2007–08 is likely explained by environmental water purchasing by the Commonwealth.



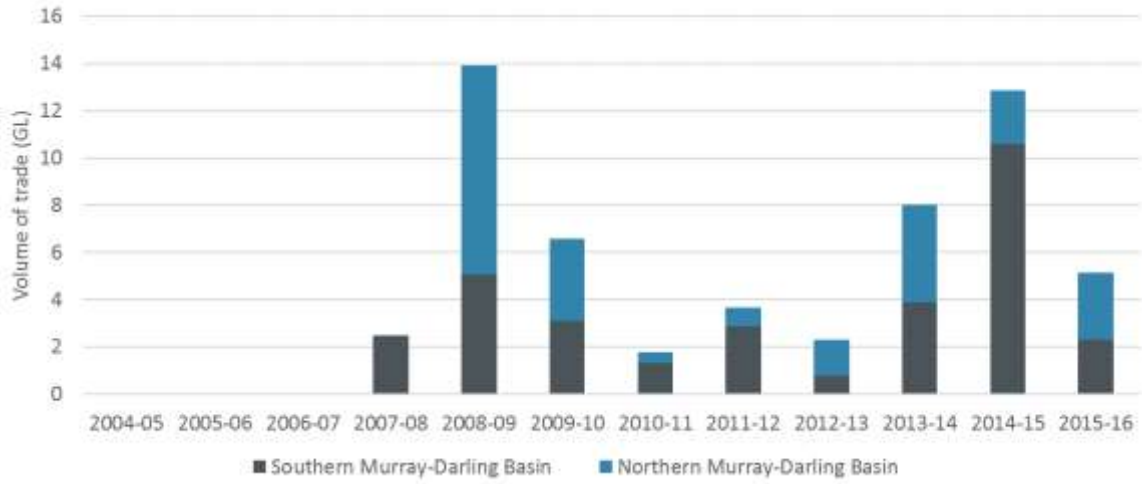
Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Excludes entitlement trades in water systems that are outside of the project scope. Also excludes trades with $0 and outlier prices.

Figure 8 Supplementary entitlement trade volumes for major New South Wales surface water zones, 2004–05 to 2015–16

2.3.2. Groundwater

There have been variable volumes of trade in groundwater entitlements over the period analysed (Figure 9). Trade has occurred in both northern and southern systems, but only began substantively in 2007–08. This fact is likely to have been driven by the timing of the introduction of water sharing plans for groundwater which enabled trade, some of which occurred later than surface water systems.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Excludes entitlement trades in water systems that are outside of the project scope. Also excludes trades with $0 and outlier prices.

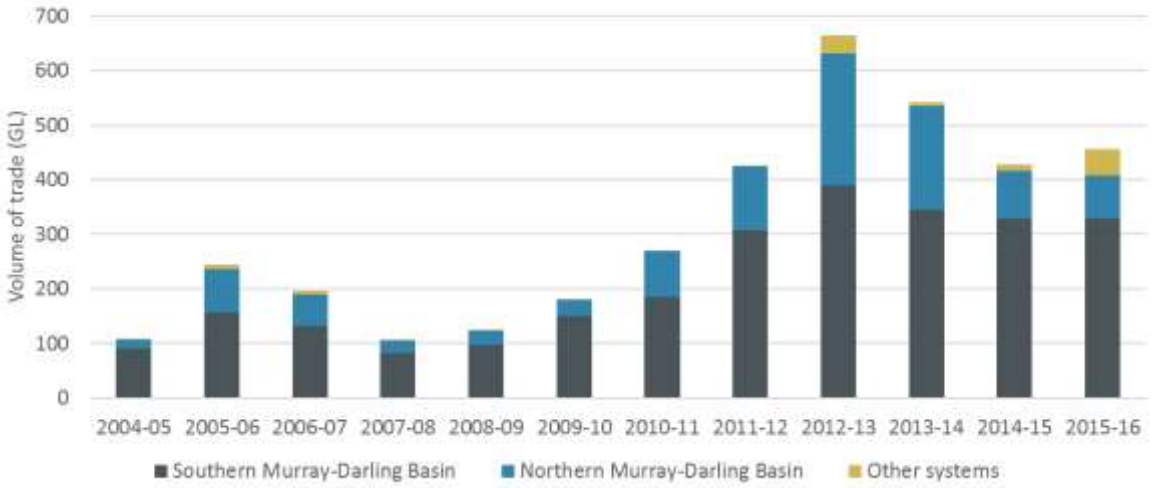
Figure 9 Aquifer entitlement trade volumes for major New South Wales groundwater zones, 2004–05 to 2015–16

2.4. Allocation trade summary

There have been large volumes of trade of allocation water in almost all years included in the analysis, with modest volumes initially in 2004–05, but consistently larger volumes thereafter.

2.4.1. Surface water

For regulated surface water, the most trade has occurred in 2012–13, 2013–14, and 2015–16, with over 450 GL traded in those years. By volume, the majority of trade tends to be in the southern MDB systems (Figure 10).



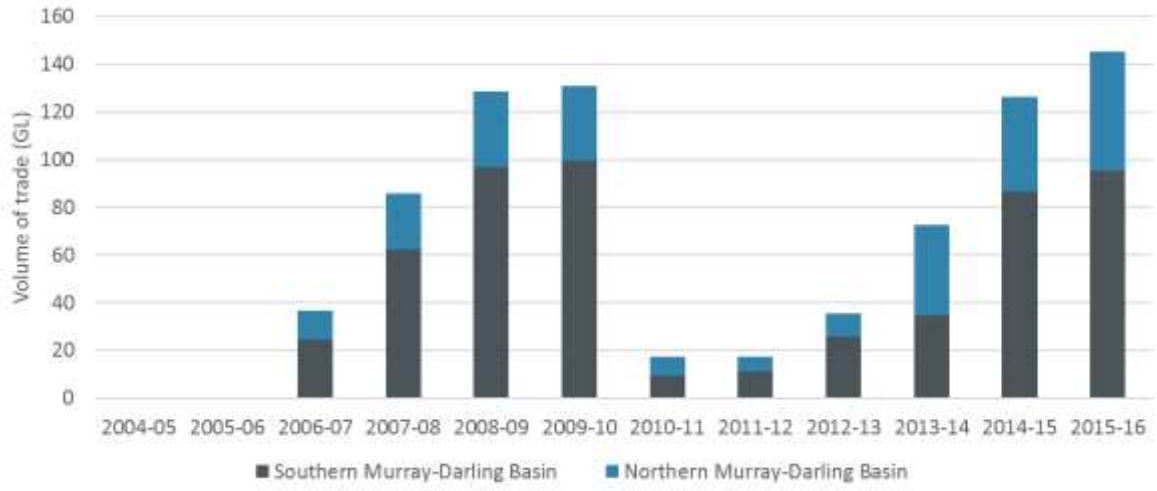
Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Includes all trades into and within zones, and excludes interstate trade. Excludes allocation trades in water systems that are outside of the project scope. Also excludes trades with $0 and outlier prices.

Figure 10 Allocation trade volumes for major New South Wales surface water zones, 2004–05 to 2015–16

2.4.2. Groundwater

Groundwater allocation trade volumes have tended to be more variable than surface water, but the southern MDB systems analysed have tended to show a greater volume of trade than the northern systems in many years. The lack of observed trade in 2004–05 and 2005–06 may be as a result of the timing of implementation of certain groundwater WSPs.



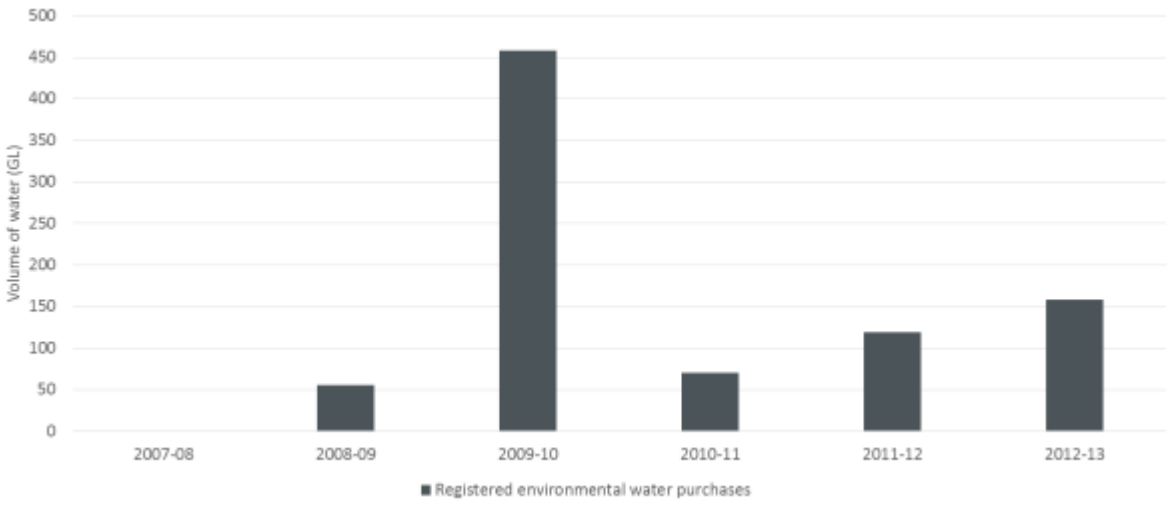
Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Excludes allocation trades in water systems that are outside of the project scope. Also excludes trades with $0 and outlier prices.

Figure 11 Allocation trade volumes for major New South Wales groundwater zones, 2004–05 to 2015–16

2.5. Water recovery

Water recovery for the environment was a key feature of entitlement market activity for several of the years during the study period. This was undertaken to address the past over-allocation of water in certain systems and was supported by major programs such as those run by the Commonwealth and state governments. Figure 12 shows that this purchasing activity appeared in registrations from 2008–09 to 2012–13, and peaked in 2009–10.

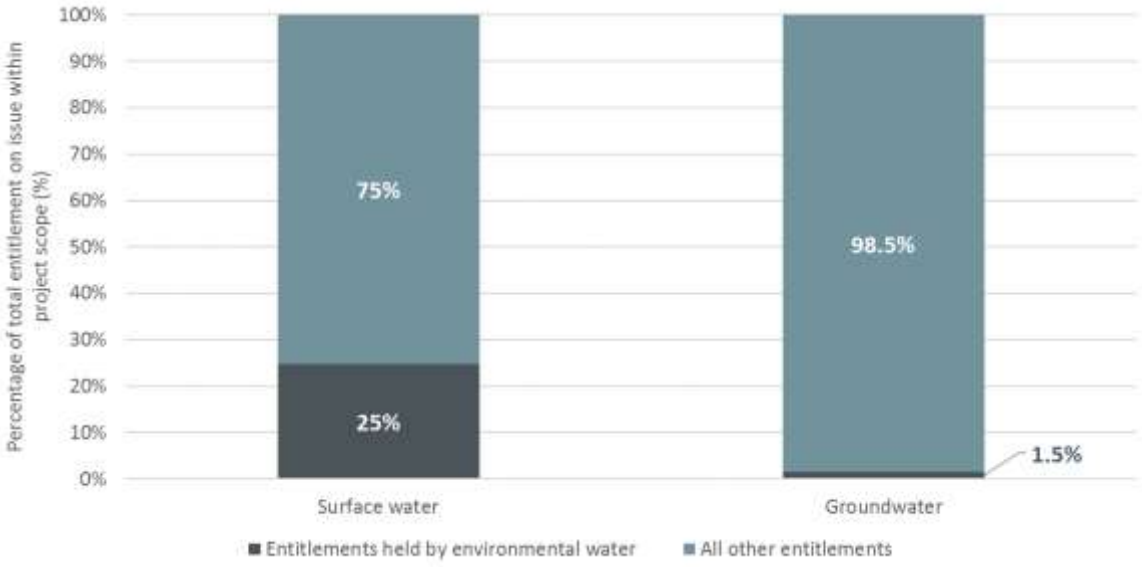


Source: Aither analysis based on data published by the National Water Commission.

Note: Data shows volumes registered in that year rather than contracted sales. This aligns most closely with water trade volume data presented elsewhere in this report. Purchasing rounds did occur in 2007–08, but given the timing of tenders and time taken to process sales, registrations frequently appear in the year after the sale is made. A small volume of water was registered in 2007–08 but does not appear due to chart scale.

Figure 12 Entitlements registered to the Commonwealth for the environment in NSW, 2007–08 to 2012–13.

Figure 13 shows the total amount of surface and groundwater entitlements now held for environmental purposes (in all systems within the scope of this report) as a proportion of all entitlements on issue, as at 2015–16. Note this includes all water considered by the NSW Government to be for environmental purposes and may reflect Commonwealth or other purchase programs, or efficiency programs.



Source: Aither 2016. Based on NSW Water Register and information provided by NSW DPI Water 2016.

Note: Environmental water holdings data is based on information from DPI Water and includes all entitlements held by different environmental entities, which may have resulted from purchases or from other means (such as efficiency programs).

Figure 13 Environmental water holdings as a percentage of total surface water and groundwater entitlement on issue, 2015–16

3. Southern Murray-Darling Basin

This chapter summarises trade outcomes and drivers associated with the following systems:

- Murray – regulated surface water, groundwater (Lower Murray groundwater)
- Lower Murray-Darling – regulated surface water
- Murrumbidgee – regulated surface water, groundwater (Lower Murrumbidgee groundwater)

3.1. Summary

The southern MDB is characterised by its connected nature, both between key NSW systems, but also with major Victorian systems and South Australia. The irrigation industries associated with the region are diverse and intensive, with a range of crop types from lower value to higher value, interruptible and non-interruptible, and a large number of water users. The area is geographically vast and can have variation in rainfall and water availability between locations. There is also a large proportion of all New South Wales' available irrigation water issued to users in this region. These factors mean that there are significant opportunities for trade, and are key drivers of the relatively large volumes of trade observed.[14] Entitlement prices are driven by the normal fundamentals, as are allocation prices, but importantly the interconnected nature of a wide number of systems has an equalising effect on allocation prices.

3.2. System overview

The southern MDB generally refers to the catchments associated with the Lachlan, Murrumbidgee and Murray rivers (for New South Wales) as well as Victorian rivers that flow into the Murray River.[15] The key characteristic of this system is the interconnected nature of the major water systems (except for the Lachlan which is intermittent) that enable water to be traded across significant distances and between regions. There is wide variation in the nature and scale of irrigation enterprises, that can experience a wide variation in climate and other factors that contribute to participation in water markets.

[14] This region, including the Victorian and South Australian components of the southern MDB accounts for the majority of water market activity nationally.

[15] The Lachlan has been grouped as northern MDB for this report as it is not connected to the other sMDB systems for the purposes of trade.

Source: MDBA.

Figure 14 Southern Murray-Darling Basin

3.3. Summary of observed water trade activity

3.3.1. Entitlement trade volumes

Figure 15 shows entitlement trade volumes for the southern MDB products considered in this report, from 2004–05 to 2015–16. With the exception of trade for NSW Murray Supplementary entitlements in 2007–08, trade consistently and rapidly rose from 2005–06 to 2009–10 (the supplementary peak may be due to environmental water recovery efforts). The low volumes of trade early in the analysis period are likely to be a result of market learning in response to reforms implemented under the water management act and in the implementation of the WSPs.

For the most part, High Security trade volumes are lower than General Security, as there are lower volumes of entitlement on issue for those products, and in many cases they tend to be more tightly held by producers, including those with permanent plantings, whose risk profile means they are less likely to trade their higher security entitlement (unless exiting or entering an industry). General Security, on the other hand, has substantially greater volume on issue, and given its lower level of reliability, producers may be more willing to trade that product in response to changes in external factors or as part of different water strategies (e.g. as part of mixed enterprise farming, or in combination with allocation based farming strategies where producers that meet some of their water needs by trading allocations onto zero share WALs). The Lower Darling has very small volumes of entitlement on issue compared to the Murray and Murrumbidgee, so there is much less potential for large volumes of entitlement to be traded, except for when intervalley trade is available and water is used at Lake Tandou or by Environmental users on the Darling Anabranch.

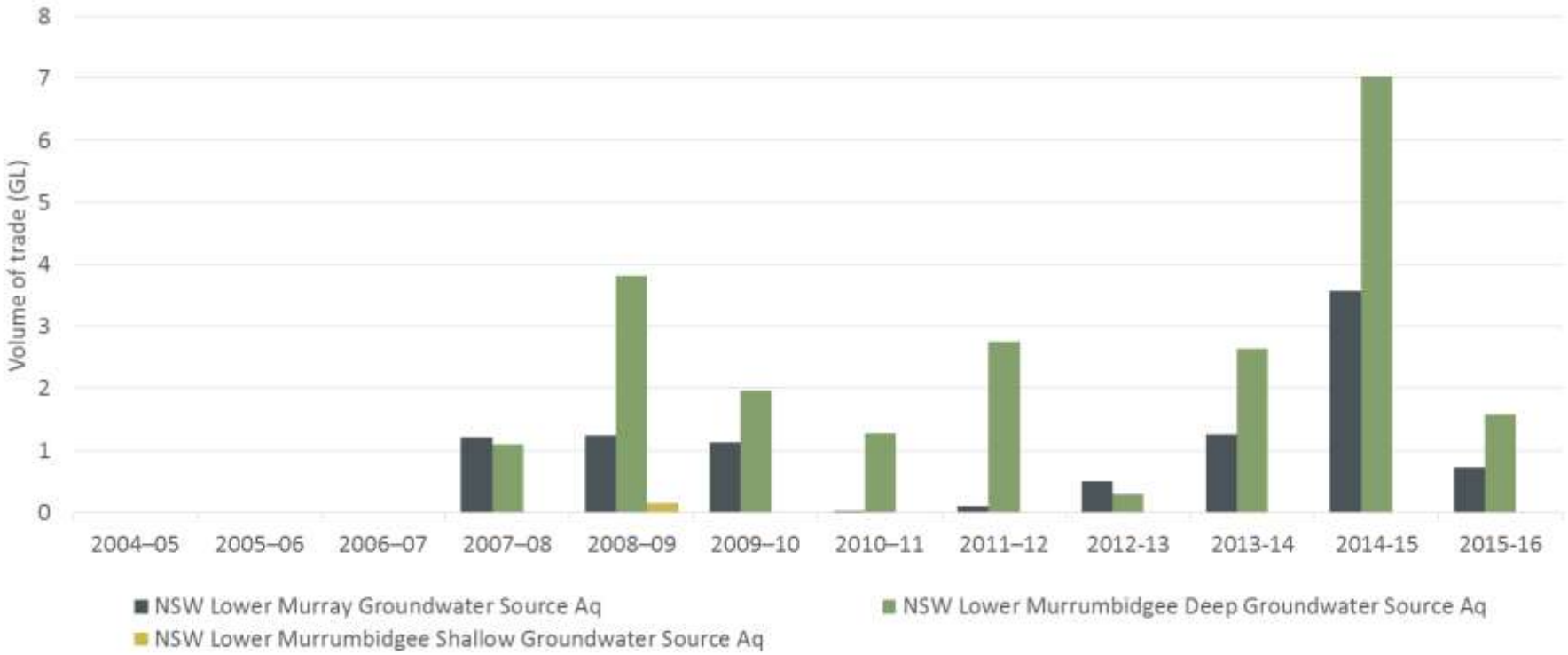
Some of the peaks or overall increases in entitlement trade volumes are likely driven by environmental purchasers, including from 2008–09 to 2012–13, however trade volumes have been relatively stable from 2008–09 onwards. In general, it would be expected that entitlement trade volumes do not move in extremes over time, as trade in entitlement is usually driven by those entering or exiting an industry, new industries entering a region, those making long-term decisions to manage risk, or to alter the nature and extent of irrigated agricultural production. Such decisions do not tend to happen frequently, which means entitlement volumes are not turning over frequently. For example, in 2013–14 around 3 per cent of the total volume of Murrumbidgee General security entitlement on issue was traded.

Groundwater trade volumes in the southern MDB systems considered in this report are lower than for surface water (See Figure 16). The lack of trade in 2004–05 to 2006–07 is likely to have been driven by the implementation dates of the relevant WSPs. Trade in the Lower Murrumbidgee Deep aquifer is frequently greater than for NSW Lower Murray, which may be due to there being a much greater volume of water on issue for that system (272,868 ML vs. 84,777 ML). There appears to have been a trend of increasing trade volumes from 2012–13 to 2014–15, with a significant decline back to 2015–16. This may have been driven by conditions in the surface water entitlement market, and expectations about the long-term climate outlooks during this period. There were substantial increases in prices for major surface water entitlements in this region from 2013 onwards, as well as poor long–term climate outlooks and declining storage levels, which in combination may have driven increased trade in groundwater entitlements as a substitute or additional risk mitigation tool.

Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Only includes 71Q trades. All $0 trades are removed in calculating both volumes and prices.

Figure 15 Southern Murray-Darling Basin surface water entitlement trade volumes, 2004–05 to 2015–16



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Only includes 71Q trades. All $0 trades are removed in calculating both volumes and prices.

Figure 16 Southern Murray-Darling Basin groundwater entitlement trade volumes, 2004–05 to 2015–16

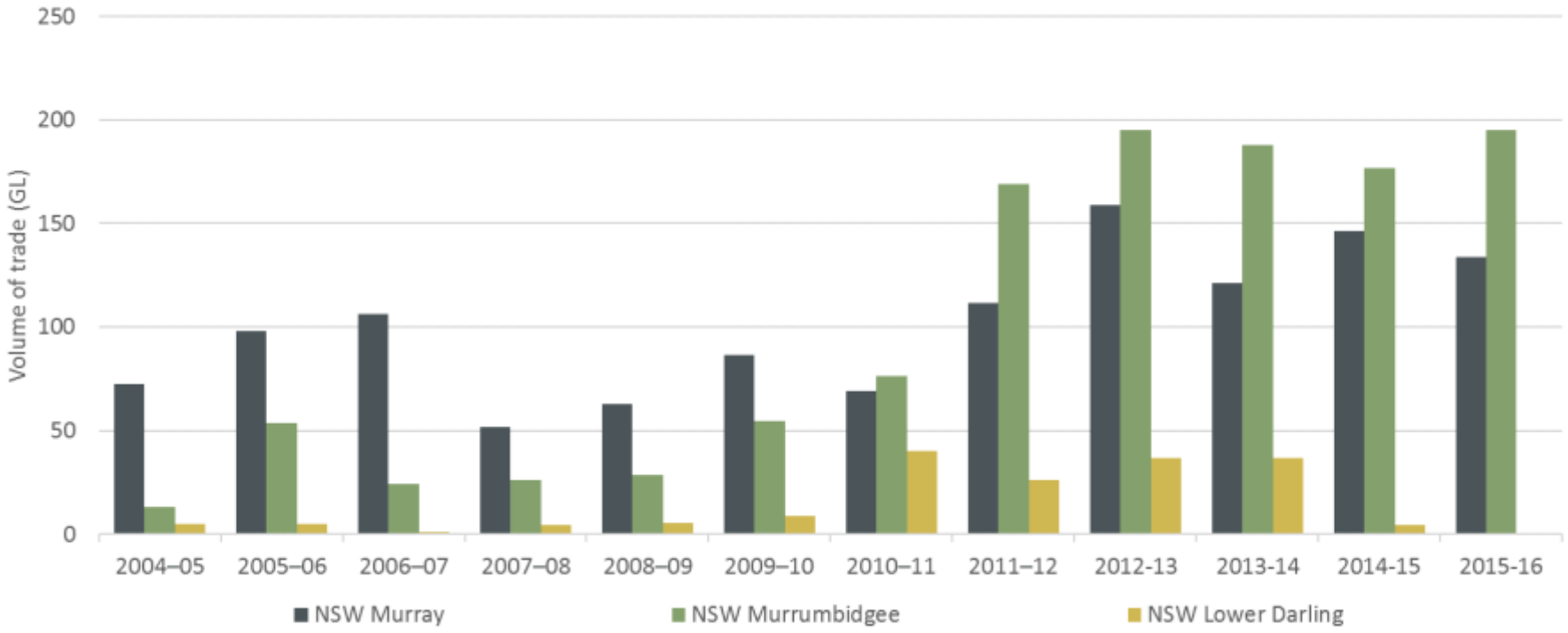
3.3.2. Allocation trade volumes

Figure 17 shows allocation trade volumes for the southern MDB zones considered in this report. Volumes traded increased from 2004–05 to 2006–07, before dropping off in drought years and increasing to relatively higher levels thereafter. This may reflect that during drought, there is generally less water available for trade (although there may be more demand for water). Because the chart shows only trade within and into the zone, it does not show the effect of interstate demand. Large volumes of allocation water were also traded downstream during the drought, to the Victorian and South Australian Murray, which does not show up in this data (see following sub-section for more details on interstate trade).

The modest trade volumes for the Lower Darling reflect the intermittent ability to trade from or to that system due to operational rules. When there is more water available (such as following flood years from 2010–11 onward), certain trade constraints are relaxed. The greater volumes of trade following flood years may reflect water being transferred in an attempt to access carryover provisions associated with different entitlement types or temporary expansions in production given the higher water availability.

Figure 18 shows allocation trade volumes for groundwater sources in the southern MDB. The overall trend for groundwater allocation trade reflects, to an extent, the conditions in surface water availability. This includes there being greater volumes of trade in drought or low water availability years, and less in years of high availability. Part of the explanation for this may include substation effects, such as where producers have access to both surface water and groundwater but have not received enough allocations to meet overall requirements. In such cases, they may purchase additional groundwater allocations instead of surface water, particularly if the cost of water is lower (surface water prices peak during drought).

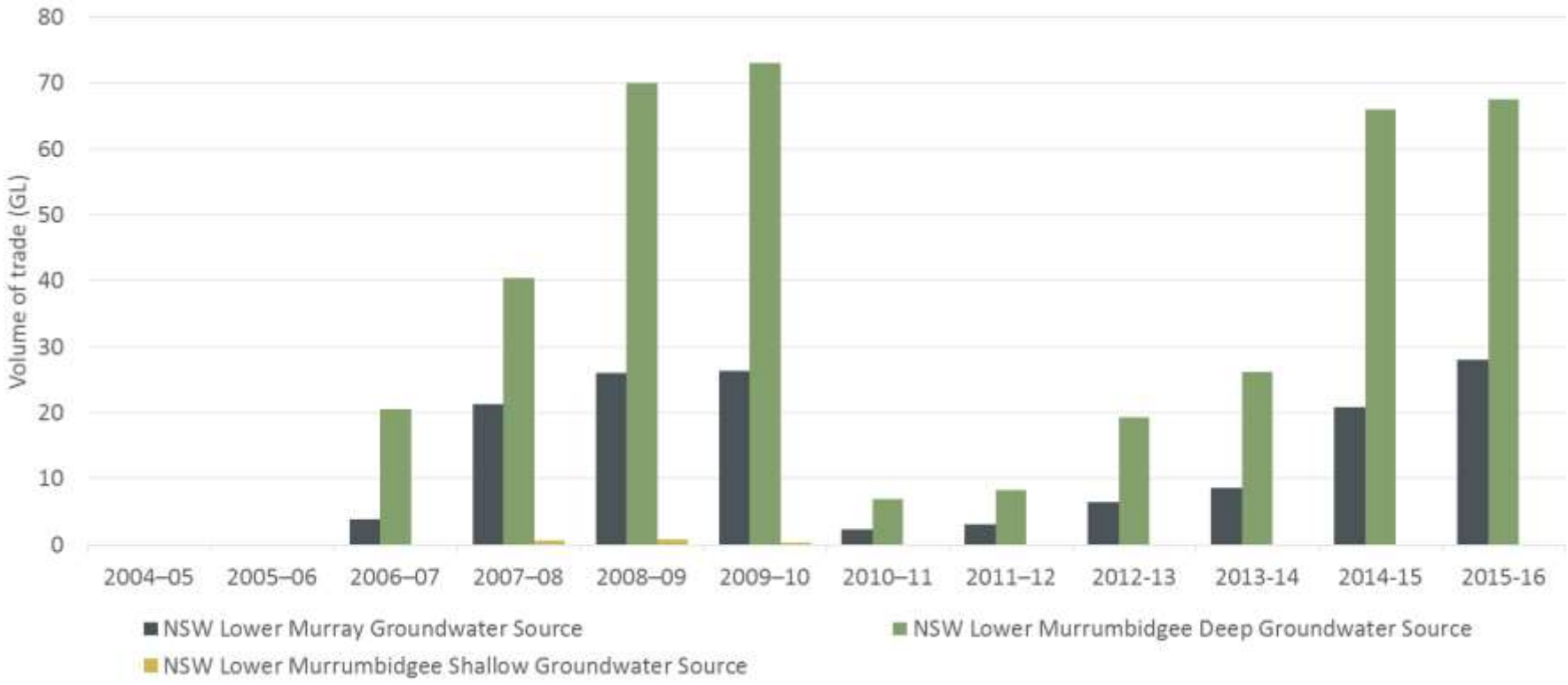
Groundwater volumes traded are always substantially lower than for surface water reflecting the lower levels of water on issue and lower overall reliance on groundwater for production in this region (relative to surface water). It also reflects that there are fewer buyers and sellers than can be accessed (e.g. only producers accessing the same aquifer). The relative differences in volumes traded within each of the two aquifers is likely to reflect the differences in the volume of water on issue (Lower Murrumbidgee Deep has much more on issue).



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Total volume of trade in a zone is defined as all trades within that zone, plus all trades into that zone, but excluding trades out of the zone (to avoid double counting).

Figure 17 Southern Murray-Darling Basin surface water allocation trade volumes, 2004–05 to 2015–16



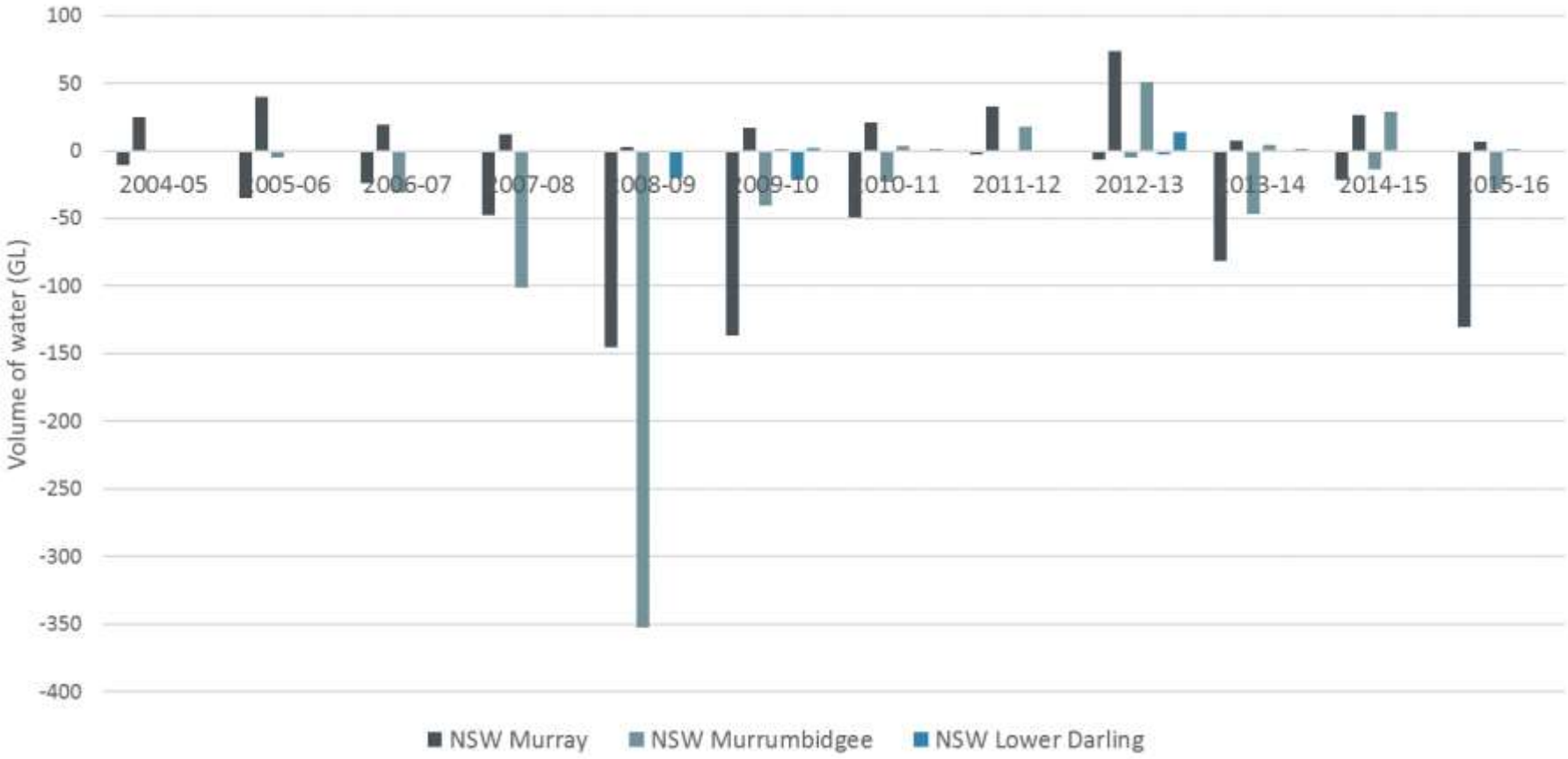
Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Total volume of trade in a zone is defined as all trades within that zone, plus all trades into that zone, but excluding trades out of the zone (to avoid double counting).

Figure 18 Southern Murray-Darling Basin groundwater allocation trade volumes, 2004–05 to 2015–16

Interstate allocation trade

Southern MDB surface water trading zones in NSW are connected to trading zones in both Victoria and South Australia. Interstate allocation trade volumes can be substantial, as shown in Figure 19, with approximately 350 GL trading out of the Murrumbidgee to interstate zones in 2008–09. In several years there has been more water traded out of NSW zones to interstate than into them. This can reflect the nature of water supply and demand across regions (e.g. wet in upstream zones and dry in downstream zones), as well as the types of crops in different locations. In drought conditions, permanent crops (which are well established in downstream interstate zones, have fixed water demand and are willing to pay higher prices for water than interruptible crops) have tended to buy water from areas with interruptible crops (which historically have been more prevalent in the Murrumbidgee). This contributed to large volumes of water being traded out of the Murrumbidgee in 2007–08 and 2008–09. The tendency for downstream trade can also reflect the size of the interconnected markets – there is substantial irrigated agricultural activity in the interstate zones and significant demand for water downstream. Further, large volumes of trade involving Victoria occurred in some years due to generous carryover provisions, which were subsequently amended. However, the net direction of trade is not always out of NSW, as shown in 2012–13, and for selected zones in other years. Interstate trade involving the Lower Darling is not always possible due to trade only being possible when certain storage level thresholds are met.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Trade volumes only include trades involving an interstate zone. Negative values indicate volumes traded out of NSW; positive values indicate volumes traded in to NSW..

Figure 19 Southern Murray-Darling Basin interstate surface water allocation trade volumes, 2004–05 to 2015–16

3.3.3. Entitlement prices

Figure 20 shows changes in entitlement prices for surface water entitlements in the southern MDB. Overall, this shows a degree of correlation with water availability, including the major drought, flood and drying cycle evident over the time series. However, within year water availability (including allocations and rainfall) is generally not the major determinant of entitlement prices.

Similar to entitlement trade volumes, entitlement prices tend to be driven by changes in demand for entitlements, which is in turn driven by decisions around risk management and long-term enterprise level decisions, including those exiting and entering industries or making long-term adjustments to levels of production (expansion/contraction), or water management strategies. Where major shifts occur within certain industries, this can be reflected in demand for entitlements, which impacts on prices. If new demand is created by new entrants, such as was the case for the environment, horticultural developments (particularly nuts) and cotton during the study period, this has the potential to influence prices.

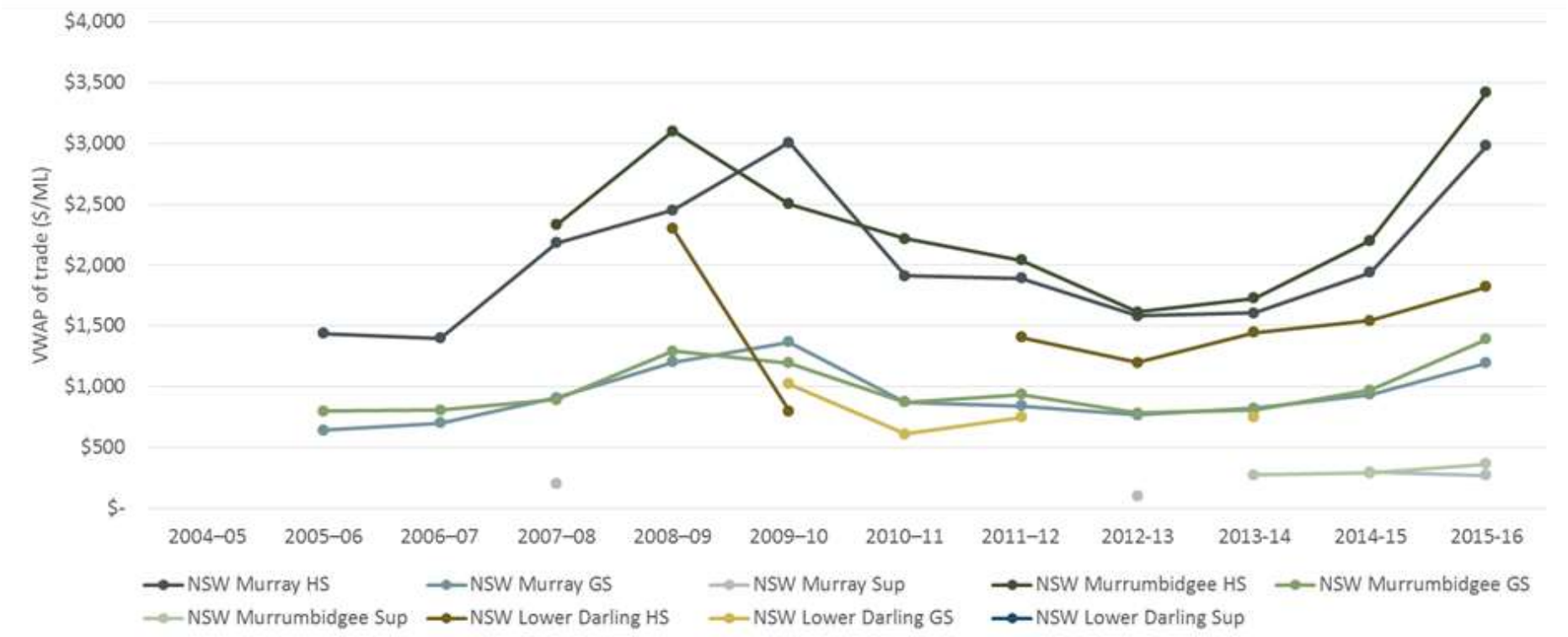
For water availability, the correlation with prices is more likely to reflect medium to long-term expectations including that driven by climate outlooks, which can have a bearing on producers' approach to (or view of) water availability risk and can change demand for entitlements. This has been the case in the later part of the study period, where certain industries or enterprises that may have been relying solely on allocation markets to meet water needs have sought more entitlements to mitigate against the potential for high allocation water prices if water availability continued to decline.

The increases in prices for High Security entitlements late in the period is likely driven by both water security outlooks and shifts from allocation based farming to entitlements (or a mix) in horticulture, as well as new irrigation developments (including for both cotton and horticulture). The increase in prices during the drought (2007–08 to 2009–10) could have been driven by both environmental demand, but also long-term expectations and risk management decisions in response to the drought sequence.

The differences in prices for the different entitlement types is mostly a reflection of their relative reliability and the nature of irrigated enterprises that require high reliability of supply. For example, the long-term average annual yield to Murrumbidgee High Security is much higher than for Murrumbidgee General Security, which drives a fairly constant price differential. Those with permanent plantings generally have higher willingness to pay for water based on their need for more reliable water, and they may also have higher gross margins on production, which supports the higher prices observed for High Security products. The more variable prices (such as for Lower Darling or supplementary types) are largely explained by the 'thin' market – meaning there are few buyers and sellers, and few trades, and therefore difficulty establishing a trend in prices.

Figure 21 shows changes in entitlement trade prices for groundwater sources in the southern MDB. The trend for groundwater entitlement prices is broadly similar to surface water entitlements, with increasing prices during drought periods, and a small increase in prices (for Murrumbidgee Deep) from 2014–15 to 2015–16 (when actual and expectations about water availability declined). An upward trend towards the end of the period may have been driven by concerns about declining long-term water availability outlooks, as groundwater may be seen as a tool to mitigate against surface water availability risk.

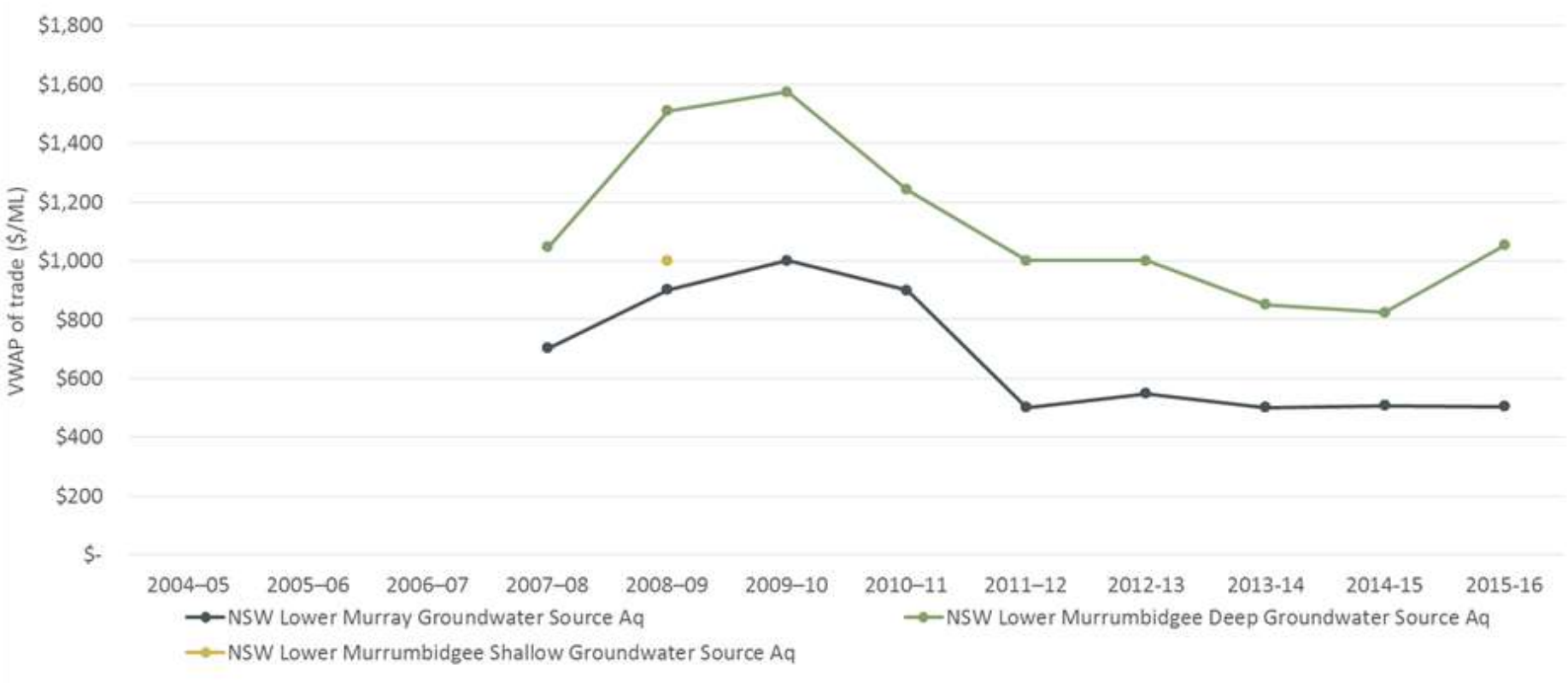
The difference in prices between the products may reflect differences in the types of irrigated agriculture in the respective aquifer locations, and the extent to which the market for these entitlement is constrained (for example, groundwater entitlements cannot be traded over as great a distance as may be possible for certain surface water entitlements, restricting buyers and sellers). These groundwater products have generally received 100 per cent allocations in all years in the analysis period so this is unlikely to be the driver.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases, outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

Figure 20 Southern Murray-Darling Basin surface water entitlement prices, 2004–05 to 2015–16



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

Figure 21 Southern Murray-Darling Basin groundwater entitlement prices, 2004–05 to 2015–16

3.3.4. Allocation prices

Allocation prices are strongly related to water availability, including in-crop rainfall, and allocations made to entitlements. As is shown in Figure 22, annual allocation prices are highly correlated with annual allocation levels (see also Figure 41), including the relative magnitude (as distinct from entitlement prices, which do not vary as much in absolute terms). In the southern MDB allocation prices in the NSW Murray and NSW Murrumbidgee zones have consistently tracked inverse to allocation levels, including the major phases of drought, flood, and drying through the time series considered here.

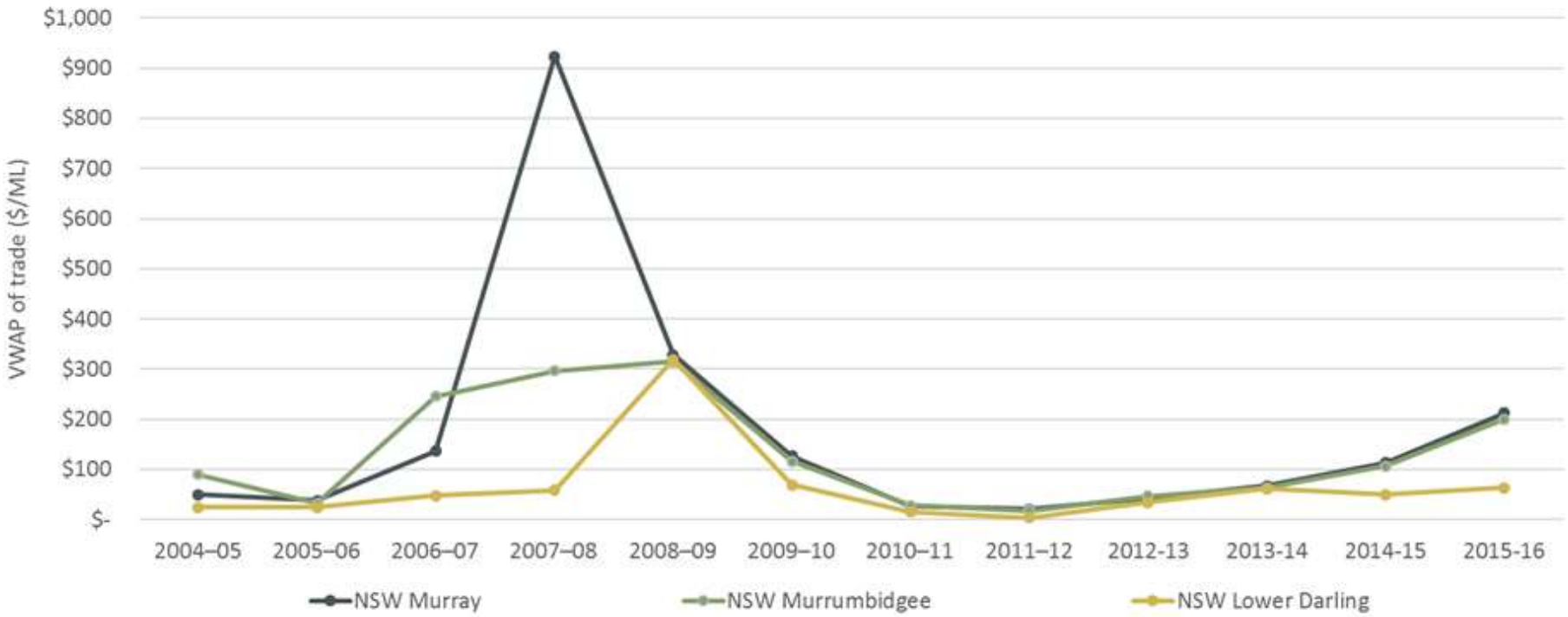
The zones considered here are connected to one another to varying degrees, meaning trade of allocation water between zones is generally (but not always) possible. This includes trade out to Victorian and South Australian zones. This tends to facilitate equalisation of prices across zones, as buyers and sellers can access the same water. However, at certain times, particular trade or water management rules can prevent trade occurring, which means water in some zones cannot be traded out (or in). This impacts supply and demand and leads to variations in prices between zones. Key examples are the Murrumbidgee intervalley trade (IVT), and connectivity of the Lower Darling based on management rules for the Menindee Lakes.

For example, after 2005–06, trade was restricted for the Lower Darling, which restricts the number of buyers that can access that water, and therefore depresses prices in that zone (the Murrumbidgee and Murray zones increased in price relative to Lower Darling after 2005–06). This has similarly occurred in 2014–15 and 2015–16. The variance in prices between Murray and Murrumbidgee allocation prices can also be explained by the Murrumbidgee IVT rule. Depending on downstream demand and the extent of backtrade and hydrological conditions, this rule prevents water from being traded out of the Murrumbidgee (although is at times not evident in the graph due to scale, and because prices are annual the rule can be binding to varying extent within a year).

Additional influences for price variance during the reporting period include suspension of the Murrumbidgee WSP in 2006 that allowed for the Murrumbidgee IVT Limit to be exceeded, and movement of account water to drought accounts to prevent access due to resources not being available to supply.

Groundwater allocation prices reveal the same inverse relationship with allocation levels and water availability more generally (see Figure 23 – the relationship is more visible in this figure as it does not include an outlier price as is shown in Figure 22). Prices are high during drought and low during flood/high water availability. However, for groundwater, these prices may reflect surface water availability more than groundwater availability, as groundwater allocations have generally been at 100 per cent throughout the study period. This supports the substitution effect – when surface availability is low, and prices high, demand for groundwater increases, and therefore groundwater prices increase.

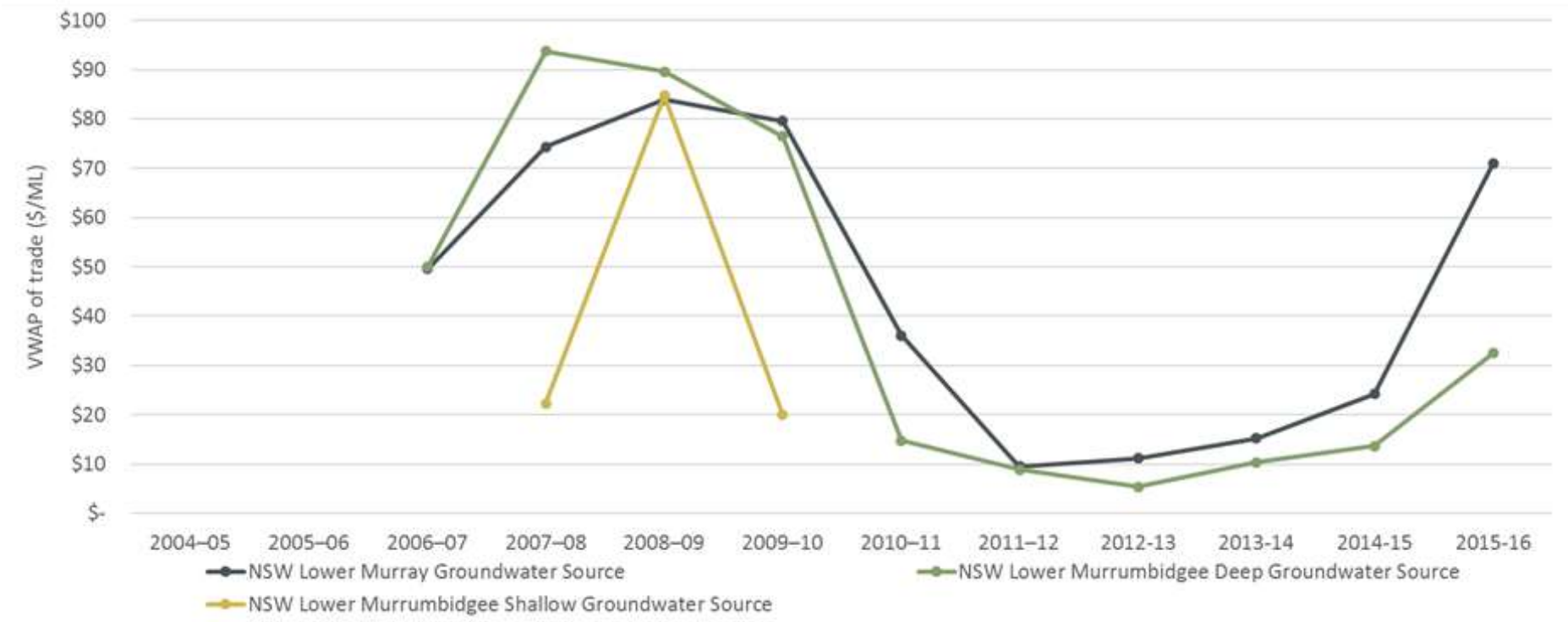
Prices in the different sources are not as tightly correlated with one another as for the surface water zones because allocations generally cannot be traded between the aquifers (although in some cases can be traded between zones defined within an aquifer, which is still equivalent to ‘within zone’ trade for surface water).



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

Figure 22 Southern Murray-Darling Basin surface water allocation prices, 2004–05 to 2015–16



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

Figure 23 Southern Murray-Darling Basin groundwater allocation prices, 2004–05 to 2015–16

3.4. Drivers of water trading

3.4.1. Supply

As discussed above, water availability is one of the key determinants of trade outcomes, including the extent of trade and prices achieved. Most important are allocations to entitlements. As is shown in the regional summaries for the Murray and Murrumbidgee in Appendix A, water allocated has followed a drought, through flood and back into drying sequence. There are differences in the absolute amounts of water allocated between the two systems because of the different entitlements on issue and their volume, but the trend is broadly similar.

This is also reflected in rainfall across the two systems. The amount of rain has naturally varied between sites, but the overall trend at a number of sites has been consistent and is generally similar to the trend for water allocations. This includes Albury, Swan Hill, and Mildura (Murray) as compared to Griffith, Balranald, and Wagga Wagga (Murrumbidgee). As noted previously, these trends are broadly the inverse of and a key driver of allocation prices.

3.4.2. Demand

The regional summaries for the systems considered in this section highlight trends in both water use and land use for different crop types. These are relatively strong (but not perfect) proxies for changes in water demand. Changes in production over time (e.g. the different types of crops planted, and the extent of planting for each crop) also help to explain changes in water market outcomes. Demand drivers in the southern MDB can be broadly characterised as follows:

- The Murray tends to be dominated by pasture, followed by other cereals, and rice (by area). Declines in land use for irrigated pasture, rice and other cereals, but increases in grapevines, have been observed, with similar trends in water use, except for irrigated pasture, for which water use has increased (comparing data for 2005–06 and 2014–15).
- The Murrumbidgee tends to be dominated by other cereals, rice, and pasture, but with a notable amount of horticulture, grapevines and other crops (by area). Declines in land use for pasture, rice and other cereals, but a significant increase in cotton, have been observed. Similar trends are evident in water use, including a notable increase for cotton (comparing data for 2005–06 and 2014–15).
- Grazing tends to dominate in the Lower Darling. ABS data suggests other cereals, other broadacre crops, cotton, and grapevines are also present. Increases in land use for other cereals, other broadacre crops, and rice, have been observed, along with a significant increase in cotton. Similar trends in water use – including a notable increase for cotton – have also been observed (comparing data for 2005–06 and 2012–13).
- Changes in cotton production have been an important driver of water markets in the southern MDB towards the end of the study period. New crop variants have enabled planting further south, and there has been investment in new cotton gins, for which certain levels of cotton production are required. Supply contracts within the cotton market enable producers to secure cotton prices for a number of years in advance. This in turn has driven demand for permanent (entitlement) water to supply cotton enterprises and is likely to have had some impacts on prices. Cotton also tends to have a higher gross margin which can influence prices achieved.

The environment

As was outlined in Section 2.5 environmental water purchasing was a key driver of demand for entitlement until 2012–13. Purchasing occurred throughout southern MDB systems, with the splits of purchases by product type provided in Figure 24. There was more General Security surface water purchased than other types, and the most substantial volumes were registered in 2009–10. This may in part explain the increases in the total volume of trade observed in this period (refer Figure 15) and increased prices (refer Figure 20).

Source: Aither analysis based on data published by the National Water Commission.

Note: Data shows volumes registered in that year rather than contracted sales. This aligns most closely with water trade volume data presented elsewhere in this report. The timing of tenders and time taken to process sales involving the Commonwealth has often meant registrations appear in the year after the sale is agreed.

Figure 24 Southern Murray-Darling Basin Commonwealth environmental water recovery (registrations), 2007–08 to 2012–13

4. Northern Murray-Darling Basin

This chapter summarises trade outcomes and drivers associated with the following systems:

- Lachlan – regulated surface water, groundwater (Lower Lachlan Groundwater)
- Macquarie – regulated surface water, groundwater (Lower Macquarie groundwater)
- Namoi – regulated surface water, groundwater (Upper and Lower Namoi groundwater)
- Peel – regulated surface water
- Gwydir – regulated surface water, groundwater (Lower Gwydir groundwater)
- Border Rivers – regulated surface water

4.1. Summary

The Northern MDB is characterised by systems that are relatively more isolated from one another, or disconnected (at least for the purposes of trade), as compared to the southern MDB. These systems tend to be smaller than systems in the south, in terms of the volume of water available for use (in many cases), the number of water users, and in some cases or time periods, industry size or economic activity. However, there are high-value industries in many, and strong reliance on irrigation water for production. Because most systems are not connected with one another, there is much less (or no) potential for intervalley trade. There is a much greater reliance on groundwater across the region which is used as a means to balance low water reliability, and unregulated systems are also present (although analysed in a separate section of this report). These matters are reflected in trade outcomes – there is generally less trade than in southern systems. Prices also reflect the fundamentals of supply and demand – significantly in the north, the relatively greater constraints on accessing more buyers and sellers due to connectivity.

4.2. System overview

The northern MDB generally refers to the catchments in the MDB that are north of the Lachlan River. While the systems all flow toward the Murray River via the Menindee Lakes (or are terminal) they are not connected to one another for the purposes of trade. There is variation in the nature and scale of irrigation enterprises across the region, which can experience a wide variation in climate and other factors that contribute to participation in water markets, but these factors influence trade differently to the southern MDB given the lack of connectivity.

Source: MDBA.

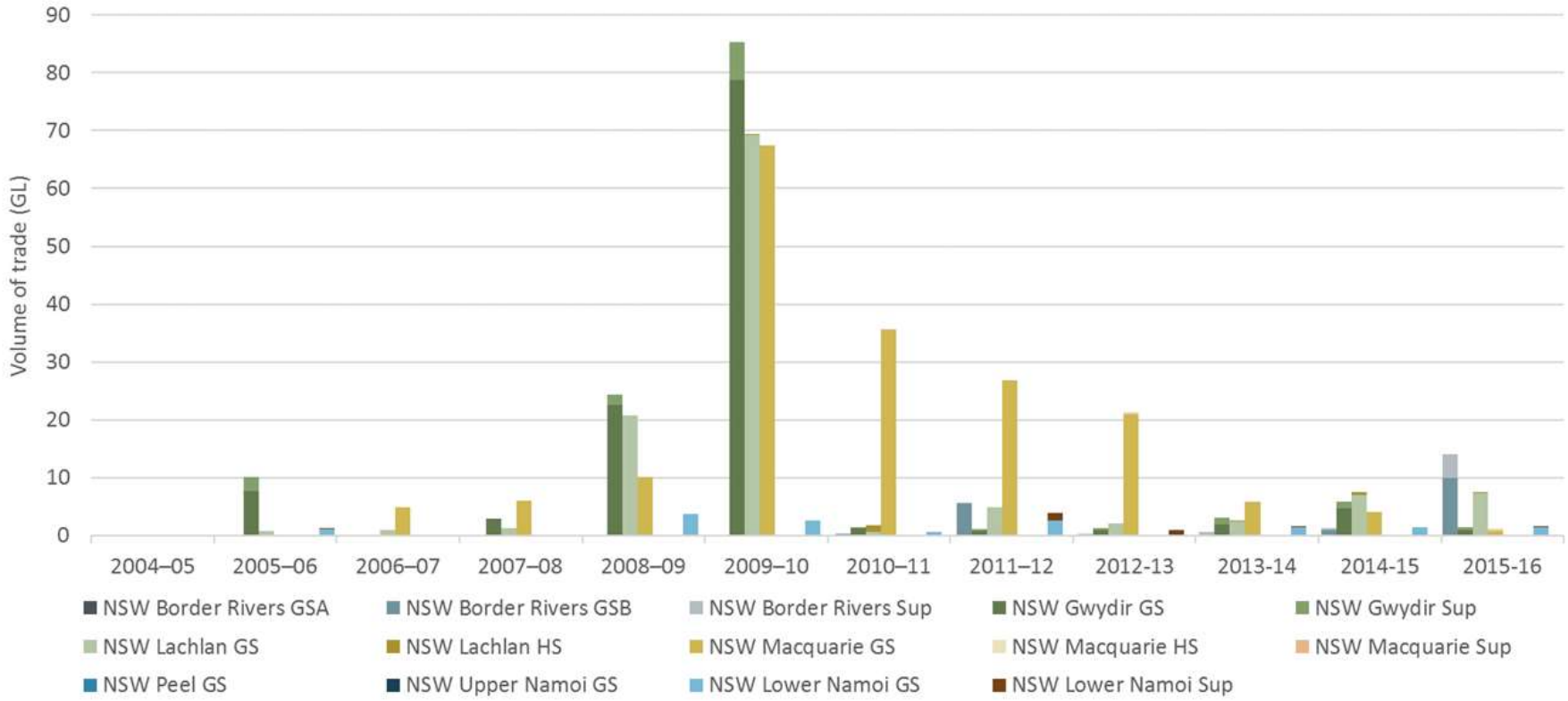
Figure 25 Northern Murray-Darling Basin

4.3. Summary of observed water trade activity

4.3.1. Entitlement trade volumes

As is shown in Figure 26, in the northern MDB, surface water entitlement trade (by volume) has been greater for General Security types than High Security types, and the volume of trade has been greatest in the Gwydir, Lachlan, and Macquarie. This may reflect the greater volume of water on issue in those systems, which may also suggest a greater number of users, and therefore the potential for trade opportunities to arise. It may also reflect the timing and targeting of environmental water recovery efforts. Overall, 2009–10 was by far the most dominant year in terms of trade volumes during the study period, which may reflect environmental demand (see Figure 35).

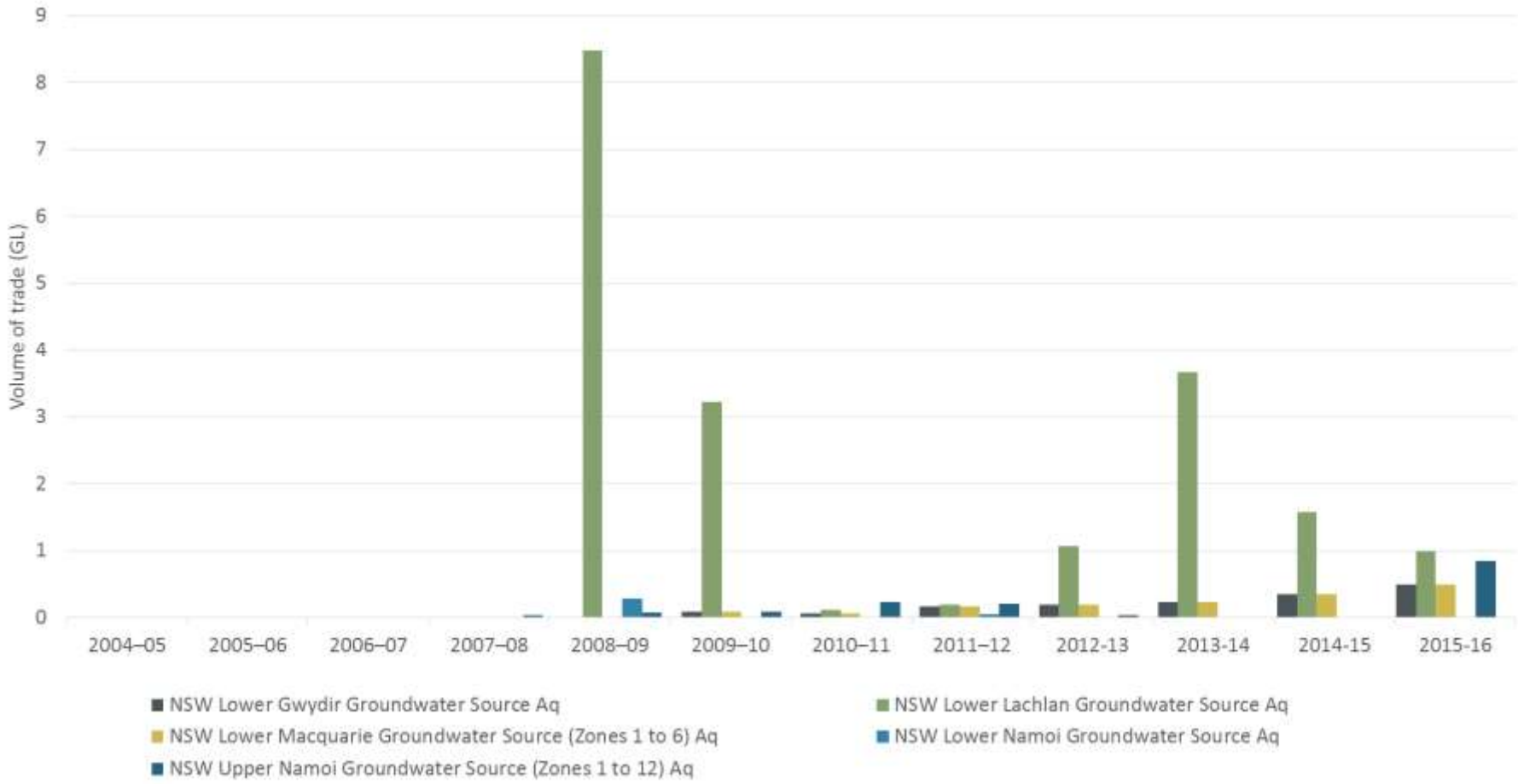
For groundwater entitlement trade (Figure 27), trade by volume has been dominated by the Lower Lachlan Groundwater source. This coincides with the introduction of the Lower Lachlan Groundwater Sharing Plan in 2008–09 and an associated reduction in entitlements from 215 GL to 108 GL. The reduction was implemented through a percentage reduction in entitlement across all groundwater licence holders, which may be a possible driver for the high volume of trade in 2008–09 as existing active groundwater users responded to reduced entitlements by buying entitlement to partially restore their position. The other groundwater aquifers have all had much lower, but generally consistently similar annual volumes, with 2008–09 having the largest single volume of trade. As for southern MDB systems, there is a much lower volume of groundwater trade than surface water, reflecting the smaller size of the resource, fewer users, and connectivity constraints.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Only includes 71Q trades. All $0 trades are removed in calculating both volumes and prices. Some products may be absent due to the removal of $0 price trades.

Figure 26 Northern Murray-Darling Basin surface water entitlement trade volumes, 2004–05 to 2015–16



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Only includes 71Q trades. All $0 trades are removed in calculating both volumes and prices.

Figure 27 Northern Murray-Darling Basin groundwater entitlement trade volumes, 2004–05 to 2015–16

4.3.2. Allocation trade volumes

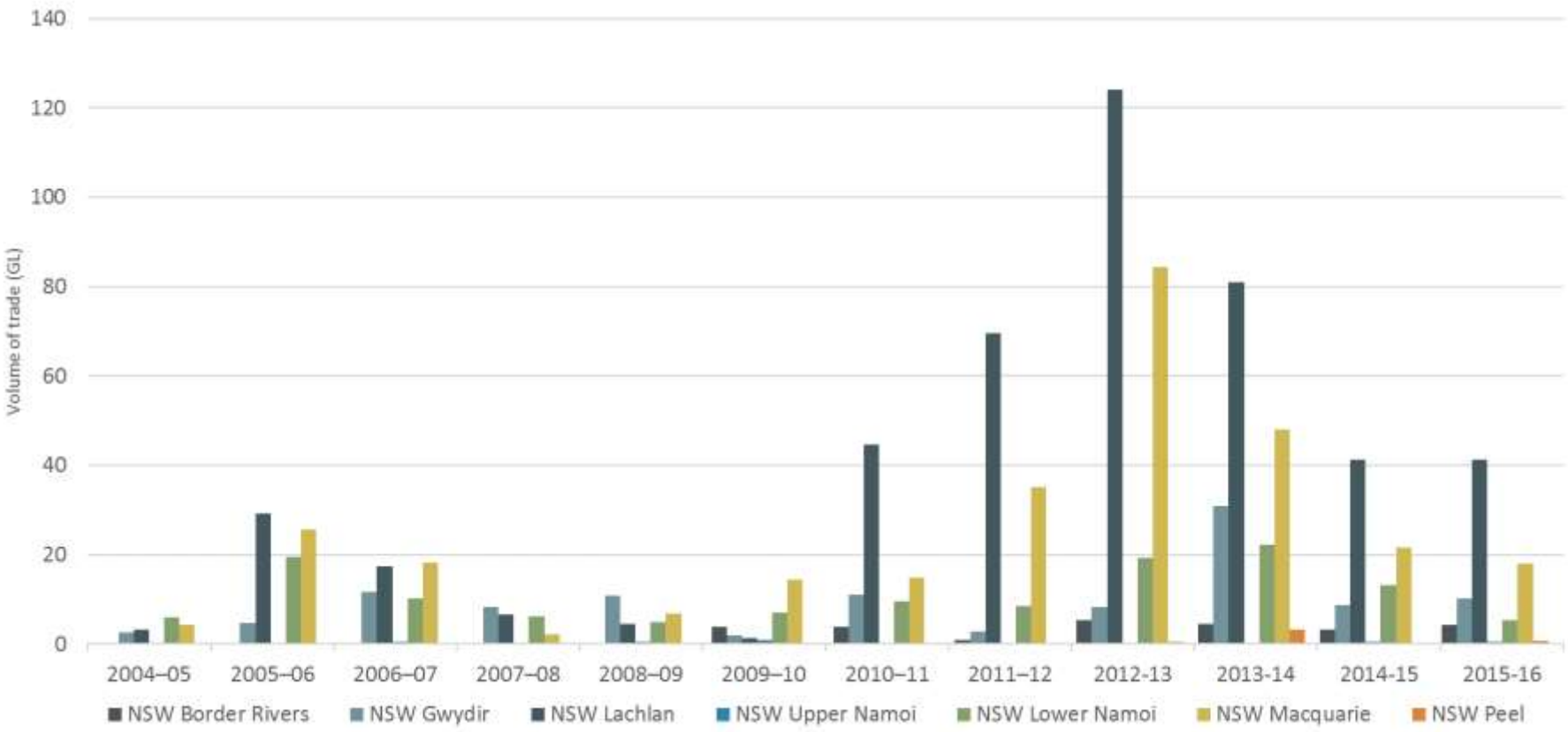
Northern MDB surface water allocation trade volumes are shown in Figure 28. The data tends to show the volume of trade being somewhat correlated to water allocations, but not inversely (the volume of trade is high when allocation levels are high – such as the wetter period from 2010). This may not reflect greater trade intensity (i.e. the amount of water traded, over the amount that was available) but rather that greater trade volumes appear simply because there is a greater volume of water available in those years. For example, in extreme drought years, there is much less water available to be transferred, despite there being a high demand for trade (and high prices). It may be that a greater proportion of water available is traded in drought, but the absolute volume transferred is much smaller than in a year with greater water availability.

Some of the increases in allocation trade (over time) may also be attributable to an increase in irrigation being undertaken on zero share WALs (for example, there appears to be a sustained increase in trade overall in the second half of the study period). This is where an irrigator or enterprise receives no annual allocation (because no share is held), and must buy all water required in any given year from the allocation market (via the zero share WAL). This may be driving overall increases in allocation trade over time (this is not unique to the northern systems, and may equally apply in the south). Another driver of increased allocation trade observed in the second half of the study period may be an increase in total water availability following the Millennium Drought from 2003–2010. Further, there may be increased demand for water following partial sales of entitlement and changes in the nature of businesses, which has been a prominent factor in certain systems including the Gwydir.

As was the case for entitlement trade in the north, there tends to be a larger volume of allocation trade associated with systems that have larger volumes of entitlement on issue – such as in the Macquarie and Lachlan in this case. For comparison, the Lachlan has over 500,000 ML of General Security water on issue, whereas the Peel has around 30,000 ML of General Security water on issue. This volume comparison reflects the potential for there to be more users (and more active users).

Figure 29 shows groundwater allocation trade volumes for northern systems. The trend for allocation trade differs from that for surface water. It appears there has been less volume of trade in years of good water availability (e.g. 2010–11) and more when conditions are worse (e.g. 2014–15). In certain northern systems, there was a sharp decline in surface water availability generally in 2013–14 and 2014–15, while groundwater has generally received 100 per cent allocations for most northern systems over the study period.

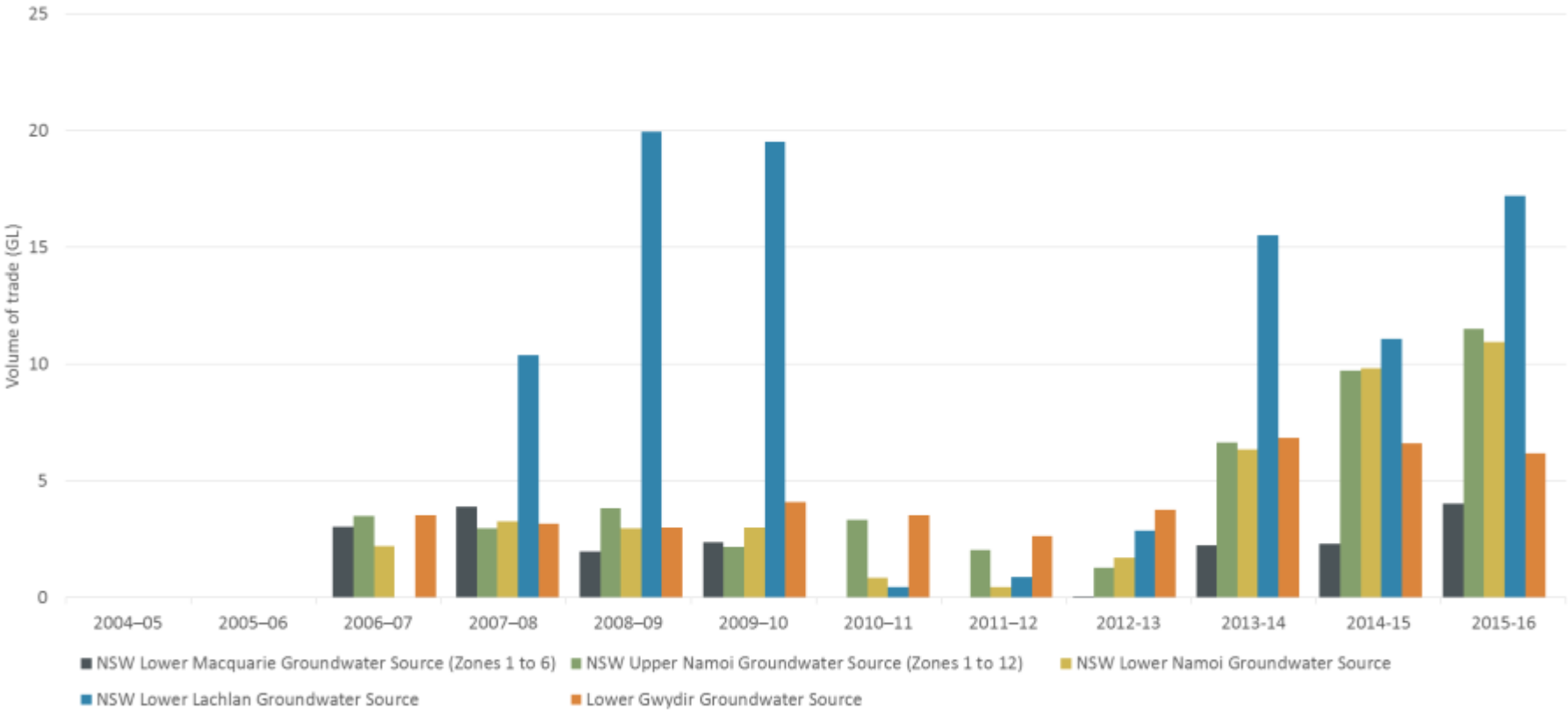
The groundwater volumes traded are therefore likely to reflect surface water availability conditions and substitution. The consistently higher volumes of trade across different groundwater systems in 2014–15 and 2015–16 likely reflect that surface water availability had declined significantly, and where it is an available option, irrigators sought to access groundwater. The effect can also be seen on a localised scale in the Lower Lachlan groundwater resource for the years 2007–08 to 2009–10.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Total volume of trade in a zone is defined as all trades within that zone, plus all trades into that zone, but excluding trades out of the zone (to avoid double counting). Interstate trade volumes to Queensland are not included.

Figure 28 Northern Murray-Darling Basin surface water allocation trade volumes, 2004–05 to 2015–16



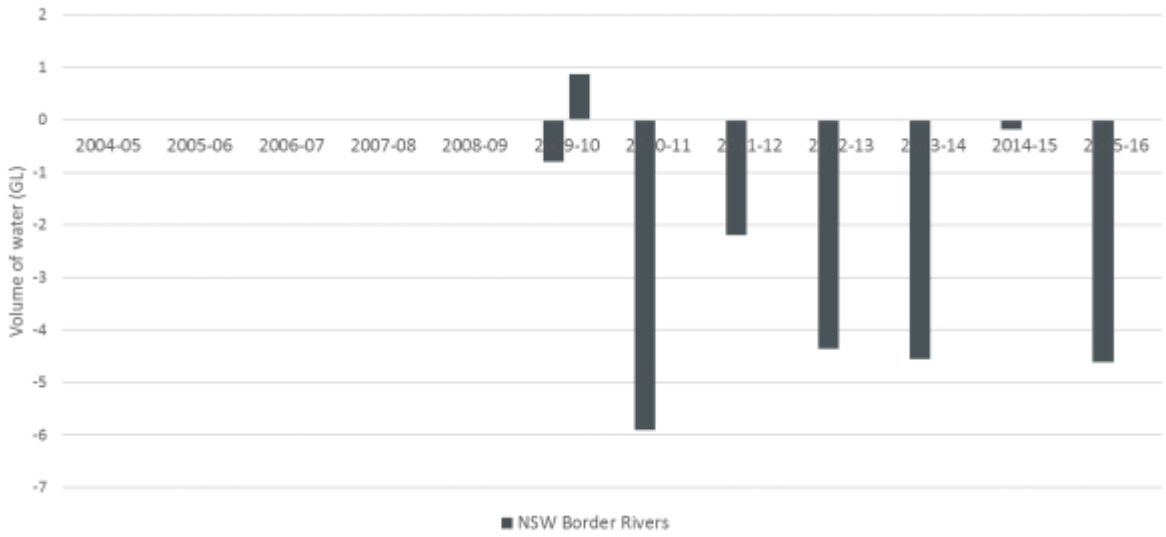
Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Total volume of trade in a zone is defined as all trades within that zone, plus all trades into that zone, but excluding trades out of the zone (to avoid double counting).

Figure 29 Northern Murray-Darling Basin groundwater allocation trade volumes, 2004–05 to 2015–16

Interstate allocation trade

In the northern MDB, the NSW Border Rivers trade zone is connected to users in Queensland and interstate allocation trade is possible. Interstate allocation trade volumes can be substantial, as shown in Figure 30, with approximately 6 GL trading out of the NSW Border Rivers to Queensland in 2010–11. There is also generally net trade from the NSW Border Rivers to Queensland. This may reflect higher demand for (and/or lower availability of) water on the Queensland side.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Trade volumes only include trades involving an interstate zone. Negative values indicate volumes traded out of NSW, positive values indicate volumes traded in.

Figure 30 Northern Murray-Darling Basin interstate surface water allocation trade volumes, 2004–05 to 2015–16

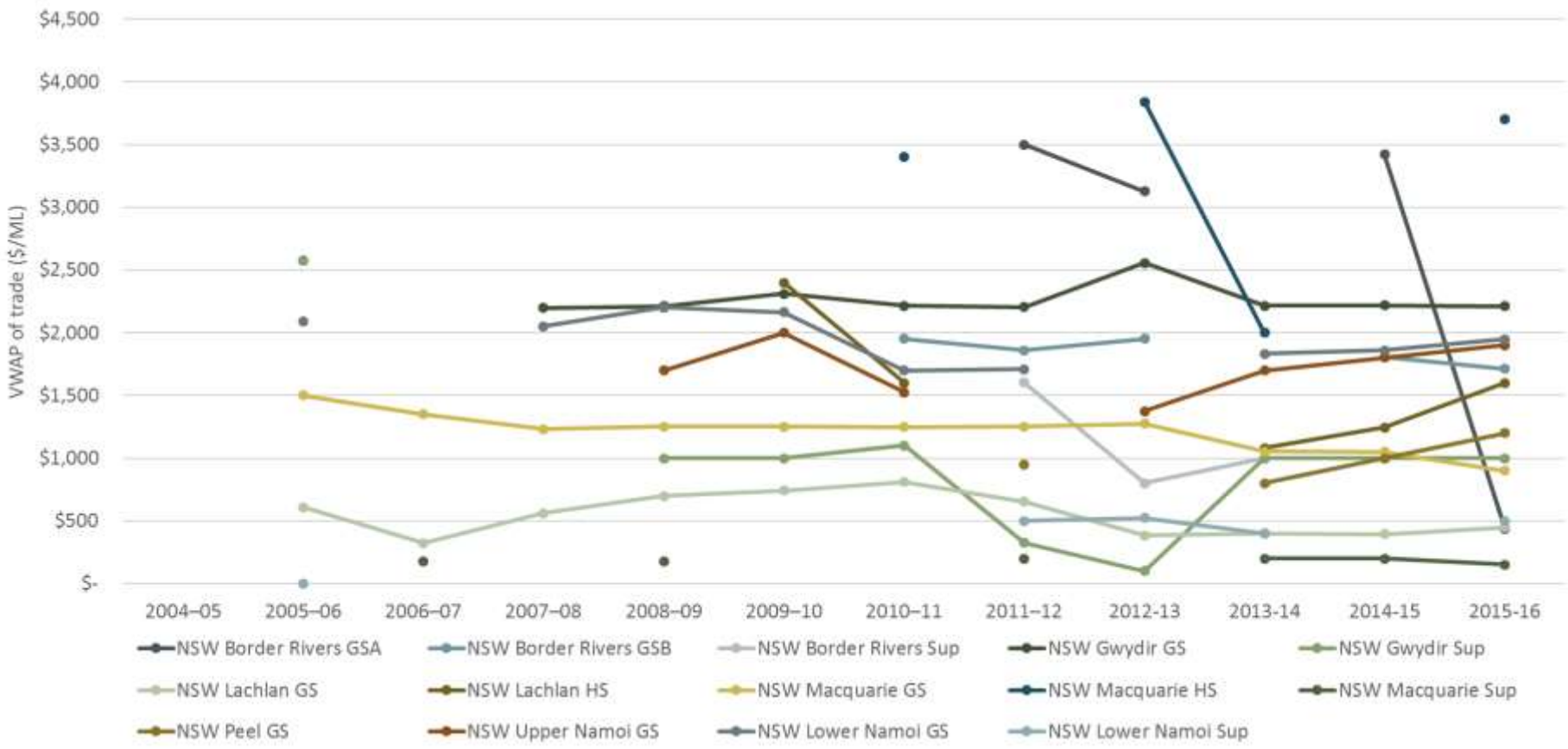
4.3.3. Entitlement prices

Entitlement prices for northern MDB surface water products are shown in Figure 31. This data can be challenging to interpret and ascertain trends from for several reasons, including there being few trades in small systems (small sample), large variations in product characteristics (i.e. not like for like), and unique drivers and circumstances between systems (e.g. different industries, system characteristics).

However, it can be shown that for more heavily traded products such as Lachlan General Security, the trend is not inconsistent with surface water entitlements in the southern MDB, including a slight and gradual increase associated with worsening water conditions (2006–07 to 2010–11) followed by declines into improving conditions, then increases again (i.e. broadly slightly correlated to water availability). This is to some extent also shown in Macquarie General Security, and in Gwydir supplementary (although Gwydir General Security appears to reverse this observation in 2012–13). For most High Security products there is generally too little turnover in entitlements to establish robust prices at a given point in time, and similarly any trends over time.

Commonwealth Government involvement in the buyback of environmental water in these systems (particularly with regard to General Security entitlements in the Lachlan) may also be an important driver of observed market outcomes across the years 2009–10 to 2012–13. This trend is unlikely to continue into the future as (based on current policy settings) any further water recovery volumes will be much less substantial (in volume terms) and may be secured through efficiency gains, rather than market purchases.

As shown in Figure 32, trends in northern groundwater entitlements prices are challenging to ascertain. There are marked and clear differences in the value of different groundwater entitlement types in different regions. The significant variations from the trend for some types may be explained by the smaller numbers of trades, and the potential for data issues given the small sample size. However, the Lower Lachlan and Upper Namoi entitlements may support the general trend in entitlement prices observed elsewhere that correlates with (general) water availability. Purchases of groundwater entitlements can represent a water availability risk mitigation strategy and may be in lower demand when surface water availability is low (refer to prices for the Lachlan in 2012–13, vs. 2015–16).



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

Figure 31 Northern Murray-Darling Basin surface water entitlement prices, 2004–05 to 2015–16

Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

Figure 32 Northern Murray-Darling Basin groundwater entitlement prices, 2004–05 to 2015–16

4.3.4. Allocation prices

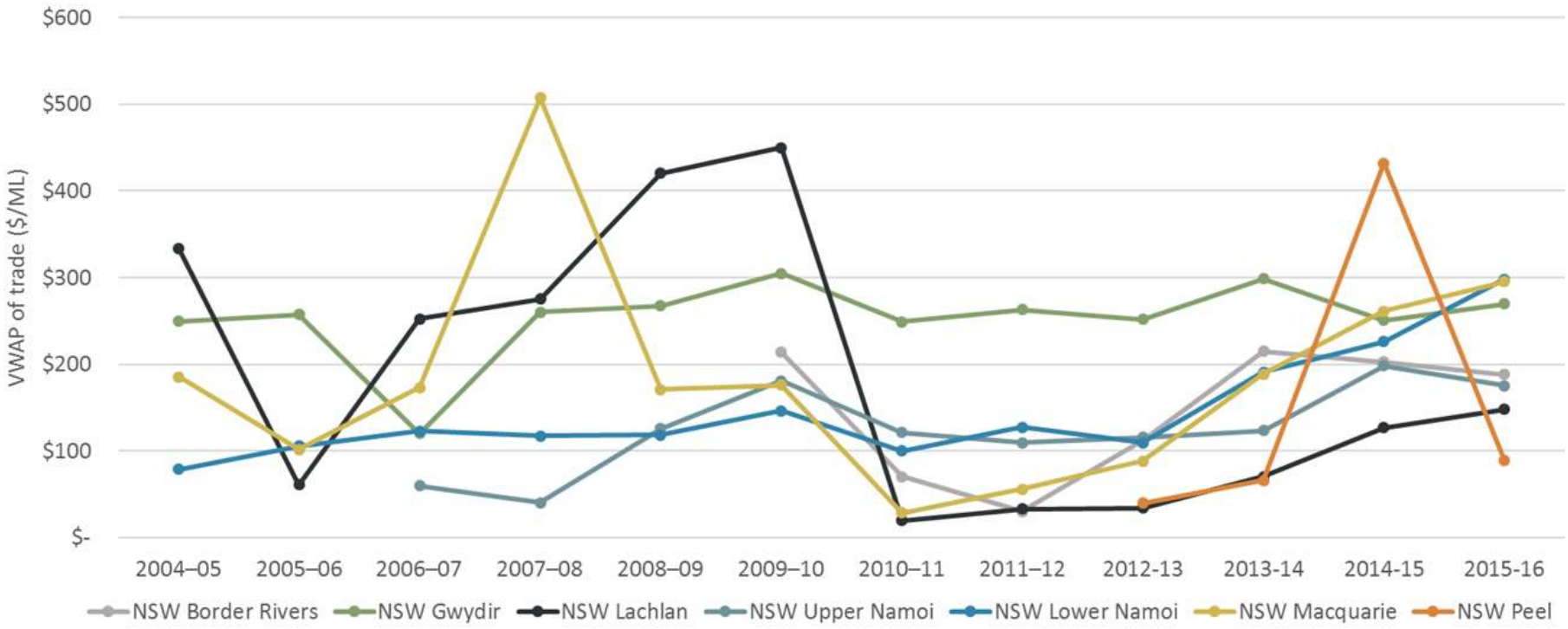
Northern MDB surface water allocation prices are shown in Figure 33. In very broad terms, and despite some significant inter-annual fluctuations within individual systems, the same correlation with water availability as was observed in the southern MDB, appears to be shown in the northern system. This is particularly so for the Lachlan and Macquarie (systems with relatively larger volumes of trade and depth of data compared to other northern MDB systems). The Border Rivers data also reveals this to an extent, as does the Upper Namoi. However, the Gwydir suggests a more even trend in prices that is not consistent with water availability in that region (refer Figure 137). Stakeholders have suggested there may be fewer larger businesses and larger properties in the Gwydir than Namoi, which may mean the Gwydir has longer term decision making than smaller operators in the Namoi or Macquarie, which may have an impact on prices.

Northern MDB groundwater allocation prices are shown in Figure 34. For these systems, it is also difficult to ascertain overall trends. However, most systems appear to show an appreciable increase in prices from 2013–14 to 2015–16 which may be tied to water availability. Some stakeholders have suggested groundwater prices may be driven by changes in water use towards higher value crops like permanent cropping, especially in the Gwydir, which can have the effect of reducing the available water for allocation trading when surface water is scarce (because permanent croppers are unwilling to sell allocations).

The differences in the value of allocation water between different regions is likely tied to the scale and nature of different agriculture industries in each region (whether for surface water or groundwater). Different crops have a greater capacity to pay different amounts for water as an input to production. If a region only contains crops with relatively low ability/willingness to pay for water (or is dominated by this crop type), then this is likely to keep prices lower than for other regions. Further to this, the amount of water on issue may have some influence on allocation prices, but this may be offset by the increased numbers of users (or size of industries) associated with the larger systems.

For example, for surface water, the Gwydir has trended relatively consistently at a higher allocation price than the Lower Namoi. The Gwydir has historically been dominated by Cotton, but is now comprised of a similar composite as the Namoi where there is a mix of pasture, other cereals, and other broadacre crops, as well as cotton (but other cereals dominate cotton by area). In addition, because allocation trade is not possible between these different systems, prices do not have the opportunity to equalise (which would occur, because demand would no longer be homogenous or contained to only those users within the one system).

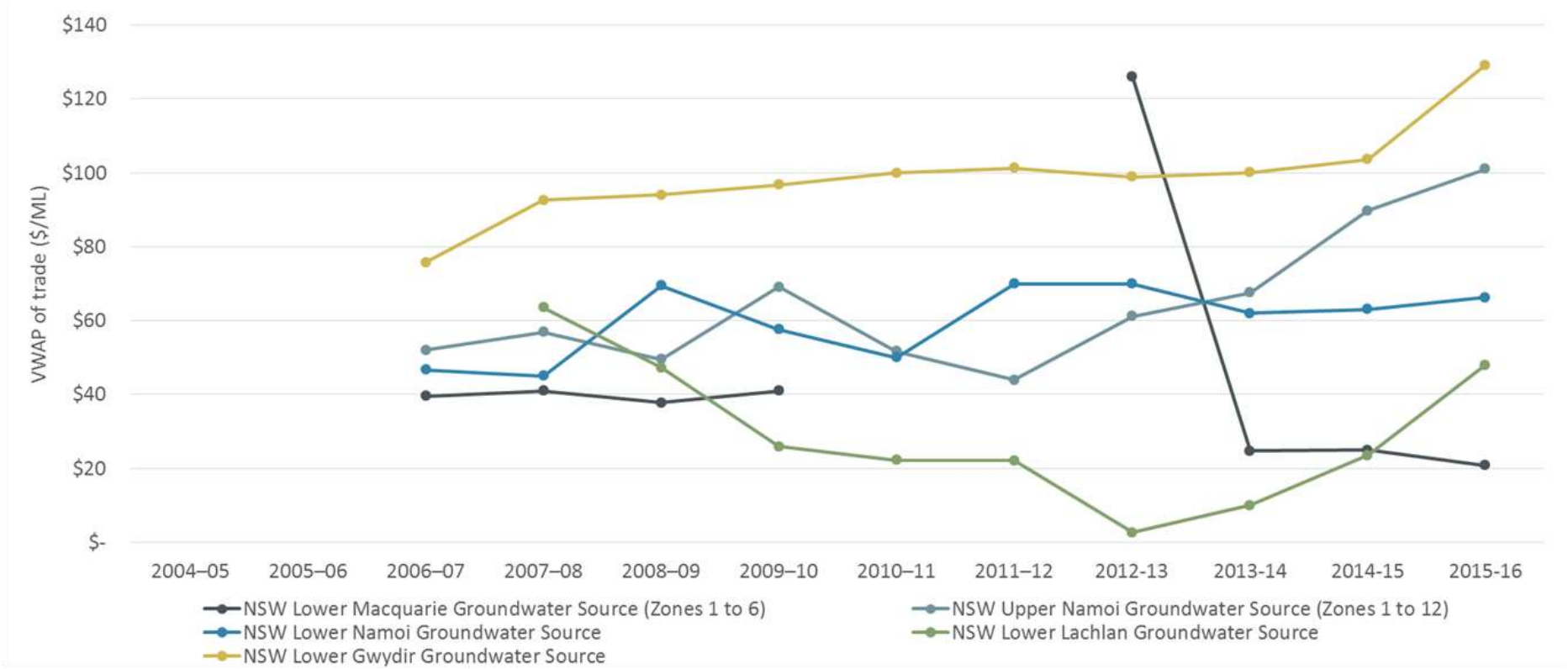
The timing of allocation sales can also have an impact within the yearly cycle. This includes increased willingness to pay for late season water to capitalise on yield and quality of crop, or in some cases lower willingness to pay early in the season due to the uncertainty of seasonal conditions and water availability.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

Figure 33 Northern Murray-Darling Basin surface water allocation prices, 2004–05 to 2015–16



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP). There is only one trade recorded for the Lower Macquarie in 2012–13 which may be contributing to the outlier observed.

Figure 34 Northern Murray-Darling Basin groundwater allocation prices, 2004–05 to 2015–16

4.4. Drivers of water trading

4.4.1. Supply

The key supply drivers in the northern systems are the same as systems elsewhere. They include water availability generally – as reflected in in-crop rainfall, inflows to storages, allocations to entitlements, and carryover – all of which influence water traded and prices achieved.

The drying, drought, flood, into drying sequence observed elsewhere in the MDB is also evident in the northern MDB systems, but not quite as strongly in some cases, or with variations in particular systems. This is expected given the wide geographic area, and given the climate characteristics in that sequence are not the same over that area.

For example, the Lachlan had poor water availability throughout 2004–05 to 2009–10 before increasing dramatically in 2010–11 but then declining from 2011–12 to 2014–15. The Macquarie exhibited the sequence more consistently with the southern MDB (e.g. a peak in 2005–06, declines into 2007–08), as did the Namoi, and the Gwydir, whereas the Peel and Border Rivers had no allocations during the first half of the study period as the relevant WSPs commenced in 2012 and 2009 respectively.[16]

4.4.2. Demand

Demand drivers in the northern MDB are unique to each system because the systems are not connected. This can mean a relatively homogenous demand for water (where the same crop type dominates), and therefore trade opportunities are lower. Or even if the demand for water is not homogenous (a variety of crop types), there may be fewer users with which to trade (a lack of potential counterparties can mean lower trade levels). Demand drivers over the study period can broadly be characterised as follows (based on ABS data):

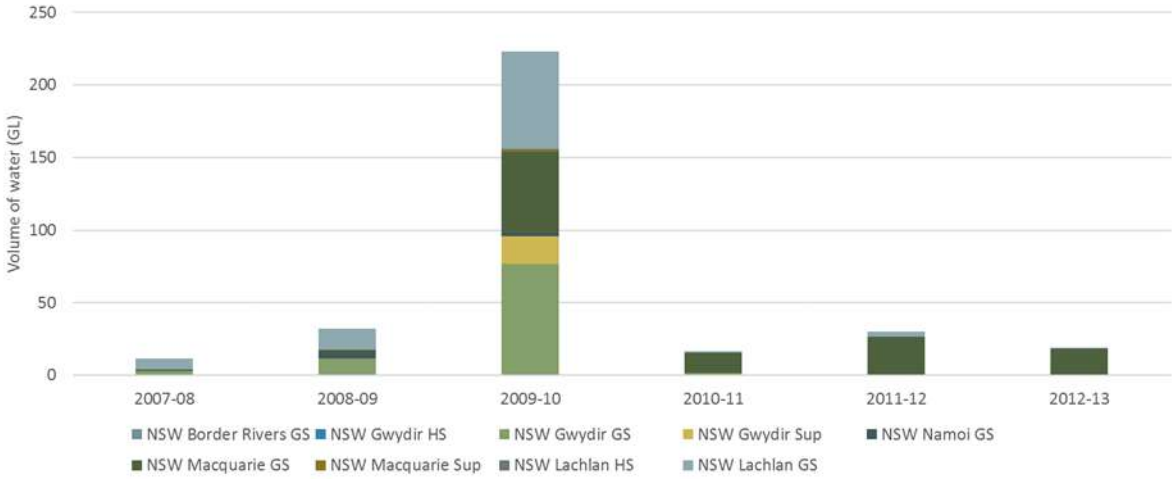
- By area, the Lachlan is dominated by pasture and other cereals, with not insignificant cotton, and a lower but even mix of other types. Over time, there have been declines in land use for pasture, other cereals, horticulture, grapevines and other crops, but increases in cotton. Similar trends in have occurred for water use, except for cotton which increased (comparing data for 2005–06 and 2014–15).
- The Macquarie is generally pasture, other cereals, and cotton, by area. There have been declines in land use for pasture, cotton, horticulture, grapevines and other crops, but increased water use for pasture, other cereals, and cotton (which may reflect the seasonal differences when comparing 2007–08 and 2014–15).
- The Namoi is mainly other cereals and cotton, followed by pasture, by area. There have been increases in land use for pasture and cotton, but decreases for other cereals, and increased water use for pasture, and cotton, but declines for other cereals (comparing 2007–08 and 2014–15).
- The Peel is primarily irrigated pastures and fodder crops, with no major cotton or cereals. Trend data has not been analysed due to inconsistencies between ABS reporting areas, and WSP area boundaries.

[16] The Peel and Border rivers had allocations under the *Water Act 1912* (NSW) during the first half of the period, however these do not fall within the scope of this report.

- The Gwydir is dominated by cotton (by area), although there has been a decline in land use for cotton, matched by declines in water use (comparing 2005–06 and 2014–15 data). Pasture and other cereals are also common in the area.
- The Border Rivers has historically been dominated by other cereals and cotton (by area). Over the study period there have been declines in land use for pasture, other cereals, and other broadacre crops, but increases in cotton. Similar trends have been observed in water use. (comparing 2007–08 and 2014–15 data).

The environment

Like the southern MDB, environmental water purchasing was undertaken in northern systems during the study period. As shown in Figure 35 this occurred in a variety of northern systems and for a variety of entitlement types. Relatively more General Security volumes were purchased, and purchases (registered) peaked in 2009–10.



Source: Aither analysis based on data published by the National Water Commission.

Note: Data shows volumes registered in that year rather than contracted sales. This aligns most closely with water trade volume data presented elsewhere in this report. The timing of tenders and time taken to process sales means registrations frequently appear in the year after the sale is made.

Figure 35 Northern Murray-Darling Basin Commonwealth environmental water recovery (registrations), 2007–08 to 2012–13

5. Coastal and unregulated systems

This chapter summarises trade outcomes and drivers associated with the following systems:

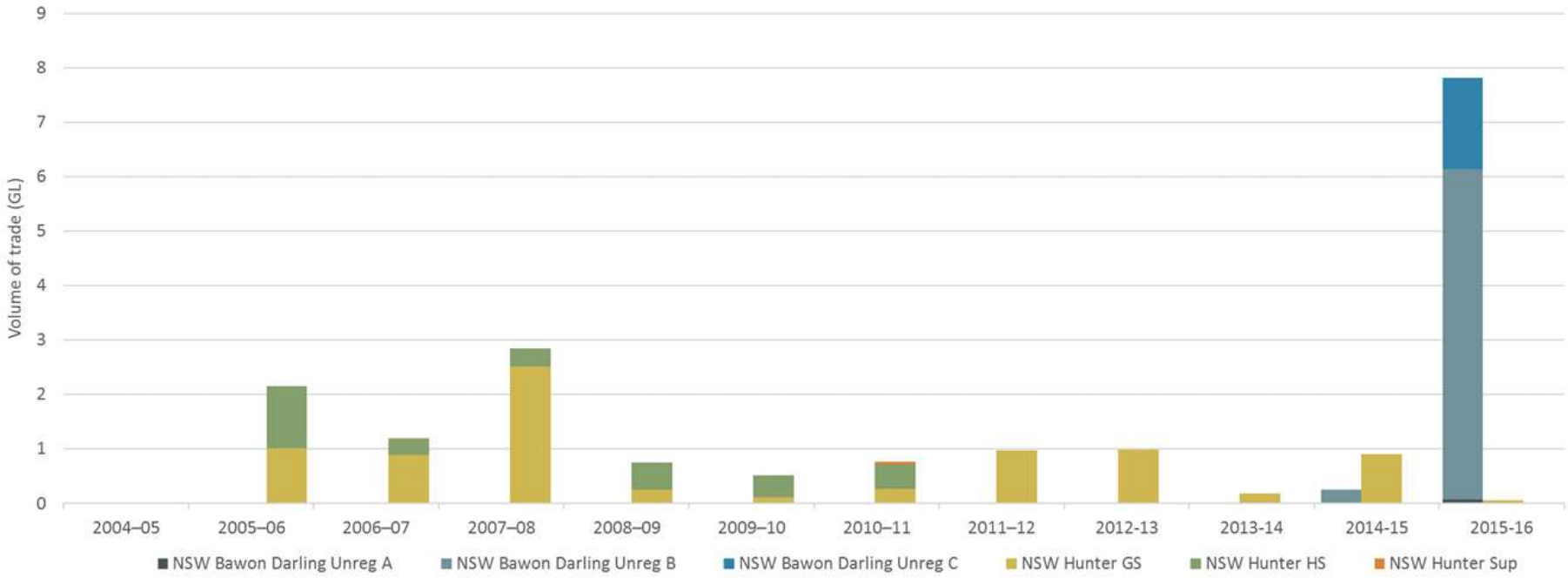
- Hunter – regulated surface water
- Barwon-Darling – unregulated surface water

While the Barwon-Darling is part of the northern MDB, these two systems have been grouped and discussed together given their uniqueness in terms of trade outcomes and drivers. Unregulated systems have significantly different water management operation and trade opportunities, while the Hunter is a coastal system with some unique drivers, and is the only coastal system where trade has been observed. Both systems also have relatively low amounts of trade meaning that data would not have presented effectively in comparison to others systems shown in figures throughout Sections 3 and 4.

5.1. Summary of observed water trade activity

5.1.1. Entitlement trade volumes

Figure 36 shows the surface water entitlement trade volumes for the Barwon-Darling, and the Hunter. Trade has been possible in the Hunter for much longer than the Barwon-Darling due to differences in when the WSPs were implemented. There are not particularly strong trends evident. Relatively greater trade volumes were observed in the Hunter in 2005–06 and 2007–08, with particularly low volumes in 2013–14 and 2015–16. In the Barwon-Darling, there was a substantial volume traded in 2015–16 with a much smaller amount traded in 2014–15. In the Barwon-Darling, unregulated class B has had most of the trade volume – which is in part explained by that class having by far the most entitlement on issue. In the Hunter, there has been a mix of General Security and High Security water traded, but very little High Security water has traded at all since 2010–11. In the Hunter, there are small volumes of High Security water on issue compared to General Security.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: Only includes 71Q trades. All $0 trades are removed in calculating both volumes and prices.

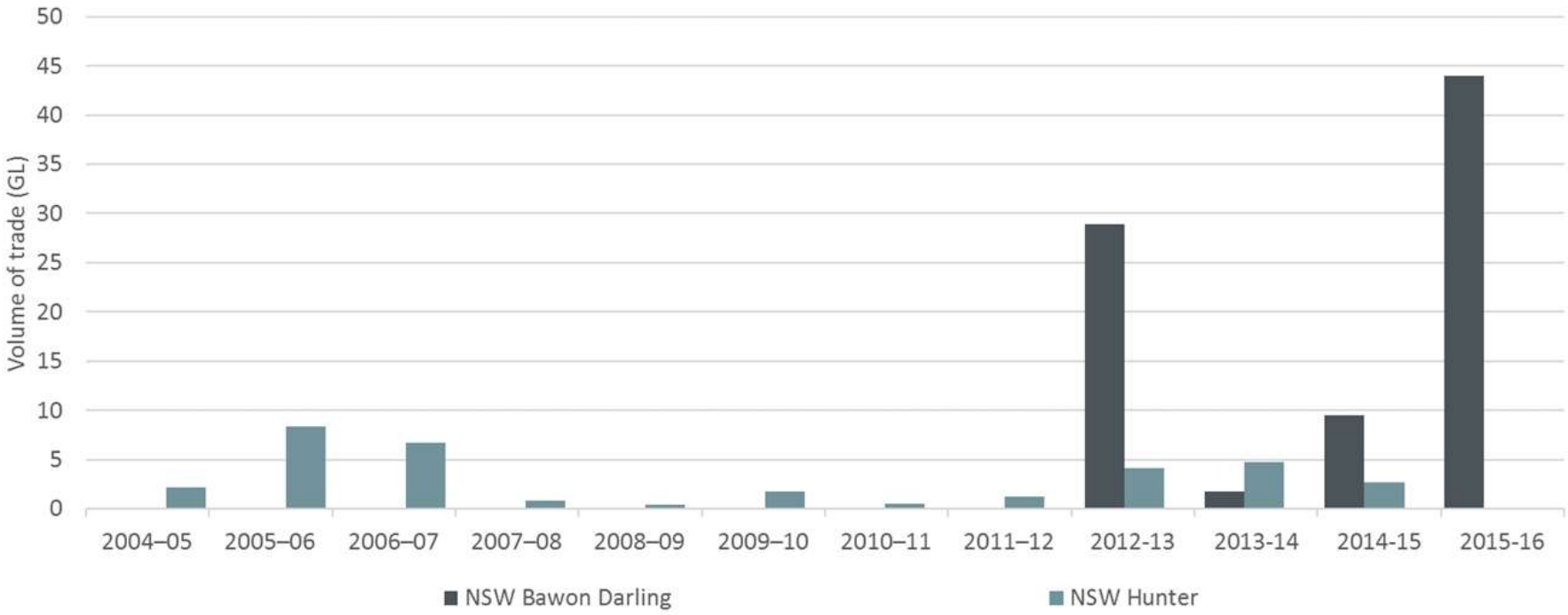
Figure 36 Coastal and unregulated surface water entitlement trade volumes, 2004–05 to 2015–16

5.1.2. Allocation trade volumes

Figure 37 shows the allocation trade volumes in the Hunter and Barwon-Darling. Trade mostly occurred in 2004–05 to 2006–07 and 2012–13 to 2014–15 in the Hunter. Peak years in the Barwon-Darling were in 2012–13 and 2015–16. While the relationship is not particularly strong, there may be a relationship between slightly lower surface water allocation amounts in 2006–07, and trade volumes, in the Hunter. Beyond this, allocation levels and trade have been somewhat consistent through the study period. Water allocation patterns over the study period in the Hunter are not the same as in the southern MDB or northern MDB – aside from the drop in 2006–07, there has been relatively consistent allocations.

The modest trade volumes in the Hunter may partly be a reflection of the modest amounts of water on issue, but also the isolated nature of the system, and the limited number of potential counterparties for trade. The large trade volumes in the Barwon-Darling are likely to relate to the nature of entitlements in an unregulated system, which can be quite large, and are held by a smaller number of users.

Allocation trade in the Barwon-Darling is characterised by relatively smaller numbers of high volume trades. This is partly due to a smaller number of users, many of which hold large volumetric rights. Allocation water trade may be driven more by pumping rights and conditions associated with licences, and the size of on-farm storages, rather than allocations and system inflows, which do not have a bearing (or really exist in the same sense) as in regulated systems.



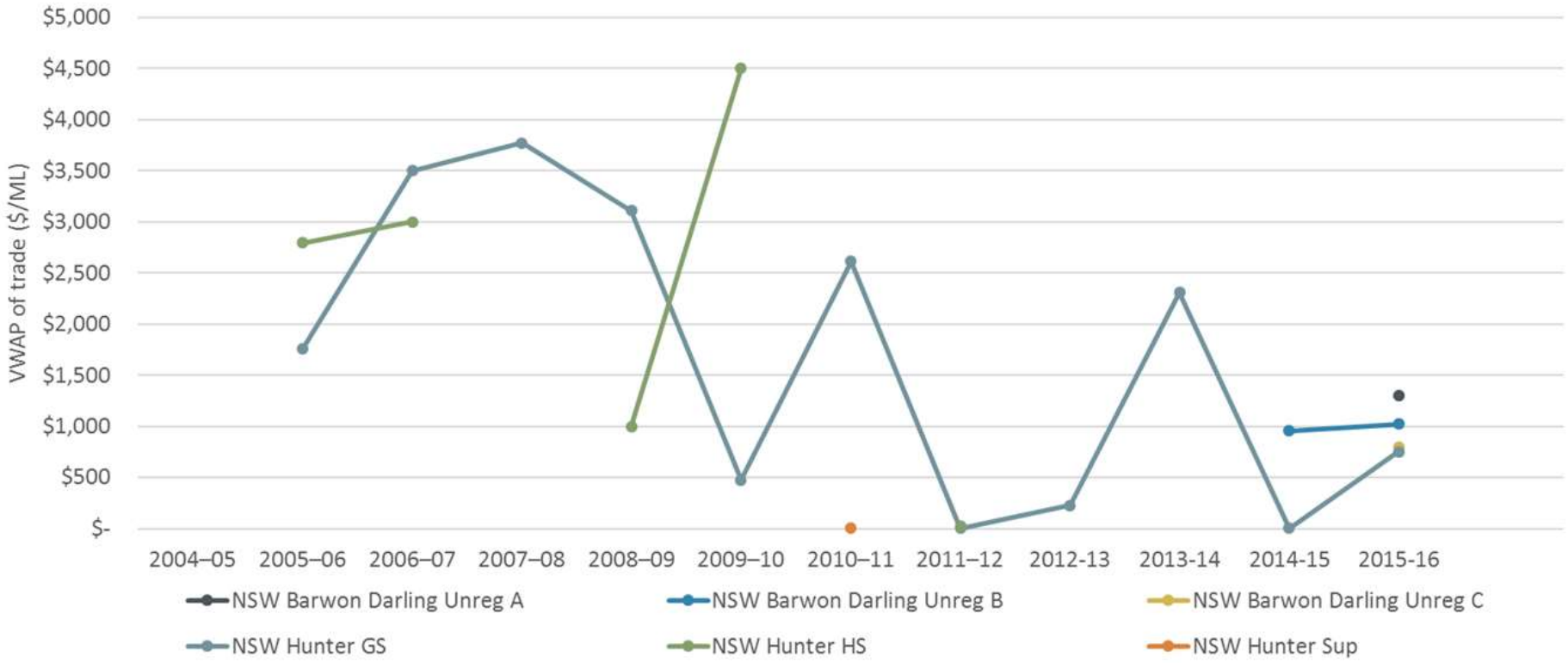
Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed from calculation of prices and volumes. Total volume of trade in a zone is defined as all trades within that zone, plus all trades into that zone, but excluding trades out of the zone (to avoid double counting).

Figure 37 Barwon-Darling and Hunter surface water allocation trade volumes, 2004–05 to 2015–16

5.1.3. Entitlement prices

Entitlement prices for the Hunter and Barwon-Darling are shown in Figure 38. Based on the available data, it is difficult to establish prices, and difficult to establish any clear trends. The Barwon-Darling Unregulated B entitlements appear to have traded consistently around $1,000 / ML in 2014–15 and 2015–16, with Unreg A and Unreg C trading marginally higher and lower than this respectively. Prices for Hunter General Security water have fluctuated dramatically over the period. Low numbers and frequency of trades may contribute to difficulty in establishing clear value of entitlements in the region. This also contributes to difficulty calculating prices (small number of data points – only 111 trade recorded over the study period, for which a much smaller subset have potentially valid prices recorded – e.g. non-zero prices).



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

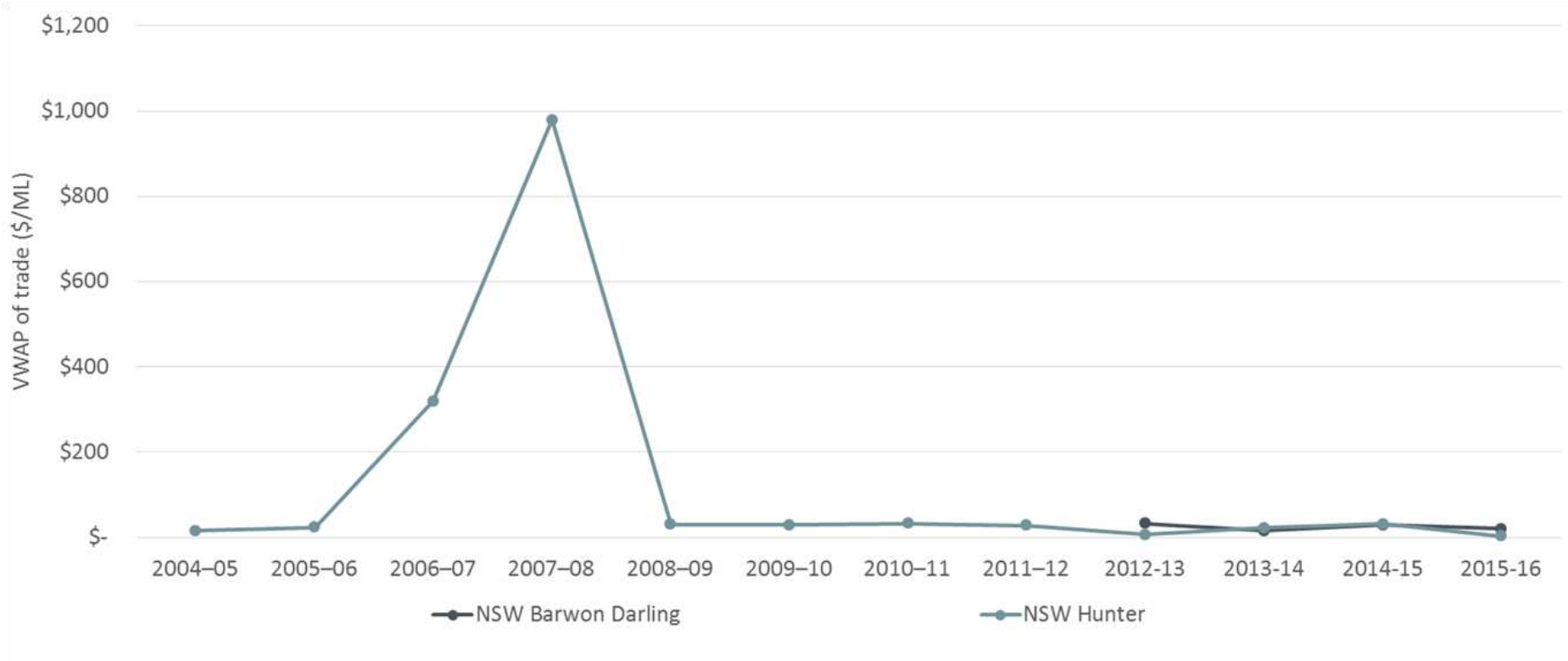
Figure 38 Barwon-Darling and Hunter surface water entitlement prices, 2004–05 to 2015–16

5.1.4. Allocation prices

Allocation prices are shown in Figure 39 for the Hunter and Barwon-Darling. Allocation prices have been mostly consistent in the Hunter outside the obvious peaks in 2006–07 and 2007–08, trading at around $30 per ML in most years. However, in 2012–13 this was around $6 per ML and in 2015–16 around $3 per ML. It is difficult to ascertain any drivers of these low prices based on supply – allocations to entitlements were consistently high in the later years. However, 2006–07 price highs are most likely explained by water supply (as well as the nature of demand), with 2006–07 being the lowest water allocation year in the study period –substantially lower than other years, which may have contributed to prices increasing in 2006–07 and 2007–08. Carryover was also extremely low in 2004–05 to 2006–07(much lower than all other years), rainfall was sharply lower than average in 2005–06, and storage levels were also substantially lower. It may be the case that the decreased water availability event had not been experienced in some time (i.e. the event was unusual), and not since water markets had been introduced. The market resulted predictably (high prices), but prices may have been driven much higher given the lack of experience with the conditions. The presence of mining activity in the region that relies on water may contribute to the high's, given these users are likely to have a very high capacity to pay for water, and must secure sufficient supply (i.e. not producing is essentially not an option).

Allocation prices in the Barwon-Darling have moved from highs of around $30 per ML to lows of around $15 per ML. There is not yet any obvious way to explain trends in allocation prices in the Barwon-Darling. Trade is relatively immature, and infrequent, and water availability conditions do not appear to have the same impact on allocation prices as they do in regulated systems.

Stakeholders have suggested that trade in the Barwon-Darling can be explained in part by the sale of two large agricultural enterprises in 2014–15. They have also suggested that continuous accounting may also have an impact. Due to a combination of drought and generations provisions upon WSP commencement, some accounts may be in surplus and may remain so for some time.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Note: All $0 trades are removed when calculating prices, however in some cases outlier prices may still be present. Prices reported are volume weighted average prices (VWAP).

Figure 39 Coastal and unregulated surface water allocation prices, 2004–05 to 2015–16

5.2. Drivers of water trading

5.2.1. Supply

Hunter

The Hunter only experienced one major water availability (supply) event during the period. This was in 2006–07, where there was a total allocation level only around half of the average total annual allocation amount for the period. This helps (in part) to explain the significant price spikes observed in 2006–07 and 2007–08. Carryover was much lower than normal in 2004–05 to 2006–07 and non-existent in 2005–06, rainfall was sharply lower than the median in 2005–06, and storages were at only around 25 per cent near July 2007.

Barwon-Darling

Rainfall in the Barwon-Darling was above average for 2009–10 to 2011–12, but below average in 2012–13 and 2013–14. Major flood events have occurred in 2010, 2011, 2012, and to a lesser extent in 2013 (which reflects upstream conditions more than local rainfall). Because of the nature of unregulated systems, these factors do not appear to be able to explain trade outcomes in the same way as regulated systems. Conditions in on-farm storages, and the pumping conditions for licences associated with those storages may play a more significant role. In addition, carryover arrangements and provisions may be a driver of lower observed trade.

5.2.2. Demand

Hunter

The Hunter is dominated by irrigated pasture, far greater by area than other land use types. There is a small amount of grapevines and other crops. There has been a decline in pasture when comparing data from 2005–06 and 2014–15 (for both land area and water use).

Mining is a significant user of water in the Hunter, and anecdotally Aither understands demand from mining may have driven some trade of entitlement away from irrigated agriculture. This may have contributed to certain price spikes observed for entitlements during the study period (such as the increase in High Security prices immediately following 2006–07). This may have been a response to the unusual conditions in 2006–07, which may have motivated miners to secure additional water.

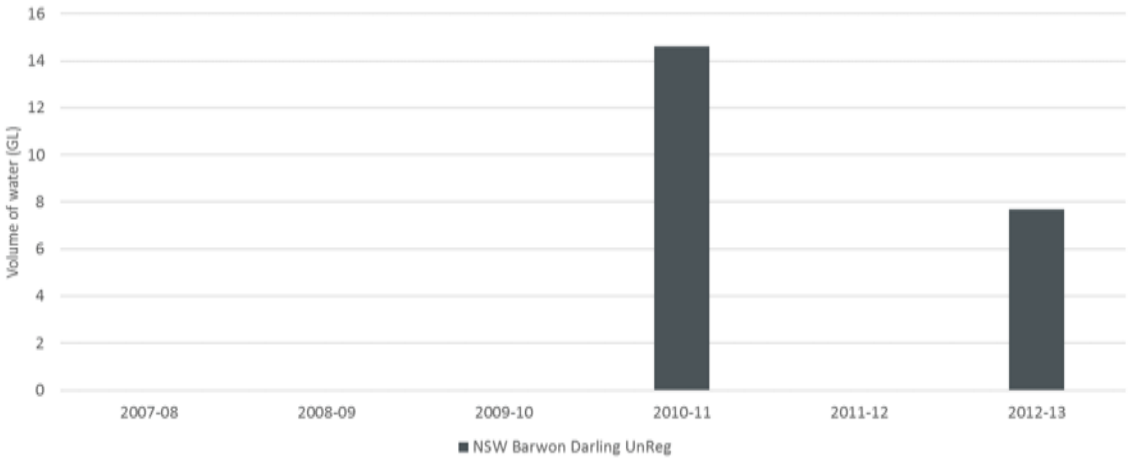
Barwon-Darling

Aither understands that agricultural activity in the Barwon-Darling is primarily beef and sheep grazing on pastoral land, with irrigated production occurring on plains adjacent to the river. This is primarily cotton. Unfortunately, publicly available land and water use data for the catchment is inconsistent and not easily comparable to establish any trends that would explain the trade that has been observed. However, it is likely that there may not be a particularly large number of irrigation enterprises, and which may have similar demand patterns, and may contribute to the relatively less frequent trade (volumes per trade are higher, reflecting the much higher volumes associated with each licence). Some stakeholders have suggested it is possible that slight increases in trade over recent years could be driven by smaller and medium irrigators moving out and entitlements consolidating amongst larger users.

The environment

There was some Commonwealth environmental purchasing in the Barwon-Darling during the study period, but not in the Hunter (Figure 40).

This data is not reflected in trade volumes on the NSW water register (and therefore does not appear in other charts in this report), which may be because the 2010–11 volumes shown are reported as being 1912 licences, a form of licence that precedes water sharing plans.



Source: Aither analysis based on data published by the National Water Commission.

Note: Data shows volumes registered in that year rather than contracted sales. This aligns most closely with water trade volume data presented elsewhere in this report. The timing of tenders and time taken to process sales means registrations frequently appear in the year after the sale is made.

Figure 40 Commonwealth environmental water recovery (registrations) in the Barwon-Darling, 2007–08 to 2012–13

6. Explaining trade outcomes and regional differences

This section presents analysis and discussion that aims to explain some of the differences observed between different water systems with respect to trade, in addition to some of the key drivers of trade outcomes explored and discussed in the preceding sections.

6.1. Key differences or relationships between systems or products

Some of the key differences that are observed in the trade data include that:

- There are differences in the prices of different entitlement classes within systems (e.g. Murray High Security vs. Murray General Security)
- There are differences between the value of similar entitlement classes across systems (e.g. Lachlan General Security vs. Murray General Security – compare a cluster of General Security and a cluster of High Security products in two charts)
- There are substantial differences in trade volumes between systems, for both entitlement and allocation trade
- Groundwater entitlements and allocations have substantially different trade volumes and prices compared to surface water
- There are differences in prices for allocation water in different regions

6.2. Key factors driving trade outcomes and regional variations

A note on the amount of trade

It is important to note that high volumes or a large extent of trade are not necessarily 'better' than low volumes or extent of trade. As noted in Section 1.3, there are various enabling factors or characteristics that drive demand for trade. In areas where these factors are not present (or partly present), there may not be demand for trade (or demand is lower), and this is not necessarily 'bad'. Where trade is possible and is occurring to a significant extent, this does support there being significant economic benefits from trade, but the extent of trade will always vary in response to a range of changing factors and circumstances. What is most important is that trade is available to water users and able to occur free of artificial constraints, in areas where there is, or is likely to be demand for trade. This broadly aligns with systems that exhibit the characteristics in Section 1.3.

6.2.1. Entitlement on issue

The amount water on issue in different systems influences the amount of irrigated agricultural activity that can occur, and therefore may also have a bearing on the number of water users. In systems with smaller volumes of water on issue there tends to be lower volumes of trade than in systems where there is more water. Having a large number of potential or actual users increases the number of

potential counterparties to trade. This is an important, but not sufficient condition, for there being larger volumes of trade.

In systems with lower volumes of water on issue, this acts as a supply constraint. This has the potential to drive higher prices because there is less water available. However, water systems that have less water on issue do not always have higher entitlement prices as this also depends on demand. This includes the nature of irrigated agriculture in the region, such as what crops can be grown and their demand characteristics. Prices also depend on the availability of alternatives (such as groundwater).

Table 2 shows the total surface water entitlement on issue, and the average annual volume of trade in the same systems.

Table 2 Comparison of entitlement on issue and annual volume of entitlement trade

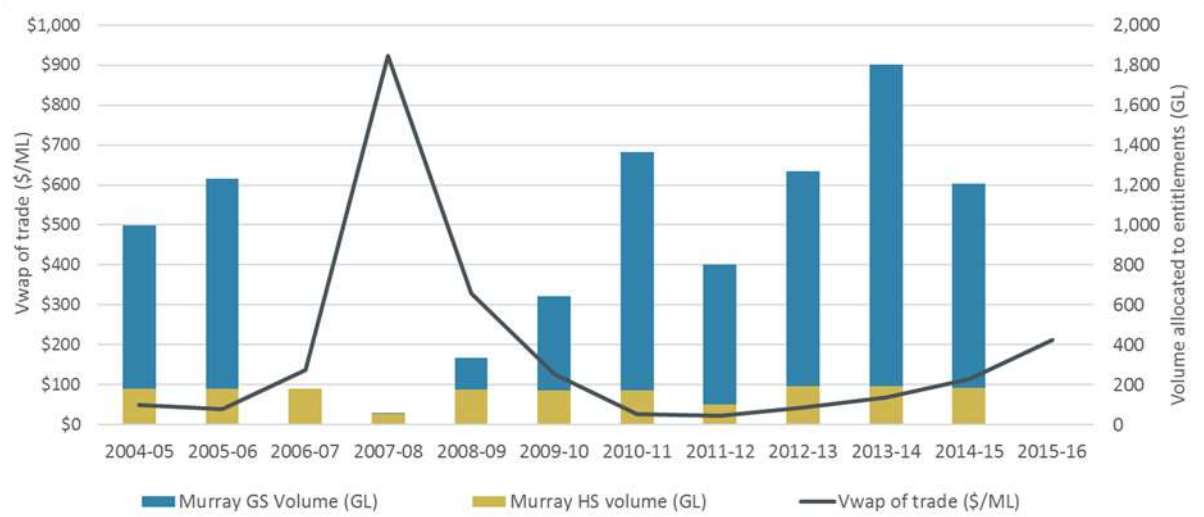
System	Total surface water volume on issue (2015–16, ML)[1]	Average annual entitlement trade 2004–05 to 2015–16 (ML)[2]
Murray	2,500,670	27,124
Murrumbidgee	3,654,220	36,906
Lower-Darling	348,784	689
Lachlan	666,700	10,860
Macquarie	725,175	28,007
Namoi	380,557	1,576
Peel	47,795	95
Gwydir	717,982	12,302
Border Rivers	386,360	3,519
Hunter	247,463	1,025
Barwon-Darling	196,499	4,031

Note: 1) Includes all regulated surface water entitlements only. 2) Includes 71Q trades only.

6.2.2. Water availability – allocations to entitlements

Water availability can explain a lot regarding prices for surface water allocations but also drives entitlement prices (to a lesser extent). This includes changes in prices over time, as well as differences in prices between systems. This is particularly the case for systems that are not hydrologically connected, and far apart geographically. This is because those systems may experience significantly different rainfall patterns (and inflows and storage levels) which in turn drive allocations (supply), as well as demand for water (demand changes with in-crop rainfall for example).

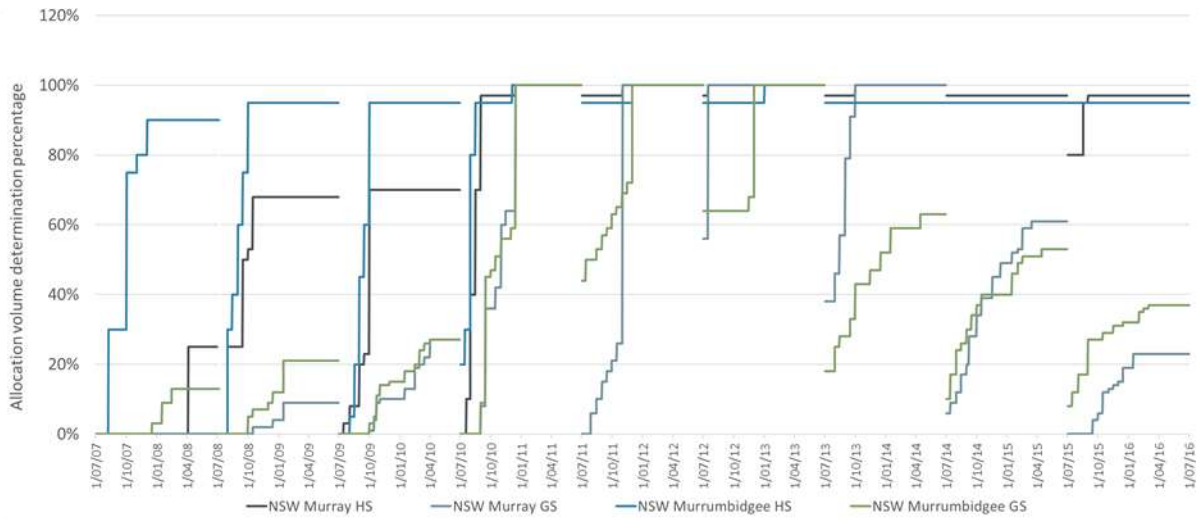
Figure 41 shows the relationship between allocation levels, and allocation prices, over time. It shows how closely aligned the level of water allocations is, with the price of allocation water. When allocations are high, prices are low, and vice versa.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Figure 41 Comparison of annual allocation prices and volume of water allocated to entitlements - NSW Murray 2004–05 to 2015–16.

Figure 42 compares announced allocation percentages (Available Water Determinations, or AWDs) across several different NSW systems over time. This shows how water available can vary significantly from one system to another, and how systems do not necessarily follow the same water availability pattern over time. Even in this case, where systems are in a similar region, there can be major variances (e.g. in later years). This can reflect several factors, such as rainfall, inflow to storages, volume already held in storages, and other factors. In part, this helps to explain why prices between systems differ (other factors play a role, including entitlement on issue, and the nature of water demand/use in the regions).



Source: Aither 2016. Based on information provided by NSW DPI Water.

Figure 42 Comparison of monthly allocation volume determination percentages for NSW Murray High Security and NSW Murrumbidgee High Security

6.2.3. Reliability of different entitlement classes

One of the major defining factors for different entitlement classes is their reliability. High Security is more reliable than General Security. This means High Security is given priority and is more likely to receive allocation than General Security. Some water users need this greater reliability and are willing to pay a premium to ensure they have it. This commonly includes irrigators with permanent plantings, enterprises that require given throughput in all years (meeting a certain level of production to support downstream processing facilities), or potentially also those with higher gross margins, or those wishing to avoid risk.

The following table shows the modelled long-term extraction factor of different major entitlement product types that have been presented in this report and compares this with their long-term average prices for the study period (reliable prices are not available prior). The long-term extraction factor is analogous to the long-term average annual reliability of entitlements, under a 'full development' scenario.[17] The table shows how prices generally vary in step with reliability – more reliable entitlements (extraction factor closer to 1.0) have greater value as revealed by prices. Differences in prices for entitlements with a very similar extraction factor (such as Lachlan High Security and Macquarie High Security) can be explained by different factors, including the amount of that entitlement on issue, and the types and scale of irrigated agriculture in the different regions.

[17] See Section 2.1.9.2 of Ribbons, C., 2009, *Water availability in New South Wales Murray-Darling Basin regulated rivers*. NSW Department of Water and Energy, Sydney.

Table 3 Comparison of the long-term extraction factor of entitlements and long-term average prices

Product	Long term extraction factor	Long term annual VWAP 2004–05 to 2015–16 ($)
Murray GS	0.80	$933
Murray HS	0.93	$2,036
Murrumbidgee GS	0.63	$978
Murrumbidgee HS	0.92	$2,350
Lower-Darling GS	0.88	$783
Lower-Darling HS	0.91	$1,502
Lachlan GS	0.42	$547
Lachlan HS	0.97	$1,585
Macquarie GS	0.53	$1,246
Macquarie HS	0.95	$3,235
Namoi GS	0.76	$1,886
Namoi HS	0.95	Insufficient trades recorded
Peel GS	0.20	$988
Peel HS	0.95	Insufficient trades recorded
Gwydir GS	0.41	$2,291
Gwydir HS	0.95	Insufficient trades recorded

Source: Aither 2016 and Ribbons, C., 2009, *Water availability in New South Wales Murray-Darling Basin regulated rivers. NSW* Department of Water and Energy, Sydney.

Notes: Long term annual VWAP values are calculated as the average over all VWAP values over 2004–05 to 2015–16 for each product. Some systems are excluded because long-term reliability data is not available. Border Rivers entitlements are not shown because long-term extraction factors are not separately published for GSA and GSB.

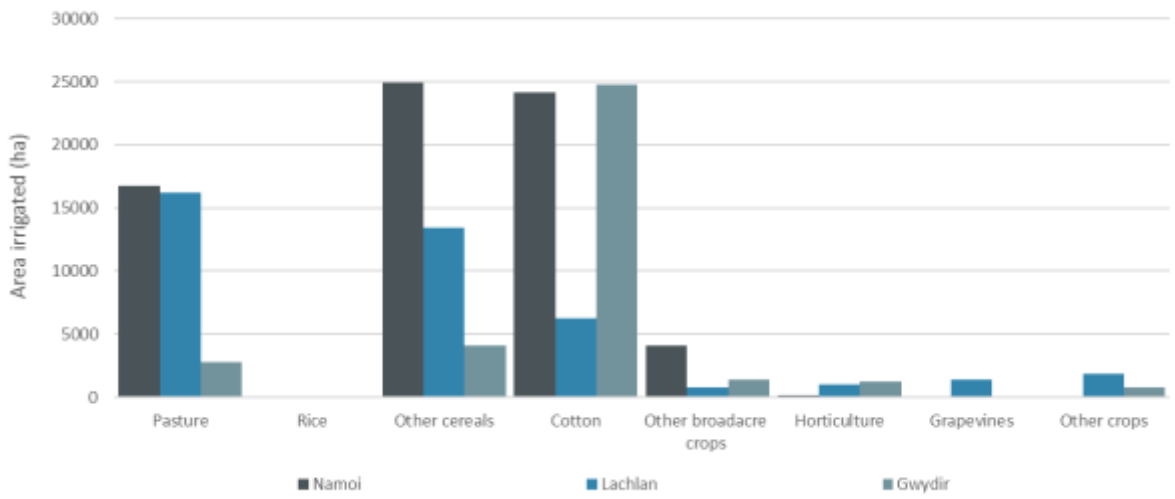
6.2.4. Crop type and extent

Different regions have different types of crops planted and to different extents. This is the major demand driver for water and has an impact on the absolute prices achieved in a location, as well as the relative prices between regions. The heterogeneity of crop type within a region has a bearing on the extent of trade that occurs. Some further observations regarding crop type include:

- Regions with a single dominant crop may have less trade because all growers face very similar water demand requirements (and supply conditions)
- Regions with a variety of crop types (or regions that are hydrologically connected) may have more trade because their water requirements are different
- Regions dominated by crop types with higher gross margins, downstream processing requirements, uninterruptible supply, or generally greater aversion to risk, are likely to support higher prices

The following figure provides a comparison of land use across different catchment areas, using the most recent comparable dataset (ABS, 2014–15). While this is not a perfect proxy indicator of demand, it gives an indication of which catchments have a diversity of crop types (e.g. Namoi, and to

lesser extent the Lachlan) vs. which crops have a dominant crop (e.g. the Gwydir), and the relative land use between them (e.g. significant variation in other cereals between the catchments).



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

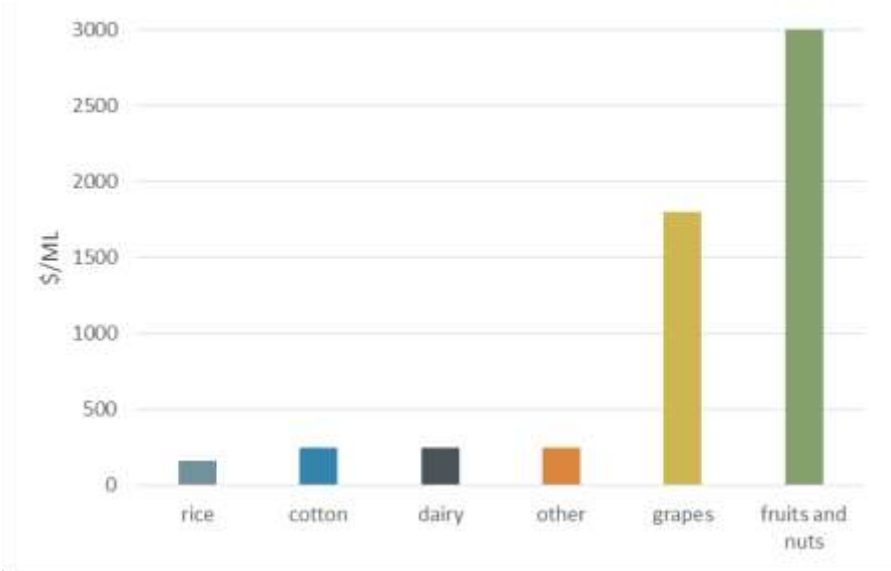
Figure 43 Comparison of land use for different irrigated crop types, Namoi, Lachlan, and Gwydir, 2014–15

As noted above, different crops have different margins, reflected in their willingness to pay for water. Table 4 and Figure 44 illustrate how this varies between crop types. Combined with consideration of the dominant crop type in a region, it helps to explain why prices may be higher in certain regions. If a crop with higher willingness to pay for water dominates an area, then there is the potential for higher prices to be achieved in that area.

Table 4 Estimated allocation water cut off price by industry, 2013–14

Crop type	Cut off price ($/ML)	Confidence ($/ML)	Basis
Grapes	1,800	Low. Potential range 1,000 to 3,000.	Analysis of land values. Analysis of farm survey data by Hughes (2011).
Fruits and nuts	3,000	Low. Potential range 2,000 to 5,000.	Analysis of land values.
Rice	165	High. Potential range 150 to 180.	Stakeholder consultations. Analysis of gross margins.
Cotton	250	Medium. Potential range 200 to 300.	Stakeholder consultations. Analysis of gross margins.
Dairy	250	Low. Potential range 150 to 350.	Stakeholder consultations. Analysis of farm survey data by Hughes (2011).
Other	250	Low. Potential range 150 to 350.	Comparison with other activities.

Source: Aither, 2016, Contemporary trends and drivers of Irrigation in the southern Murray-Darling Basin. RIRDC, ACT.
Note: Cut off price is the highest per ML price that the average producer is willing to pay to secure water per unit of production. This may vary both within and between seasons as other factors change. Confidence is the plausible range of willingness to pay either side of the assumed average cut off price.



Source: Aither, 2016, Contemporary trends and drivers of irrigation in the southern Murray-Darling Basin. RIRDC, ACT.

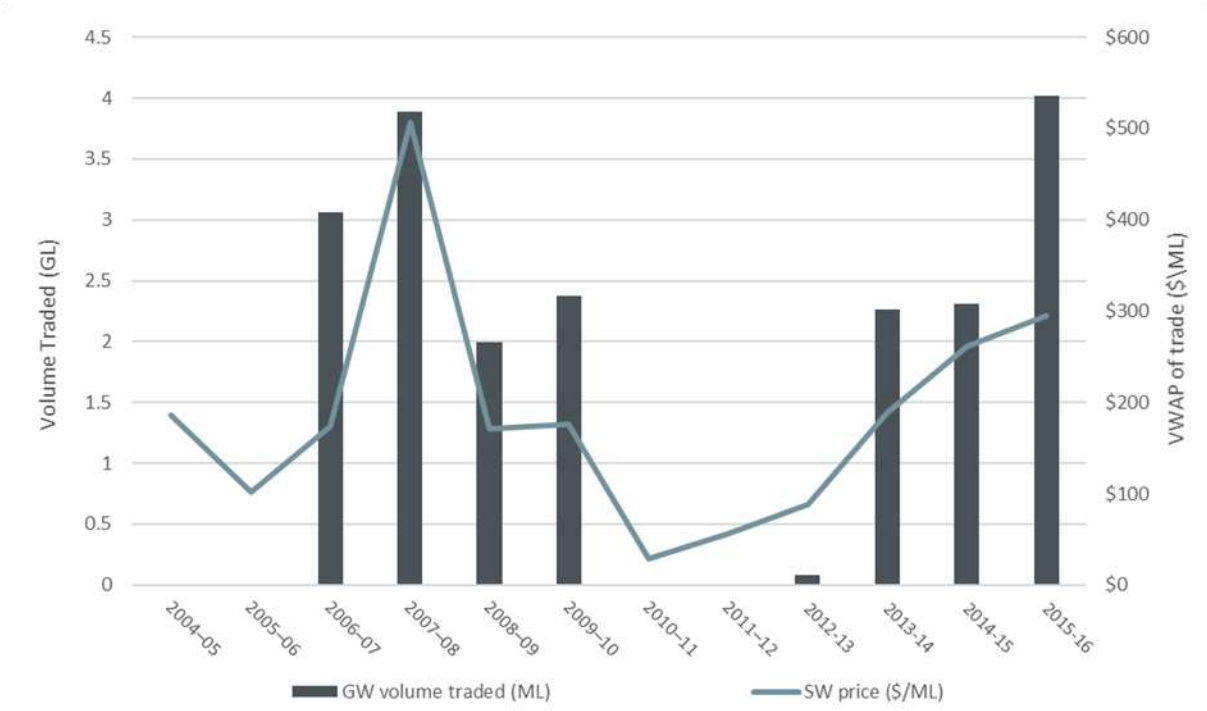
Figure 44 Estimated cut off price by industry, 2013–14

6.2.5. Groundwater

As has been discussed in preceding chapters, groundwater can act as a substitute source for surface water. However, it can also be relied upon solely by irrigators in some circumstances. In general groundwater may be more expensive to apply (due to the cost of establishing and maintaining a bore, and the higher pumping costs), but the per unit cost of groundwater (as traded in the market) is often cheaper than surface water. The fact that the costs of applying are higher may partly be a driver of lower per unit costs.

Groundwater is also very difficult to trade across space as there is no river to deliver water to another user. Users must generally trade allocation water within their aquifer and potentially within smaller zones within an aquifer. Entitlements generally must also be traded within an aquifer or zones. In both cases, this restricts the number of potential buyers and sellers, which can put downward pressure on prices overall (meaning groundwater entitlement and allocation prices are frequently lower than surface water).

The slightly more restricted nature of groundwater trade, and the costs associated with applying for and having trades approved (including financial and time cost, and uncertainty), could also have a bearing on the extent of groundwater trade, and prices. If margins in an industry are set, and all other factors are held constant, prices achieved are likely to be lower to account for the higher cost and risk associated with applying for and processing a trade.



Source: Aither 2016. Based on information provided by NSW DPI Water.

Figure 45 Comparison of annual groundwater allocation trade volume, and surface water allocation prices, NSW Macquarie 2004–05 to 2015–16

6.2.6. Connectivity and market depth

As explained in Sections 3 and 4, the southern MDB and northern MDB differ substantially because the southern MDB is connected, and also connected to interstate markets. The connectivity creates a much larger market with many more potential participants, with a wide variety of crop types over large geographic areas. This creates vast opportunities for trade and provides a significantly deeper market. This is a key factor in the equalisation of allocation prices across a number of water systems (Murray, Murrumbidgee, and to a lesser extent Lower Darling in NSW, Victorian and South Australian systems).

In contrast, northern MDB systems, and coastal systems, generally cannot trade to others outside their systems. This limits the number of potential buyers and sellers, which means lower volumes of trade may be observed relative to larger connected systems.

As noted above, this also applies to groundwater systems, which can be even less connected (i.e. the aquifer defines the boundary, and zones within an aquifer may even more tightly contain potential trade).

In the case of isolated or less connected systems, this is not necessarily a bad thing. Many systems cannot trade with one another simply because water cannot be delivered, or could only be delivered with unacceptable third party impacts (such as loss of water during transmission).

The following table illustrates the number of discrete water access licences in several different systems. While one entity or user can hold several WALs (and WALs can also be combined or split) this provides a broad indication of the relative potential size of a market in the different systems (greater number of WALs support a larger potential market because there are more counterparties).

Table 5 Number of separate WALs involved in allocation trades from 2004–05 to 2015–16

Region	Number of separate WALs involved in trade 2004–05 to 2015–16[b]
Southern Murray-Darling Basin[a]	3937
Lachlan	900
Macquarie	689
Namoi	393
Peel	144
Gwydir	187
Border Rivers	219
Hunter	462
Barwon-Darling	59

Source: Aither 2016, based on data provided by NSW DPI Water.

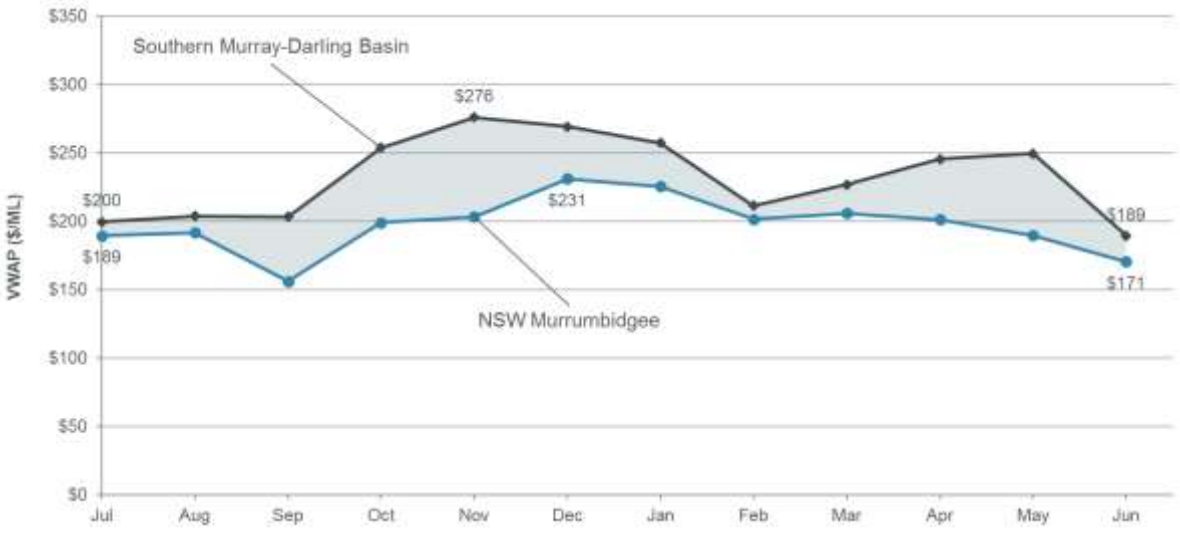
Notes: a) This is the sum of Murray, Murrumbidgee, and Lower-Darling. b) Based only on surface water allocation trades. Table excludes within irrigation corporation trades.

6.2.7. Trade rules

Trade rules can impact on trade, by restricting the direction or extent of trade in certain circumstances or preventing it entirely. In most cases, trade rules are designed to reflect hydrological realities such as systems not being connected, or not connected enough to facilitate trade. They may also be designed to prevent unacceptable third party impacts, such as aquifer drawdown preventing other users from accessing the water.

A high profile example of the way in which trade rules can impact on trade includes the Murrumbidgee Intervalley Transfer limit (often called the Murrumbidgee IVT). This rule limits the extent of downstream trade out of the Murrumbidgee based on underlying rules related to hydrological constraints. For a period of time in some years the rule is ‘binding’ meaning that there is demand for trade that cannot be fulfilled due to the rule. This can have implications for allocation prices (because demand within the Murrumbidgee is constrained by the rule) but can also have broader economic efficiency implications (because not all available water is moving to higher value uses). However, as noted, there is a trade off between these outcomes and potential downside hydrological or third party impacts.

As is shown in Figure 46, during the 2015–16 water year, the price for allocation water in the Murrumbidgee was substantially lower than the rest of the southern MDB, despite being part of the connected system. This illustrates not only how the trade rule impacts on trade, but also how ‘disconnected’ systems mean there will be differences in prices. In the southern MDB this can often occur because there is greater demand from higher value and permanent plantings downstream in the Murray that have higher willingness to pay for water than many growers or crop types in the Murrumbidgee.



Source: Aither 2016. Based on NSW, SA, and Victorian water registers.

Figure 46 Comparison of monthly water allocation prices, Murrumbidgee and southern MDB, 2015–16

6.2.8. Infrastructure costs and pricing issues

Another factor, but which is likely of more limited impact on market outcomes or regional differences, is the costs associated with the infrastructure in different locations, and how this is recovered from users. In the different systems, there are different types and extent of infrastructure. Some have many structures (e.g. dams or weirs) with some of these significant in terms of size, as well as the cost to maintain and run them. In other systems, there may be less infrastructure (e.g. a small system with one dam structure), which may have lower costs. In the southern connected systems there are generally a large number of users of which to spread the costs of this infrastructure, which means that per user, the costs may be very manageable. However, in some systems there are a much smaller number of users, which can contribute to higher per user costs (even if infrastructure costs are lower).

Fees and charges associated with the infrastructure are partly recovered based on entitlements held by water users. If the infrastructure costs are higher in a certain area, this could contribute to how entitlements are valued in that region (e.g. buyers and sellers build their understanding of ongoing entitlement charges into their valuations of entitlements). For example, the fixed and variable charge for a General Security WAL in the Murray valley in 2016–17 is $0.97 and $2.31 per Megalitre (ML) respectively. While in the Peel valley, the fixed and variable charge for a General Security WAL is $3.88 and $58.26 per ML respectively. While this is a substantial difference, in reality, these issues are likely to play a substantially lesser role in entitlement valuation than other factors, and are unlikely to play any role in the extent of trade that occurs.

6.2.9. Unregulated systems

Water management in unregulated systems (no dams or structures that store water for release) is somewhat different to that in regulated systems (systems with dams that hold water for subsequent orders and use). In unregulated systems, entitlements are generally based on the right to pump water given flow conditions (such as river height) rules being met. No water is held in shared off-farm storage for an irrigator to order from and have delivered when they choose. To substitute for this lack of storage, many enterprises have large on-farm storages which are filled by privately pumping from the river.

By southern MDB standards, major irrigated agriculture water users in the Barwon-Darling River hold relatively large entitlements (tens of gigalitres in some cases). These major water users can fill large on-farm water storages with water diverted from the river and use this stored water to manage their within and inter-year water use for irrigation.

Entitlement trade in unregulated systems may be driven by similar factors as elsewhere. These include longer term decisions by enterprises to exit or enter the industry or to permanently expand or contract their levels of production over the longer term.

However, allocation trade does not follow the same trends, and isn't driven by the same factors as in regulated water systems. Trade may be more opportunistic and drivers may more likely reflect the unique pumping and storage arrangements, such as an irrigator reaching their on-farm water storage capacity and choosing to sell excess water temporarily (i.e. pumping capacity for the year) to another producer.

The limited number of trades observed in the Barwon-Darling in part reflect the uniqueness of the system, but also the relatively recent commencement of the WSP in 2012. Prices and volume for allocation water have varied markedly, possibly due to the relative immaturity of the market and its size. There tends to be fewer users, who hold much larger water rights, than in southern systems, which limits the counterparties and opportunities for trade. Trades that have been observed are frequently larger in volume, reflecting factors such as very high carryover capacity and the ability to extract multiples of share volume every year.

Appendix A – Regional summaries

Murray Catchment

Summary

The Murray is part of the southern MDB, and covers a relatively wide geographic area from the east to west of the state. This summary covers regulated surface water, and groundwater, both of which form an important part of irrigated agriculture.

The majority of water is issued in General Security (67 per cent of surface water) with High Security forming 8 per cent. The Murray has a large volume of water on issue compared to other systems. (There is a combined total 2,585,459 ML allocated in the Murray catchment compared to 47,795 ML overall in the Peel catchment).

Water in the Murray is able to be traded with a number of connected systems (Murrumbidgee, Lower Darling, but also Victoria and South Australia). Entitlement trade has been occurring throughout the study period, and there is relatively more General Security trade. Allocation trade markets are deep – there are substantial volumes of trade in all years. Groundwater trade is modest but occurs.

Allocations to entitlements, and rainfall have followed a drying, drought, flood, drying sequence through the study period.

Land and water use data tends to suggest pasture, rice, and other cereals are dominant in the region.

Geographic and hydrological overview

There are two major surface and groundwater water sources and associated water sharing plans located within the Murray that are the focus of this regional summary:

- New South Wales Murray Regulated River Water Source
- Lower Murray Groundwater Source.

The Murray system is managed alongside the Lower Darling system under the same water sharing plan. However, the two systems are presented in separate regional summaries according to their relevant water sources.

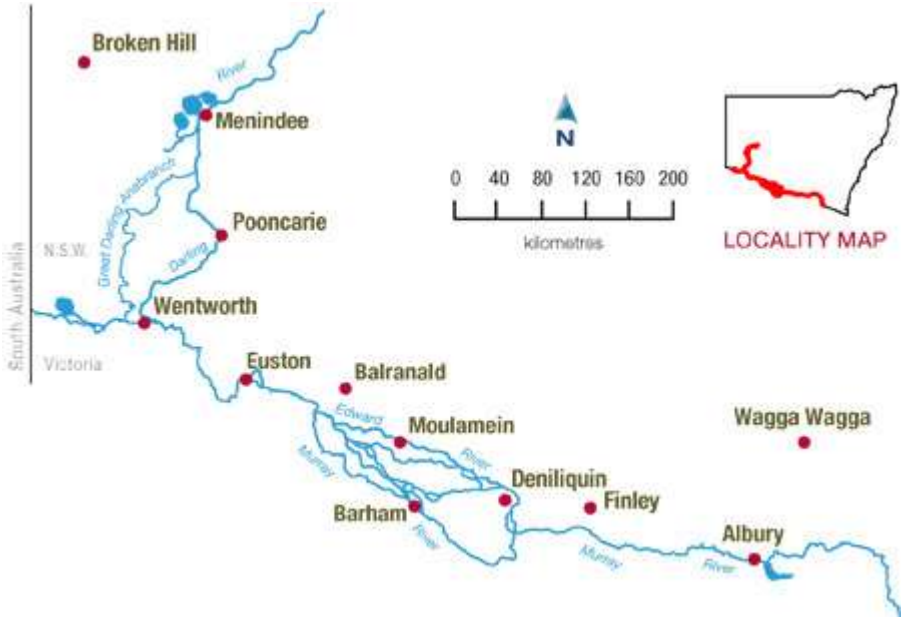
New South Wales Murray Regulated River Water Source

The New South Wales Murray Regulated River Water Source (the Murray River) is a regulated surface water system located within the Murray Catchment in southern New South Wales (Figure 47). The Murray River forms a major arm of the MDB and serves a number of large regional towns – Albury, Corowa, and Deniliquin in NSW and Swan Hill on the Victorian side of the river. In the lower portion of the Murray catchment, the Murray River is joined by its major tributary, the Darling River, at Wentworth.

The headwaters of the Murray rise in the Southern Alps of NSW and Victoria, flowing into Hume Dam near Albury, which is the major regulated storage on the system. From Hume Dam the Murray River flows in a westerly direction across southern NSW and northern Victoria towards its outlet on the South Australian coast. Dartmouth Dam in North-eastern Victoria is the other major headwater storage in the Murray system and is operated as a shared water resource. Water transfers to Hume

Dam are made via the Mitta Mitta River. The Snowy River Scheme also provides substantial inflows to the Murray.

There is significant irrigation district infrastructure development along the Murray River which supports irrigated agriculture in the region. River red gum forests on the Murray and Edward-Wakool Rivers are listed as Wetlands of International Importance under the Ramsar Convention. These were incorporated as a national park to conserve the largest area of river red gum forest in the world.



Source: NSW DPI Water 2016.

Figure 47 Murray Catchment – New South Wales Murray Regulated River Water Source

Lower Murray Groundwater Source

Groundwater also plays an important role in the Murray Catchment, with urban, agricultural, and industrial users all using groundwater to different degrees. A number of groundwater sources are located within the catchment, some which are connected to the Murray River. The groundwater source of focus in this regional summary is the Lower Murray Groundwater Source. The Lower Murray Shallow Groundwater Source is also located within the boundary of the WSP area, however is not included in this regional summary.

The Lower Murray Groundwater Source is accessible within the Murray Catchment – and includes all water contained in the unconsolidated alluvial aquifers deeper than 12 meters below the ground in Figure 48. There are 378 production bores pumping from the groundwater management area.

Source: NSW DPI Water 2016.

Figure 48 Murray Catchment – Lower Murray Groundwater Source

Water entitlements

Entitlements on issue

Table 6 summarises entitlement on issue for the water systems covered by this regional summary. Surface water entitlements are dominated by General Security, a substantial proportion of which is held by the environment. The total volume of surface water entitlement on issue is much larger than the volume of water on issue in the two groundwater systems.

Table 6 Entitlement on issue for Murray Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of total entitlement on issue held by environment (%)
New South Wales Murray Regulated River Water Source					
General Security	1,262	1,673,764	67%	457,215	27%
High Security[3]	728	193,746	8%	24,827	13%
Local water utility	16	33,497	1%	0	0%
Domestic and stock	1,019	17,084	1%	0	0%
Supplementary	200	252,579	10%	100,211	40%
Conveyance	3	330,000	13%	37,990	12%
Total	**3,228**	**2,500,670**	**100%**	**620,243**	**25%**
Lower Murray Groundwater Source					
Aquifer[4]	343	84,777	>99%	**1,323**	2%
Local water utility	2	12	<1%	0	0%
Total	**345**	**84,789**	**100%**	**1,323**	**2%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and data from NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 3) Includes High Security (community and education), High Security (research) and High Security (town water supply). 4) Includes Aquifer (town water supply) and Aquifer (research).

Entitlement characteristics

Table 7 presents a high-level comparative analysis of the characteristics of each entitlement type. The comparison suggests that groundwater entitlements are generally the most secure but most inflexible in regards to carryover or trade. Comparatively, surface water entitlement types are generally less secure but can be used or traded in more flexible ways.

Table 7 Entitlement characteristics comparison for Murray Catchment water systems

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
New South Wales Murray Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes (equal to 0.5 ML multiplied by the unit share specified)	Within: Restricted Out of: Restricted	Annual[1]
High Security	High	Allocated water after urban and domestic and stock needs have been secured	No	Within: Restricted Out of: Restricted	Annual
Local water utility	High	Allocated before General Security, High Security entitlements	No	Within: Restricted Out of: Restricted	Annual
Domestic and stock	High	Allocated before General Security, High Security entitlements	No	Within: No Out of: No	Annual
Supplementary	Infrequent	Always allocated at 1 ML per share. Supplementary access announcements permit take during high flow events.	No	Within: Restricted Out of: No	Water cannot generally be stored
Conveyance	Medium-High	Allocated water after urban, domestic, and High Security needs have been secured	No	Within: Yes Out of: Restricted	Annual
Lower Murray Groundwater Source					
Aquifer	High	Allocated water after urban and domestic needs have been secured	Yes (up to 2 ML account limit per water share)	Within: Restricted Out of: No	Annual
Local water utility	High	First entitlement type to be allocated water	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before Aquifer needs have been secured	No	Within: Restricted Out of: No	Annual

Source: Aither 2016. Water Sharing Plan for the NSW Murray and Lower Darling Regulated River Water Sources 2016 and Water Sharing Plan for the Lower Murray Groundwater Source 2006.

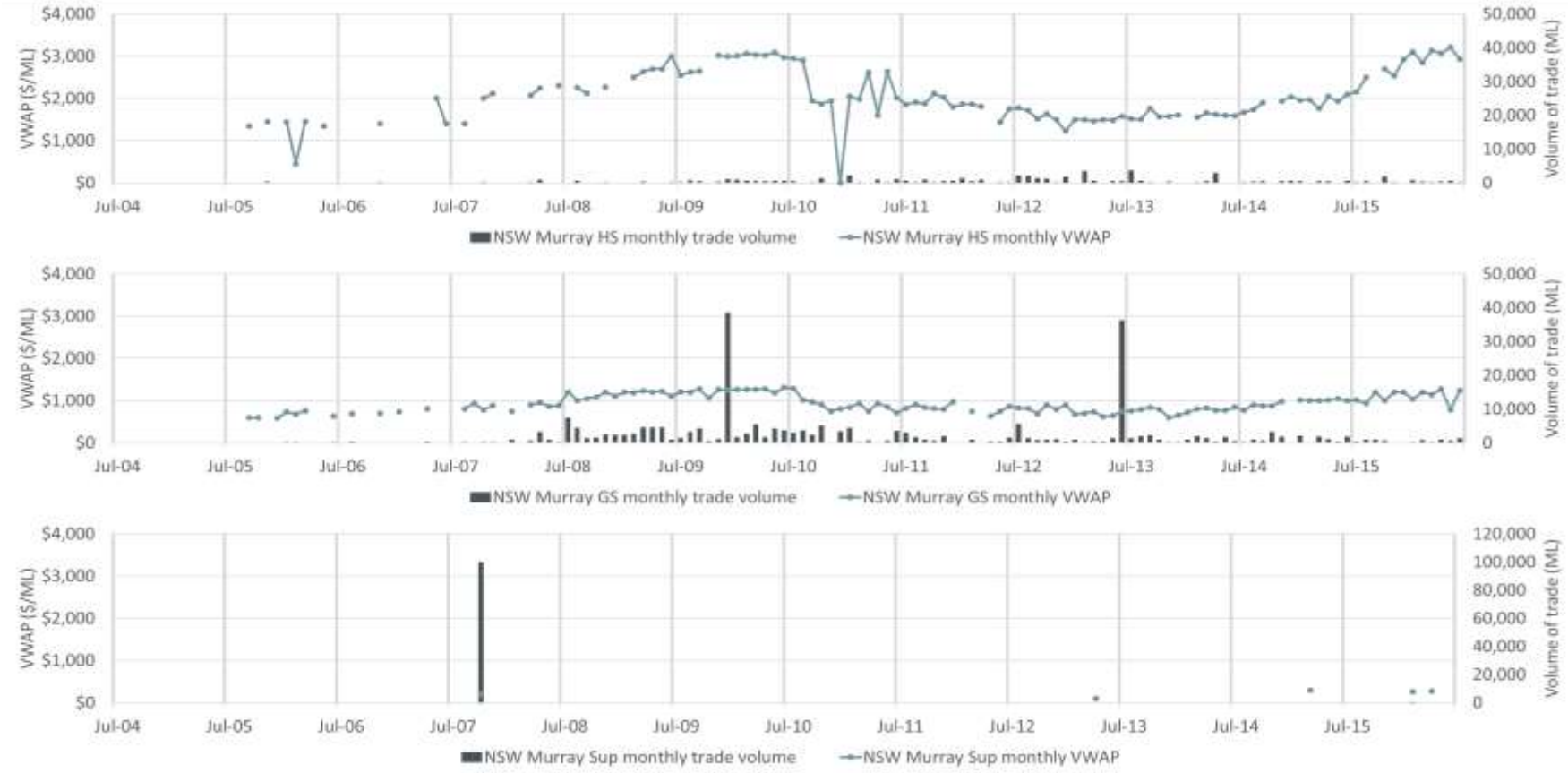
Note: 1) Uncontrolled flow is non-debit water accessible during supplementary flow events in periods of low allocations. Rules in water sharing plans, linked to allocation levels, define when uncontrolled flow taken converts to debit water against General Security accounts. Some water sources also have High Security uncontrolled flow.

Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

High Security entitlements in the Murray River are infrequently traded and command relatively higher prices (Figure 49). In comparison, General Security entitlements are traded more frequently but command a lower price. Supplementary entitlements are also infrequently traded, as all licence holders in the Murray are allowed to access uncontrolled flows without debit to their allocation in years of low allocation.

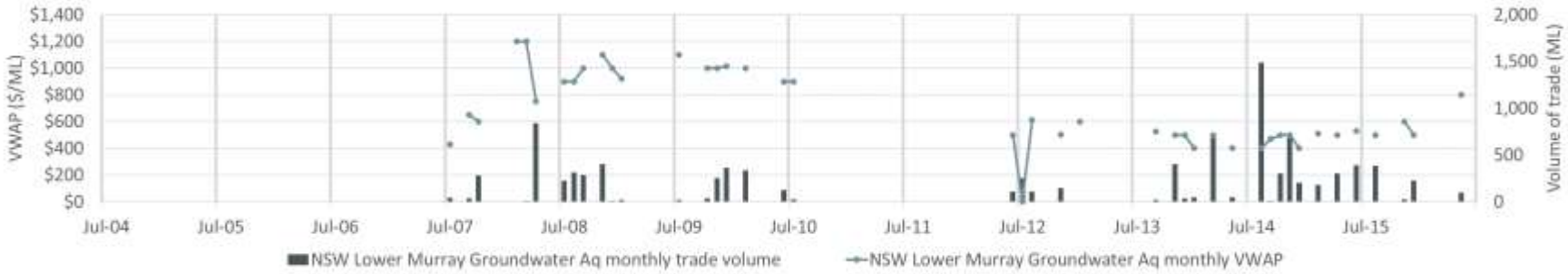
Aquifer entitlements have been traded in the Lower Murray Groundwater Source (Figure 50), but at lower volume and frequency compared to surface water.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 49 Monthly average High Security, General Security and Supplementary entitlement prices and trade volumes New South Wales Murray Regulated River Water Source, 2004–05 to 2015–16



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

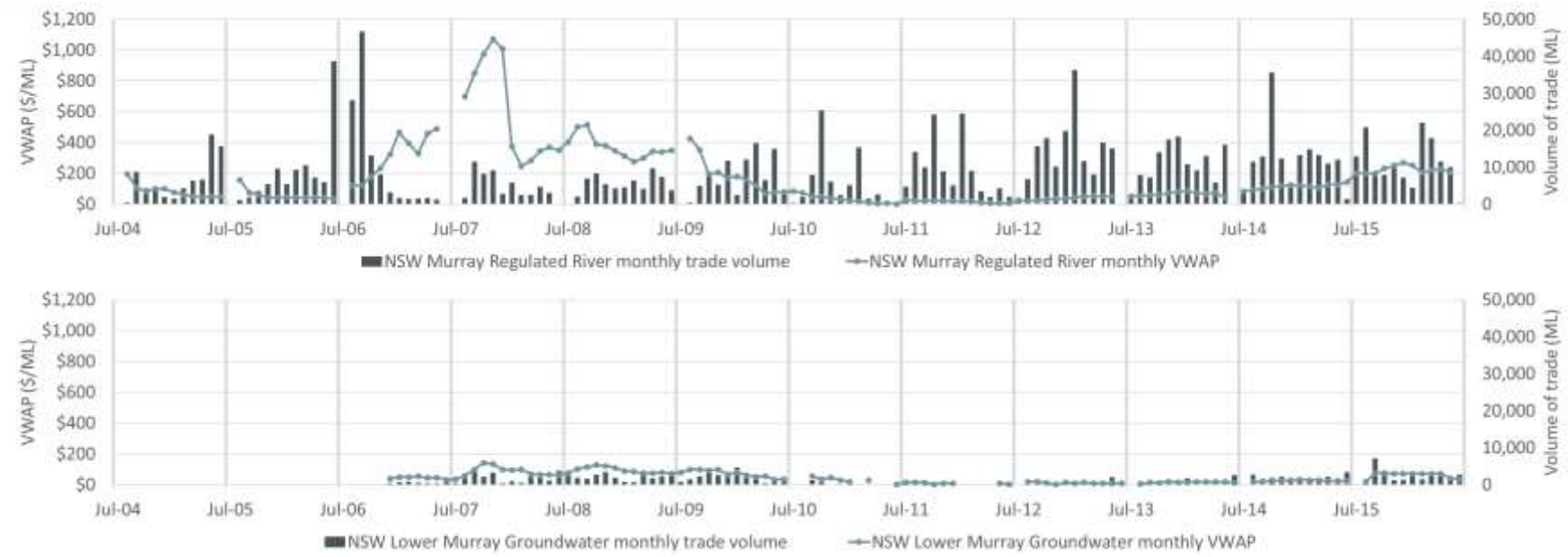
Figure 50 Monthly average Aquifer entitlement prices and trade volumes Lower Murray Groundwater Source, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the NSW Murray River is active and relatively mature. It is connected to the broader southern MDB market meaning that trade is possible between the Murray and other surface water systems.

There have been substantial volumes of annual trade in most years since 2004–05. Prices for allocation water have varied markedly, from record highs in 2007 to record lows in 2010–11 to 2011–12. Between 2012–13 and 2015–16, prices increased to a high of more than $260 per ML.

There is comparatively less trade and lower prices for allocations in the Lower Murray Groundwater Source, which is unsurprising given the amount of water available to trade relative to other systems, and the fact that water can only be traded amongst a smaller range of buyers and sellers (Figure 51). In the Lower Murray Groundwater Source commercial trades are recorded from 2006–07 to the present. For 2015–16 there is some strengthening of the market in terms of the volume and price observed.



Source: Aither 2016. Based on New South Wales Water Register 2016.

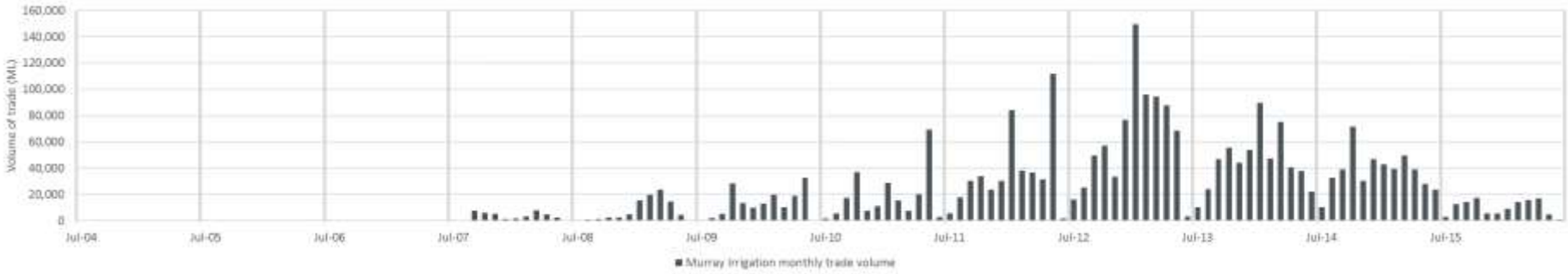
Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. For the NSW Murray regulated source, trade volumes reported are for trades within and into, but not out of, the zone.

Figure 51 Monthly average allocation prices and trade volumes New South Wales Murray Regulated River Water Source and Lower Murray Groundwater Source, 2004–05 to 2015–16

Allocation trade activity within irrigation corporations

Murray Irrigation is a significant irrigation corporation that manages the Murray Irrigation Districts on the Murray. Trade within the Murray Irrigation Districts (between irrigation corporation members) is not recorded on the NSW water register but constitutes a significant volume of trade activity in the Murray catchment (trade between users inside the districts with those outside it are recorded in NSW register data).

Figure 52 illustrates recorded trade activity within irrigation areas in the Murray Catchment. There have been substantial volumes of trade in most of the past ten years.



Source: Aither 2016. Based on data provided by NSW DPI Water 2016.

Note: The reporting of allocation trade prices within irrigation corporations is poor. This is understood to be the result of irrigation corporations not collecting price data rather than the prevalence of related party transfers or intentional non-reporting of price by counterparties. As a result, price data is not robust enough to apply Aither's standard data cleaning methods. Trade activity charted above includes all trades (including $0) reported within Murray Irrigation between July 2004 and June 2016.

Figure 52 Monthly average allocation prices and trade volumes Murray Irrigation, 2004–05 to 2015–16

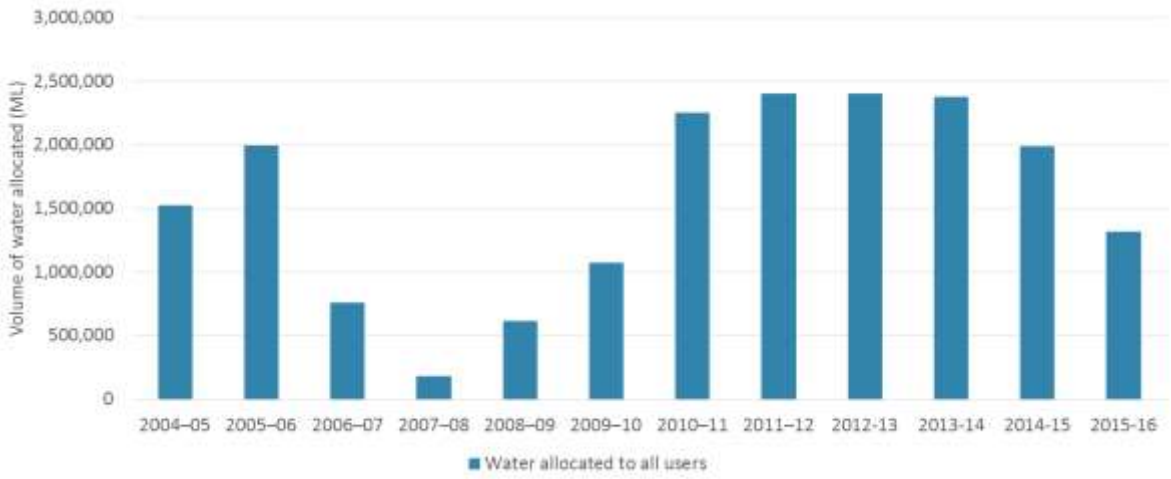
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Murray Catchment, these drivers are explored below.

Allocations to entitlements

New South Wales Murray Regulated River Water Source

Figure 53 presents the volumes of water allocated to all water users in the Murray River from 2004–05 to 2015–16. Allocations are characterised by relatively low volumes from 2006–07 to 2009–10, high volumes from 2010–11 to 2012–13, and declining volumes thereafter.



Source: Aither 2016. Based on data provided by NSW DPI Water 2016.

Note: Includes available water determinations (AWD) plus carryover.

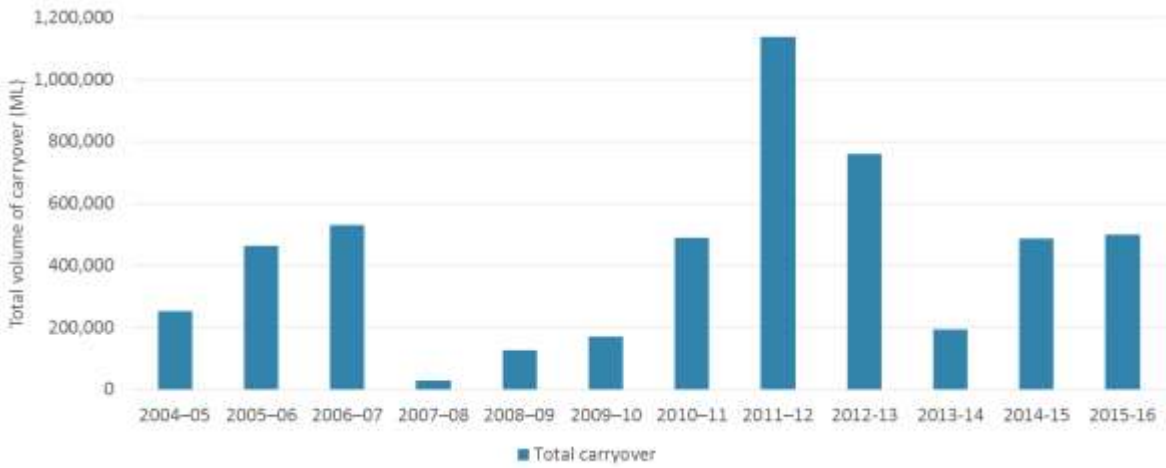
Figure 53 Total volume of water allocated to all entitlement types in the Murray River, 2004–05 to 2015–16

Lower Murray Groundwater Source

In every water year since 2009–10 Aquifer entitlements in the Lower Murray Groundwater Source have received 100 per cent allocations by the end of the water year.

Carryover

Figure 54 presents carryover in the NSW Regulated Murray River. It is only possible for General Security entitlement types in the Murray River to carryover water (see Table 6 for a full list of entitlement types). Since 2004–05, owners of theses entitlement types have on average carried over 428,405 ML in aggregate into the following water year. This equates to approximately 51 per cent of the total 836,882 ML that can be carried over in the system each year. Between 2010–11 and 2014–15, the average annual volume of carryover has increased to 613,210 ML per year. The high carryover figure for 2011–12 may partially be a result of the suspension of the WSP from 2006–07 to 2011–12, during which licence holders were permitted to carryover 100 per cent of allocations against their entitlement.

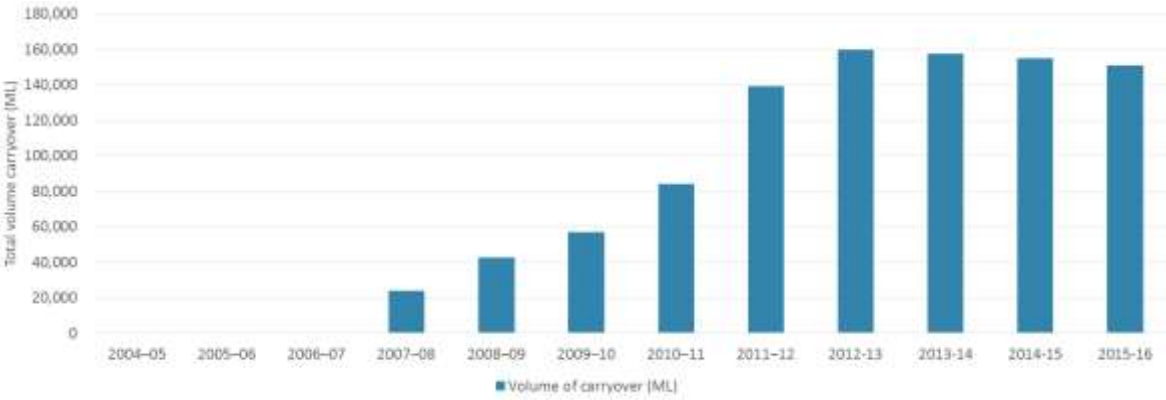


Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes General Security entitlement types as these are the only entitlement types in the Murray which allow carryover.

Figure 54 Carryover in the NSW Murray Regulated River, 2004–05 to 2015–16

In the Lower Murray Groundwater source, only Aquifer access licences can carryover water into the following year. Entitlement owners for these Aquifer entitlement types can carryover a total of 2 ML per unit share of their entitlement, meaning that carryover can exceed the total entitlement in any given year. As shown in Figure 55, since 2007–08 there has been an average of 107,705 ML carried over into the following year. Between 2010–11 and 2015–16 there has been an average of 140,999 ML carried over.



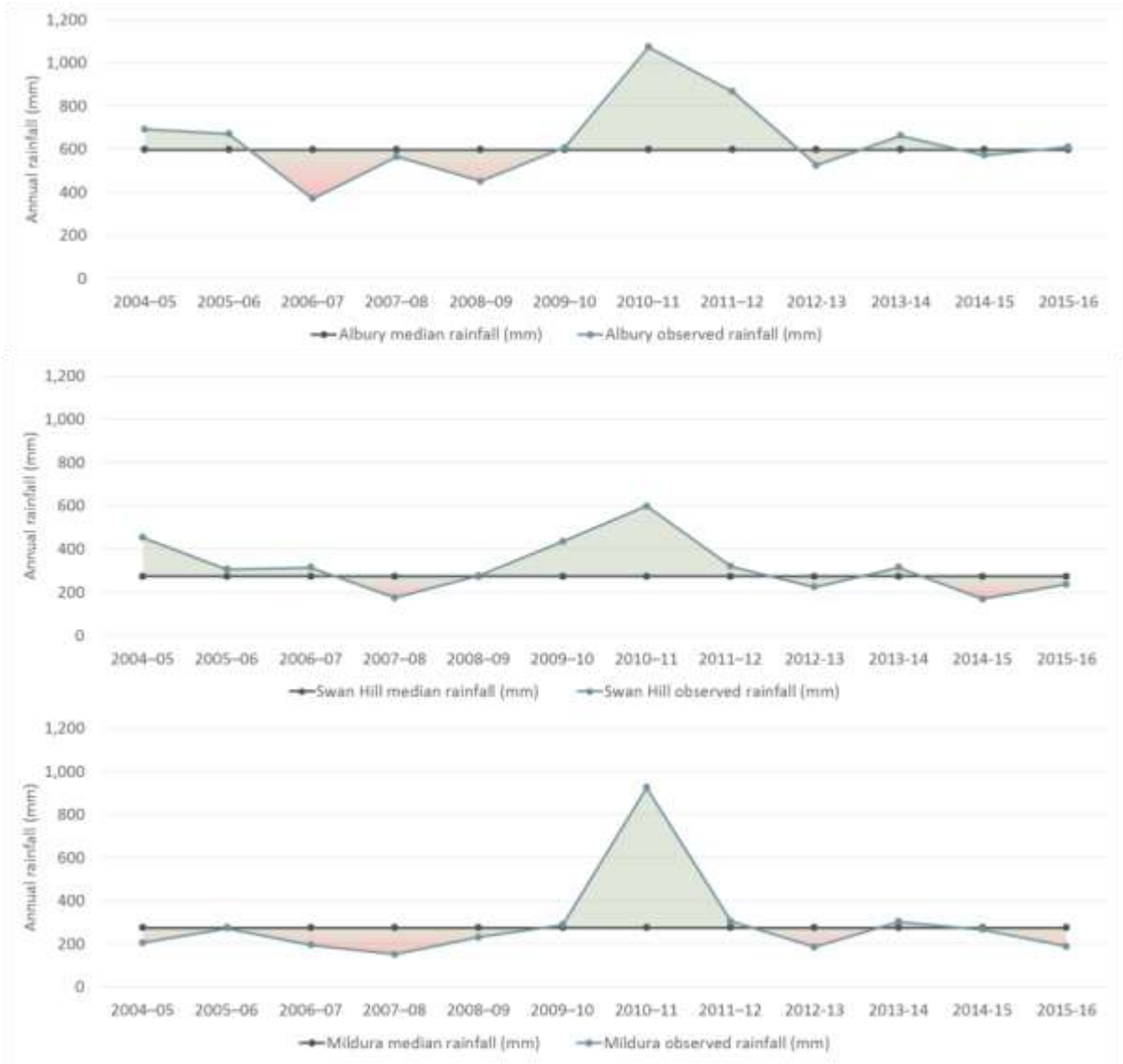
Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes Aquifer entitlement types as these are the only entitlement types in the Murray which allow carryover.

Figure 55 Carryover in the Lower Murray Groundwater Source, 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Murray region given different climatic regions; for example, the median in Albury is over 595 mm per annum compared to over 270 mm in Mildura. Figure 56 presents annual median rainfall in Albury, Swan Hill and Mildura from 2004–05 to 2015–16. Observed annual rainfall patterns across the three sites are strongly correlated – each site shares at least nine of twelve the same years above or below median rainfall.

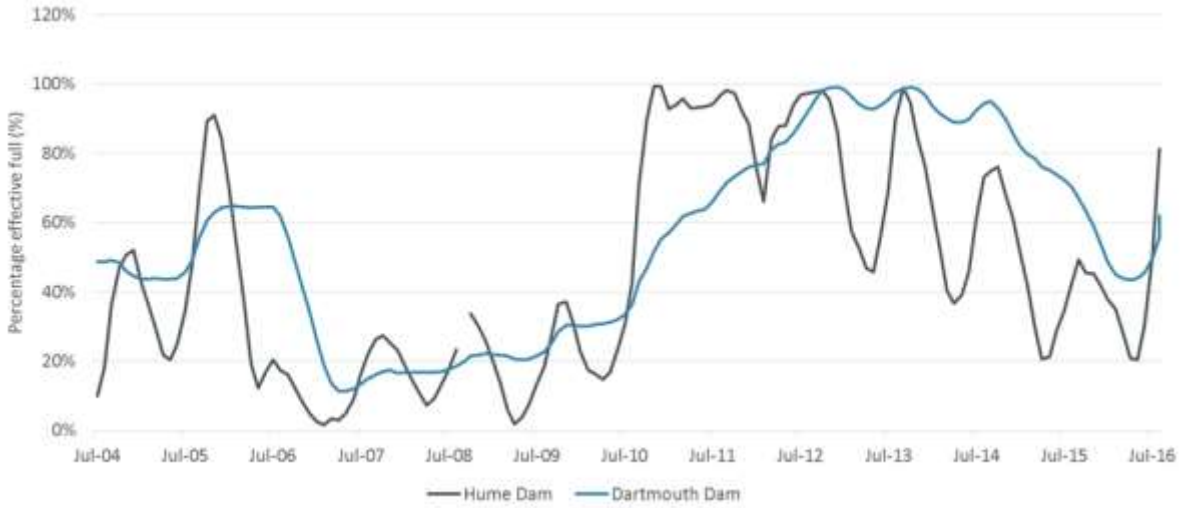


Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 56 Rainfall across the Murray Catchment, 2004–05 to 2015–16

Water storages

The two primary water storages at the headwater of the Murray River are Dartmouth Dam (3,856 GL) and Hume Dam (3,005 GL). Management of the storages effectively regulate the Murray River. Figure 57 presents changes in storage levels for Dartmouth and Hume Dam from 2004–05 to 2015–16. Over time storage levels have fluctuated from lower levels during the Millennium Drought to higher levels in the wet years from 2010–11 to 2011–12. Since 2011–12, a downward trend in storage levels has been observed across both storages, however, as of 2015–16 storages are trending back upwards. For Hume, this trend is marked by high inter-year variance whereas Dartmouth is observed to be less variable. The variance observed between storages is a function of the management regime for each storage; Hume Dam supplies water for irrigation demands, while water from Dartmouth Dam is transferred to Hume Dam intermittently to replenish supply.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

Figure 57 Effective percentage full of major Murray water storages, 2004–05 to 2015–16

Demand drivers

Changes in irrigated production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. With reference to the water systems located in the Murray Catchment, these drivers are explored below.

The 2014–15 ABS water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2014–15 year is the most recently available data, and it has been compared with 2005–06 because that was a similar year in relation to water allocations and rainfall, and therefore provides a reasonable comparison regarding how production in the system has changed over time. [18,19]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 58. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the Murray WSP areas.[20]

[18] While the years presented appear similar at face value, there was low water availability in the years leading into 2005-06 and 2014-15 followed a period of four years of high water availability. These differences are significant as land use and water use may be influenced by this. It is not possible to find two years in the time series which are perfectly comparable (including having the same lead in water availability), so 2005-06 and 2014-15 have been selected as they offer the best comparison available.

[19] Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years.

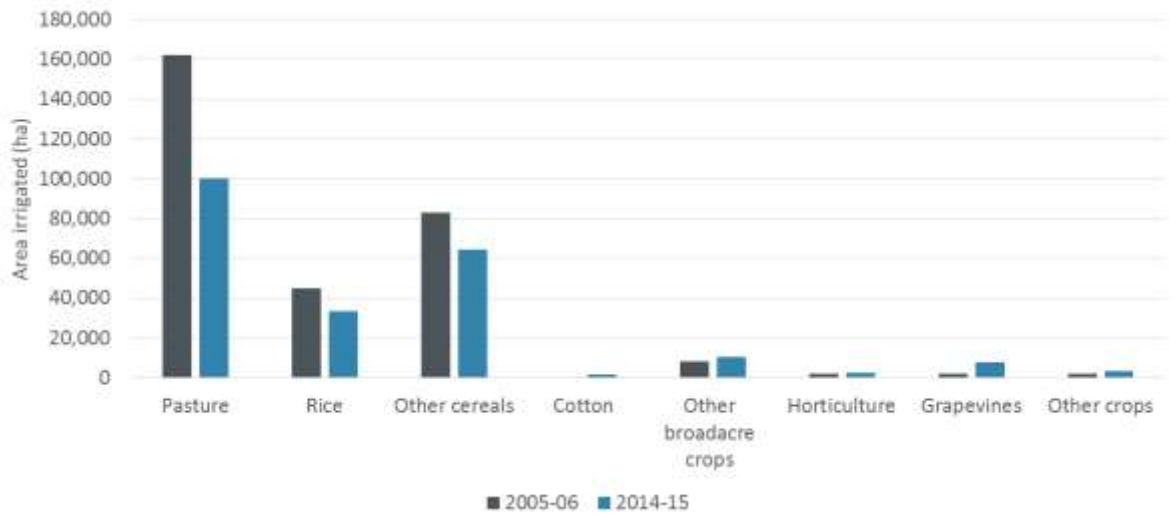
[20] At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.

Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 58 Alignment of NRM regions and WSP boundaries – Murray

Land use

There is a significant amount of irrigated agricultural activity in the Murray Catchment. Important plantings include rice, pasture for livestock and dairying and citrus (Figure 59). The figure compares land use by irrigated agricultural industries in the Murray for 2005–06 and 2014–15. For the two years presented, there is a contraction in the area of irrigated pasture. Figure 59 also highlights a possible decline in land use for rice and other cereals over the past decade. In contrast, land use for grapevines, cotton, and other broadacre crops appears to increase between 2005–06 and 2014–15. Land use for horticulture is relatively stable for the two years, while there is a marginal increase in plantings of other crops (such as vegetables).

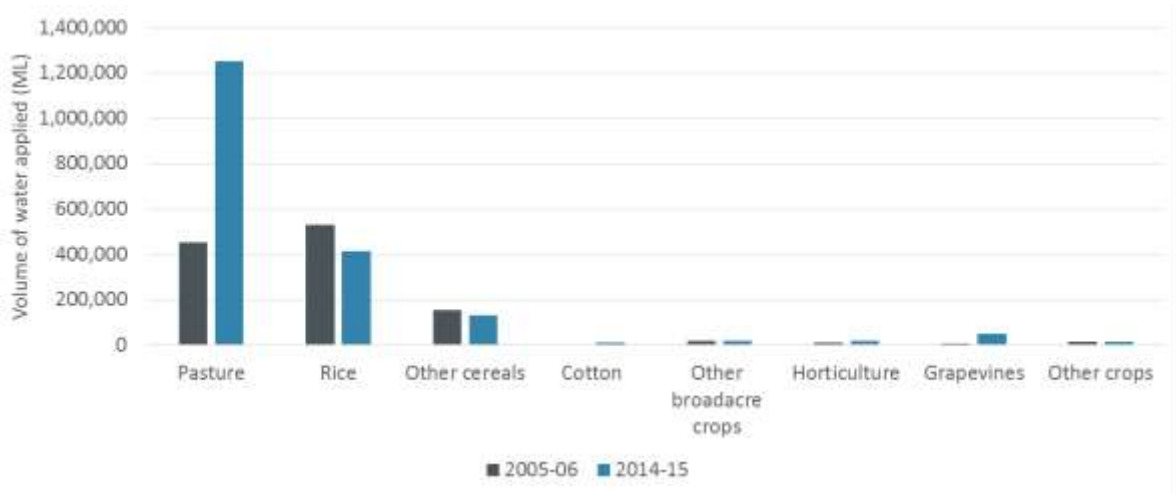


Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 59 Land use by irrigated agricultural industry Murray Catchment, 2005–06 and 2014–15

Water use

Figure 60 compares water use by irrigated agricultural industries in the Murray Catchment for 2005–06 and 2014–15. This suggests that between the two years there has been a significant growth in water applied to pasture and that pasture has surpassed rice as the largest water user. Figure 60 also suggests increased water use for grape production, which aligns with growth in the area of grapevines planted (compare to Figure 59). Water use by other broadacre crops and other crops (such as vegetables) is stable for the years presented.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 60 Water use by irrigated agricultural industry Murray Catchment, 2005–06 and 2014–15

Institutional and policy

Trade rules

Trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. The following section outlines rules of particular significance in the NSW Murray region.[21]

New South Wales Murray Regulated River Water Source

Water allocations may be transferred:

- Within the NSW Murray Regulated River Water Source
- From the Lower Darling Regulated River Water Source, Murrumbidgee Regulated River Water Source or Snowy River into the NSW Murray Regulated River Water Source
- To the Lower Darling Regulated River Water Source or Murrumbidgee Regulated River Water Source from the NSW Murray Regulated River Water Source
- If the dealing does not involve transferring rights, allocation or licence to an extraction point in the Murray River downstream of the Barmah Choke.[22] These rules are in place due to the restricted channel capacity in this reach.

Such rules have the potential to create price differentials for allocation water between zones if or when capacity constraints are binding (e.g. trade is not able to occur).

Lower Murray Groundwater Source

Permanent and temporary trading may occur within the Lower Murray Groundwater Source subject to a hydrogeological assessment of potential impacts on other users and the water source.[23] This increases the cost and time involved in trading water for market participants and has the potential to act as a deterrent to trade.

Other policy issues

NSW Murray Regulated River Water Source

Due to good profitability of irrigated nuts enterprises (especially almonds) there has been strong investment in these industries in recent years. Increased investment in nuts has implications for trade with regard to the price of water and physical water delivery.

An increase in water demand by the nuts industries is expected in future years as orchards become established. Combined with low water availability, demand for water by high-value horticultural crops can impact prices, as irrigators are willing to pay a higher price to access water for high-value horticultural crops.

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[21] This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

[22] For further information, refer to Water Sharing Plan for the New South Wales Murray and Lower Darling Regulated Rivers Water Sources 2016 (http://www.legislation.nsw.gov.au/#/view/regulation/2016/366)

[23] For further information, refer to Lower Murray Groundwater Source Summary Report 2006-2014 (http://www.water.nsw.gov.au/__data/assets/pdf_file/0009/548109/lower_murray_groundwater_summary_report_2006_2014.pdf)

A related concern exists regarding the security of water portfolios held by some nuts (and other horticulture) enterprises. Some enterprises have previously chosen a water strategy that relies on zero share WALs, which allows operators to secure water needs using the temporary market, thus outlaying less upfront capital investment but being more susceptible to allocation price fluctuations. Enterprises that are reliant on zero share WALs risk water being expensive during dry conditions when temporary water is in high demand. This may be an acceptable level of risk in the short term, but not necessarily in the long-term, and may subsequently impact the price of entitlements as participants pursue alternative water strategies, including seeking to secure permanent High Security water access.

The extent to which the system will be able to deliver water to newly developed irrigated nuts enterprises in some areas of the region is also of concern. The boom in investment in nuts enterprises has led to developments in new areas of the Murray, some of which have been approved by local planning authorities with potentially limited due diligence with regard to water deliverability, or oversight and approval from NSW DPI Water. There is concern that the increased demands on the system will exceed system capacity, particularly around the Barmah Choke and may impact on water delivery, including water orders not being able to be fulfilled at key times in the growing season.

Lower Murray Groundwater Source

A general and overarching policy and operational issue for the Lower Murray Groundwater Source is the need to undertake specific assessments for all trade applications. This is not only resource intensive and time consuming for government, but adds costs, time and risk for market participants. This issue is likely to become more pronounced and act as more of a constraint if demand for groundwater, and for groundwater trade, increases.

Murrumbidgee Catchment

Summary

The Murrumbidgee is part of the southern MDB, and covers a diverse geographic area from the edge of the Australian Alps in the east to its confluence with the Murray in the west of New South Wales. This summary covers regulated surface water, and groundwater, both of which form an important part of irrigated agriculture.

The majority of water in the Murrumbidgee River is allocated to General Security (52 per cent), with High Security making up 10 per cent of allocations. Entitlements in the two groundwater systems are almost exclusively issued to Aquifer entitlement types (99 per cent and 100 per cent of entitlements). There is a total 3,934,823 ML of water on issue in the Murrumbidgee catchment, which makes it the largest water market by volume of entitlement on issue in New South Wales.

While water in the Murrumbidgee is able to be traded with a number of connected systems (Murray and Lower Darling, as well as to Victoria and South Australia), limits apply. Entitlement trade has been occurring throughout the study period, and there is relatively more General Security trade than High Security. Allocation trade markets are deep – there are substantial volumes of trade in all years. Groundwater trade is modest but occurs.

Allocations to entitlements, rainfall, and storages suggest a sequence of drying, drought, floods and drying over the study period.

Land and water use data tends to suggest other cereals, rice, cotton, and grapevines as the dominant crops grown in the region.

Geographic and hydrological overview

There are two major surface and groundwater water sources located within the Murrumbidgee Catchment that are the focus of this regional summary:

- Murrumbidgee Regulated River Water Source
- Lower Murrumbidgee Groundwater Sources (both deep and shallow).

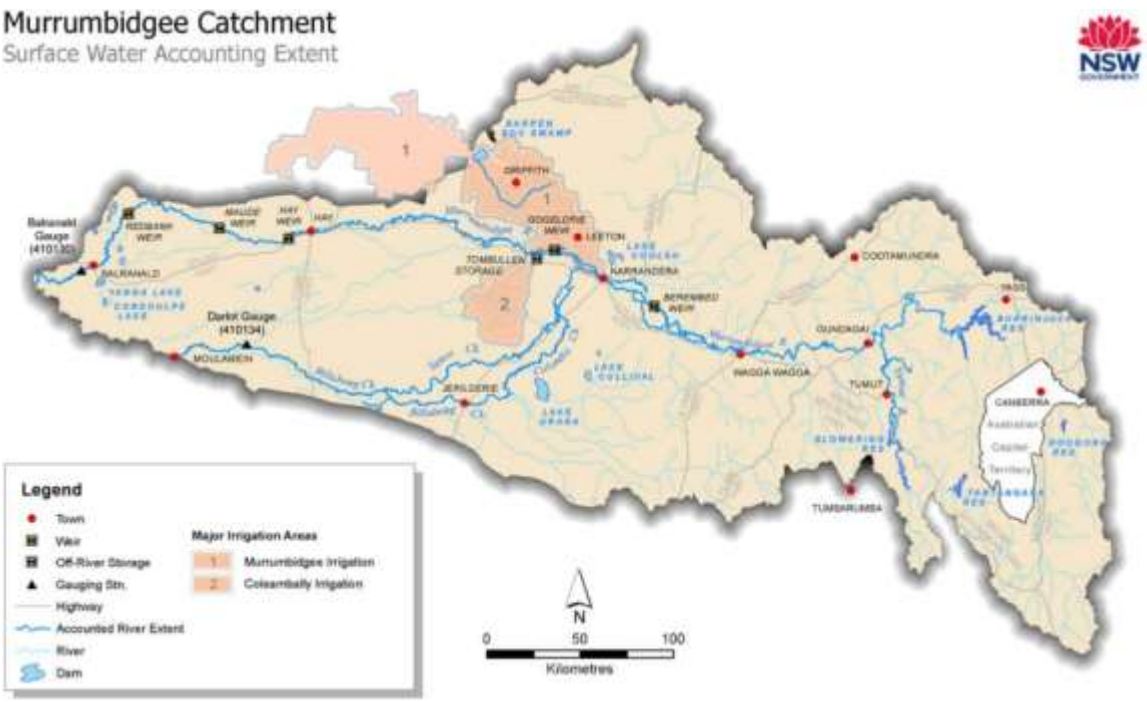
Murrumbidgee Regulated River Water Source

The Murrumbidgee Regulated River Water Source (the Murrumbidgee River) is a regulated surface water system located within the Murrumbidgee Catchment in southern New South Wales (Figure 61). The Murrumbidgee River serves a number of large regional towns – such as Wagga Wagga, Narrandera, Griffith, Hay and Balranald.

Beginning at the Blowering and Burrinjuck water storages in the east near the Australian Capital Territory, the Murrumbidgee River flows west towards the Murray River. The Snowy River Scheme provides substantial inflows into the system.

There is significant irrigation district infrastructure along the Murrumbidgee River which supports irrigated agriculture in the region. Australia's second largest river red gum forest, which is a significant

environmental asset, is located in the Lowbidgee floodplain along the western portion of the Murrumbidgee River.



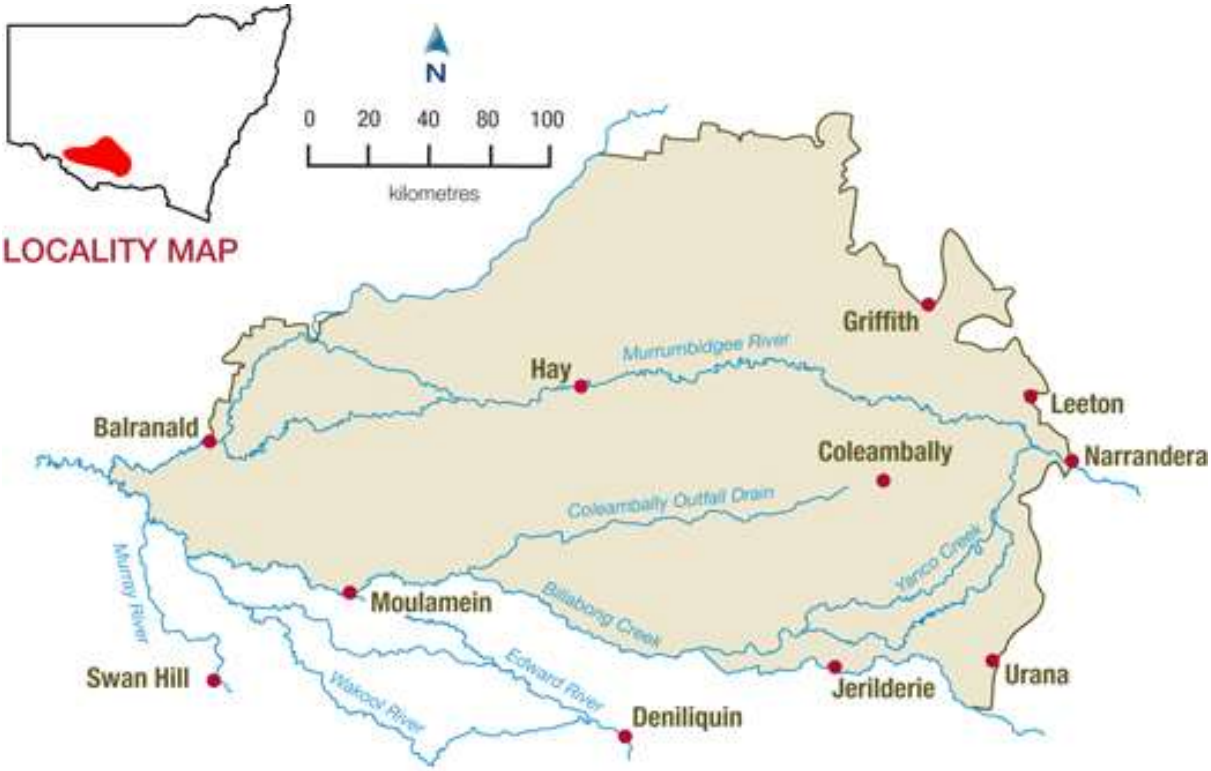
Source: NSW DPI Water 2016.

Figure 61 Murrumbidgee catchment – Murrumbidgee Regulated River Water Source

Lower Murrumbidgee Groundwater Sources

Groundwater also plays an important role in the Murrumbidgee Catchment, with urban, agriculture, and industrial users all using groundwater. A number of groundwater sources are located within the catchment, some of which are hydrologically connected (to varying degrees) to the Murrumbidgee River. The groundwater sources of focus in this regional summary are the Lower Murrumbidgee Deep Groundwater Source and the Lower Murrumbidgee Shallow Groundwater Source.

The Lower Murrumbidgee Groundwater Sources are accessible within the Lower Murrumbidgee catchment – bordered in the east by Narrandera and in the west by Balranald (Figure 62). The Lower Murrumbidgee Shallow Groundwater Source extends to a depth of approximately 40 to 70 metres below ground level. The Lower Murrumbidgee Deep Groundwater Source is located below the Shallow groundwater source and extends to bedrock level (which is approximately 100 to 300 metres thick). Bores are primarily located in the eastern half of the groundwater management area.



Source: NSW DPI Water 2016.

Figure 62 Murrumbidgee catchment – Lower Murrumbidgee Groundwater Sources

Water entitlements

Entitlements on issue

Table 8 summarises entitlement on issue for the water sources covered by this regional summary (current as at 2016–17). Total surface water entitlements are dominated by General Security, a substantial proportion of which is held by the environment. The total volume of surface water entitlement on issue is much larger than the volume of water on issue in the two groundwater systems.

Table 8 Entitlement on issue for Murrumbidgee Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of entitlement on issue held by environment (%)
Murrumbidgee Regulated River Water Source					
General Security	824	1,891,995	52%	430,846	23%
High Security[3]	193	382,216	10%	9,733.8	3%
Local water utility	14	23,816	1%	0	0
Domestic and stock	491	34,445	1%	0	0
Supplementary[4]	235	945,7780	26%	557,773	59%
Conveyance	9	375,968	10%	49,332	13%
Total	**1,766**	**3,654,220**	**100%**	**1,047,685**	**29%**
Lower Murrumbidgee Deep Groundwater Source					
Aquifer[5]	349	272,868	99%	5,048	0.02%
Local water utility	3	2,210	1%	0	0%
Domestic and stock	1	324	<1%	0	0%
Total	**353**	**275,402**	**100%**	**5,048**	**0.02%**
Lower Murrumbidgee Shallow Groundwater Source					
Aquifer	30	5,201	100%	0	0%
Total	**30**	**5,201**	**100%**	**0**	**0%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and information provided by NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate as at July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 3) Includes High Security (Aboriginal cultural), High Security (research) and High Security (town water supply). 4) Includes Supplementary Lowbidgee. 5) Includes Aquifer (community and education) and Aquifer (town water supply).

Entitlement characteristics

Table 9 presents a high-level comparative analysis of the characteristics of each entitlement type. The comparison suggests that groundwater entitlements are generally the most secure but are relatively more inflexible regarding carryover or trade. While surface water entitlement types may be marginally less secure (as urban and stock and domestic is allocated first) they have different levels of security and can be used or traded in more flexible ways.

Table 9 Entitlement characteristics comparison for Murrumbidgee Catchment

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Murrumbidgee Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes (up to 30% of entitlement volume from year to year)	Within: Yes Out of: Restricted	Annual[1]
High Security	High	Allocated water after urban and domestic and stock needs have been secured	No	Within: Yes Out of: Restricted	Annual
Local water utility	High	Allocated before General Security, High Security entitlements	No	Within: Restricted Out of: Restricted	Annual
Domestic and stock	High	Allocated before General Security, High Security entitlements	No	Within: No Out of: No	Annual
Supplementary	Infrequent	Supplementary access announcements permit take during high flow events.	No	Within: Restricted Out of: No	Annual
Conveyance	Medium-High	Allocated water after urban and domestic and stock needs have been secured	Yes (up to 30% of entitlement volume from year to year)	Within: Yes Out of: Restricted	Annual
Lower Murrumbidgee Deep Groundwater Source					
Aquifer	High	Allocated water after urban, domestic, and High Security needs have been secured	Yes (up to 2 ML per unit share)	Within: Restricted Out of: No	Annual
Local water utility	High	Allocated before Aquifer entitlements	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before Aquifer entitlements	No	Within: No Out of: No	Annual

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Lower Murrumbidgee Shallow Groundwater Source					
Aquifer	High	First entitlement type to be allocated water as there are no other types in this system	Yes (up to 2 ML per unit share)	Within: Restricted Out of: No	Annual

Source: Aither 2016. Based on Water Sharing Plans for Murrumbidgee catchment systems.

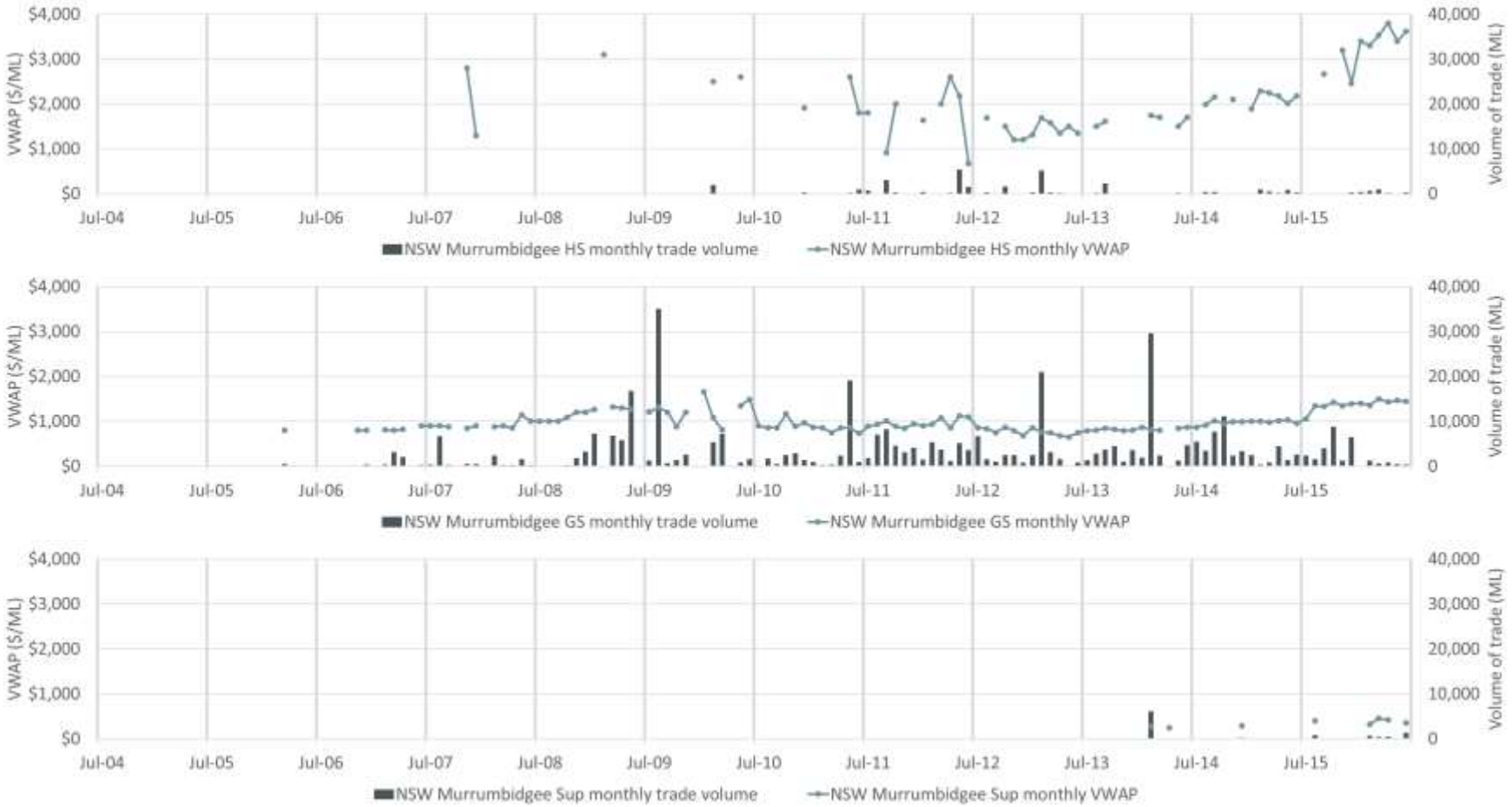
Note: 1) Uncontrolled flow is non-debit water accessible during supplementary flow events in periods of low allocations. Rules in water sharing plans, linked to allocation levels, define when uncontrolled flow taken converts to debit water against General Security accounts. Some water sources also have High Security uncontrolled flow.

Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

High Security entitlements in the Murrumbidgee River are infrequently traded and command relatively higher prices (Figure 63). In comparison, General Security entitlements in the Murrumbidgee River are traded more frequently and command a lower price (which is expected due to their lower reliability). Supplementary entitlements are infrequently traded as they are a high-flow licence with limited access), such that it is difficult to ascertain any associated trends.

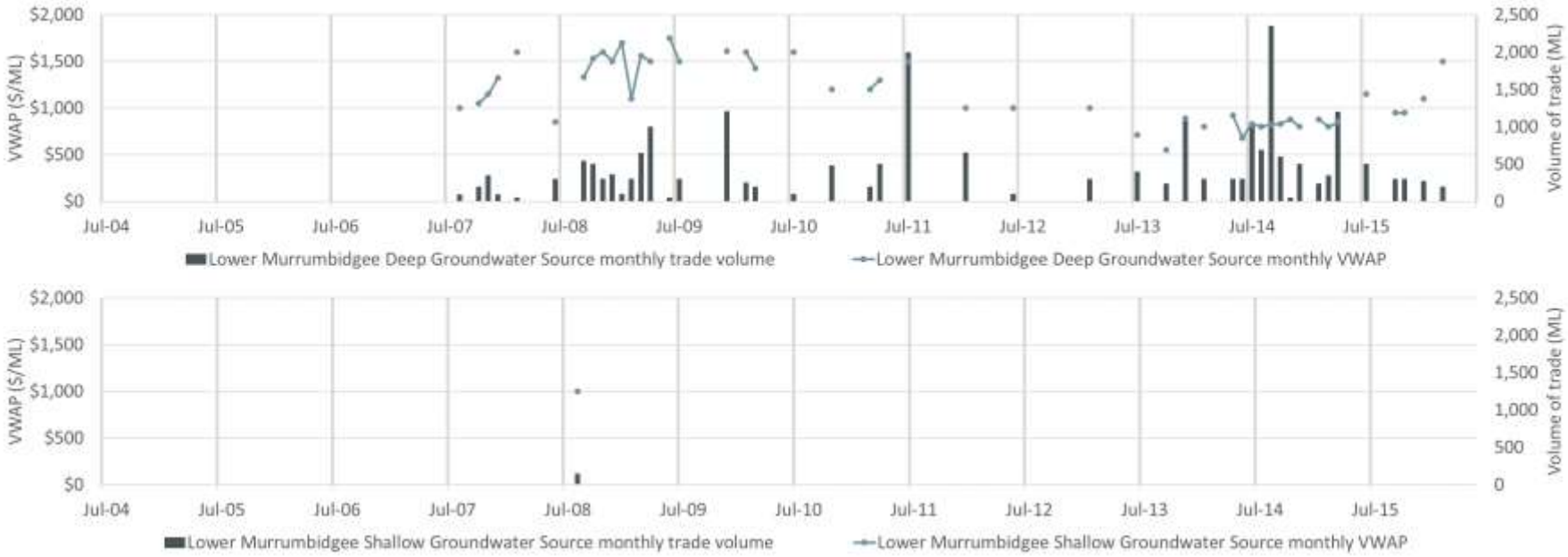
Aquifer entitlements have been traded in the Lower Murrumbidgee Deep Groundwater Source (Figure 64), but at lower volume and frequency compared to surface water. Since 2004–05 there has only been one commercial trade for Aquifer entitlements in the Lower Murrumbidgee Shallow Groundwater Source.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 63 Monthly average High Security, General Security and Supplementary entitlement prices and trade volumes Murrumbidgee Regulated River Water Source, 2004–05 to 2015–16



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

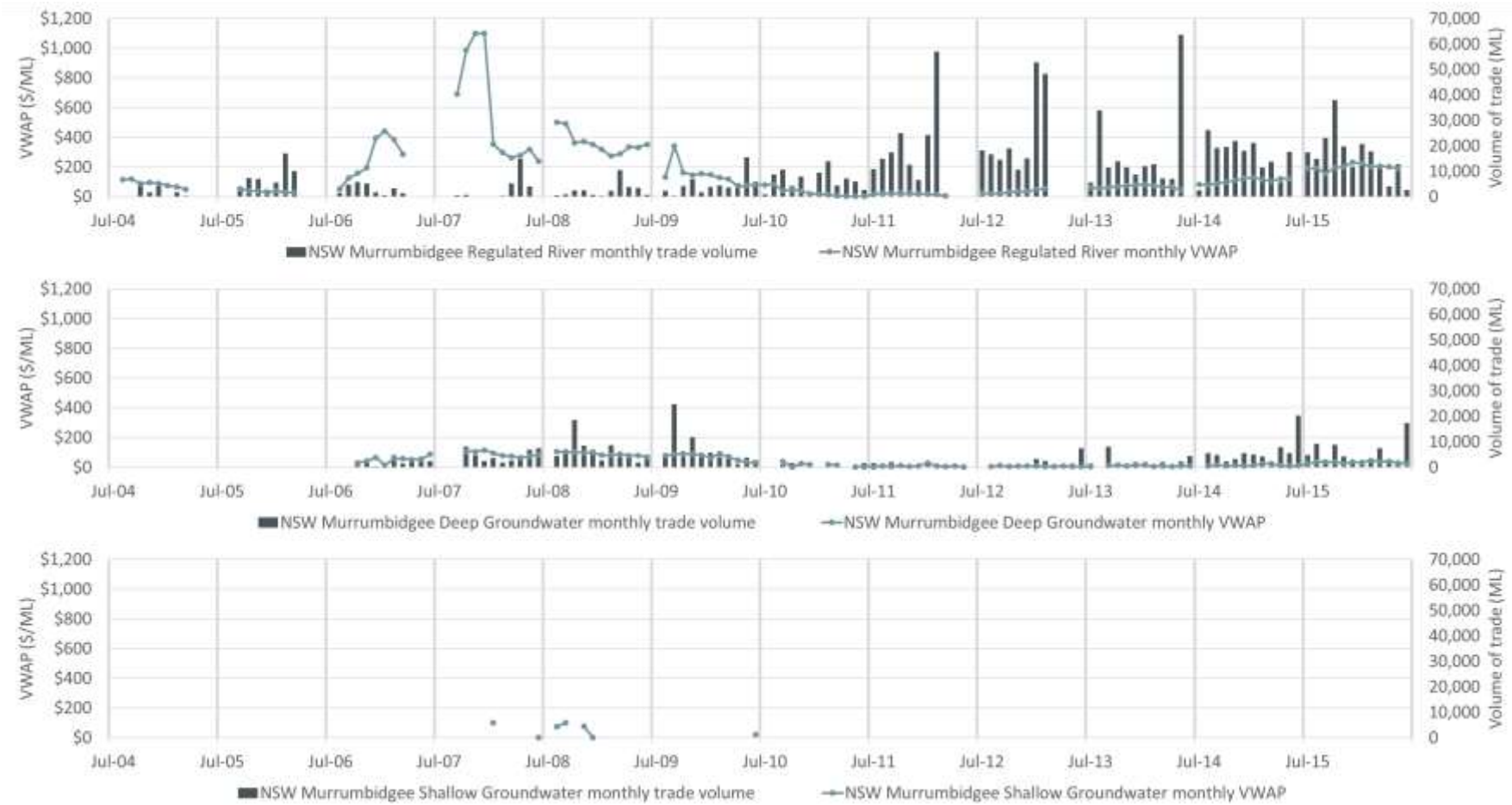
Figure 64 Monthly average Aquifer entitlement prices and trade volumes Lower Murrumbidgee Groundwater Sources, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the Murrumbidgee River is active and relatively mature. It is connected to the broader southern MDB market meaning that trade is generally possible between the Murrumbidgee, Murray and Lower Darling regulated river systems (as well as connected Victorian and South Australian Zones).

There have been substantial volumes of annual allocation trade in most of the past ten years (Figure 65). Prices for allocation water have varied markedly, from record highs in 2007 to record lows in 2010–11 to 2012–13. Between 2012–13 and 2015–16, prices increased to a high of more than $200 per ML.

There is comparatively less trade and lower prices for allocations in the Lower Murrumbidgee Deep Groundwater Source (Figure 65). In the Lower Murrumbidgee Shallow Groundwater Source, the only commercial trades on record were between 2007–08 and 2009–10.



Source: Aither 2016. Based on New South Wales Water Register 2016.

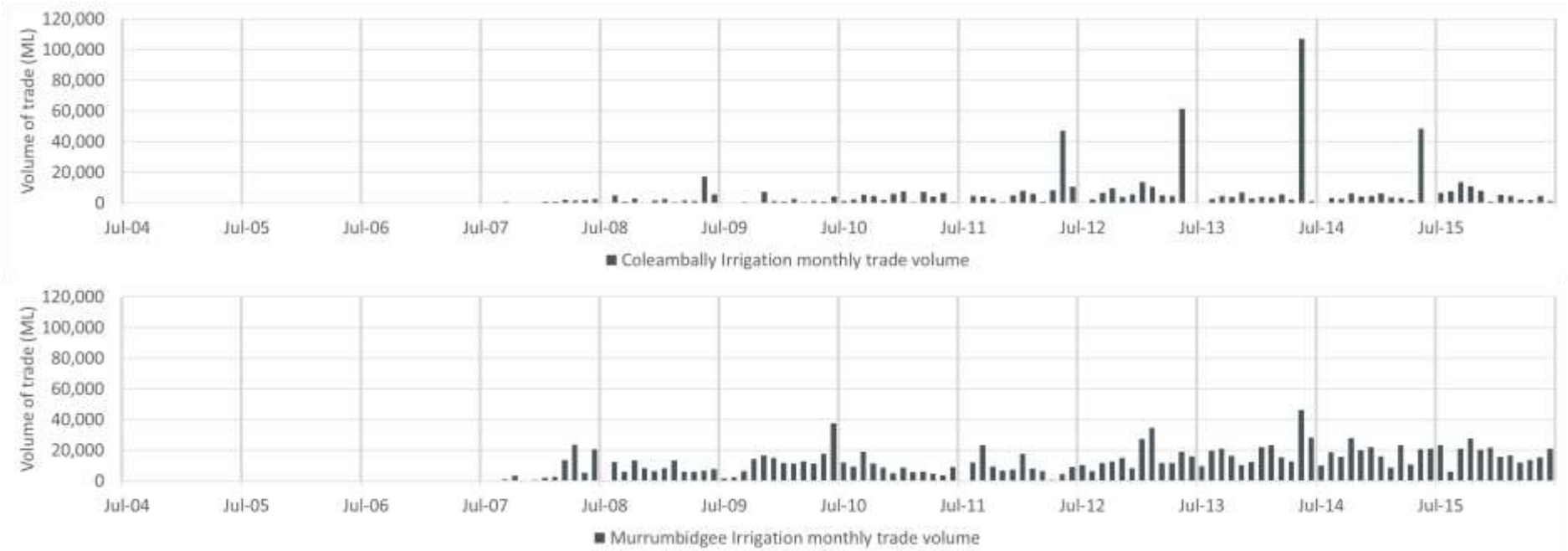
Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. For Murrumbidgee regulated source, trade volumes reported are for trades within and into, but not out of, the zone.

Figure 65 Monthly average allocation prices and trade volumes Murrumbidgee Regulated River Water Source and Lower Murrumbidgee Groundwater Sources, 2004–05 to 2015–16

Allocation trade activity within irrigation corporations

There are two significant irrigation areas managed by irrigation corporations in the Murrumbidgee system – Murrumbidgee Irrigation and Coleambally Irrigation. Trade within irrigation areas (between irrigation corporation members) is not recorded on the NSW water registe, but constitutes a significant volume of trade activity in the Murrumbidgee catchment (trade between users inside the districts with those outside are recorded in NSW register data).

Figure 66 illustrates recorded allocation trade activity within irrigation areas in the Murrumbidgee Catchment. There have been substantial volumes of trade in most of the past ten years. Prices of trades are not shown as price data is either not collected, not reported, or is otherwise unreliable.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: The reporting of allocation trade prices within irrigation corporations is poor. This is understood to be the result of irrigation corporations not collecting price data rather than the prevalence of related party transfers or intentional non-reporting of price by counterparties. As a result, price data is not robust enough to apply Aither's standard data cleaning methods. Trade activity charted above includes all trades (including $0) reported within Murray Irrigation between July 2004 and June 2016.

Figure 66 Monthly average allocation trade volumes Murrumbidgee Irrigation and Coleambally Irrigation, 2004–05 to 2015–16

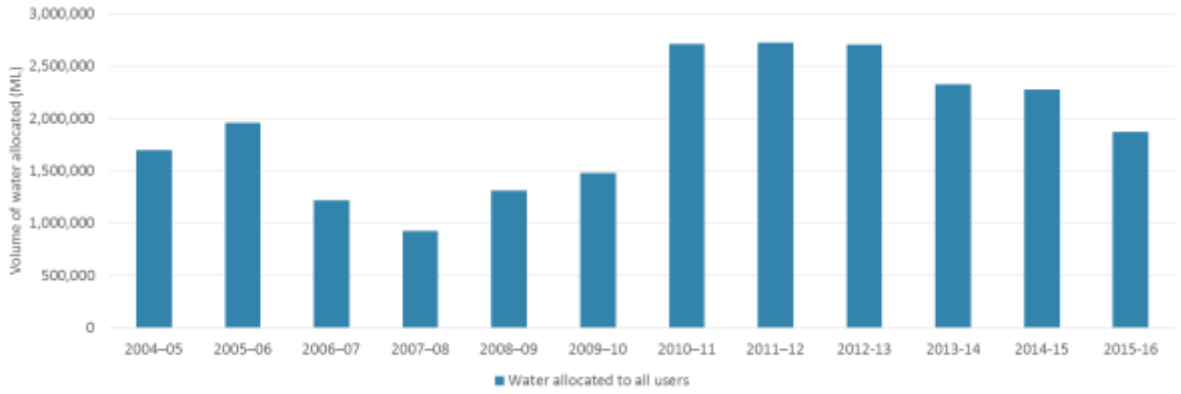
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Murrumbidgee Catchment, these drivers are explored below.

Allocations to entitlements

Murrumbidgee Regulated River Water Source

Figure 67 presents the volumes of water allocated to all water users in the Murrumbidgee River from 2004–05 to 2015–16. Allocations are characterised by relatively low volumes from 2006–07 to 2009–10, high volumes from 2010–11 to 2012–13, and declining volumes to 2015–16.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: Includes available water determinations (AWD) and carryover.

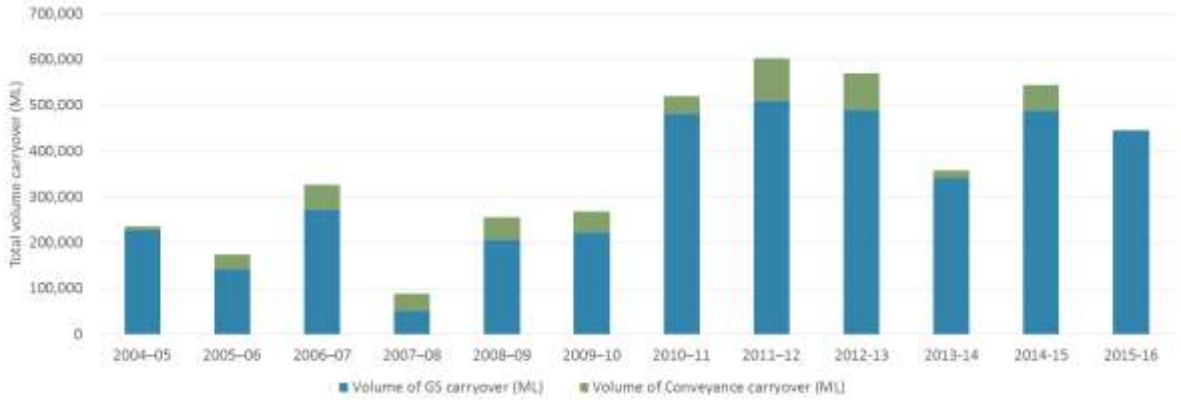
Figure 67 Total volume of water allocated to major entitlement types in the Murrumbidgee River, 2004–05 to 2015–16

Lower Murrumbidgee Groundwater Sources

In every water year since 2006–07 Aquifer entitlements in both the Lower Murrumbidgee Deep Groundwater Source and Lower Murrumbidgee Shallow Groundwater Source have received 100 per cent allocations by the end of the water year.

Carryover

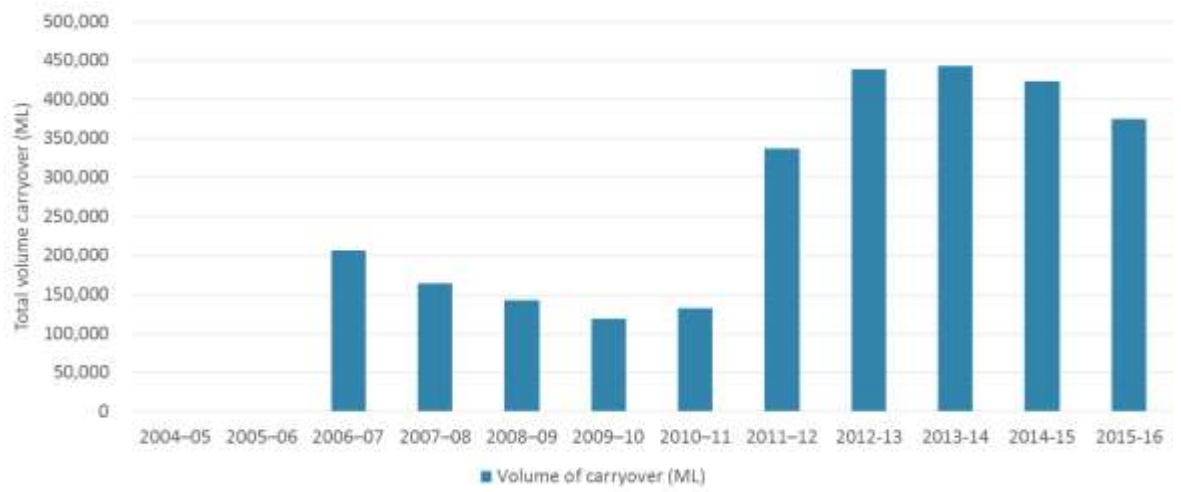
Figure 68 presents carryover in the Murrumbidgee Regulated River Water Source. It is possible for General Security and Conveyance entitlement types in the Murrumbidgee River to carryover water (see Table 8 for a full list of entitlement types). Since 2004–05, the combined average annual volume of water carried over into the following water year for General Security and Conveyance is 365,764 ML, which is just over half of the combined carryover limit of 680,389 ML. Between 2010–11 and 2014–15, the combined average annual volume of carryover for General Security and Conveyance increased to 518,824 ML.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

Figure 68 General Security and Conveyance carryover in the Murrumbidgee Regulated River, 2004–05 to 2015–16

In the Lower Murrumbidgee Groundwater source, only Aquifer access licences can carryover water into the following year. Entitlement owners for these Aquifer entitlement types can carryover a total of 2 ML per unit share of their entitlement, meaning that carryover can exceed the total entitlement in any given year. As shown by Figure 69, since 2006–07 there has been an average of 278,302 ML carried over into the following year. Between 2010–11 and 2015–16 there has been an average of 358,372 ML carried over. Low carryover in the first four years may be due to high usage resulting from low surface water availability.



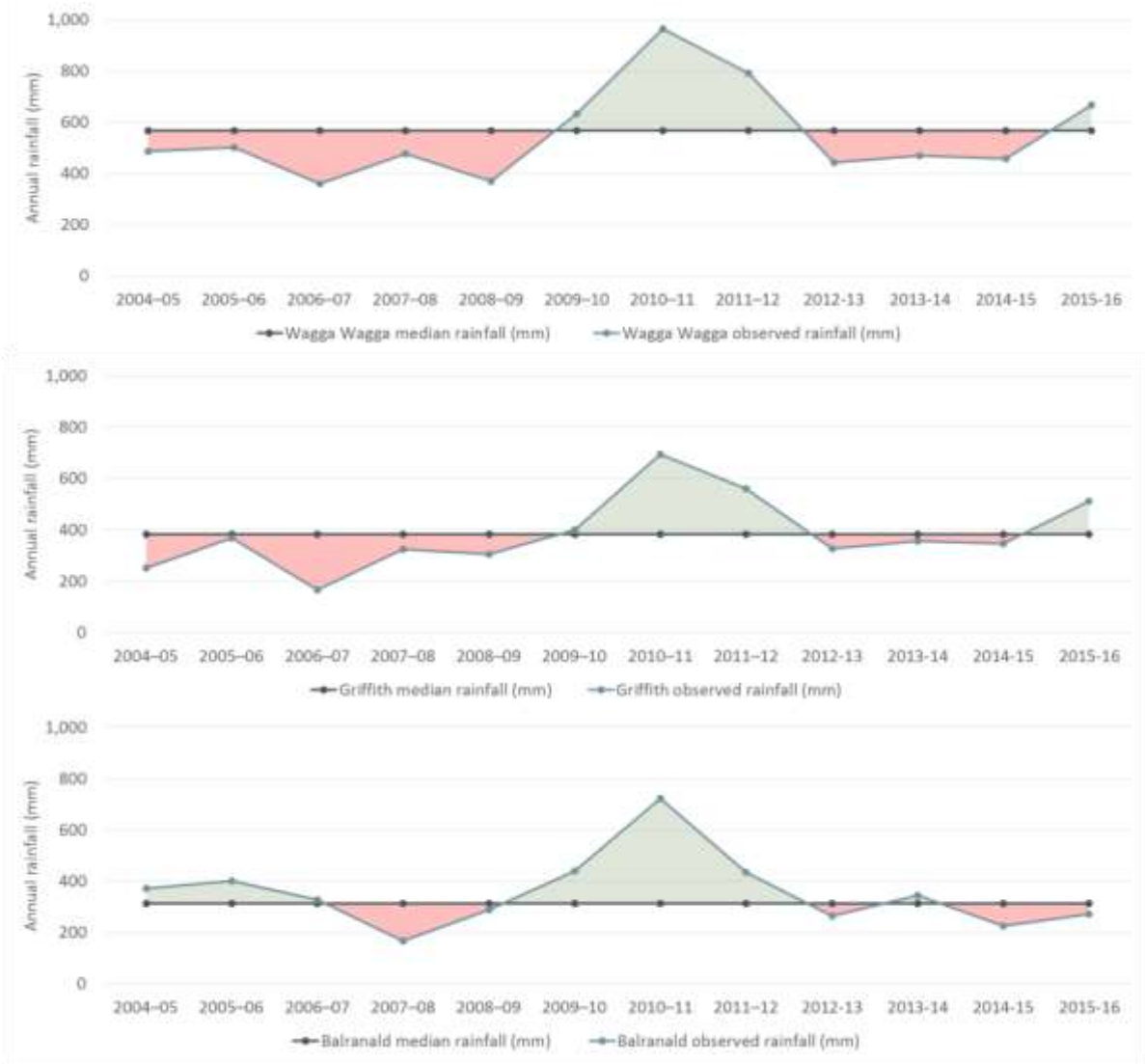
Source: Aither 2016. Based on data provided by NSW DPI Water 2016.

Figure 69 Carryover in the Lower Murrumbidgee Groundwater sources (Shallow and Deep) 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Murrumbidgee region given different climatic regions; for example, the median in Wagga Wagga is over 560 mm per annum compared to 300 mm in Balranald. Figure 70 presents annual median

rainfall in Wagga Wagga, Griffith and Balranald from 2004–05 to 2015–16. Annual rainfall between Wagga Wagga and Griffith across this period is highly correlated – with the same years above and below median rainfall. Observed rainfall patterns in Balranald are similar to Wagga Wagga and Griffith but not as highly correlated.

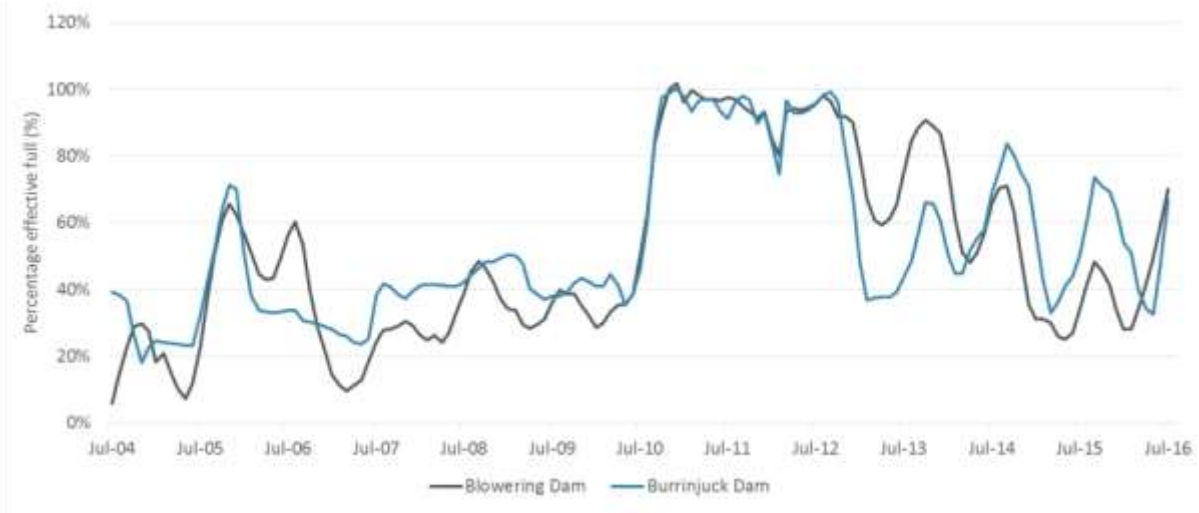


Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 70 Rainfall across the Murrumbidgee catchment, 2004–05 to 2015–16

Water storages

The two primary water storages at the headwater of the Murrumbidgee River are Blowering Dam (1,628 GL) and Burrinjuck Dam (1,026 GL). However, the Snowy River Scheme releases substantial flows into the Murrumbidgee system. Management of the storages effectively regulates the Murrumbidgee River. Figure 71 presents changes in storage levels for Blowering and Burrinjuck Dam from 2004–05 to 2015–16. Over time storage levels have fluctuated from lower levels during the Millennium Drought to higher levels in the wet years from 2010–11 to 2011–12. Since 2011–12, a downward trend in storage levels with high inter-year variance has been observed. However, storage levels have since increased substantially to 97 per cent for Blowering and 94 per cent for Burrinjuck in October 2016.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

Figure 71 Murrumbidgee storages (Blowering Dam and Burrinjuck Dam), 2004–05 to 2015–16

Demand drivers

Changes in irrigated agricultural production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. With reference to the water systems located in the Murrumbidgee Catchment, these drivers are explored below.

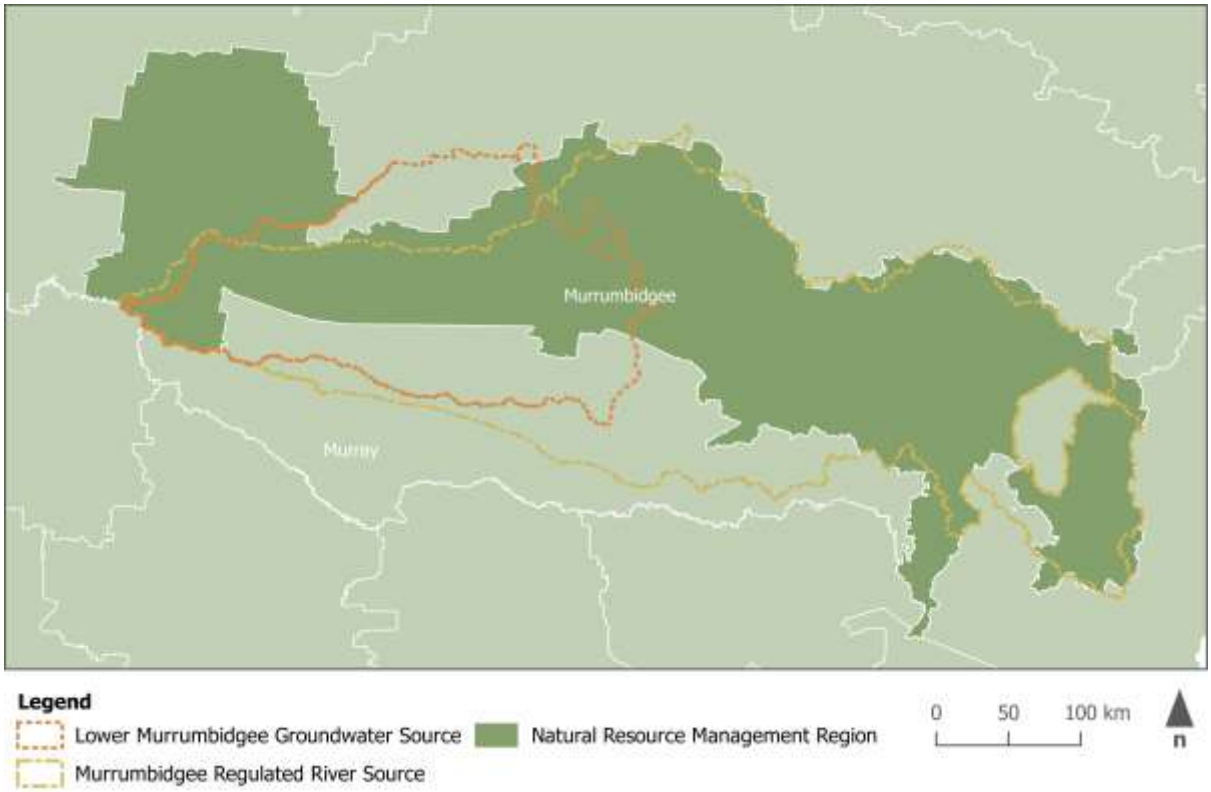
For this regional summary, Aither has compared land use and water use in the Murrumbidgee Catchment for 2005–06 and 2014–15. The 2014–15 ABS water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2014–15 year is the most recently available data, and it has been compared with 2005–06 because that was a similar year in relation to water allocations and rainfall, and therefore provides a reasonable comparison regarding how production in the system has changed over time [24,25]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 74. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the Murrumbidgee WSP areas.[26]

[24] While the years presented appear similar at face value, 2005-06 was in the middle of a significant drought (i.e. the preceding years all had significant restrictions) and 2014-15 followed a period of four years of high water availability. These differences are significant as land use and water use may be influenced by this. It is not possible to find two years in the time series which are perfectly comparable (including having the same lead in water availability), so 2005-06 and 2014-15 have been selected as they offer the best comparison available.

[25] Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years.

[26] At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.



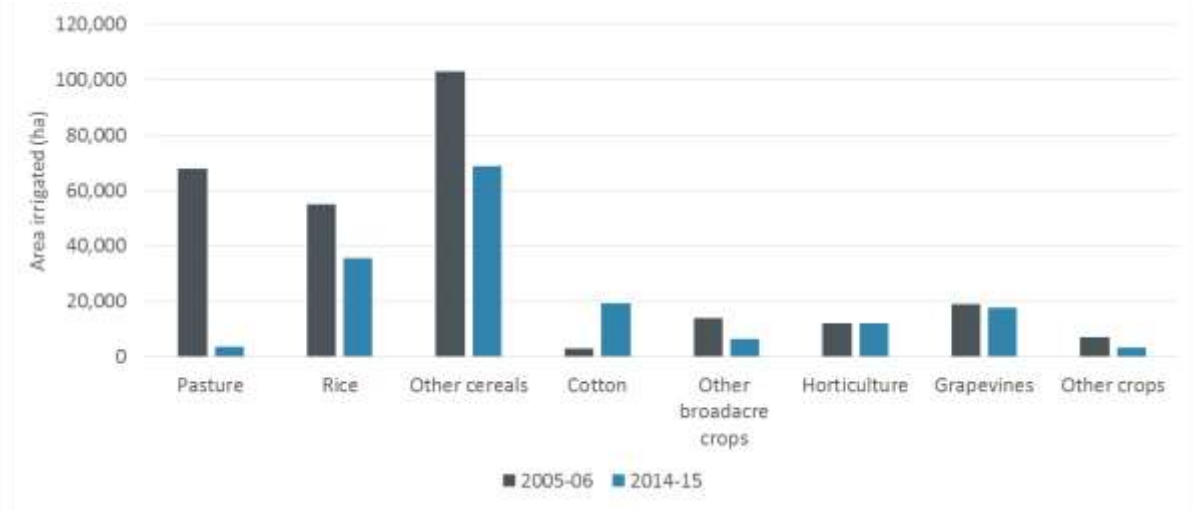
Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 72 Alignment of NRM regions and WSP boundaries - Murrumbidgee

Land use

There is a significant amount of irrigated agricultural activity in the Murrumbidgee Catchment. Grapes, other horticulture and rice dominate plantings in irrigation districts. Outside of irrigation districts, cotton, high-value horticulture, and pasture are the large irrigated agricultural industries.

Figure 73 compares land use by irrigated agricultural industries in the Murrumbidgee for 2005–06 and 2014–15. For the two years presented, there is an overall reduction in the overall area irrigated. Despite this, the irrigated cotton industry appears to have emerged as a major industry over the past decade. Figure 73 also highlights a possible decline in land use for pasture, rice, other cereals and other crops (such as vegetables). In contrast, land use for horticulture and grapevines is relatively stable when comparing 2005–06 and 2014–15, which can be expected for permanent plantings.

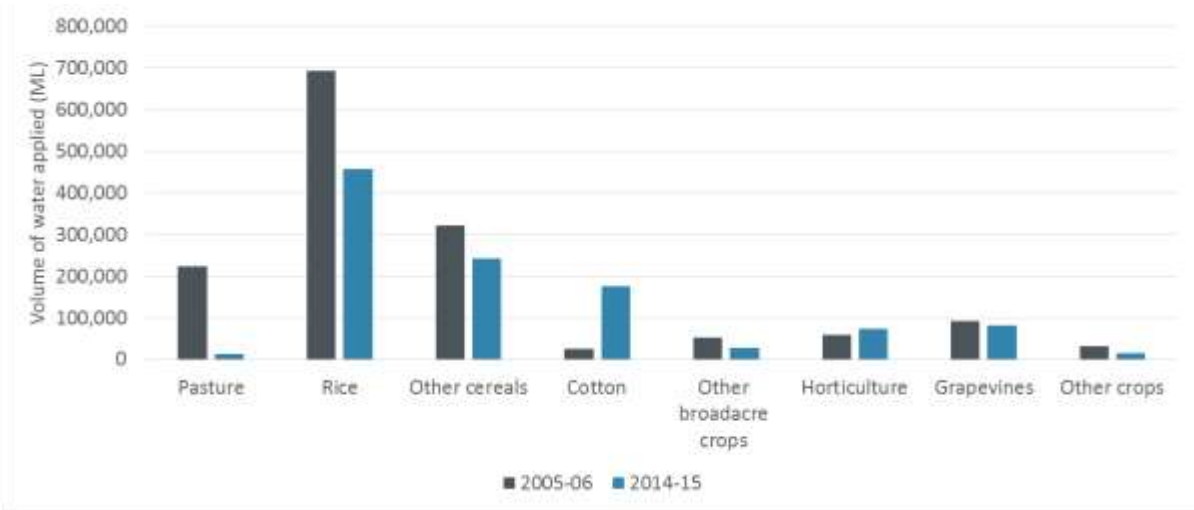


Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 73 Land use by irrigated agricultural industry Murrumbidgee Catchment, 2005–06 and 2014–15

Water use

Figure 74 compares water use by irrigated agricultural industries in the Murrumbidgee Catchment for 2005–06 and 2014–15. This suggests an overall decrease in water usage between these years. Coinciding with this reduction, there has been a significant reduction in water use by the rice industry, but rice is still the largest water user. Figure 74 also shows increased water use by the cotton industry which aligns with a growth in the area of cotton planted (compared to Figure 73). There has also been a decline in water use for pasture, rice, other cereals and other crops (such as vegetables). Across this same period, horticulture has marginally increased water use, and water use by grapevines has slightly decreased.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 74 Water use by irrigated agricultural industry Murrumbidgee Catchment, 2005–06 and 2014–15

Institutional and policy

Trade rules

Water trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. [27]

Murrumbidgee Regulated River Water Source

Of particular interest for the Murrumbidgee Regulated River is that intervalley transfers may occur between the Murrumbidgee and selected other sources under certain conditions.[28] Access licences (excluding supplementary licences) may be transferred (cancelled and reinstated in a different water source) between the Murrumbidgee Regulated River Source and the New South Wales Murray, Lower Darling or unregulated rivers in the Murrumbidgee catchment under provisions in the WSP. However, the necessary mechanisms to support implementation of transfer dealings do not exist, so in reality, these types of dealings do not occur. This limitation is currently being addressed by tag trading, for example, a Murrumbidgee licence is purchased by a Murray irrigator who attaches the licence to their works approval.

Water allocations may be assigned *to* the Murrumbidgee Regulated River *from* the NSW Murray, and Lower Darling regulated rivers, while allocations may be assigned *from* the Murrumbidgee Regulated River *to* the NSW Murray and or Lower Darling. They can also be traded to interstate river systems. For administrative purposes, applications to trade water allocations for General and High Security licences must be received no later than 31 May in each water year. Connectivity with other river systems within NSW and the broader southern MDB expands the potential for water users to participate in the market.

The WSP for the Murrumbidgee Regulated River Water Source also contains volume based provisions which govern and limit allocation trade into and out of the Murrumbidgee River from other valleys and interstate (IVT limit).[29] The IVT limit reduces the likelihood that water will remain undelivered to downstream valleys in a year. It also limits the potential for water losses that occur when a large proportion of the available water is required to be delivered through choke points. These restrictions are primarily focused on reducing third party impacts on Murrumbidgee licence holders resulting from trade, however, can lead to price impacts on allocation water around or during periods when water cannot be traded out of the Murrumbidgee.

Lower Murrumbidgee Groundwater Sources

Two local management areas (local management areas 1 and 2) have been defined within the Lower Murrumbidgee Deep Groundwater Source area to better manage drawdown of groundwater resources. Specific rules within these areas govern groundwater trade.[30] Local management areas are defined based on how well groundwater resources recover following seasonal pumping, based on changes in depth to groundwater. Allocations and licences may only be traded from area 1 to area 2

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[27] This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

[28] For further information, refer to A guide to the Water sharing Plan for the Murrumbidgee Regulated River Water Source (http://www.water.nsw.gov.au/__data/assets/pdf_file/0010/547705/murrumbidgee-reg-guide.pdf)..

[29] For further information, refer to the Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016 (http://www.legislation.nsw.gov.au/#/view/regulation/2016/367/part10/sec76).

[30] For further information, refer to Groundwater trading and management of local impacts – Lower Murrumbidgee Deep Groundwater Source.(http://www.water.nsw.gov.au/__data/assets/pdf_file/0007/547819/groundwater_trading_and_management-of_local_impacts_lower_murrumbidgee_alluvium.pdf)

or the wider WSP, and from area 2 to the wider WSP. Restrictions on the direction and extent of trade effectively can impact the frequency and volume of trade.

Other policy issues

The IVT in the Murrumbidgee has been a contentious issue in recent years, and some water market participants and other stakeholders still view this as a significant policy issue, noting that measures have been implemented to ensure that the IVT limit is not exceeded, and that trade applications can be fulfilled when limit becomes available. Some stakeholders are skeptical of the need for (or extent of) the limitation imposed, whilst other concerns have been raised about information and communication regarding the status of the limit at different points in time, including the ability of traders to see a 'live' view of the limit. Conversely, some stakeholders are supportive of the IVT and view it as an important mechanism to protect access to the water resource (which would not be possible if trade was unrestricted). Similarly, the impact that the IVT has on prices (which are generally lower in the Murrumbidgee, but can invert) can be beneficial to producers. These issues are important to traders given the market impacts the IVT gives rise to.

Another issue that is sometimes raised in relation to the Murrumbidgee (given the potential for trade, but which applies more broadly) are usage charges associated with allocation trade. In New South Wales, fees for allocation trade are collected by WaterNSW and involve a two-part fixed and variable (usage) charge.[31] This type of charge (fixed and variable) means that if water is traded interstate and the usage charges are not collected (because water is not used in NSW) then WaterNSW's revenue may be impacted. This was changed such that WaterNSW now requires the payment of variable usage charges for all allocation assignments involving a buyer licence not linked to a NSW Works Approval. However, concerns are sometimes raised in relation to the basis for charging a variable charge for trade processing at all, regardless of where water is traded to.

[31] The tariff structure and level is determined and set as part of economic regulation for water utilities in NSW, which is overseen by IPART, and the ACCC (for MDB valleys).

Lower Darling Catchment

Summary of key drivers

The Lower Darling is part of the southern MDB and constitutes the regulated portion of the Darling River below the Menindee Lakes Scheme in south-western NSW. This summary covers the regulated surface water in the catchment, which supports irrigation and environmental values.

Of the 348,784 ML of water on issue in the Lower Darling, 72 per cent (250,000 ML) is issued to Supplementary entitlement types, and can only be accessed when there is excess water in the system than is committed to other water users. General Security entitlements make up 23 per cent of the entitlement on issue, a substantial proportion of which is held by the environment.

Water in the Lower Darling can be traded with connected systems including the Murray, Murrumbidgee and Victoria and South Australia. Despite this, both High Security and General Security entitlements are infrequently traded. There is relatively more trade activity on the allocation market, especially in years when there is water available in the system to be traded.

Allocations to entitlements and rainfall have followed a drying to drought phase until 2010–11, with inter-year variability between wet and dry years thereafter.

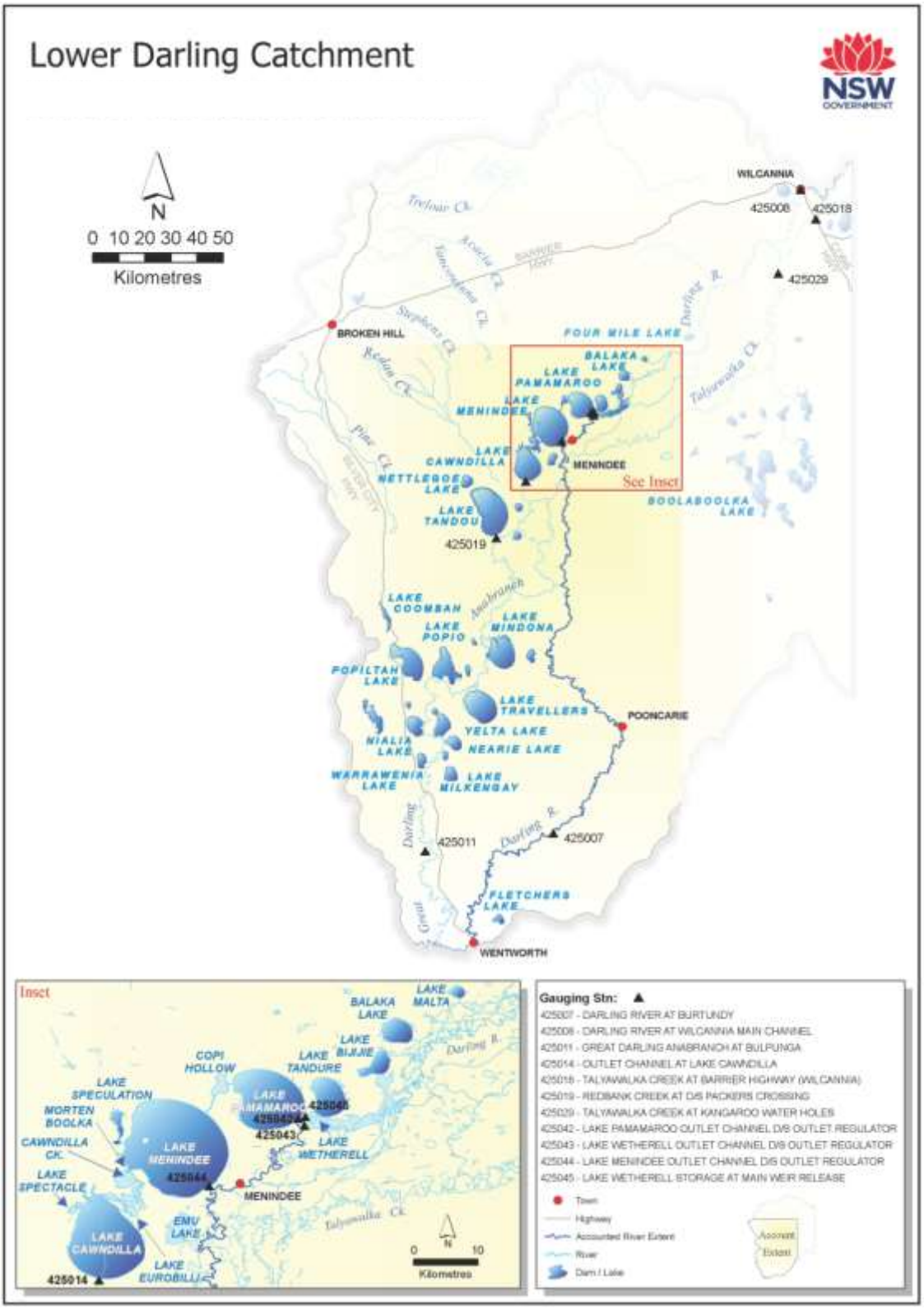
Geographic and hydrological overview

The main surface water source located within the Lower Darling Catchment that is the focus of this regional summary is the Lower Darling Regulated River Water Source. Management of water in the catchment is provided for by the water sharing plan for the NSW Murray and Lower Darling Regulated River Water Sources. The Lower Darling and the Murray catchment are presented in separate regional summaries despite being managed under the same water sharing plan.

Lower Darling Regulated River Water Source

The Lower Darling Regulated River Water Source (the Lower Darling River) is a regulated surface water system located within the Lower Darling Catchment in south-western New South Wales (Figure 75). The Lower Darling River is a major tributary of the Murray River and serves a sparse regional population including the regional town of Wentworth in the south at the junction of the Darling and Murray Rivers, and the small townships of Menindee and Pooncarie.

The Lower Darling Regulated River Water Source (Lower Darling River) is located in the semi-arid environment of south-western NSW and refers to the portion of the Darling River regulated by the Menindee Lakes Scheme. The dominant topographic feature of the catchment is flat floodplain with elevations less than 100 meters. Whilst the most significant land use in the catchment is grazing there is some minor irrigation development around Wentworth. The Lower Darling also contains substantial environmental values including Kinchega National Park near Menindee, which conserves important river red gum, rare acacia and bluebush communities. The Menindee Lakes Scheme provides important waterbird habitat.



Source: NSW DPI Water 2016.

Figure 75 Lower Darling catchment – Lower Darling Regulated River Water Source

Water entitlements

Entitlements on issue

Table 10 summarises entitlement on issue for the water systems covered by this regional summary. Surface water entitlements are dominated by General Security, a substantial proportion of which is held by the environment. There is also a significant amount of supplementary water in the system which is announced when there is water in the system that is in excess to the amount committed to water users.

Table 10 Entitlement on issue for Lower Darling Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of total entitlement on issue held by environment (%)
Lower Darling Regulated River Water Source					
General Security	93	79,507	23%	50,003	63%
High Security[3]	68	7,771	2%	1,035	13%
Local water utility	2	10,135	3%	0	0%
Domestic and stock	115	1,371	<1%	0	0%
Supplementary	3	250,000	72%	250,000	100%
Total	**281**	**348,784**	**100%**	**301,038**	**86%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and data from NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 3) Includes High Security (Aboriginal cultural), High Security (research) and High Security (town water supply).

Entitlement characteristics

Table 11 presents a high-level comparative analysis of the characteristics of each entitlement type.

Table 11 Entitlement characteristics comparison for Lower Darling Catchment water systems

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Lower Darling Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes (equal to 0.5 ML per unit share)[2]	Within: Yes Out of: Restricted	Annual[1]
High Security	High	Allocated water after urban and domestic and stock needs have been secured	No	Within: Yes Out of: Restricted	Annual
Local water utility	High	Allocated before General Security, High Security entitlements	No	Within: Restricted Out of: Restricted	Annual
Domestic and stock	High	Allocated before General Security, High Security entitlements	No	Within: No Out of: No	Annual
Supplementary	Infrequent	Always allocated at 1 ML per share. Supplementary access announcements permit take during high flow events.	No	Within: Restricted Out of: No	Water cannot generally be stored

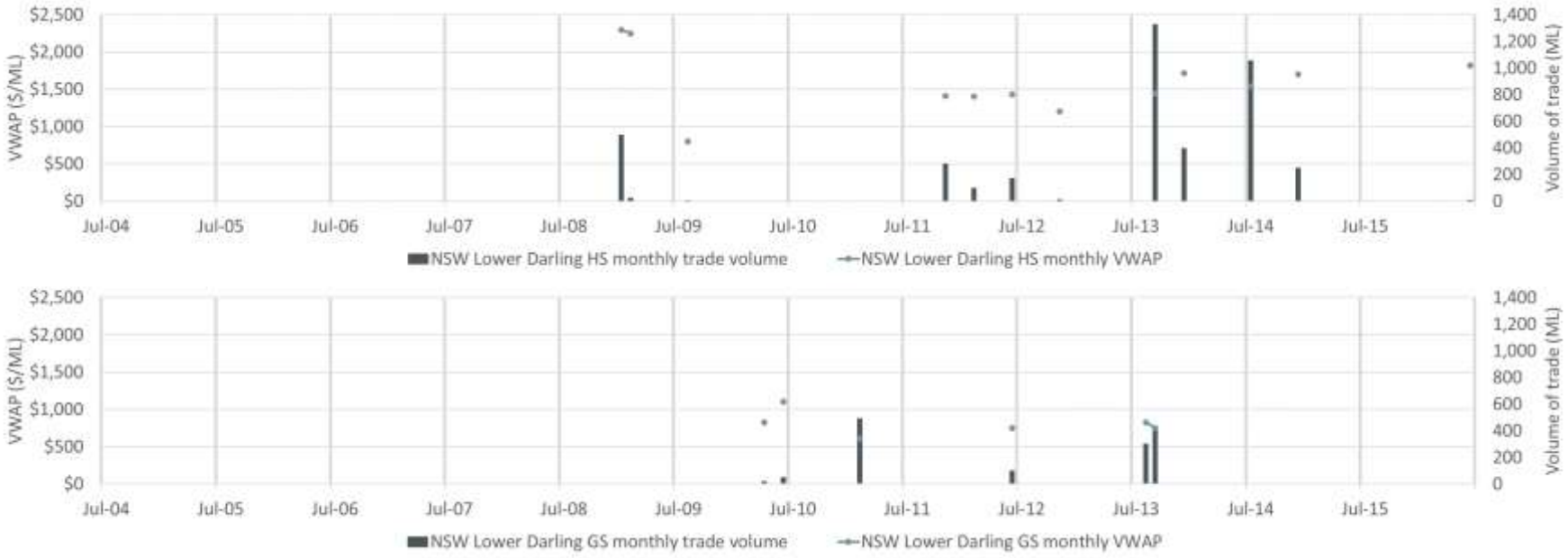
Source: Aither 2016. Based on Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2016.

Note: 1) Uncontrolled flow is non-debit water accessible during supplementary flow events in periods of low allocations. Rules in water sharing plans, linked to allocation levels, define when uncontrolled flow taken converts to debit water against General Security accounts. Some water sources also have High Security uncontrolled flow. 2) The storage volume of airspace in on-farm storages supplied by works nominated on the access licence can also be carried over against General Security entitlements.

Trade activity

Entitlement trade activity

High Security entitlements in the Lower Darling River are infrequently traded and generally command relatively higher prices (Figure 76). General Security entitlements in the Lower Darling River are also traded infrequently and command a lower price.



Source: Aither 2016. Based on New South Wales Water Register 2016.

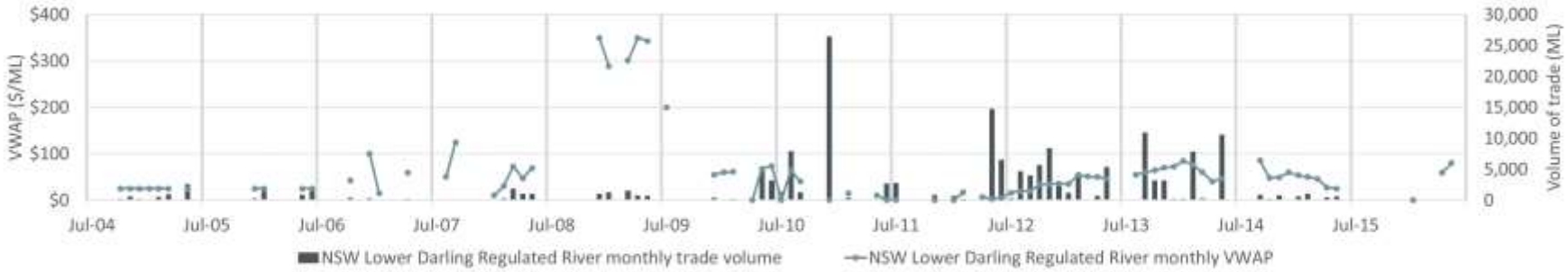
Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 76 Monthly average High Security and General Security entitlement prices and trade volumes Lower Darling Regulated River Water Source, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the Lower Darling River is relatively mature and is active in years with good water availability. It is connected to the broader southern MDB market meaning that trade is generally possible between the Lower Darling and other surface water systems in the southern MDB, although hydrological or other water management constraints can be more significant than for other water sources.

There have been variable volumes of annual trade recorded in most years since 2004–05 dependent on the amount of water available in the system. As shown in Figure 77, prices for allocation water have varied markedly, from record highs in 2008 to record lows in 2010–11 to 2013–14. From 2010–2011 to 2014–15 prices have remained relatively stable below the $100 per ML mark.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 77 Monthly average allocation prices and trade volumes Lower Darling Regulated River Water Source, 2004–05 to 2015–16

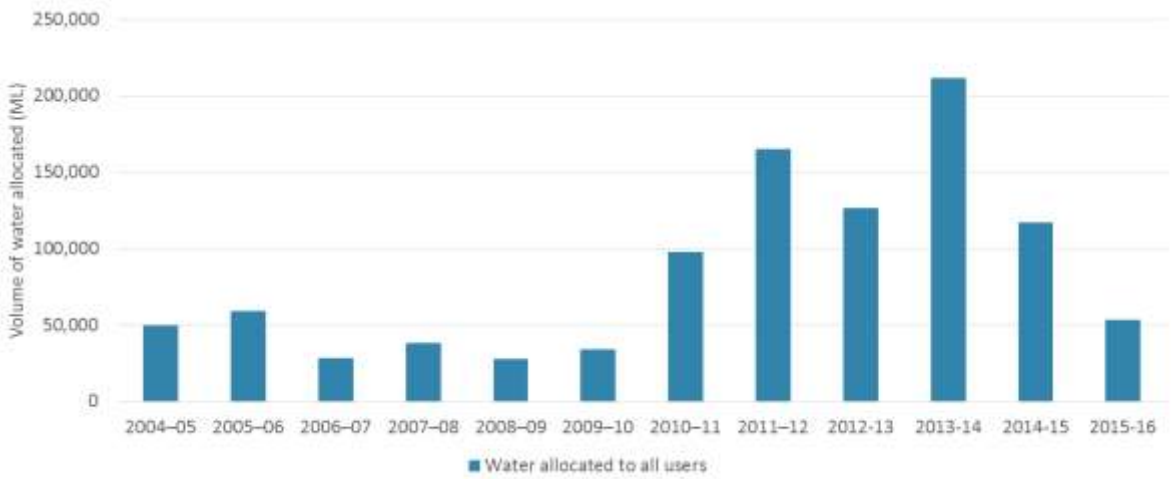
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Lower Darling Catchment, these drivers are explored below.

Allocations to entitlements

Lower Darling Regulated River Water Source

Figure 78 presents the volumes of water allocated to all water users in the Lower Darling River from 2004–05 to 2015–16. Allocations are characterised by relatively low volumes from 2006–07 to 2009–10, high volumes from 2010–11 to 2012–13, and declining volumes thereafter.



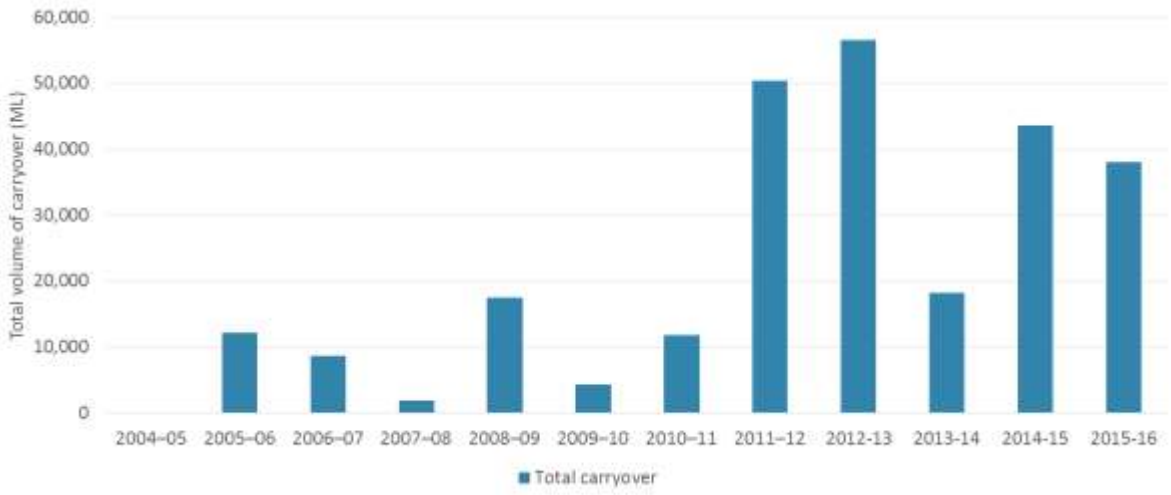
Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: Includes available water determinations (AWD) plus carryover.

Figure 78 Total volume of water allocated to all entitlement types in the Lower Darling River, 2004–05 to 2015–16

Carryover

It is only possible for General Security entitlement types in the Lower Darling River to carryover water (see Table 10 for a full list of entitlement types). Since 2004–05, owners of theses entitlement types have on average carried over 21,945 ML in aggregate into the following water year. This equates to 55 per cent of the total 39,754 ML that can be carried over under these entitlement types in the system per year. Between 2011–12 and 2015–16, the average total volume of carryover has increased to 42,184 ML per year.



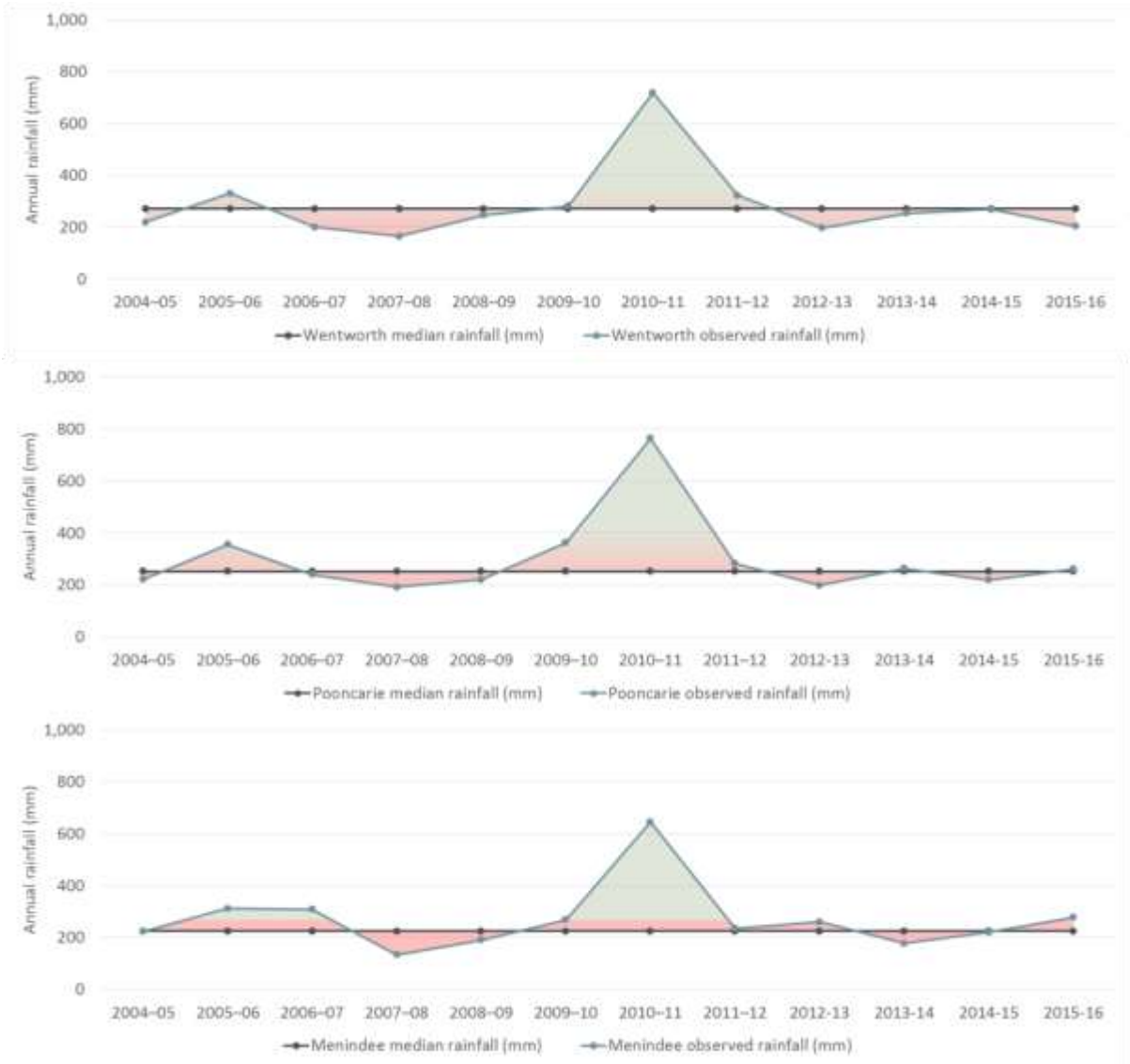
Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes General Security entitlement types as these are the only entitlement types in the Lower Darling which allow carryover. Excludes supplementary water.

Figure 79 Carryover in the Lower Darling Regulated River, 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall are typically very low across the Lower Darling region; for example, the median in Wentworth is 272 mm per annum compared to 224 mm in Menindee. Figure 80 presents annual median rainfall in Wentworth, Pooncarie, and Menindee from 2004–05 to 2015–16. Annual rainfall between Wentworth and Pooncarie across this period is closely correlated – with the ten out of twelve of the same years above and below median rainfall. Observed rainfall patterns in Menindee are similar to Wentworth and Pooncarie but not as highly correlated.



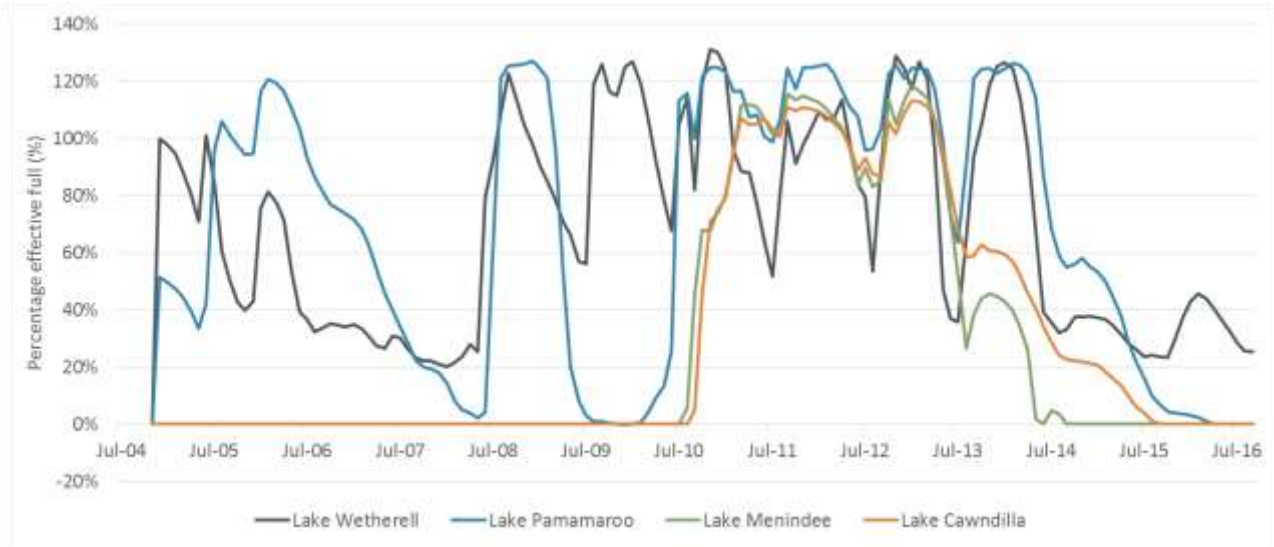
Source: Aither 2016. Based on Bureau of Meteorology 2016.

Note: Due to incomplete data points, median rainfall has been used to calculate observed rainfall for some months.

Figure 80 Rainfall across the Lower Darling catchment, 2004–05 to 2015–16

Water storages

The Lower Darling River is effectively regulated by the Menindee Lakes Scheme, which stores 1,730 GL in its four main lakes – Menindee, Cawndilla, Pamamaroo, and Wetherell. Figure 81 presents changes in storage levels for the main lakes in the Menindee Lakes Scheme from 2004–05 to 2015–16. Over time storage levels have fluctuated from extremly low levels during the Millennium Drought to higher levels with high inter-year variance in the wet years from 2010–11 to 2012–13. Since 2012–13, a downward trend in storage levels has been observed.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

Note: Complete data for all storages not available for all years.

Figure 81 Lower Darling water storages (Menindee Lakes Scheme), 2004–05 to 2015–16

Demand drivers

Changes in irrigated agricultural production is an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. With reference to the water systems located in the Lower Darling Catchment, these drivers are explored below.

For this regional summary, Aither has compared land use and water use changes in the Lower Darling Catchment for 2005–06 and 2012–13. The 2012–13 Australian Bureau of Statistics water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2012–13 year is the most recently available data, and it has been compared with 2005–06 because that was a similar year in relation to water allocations and rainfall, and therefore provides a reasonable comparison for regarding how production in the system has changed over time.[32,33]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 82. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the WSP for the Lower Darling Regulated River Water source area.[34]

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32 There are some important differences between 2005-06 and 2012-13. Rainfall for 2005-06 was slightly above median, whilst 2012-13 had slightly below median rainfall. In terms of water allocations, in 2005-06 there was over 50,000 ML allocated whereas 150,000 ML was allocated in 2012-13. These differences are significant as land use and water use may be influenced by this. It is not possible to find two years in the time series which are perfectly comparable (including having the same lead in water availability), so 2005-06 and 2012-13 have been selected as they offer the best comparison available.

33 Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years.

34 At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.

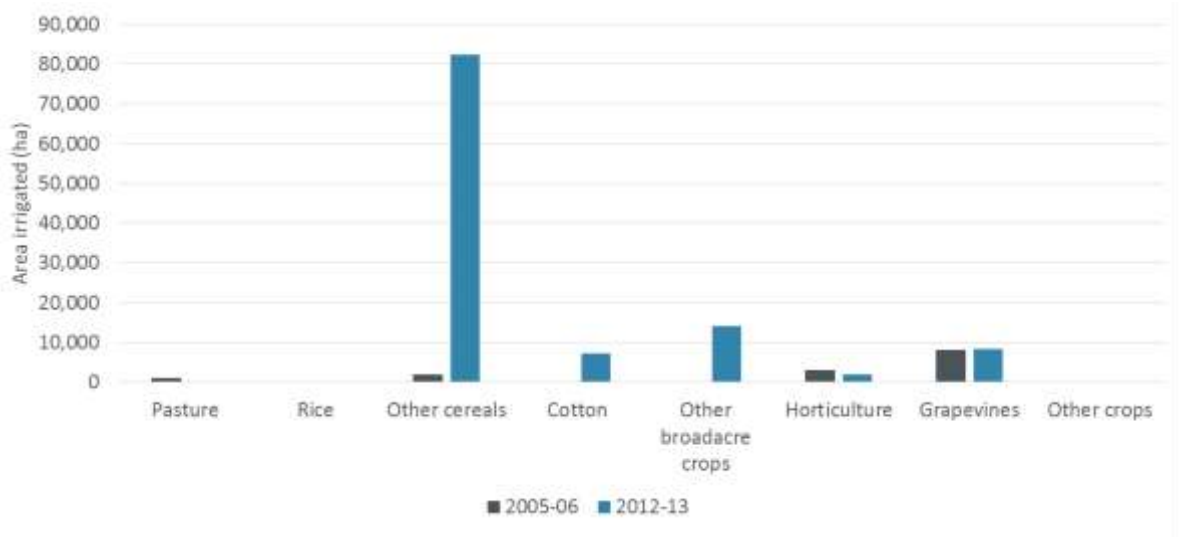
Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 82 Alignment of NRM regions and WSP boundaries – Lower Darling

Land use

Grazing accounts for the majority of land use in the Lower Darling catchment. However, there is a small amount of irrigated agricultural activity that occurs around Wentworth. According to ABS data, other cereals are the main crops under irrigated production. Aither understands from stakeholder feedback that land use by other cereals data may be exaggerated, potentially due to definition issues and being outdated.

Figure 83 compares land use by irrigated agricultural industries in the Lower Darling for 2005–06 and 2012–13. This analysis suggests that other cereals have emerged as the dominant crop over this period. Figure 83 also appears to show a decline in land use for pasture. There is also a slight decline in land use for horticulture for 2005–06 and 2012–13, whilst land use for grapevines is stable. The appearance of cotton in 2012–13 as a significant irrigated planting may be due to producers planting cotton opportunistically.

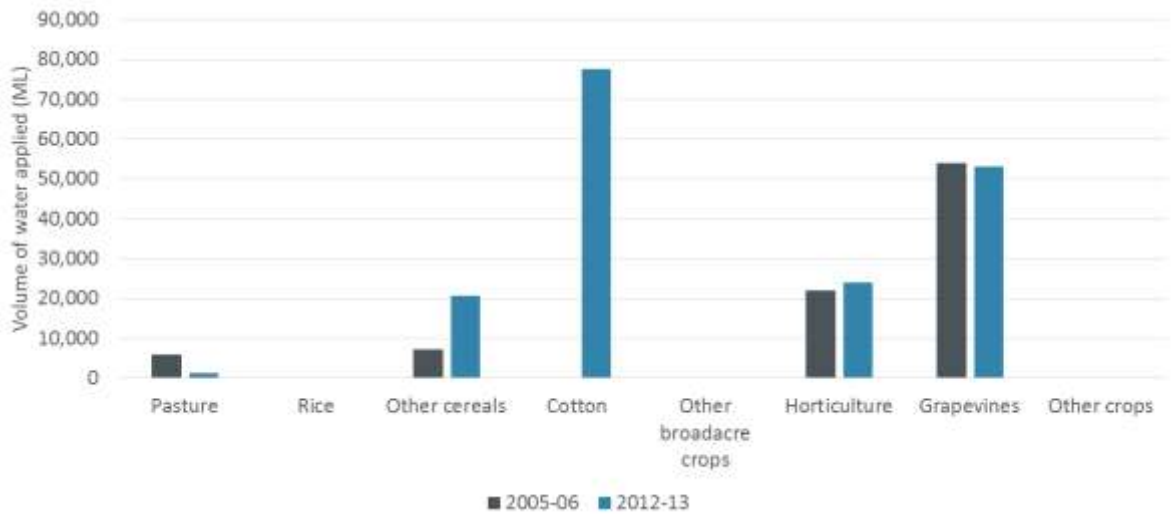


Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 83 Land use by irrigated agricultural industry Lower Darling Catchment, 2005–06 and 2014–15

Water use

Figure 84 compares water use by irrigated agricultural industries in the Lower Darling Catchment for 2005–06 and 2012–13. The analysis suggests that for these years there has been a significant reduction in water use for pasture. Figure 84 also suggests increased water use by other cereals which aligns with strong growth in the area of cereals planted (compared to Figure 83). Across this same period, horticulture appears to have marginally increased water use, while water use by grapevines has slightly decreased. Cotton appears as a major water user in 2012–13. However, no water use is recorded for 2005–06, possibly due to opportunistic planting.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Note: The 2005–06 ABS water use on Australian farms data set does not contain data for cotton and other broad acre crops.

Figure 84 Water use by irrigated agricultural industry Lower Darling Catchment, 2005–06 and 2014–15

Institutional and policy

Trade rules

Trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. The following section outlines rules of particular significance in the Lower Darling region.[35]

Allocations may be traded from the Lower Darling Regulated River Water Source to the NSW Murray Regulated River Water Source and Murrumbidgee Regulated River Source, while allocations may be traded into the Lower Darling from the NSW Murray and Murrumbidgee Regulated River Water Sources. Intervalley trades cease when storage volume in the Menindee Lakes falls below 480 GL and resume when the storage volume exceeds 640 GL.[36] These restrictions are tied to broader management of the lakes, including interstate agreements and management arrangements between NSW and the MDBA. Triggers are in place to protect water supply for critical human needs and to manage evaporative and transmission losses.

Other issues

Management of the Lower Darling and main storages at the Menindee Lakes scheme is shared between the NSW Government water agencies and the Murray-Darling Basin Authority. The Menindee Lakes Storage is managed by New South Wales when storage volumes fall below 480 GL.

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35 This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

36 For further information, refer to Murray-Darling Basin Agreement (Schedule D — Permissible Transfers between Trading Zones) Protocol 2010 (https://www.legislation.gov.au/Details/F2010L02466)

The MDBA may direct water to be released from the lakes to meet downstream demand when their volume rises above 640 GL, and until they drop below 480 GL.

Management and operation of the Menindee Lakes is sometimes raised by stakeholders as an issue, particularly during periods of drought or flood and when the management trigger changes to operational arrangements.

Lachlan Catchment

Summary

The Lachlan River is part of the northern MDB and flows 1,400km across central NSW. This summary covers the regulated surface water and ground water in the catchment, which is an important input into irrigated agriculture.

Water is mostly issued to General Security entitlements, which comprise 89 per cent (592,801 ML) of the total amount of entitlement on issue. High Security entitlements form four per cent of the total resource on issue. Compared to surface water in the Lachlan catchment, there is a high proportion of groundwater entitlements on issue, forming 16 per cent of the total water available in the Lachlan catchment (for both groundwater and surface water systems).

Water in the Lachlan is unable to be traded with other systems due to a low degree of hydrological connectivity. As such, entitlements are infrequently traded. There is comparatively more activity in the allocation market, which shows good trade volumes and prices throughout most years. Groundwater trade markets display modest activity.

Allocations to entitlements, rainfall, and storage volumes suggest drying to drought conditions with a significant wet period from 2010–11. There is a drying phase thereafter.

Land and water use data suggests that pasture, other cereals, cotton and other crops are the dominant crops in the Lachlan.

Geographic and hydrological overview

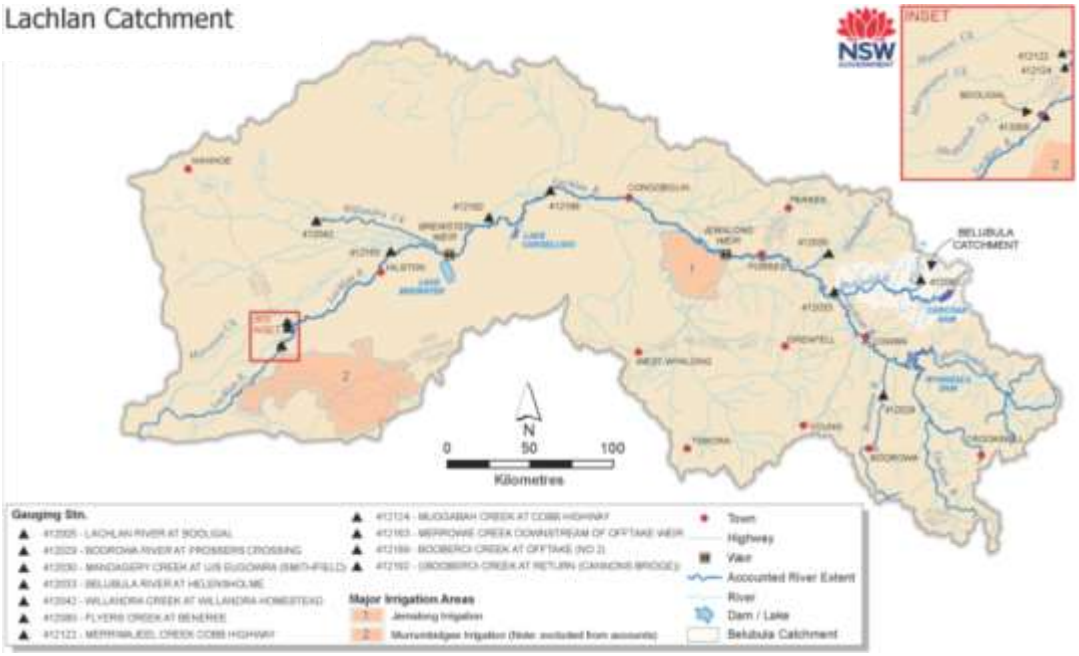
There are two major surface and groundwater water sources and associated water sharing plans located within the Lachlan Catchment that are the focus of this regional summary:

- Lachlan Regulated River Water Source
- Lower Lachlan Groundwater Source.

Lachlan Regulated River Water Source

The Lachlan Regulated River Water Source (the Lachlan River) is a regulated surface water system located within the Lachlan Catchment in central New South Wales (Figure 85). The Lachlan River flows approximately 1,400 km to its junction with the Murrumbidgee River. The regulated Belubula River is a major tributary to the Lachlan River, but is managed under a separate water allocation scheme and WSP. Despite connection to the Murrumbidgee River via the Great Cumbung Swamp, the Lachlan only provides significant inflows into the Murrumbidgee system during major flooding events. A number of major rural towns rely on the Lachlan River for water including Cowra, Parkes, Forbes and Young.

Beginning near Gunning, the Lachlan River is regulated by Wyangala Dam, which is the main storage in the catchment. There is a private irrigation district at Jemalong in the mid-Lachlan region. A number of nationally significant wetlands are located along the extent of the Lachlan River, nine of which are featured in the Directory of Important Wetlands in Australia.



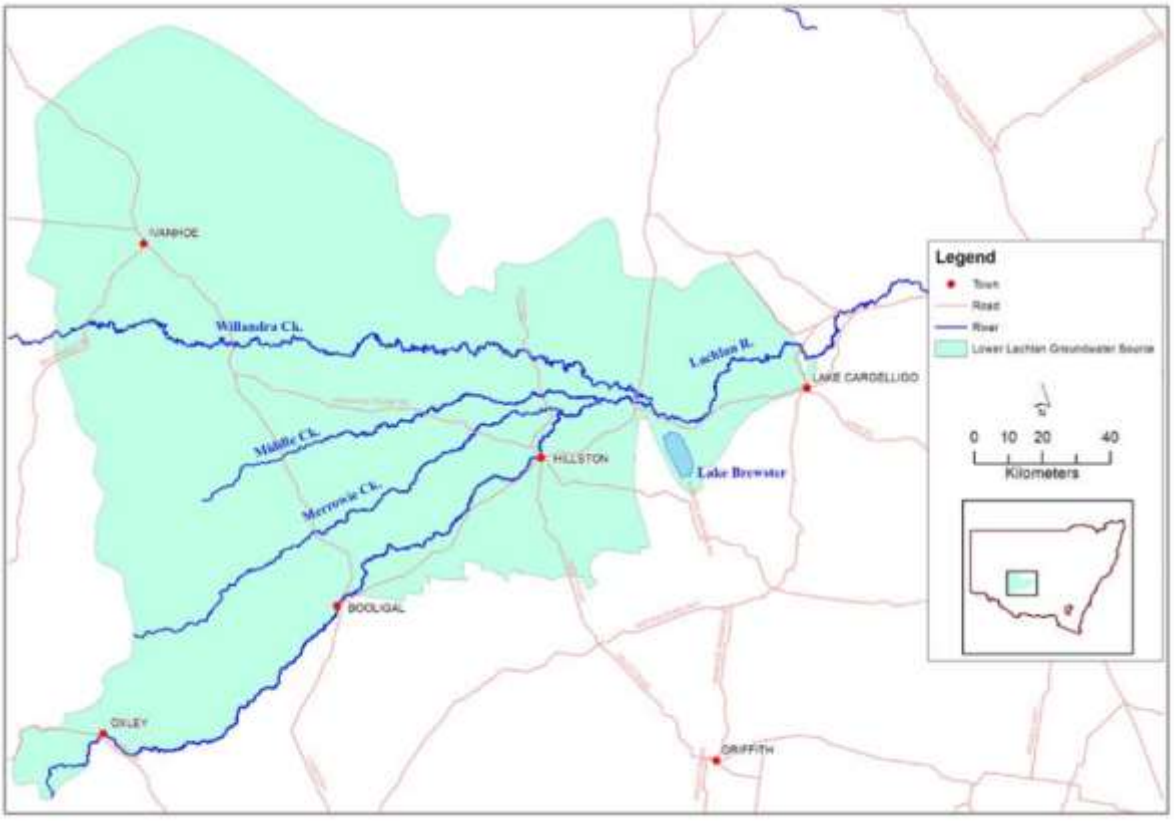
Source: NSW DPI Water 2016.

Figure 85 Lachlan Catchment – Lachlan Regulated River Water Source

Lower Lachlan Groundwater Source

Groundwater also plays an important role in the Lachlan Catchment, with urban, agriculture, and industrial users all using groundwater to different degrees. A number of groundwater sources are located within the catchment, some which are connected to the Lachlan River. The groundwater source of focus in this regional summary is the Lower Lachlan Groundwater Source.

The Lower Lachlan Groundwater Source is bordered in the east by Lake Cargelligo, Ivanhoe in the north-west and Oxley in the south-west (Figure 86).



Source: NSW DPI Water 2016.

Figure 86 Lachlan Catchment – Lower Lachlan Groundwater Source

Water entitlements

Entitlements on issue

Table 12 summarises entitlement on issue for the water sources covered by this regional summary. Surface water entitlements are dominated by General Security, a substantial proportion of which is held by the environment. The total volume of surface water entitlement on issue is much larger than the volume of water on issue in the groundwater source.

Table 12 Entitlement on issue for Lachlan Catchment water systems, 2016–17

Entitlement type	Number of entitlements[1]	Total volume of entitlement on issue (ML)	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of total entitlement on issue held by environment (%)
Lachlan Regulated River Water Source					
General Security	823	592,801	89%	124,518	21%
High Security	175	27,680	4%	2,638	10%
Local water utility	9	15,545	2%	0	0%
Domestic and stock	584	12,762	2%	0	0%
Conveyance	1	17,911	3%		0%
Total	**1,592**	**666,700**	**100%**	**127,156**	**19%**
Lower Lachlan Groundwater Source					
Aquifer[3]	91	105,680	81%	0	0%
Local water utility	5	2,922	2%	0	0%
Supplementary[4]	44	21,237[4]	16%	0	0%
Total	**140**	**129,839**	**100%**	**0**	**0%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and data from NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 3) Includes Aquifer and Aquifer (town water supply). 4) Supplementary groundwater licences will cease to exist at the end of 2016/17. Water available under these licences is progressively reduced each year.

Entitlement characteristics

Table 13 presents a high-level comparative analysis of the characteristics of each entitlement type. The comparison suggests that groundwater entitlements are generally the most secure but may be less flexible regarding trade due to physical constraints. While surface water entitlement types may be marginally less secure (as urban and stock and domestic is allocated first) they have different levels of security and can be used or traded in more flexible ways.

Table 13 Entitlement characteristics comparison for Lachlan Catchment water systems

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Lachlan Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes (up to 2 ML account limit per water share)	Within: Yes Out of: No	Annual
High Security	High	Allocated water after urban and domestic and stock needs have been secured	No	Within: Yes Out of: No	Annual
Local water utility	High	Allocated before General Security, High Security entitlements	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before General Security, High Security entitlements	No	Within: No Out of: No	Annual
Conveyance	Medium-High	Allocated water after urban and domestic needs have been secured	No	Within: Yes Out of: No	Annual
Lower Lachlan Groundwater Source					
Aquifer	High	Allocated water after urban and domestic and stock needs have been secured	Yes (up to 2 ML account limit per water share)	Within: Restricted Out of: No	Annual
Local water utility	High	Allocated before Aquifer entitlements	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before Aquifer entitlements	No	Within: No Out of: No	Annual
Supplementary	Very low[1]	Finite allocation progressively reduced as extraction occurs	No	Not permitted	Continuous

Source: Aither 2016. Based on the Water Sharing Plan for the Lachlan Regulated River Water Source 2016 and Water Sharing Plan for the Lower Lachlan Groundwater Source 2008.

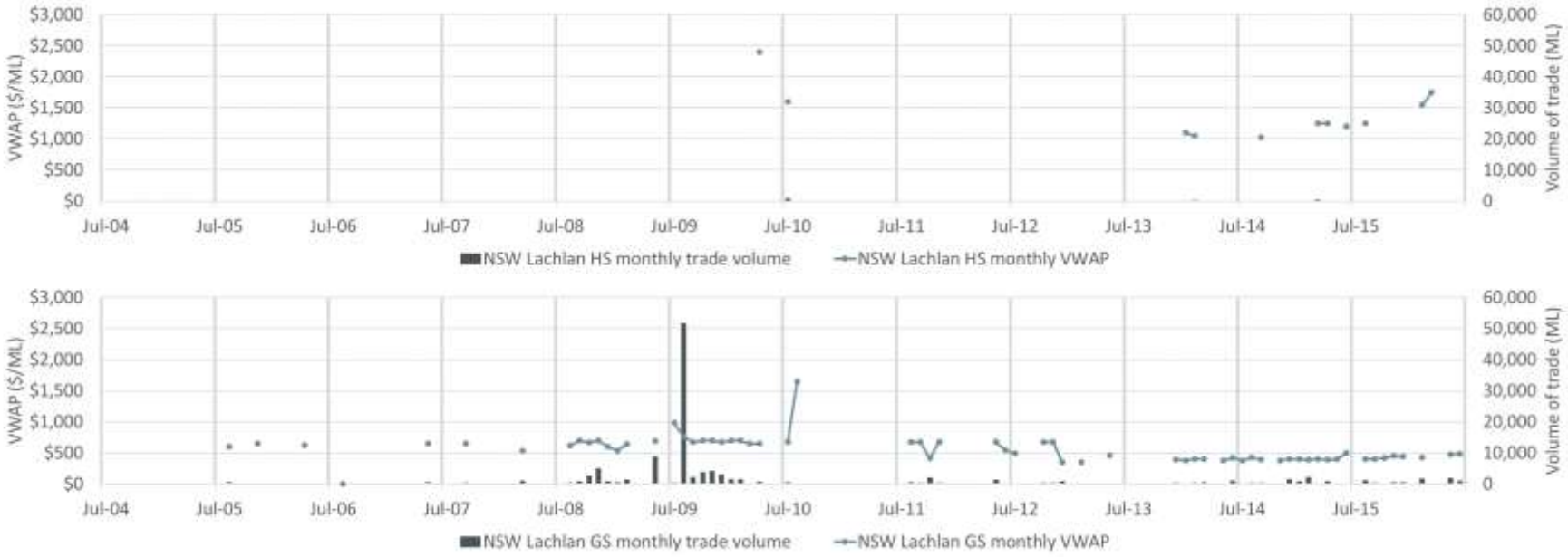
Note: 1) Supplementary water access licences are issued as a one-off volume up to the groundwater storage extraction limit, which is equal to 0.002 per cent of storage.

Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

High Security entitlements in the Lachlan River are infrequently traded and generally command higher prices (Figure 87). In comparison, General Security entitlements in the Lachlan River trade more but have historically commanded a lower price. Peaks in General Security trade volumes and prices observed during 2009–10 may be partially driven by stronger Commonwealth involvement in the market during this time.

Aquifer entitlements have been traded in the Lower Lachlan Deep Groundwater Source (Figure 88), but at lower volume and frequency compared to surface water. Since 2008–09, Aquifer entitlements in the Lower Lachlan Shallow Groundwater Source have commanded a slightly higher price than General Security entitlements in the surface water system.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 87 Monthly average High Security and General Security entitlement prices and trade volumes Lachlan Regulated River Water Source, 2004–05 to 2015–16

Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

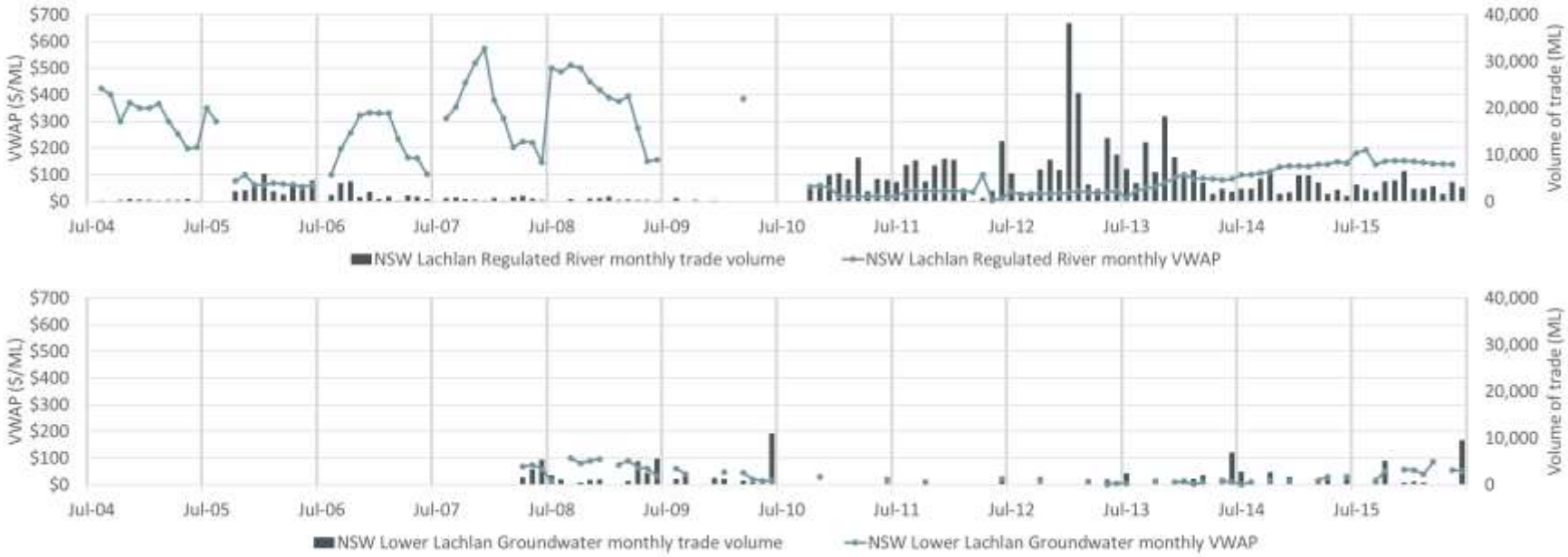
Figure 88 Monthly average Aquifer entitlement prices and trade volumes Lower Lachlan Groundwater Source, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the Lachlan River is active and relatively mature. Trade is not possible between the Lachlan and the Murrumbidgee.

There have been substantial volumes of annual trade in most of the past ten years. Prices for allocation water have varied markedly, from record highs in 2007 to record lows in 2010–11 to 2012–13. Between 2012–13 and 2015–16, prices increased to a high of more than $190 per ML.

There is comparatively less trade and lower prices for allocations in the Lower Lachlan Groundwater Source (Figure 89). Commercial trades for Lower Lachlan Groundwater are recorded from 2007–08 onwards.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 89 Monthly average allocation prices and trade volumes Lachlan Regulated River Water Source and Lower Lachlan Groundwater Source, 2004–05 to 2015–16

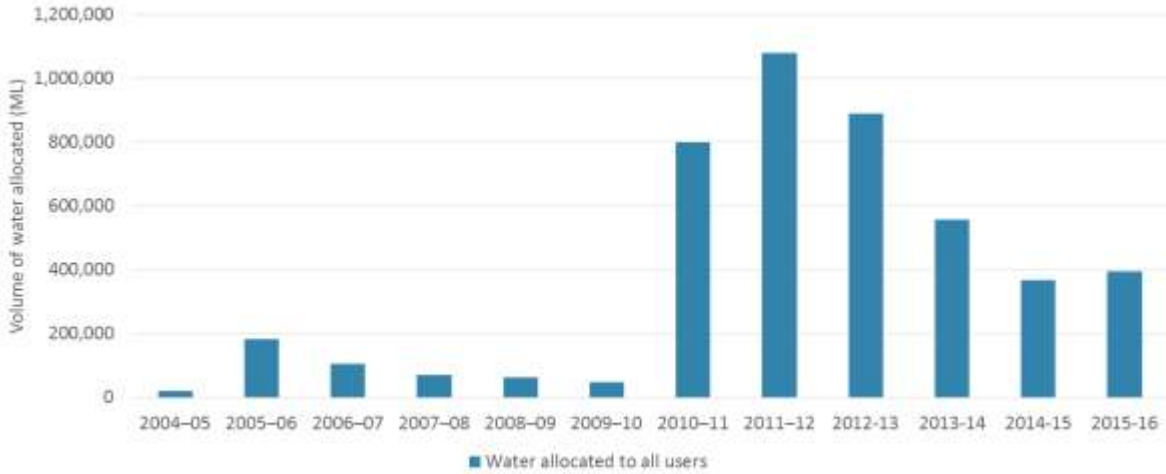
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Lachlan Catchment, these drivers are explored below.

Allocations to entitlements

Lachlan Regulated River Water Source

Figure 90 presents the volumes of water allocated to all water users in the Lachlan River from 2004–05 to 2015–16. Allocations are characterised by relatively low volumes from 2006–07 to 2009–10, high volumes from 2010–11 to 2012–13, and declining volumes to 2015–16.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: Includes available water determinations (AWD) plus carryover.

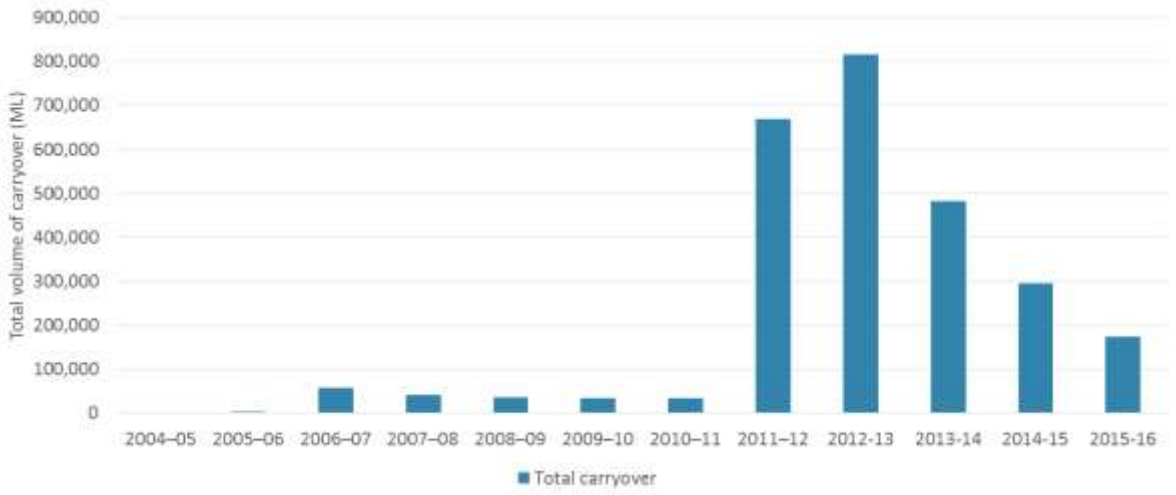
Figure 90 Total volume of water allocated to all entitlement types in the Lachlan River, 2004–05 to 2015–16

Lower Lachlan Groundwater Source

In every water year since 2007–08 Aquifer entitlements in the Lower Lachlan Groundwater Source have received 100 per cent allocations by the end of the water year.

Carryover

It is only possible for General Security entitlement types in the Lachlan River to carryover water (see Table 11 for a full list of entitlement types). Figure 91 shows the volume of carryover in the Lachlan Regulated River over the period 2004–05 to 2015–16. Until the year 2010–2011, the average annual volume of water carried over into the next year was 29,119 ML. Between 2011–12 and 2015–16, the volume of carryover has increased significantly, which relates to the amount of water allocated (compare Figure 90). Carryover trended downward from 2012–13.

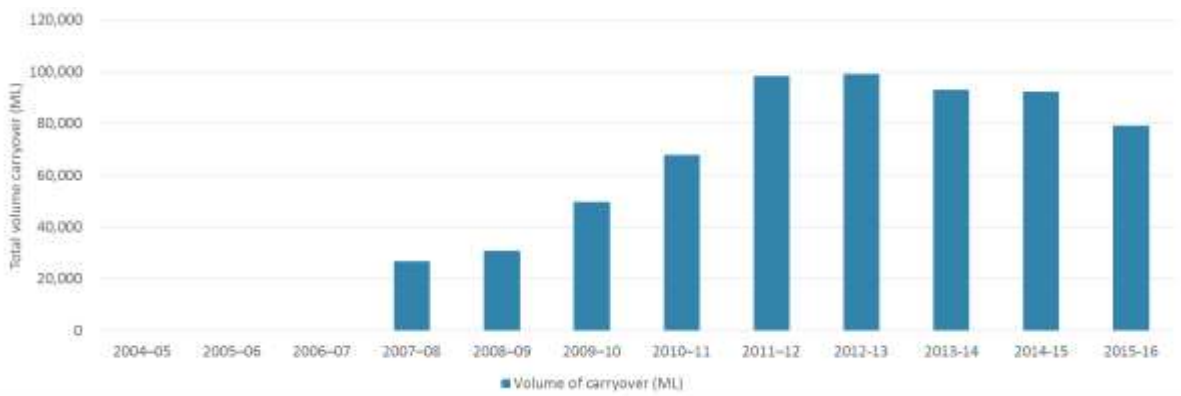


Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes General Security entitlement types as these are the only entitlement types in the Lachlan which allow carryover.

Figure 91 Carryover in the Lachlan Regulated River, 2004–05 to 2015–16

In the Lower Lachlan Groundwater Source, only Aquifer access licences can carryover water into the following year. Entitlement owners for these Aquifer entitlement types can carryover a total of 2 ML per unit share of their entitlement, meaning that carryover can exceed the total entitlement in any given year. As shown in Figure 92, since 2007–08 there has been an average of 70,771 ML carried over into the following year.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

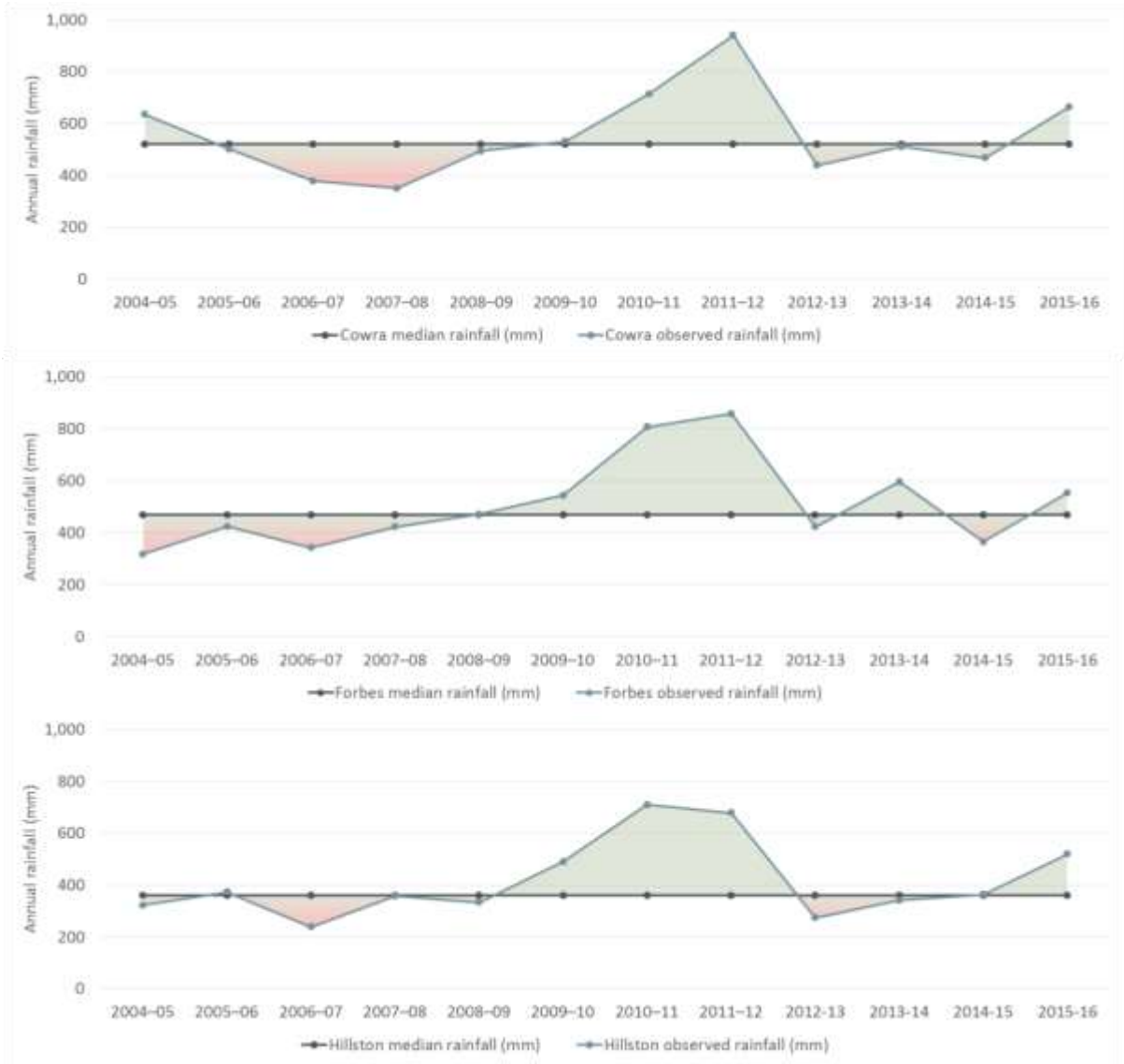
Notes: Only includes Aquifer entitlement types as these are the only entitlement types in the Lachlan which allow carryover.

Figure 92 Carryover in the Lower Lachlan Groundwater Source, 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Lachlan region given different climatic regions; for example, the median in Cowra is over 520 mm per annum compared to 359 mm in Hillston. Figure 93 presents annual median rainfall in Cowra, Forbes, and Hillston from 2004–05 to 2015–16. Annual rainfall between Cowra and Forbes across this period is

strongly correlated – with eleven out of twelve of the same years above and below median rainfall. Observed rainfall patterns in Hillston are similar to Cowra and Forbes but not as highly correlated.

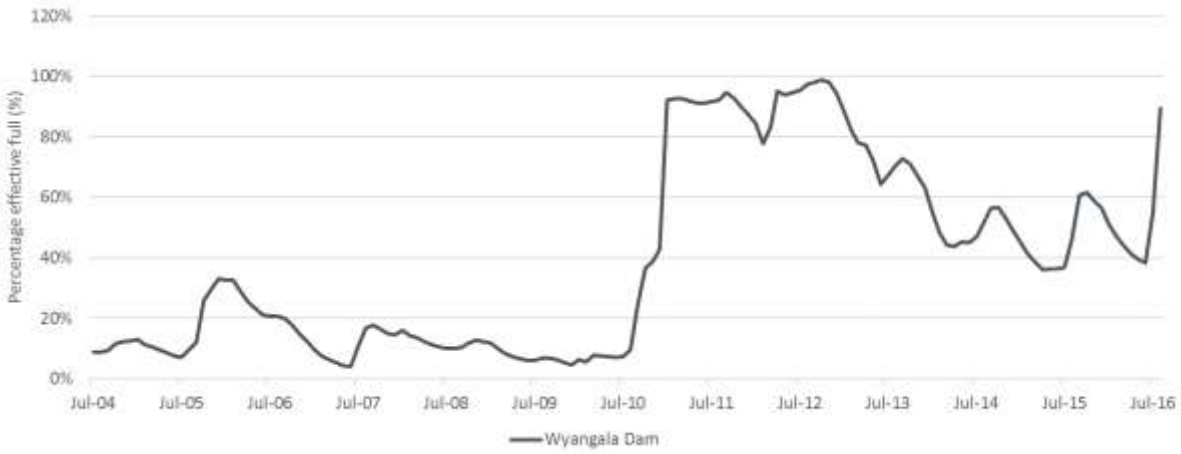


Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 93 Rainfall across the Lachlan Catchment, 2004–05 to 2015–16

Water storages

The primary water storage at the headwater of the Lachlan River is Wyangala Dam (1,217 GL) on the junction of the Lachlan and Abercrombie Rivers. Management of the storage effectively regulates the Lachlan River. Figure 94 presents changes in storage levels for Wyangala Dam from 2004–05 to 2015–16. Over time storage levels have fluctuated from extreme lower levels during the Millennium Drought to higher levels in the wet years from 2010–11 to 2011–12. Between 2011–12 and 2014–15, a downward trend in storage levels with high inter-year variance has been observed; however, storages are now trending up again.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

Figure 94 Lachlan water storages (Wyangala Dam), 2004–05 to 2015–16

Demand drivers

Changes in irrigated agricultural production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. With reference to the water systems located in the Lachlan Catchment, these drivers are explored below.

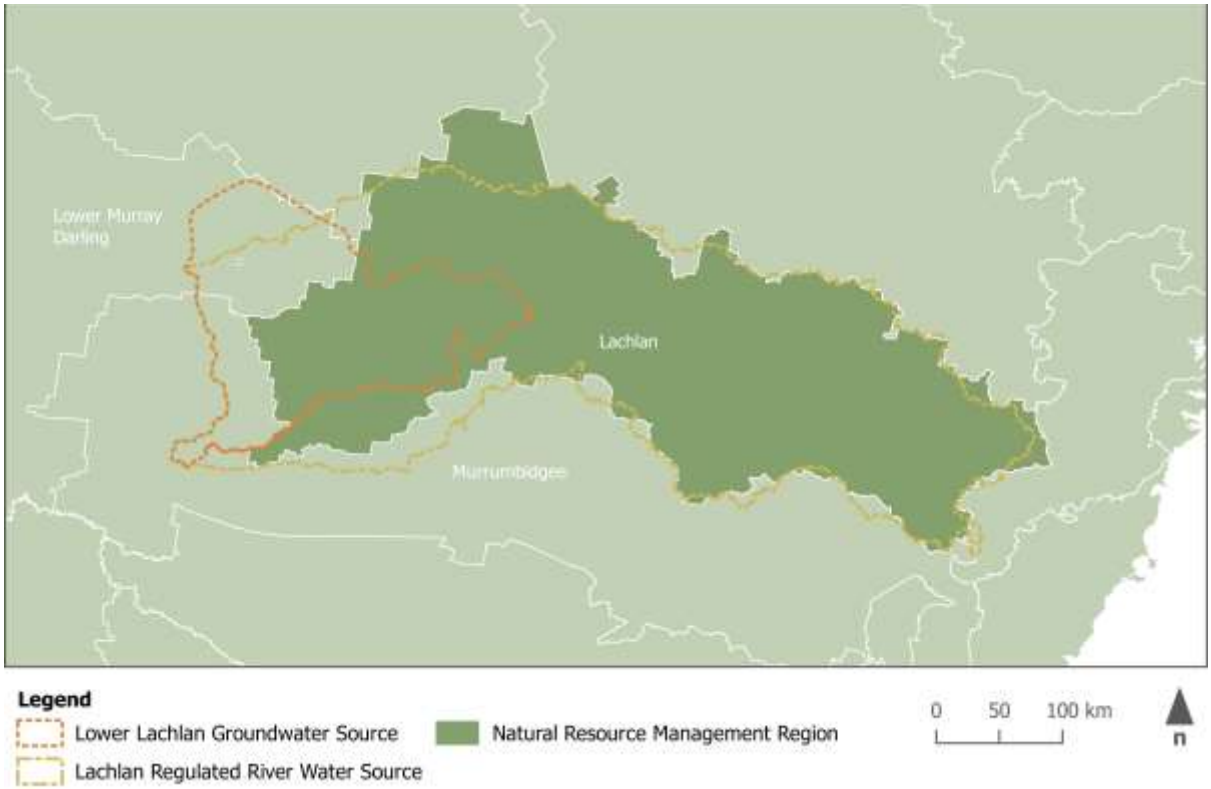
For this regional summary, Aither has compared land use and water use in the Lachlan Catchment for 2005–06 and 2014–15. The 2014–15 Australian Bureau of Statistics water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2014–15 year is the most recently available data, and it has been compared with 2005–06 because that was a similar year in relation to water allocations and rainfall, and therefore provides a reasonable comparison regarding how production in the system has changed over time.[37,38]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 95. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the Lachlan WSP areas.[39]

[37] While there are more comparable years in terms of storages within the time series (such as 2005-06 and 2010-11), a comparison between 2005-06 and 2014-15 has been selected due to stronger similarities between rainfall and because 2014-15 is closer to the present time. Nevertheless, there are a number of differences in water availability in the years leading into 2005-06 (which was characterised by very low water availability) and 2014-15 (in which there was considerably higher water availability). The differences in water availability between these years may have significant impact on water use and land use.

[38] Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years.

[39] At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.



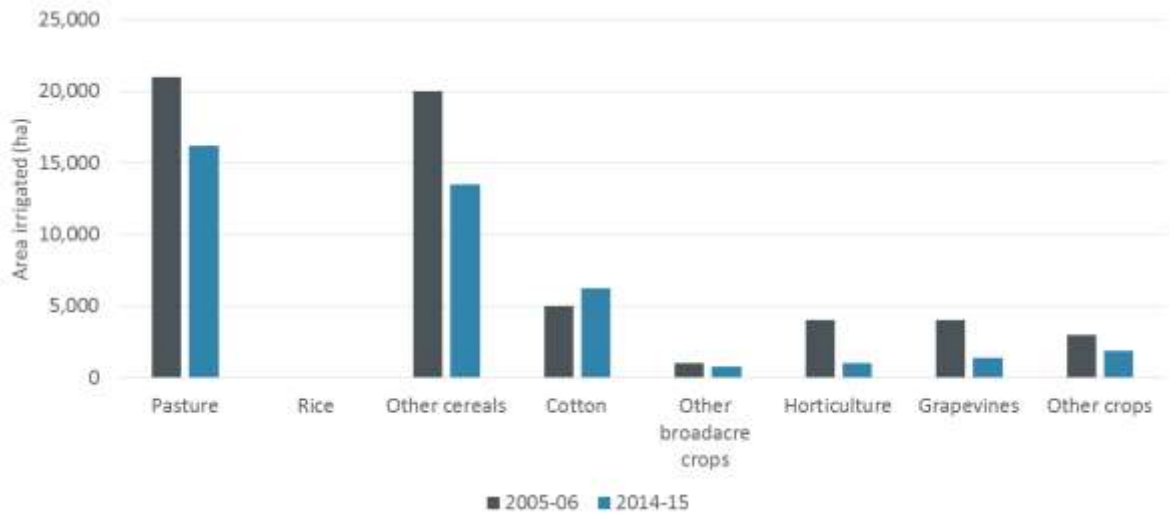
Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 95 Alignment of NRM regions and WSP boundaries – Lachlan

Land use

There is a significant amount of irrigated agricultural activity in the Lachlan Catchment. Despite being economically important, irrigated crops only cover approximately 1.4 per cent of the catchment area (NSW DPI Water 2011). The main crops under irrigation are cereals, lucerne (for pasture) and cotton. Other crops include oilseeds, vegetables, wine grapes and stone fruits.

Figure 96 compares land use by irrigated agricultural industries in the Lachlan for 2005–06 and 2014–15. This analysis points to the emergence of the irrigated cotton industry over the past decade. Figure 96 also appears to show a decline in land use for pasture, and other cereals, although these crops still dominate plantings. For the years presented there are also reductions in horticulture, grapevines, and other crops (such as vegetables). Comparing 2005–06 with 2014–15 there is a marginal decline in the area of other broadacre crops planted.



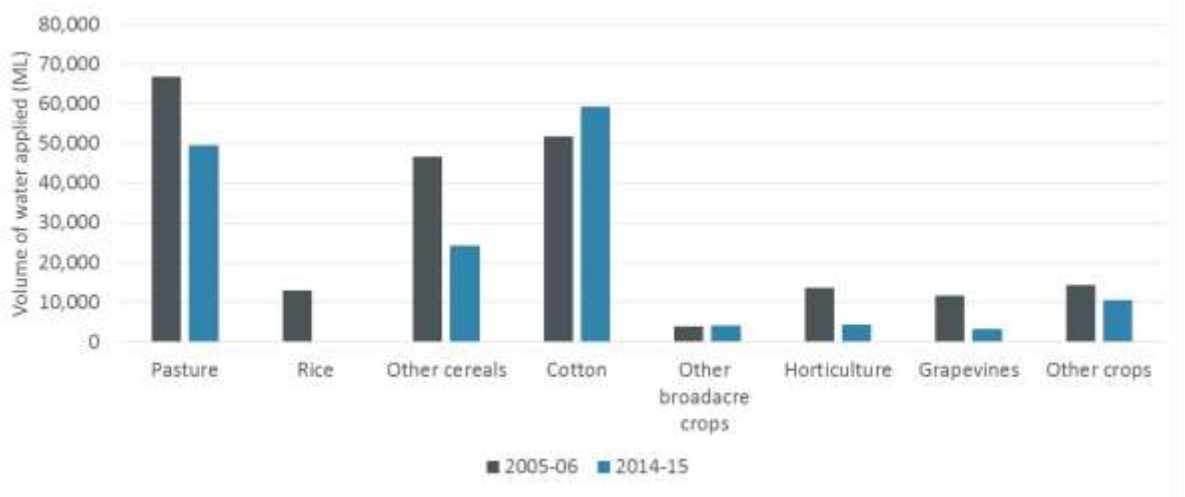
Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Note: Rice has historically been grown in the Lalchan Catchment. Despite water use being recorded, land use data for rice production in the Lalchan Catchment was not available from the 2005–06 farm survey collection.

Figure 96 Land use by irrigated agricultural industry Lachlan Catchment, 2005–06 and 2014–15

Water use

Figure 97 compares water use by irrigated agricultural industries in the Lachlan Catchment for 2005–06 and 2014–15. The analysis suggests that for these years there has been growth in water use by the cotton industry, and that cotton has emerged as the biggest water user in the catchment. This is aligned with the apparent growth in the area of cotton irrigated over the period (compare to Figure 96). Water use by rice appears to have fallen significantly, as does water use by pasture, other cereals, horticulture, and grapevines.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 97 Water use by irrigated agricultural industry Lachlan Catchment, 2005–06 and 2014–15

Institutional and policy

Trade rules

Trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. The following section outlines rules of particular significance in the Lachlan region.[40]

Lachlan Regulated River Source

In the Lachlan Regulated River Source, there are rules that affect net trade within the system to ensure that total share components within specific areas are not exceeded to prevent losses, support reliability of entitlements and protect environmental assets by not exceeding channel capacity constraints.[41]

The total share component of access licences allowed to take water from the Lachlan River downstream of Boologal is capped, and trade may only occur if this level is not exceeded. Similarly, trade may only occur if it does not result in an increase in the total share component in Willandra Creek. Otherwise, access licences may be traded between the Lachlan Regulated River and the Belubula Regulated River.

Based on current rules, trading of water between upstream of Lake Cargelligo and downstream of Cargelligo does not comply with the Basin Plan Trade Rules. As such. They are under review as part of the Water Resource Plan development process. Trade cannot occur between these reaches until the review process is completed.

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40 This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

41 For further information, refer to A guide to the Water Sharing Plan for the Lachlan Regulated River Water Source (http://www.water.nsw.gov.au/__data/assets/pdf_file/0020/548003/lachlan-reg-guide.pdf).

In general, such rules can limit the extent and frequency of trade within the region.

Lower Lachlan Groundwater Source

The Lower Lachlan Groundwater Source is fully allocated. Access licences may only be traded within the source to protect both it and neighbouring sources from over-extraction and unsustainable depletion.[42] This creates an isolated trading zone, limiting the potential counterparties with whom to trade.

Trading within the source is subject to the following trade rules to reduce interference with neighbouring bores:

- An access licence authorised to extract more than 15 ML/d may only be traded if the new extraction point is more than 3 km from an existing bore.
- An access licence authorised to extract more than 10 ML/d and up to and including 15 ML/d may only be traded if the new extraction point is more than 2 km from an existing bore.
- An access licence authorised to extract up to and including 10 ML/d may only be traded if the new extraction point is more than 1 km from an existing bore.

These restrictions can impact the frequency of trade in the groundwater system as it may not be possible to conduct trade, even when there is an interested party.

Other policy issues

There is currently some discussion about trade rules governing trade between the Lachlan and the Belubula River as part of the Water Resource Plan development and Basin Plan trade rule compliance initiatives. Discussion is focused on whether restrictions should be lifted to allow trade between these water sources.

[42] For further information, refer to the Water Sharing Plan for the Lower Lachlan Groundwater Source 2003 (http://www.legislation.nsw.gov.au/#/view/regulation/2003/187/part11).

Macquarie Catchment

Summary

The Macquarie Catchment forms part of the northern MDB, stretching from the Great Dividing Range to the Barwon River in western NSW. This summary covers the Macquarie and Cudgegong Rivers Water Source (Macquarie River) and the Lower Macquarie Groundwater Sources.

There are a total of 725,175 ML of entitlements issued in the Macquarie River. Entitlements are predominately issued to General Security, which make up 632,466 ML of the total volume of entitlements on issue in that resource. Of the 67,725 ML of entitlements issued in the Lower Macquarie Groundwater Sources, 65 per cent are held within two management zones.

It is not possible to trade water in the Macquarie with other systems due to a lack of connectivity. Trade in the entitlement market is infrequent compared with other larger and more established markets in NSW. General Security is traded most frequently, while smaller amounts of High Security and Supplementary occur in some years. The allocations market is comparatively more active and mature than the entitlement market. Trade in the groundwater systems is infrequent.

Allocations to entitlements, rainfall and water storages over the study period are marked by low water availability until June 2010, with water availability improving thereafter.

Water and land use data suggest that the dominant crops types grown in the catchment are cotton, pasture, and cereals.

Geographic and hydrological overview

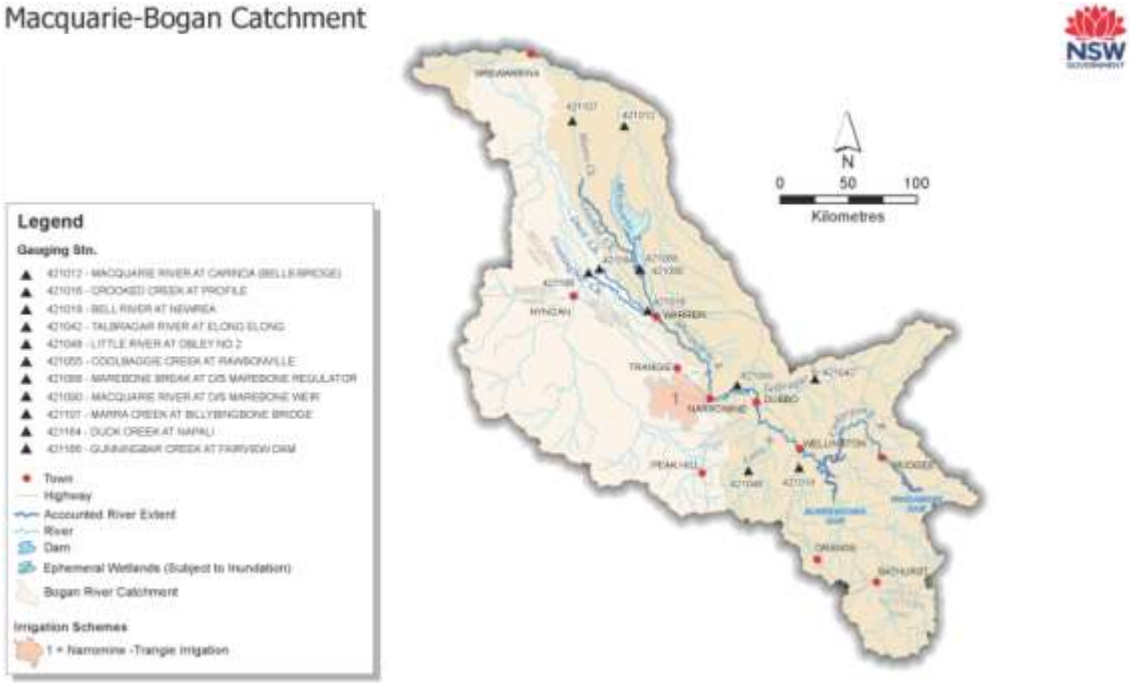
There are two major surface and groundwater water sources and associated water sharing plans located within the Macquarie Catchment that are the focus of this regional summary:

- Macquarie and Cudgegong Regulated Rivers Water Source
- Lower Macquarie Groundwater Source (Zones 1 to 6).

Macquarie and Cudgegong Regulated Rivers Water Source

The Macquarie and Cudgegong Regulated Rivers Water Source (the Macquarie River) is a regulated surface water system located within the Macquarie Catchment in the central west of New South Wales (Figure 98). The Macquarie River is the major watercourse within the catchment, along with its major tributary, the Cudgegong River. The rivers and tributaries within the catchment serve a number of major regional towns – such as Bathurst, Orange, Dubbo, Narromine and Mudgee.

Both the Macquarie and the Cudgegong Rivers rise in the Great Dividing Range flowing north-west towards the Barwon River above Bourke. There are two major storages located within the catchment that regulate the system – Windamere Dam on the Cudgegong River and Burrendong Dam on the Macquarie River. There is significant irrigation district infrastructure along the Macquarie River which supports irrigated agriculture in the region, predominantly cotton. The Ramsar listed Macquarie Marshes are located on the Macquarie River between Warren and Carinda. This site is one of the most important colonial nesting waterbird breeding sites in Australia.



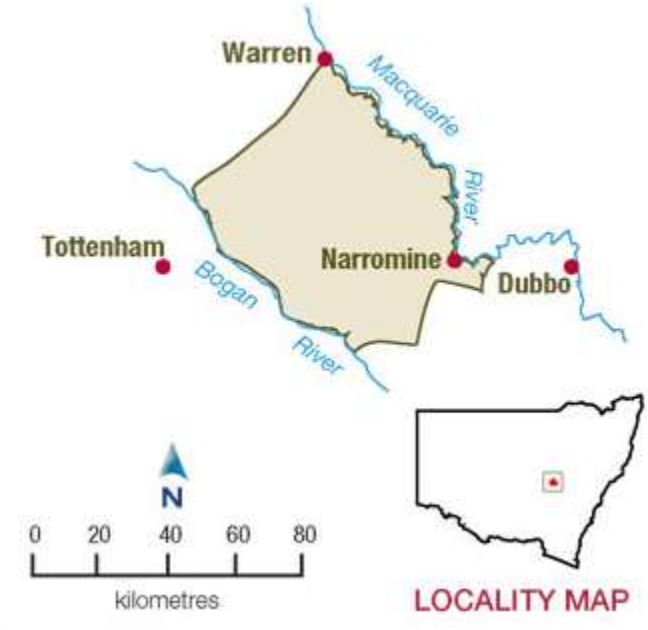
Source: NSW DPI Water 2016.

Figure 98 Macquarie Catchment – Macquarie and Cudgegong Regulated Rivers Water Source

Lower Macquarie Groundwater Sources

Groundwater also plays an important role in the Macquarie Catchment, with urban, agriculture, and industrial users all using groundwater to different degrees. A number of groundwater sources are located within the catchment, some of which are connected to the Macquarie River. The groundwater source of focus in this regional summary is the Lower Macquarie Groundwater Source, which is divided into six management zones.

The Lower Macquarie Groundwater Source is accessible within the Macquarie Catchment – confined by the borders of the Macquarie River in the north and the Bogan River in the south (Figure 99). Major towns within the Lower Macquarie Groundwater Source include Warren and Narromine.



Source: NSW DPI Water 2016.

Figure 99 Macquarie Catchment – Lower Macquarie Groundwater Sources

Water entitlements

Entitlements on issue

Table 14 summarises entitlement on issue for the water systems covered by this regional summary. Surface water entitlements are dominated by General Security, a substantial proportion of which is held by the environment. The total volume of surface water entitlement on issue is much larger than the volume of water on issue in the groundwater systems.

Table 14 Entitlement on issue for Macquarie Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of total entitlement on issue held by environment (%)
Macquarie and Cudgegong Regulated Rivers Water Source					
General Security	633	632,466	87%	174,643	28%
High Security[3]	83	17,913	2%	0	0%
Local water utility	9	18,805	3%	0	0%
Domestic and stock	295	5,993	1%	0	0%
Supplementary	506	49,998	7%	9,744	19%
Total	**1,526**	**725,175**	**100%**	**184,387**	**25%**
Lower Macquarie Groundwater Sources (combined)[4]					
Aquifer	118	65,375	97%	0	0%
Local water utility	2	2,350	3%	0	0%
Total	**120**	**67,725**	**100%**	**0**	**0%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and data from NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 3) Includes High Security (research) and High Security (town water supply). 4) Lower Macquarie Groundwater Source is comprised of six separate management zones.

Table 15 Entitlement on issue for Lower Macquarie Groundwater Sources by management zone, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Proportion of overall Lower Macquarie Groundwater source
Lower Macquarie Zone 1 Groundwater Source				
Aquifer	31	19,680	91%	
Local water utility	1	2,000	9%	
Total	**32**	**21,680**	**100%**	**32%**
Lower Macquarie Zone 2 Groundwater Source				
Aquifer	18	22,608	100%	
Total	**18**	**22,608**	**100%**	**33%**
Lower Macquarie Zone 3 Groundwater Source				

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Proportion of overall Lower Macquarie Groundwater source
Aquifer	26	8,264	96%	
Local water utility	1	350	4%	
Total	**27**	**8,614**	**100%**	**13%**
Lower Macquarie Zone 4 Groundwater Source				
Aquifer	6	5,103	100%	
Total	6	5,103	100%	8%
Lower Macquarie Zone 5 Groundwater Source				
Aquifer	7	2,477	100%	
Total	**7**	**2,477**	**100%**	**4%**
Lower Macquarie Zone 6 Groundwater Source				
Aquifer	30	7,243	100%	
Total	**30**	**7,243**	**100%**	**11%**

Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016.

Entitlement characteristics

Table 16 presents a high-level comparative analysis of the characteristics of each entitlement type. The comparison suggests that groundwater entitlements are generally the most secure but are relatively more inflexible regarding carryover or trade. While surface water entitlement types may be marginally less secure (as urban and domestic and stock is allocated first) they have different levels of security and can be used or traded in more flexible ways.

Table 16 Entitlement characteristics comparison for Macquarie Catchment water systems

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Macquarie and Cudgegong Regulated Rivers Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes	Within: Yes Out of: No	Annual
High Security	High	Allocated water after urban and domestic and stock needs have been secured	No	Within: Yes Out of: No	Annual
Local water utility	High	Allocated before General Security, High Security and Supplementary entitlements	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before General Security, High Security and Supplementary entitlements	No	Within: No Out of: No	Annual
Supplementary	Infrequent	Always allocated at 1 ML per share. Supplementary access announcements permit take during high flow events.	No	Within: Restricted Out of: No	Water cannot generally be stored
Lower Macquarie Groundwater Source					
Aquifer	High	Allocated water after local water utility needs have been secured	Yes (up to 2 ML account limit per water share)	Within: Restricted Out of: No	Annual
Local water utility	High	First entitlement type to be allocated water	No	Within: Restricted Out of: No	Annual

Source: Aither 2016. Based on Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2016.

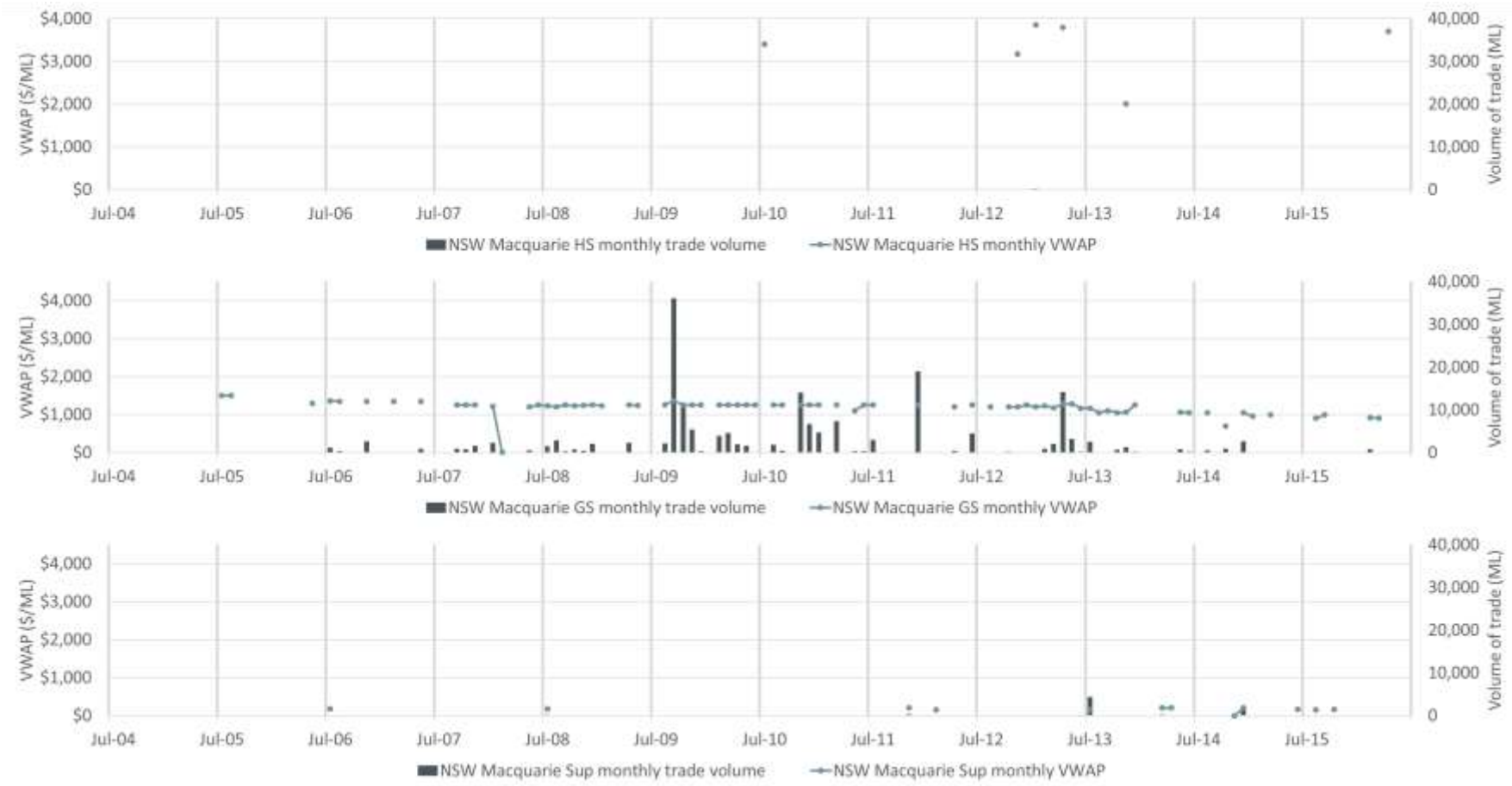
Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

High Security entitlements in the Macquarie River are infrequently traded and generally command relatively higher prices than General Security (Figure 100). In comparison, General Security

entitlements in the Macquarie River are traded more frequently and command a lower price (which is expected due to their lower reliability). Supplementary entitlements are also infrequently traded, at lower volumes and prices than High Security and General Security entitlements.

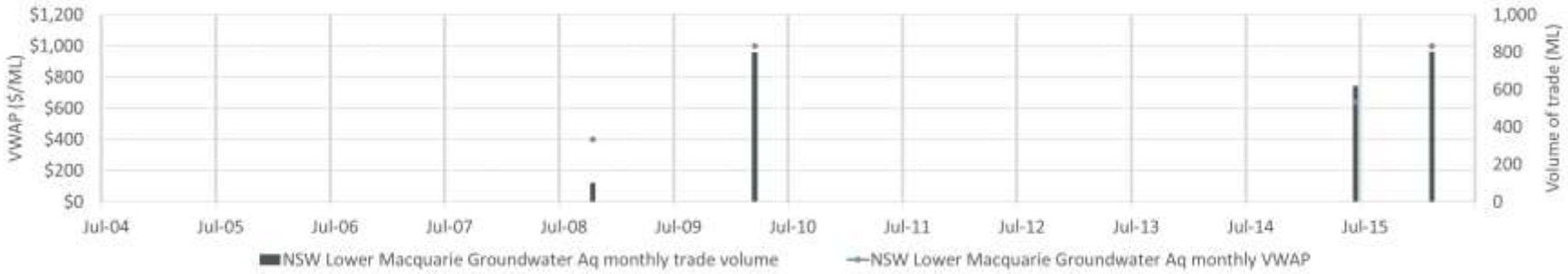
Aquifer entitlements have been traded in the Lower Macquarie Groundwater Source (Figure 101), but at lower volume and frequency compared to surface water. Since 2004–05 there has only been four commercial trades recorded for Aquifer entitlements in the Lower Macquarie Groundwater Source.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 100 Monthly average High Security, General Security and Supplementary entitlement prices and trade volumes Macquarie and Cudgegong Regulated Rivers Water Source, 2004–05 to 2015–16



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

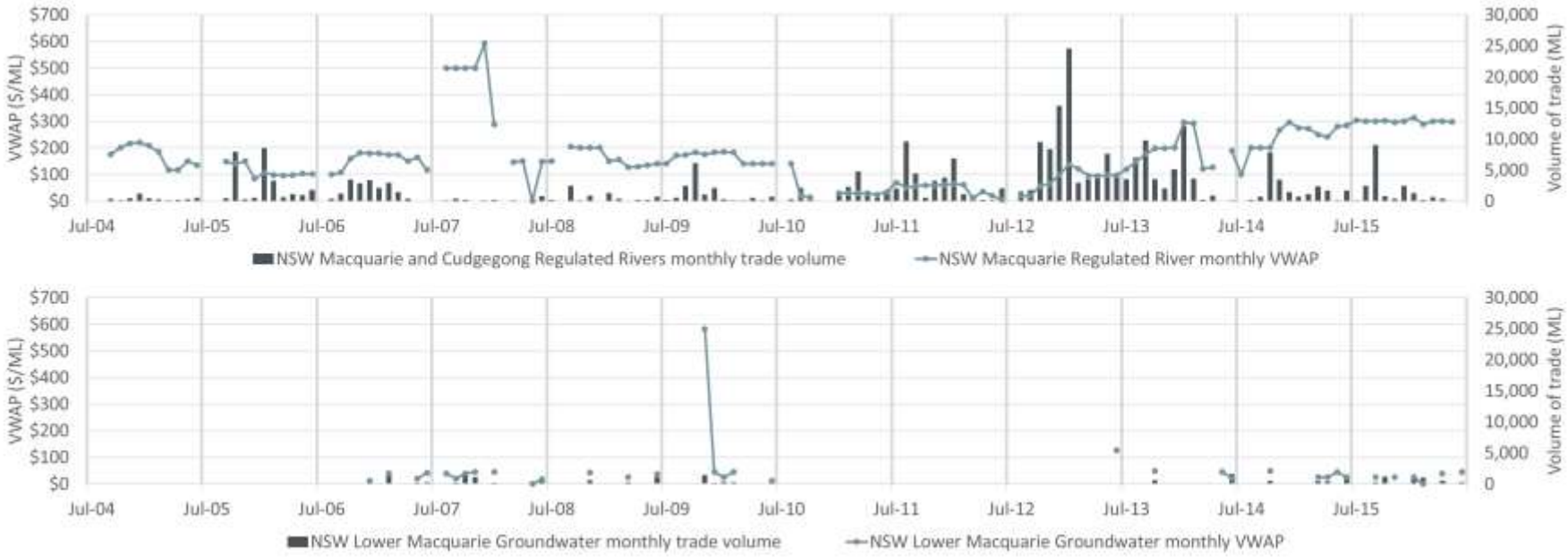
Figure 101 Monthly average Aquifer entitlement prices and trade volumes Lower Macquarie Groundwater Source, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the Macquarie and Cudgegong River system is active and relatively mature. It is isolated from the broader southern MDB market meaning that trade between the Macquarie and other surface water systems is not possible.

There have been variable volumes of annual trade in most of the past ten years. Prices for allocation water have also varied markedly, from record highs in 2007 to record lows in 2010–11 and 2011–12. Between 2012–13 and 2015–16, prices increased to a high of more than $300 per ML.

There is comparatively less trade and lower prices for allocations in the Lower Macquarie Groundwater Source (Figure 102). In the Lower Macquarie Groundwater Source, the only commercial trades on record appear in two discrete phases, between 2006–07 and 2009–10, and again in 2013–14 to present.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 102 Monthly average allocation prices and trade volumes Macquarie and Cudgegong Regulated Rivers Water Source and Lower Macquarie Groundwater Source, 2004–05 to 2015–16

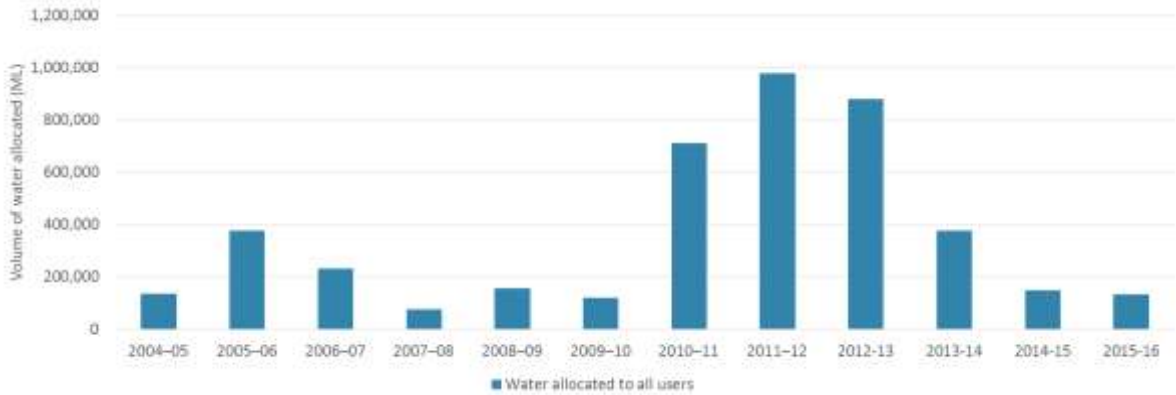
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Macquarie Catchment, these drivers are explored below.

Allocations to entitlements

Macquarie and Cudgegong Regulated Rivers Water Source

Figure 103 presents the volumes of water allocated to all water users in the Macquarie and Cudgegong Rivers from 2004–05 to 2015–16. Allocations are characterised by relatively low volumes from 2006–07 to 2009–10, high volumes from 2010–11 to 2012–13, and declining volumes thereafter. High allocations in 2011–12 and 2012–13 are the result of storage spill which triggers an emptying of accounts and then a 1 ML/share allocation announcement.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: Includes available water determinations (AWD) and carryover.

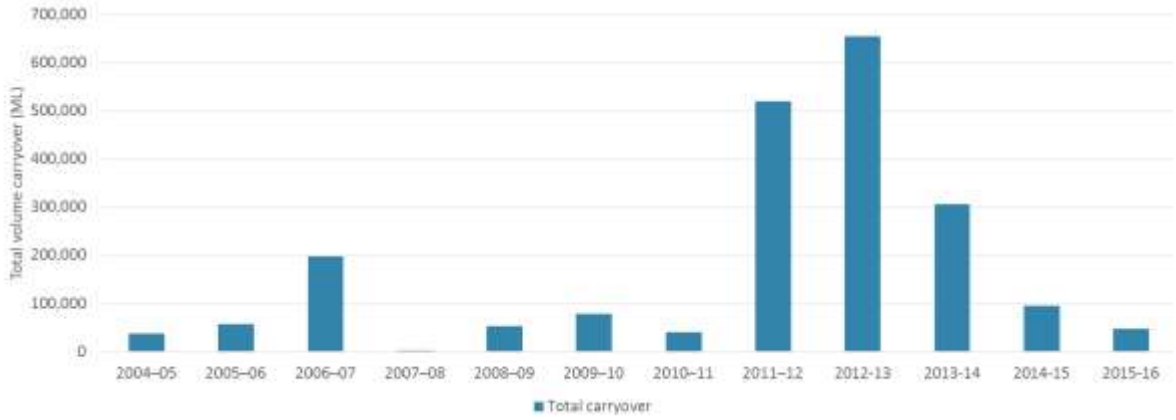
Figure 103 Total volume of water allocated to all entitlement types in the Macquarie River, 2004–05 to 2015–16

Lower Macquarie Groundwater Source

In every water year since 2006–07 Aquifer entitlements in the Lower Macquarie Groundwater Sources have received 100 per cent allocations by the end of the water year.

Carryover

Figure 104 presents carryover I the Macquarie and Cudgegong Rivers. It is only possible for General Security entitlement types in the Macquarie and Cudgegong Rivers to carryover water (see Table 14 for a full list of entitlement types). Since 2004–05, owners of theses entitlement types have on average carried over 174,166 ML in aggregate into the following water year. This equates to 28 per cent of the total 632,466 ML that can be carried over in the system each year. Between 2011–12 and 2014–15, average total volume of carryover has increased to 393,858 ML per year or 62 per cent of the total entitlement available for carryover. Carryover in 2012–13 is in excess of the total entitlement on issue, which is a result of specific General Security licences in the Cudgegong catchment listed in the WSP schedule. These licences are permitted to carryover volumes as listed in the schedule, which exceed those resulting from the WSP carryover rule.

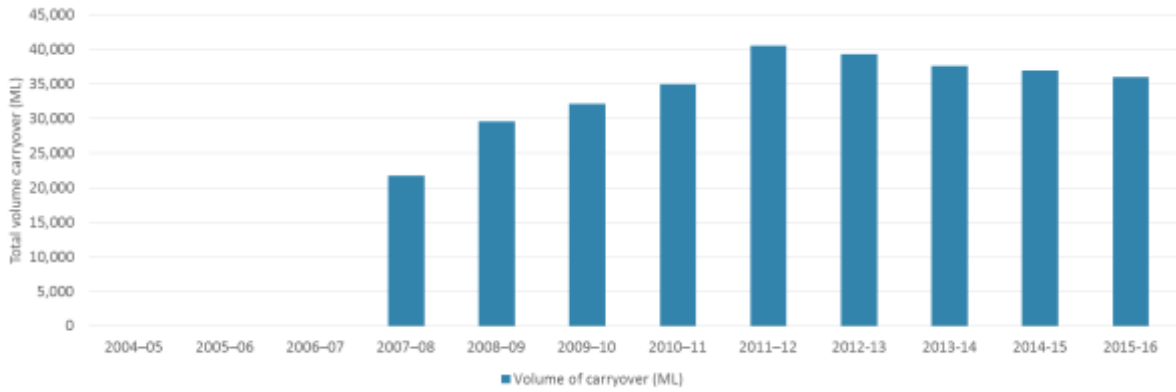


Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes General Security entitlement types as these are the only entitlement types in the Macquarie which allow carryover.

Figure 104 Carryover in the Macquarie and Cudgegong Regulated Rivers, 2004–05 to 2015–16

In the Lower Macquarie Groundwater source, only Aquifer access licences can carryover water into the following year. Entitlement owners for these Aquifer entitlement types can carryover a total of 2 ML per unit share of their entitlement, meaning that carryover can exceed the total entitlement in any given year. As shown in Figure 105, since 2006–07 there has been an average of 34,298 ML carried over into the following year.



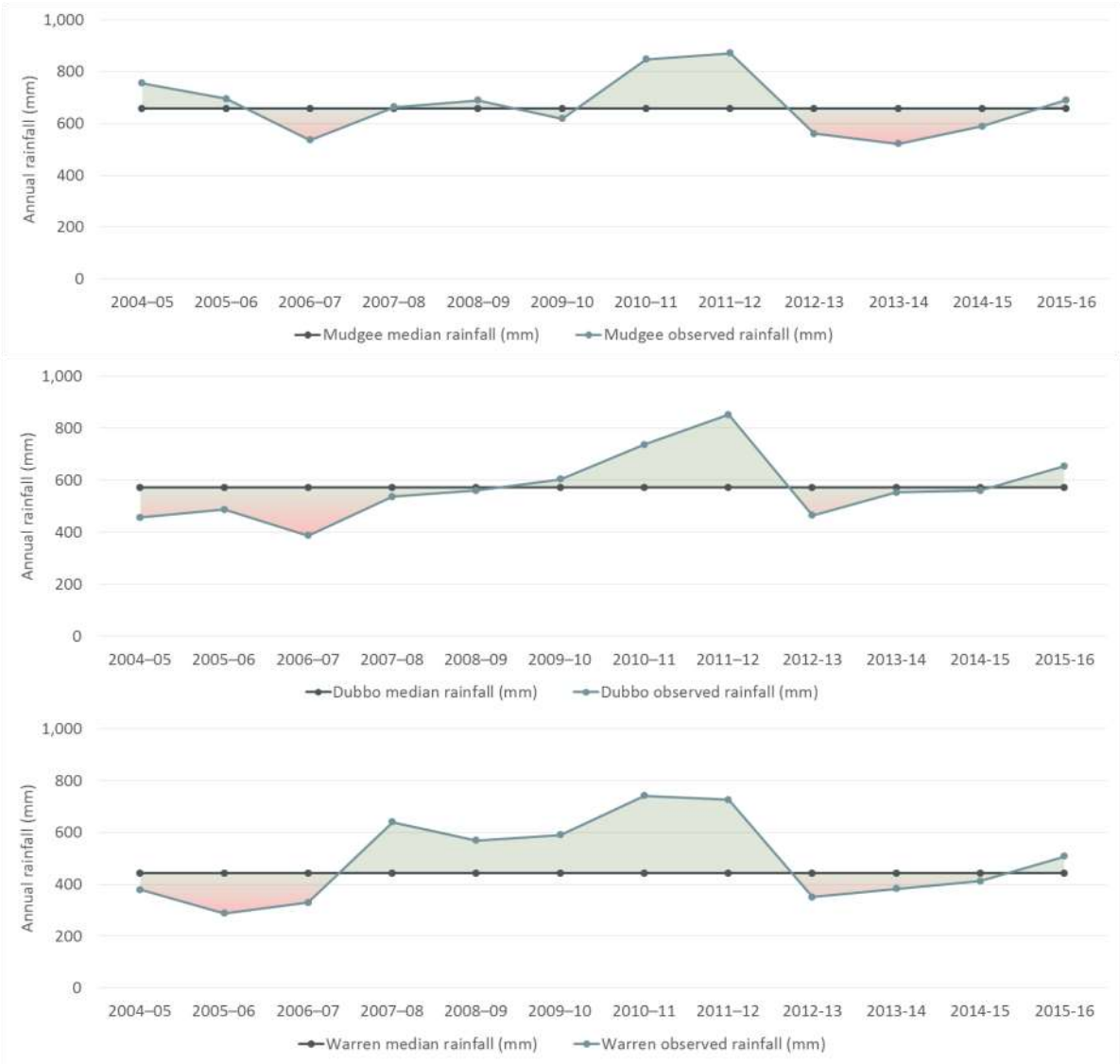
Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes Aquifer entitlement types as these are the only entitlement types in the Macquarie which allow carryover.

Figure 105 Carryover in the Lower Macquarie Groundwater Source, 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Macquarie region given different climatic regions; for example, the median in Mudgee is over 650 mm per annum compared to 440 mm in Balranald. Figure 106 presents annual median rainfall in Mudgee, Dubbo, and Warren from 2004–05 to 2015–16. Annual rainfall between Dubbo and Warren across this period is correlated – with the ten out of twelve of the same years above and below median rainfall. Observed rainfall patterns in Mudgee follow similar general trends to Dubbo and Warren but are not as highly correlated.



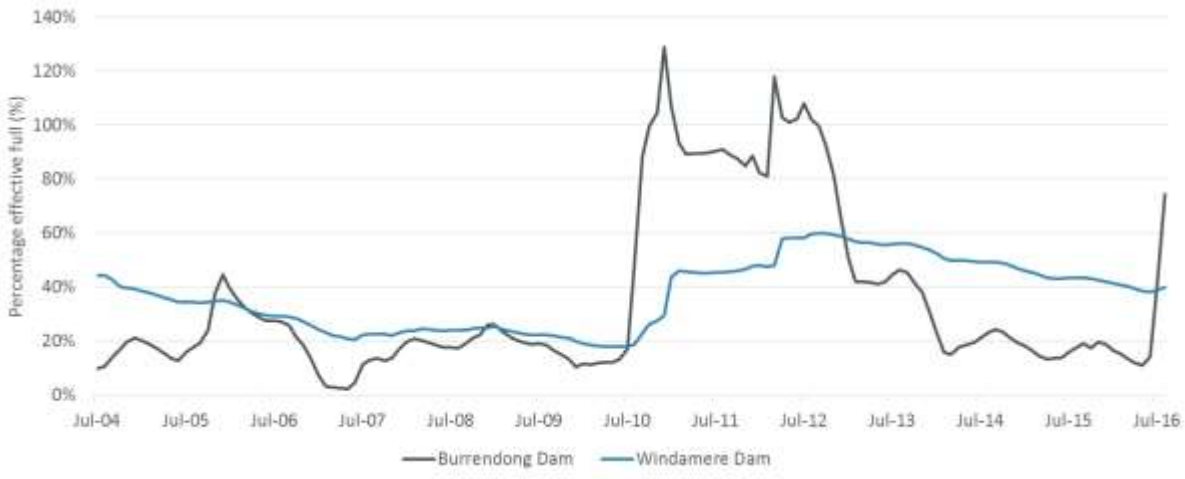
Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 106 Rainfall across the Macquarie Catchment, 2004–05 to 2015–16

Water storages

The main water storages in the Macquarie catchment are Burrendong Dam (1,680 GL[43]) on the Macquarie and its smaller supplementary storage Windamere Dam (368 GL) on the Cudgegong River. Management of the storages effectively regulates the system. Figure 107 presents changes in storage levels for Burrendong and Windamere Dam from 2004–05 to 2015–16. Over time storage levels have fluctuated from lower levels during the Millennium Drought to higher levels in the wet years from 2010–11 to 2011–12. Since 2011–12, a downward trend in storage levels has been observed until late 2016.

[43] This volume includes the flood mitigation zone of 490 GL. Total regulated capacity is 1,190 GL.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

Figure 107 Macquarie water storages (Burrendong Dam and Windamere Dam), 2004–05 to 2015–16

Demand drivers

Changes in irrigated agricultural production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. With reference to the water systems located in the Macquarie Catchment, these drivers are explored below.

For this regional summary, Aither has compared land use and water use changes in the Macquarie Catchment between 2007–08 and 2014–15. The 2014–15 ABS water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2014–15 year is the most recently available data, and it has been compared with 2007–08 because that was a similar year in relation to water allocations and rainfall, and therefore provides a reasonable comparison regarding how production in the system has changed over time.[44,45]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 108. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the Macquarie WSP areas.[46]

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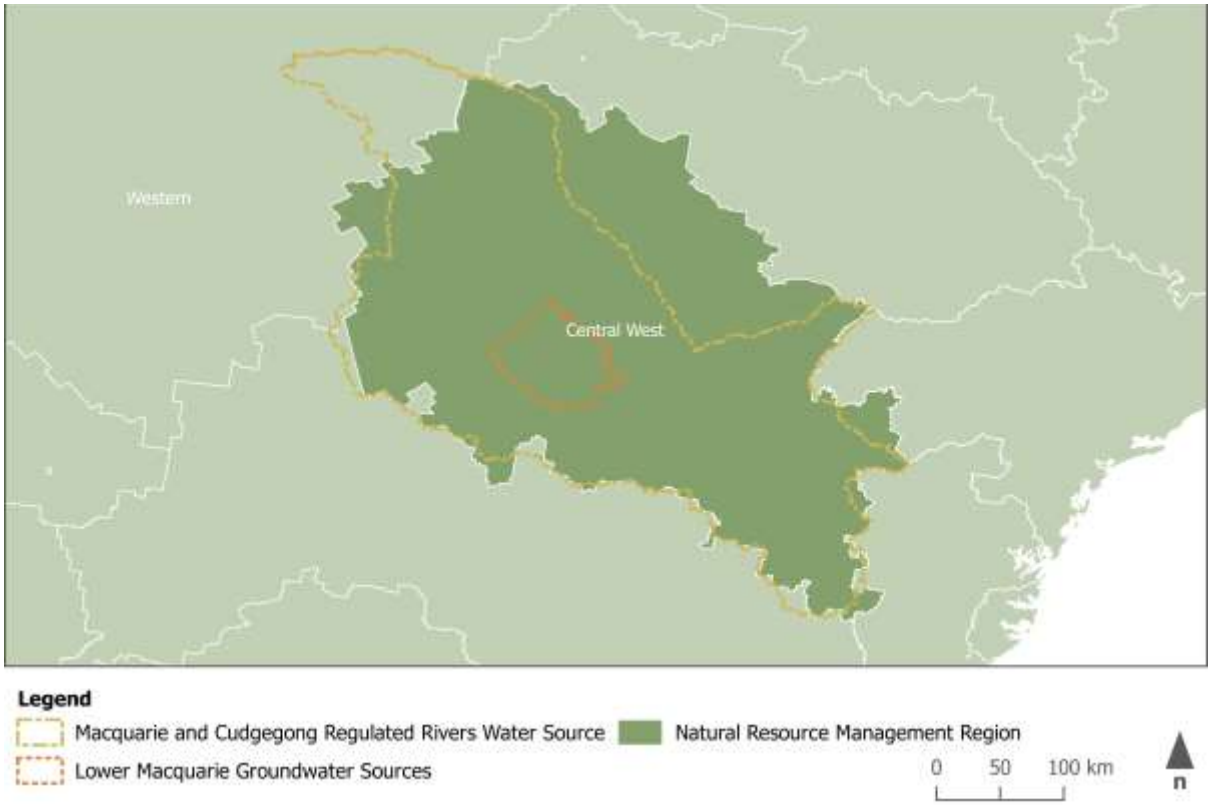
44 While the years presented appear similar at face value, 2007-08 followed a period of low water availability and 2014-15 followed a period of higher water availability. These differences are significant as land use and water use may be influenced by this. It is not possible to find two years in the time series which are perfectly comparable (including having the same lead in water availability), so 2007-08 and 2014-15 have been selected as they offer the best comparison available.

45 Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years.

46 At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.



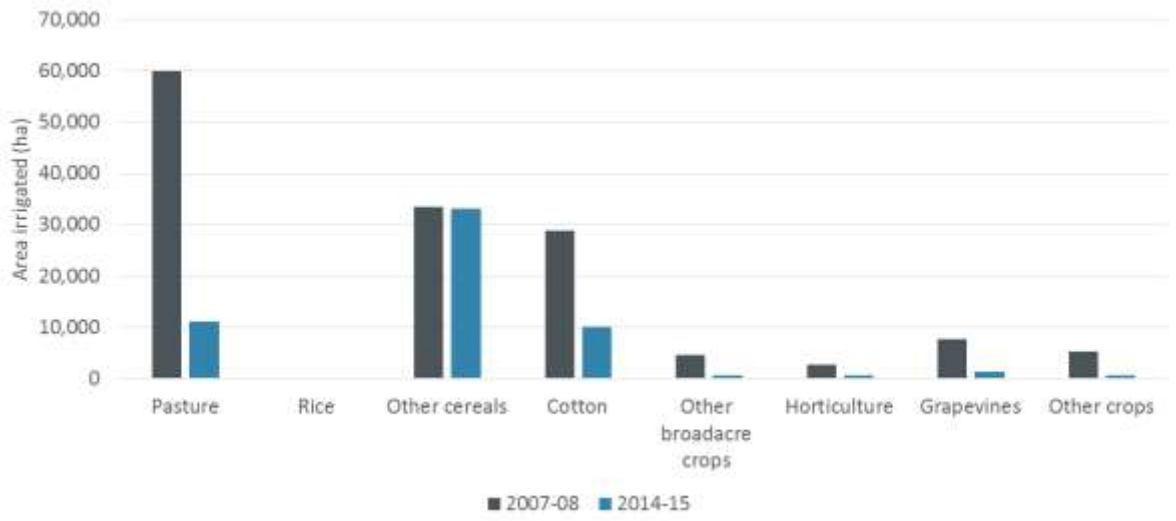
Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 108 Alignment of NRM regions and WSP boundaries – Macquarie

Land use

There is a significant amount of irrigated agricultural activity in the Macquarie Catchment. Cotton is the dominant user of irrigation water, along with pasture, cereals and other crops (such as vegetables).

Figure 109 compares land use by irrigated agricultural industries in the Macquarie for 2007–08 and 2014–15. This suggests a decline in pasture as the major irrigated industry over the past decade. Figure 109 also appears to show a decline in land use for cotton, grapes and horticulture, other broadacre crops and other crops over the past decade. In contrast, land use for other cereals is stable for 2007–08 and 2014–15.

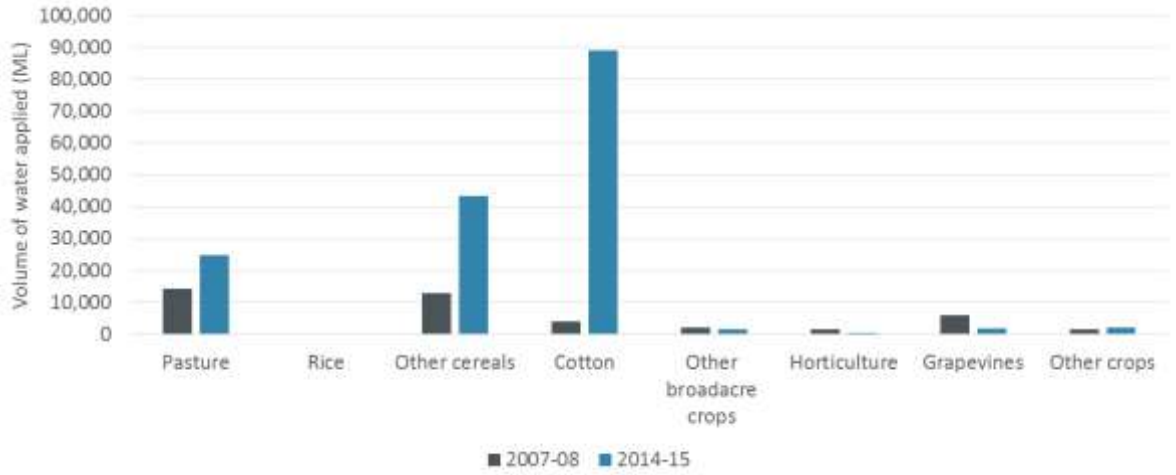


Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 109 Land use by irrigated agricultural industry Macquarie Catchment, 2007–08 and 2014–15

Water use

Figure 110 compares water use for different irrigated agricultural industries in the Macquarie Catchment for 2007–08 and 2014–15. For the two years presented, there is a significant increase in water use by the cotton industry. This coincides with a decline in the total area of irrigated cotton plantings in the region (compare to Figure 109). Figure 110 also suggests increased water use by the other cereals and pasture industries. There also appears to have been a decline in water use for grapes, along with smaller possible decreases in other broadacre crops and horticulture. When comparing 2007–08 and 2014–15, other crops (such as vegetables) appear to have marginally increased water use.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 110 Water use by irrigated agricultural industry Macquarie Catchment, 2007–08 and 2014–15

Institutional and policy

Trade rules

Trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. The following section outlines rules of particular significance in the Macquarie region.[47]

Macquarie and Cudgegong Regulated Rivers Water Source

In the Macquarie region, there are restrictions relating to temporary and permanent trade that would increase access components in specific areas within the Regulated River Water Source. In particular, trade may occur between Windamere Dam and Burrendong Dam if the total share component is below the specified cap 40,000 ML.[48] Restrictions in trade of High Security water upstream of Burrendong Dam are in place to protect the reliability of existing General Security licenses and allocations in that section of the water source. These restrictions may limit the number of counterparties with whom trade may occur, impacting the ability of some developments to secure entitlements with adequate security.

Lower Macquarie Groundwater Source

The Lower Macquarie Groundwater Source is divided into six management zones, each of which have extraction limits based on aquifer recharge rates and environmental water requirements. Allocations may be traded between zones if the extraction limit is not exceeded and if the trade does not involve assigning water from an access licence in Zone 1, 2 or 6 to an access licence in Zone 3, 4 or 5. The restrictions create smaller markets within the region where there are limited counterparties with whom trade may occur.

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47 This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

48 For further information, refer to Part 10 of Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2016 (http://www.legislation.nsw.gov.au/#/view/regulation/2015/630/part10)

Other issues

The distribution of Supplementary access licences has been highlighted by some water users in the Macquarie as a potential issue. There is 50,000 ML of Supplementary access licences in the Macquarie that were historically allocated to entitlement holders in proportion to the amount of General Security entitlements held at the time of issue. As a result, there are a number of disparate entitlement holders in the Macquarie that hold small amounts of Supplementary water entitlements, who are not properly set up to access their share of water during supplementary water events. These licences represent a portion of the total entitlement on issue that is unable to be used or traded. Some water users in the Macquarie have expressed a desire to aggregate these licences into larger portfolios and sell them to licence holders properly set up for supplementary water capture. While the provisions in the WSP technically allow for this to occur, the administrative challenge of this is such that it does not occur in practice.

Namoi Catchment

Summary

The Namoi catchment is a significant sub-catchment of the Murray-Darling Basin, and is located in north-western NSW. The water sources covered by this regional summary are the Upper and Lower Namoi Regulated River Water Sources and the Upper and Lower Namoi Groundwater Sources.

The majority of water entitlements issued in the Namoi surface water systems is issued to General Security and Supplementary entitlement types (67 per cent and 30 per cent respectively). 2.5 per cent of the total entitlement on issue is held by the environment, which is the lowest proportion of any surface water system covered in the regional summaries. Groundwater entitlements are a large proportion of the total entitlements on issue across surface and groundwater systems.

Entitlement trade does occur in the Namoi River, although far less frequently than in other New South Wales systems. There were no recorded entitlement trades for High Security entitlements in the Namoi River over the study period. The allocation market in the Lower Namoi is more active than Namoi entitlements markets, with trade occurring in every year across the study period. The Upper Namoi has markedly less trade recorded. Allocation markets for the Upper and Lower Namoi groundwater systems are similar, with less trade and lower prices for allocations observed.

Allocations to entitlements and water in storages follow a drying, drought, wet and drying to drought progression during the study period.

Water and land use data suggest cotton as the dominant irrigated crop in the Namoi. Other important crops include pasture, other cereals, and other broadacre crops.

Geographic and hydrological overview

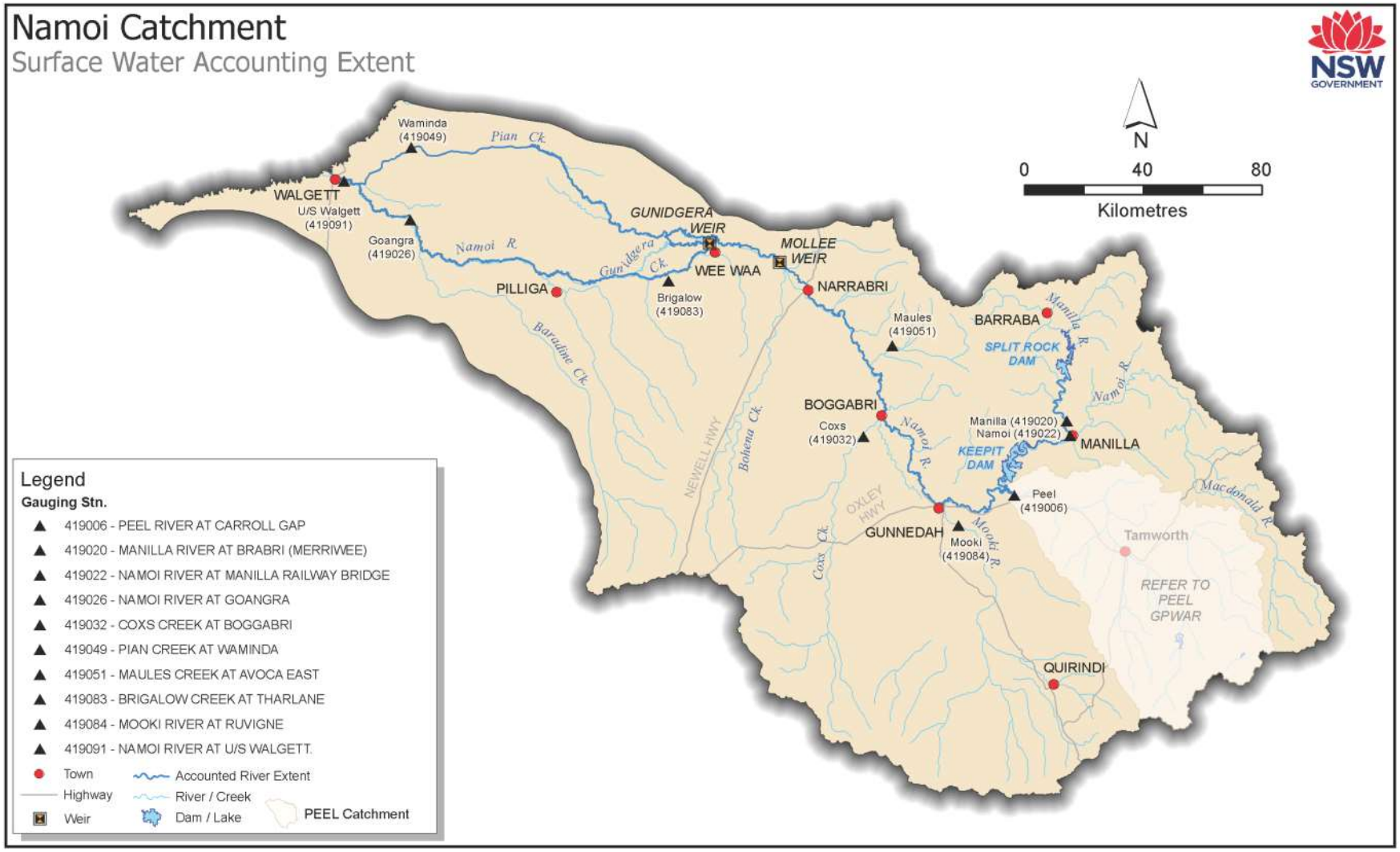
There are two major surface and groundwater water sources and associated water sharing plans located within the Namoi Catchment that are the focus of this regional summary:

- Upper Namoi and Lower Namoi Regulated River Water Sources
- Upper and Lower Namoi Groundwater Sources.

Upper Namoi and Lower Namoi Regulated River Water Sources

The Upper and Lower Namoi Regulated River Water Sources (the Namoi River) is a regulated surface water system located within the Namoi Catchment in north-western New South Wales (Figure 111). The Namoi Catchment includes its regulated tributary the Peel River, which is managed under a separate water allocation scheme and water sharing plan. The region's largest regional centre is Tamworth, located within the Peel River catchment. Smaller regional towns served by the Namoi River include Narrabri, Gunnedah, Manilla, Wee Waa, and Walgett.

The Namoi River rises in the ranges near Tamworth and flows into Keepit Dam, which is the major storage in the catchment located between Gunnedah and Manilla. From Keepit Dam the Namoi flows north-west towards the Barwon River at Walgett. Major water users in the Namoi River system are General Security irrigators, who primarily produce cotton. The catchment is home to significant ecological features including numerous small floodplain wetlands and the large internal drainage basin of Lake Goran south of Gunnedah. The Pilliga Forest conserves the largest remaining dry sclerophyll forest west of the Great Dividing Range in NSW.



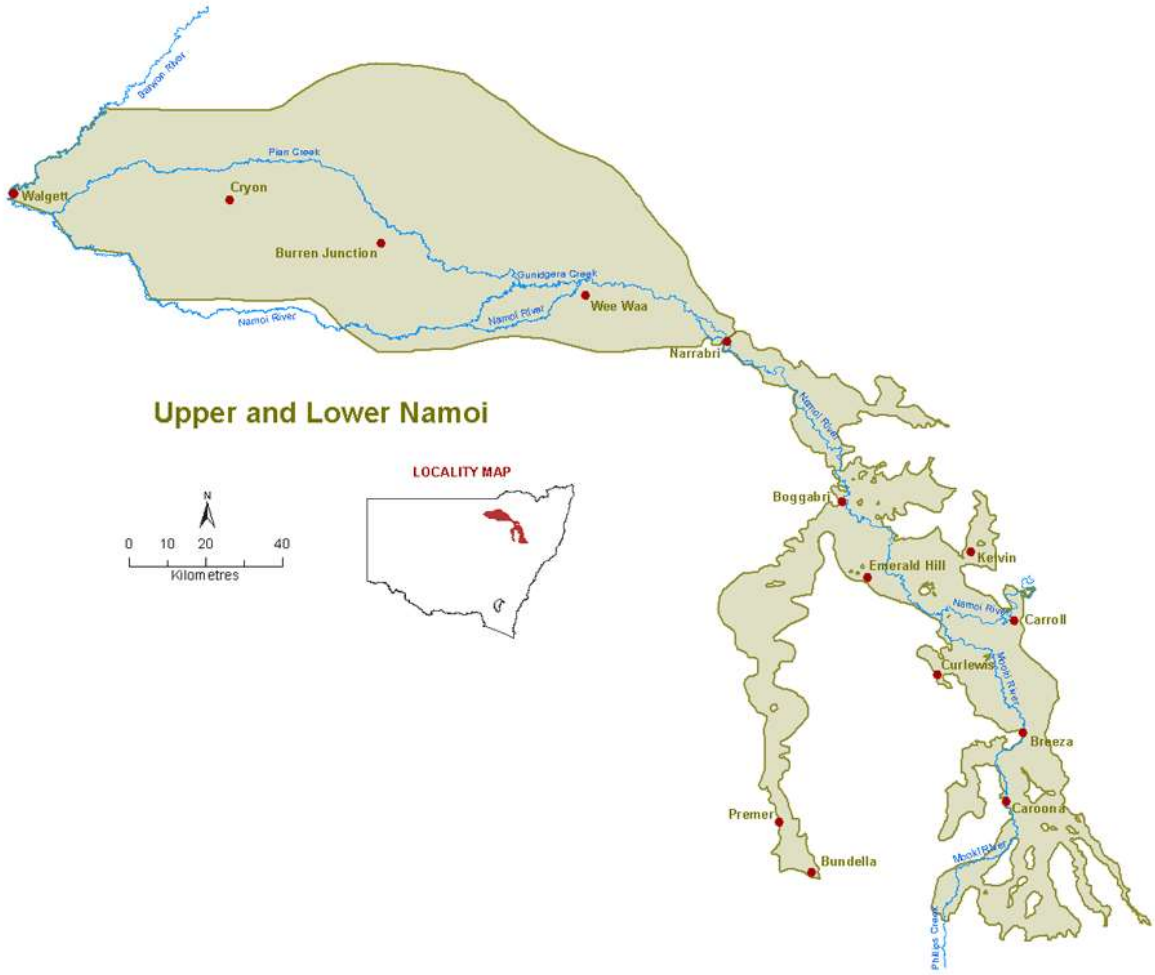
Source: NSW DPI Water 2016.

Figure 111 Namoi catchment – Upper Namoi and Lower Namoi Regulated River Water Source

Upper and Lower Namoi Groundwater Sources

Groundwater also plays an important role in the Namoi Catchment, with urban, agriculture, and industrial users all using groundwater to different degrees. The high yielding aquifers of the Namoi Catchment are managed as two groundwater resources – the Lower Namoi Groundwater Source and the Upper Namoi Groundwater Source. These are both managed under the same water sharing plan and are the focus of this regional summary.

The Lower and Upper Namoi Groundwater Sources are accessible along the Namoi River and its major tributaries (Figure 112). The Lower Namoi Groundwater Source extends approximately 160 km west of Narrabri and runs to a depth of up to 120 meters. The Upper Namoi Groundwater Sources extend 175 km upstream from Narrabri and are comprised of 12 separate ground water sources which are managed as separate management zones. Aquifers in the Upper Namoi valley are mostly found in two main rock formations; the shallower Narrabri formation (up to 30 to 40 meters deep) and the more productive Gunnedah formation (40 to 100 meters in thickness).



Source: NSW DPI Water 2016.

Figure 112 Namoi catchment – Upper Namoi and Lower Namoi Groundwater Sources

Water entitlements

Entitlements on issue

Table 17, Table 18 and Table 19 summarise entitlement on issue for the surface and ground water systems covered by this regional summary. Surface water entitlements are dominated by General Security, approximately four per cent of which is held by the environment. The total volume of surface water entitlement on issue is much larger than the volume of water on issue in the two groundwater systems.

Table 17 Entitlement on issue for Namoi Catchment surface water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of total entitlement on issue held by environment (%)	Proportion of total entitlement in Upper Namoi (%)	Proportion of total entitlement in Lower Namoi (%)
Upper and Lower Namoi Regulated River Water Sources							
General Security	358	256,212	67%	9,547	3.7%	4%	96%
High Security[3]	18	3,984	1%			2%	98%
Local water utility	3	2,786	1%			18%	82%
Domestic and stock	148	2,096	1%			4%	96%
Supplementary	215	115,479	30%				100%
Total	**742**	**380,557**	**100%**	9,547	2.5%	**3%**	**97%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and information provided by NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 3) Includes High Security (research).

Table 18 Entitlement on issue for Namoi Catchment groundwater systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[1]	Proportion of total entitlement on issue held by environment (%)
Upper Namoi Groundwater Sources (combined)[2]					
Aquifer	562	109,804	95%	0	0
Local water utility	9	6,280	5%	0	0
Total	**571**	**116,084**	**100%**	**0**	**0**
Lower Namoi Groundwater Source					
Aquifer	213	81,586	95%	0	0
Local water utility	3	4,407	5%	0	0
Total	**216**	**85,993**	**100%**	**0**	**0**

Source: Aither based on New South Wales Water Register 2016.

Note: 1) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 2) The Upper Namoi Groundwater Sources are comprised of 12 management zones.

Table 19 Entitlement on issue for Upper Namoi Groundwater source – expanded across all zones, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)	Proportion of total entitlement on issue (%)	Proportion of overall Upper Namoi Groundwater source
Upper Namoi Zone 1 Borambil Creek Groundwater Source				
Aquifer	35	384	24%	<1%
Local water utility	2	1,216	76%	1%
Total	**37**	**1,600**	**100%**	**1%**
Upper Namoi Zone 2 Coxs Creek (Mullaley to Boggabri) Groundwater Source				
Aquifer	30	7,141	99	6%
Local water utility	1	59	1	<1%
Total	**31**	**7,200**	**100**	**6%**
Upper Namoi Zone 3 Mooki Valley (Breeza to Gunnedah) Groundwater Source				
Aquifer	61	17,101	99%	15%
Local water utility	1	198	1%	<1%
Total	**62**	**17,299**	**100%**	**15%**
Upper Namoi Zone 4 Namoi Valley (Keepit to Gins Leap) Groundwater Source				
Aquifer	173	21,032	82%	18%
Local water utility	2	4,660	18%	4%
Total	**175**	**25,692**	**100%**	**22%**
Upper Namoi Zone 5 Namoi Valley (Gins Leap to Narrabri) Groundwater Source				
Aquifer	71	15,992	100%	14%
Total	**71**	**15,992**	**100%**	**14%**
Upper Namoi Zone 6 Tributaries of the Liverpool Range Groundwater Source				
Aquifer	32	11,448	100%	10%
Total	**32**	**11,448**	**100%**	**10%**
Upper Namoi Zone 7 Yarraman Creek Groundwater Source				
Aquifer	17	3,697	100%	3%
Total	**17**	**3,697**	**100%**	**3%**
Upper Namoi Zone 8 Mooki Valley (Quirindi – Pine Ridge Road to Breeza) Groundwater Source				
Aquifer	62	16,122	>99%	14%
Local water utility	1	50	<1%	
Total	**63**	**16,172**	**100%**	**14%**
Upper Namoi Zone 9 Coxs Creek (Up-Stream Mullaley) Groundwater Source				
Aquifer	28	11,245	99%	10%

Local water utility	2	97	1%	
Total	**30**	**11,342**	**100%**	**10%**
Upper Namoi Zone 10 Warrah Creek Groundwater Source				
Aquifer	5	1,420	100%	1%
Total	**5**	**1,420**	**100%**	**1%**
Upper Namoi Zone 11 Maules Creek Groundwater Source				
Aquifer	28	2,223	100%	2%
Total	**20**	**2,223**	**100%**	**2%**
Upper Namoi Zone 12 Kevin Valley Groundwater Source				
Aquifer	20	1999	100%	2%
Total	**20**	**1999**	**10%**	**2%**

Source: Aither 2016. Based on New South Wales Water Register 2016.

Entitlement characteristics

Table 20 presents a high-level comparative analysis of the characteristics of each entitlement type. The comparison suggests that groundwater entitlements are generally the most secure but are relatively more inflexible regarding carryover or trade. While surface water entitlement types may be marginally less secure (as urban and stock and domestic is allocated first) they have different levels of security and can be used or traded in more flexible ways.

Table 20 Entitlement characteristics comparison for Namoi Catchment water systems

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Upper Namoi Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes Up to 0.5 ML per water share	Within: Yes (both Upper and Lower sources) Out of: No	Annual[1 2]
High Security	High	Allocated water after urban and domestic needs have been secured	No	Within: Yes Out of: No	Annual
Local water utility	High	Allocated before General Security, High Security and Supplementary entitlements	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before General Security, High Security and Supplementary entitlements	No	Within: No Out of: No	Annual

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Supplementary	Infrequent	Always allocated at 1 ML per share. Supplementary access announcements permit take during high flow events.	No	Within: No Out of: No	Annual
Lower Namoi Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes Up to 200% account limit	Within: Yes (both Upper and Lower sources) Out of: Restricted	Continuous[1 2]
High Security	High	Allocated water after urban and domestic needs have been secured	No	Within: Yes Out of: No	Annual
Local water utility	High	Allocated before General Security, High Security and Supplementary entitlements	No	Within: Restricted Out of: Restricted	Annual
Domestic and stock	High	Allocated before General Security, High Security and Supplementary entitlements	No	Within: No Out of: No	Annual
Supplementary	Infrequent	Always allocated at 1 ML per share. Supplementary access announcements permit take during high flow events.	No	Within: Yes Out of: No	Annual
Upper Namoi Groundwater Source					
Aquifer	High	Allocated water after urban and domestic needs have been secured	Yes (up to 2 ML account limit per water share)	Within: Restricted Out of: No	Annual
Local water utility	High	First entitlement type to be allocated water	With Ministerial approval	Within: Restricted Out of: No	Annual
Domestic and stock	High	First entitlement type to be allocated water	No	Within: No Out of: No	Annual

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Lower Namoi Groundwater Source					
Aquifer	High	First entitlement type to be allocated water as there are no other types in this system	Yes (up to 2 ML account limit per water share)	Within: Restricted Out of: No	Annual

Source: Aither 2016. Based on Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016 and Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2006..

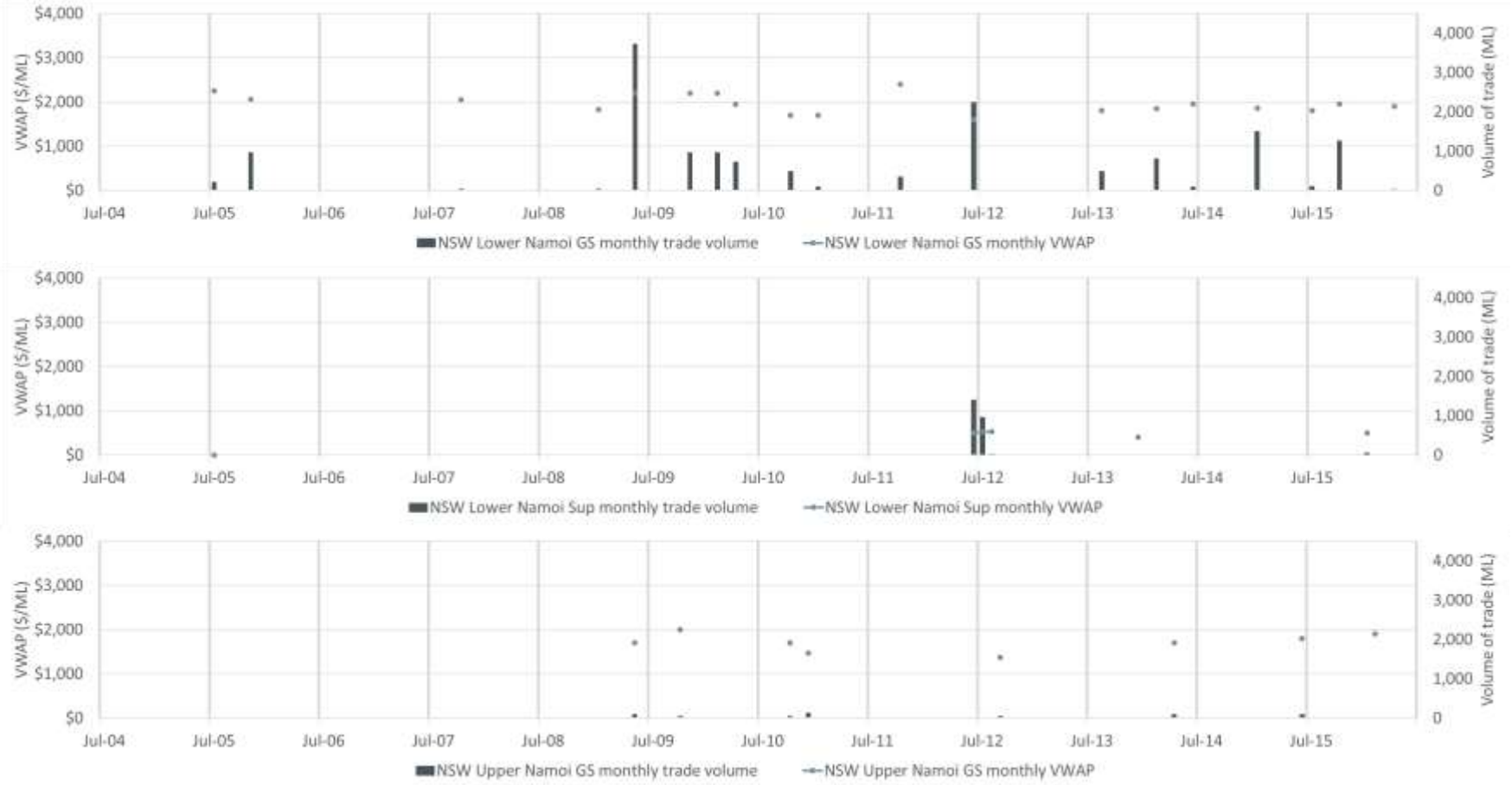
Note: 1) Uncontrolled flow is non-debit water accessible during supplementary flow events in periods of low allocations. Rules in water sharing plans, linked to allocation levels, define when uncontrolled flow taken converts to debit water against General Security accounts. 2) The Upper Namoi has uncontrolled flow provisions and Lower Namoi have supplementary access provisions.

Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

There are no recorded trades for High Security entitlements in the Namoi River over the period 2004–05 to 2015–16 (Figure 113). General Security entitlements in the Namoi River are traded relatively frequently, but in low volumes compared to other New South Wales systems, generally commanding a price between $1,500 and $2,000 per ML. Likewise, Supplementary entitlements are infrequently traded, at a lower price and volume than General Security entitlements.

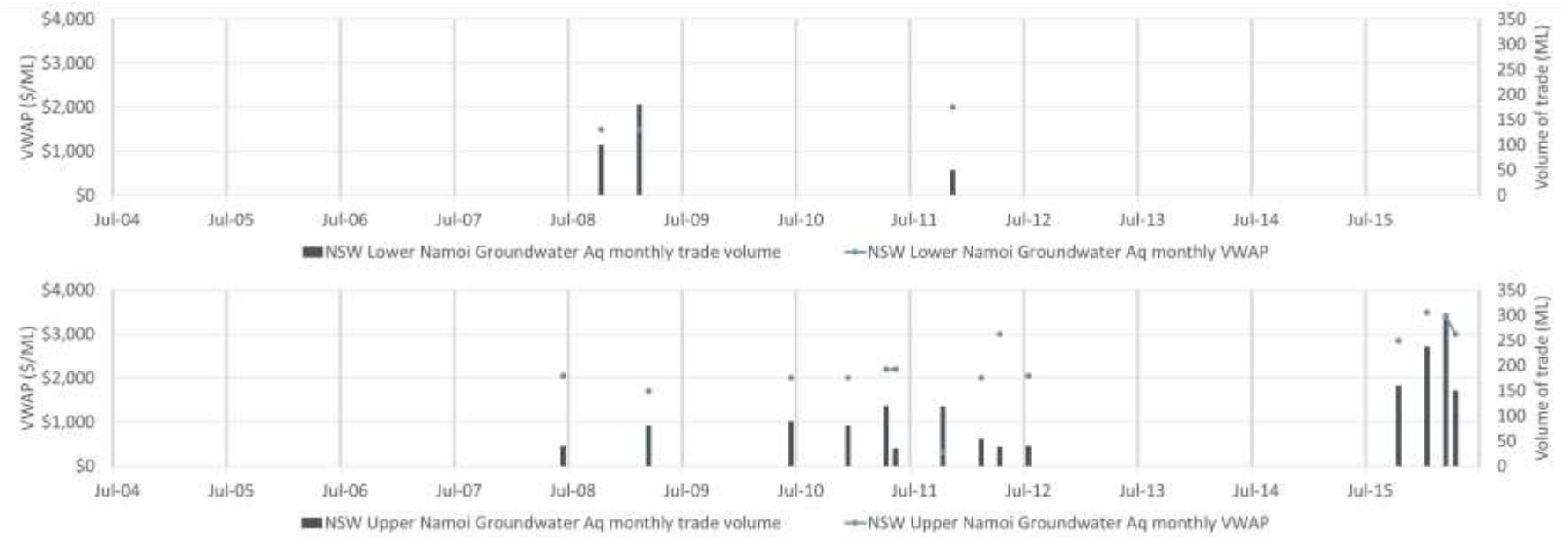
Aquifer entitlements are also traded in the Upper Namoi and Lower Namoi Deep Groundwater Sources (Figure 114). In the Lower Namoi Groundwater Source trades occur at a lower volume and frequency compared to the surface water systems. In comparison, trade in the Upper Namoi Groundwater Source is similar in terms of price but occurs at lower volumes.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 113 Monthly average General Security and Supplementary entitlement prices and trade volumes Lower and Upper Namoi Regulated River Water Sources, 2004–05 to 2015–16



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

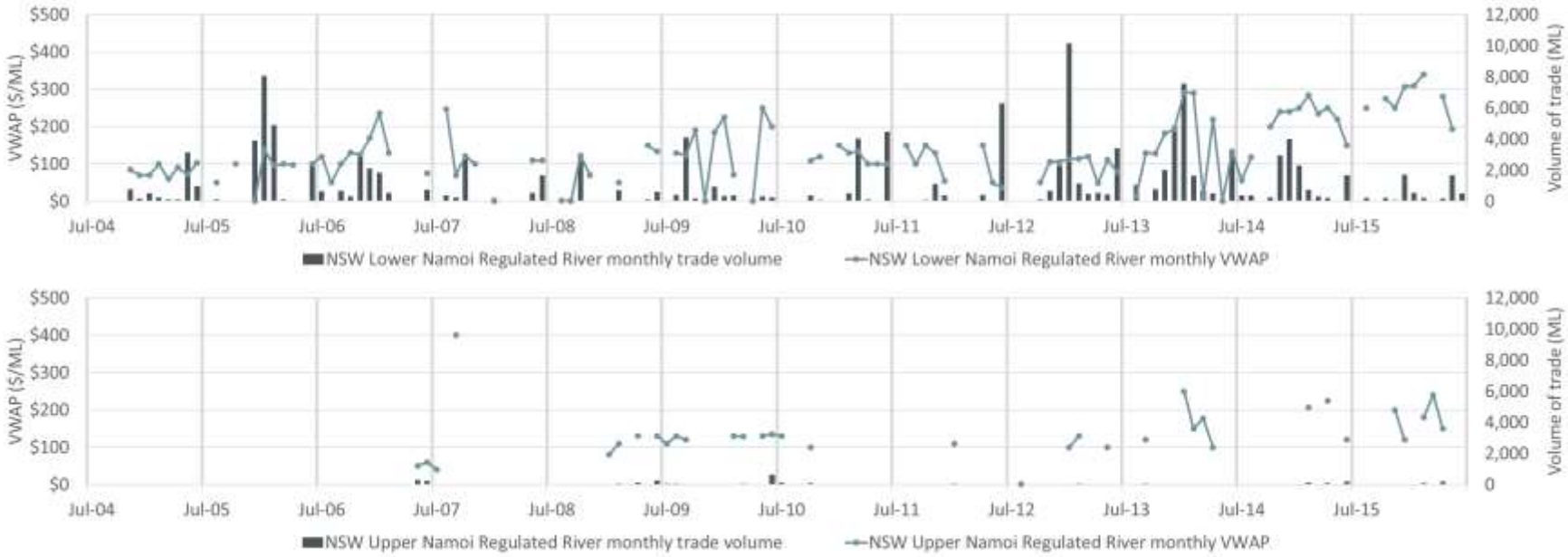
Figure 114 Monthly average Aquifer entitlement prices and trade volumes Upper Namoi and Lower Namoi Groundwater Sources, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the Namoi River is active and relatively mature. It is isolated from the broader southern MDB market meaning that trade between the Namoi and other surface water systems is not possible.

There have been reasonable volumes of annual trade in most of the past ten years (Figure 115). Across the time series presented, there has been a high degree of variation in the prices observed for allocation water. Between 2011–12 and 2015–16, prices strengthened to a high of above $300 per ML.

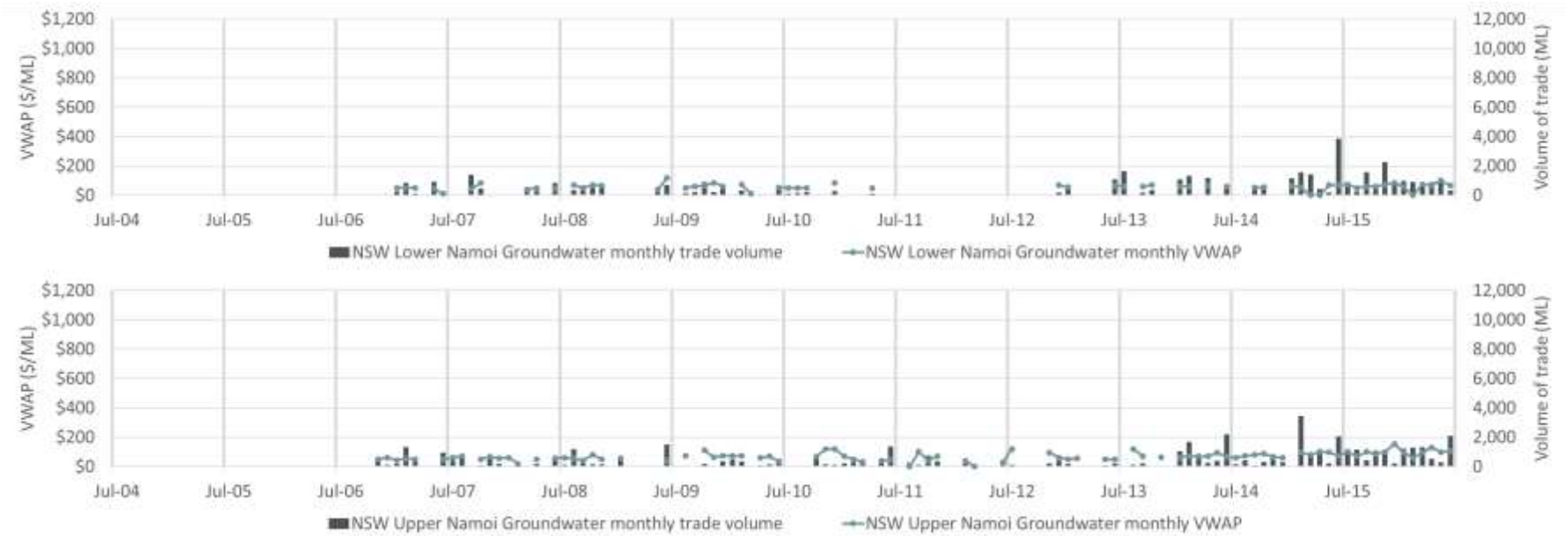
There is comparatively less trade and lower prices for allocations in the Upper Namoi and Lower Namoi Groundwater Sources (Figure 116). In the Upper Namoi and Lower Namoi Groundwater Sources there has been an increase in the volume of trade since 2012–13.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 115 Monthly average allocation prices and trade volumes Lower and Upper Namoi Regulated River Water Sources, 2004–05 to 2015–16



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 116 Monthly average allocation prices and trade volumes Lower Namoi and Upper Namoi Groundwater Sources, 2004–05 to 2015–16

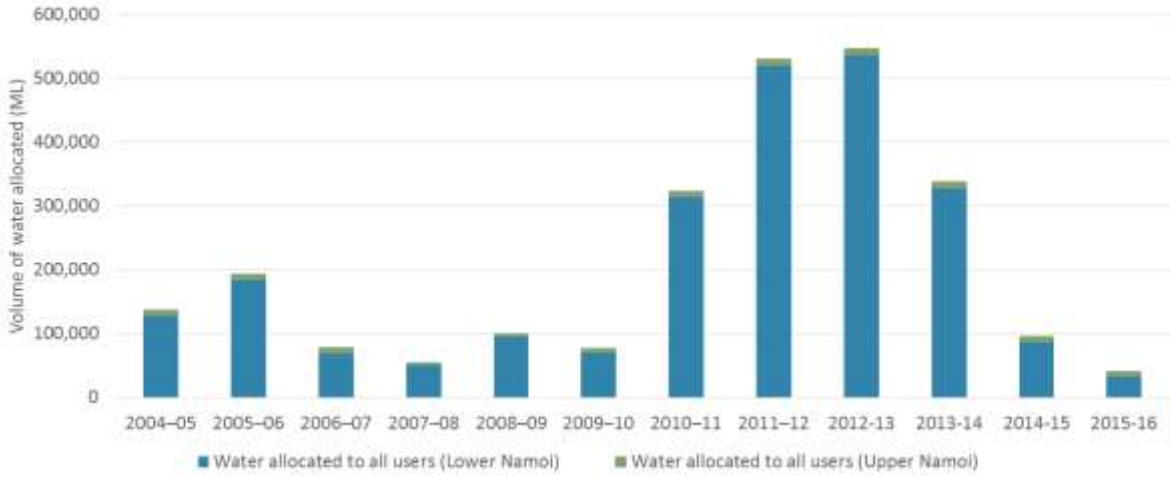
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Namoi Catchment, these drivers are explored below.

Allocations to entitlements

Lower and Upper Namoi Regulated River Water Sources

Figure 117 presents the volumes of water allocated to all water users in the Namoi River from 2004–05 to 2015–16. Allocations are characterised by relatively low volumes from 2006–07 to 2009–10, high volumes from 2010–11 to 2012–13, and declining volumes thereafter.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: Includes available water determinations (AWD) plus carryover.

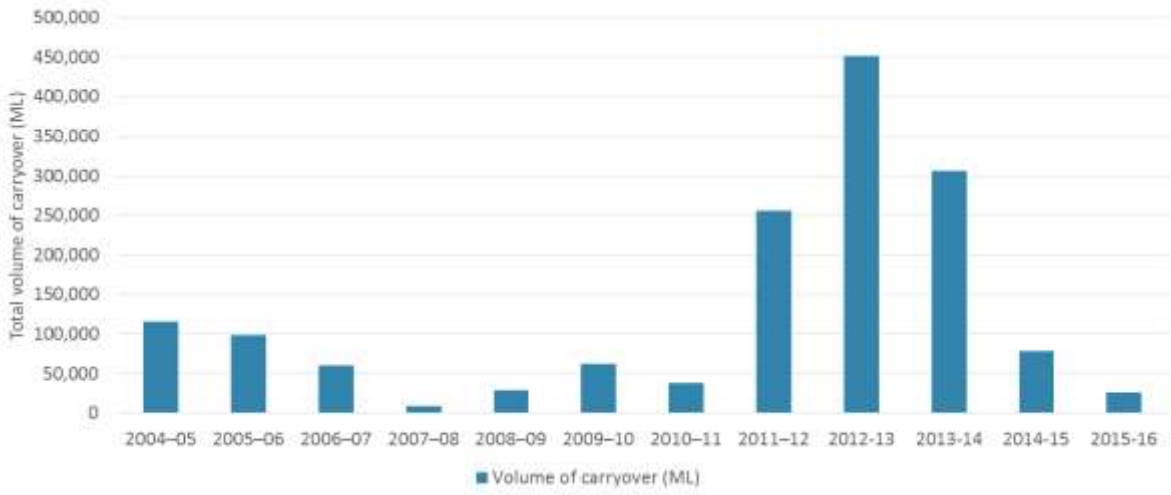
Figure 117 Total volume of water allocated to major entitlement types in the Lower and Upper Namoi River, 2004–05 to 2015–16

Upper Namoi and Lower Namoi Groundwater Sources

In every water year since 2006–07 Aquifer entitlements in the Upper Namoi and Lower Namoi Groundwater Sources have received 100 per cent allocations by the end of the water year.

Carryover

It is only possible for General Security entitlement types in the Namoi River to carryover water (see Table 17 for a full list of entitlement types). Since 2004–05, owners of theses entitlement types carried over an average of 127,312 ML of water into the following water year. Between 2011–12 and 2013–14, volume of carryover increased significantly, peaking around 450,000 ML in 2012–13. Across this time series, there is a high degree of variation in the volume of water carried over from year to year (see Figure 118).

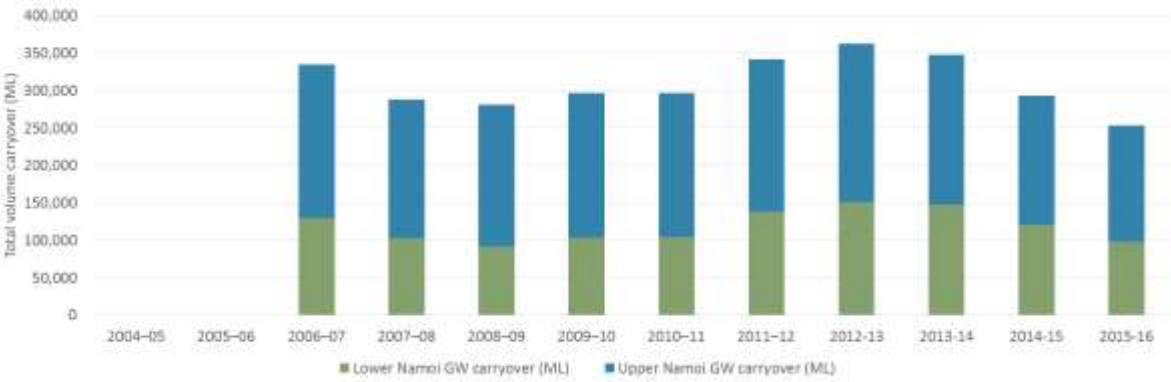


Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes General Security entitlement types as these are the only entitlement types in the Namoi which allow carryover. Includes combined Upper and Lower Namoi carryover volumes.

Figure 118 Carryover in the Lower and Upper Namoi Regulated River, 2004–05 to 2015–16

Only Aquifer entitlement types are permitted to carryover water in the Upper and Lower Namoi Groundwater Sources (see Table 18 for a full list of entitlement types). Account holders may carryover up to a maximum of 2 ML per share against their Aquifer entitlements. Since 2006–07, owners of Aquifer entitlement types in the Upper and Lower Namoi Groundwater Sources carried over a combined average of 190,834 ML of water into the following water year.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

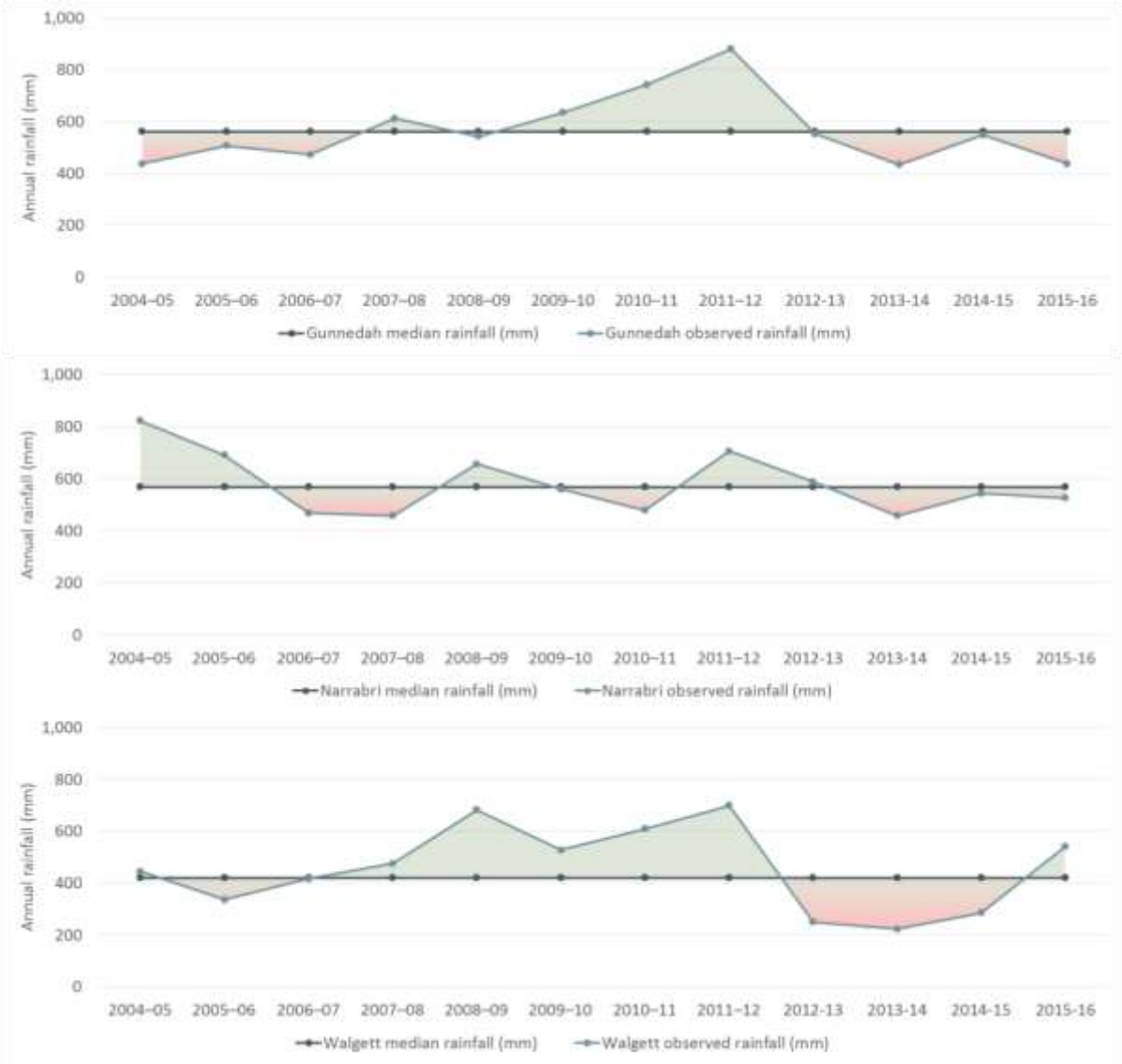
Notes: Only includes Aquifer entitlement types as these are the only entitlement types in the Namoi groundwater sources which allow carryover.

Figure 119 Carryover in the Upper and Lower Namoi Groundwater Sources, 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Namoi region given different climatic regions; for example, the median in Gunnedah is over 560 mm per

annum compared to 420 mm in Walgett. Figure 120 presents annual median rainfall in Gunnedah, Narrabri, and Walgett from 2004–05 to 2015–16. Observed annual rainfall patterns for Narrabri vary somewhat from those observed in Walgett and Gunnedah, which across this period are roughly correlated.

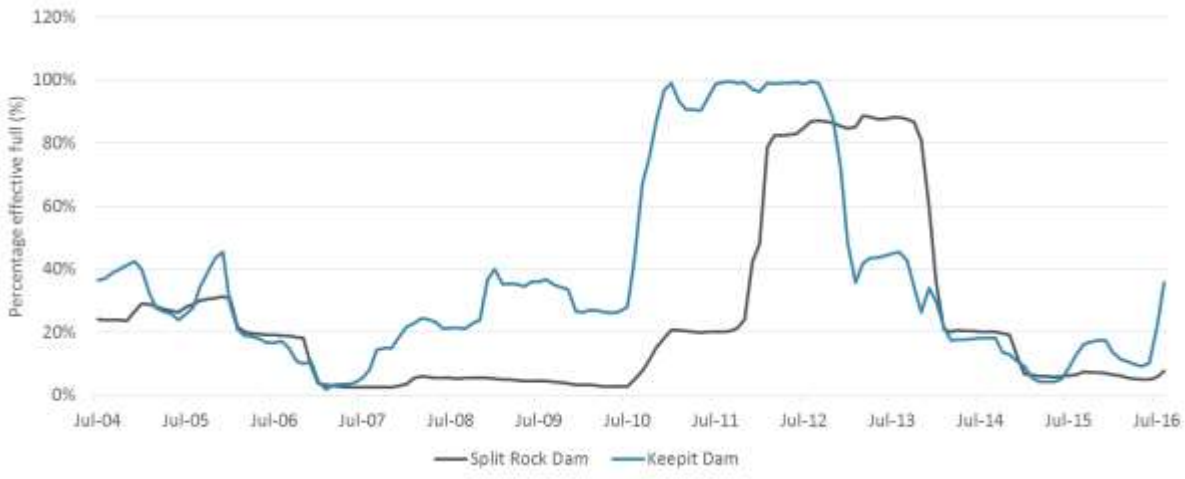


Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 120 Rainfall across the Namoi catchment, 2004–05 to 2015–16

Water storages

For the purpose of this analysis, the primary water storages are Keepit Dam (420 GL) on the Namoi River and Split Rock Dam (397 GL) on the Manilla River. Management of these storages effectively regulates the flow of the Namoi River. Figure 121 presents changes in storage levels for Keepit and Split Rock Dam from 2004–05 to 2015–16. Over time storage levels have fluctuated from lower levels during the Millennium Drought to higher levels in the wet years from 2010–11 to 2011–12. Since 2011–12, storage levels have declined to near Millennium Drought levels; however, some recent increases in storage levels are observed, particularly for Keepit Dam.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

Figure 121 Namoi water storages (Split Rock Dam and Keepit Dam), 2004–05 to 2015–16

Demand drivers

Changes in irrigated agricultural production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. With reference to the water systems located in the Namoi Catchment, these drivers are explored below.

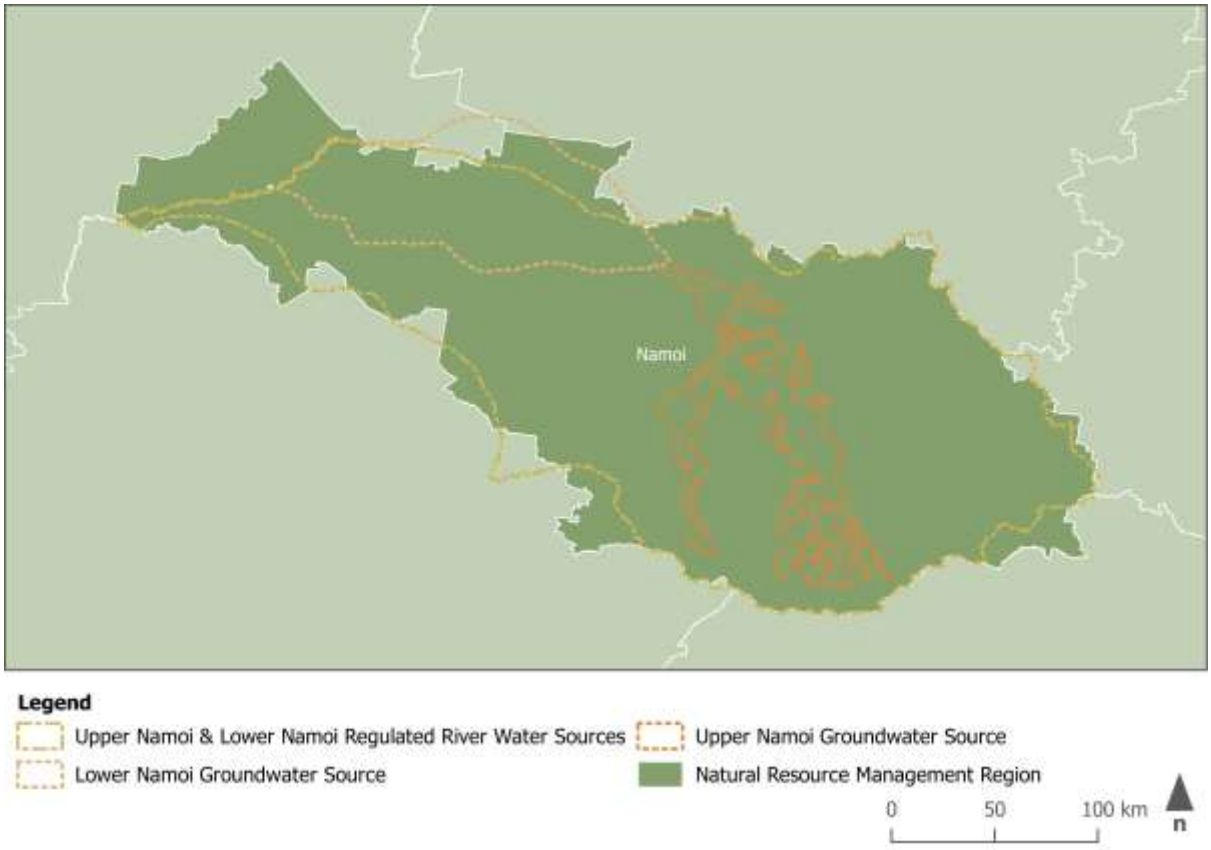
For this regional summary, Aither has compared land use and water use changes in the Namoi Catchment between 2007–08 and 2014–15. The 2014–15 ABS water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2014–15 year is the most recently available data, and it has been compared with 2007–08 because that was a similar year in relation to water allocations and rainfall, and therefore provides a reasonable comparison regarding how production in the system has changed over time.[49,50]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 122. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the Namoi WSP areas. [51]

[49] While the years presented appear similar at face value, there was lower water availability in the years preceding 2007-08. In comparison, 2014-15 followed a period of higher water availability. These differences are significant as land use and water use may be influenced by this. It is not possible to find two years in the time series which are perfectly comparable (including having the same lead in water availability), so 2007-08 and 2014-15 have been selected as they offer the best comparison available.

[50] Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years.

[51] At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.



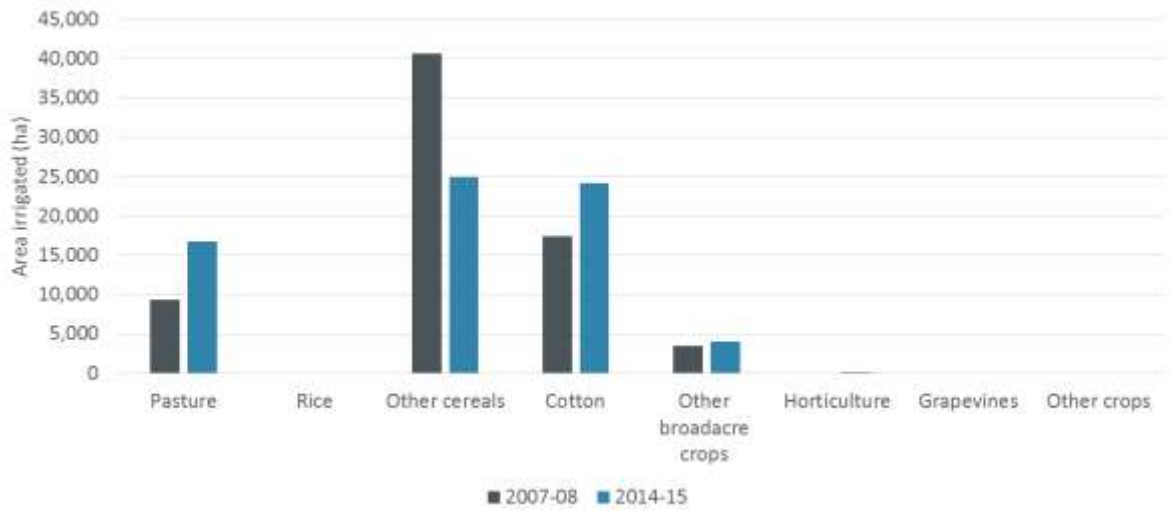
Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 122 Alignment of NRM regions and WSP boundaries – Namoi

Land use

There is a significant amount of irrigated agricultural activity in the Namoi Catchment, of which cotton production is the largest land use by irrigated area. Other important irrigated industries include pasture, other cereals, and other broadacre crops.

Figure 123 compares land use by irrigated agricultural industries in the Namoi for 2007–08 and 2014–15. This analysis appears to show a contraction of cereals over the period. In contrast, there is strong growth in cotton and pasture for the two years presented. Figure 123 also highlights a possible increase in land use for other broadacre crops.

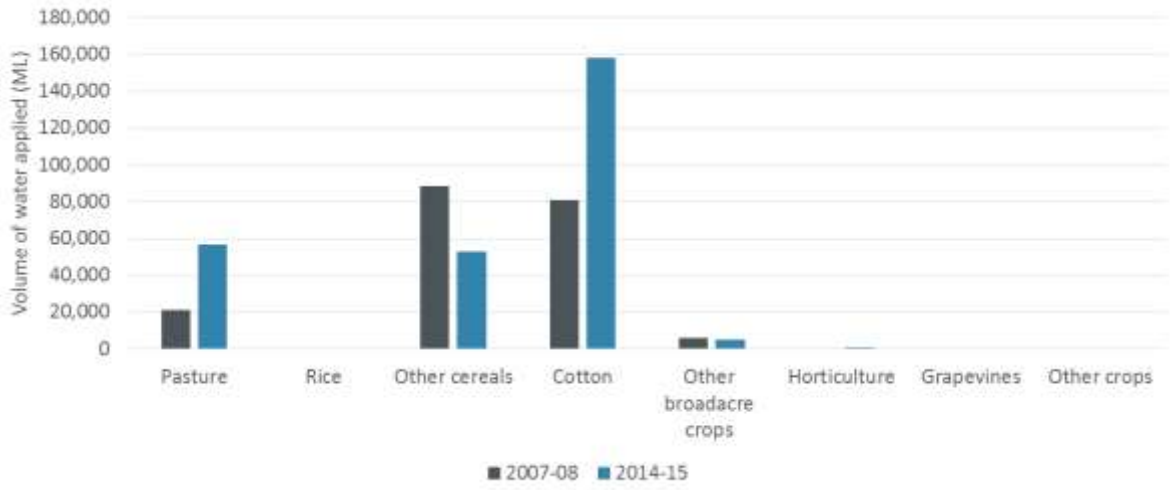


Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 123 Land use by irrigated agricultural industry Namoi Catchment, 2007–08 and 2014–15

Water use

Figure 124 compares water use by irrigated agricultural industries in the Namoi Catchment for 2007–08 and 2014–15. This suggests that for these years there has been a significant growth in water use by the cotton industry, and that cotton has become the biggest water user in the Namoi. This is aligned with an apparent growth in cotton plantings. Figure 124 also suggests increased water use by the irrigated pasture industry for 2007–08 and 2014–15, which is commensurate with the growth in area of pasture irrigated (compare to Figure 123). In comparison, water use for other cereals appears to have declined over the decade.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 124 Water use by irrigated agricultural industry Namoi Catchment, 2007–08 and 2014–15

Institutional and policy

Trade rules

Trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. The following section outlines rules of particular significance in the Namoi region.[52]

Upper and Lower Namoi Regulated River Water Sources

Allocations and entitlements can be traded between the Upper Namoi and Lower Namoi Water Sources.[53] These trades are not subject to conversion factors, although some restrictions based on seasonal availability may apply. At the time of writing, allocations from the Peel Regulated River Water Source were permitted to be traded into the Lower Namoi Regulated River Water Source; however this provision is in the process of being reassessed.[54]

Provisions in the WSP's allow for transfer of licence subject to a range of conditions. In reality, the mechanisms to transfer a licence between valleys in unconnected water sources without negative third party impacts are non-existent. As such, dealings involving the transfer of licence between unconnected valleys are not observed. Channel capacity in the Namoi systems limits the delivery of water in some areas (such as Pian Creek), and as such acts as an internal constraint on trade. The Upper and Lower Namoi Regulated River Water Sources form isolated trading zones, which means that any potential gains from inter-zone trades cannot be realised.

Upper and Lower Namoi Groundwater Sources

The Lower Namoi Groundwater Source contains three areas.[55] Trading may occur between properties within the same area. Trading may also occur from Area 3 into areas 1 and 2, and from Area 2 into Area 1. Other trade between areas may only occur if the two properties involved are contiguous and operated as a single farming unit that is dissected by the two trade areas.

Restrictions on trading between areas or zones reflect relative groundwater availability and aquifer recharge within these areas or zones. The restrictions can create smaller markets within the region where there are limited counterparties with whom trade may occur, which may mean potential gains from trade cannot be fully realised. However such rules may be necessary to minimise third party impacts.

Other policy issues

Upper and Lower Namoi Regulated River Water Sources

Channel capacity constraints exist in the system such that during periods of high demand, it may not be possible to deliver water to all users without exceeding channel capacity. Exceeding channel

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52 This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

53 For further information, refer to the Guide to the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources (http://www.water.nsw.gov.au/__data/assets/pdf_file/0011/548813/namoi-reg-guide.pdf)

54 For further information, refer to Part 10 of the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016 (http://www.legislation.nsw.gov.au/#/view/regulation/2015/631/part10)

55 For further information, refer to the Lower Namoi Groundwater Sources Summary Report 2006-2013 (http://www.water.nsw.gov.au/__data/assets/pdf_file/0003/548031/avail_ground_lower_namoi_groundwater_sources_summary_report.pdf)

capacity could result in losses and negative third party impacts. The relevant authority may declare restrictions on capacity share when channel capacity is expected to be exceeded at:

- the Pian Creek channel downstream of Gunidgera offtake,
- Gunidgera offtake.

Channel capacity constraints can limit trades when they are binding, including by limiting the number of potential buyers or sellers and can lead to price discrepancies between zones.

Upper and Lower Namoi Groundwater Sources

Pre-WSP extraction rates were set above the sustainable rate of extraction for the aquifers within the Upper and Lower Namoi Groundwater Sources. As a result, a key focus of the WSP has been to reduce the volume of annual water determinations to a sustainable level. As part of this initiative, Supplementary Water Aquifer access licences were gradually reduced and finally ceased in 2015. These actions have been successful in reducing the long-term extraction rate to within a sustainable limit.

Peel Catchment

Summary

The Peel Catchment is part of the northern MDB and covers a relatively small area in north-western NSW. This regional summary focuses on the Peel Regulated River Water Source, which flows approximately 210 kilometres to its junction with the Namoi River.

Compared to other systems in New South Wales, the amount of water on issue is small (47,795 ML). Local Water Utility entitlement types form a large proportion of the total volume of entitlement on issue (34.3 per cent). There is no carryover permitted in the system.

Trade is not possible between the Peel and other systems. Entitlement trade does occur, but only infrequently. General Security entitlements are the only entitlements that have recorded trade during the study period. There is comparatively more allocation trade in the Peel; however volumes and price are variable. There was no recorded allocation trade from August 2014 to July 2015.

Since commencement of the Water Sharing Plan for the Peel in 2012, supply-side drivers of trade have progressively indicated drying conditions.

Irrigated agricultural activity in the Peel Catchment is primarily for irrigated pastures and fodder crops.

Geographic and hydrological overview

This regional summary focuses on the Peel Regulated River Water Source and associated water sharing plan located within the Peel Catchment.

Peel Regulated River Water Source

The Peel Regulated River Water Source (the Peel River) is a regulated surface water system located within the Peel Catchment in north-western New South Wales (Figure 125). The Peel Catchment itself is a major sub-catchment within the Namoi catchment. The most significant regional town in the system is the regional centre of Tamworth, followed by smaller towns including Nundle, Attunga, Somerton, and Dungowan.

The Peel River forms in the northern slopes of the Liverpool range flowing northwest for approximately 210 kilometres to its junction with the Namoi River near Gunnedah. Chaffey Dam regulates the flow of the Peel River syste, and provides for urban and agricultural uses in the region. The system supports 66 square kilometres of irrigation, most of which is used for irrigated pasture or fodder crops. From a water management perspective, the Peel catchment is managed and operated independently of the regulated Namoi water sources.

Source: NSW DPI Water 2016.

Figure 125 Peel Catchment – Peel Regulated River Water Source

Water entitlements

Entitlements on issue

Table 21 summarises entitlement on issue for the water systems covered by this regional summary. Surface water entitlements are dominated by General Security entitlements, four per cent of which is held by the environment.

Table 21 Entitlement on issue for Peel Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of total entitlement on issue held by environment (%)
Peel Regulated River Water Source					
General Security	180	30,428	63.7%	1,257	4%
High Security[3]	13	804	1.7%	0	0%
Local water utility	1	16,400	34.3%	0	0%
Domestic and stock	19	163	0.3%	0	0%
Total	**213**	**47,795**	**100%**	**1,257**	**4%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and data provided by NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 3) Includes High Security (research).

Entitlement characteristics

Table 22 presents a high-level comparative analysis of the characteristics of each entitlement type. Notably, no carryover is permissible for any licence category in the Peel.

Table 22 Entitlement characteristics comparison for Peel Catchment water systems

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Peel Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	No	Within: Yes Out of: Restricted	Annual[1]
High Security	High	Allocated water after urban and stock and domestic needs have been secured	No	Within: Restricted Out of: Restricted	Annual
Local water utility	High	Allocated before General Security, High Security	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before General Security, High Security	No	Within: No Out of: No	Annual

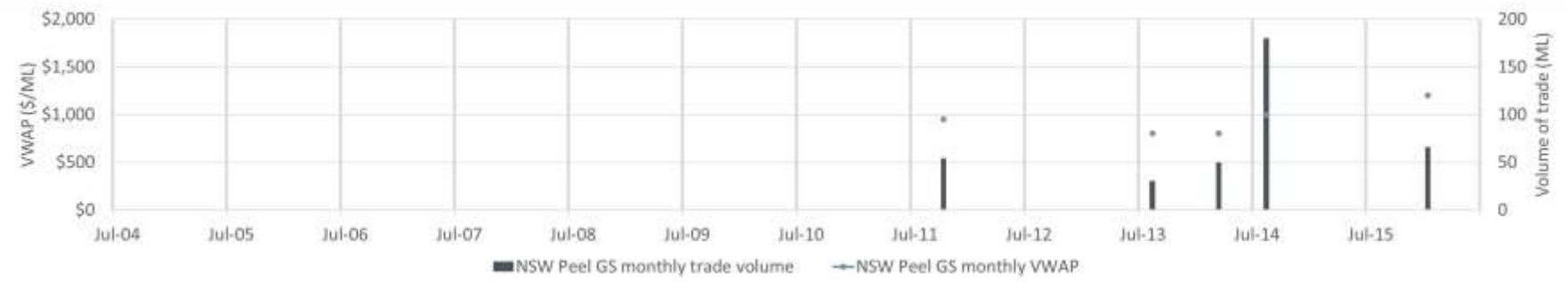
Source: Aither 2016. Based on Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010.

Note: 1) Uncontrolled flow is non-debit water accessible during supplementary flow events in periods of low allocations. Rules in water sharing plan, linked to allocation levels, define when uncontrolled flow taken converts to debit water against General Security accounts. (Some water sources also have High Security uncontrolled flow).

Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

There are no commercial trades recorded for High Security entitlement types in the Peel system since the commencement of the water sharing plan in 2010. In comparison, General Security entitlements in the Peel River have been traded, but only infrequently (Figure 126). As a result, it is difficult to ascertain any associated trends.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 126 Monthly average General Security entitlement prices and trade volumes Peel Regulated River Water Source, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the Peel River is relatively mature, however is less active than other systems in NSW. Allocation trade is generally not possible between the Peel and other surface water systems.[56] Trade can occur between users within the Peel River.

There is no allocation trade recorded in the system prior to 2012. This may partly align with the commencement of the Water Sharing Plan for the Peel Valley in 2010. Since 2012–13, trade has been highly variable year to year including no recorded trade from August 2014 to July 2015 (Figure 127). In addition, the volume traded is relatively low. Prices for allocation water have varied markedly, from record lows in 2013 to record highs in 2014–15. Between 2012–13 and 2015–16, prices increased to a high of more than $450 per ML.

[56] At the time of writing, allocations from the Peel Regulated River Water Source were permitted to be traded into the Lower Namoi Regulated River Water Source; however this provision is in the process of being removed from the WSP.

Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 127 Monthly average allocation prices and trade volumes Peel Regulated River Water Source, 2004–05 to 2015–16

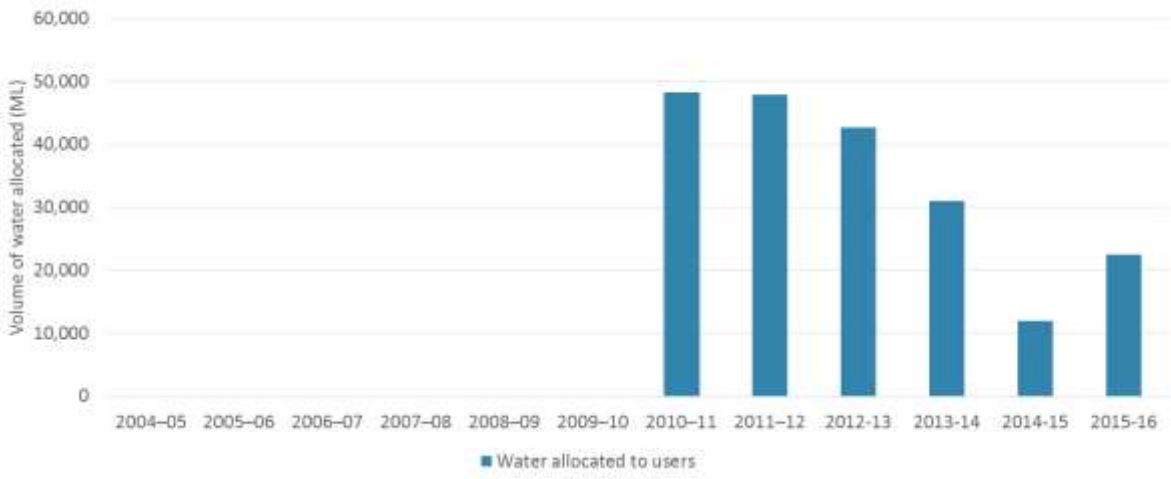
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Peel Catchment, these drivers are explored below.

Allocations to entitlements

Peel Regulated River Water Source

Figure 128 presents the volumes of water allocated to all water users in the Peel River from 2004–05 to 2015–16. There is no reliable publicly available allocation data for the years prior to the commencement of the water sharing plan in 2010–11. Allocations are characterised by relatively high volumes in 2010–11 and 2011–12 and declining volumes of allocation thereafter.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: Includes available water determinations (AWD) plus carryover.

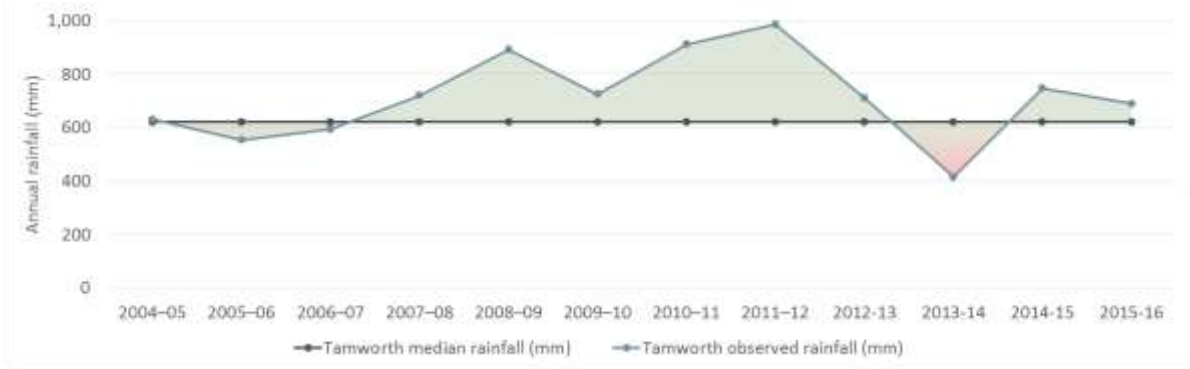
Figure 128 Total volume of water allocated to all entitlement types in the Peel River, 2004–05 to 2015–16

Carryover

No carryover is permitted for entitlements in the Peel Catchment (see Table 22).

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Given the small size of the Peel catchment and the availability of reliable rainfall data, only rainfall data for Tamworth is presented in this regional summary. As can be seen in Figure 129 rainfall at Tamworth between 2004–05 and 2015–16 has varied significantly from the median. From 2004–05 to 2006–07 there was below average annual rainfall. The years 2007–08 to 2012–13 were markedly wetter, with all years significantly above the median. Since 2012–13 there has been considerable variation in years above and below the median.

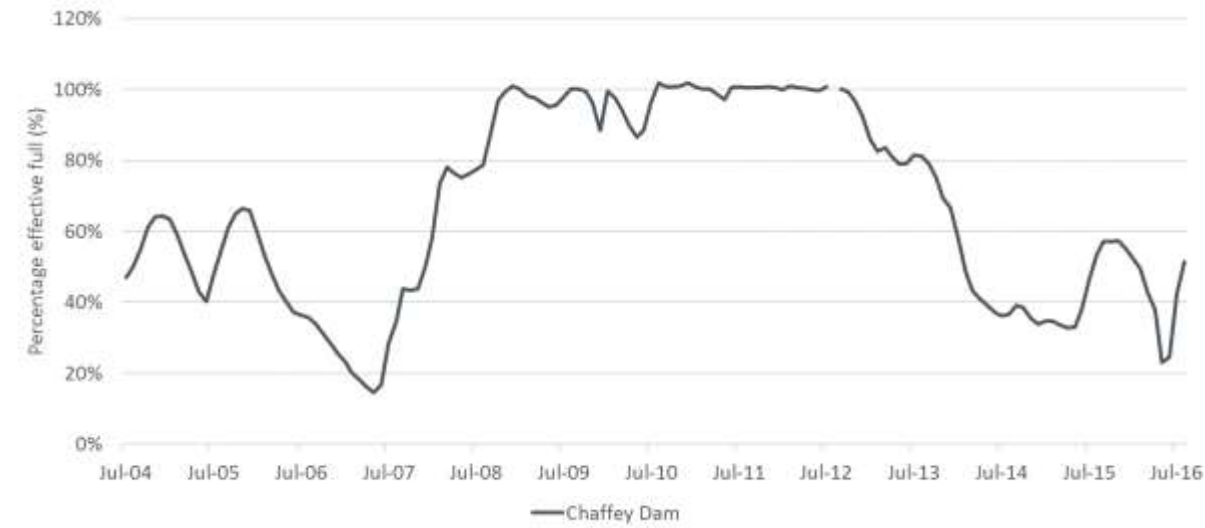


Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 129 Rainfall in the Peel Catchment (Tamworth) 2004–05 to 2015–16

Water storages

The primary water storage at the headwater of the Peel River is Chaffey Dam (102 GL), which effectively regulates the Peel River. Figure 130 presents changes in storage levels for Chaffey Dam for 2004–05 to 2015–16. Over time storage levels have fluctuated from lower levels during the Millennium Drought to higher levels in the wet years from 2008–09 to 2011–12. Since 2011–12, a downward trend in storage levels with high inter-year variance has been observed. In May 2016, Chaffey Dam was enlarged to enable it to store more water and to meet updated safety standards. The low storage levels observed at the beginning of 2016 may be a function of this increase in capacity from 62 GL to 102 GL.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

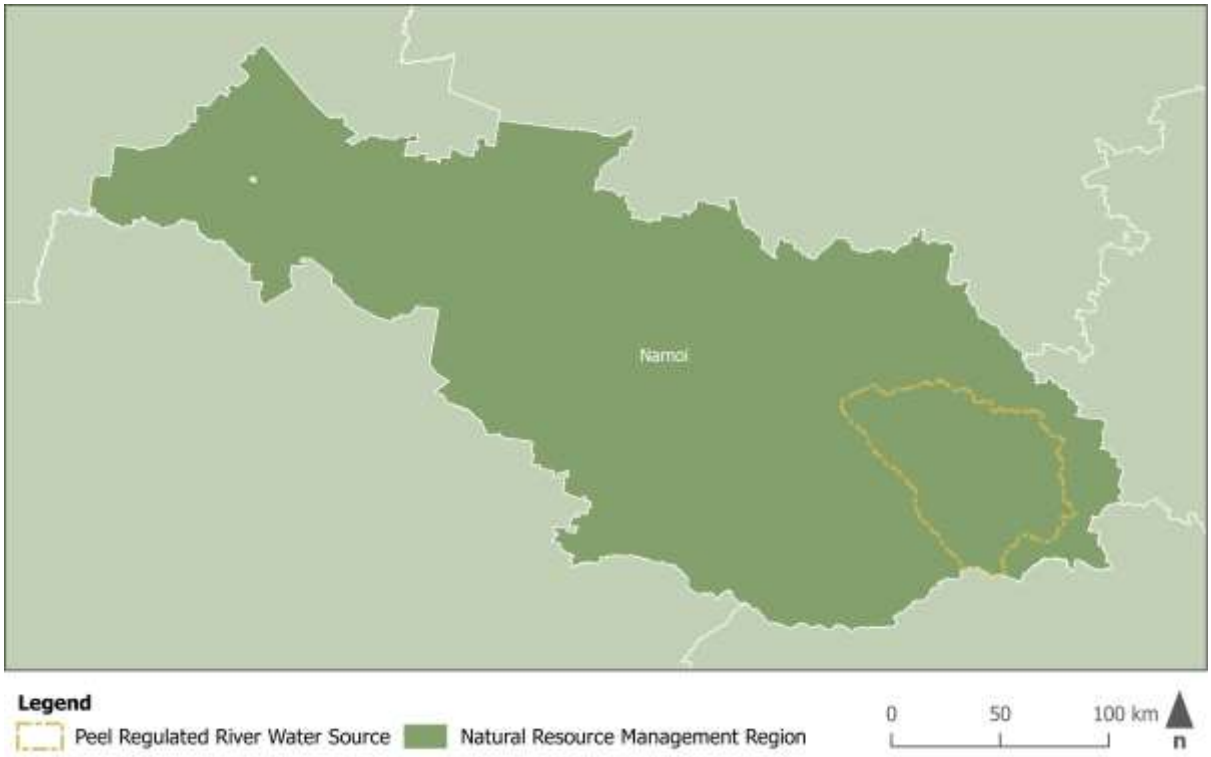
Note: Note that Chaffey Dam was enlarged (storage capacity increased) towards the end of the time series.

Figure 130 Peel water storage (Chaffey Dam), 2004–05 to 2015–16

Demand drivers

Changes in irrigated agricultural production is an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types.

For this regional summary, Aither has not compared land use and water use in the Peel by using a comparison of ABS data about irrigated agricultural water use. This is because the ABS data is aggregated by a much larger Natural Resource Management (NRM) region (Namoi) that does not align with the Peel Water Sharing Plan boundary – as shown in Figure 131 . Using ABS data for the Namoi NRM region would not provide an accurate representation for land use and water use changes over time in the Peel WSP area.



Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 131 Alignment of NRM regions and WSP boundaries – Peel

Agricultural activity in the Peel Catchment is primarily irrigated pastures and fodder crops. Unlike in the broader Namoi Catchment, there is no major irrigated cotton or cereals production in the Peel.

Institutional and policy

Trade rules

Water trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. In the Peel Regulated River Source, water trade is most significantly affected by rules reflecting limitations to the ability of operators to provide High Security access at points downstream of the Jewry Street Bridge in Tamworth.[57]

[57] Further information can be found in the background document to the Water Sharing Plan for Peel Valley regulated, unregulated, alluvial and fractured rock water sources (http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/548045/wsp_peel_valley_background.pdf)

A High Security entitlement from upstream of the Jewry Street Bridge may only be permanently traded to another user who is also located upstream of the bridge. Below the Jewry Street Bridge, permanent trading of a High Security licence may only occur in an upstream direction. Permanent (licence) and temporary (allocation) trading is unrestricted between Jewry Street Bridge and Chaffey Dam; however, temporary trading may not occur downstream of the bridge.

Other policy issues

Local Water Utility access licences comprise a significant volume of the total entitlement on issue within the Peel system (16,400 ML/year, or 34 per cent). The proportion of entitlements issued to Local Water Utility licence types is high compared to other regions in New South Wales. For example, Local Water Utility is one per cent of the total entitlement on issue for the Murrumbidgee system.

The entitlements are held by Tamworth Regional Council (TRC) and used to secure the majority of Tamworth's water supply. While both temporary and permanent trade is possible for Local Water Utility access licences, TRC must comply with policies such as having a Drought Management Plan in place, which specifies how much water must be held in reserve by the Council for town water supply purposes.

Aither understands that concerns have been raised in the Peel region about the potential impacts that TRC could have on the market if it were to trade, given the size of its holdings in comparison to the overall entitlement on issue.[58] Some specific potential issues raised include the TRC's potential for growth in water use, questions about TRC trading water given the high level of entitlement, and possible impacts on water security for other licence holders as unused TRC water may return to the consumptive pool at the end of each water year.

Water prices in the Peel system could be high when compared to the Namoi, potentially as a result of charges for water delivery. High water charges in the Peel are a result of on-going maintenance costs for water supply infrastructure per licence holder in the system.

[58] Tamworth's water supply resources are supplemented with water from privately owned Dungowan Dam.

Gwydir Catchment

Summary of key drivers

The Gywdir Catchment forms part of the northern MDB and is located in north-western New South Wales. This regional summary covers both the regulated surface and groundwater systems within the catchment.

Surface water entitlements are dominated by General Security and Supplementary entitlement types, which account for 71 per cent (509,665 ML) and 25 per cent (181,982 ML) of the total volume of entitlement on issue respectively.

Trade is not possible between the Gywdir and other systems due to limited connectivity. Compared with other surface water systems in New South Wales (such as the Murray and the Murrumbidgee) entitlement and allocation trade is less developed. Aquifer entitlements command higher prices than surface water entitlements. There is less groundwater allocation trade than for the surface water allocation market. However, prices and to a lesser extent volumes are more consistent year on year.

Allocation to entitlements, rainfall and water in storages indicate drying to drought conditions for all years except the period 2011–12 to 2013–14.

Water use and land use data indicate cotton as the dominant crop grown in the Gwydir region. Other important crops include cereals and pasture.

Geographic and hydrological overview

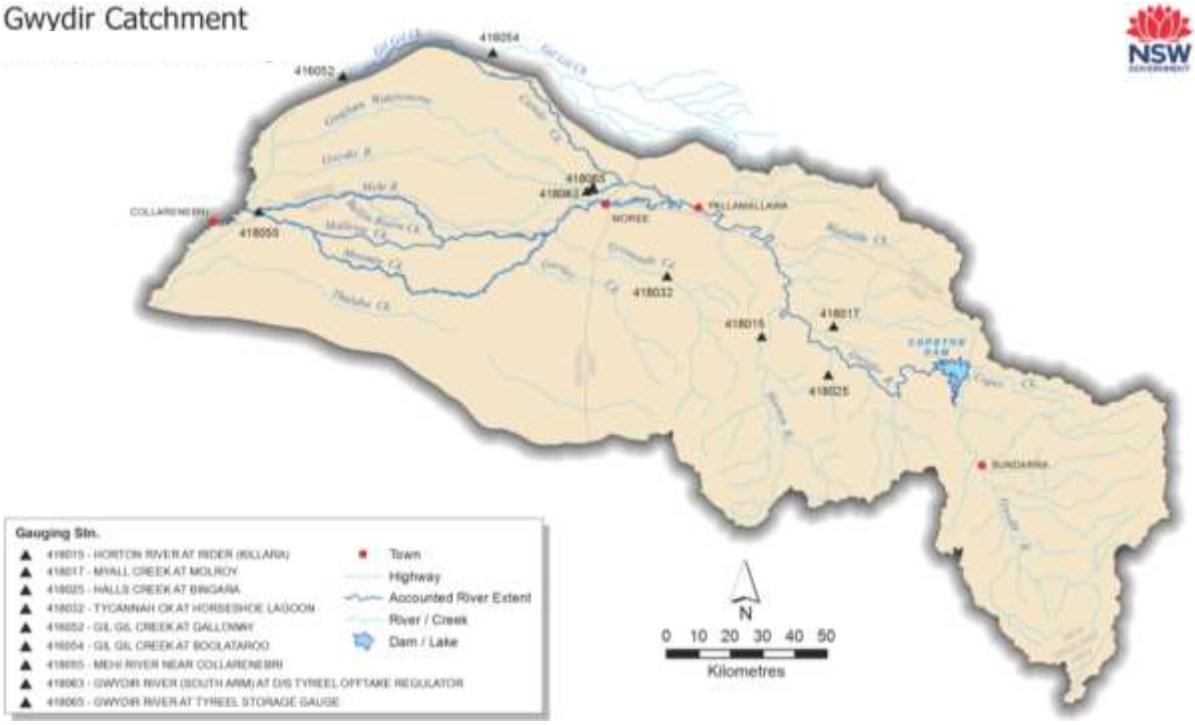
There are two major surface and groundwater water sources and water sharing plans located within the Gwydir Catchment that are the focus of this regional summary:

- Gwydir Regulated River Water Source
- Lower Gwydir Groundwater Source.

Gwydir Regulated River Water Source

The Gwydir Regulated River Water Source (the Gwydir River) is a regulated surface water system located within the Gwydir Catchment in north-western New South Wales (Figure 132). The Gwydir River rises in the New England Tablelands near Uralla and flows north-west towards the Barwon River. The largest town in the catchment is Moree, which acts as a commercial, transport and tourism hub for the region.

Located on the Gwydir River south of Inverell, Copeton Dam is the major storage within the Gwydir catchment. Major water users in the catchment include local councils, livestock grazing and irrigated agriculture, predominantly cotton. Downstream of Moree, the Lower Gwydir wetlands cover approximately 1,000 square kilometres and are a major environmental feature of international significance under the Ramsar Convention.



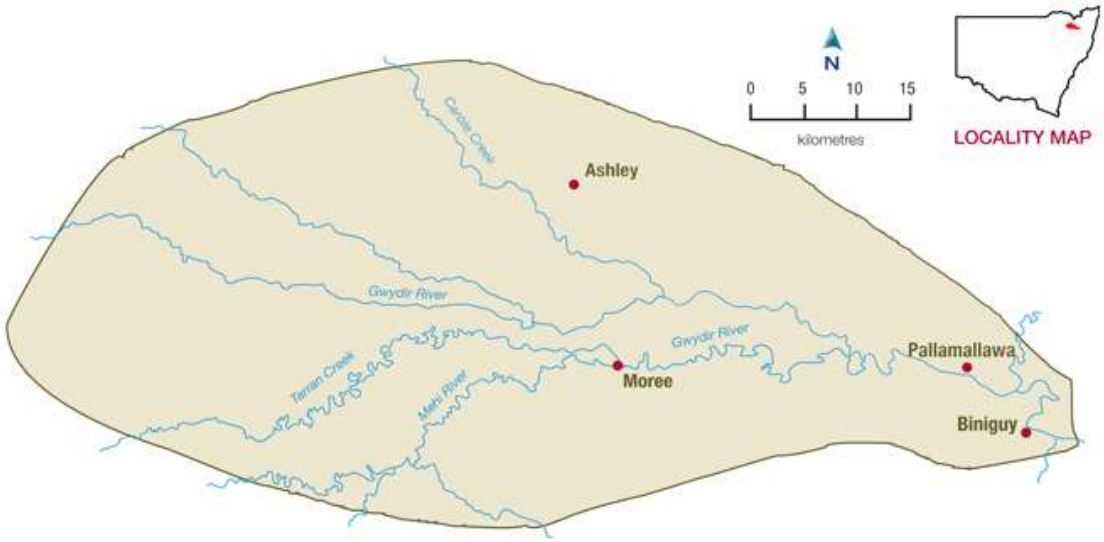
Source: NSW DPI Water 2016.

Figure 132 Gwydir Catchment – Gwydir Regulated River Water Source

Lower Gwydir Groundwater Source

Groundwater also plays an important role in the Gwydir Catchment, with urban, agriculture, and industrial users all using groundwater to different degrees. A number of groundwater sources are located within the catchment, some which are connected to the Gwydir River. The groundwater source of focus in this regional summary is the Lower Gwydir Groundwater Source.

The Lower Gwydir Groundwater Source encapsulates the towns of Ashley in the North, Biniguy and Pallamallawa in the East and Moree in the centre (Figure 133). The Lower Gwydir Groundwater Source is generally divided into two main aquifer systems – a shallower system extending to a depth of approximately 10 to 30 metres below ground level and a deeper system extending to a depth of 35 to 80 metres below ground level. Bores are primarily clustered through the middle of the groundwater management area in areas adjacent to the main surface water systems.



Source: NSW DPI Water 2016.

Figure 133 Gwydir Catchment – Lower Gwydir Groundwater Source

Water entitlements

Entitlements on issue

Table 23 summarises entitlement on issue for the water sources covered by this regional summary. Surface water entitlements are dominated by General Security, a substantial proportion of which is held by the environment. More significant is the proportion of High Security licence entitlement held for the environment. The total volume of surface water entitlement on issue is much larger than the volume of water on issue in the groundwater system.

Table 23 Entitlement on issue for Gwydir Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[1]	Proportion of total entitlement on issue held by environment (%)
Gwydir Regulated River Water Source					
General Security	173	509,665	71%	106,617	21%
High Security[3]	22	20,260	3%	5,757	28%
Local water utility	4	3,836	1%	0	0%
Domestic and stock	100	2,824	0%	0	0%
Supplementary	159	181,397	25%	23,592	13%
Total	**458**	**717,982**	**100%**	**135,965**	**19%**
Lower Gwydir Groundwater Source					
Aquifer	155	28,858	89%	0	0%
Local water utility	2	3,572	11%	0	0%
Total	**157**	**32,430**	**100%**	**0**	**0%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and data provided by NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH). 3) Includes High Security (research).

Entitlement characteristics

Table 24 presents a high-level comparative analysis of the characteristics of each entitlement type.

Table 24 Entitlement characteristics comparison for Gwydir Catchment water systems

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Gwydir Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes (up to 1.5 ML per unit share of entitlement volume from year to year)	Within: Yes Out of: Restricted	Annual[1]
High Security	High	Allocated water after urban and domestic and stock needs have been secured	No	Within: Yes Out of: Restricted	Annual
Local water utility	High	Allocated before General Security, High Security entitlements	No	Within: Restricted Out of: Restricted	Annual
Domestic and stock	High	Allocated before General Security, High Security entitlements	No	Within: No Out of: No	Annual
Supplementary	Infrequent	Always allocated at 1 ML per share. Supplementary access announcements permit take during high flow events.	No	Within: Restricted Out of: No	Water cannot generally be stored
Lower Gwydir Groundwater Source					
Aquifer	High	Allocated water after urban and domestic needs have been secured	Yes (up to 2 ML account limit per water share)	Within: Restricted Out of: No	Annual
Local water utility	High	Allocated before Aquifer entitlements	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before Aquifer entitlements	No	Within: No Out of: No	Annual

Source: Aither 2016. Based on the Water Sharing Plan for the Gwydir Regulated River Water Source 2016.

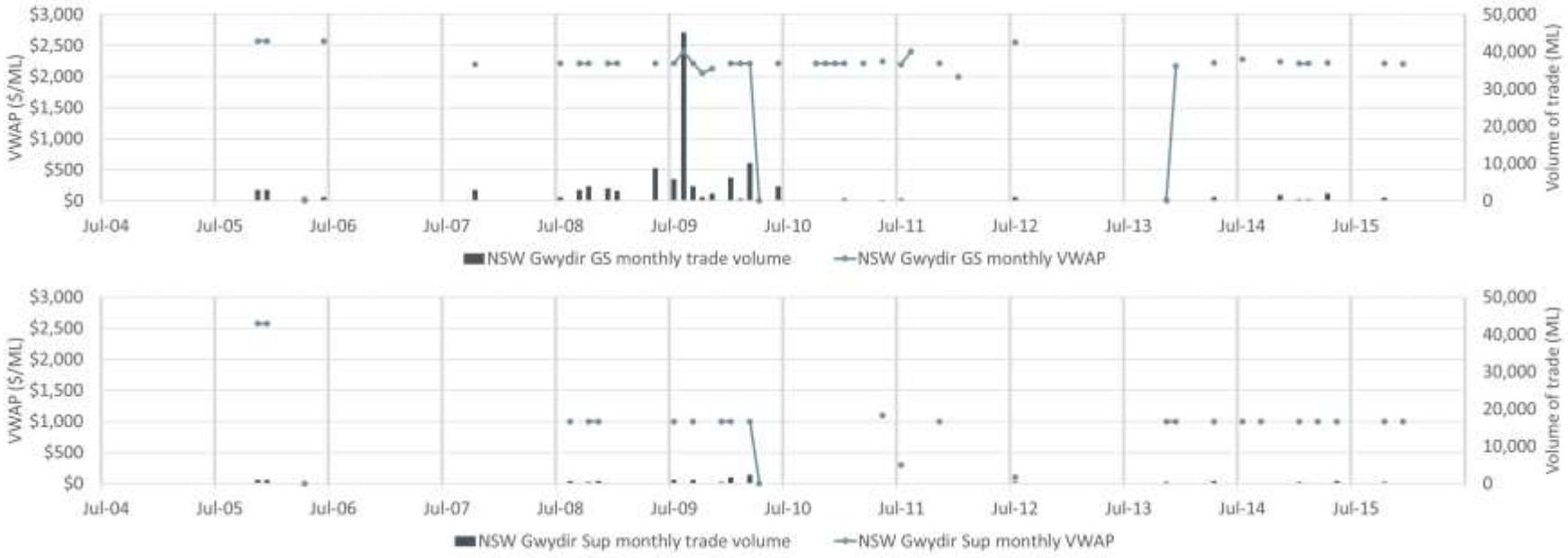
Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

There are no trades recorded for High Security entitlements in the Gwydir River.[59] In comparison, General Security entitlements in the Gwydir River are traded relatively frequently and generally command a price within the $2,000 and $2,500 range (Figure 134). Supplementary entitlements are less frequently traded than General Security, and command a lower price.

Aquifer entitlements have been traded in the Lower Gwydir Groundwater Source (Figure 135), but at lower volume and frequency compared to surface water. The prices commanded for Aquifer entitlements are generally higher than entitlements in surface water systems.

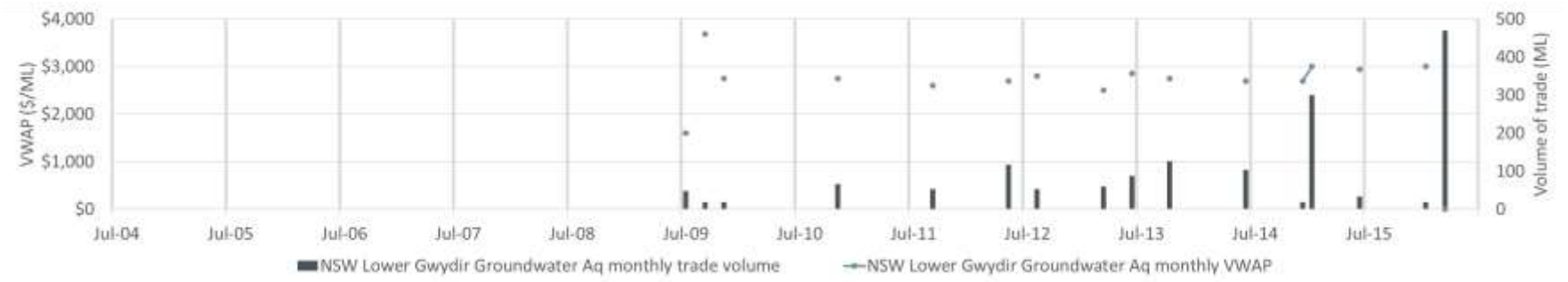
[59] This may be the result of data filtering rules applied. Stakeholders have suggested Commonwealth purchases occurred in 2008 and more recently.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 134 Monthly average General Security and Supplementary entitlement prices and trade volumes Gwydir Regulated River Water Source, 2004–05 to 2015–16



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

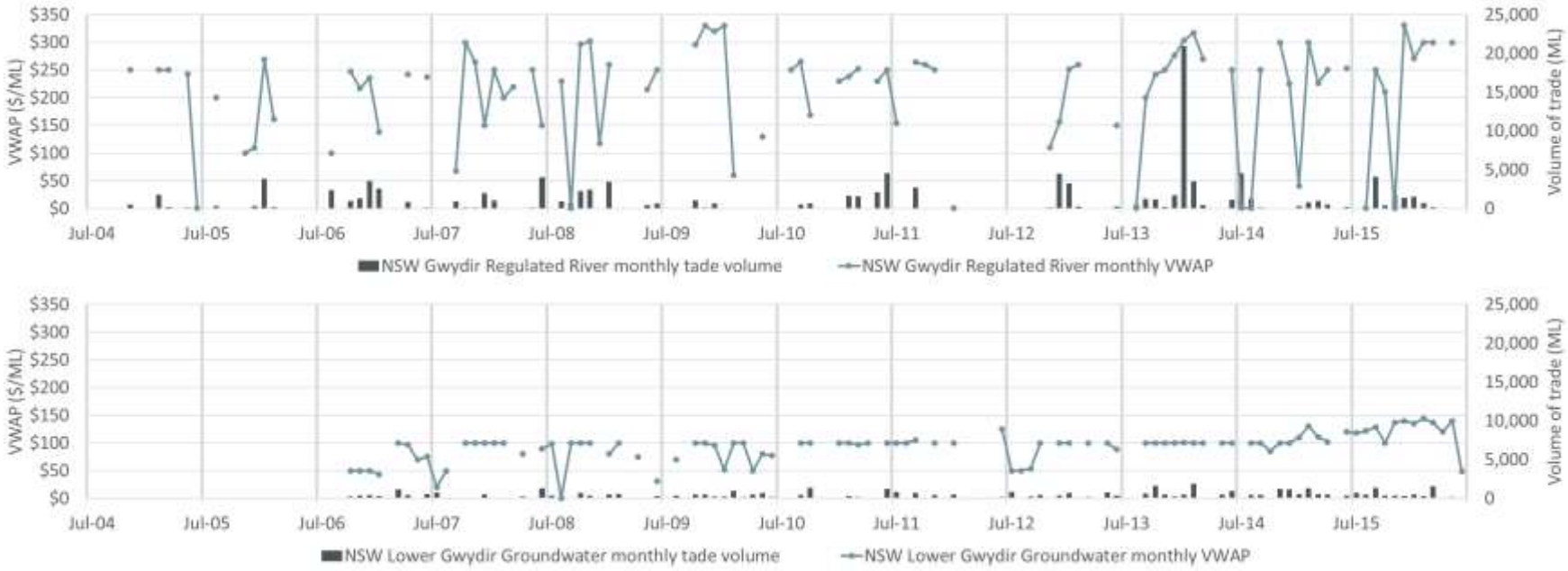
Figure 135 Monthly average Aquifer entitlement prices and trade volumes Lower Gwydir Groundwater Source, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the Gwydir River is active and relatively mature. It is isolated from other MDB markets; trade is not possible between the Gwydir and other surface water systems.

There have been variable volumes of annual allocation trade in most of the past ten years. Prices for allocation water vary markedly.

There is comparatively less trade and lower prices for allocations in the Lower Gwydir Groundwater Source (Figure 136). However prices, and to a lesser extent, volumes, are much more consistent year on year for groundwater allocations.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 136 Monthly average allocation prices and trade volumes Gwydir Regulated River Water Source and Lower Gwydir Groundwater Source, 2004–05 to 2015–16

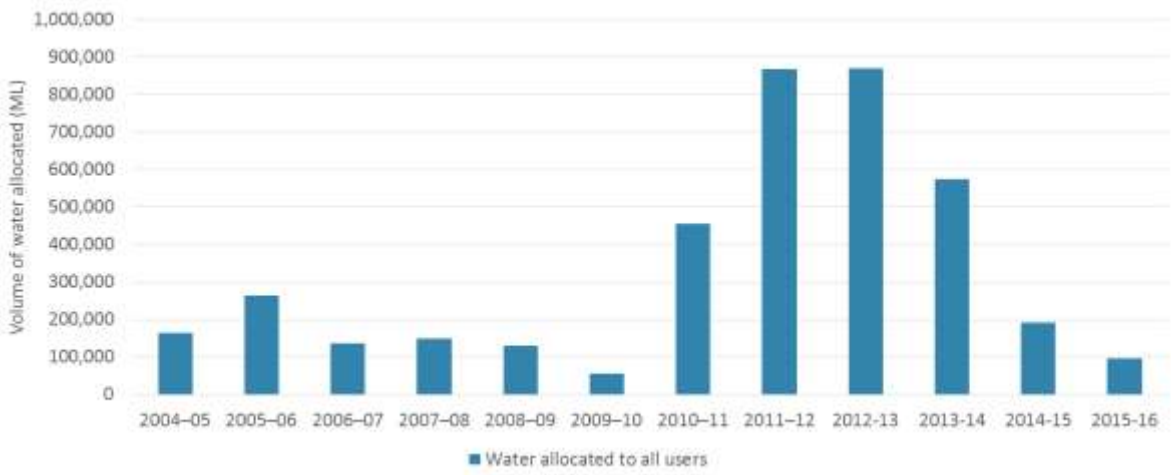
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Gwydir Catchment, these drivers are explored below.

Allocations to entitlements

Gwydir Regulated River Water Source

Figure 137 presents the volumes of water allocated to all water users in the Gwydir River from 2004–05 to 2015–16. Allocations are characterised by relatively low volumes from 2006–07 to 2009–10, high volumes from 2010–11 to 2012–13, and declining volumes thereafter.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: Includes available water determinations (AWD) plus carryover.

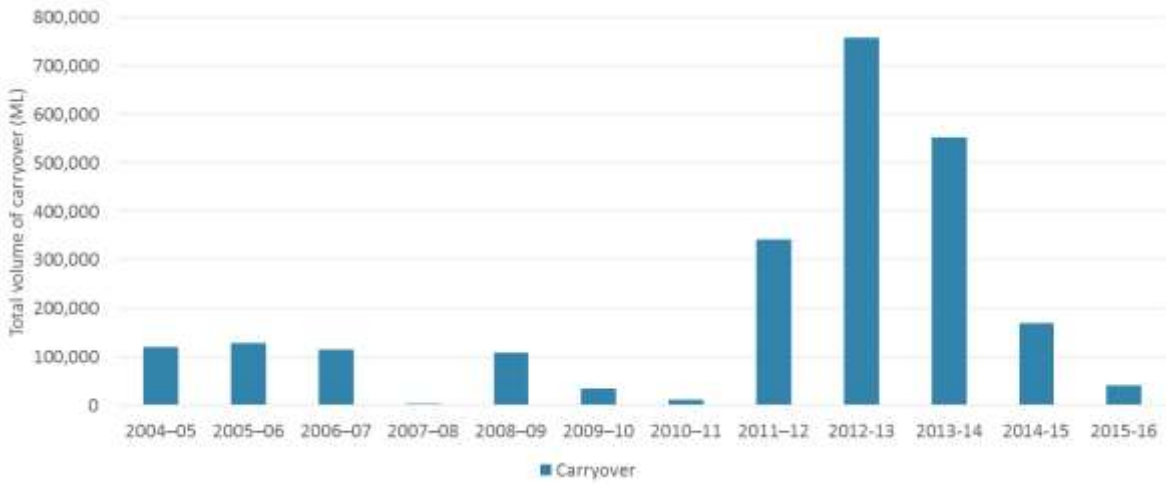
Figure 137 Total volume of water allocated to all entitlement types in the Gwydir River, 2004–05 to 2015–16

Lower Gwydir Groundwater Source

In every water year since 2006–07 Aquifer entitlements in the Lower Gwydir Groundwater Source have received 100 per cent allocations by the end of the water year.

Carryover

It is only possible for General Security entitlement types in the Gwydir River to carryover water (see Table 23 for a full list of entitlement types). Between 2004–05 and 2010–11, an average of 74,356 ML of water has been carried over into the following water year, which is approximately 10 per cent of the total volume that can be carried over in any year. Incorporating the years 2011–12 to 2015–16 to the long–term average, average annual carryover has increased significantly to 26 per cent of the total volume of permitted carryover.

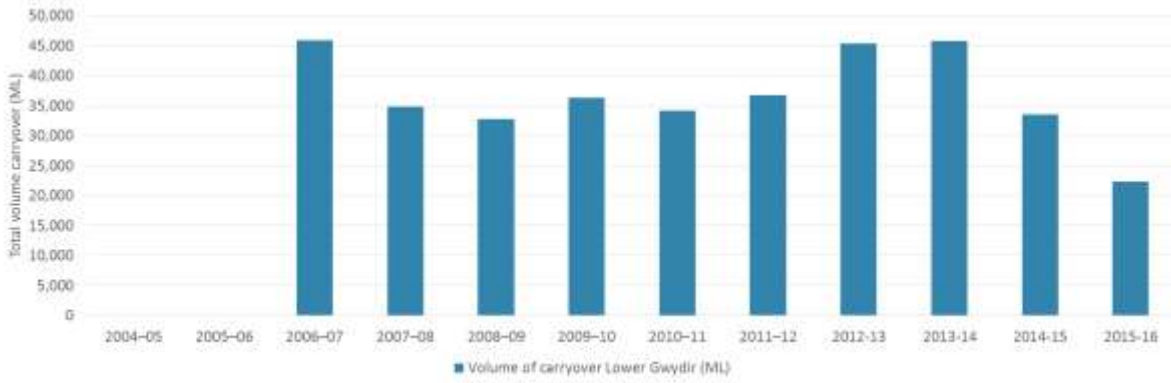


Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes General Security entitlement types as these are the only entitlement types in the Gwydir which allow carryover.

Figure 138 Carryover in the Gwydir Regulated River, 2004–05 to 2015–16

In the Lower Gwydir Groundwater source, only Aquifer access licences can carryover water into the following year. Entitlement owners for these Aquifer entitlement types can carryover a total of 2 ML per unit share of their entitlement, meaning that carryover can exceed the total entitlement in any given year. As shown in Figure 139, since 2006–07 there has been an average of 36,782 ML carried over into the following year.



Source: Aither 2016. Based on data from NSW DPI Water 2016.

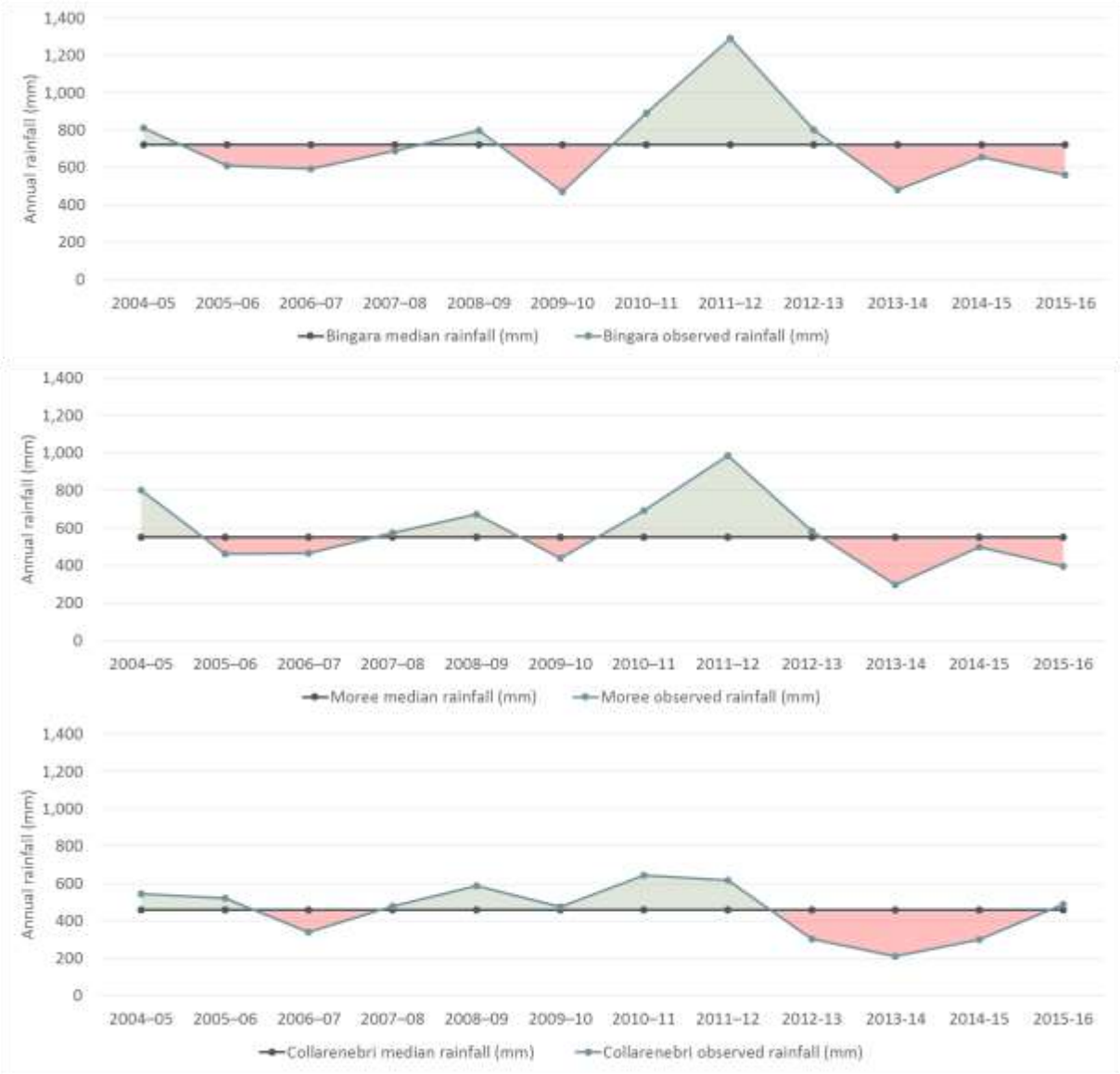
Notes: Only includes Aquifer entitlement types as these are the only entitlement types in the Lower Gwydir Groundwater Source which allow carryover.

Figure 139 Carryover in the Lower Gwydir Groundwater Source, 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Gwydir region given different climatic regions; for example the median in Bingara is 720 mm per annum compared to 458 mm in Collarenebri. Figure 140 presents annual median rainfall in Bingara, Moree. and Collarenebri from 2004–05 to 2015–16. Annual rainfall between Bingara and Moree across this period is highly correlated – with 11 out of 12 of the same years above and below median rainfall.

Observed rainfall patterns in Collarenebri are similar to Bingara and Moree but not as highly correlated.

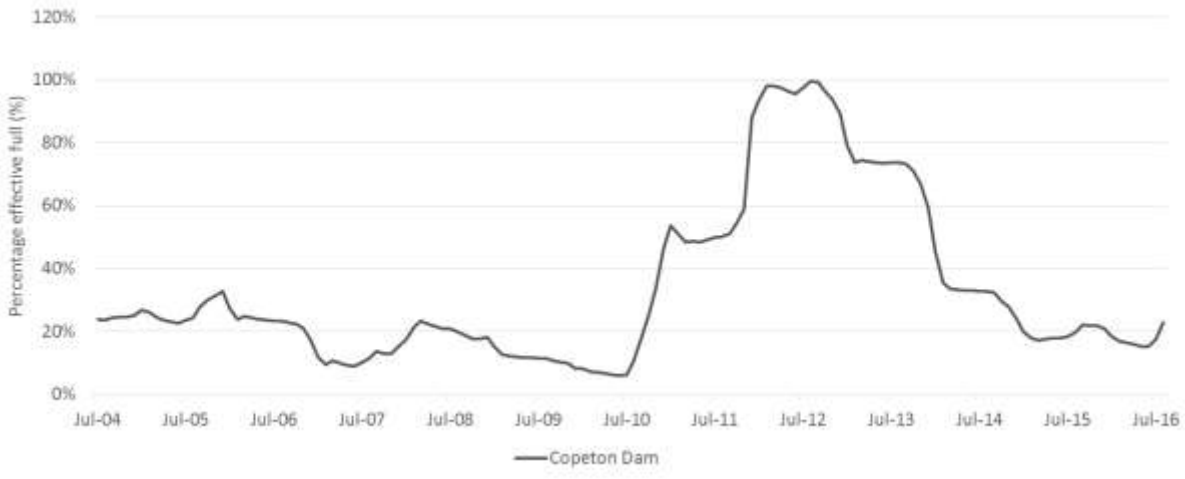


Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 140 Rainfall across the Gwydir Catchment, 2004–05 to 2015–16

Water storages

The primary water storage at the headwater of the Gwydir River is Copeton Dam (1,364 GL). Management of the storage effectively regulates the Gwydir River. Figure 141 presents changes in storage levels for Copeton Dam from 2004–05 to 2015–16. Over time storage levels have fluctuated from lower levels during the Millennium Drought to higher levels in the wet years from 2010–11 to 2011–12. Since 2011–12, a downward trend in storage levels with high inter-year variance has been observed. At present, storages are at similar levels to those observed during the Millennium Drought.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

Figure 141 Gwydir storage levels (Copeton Dam), 2004–05 to 2015–16

Demand drivers

Changes to irrigated agricultural production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. Regarding the water systems located in the Gwydir Catchment, these drivers are explored below.

For this regional summary, Aither has compared land use and water use in the Gwydir Catchment for 2005–06 and 2014–15. The 2014–15 ABS water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2014–15 year is the most recently available data, and it has been compared with 2005–06 because that was a similar year in relation to water allocations and rainfall, and therefore provides a reasonable comparison regarding how production in the system has changed over time.[60,61]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 142. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the Gwydir WSP area.[62]

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60 The years presented appear similar at face value, given similar volume of allocations, carryover and rainfall in the across these years. Looking at the years preceding 2005-06, there was a sustained period of low water availability. In comparison, the years preceding 2014-15 had considerably more water available. These differences are significant as land use and water use may be influenced by this. It is not possible to find two years in the times series which are perfectly comparable (including having the same lead in water comparability), so 2005-06 and 2014-15 have been selected as they offer the best comparison available.

61 Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years. Stakeholders have suggested however, that while they may be similar allocation years, there were significant changes in behaviour and ownership.

62 At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.

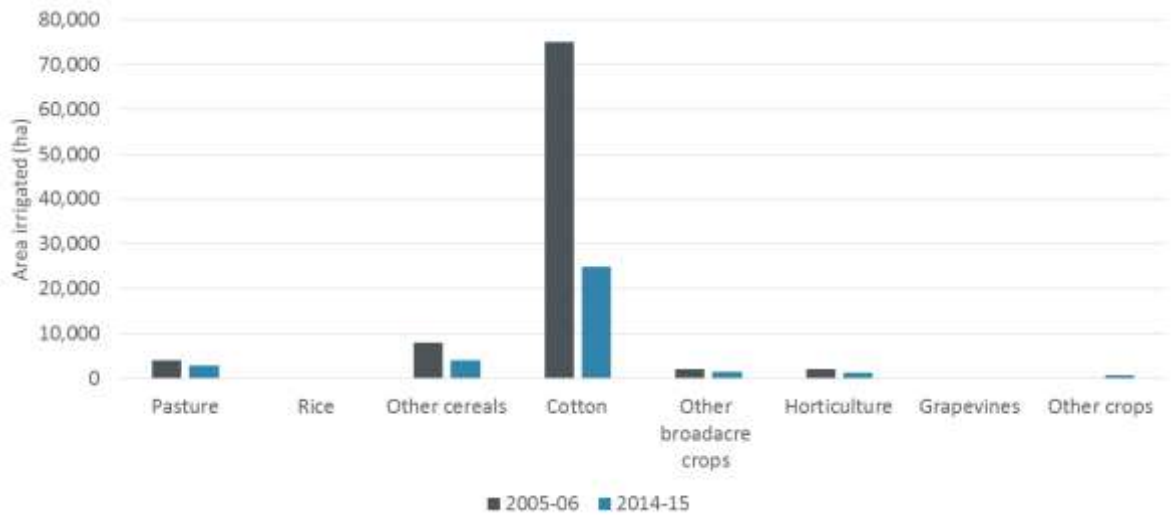
Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 142 Alignment of NRM regions and WSP boundaries – Gwydir

Land use

There is a significant amount of irrigated agricultural activity in the Gwydir Catchment. Cotton, other cereals and pasture dominate plantings amongst irrigated agricultural industries.

Figure 143 compares land use by irrigated agricultural industries in the Gwydir for 2005–06 and 2014–15. This highlights a possible contraction of the irrigated cotton industry over the past decade. Figure 143 also suggests a decline in land use for pasture and other cereals. Comparing the two years, there appears to have been a marginal decline for other broadacre crops and horticulture over the past decade. In contrast, land use for other crops has slightly increased for the years 2005–06 and 2014–15.

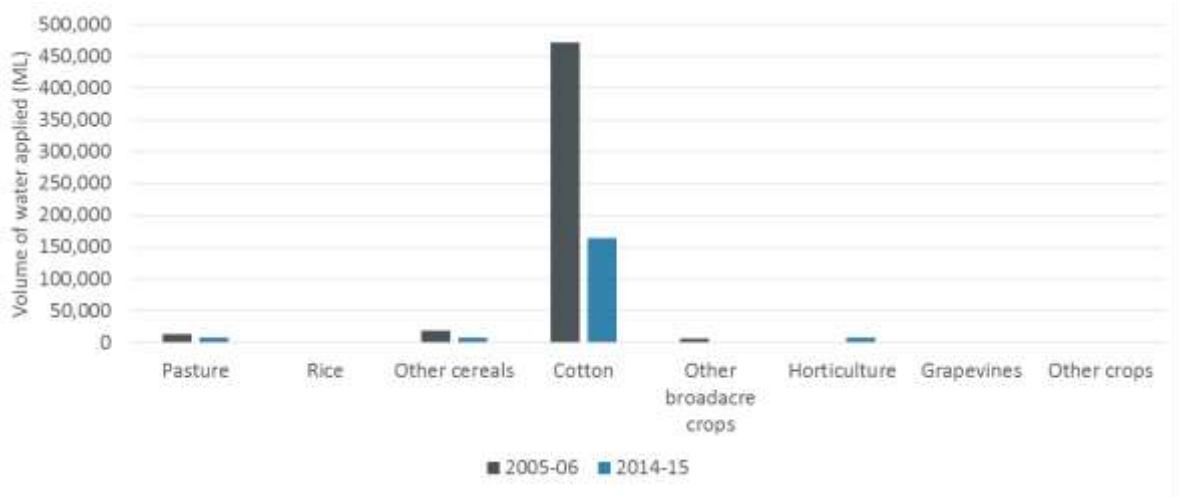


Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 143 Land use by irrigated agricultural industry Gwydir Catchment, 2005–06 and 2014–15

Water use

Figure 144 compares water use by irrigated agricultural industries in the Gwydir Catchment between 2005–06 and 2014–15. The analysis suggests that for these years there has been a significant reduction in water use by the cotton industry, but that cotton is still the largest water user, which may partly be explained by increased dryland cotton cropping. Figure 144 also highlights possible reductions in water use by the pasture and other cereals industries which is aligned with a reduction in the area planted for those industries (compare to Figure 143). Comparing these two years, there also appears to have been a decline in water use for other broadacre crops. Horticulture appears to have marginally increased water use.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 144 Water use by irrigated agricultural industry Gwydir Catchment, 2005–06 and 2014–15

Institutional and policy

Trade rules

Trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. The following section outlines rules of particular significance in the Gwydir region.[63]

Gwydir Regulated River Water Source

Access licences may only be traded within the Gwydir River Water Management Area, while allocations may only be traded within the Regulated River Water Source.[64] These restrictions reflect channel capacity constraints. Extraction components are yet to be determined in some areas and until these are established trading may only occur if the total share components of access licences are not increased in:

- Gwydir River below Tyreel Regulator,
- the Mehi River below the Moomin Creek junction,
- Moomin Creek
- Carole Creek.

Lower Gwydir Groundwater Source

The Lower Gwydir Groundwater Source contains two areas. Area 2 has been identified as having significant drawdown and recovery decline and there are trade rules in place to protect groundwater and licence holders within this area. Permanent trade may occur within the same area and from

[63] This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

[64] For further information, refer to A guide to the Water Sharing Plan for the Gwydir Regulated River Water Source (http://www.water.nsw.gov.au/__data/assets/pdf_file/0011/548885/gwydir-reg-guide.pdf)

Area 2 to Area 1. Temporary trade may occur within Area 1, while temporary trades into and within Area 2 may occur subject to a cap.[65]

Other issues

There are a number of policy, operational and management issues that influence trade in the Gwydir region. Importantly, channel capacity constraints exist in the system such that during periods of high water demand, it may not be possible to deliver water to all users without exceeding channel capacity. The relevant authority may declare restrictions on capacity share when channel capacity is expected to be exceeded at:

- the Gwydir River downstream of Tyreel Regulator,
- the Mehi River downstream of the Moomin Creek junction,
- Moomin Creek, and
- Carole Creek.

This may impact confidence in the reliability of entitlements for water users as there is some uncertainty about the likelihood of delivery during periods of high demand, although this may be mostly an issue for new participants in the region rather than existing participants.

Stakeholders have also noted the ability to share system capacity with environmental water users as an issue in this catchment.

[65] For further information, refer to Appendix A of Lower Gwydir Groundwater Source Groundwater Management Area 004 Groundwater Status Report – 2008 (http://www.water.nsw.gov.au/__data/assets/pdf_file/0003/549084/avail_ground_lower_gwydir_report_2008.pdf)

Border Rivers Catchment

Summary

The Border Rivers catchment is located in far northern New South Wales, and forms the northern most sub-catchment in the northern MDB. Water in the catchment is shared between states under the New South Wales – Queensland Border Rivers Intergovernmental Agreement 2008. This regional summary focuses on the regulated surface waters in the catchment.

There is a total of 386,360 ML of water on issue in the Border Rivers catchment. General Security B entitlement types dominate the total volume of entitlement on issue (241,211 ML), comprising 62 per cent of entitlements issued. High Security entitlements comprise less than one per cent of the total entitlement on issue (1,500 ML).

Trade is not possible between the Border Rivers and other surface water systems in New South Wales; however 'tagged trade' for entitlements occurs between New South Wales and Queensland Border Rivers. Both entitlement and allocation water markets in the Border Rivers are modest compared to other systems.

Allocations to entitlements data are only available for the Border Rivers from commencement of the Water Sharing Plan in 2009–10. Allocations are characterised by a low, higher and declining volumes. Rainfall and storages data suggest a broader time step of drying, drought, flood and drying conditions.

Water and land use data suggest cotton as the major irrigated agricultural activity in the catchment, with horticulture and pasture production other important crops.

Geographic and hydrological overview

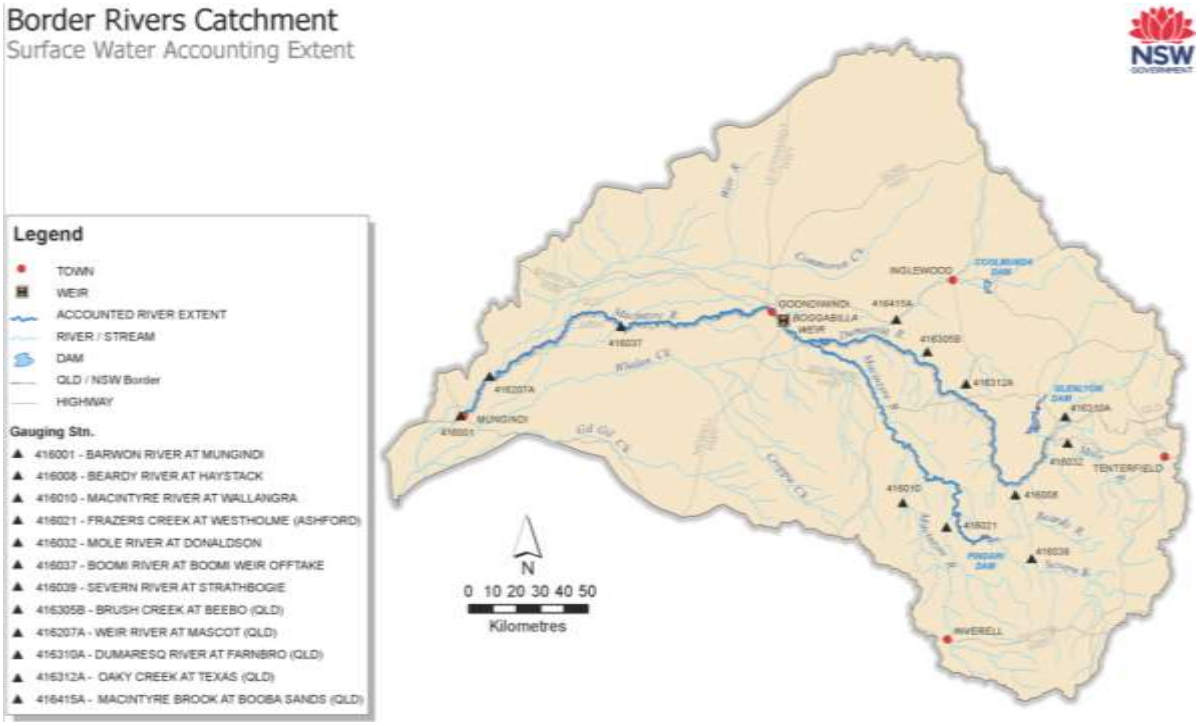
This regional summary focuses on the Border Rivers Regulated River Water Source and water sharing plan located within the Border Rivers Catchment.

NSW Border Rivers Regulated River Water Source

The NSW Border Rivers Regulated River Water Source (the Border Rivers) is a regulated surface water system located within the Border Rivers Catchment in far northern New South Wales and southern Queensland (Figure 145). The Border Rivers comprise the catchments of the Dumaresq, Severn and Macintyre rivers. The Dumaresq and Macintyre rivers form the border between NSW and Queensland for approximately 470 kilometres. Water in the catchment is shared between states under the New South Wales – Queensland Border Rivers Intergovernmental Agreement 2008. A number of urban areas and towns are located within the catchment including Glen Innes, Inverell and Tenterfield in NSW and Goondiwindi on the northern side of the Macintyre River in southern Queensland.

The Border Rivers catchment drains from the western side of the Great Dividing Range and is regulated in the NSW catchment by Pindari Dam on the Severn River. Glenlyon Dam in Queensland is situated on Pikes Creek (a tributary of the Dumaresq River) and stores New South Wales entitlements. The catchment supports a variety of different water uses including urban and town water use, dryland agricultural cropping and irrigated cropping (cotton, fruit, vegetables, wine grapes and lucerne). A nationally listed wetland complex comprising Morella Lagoon, Pungbougal Lagoon and Boobera Lagoon are part of a remnant channel of the Macintyre River south of Goondiwindi. Boobera

Lagoon is considered to be one of the most important Aboriginal sites in eastern Australia due to its significant Aboriginal heritage value (NSW DPI Water 2012).



Source: NSW DPI Water 2016.

Figure 145 Border Rivers catchment – Border Rivers Regulated River Water Source

Water entitlements

Entitlements on issue

Table 25 summarises entitlement on issue for the water systems covered by this regional summary. Surface water entitlements are dominated by General Security, a small proportion of which is held by the environment.

Table 25 Entitlement on issue for Border Rivers Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of total entitlement on issue held by environment (%)
Border Rivers Regulated River Water Source					
General Security A	126	22,027	6%		0%
General Security B	109	241,211	62%	1,683	1%
High Security	11	1,500	<1%		0%
Local water utility	3	620	<1%		0%
Domestic and stock	57	1,001	<1%		0%
Supplementary	129	120,001	31%	1,300	1%
Total	**435**	**386,360**	**100%**	**2,983**	**1%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and data provided by NSW DPI Water.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH).

Entitlement characteristics

Table 26 presents a high-level comparative analysis of the characteristics of each entitlement type.

Table 26 Entitlement characteristics comparison for Border Rivers Catchment water systems

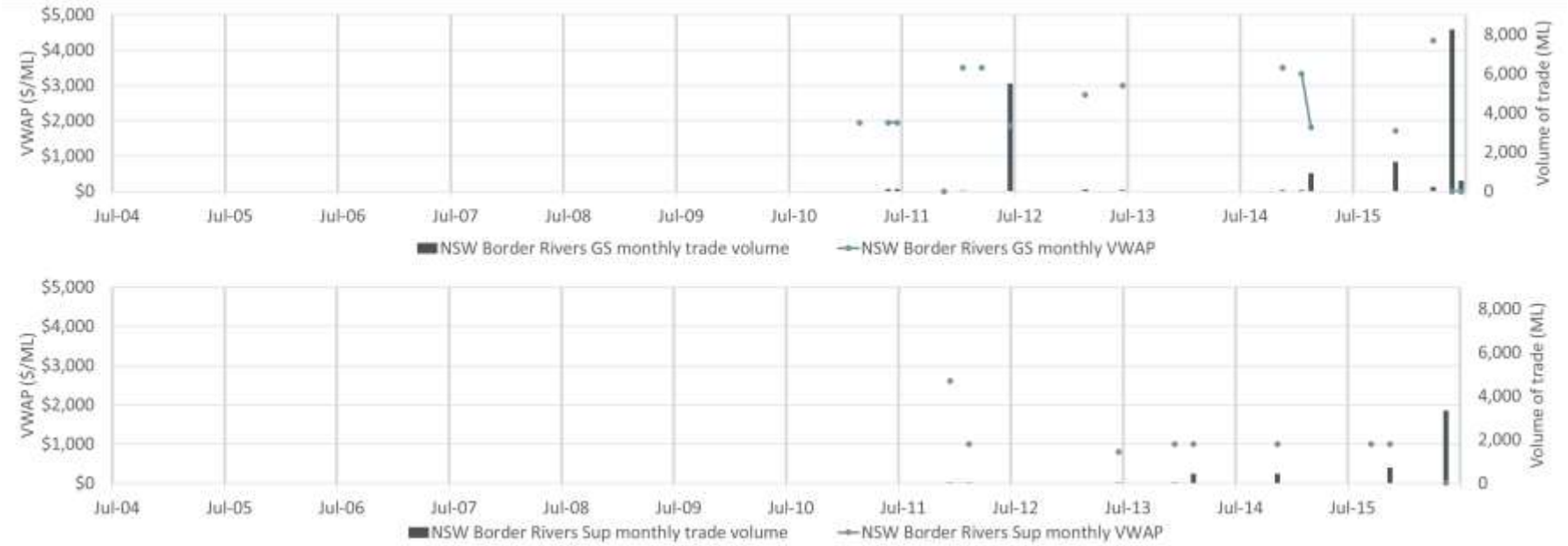
Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Border Rivers Regulated River Water Source					
General Security (A)	Medium	Allocated water after all entitlements, except General Security B	Yes (1 ML per unit share into the next year)	Within: Yes Out of: Restricted	Annual
General Security (B)	Medium	Last entitlement type to be allocated water after all others	Yes (1 ML per unit share into the next year)	Within: Yes Out of: Restricted	Continuous
High Security	High	Allocated water after urban and domestic and stock needs have been secured	No	Within: Yes Out of: Restricted	Annual
Local water utility	High	Allocated before General Security, High Security entitlements	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before General Security, High Security entitlements	No	Within: No Out of: No	Annual
Supplementary	Infrequent	Always allocated at 1 ML per share. Supplementary access announcements permit take during high flow events.	No	Within: Restricted Out of: Restricted	Annual

Source: Aither 2016. Based on Water Sharing Plan for the NSW Border Rivers Regulated River Water Source 2009.

Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

There has been no recorded trade for High Security entitlements in the Border Rivers system. There is more trade recorded for General Security entitlements, however, the infrequency of trade is such that it is difficult to ascertain associated trends (Figure 146). Similarly, Supplementary entitlements are also infrequently traded.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

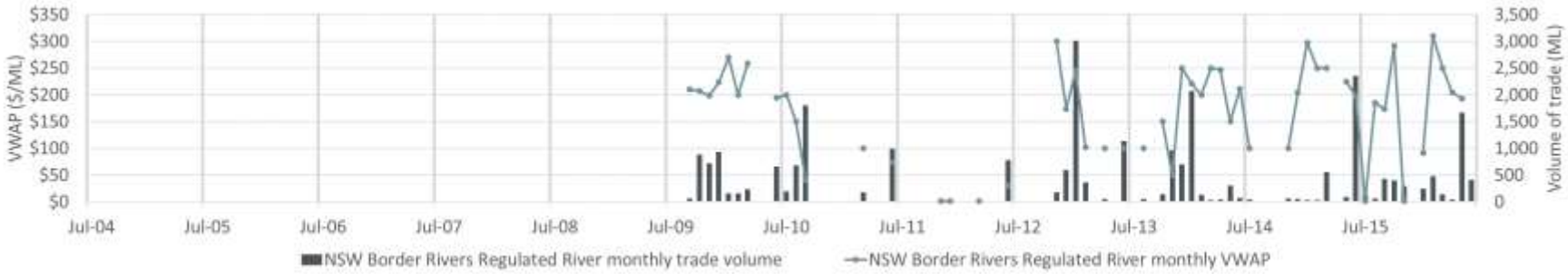
Figure 146 Monthly average General Security and Supplementary entitlements entitlement prices and trade volumes for Border Rivers Regulated River Water Source, 2004–05 to 2015–16

Allocation trade activity

The surface water allocation market in the Border Rivers is active and relatively mature. It is isolated from other New South Wales systems, meaning that allocation trade is not possible between the Border Rivers and other NSW surface water systems.[66] Trade is, however, possible between Queensland and NSW water licence holders.

There have been variable volumes of annual trade in the Border Rivers system since the commencement of the water sharing plan in 2009–10 (Figure 147). Prices for allocation water have varied markedly, peaking at an upper limit above $300 per ML and reaching lows of $100 per ML in 2012–13.

[66] 'Tagged trade' for entitlements occurs between NSW and Queensland Border Rivers. For more information on tagged trade see 'Interstate tagging' NSW DPI Water at http://www.water.nsw.gov.au/water-licensing/dealings-and-trade/interstate-tagging



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 147 Monthly average allocation prices and trade volumes Border Rivers Regulated River Water, 2004–05 to 2015–16

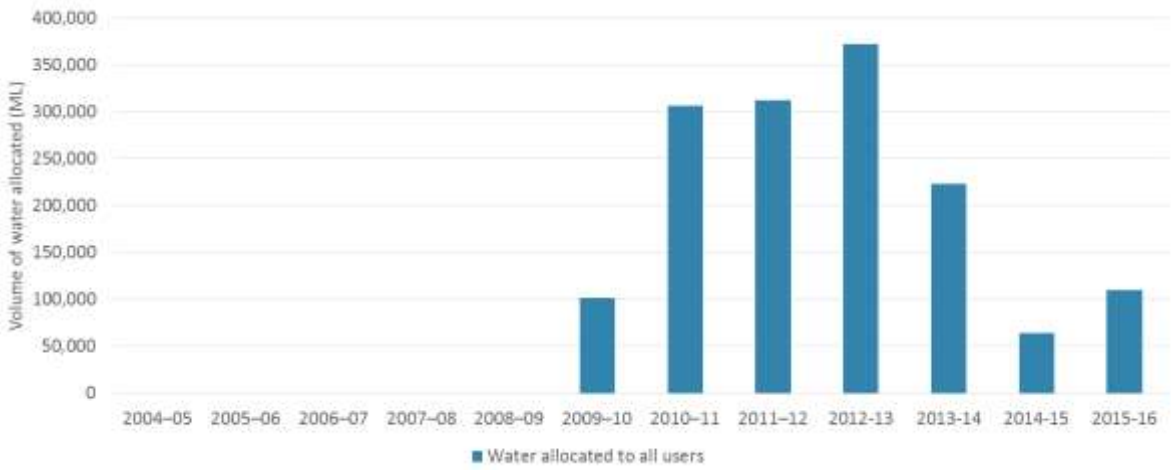
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Border Rivers Catchment, these drivers are explored below.

Allocations to entitlements

Border Rivers Regulated River Water Source

Figure 148 presents the volumes of water allocated to all water users in the Border Rivers from 2004–05 to 2015–16. Data is only available from the commencement of the water sharing plan in 2009–10. Allocations are characterised by relatively low volumes in 2009–10, high volumes from 2010–11 to 2012–13, and declining volumes thereafter.



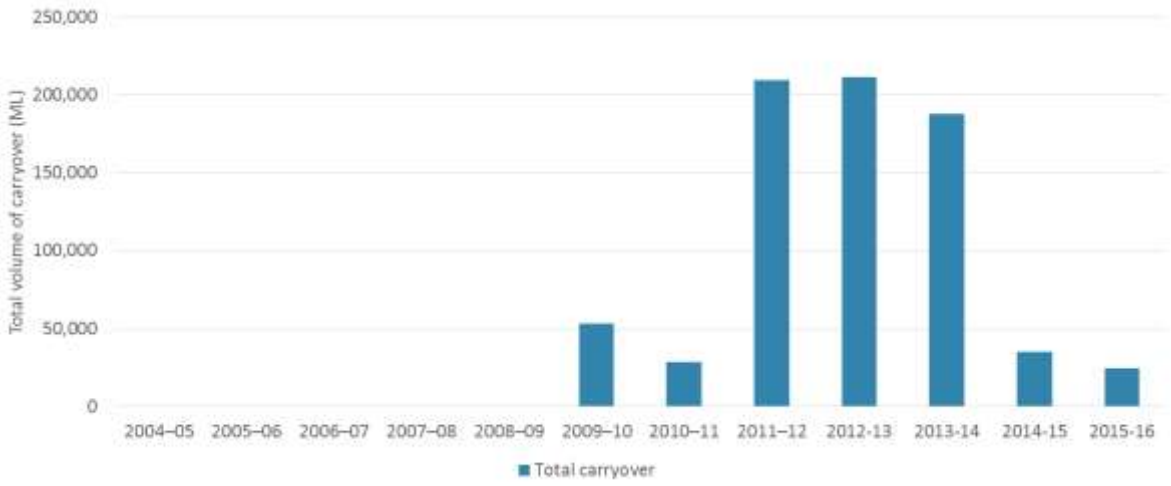
Source: Aither 2016. Based on data provided by NSW DPI Water 2016.

Note: Includes available water determinations (AWD) plus carryover.

Figure 148 Total volume of water allocated to all entitlement types in the Border Rivers, 2004–05 to 2015–16

Carryover

It is only possible for General Security entitlement types in the Border Rivers to carryover water (see Table 25 for a full list of entitlement types). Prior to the commencement of the WSP in 2009–10, there is no carryover recorded in the Border Rivers catchment (Figure 149). Since 2009–10, the average volume of water carried over into the next year under General Security entitlement types is 107,112 ML, which is around 41 per cent of the total available water able to be carried over.



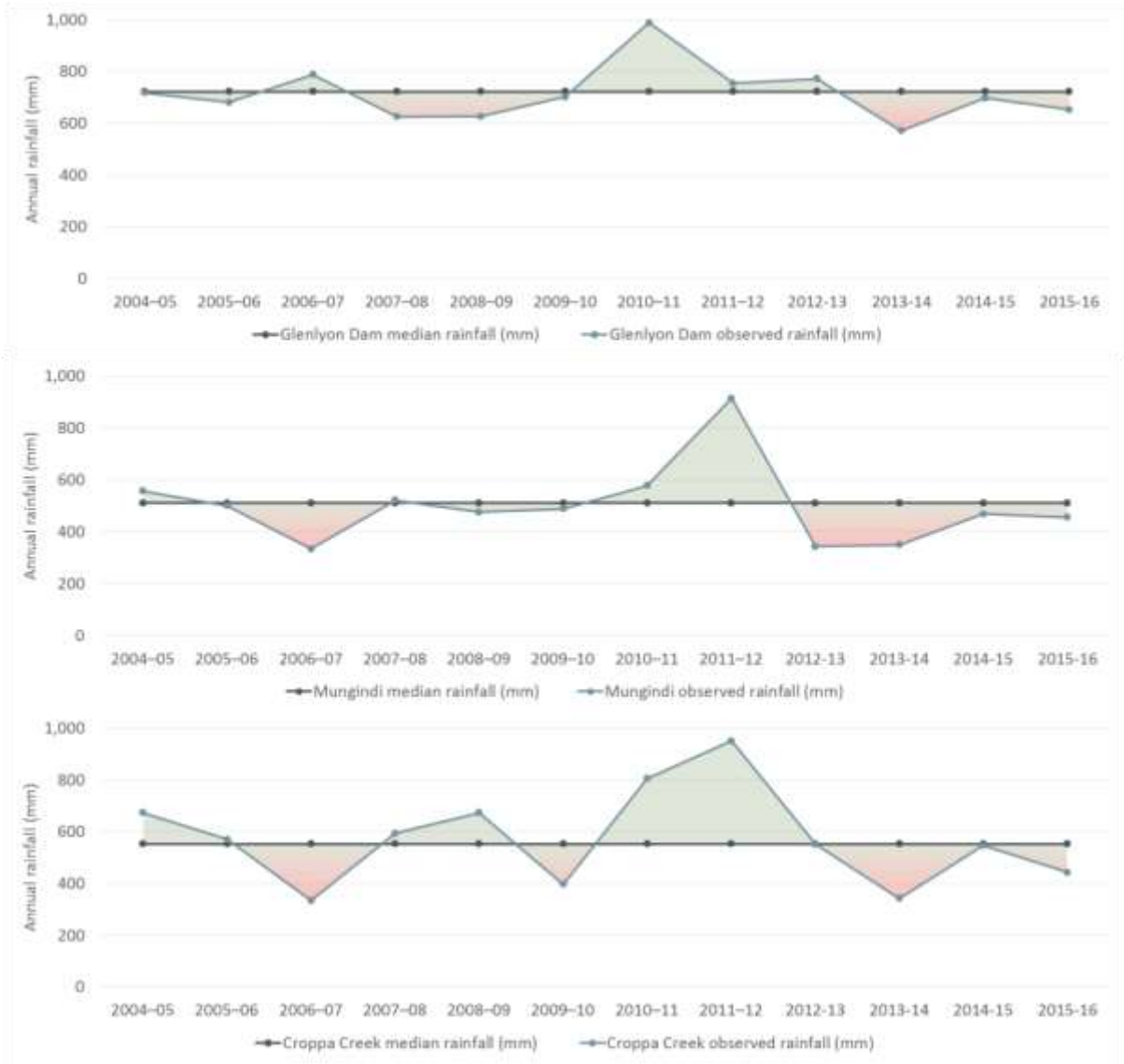
Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes General Security A and B entitlement types as these are the only entitlement types in the Border Rivers which allow carryover. Only data 2004–05 to 2014–15 available in NSW DPI Water accounting data.

Figure 149 Carryover in the Border Rivers Regulated River, 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Border Rivers region given different climatic regions; for example, the median in Glenlyon Dam is over 722 mm per annum compared to 510 mm in Mungindi. Figure 150 presents annual median rainfall in Glenlyon Dam, Mungindi and Croppa Creek from 2004–05 to 2015–16. Annual rainfall between Mungindi and Croppa Creek across this period is correlated – with many of the same years above and below median rainfall. Observed rainfall patterns in Glenlyon Dam are similar to Mungindi and Croppa Creek but not as highly correlated.



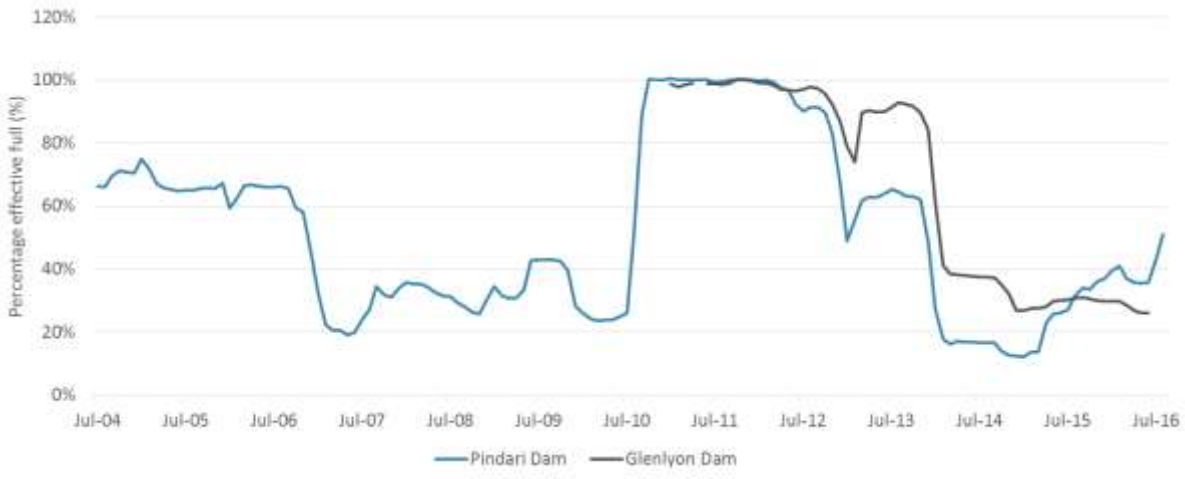
Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 150 Rainfall across the Border Rivers catchment, 2004–05 to 2015–16

Water storages

The two primary water storages in the Border Rivers catchment are Pindari Dam (312 GL) in NSW and Glenlyon Dam (254 GL) in Queensland. Management of these storages effectively regulates the Severn, Dumaresq and Macintyre Rivers. Figure 151 presents changes in storage levels for Pindari and Glenlyon Dam from 2004–05 to 2015–16. Over time storage levels have fluctuated from lower levels during the Millennium Drought to higher levels in the wet years from 2010–11 to 2011–12. Since 2011–12, a downward trend in storage levels with some inter-year variance has been observed.

Use of on-farm storages, which have greater capacity to store water than Glenlyon and Pindari Dams, is also an important supply-side driver of trade in the Border Rivers catchment. While outside the scope of this report, access to water held on privately held on-farm storages may influence the extent to which entitlement holders access the market to secure water for production within season.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016

Note: Storage data for Glenlyon Dam unavailable prior to 2011.

Figure 151 Border Rivers storage levels (Pindari Dam and Glenlyon Dam), 2004–05 to 2015–16

Demand drivers

Changes in irrigated agricultural production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. With reference to the water systems located in the Border Rivers Catchment, these drivers are explored below.

For this regional summary, Aither has compared land use and water use changes in the Border Rivers Catchment between 2007–08 and 2014–15. The 2014–15 ABS water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2014–15 year is the most recently available data, and it has been compared with 2007–08 because that was a similar year in relation to overall water allocations and rainfall, and therefore provides a reasonable comparison regarding how production in the system has changed over time.[67,68]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 152. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the Border Rivers WSP area.[69]

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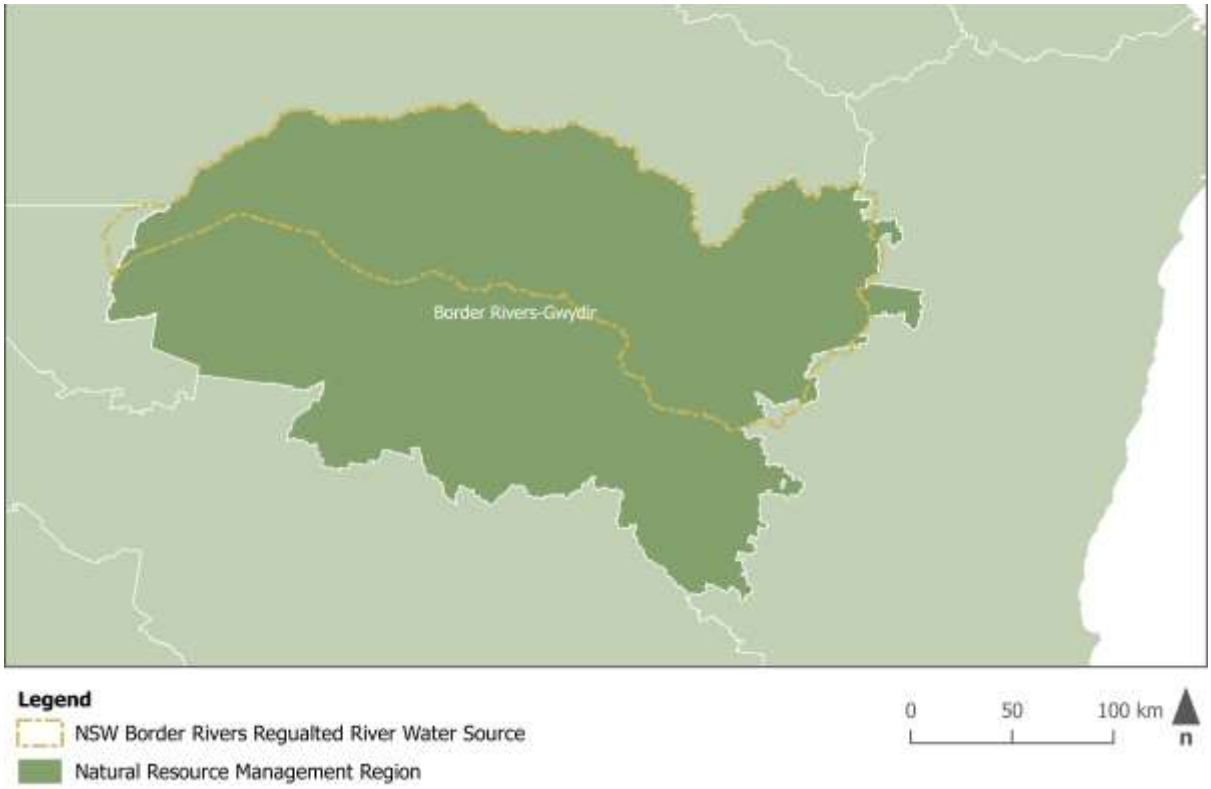
67 While the years presented appear similar at face value, 2007-08 fell in the middle of the Millennium Drought and the majority of water was allocated after the summer planting window had passed, whereas 2014-15 followed a period of four years of high water availability. These differences are significant as land use and water use may be influenced by this. It is not possible to find two years in the time series which are perfectly comparable (including having the same lead in water availability), and so 2007-08 and 2014-15 have been selected as they offer the best comparison available.

68 Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years.

69 At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.



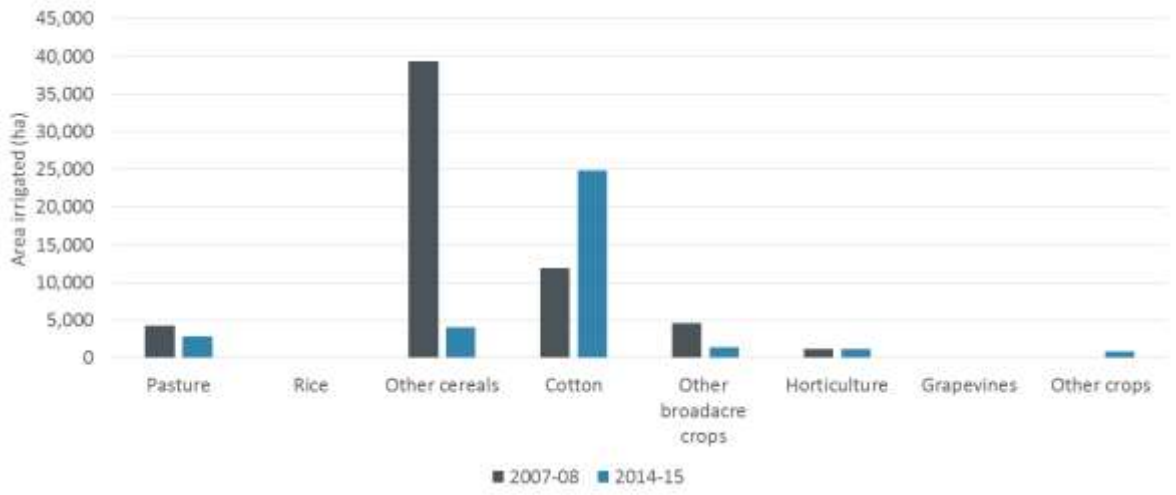
Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 152 Alignment of NRM regions and WSP boundaries – Border Rivers

Land use

There is a significant amount of irrigated agricultural activity in the Border Rivers Catchment, with cotton a major activity, as well as high value horticulture and pasture.

Figure 153 compares land use by irrigated agricultural industries in the Border Rivers for 2007–08 and 2014–15. This analysis reinforces the significance of the irrigated cotton industry. Figure 153 highlights a possible decline in land use for other cereals, pasture and other broadacre crops for the years presented. In contrast, land use for other crops (such as vegetables) appears to have increased slightly while horticulture has remained constant over the period. Feedback from stakeholders suggested that while there appears to have been an increase in land use over time, only the area planted has changed not the developed area, and that this is strongly influenced by water availability at the time of planting.

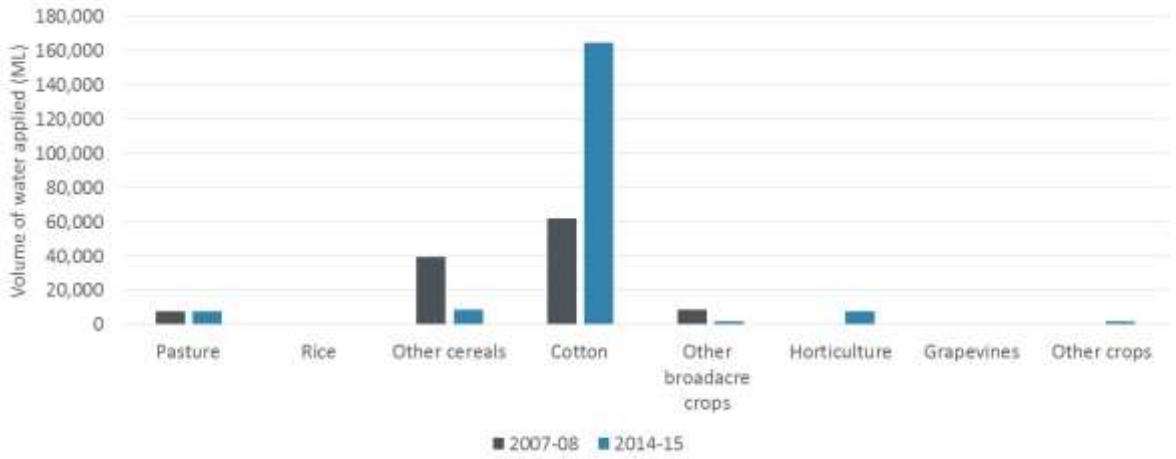


Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 153 Land use by irrigated agricultural industry Border Rivers Catchment, 2007–08 and 2014–15

Water use

Figure 154 compares water use by irrigated agricultural industries in the Border Rivers Catchment for 2007–08 and 2014–15. The analysis suggests that for these years there has been a significant increase in water use by the cotton industry, which aligns with the apparent growth in that area (compare Figure 153). Figure 154 also shows increased water use by horticulture and other crops (such as vegetables). For the years 2007–08 and 2014–15 there appears to have been a decline in water use for other cereals and other broadacre crops. Comparing the two years, water use for pasture is stable.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 154 Water use by irrigated agricultural industry Border Rivers Catchment, 2007–08 and 2014–15

Institutional and policy

Trade rules

Water trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. Most significantly for trade in the Border Rivers region are those rules relating to trade of water between New South Wales and Queensland water holders.

Licences can only be traded between parties within the same State. However, a licence from one State may be linked to a water supply works in the other State.[70]

Other policy issues

The most significant policy issue that impacts trade in the Border Rivers region is related to the Basin Plan and associated water recovery. The Commonwealth Government has previously recovered water for environmental purposes through direct buyback (which occurs through an open tender process) or through on-farm water efficiency infrastructure investments. Stakeholders have suggested that buyback has had an influence in establishing prices for permanent water in a fairly illiquid (and relatively new) market.

Another policy issue in the Border Rivers arises from the complexity of accounting mechanisms and rules governing trade between New South Wales and Queensland water holders. Uncertainty given the complexity of trade may act as a barrier to trade.

[70] Further information can be found in the background document to the Water Sharing Plan for NSW Border Rivers regulated water source http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/546434/wsp_border_rivers_background.pdf

Hunter Catchment

Summary of key drivers

The Hunter Catchment is a coastal system situated east of the Great Dividing Range in eastern New South Wales. The catchment supports a large range of important water users including major water corporations, local councils, power generators, major coal mines, and high-value agriculture.

There is a total of 247,463 ML of water issued to entitlements in the Hunter System. Major Utility (Power Generation) forms a significant portion of the total entitlement on issue (15 per cent). There is no environmental water held via entitlements in the Hunter system, although the water sharing plan for the Hunter contains provisions for environmental water flows.

Entitlement and allocation markets in the Hunter are relatively mature due to the early introduction of the Water Sharing Plan. Entitlement trade is more substantial for General Security than for High Security, Supplementary, and Major Utility (Power Generation) entitlements. Compared with the major connected water markets in NSW, the allocation market in the Hunter River is relatively inactive. For example, the average annual trade volume for the Murrumbidgee system between 2004–05 and 2015–16 is 153,545 ML versus 6,605 ML in the Hunter system.

Water allocations, rainfall, and storages data indicate relatively high availability of water in the Hunter system, despite some natural variation between years.

Irrigated agriculture accounts for 40,429 hectares of land in the Hunter Catchment. Water and land use data suggest that pasture for high-value dairy is the major irrigated agricultural industry, as well as substantial plantings of grapes, horticulture and other crops. Mining is also a significant water user in the Hunter Catchment.

Geographic and hydrological overview

This regional summary focuses on the Hunter Regulated River Water Source and associated water sharing plan located within the Hunter Catchment.

Hunter Regulated River Water Source

The Hunter Regulated River Water Source (the Hunter River) is a regulated surface water system located within the Hunter Catchment, east of the Great Dividing Range in New South Wales (Figure 155). The Hunter River is the most significant river in the catchment and serves a number of large regional towns such as Muswellbrook, Singleton and Maitland, as well as the city of Newcastle.

Beginning in the Mount Royal Range on the Western side of the Barrington Tops, the Hunter River flows east towards its confluence with the sea at Newcastle. The Hunter is regulated by two major headwater storages – Glenbawn Dam and Glennies Creek Dam. The region supports a range of important water users due to its large population and significant industry. Water users include a major water corporation, local councils, power generators that provide the majority of NSW's electricity, major coal mines, and high-value agriculture. The Kooragang Nature Reserve, Hexam Swamp, the upland swamps of Barrington Tops and the Shortland Wetlands Centre provide nationally or internationally significant waterbird habitat.

Source: NSW DPI Water 2016.

Figure 155 Hunter Catchment – Hunter Regulated River Water Source

Water entitlements

Entitlements on issue

Table 27 summarises entitlement on issue for the water systems covered by this regional summary. Surface water entitlements are dominated by General Security. There is no environmental water held via entitlements in the Hunter system, although the water sharing plan for the Hunter contains provisions for environmental water flows.

Table 27 Entitlement on issue for Hunter Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of total entitlement on issue held by environment (%)
Hunter Regulated River Water Source					
General Security	809	128,544	52%	0	0
High Security	151	21,740	9%	0	0
Local water utility	5	10,832	4%	0	0
Domestic and stock	248	1,828	1%	0	0
Major Utility (Power Generation)	1	36,000	15%	0	0
Supplementary	241	48,519	20%	0	0
Total	**1,455**	**247,463**	**100%**	**0**	**0**

Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: 1) Entitlement on issue figures are accurate to July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH).

Entitlement characteristics

Table 28 presents a high-level comparative analysis of the characteristics of each entitlement type.

Table 28 Entitlement characteristics comparison for the Hunter Catchment water system

Entitlement type	Reliability	Allocation approach	Carryover	Tradability	Accounting approach
Hunter Regulated River Water Source					
General Security	Medium	Last entitlement type to be allocated water after all others	Yes (up to 25% of entitlement volume from year to year)	Within: Restricted Out of: No	Annual[1]
High Security	High	Allocated water after urban and domestic and stock needs have been secured	Yes (up to 25% of entitlement volume from year to year)	Within: Restricted Out of: No	Annual
Local water utility	High	Allocated before General Security, High Security entitlements	No	Within: Restricted Out of: No	Annual
Domestic and stock	High	Allocated before General Security, High Security entitlements	No	Within: No Out of: No	Annual
Major Utility (power generation)	High	First entitlement type to be allocated water	Yes (up to 32,400 ML into the next year provided Glenbawn Dam has more than 25% water in conservation storage)[2]	Within: Restricted Out of: No	Annual
Supplementary	Infrequent	Always allocated at 1 ML/share. Supplementary access announcements permit take during high flow events.	No	Within: Restricted Out of: No	Water cannot generally be stored

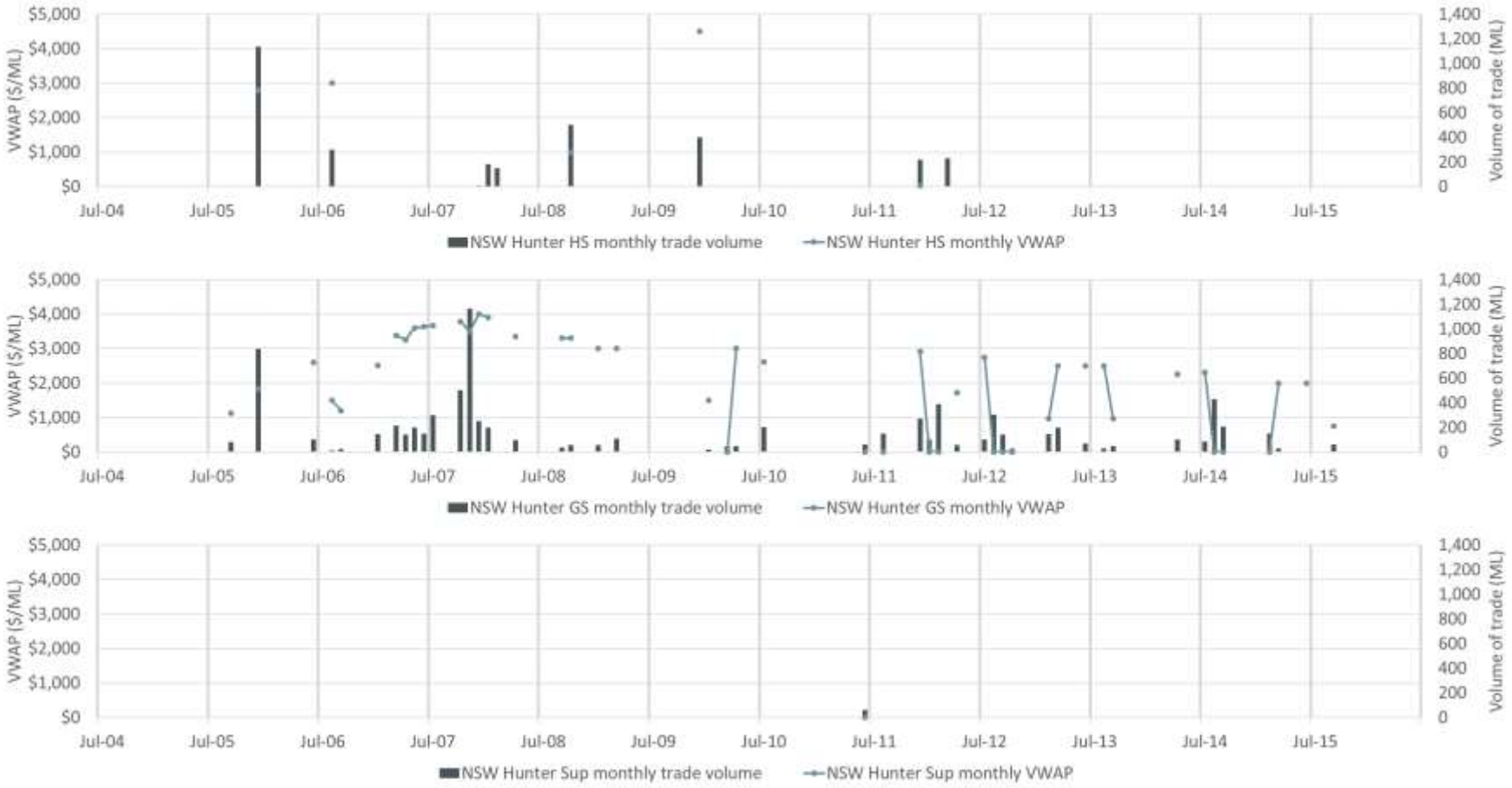
Source: Aither 2016. Based on Water Sharing Plan for the Hunter Regulated River Water Source 2016.

Note: 1) Uncontrolled flow is non-debit water accessible during supplementary flow events in periods of low allocations. Rules in water sharing plan, linked to allocation levels, define when uncontrolled flow taken converts to debit water against General Security accounts. 2) For Major Utility licences held in the Barnard River Scheme, 100% of entitlement can be carried forward to the next year.

Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

High Security entitlements in the Hunter River are infrequently traded and generally command relatively higher prices (Figure 156). In comparison, General Security entitlements in the Hunter River are traded more frequently but command a lower price. Supplementary entitlements are also infrequently traded, such that it is difficult to ascertain any associated trends. There have not been any recorded commercial trades of local water utility or Major Utility (power generation) entitlements.



Source: Aither 2016. Based on New South Wales Water Register 2016.

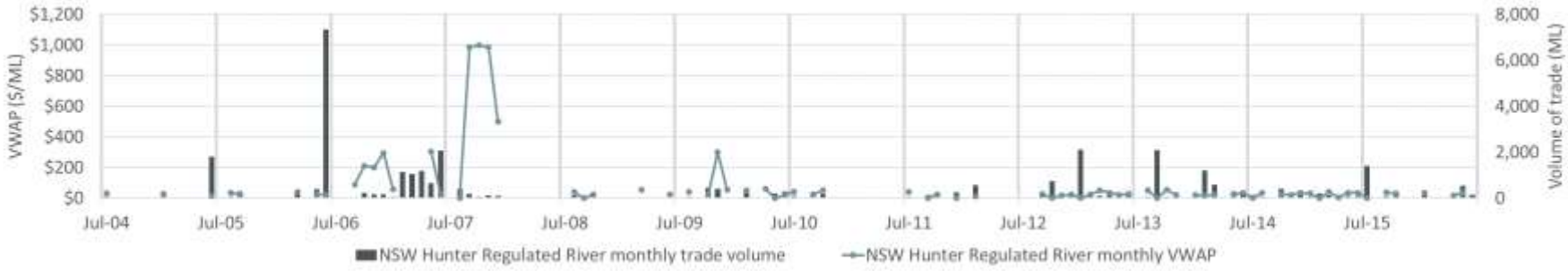
Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades.

Figure 156 Monthly average High Security, General Security and Supplementary entitlement prices and trade volumes Hunter Regulated River Water Source, 2004–05 to 2015–16

Allocation trade activity

Compared with the major connected water markets in NSW (i.e. the southern MDB), the surface water allocation market in the Hunter River is relatively inactive even though it is relatively mature (trade has been possible for some time due to the early introduction of the WSP). For example, the average annual trade volume for the Murrumbidgee system between 2004–05 and 2015–16 is 153,545 ML vs. 6,605 ML in the Hunter system. The Hunter is not connected to other major surface water systems which contribute to lesser opportunities for trade.

There have been limited volumes of annual trade recorded over the past ten years (Figure 157). Greater volume of trade is observed for the years 2012–13 to the present. Prices for allocation water in the Hunter have remained low and relatively consistent since 2004–05, excluding a significant spike of $1000 per ML in 2007–08.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 157 Monthly average allocation prices and trade volumes Hunter Regulated River Water Source, 2004–05 to 2015–16

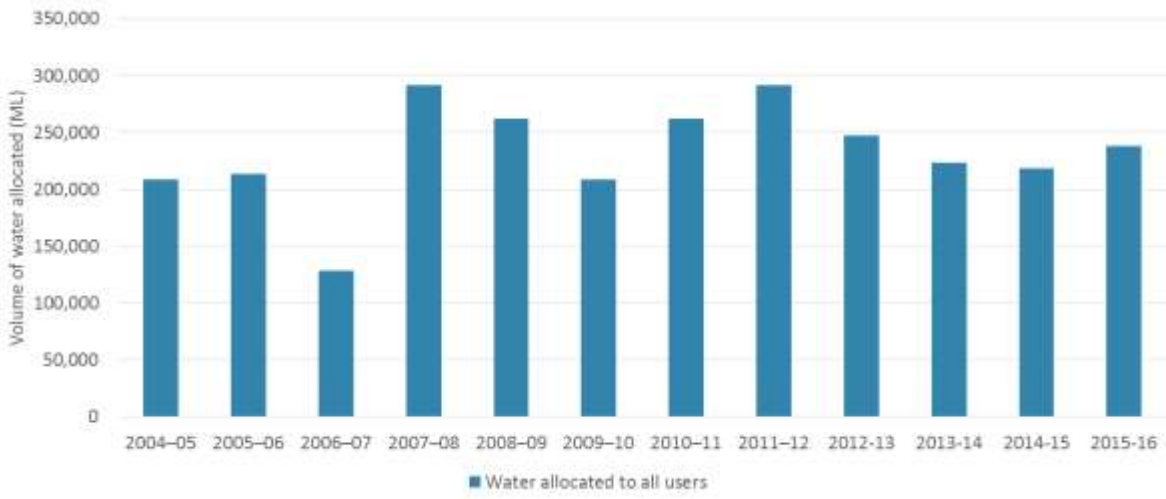
Supply drivers

The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Hunter Catchment, these drivers are explored below.

Allocations to entitlements

Hunter Regulated River Water Source

Figure 158 presents the volumes of water allocated to all water users in the Hunter River from 2004–05 to 2015–16. Allocations are characterised by lower volumes from 2004–05 to 2006–07, higher volumes from 2007–08 to 2011–12, and declining volumes thereafter. Overall since 2007–08 allocation volumes have been relatively stable.



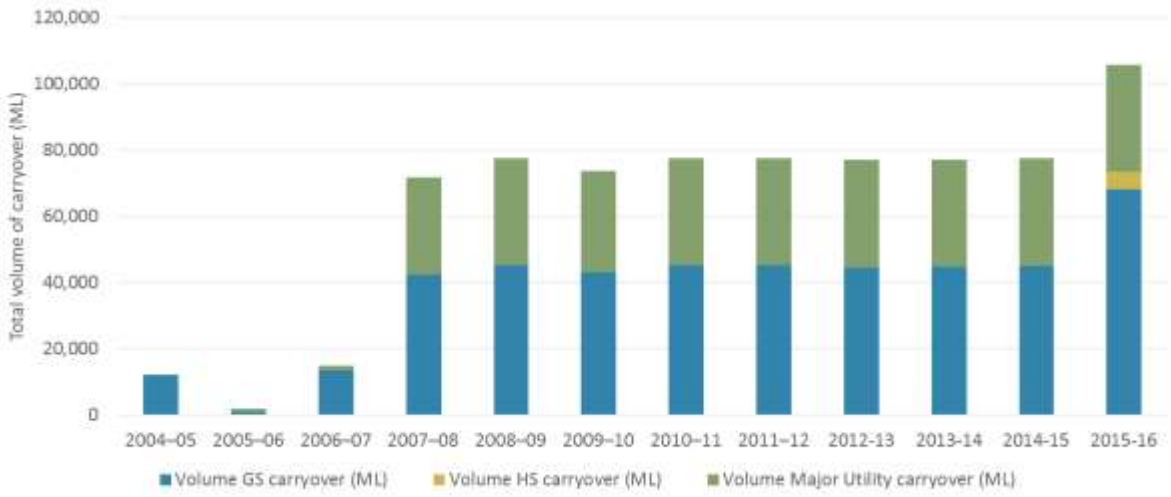
Source: Aither 2016. Based on data from NSW DPI Water 2016.

Note: Includes only AWD amounts, does not include carryover.

Figure 158 Total volume of water allocated to major entitlement types in the Hunter River, 2004–05 to 2015–16

Carryover

General Security, High Security and Major Utility entitlement types are able to carryover water in the Hunter (see Table 27 for a full list of entitlement types). Despite carryover being permitted against High Security entitlement types, carryover for these entitlement types is only recorded for 2015–16 (Figure 159). Since 2004–05, owners of General Security entitlement types have on average carried over 37,450 ML of water into the following water year. Between 2007–08 and 2015–16, average annual carryover in the Hunter system has increased to 47,000 ML. Since 2010–11 the volume of carryover for Major Utility entitlement types has remained stable.



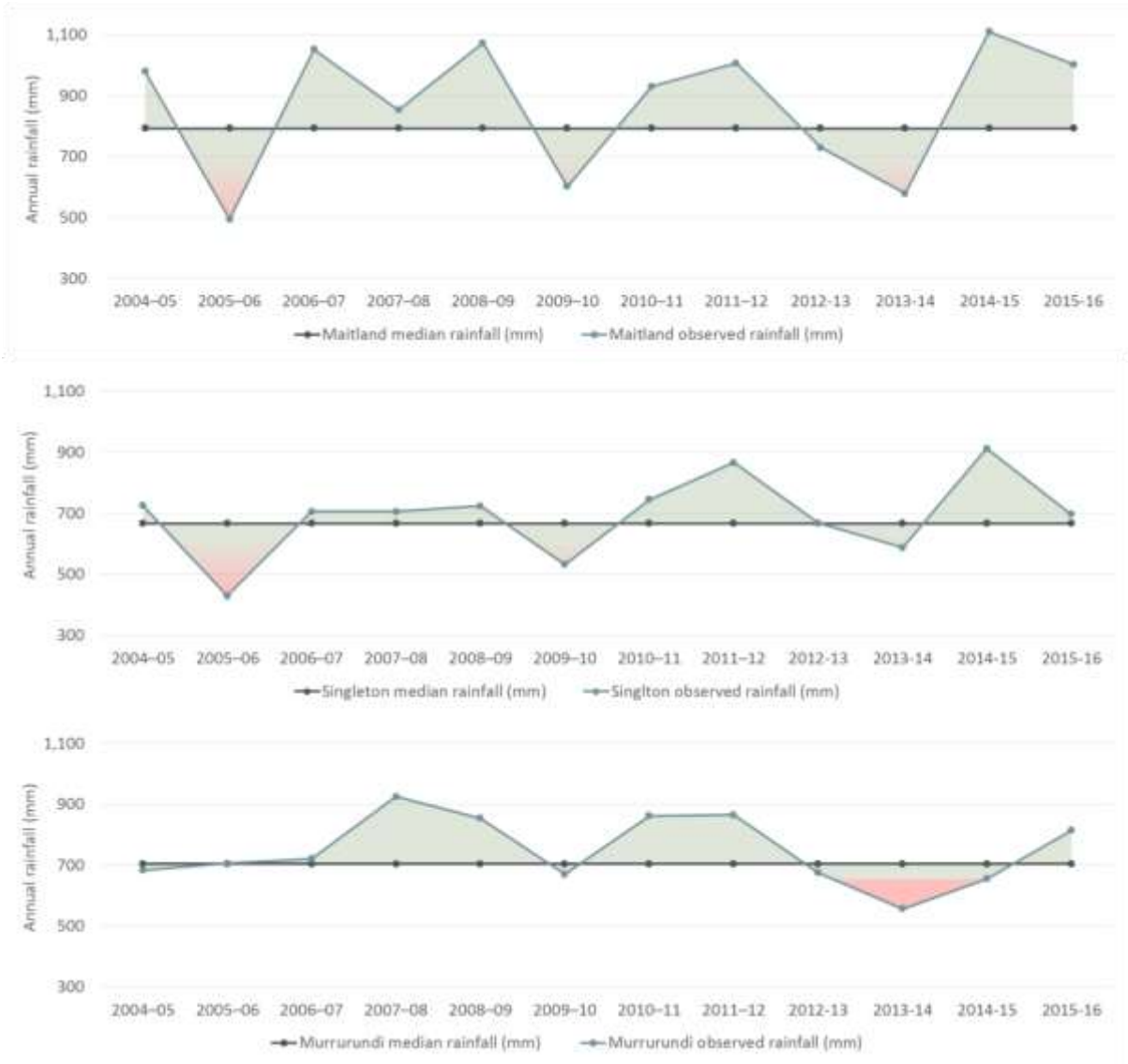
Source: Aither 2016. Based on data from NSW DPI Water 2016.

Notes: Only includes General Security, High Security and Major Utility entitlement types as these are the only entitlement types in the Hunter which allow carryover.

Figure 159 Carryover in the Hunter Regulated River, 2004–05 to 2015–16

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Hunter region given different climatic regions; for example, the median around Maitland is over 790 mm per annum compared to 665 mm in Singleton. Figure 160 presents annual median rainfall in Maitland, Singleton, and Murrurundi from 2004–05 to 2015–16. Annual rainfall between Maitland and Singleton across this period is highly correlated – with the same years above and below median rainfall. However, there is some variation in the proximity of observed rainfall with the median. Observed rainfall patterns in Murrurundi are similar to Maitland and Singleton but not as highly correlated.



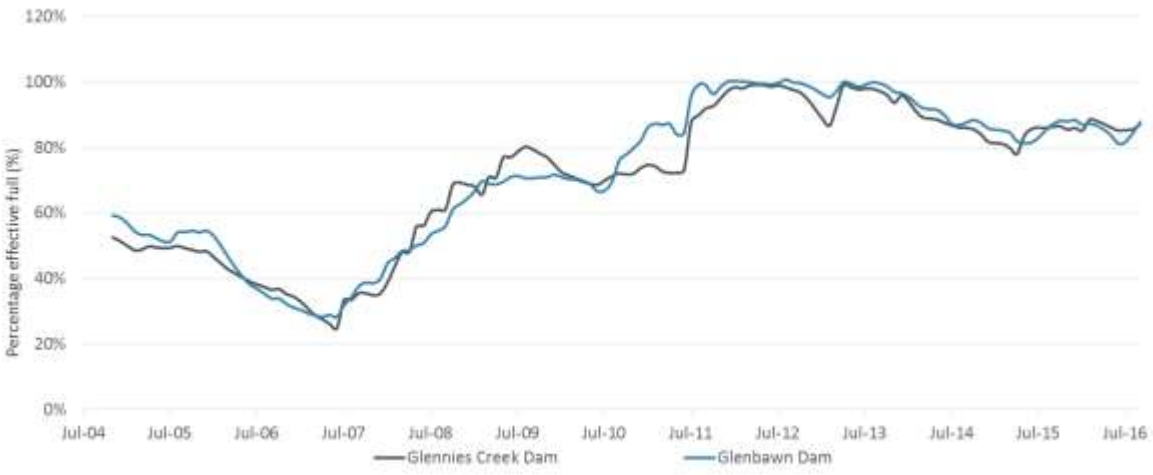
Source: Aither 2016. Based on Bureau of Meteorology 2016.

Note: Due to incomplete data, monthly observed rainfall has been calculated using the monthly median.

Figure 160 Rainfall across the Hunter Catchment, 2004–05 to 2015–16

Water storages

The two primary water storages in the upper catchment of the Hunter River are Glenbawn Dam (750 GL) and Glennies Creek Dam (283 GL). Management of the storages effectively regulate the Hunter River. Figure 161 presents changes in storage levels for Glenbawn and Glennies Creek Dam from 2004–05 to 2015–16. Over time storage levels have fluctuated from lower levels during the Millennium Drought to higher levels in the wet years from 2010–11 to 2012–13. Since 2011–12, the storage has experienced a slight downward trend. However, it remains in the upper range of capacity.



Source: Aither 2016. Based on New South Wales Department of Primary Industries 2016.

Figure 161 Hunter storage levels (Glennies Creek Dam and Glenbawn Dam), 2004–05 to 2015–16

Demand drivers

Changes in irrigated agricultural production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types. With reference to the water systems located in the Hunter Catchment, these drivers are explored below.

For this regional summary, Aither has compared land use and water use changes in the Hunter Catchment between 2005–06 and 2014–15. The 2014–15 ABS water use on Australian farms is the only reliable and public dataset that enables such a comparison. The 2014–15 year is the most recently available data, and it has been compared with 2005–06 because that was a similar year in relation to water allocations and rainfall, and therefore provides a reasonable comparison regarding how production in the system has changed over time.[71,72]

The ABS data is aggregated by Natural Resource Management (NRM) regions. These regions do not align directly with the Water Sharing Plan boundaries, as shown in Figure 162. Therefore, care must be taken when considering the ABS data as an indication of the drivers of water market outcomes in the Hunter WSP area.[73]

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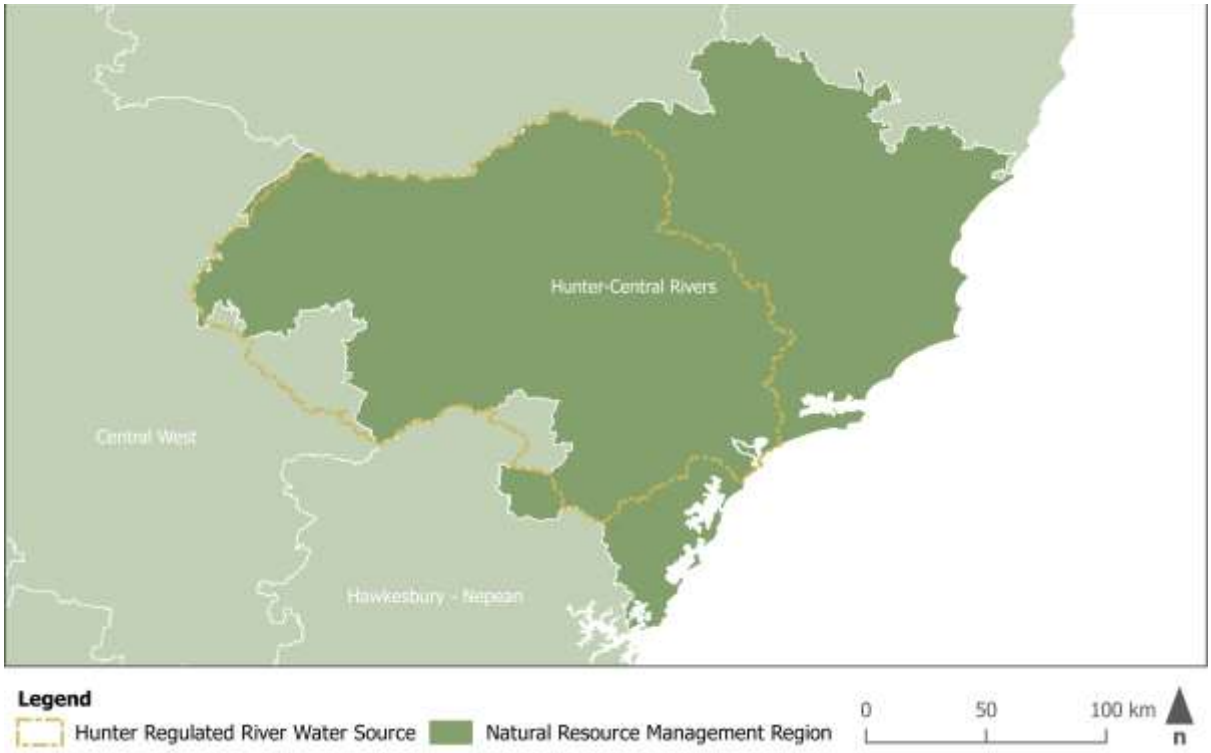
71 While the years look similar at face value there are some differences that will influence these figures. 2005-06 followed a period of variable rainfall and lower storages levels. 2014-15 followed a period with high levels of water in storages but variable rainfall. These differences are significant as land use and water use may be influenced by this. It is not possible to find two years in the time series which are perfectly comparable (including having the same lead in water availability), so 2005-06 and 2014-15 have been selected as they offer the best comparison available.

72 Time series data for land and water use has not been presented due to the complexity and time taken to adjust the ABS data for changes in sampling methodology that have been used by the ABS for different years.

73 At the time of writing there were no viable alternative options to this approach. An alternative approach, would be to utilise geocoded agricultural census data aggregated by WSP boundaries, but this information was not available at the time of writing.



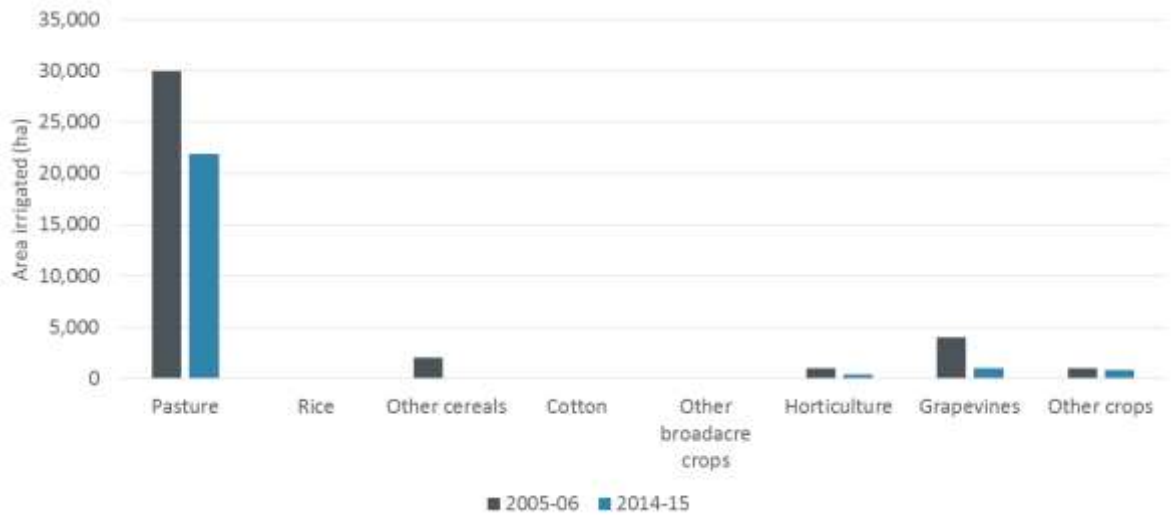
Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 162 Alignment of NRM regions and WSP boundaries – Hunter

Land use

Irrigated agriculture accounts for 40,429 hectares of land in the Hunter Catchment and constitutes a significant activity. Pasture supports high-value dairy industries, and there are also substantial plantings of grapes, high-value horticulture, and other crops.

Figure 163 compares land use by irrigated agricultural industries in the Hunter for 2005–06 and 2014–15. This analysis suggests some declines in certain industries over the past decade such as irrigated pasture. Plantings of grapevines and other cereals also appear to have contracted for the decade. There appears to have been a more marginal decrease in land use by horticulture for the two years, while land use for other crops (such as vegetables) is relatively stable.

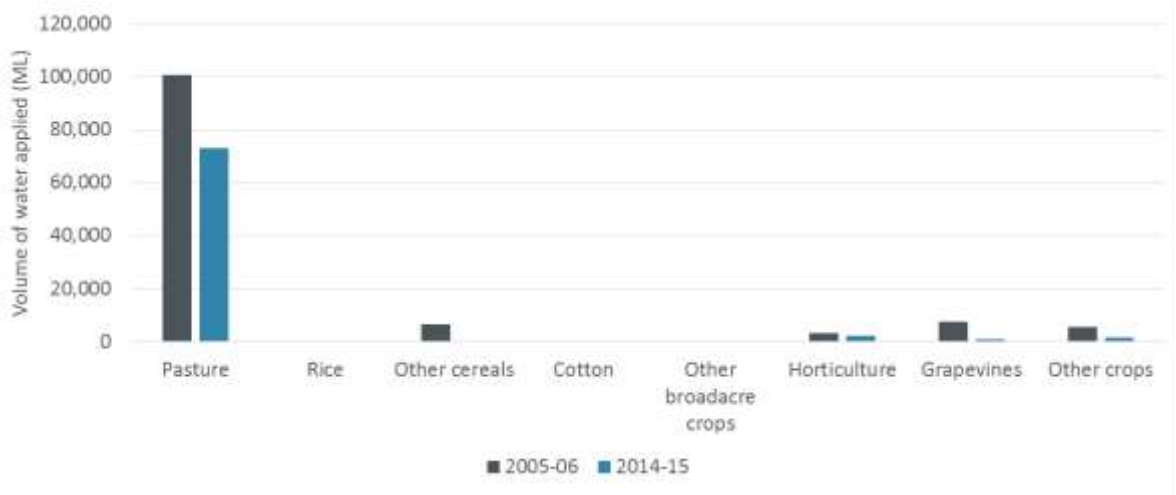


Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 163 Land use by irrigated agricultural industry Hunter Catchment, 2005–06 and 2014–15

Water use

Figure 164 compares water use by irrigated agricultural industries in the Hunter Catchment for 2005–06 and 2014–15. This suggests that between these years there has been a significant reduction in water use by irrigated pasture producers, but that pasture is still the largest water user. Figure 164 also highlights possible reductions in water use across other cereals, grapevines and other crops (such as vegetables), which aligns with an apparent reduction in the area irrigated of those industries (compare to Figure 163). Comparing the two years, water use by horticulture is relatively stable.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

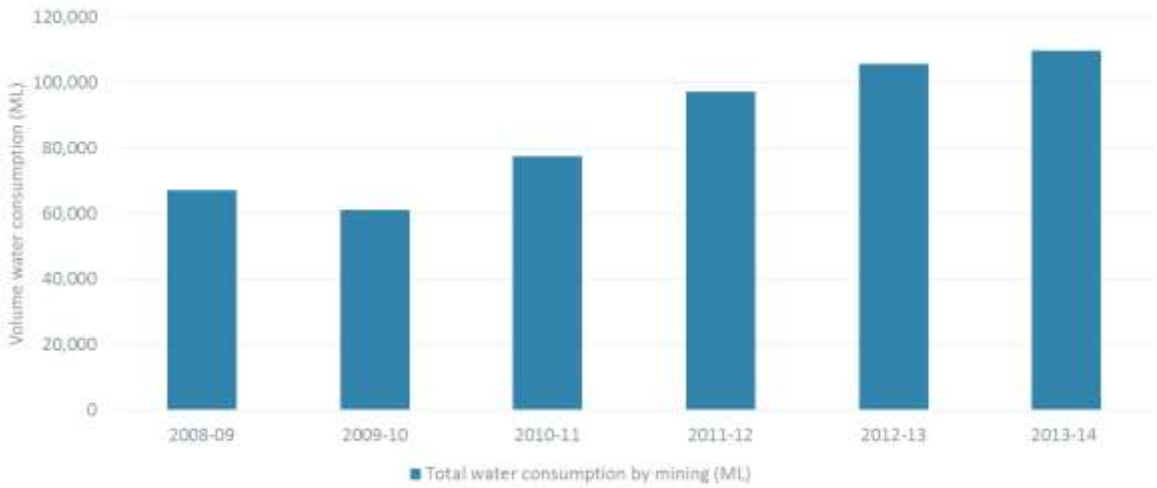
Figure 164 Water use by irrigated agricultural industry Hunter Catchment, 2005–06 and 2014–15

Mining

Mining industries are significant water users in NSW, particularly in the Hunter region, where there is considerable interests extracting coal for export and domestic consumption. The ABS Water Account

Australia dataset provides up to date public information about water usage in NSW. Comparing the total volumes of water consumed by mining industries during the years 2008–09 to 2013–14 provides a reasonable insight into the extent of water usage at the state level. Data in this dataset is not broken down to the regional or catchment level, so it is not possible to make precise observations about the demands on water mining industries in the Hunter catchment.

Figure 165 presents water consumption by mining industries in NSW between 2008–09 and 2013–14. Consumption by mining has increased year on year from 2009–10 from 61,040 GL to 109,729 GL.



Source: Aither 2016. Based on Australian Bureau of Statistics 2016.

Figure 165 Water consumption by mining industries, NSW, 2008–09 to 2013–14

Institutional and policy

Trade rules

Trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. The following section outlines rules of particular significance in the Hunter region.[74] These rules are in place to protect environmental values and existing licence holders.

Access licences and water allocations may only be traded within the Hunter Regulated River Water Source. Total extractions from the Hunter River Regulated Water Source upstream of Glennies Creek junction is capped and trade may only occur if it does not result in this cap being exceeded.[75] These restrictions create an isolated trading zone with restrictions within that zone, which means that the potential gains from interzone trades cannot be realised.

Conversions between General Security and High Security access licences are permitted. However, these dealings are subject to conversion factors and other rules to protect other existing access licences.[76]

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[74] This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

[75] For further information, refer to A guide to the Water Sharing Plan for the Hunter Regulated River Water Source (http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/548108/hunter_reg_guide.pdf)

[76] For further information, refer to A guide to the Water Sharing Plan for the Hunter Regulated River Water Source (http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/548108/hunter_reg_guide.pdf)

Other policy issues

A potentially significant policy issue in the Hunter region relates to the shift in water access licence ownership from agricultural interests to mining interests. Aither understands that mining interests may hold the majority of High Security entitlements in the Hunter region, which means there may be a greater reliance on General Security water for agricultural enterprises and other mining interests that have not secured High Security water entitlements. Reliance on General Security entitlements may present a considerable risk for certain businesses during periods of low water availability, where they may not be able to access water allocations. Additionally, the high capacity of mining interests to pay for High Security water, and their unwillingness to sell High Security water may influence prices and prevent substantive reallocation. Overall, this may have wider impacts on the nature and distribution of water using industries in the region.

If there are restrictions associated with allocation trade for unused water held by Major Utility (power generation) licensees, this could be an important policy issue. For example, if power generators hold large volumes of special purpose entitlements but cannot trade the allocations (assuming they are surplus to their needs) this limits other industries from using that water (essentially ensuring forfeiture of any unused water) and would act as a supply constraint, thereby increasing allocation prices.

Barwon-Darling Catchment

Summary

The Barwon-Darling Catchment covers a large area spanning from north-western New South Wales to south-western New South Wales. The water source covered by this regional summary is the Barwon-Darling Unregulated River Water Source that constitutes Barwon and Darling Rivers north of the Menindee Lakes Scheme. Flowing south-west, the Barwon-Darling provides the only connection between the northern and southern MDB.

There is a total of 196,499 ML of water issued to entitlements in the Barwon-Darling (the amount is closer to around 189,000 ML when including only irrigation water). Water entitlements are dominated by Unregulated B Class entitlement types, a substantial proportion of which is held by the environment (13 per cent). As water is shared based on flow conditions for unregulated systems, basic water for the environment is also provided for by access conditions under the water sharing framework.

Due to the recent introduction of the Water Sharing Plan for the Barwon-Darling (2012), water markets in the Barwon-Darling are relatively less mature, but trades have occurred (low in frequency, but involving large volumes). Stakeholders have suggested there is some anecdotal evidence of a recent gradual increase in trade, and that this may be driven by small to medium irrigators trading out of the market and the market consolidating amongst larger users.

Rainfall data across the catchment is variable – ranging from 580 mm per annum in Collarenebri to 249 mm in Wilcannia. Rainfall data recorded for the period 2004–05 to 2015–16 suggests drying to drought conditions with flooding in 2010–11to 2011–12. Continuing the trend of high variability, the 2016 winter saw very wet conditions.

Agricultural activity in the Barwon-Darling is primarily beef and sheep grazing on pastoral land. A small amount of irrigated production (mostly cotton) occurs on the western plains next to the river.

Geographic and hydrological overview

The main surface water source located within the Barwon-Darling Catchment that is the focus of this regional summary is the Barwon-Darling Unregulated River Water Source. Management of water in the catchment is provided for by the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources. Due to no recorded trade in the Upper Darling Alluvial Groundwater Source, that water source is omitted from this regional summary.

The Barwon-Darling Unregulated River Water Source is an unregulated system. Due to differences between the way that regulated and unregulated systems are managed and operated, and the impact that this has on trade, some of the content in this regional summary differs from the information presented for the regulated systems that were prepared for this report.

Barwon-Darling Regulated River Water Source

The Darling River is the longest River in Australia, flowing 2,750 km from the Great Dividing Range in southern Queensland and north-western New South Wales to its junction with the Murray in south-western New South Wales. The information in this regional summary focuses on the unregulated section of the upper catchment comprising the Barwon and Darling Rivers (Figure 166). The Barwon-

Darling Unregulated River Water Source (the Barwon-Darling River) is formed by the junction of the Macintyre and Weir Rivers upstream of Mungindi. Major tributaries flowing into the Barwon-Darling include the Gwydir, Namoi, Macquarie, Culgoa and Bogan Rivers. Flowing south-west, the Barwon-Darling provides the only connection between the northern and southern MDB. The River supports a number of regional centres including Bourke, Brewarrina and Walgett.

The catchment can be divided into three distinct geomorphic reaches. The Barwon River flows south-west through a narrow floodplain with a tightly meandering channel from Mungindi to Walgett. Downstream of Walgett the river flows unrestricted across a wide alluvial floodplain including many anabranches and effluent channels. Above Bourke, the Barwon merges with the Culgoa River to become the Darling River. From Bourke, it flows through a deeply incised channel and narrow floodplain towards Wilcannia. Water flows in the system are highly variable, due to inflows from various tributaries throughout southern Queensland and north-western New South Wales.

Elevation of the Barwon-Darling is mostly below 110 meters above sea level, flowing over a low gradient across the entire length of the system. Major water users on the Barwon-Darling include town water supply and some irrigation, mainly for cotton. Nationally important environmental values are also upheld by the system, including Talyawalka Lakes, which is a series of 19 large overflow lakes that provide important waterbird habitat when full.

Source: NSW DPI Water

Figure 166 Barwon-Darling catchment – Barwon-Darling Unregulated River Water Source

Water entitlements

Entitlements on issue

Table 29 summarises entitlement on issue for the water systems covered by this regional summary (current as at 2016–17). Total surface water entitlements are dominated by Unregulated B Class entitlement types, a substantial proportion of which is held by the environment (13 per cent). There is also a significant amount of Unregulated C Class entitlements, which are permitted to pump when the river is in higher flow.

Table 29 Entitlement on issue for Barwon-Darling Catchment water systems, 2016–17

Entitlement type	Number of entitlements	Total volume of entitlement on issue (ML)[1]	Proportion of total entitlement on issue (%)	Environmental water holdings (ML)[2]	Proportion of entitlement on issue held by environment (%)
Barwon-Darling Unregulated River Water Source					
Domestic and stock	20	968	0.5%		
Local Water Utility	7	5,373	3%		
Unregulated River	1	1,488	1%	1,488	1%
Unregulated River (A Class)	114	9,856	5%	264	0.1%
Unregulated River (B Class)	83	133,069	68%	26,400	13%
Unregulated River (C Class)	15	45,746	23%		
Total	**240**	**196,499**	**100%**	**28,152**	**14%**

Source: Aither 2016. Based on New South Wales Water Register 2016 and information provided by NSW DPI Water 2016.

Note: 1) Entitlement on issue figures are accurate as at July 2016. 2) Environmental water includes both water secured through water savings initiatives and water purchased by the Commonwealth Environmental Water Holder (CEWH) and New South Wales Office of Environment and Heritage (OEH).

Entitlement characteristics

Table 30 presents a high-level comparative analysis of the characteristics of each entitlement type.

Table 30 Entitlement characteristics comparison for Barwon-Darling Catchment

Entitlement type	Reliability[1]	Access conditions[2]	Carryover	Tradability	Accounting approach[3]
Barwon-Darling Unregulated River Water Source					
Domestic and stock	High	Can access water under all but the direst flow conditions	No	Within: Restricted Out of: No	Annual
Local Water Utility	Very high	Can access water under extremely low flows. Has priority of access.	No	Within: Restricted Out of: No	Annual
Unregulated River (A Class)	Medium-high	Can access water under low flows	Unlimited	Within: Restricted Out of: No	Continuous
Unregulated River (B Class)	Medium	Can access water under low to moderate flows	Unlimited	Within: Restricted Out of: No	Continuous
Unregulated River (C Class)	Low	Can access water under moderate to high flows	Unlimited	Within: Restricted Out of: No	Continuous

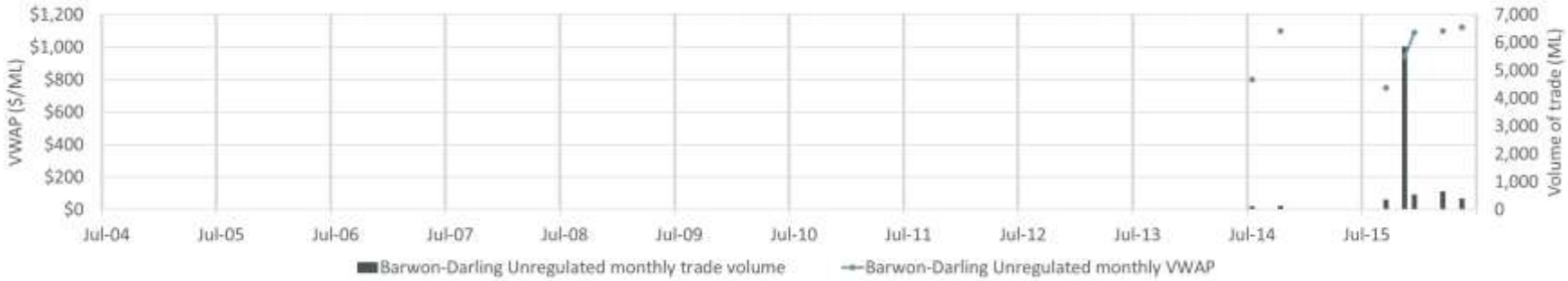
Source: Aither 2016. Based on the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources.

Note: 1) Reliability for unregulated river systems is based on certain flow conditions, where highest reliability is permitted to extract water under the broadest spectrum of flow conditions (i.e. high reliability entitlements are allowed to pump except when flow is extremely low). Lower reliability entitlements can only extract water when flow is high. 2) Unregulated river access licences within the Barwon-Darling may access flows at or above their relevant flow class only. (E.g. A class access licences can access A, B and C class flows). 3) Unregulated River Class (A, B & C) have 300 per cent annual use limit and 100 per cent annual AWD limit.

Trade activity

Entitlement trade activity (assignments of share and transfer of licence)

There has been limited trade in the Barwon-Darling entitlement market since the commencement of the WSP for the Barwon-Darling Unregulated and Alluvial Water Sources (Figure 167). Price and volume of trade varies greatly, such that it is not possible to derive any specific market trends.



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades. This analysis only includes 71Q trades, but includes trade of all unregulated entitlement types given the low number of trades. 71Q trades are relevant for the water sharing plan period only. The WSP in the Barwon-Darling started in 2012 which is why there is no data in the period from 2004.

Figure 167 Monthly average entitlement prices and trade volumes Barwon-Darling Unregulated River Water Source, 2004–05 to 2015–16

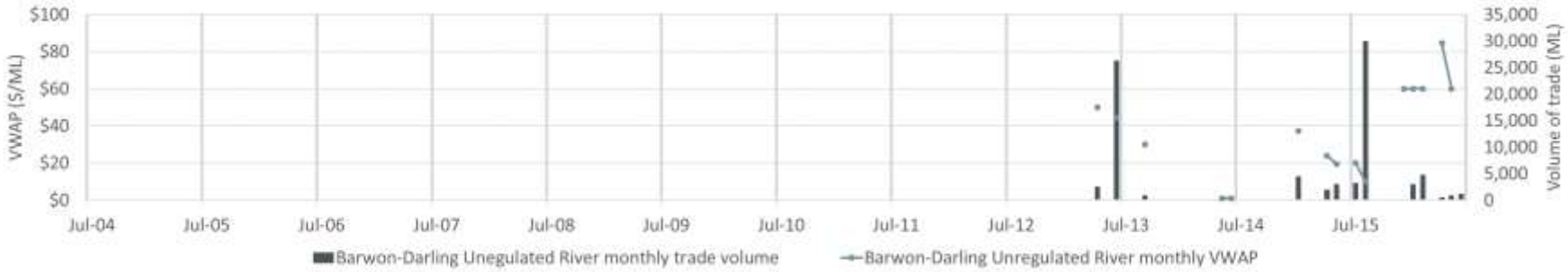
Allocation trade activity

The surface water allocation market in the Barwon-Darling River is relatively less mature and developed than other river systems in NSW. Trade is not permitted between other water sources in NSW or interstate, meaning that all trade must be conducted within the Barwon-Darling River. There are also trade rules within the Barwon-Darling River that restrict trade between different reaches of the river.

By southern MDB standards, major irrigated agriculture water users in the Barwon-Darling River hold relatively large entitlements (tens of gigalitres in some cases). These major water users can fill large on-farm water storages with water diverted from the river and use this stored water to manage their within and inter-year water use for irrigation.

Allocation trade does not follow the same trends as other areas and isn't driven by the same factors as in regulated water systems. Trade may be more opportunistic and may be negotiated through one-on-one deals (as opposed to a more formal active market where exchanges and brokers may play more of a role). Drivers of trade in this system may include decisions by irrigators not to produce in a given year; an irrigator reaching their on-farm water storage capacity and choosing to sell excess water temporarily to another producer; or an irrigator requiring extra water to finish off a crop. However, stakeholders have suggested that in many cases allocation trade is associated with those who have licences they aren't currently using and that 100 per cent carryover may have the effect of reducing demand for trade.

There have been limited trades of water allocations since the commencement of the WSP in 2012 (Figure 168). Prices and volume for allocation water have varied markedly, such that it is not possible to identify any clear trends between years. Despite this, prices have generally been observed below $60 per ML for allocation water. As certain entitlement types in the Barwon-Darling River have effectively unlimited carryover and the ability to extract multiples of share volume every year, commercial trades in the Barwon-Darling are generally large (in some cases over 10 GL).



Source: Aither 2016. Based on New South Wales Water Register 2016.

Note: To generate robust statistics about water market activity, Aither uses a proprietary data cleaning method to filter out outlier and non-commercial trades (such as $0 trades), which are excluded in calculating the volume and price results. However, in some cases outlier prices may still be present due to very low numbers of trades.

Figure 168 Monthly average allocation prices and trade volumes Barwon-Darling Unregulated River Water Source, 2004–05 to 2015–16

Supply drivers

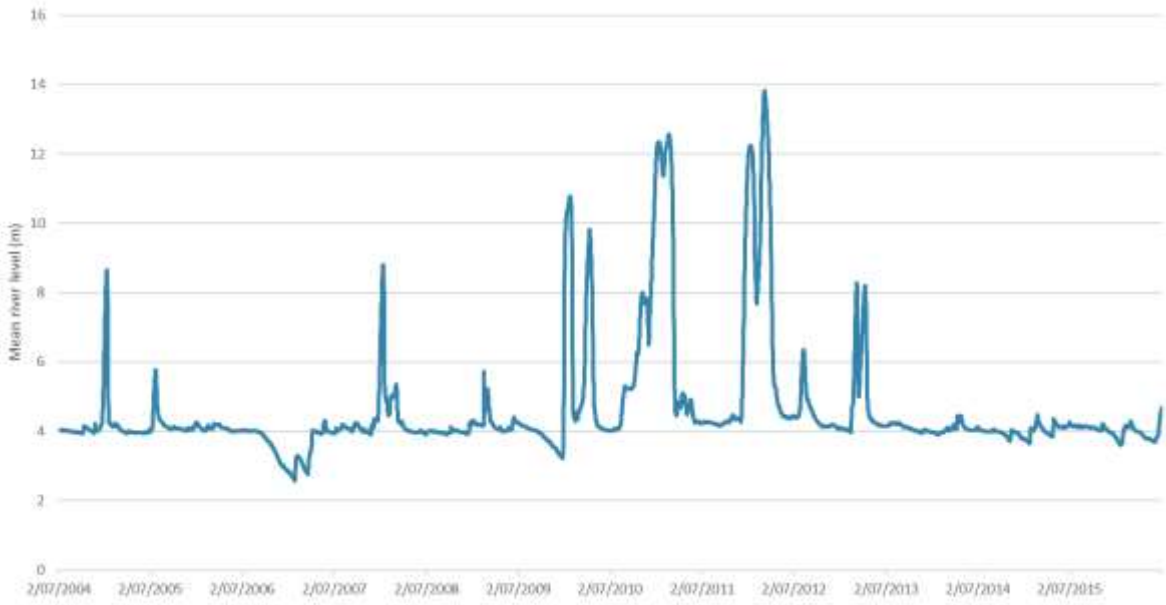
The primary supply-side drivers of water market activity (price and volume traded) include allocations made to entitlements, carryover, rainfall and water held in storage. With reference to the water systems located in the Barwon-Darling Catchment, these drivers are explored below.

Allocations to entitlements

Barwon-Darling Unregulated River Water Source

In unregulated systems, all entitlement types are issued with 100 per cent AWD at the commencement of each water year. Entitlement holder's accounts are credited water at each AWD announcement, which enables access to water under the rules and requirements specified in the WSP. Water is debited from the account whenever water is extracted, and a licence holder's account is not permitted to go into debit. In addition, access to account water is permitted under physical flow conditions specified under each water licence, which limit rather than guarantee water supply.

Figure 169 shows the mean daily river level for the Barwon-Darling river over the study period. The river level is a broad indicator of water conditions upstream and in the area. The figure shows that there have been a number of significant events, most significantly in 2010, 2011, and 2012. However, water availability is not as significant driver of allocation levels as it is in regulated systems, and cannot be used to easily explain the trade that has been observed. Pumping rules associated with licences, on-farm storage capacity, and other factors may play a more important role in trade outcomes. (For example, it is difficult to establish any correlation between trade events in Figure 168 and river level conditions in Figure 169, noting a number of flood events occurred prior to the introduction of the WSP).

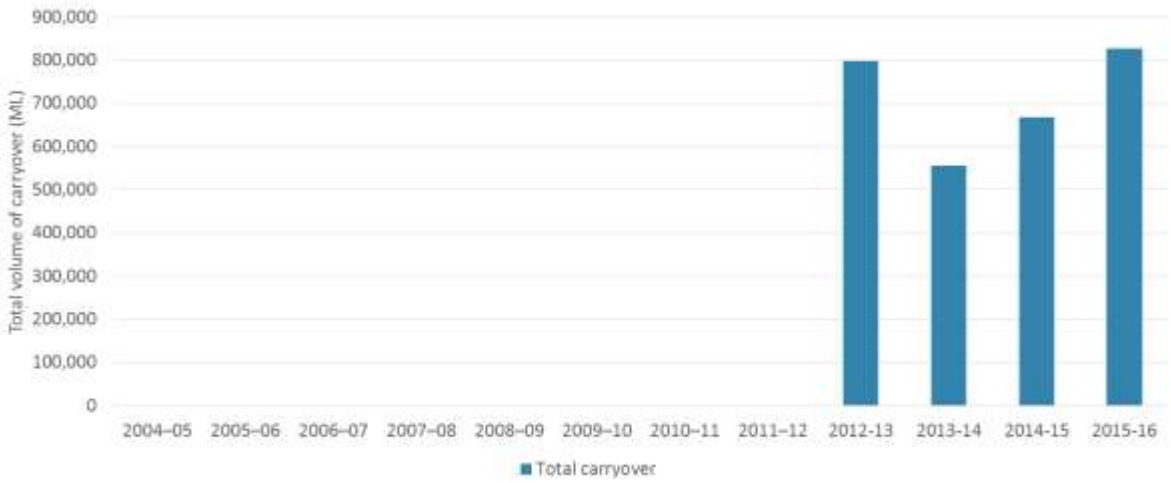


Source: Aither 2016. Based on data from NSW DPI Water 2016.

Figure 169 Mean daily river level in the Barwon-Darling River, Bourke, 2004–05 to 2015–16

Carryover

It is possible for Unregulated River Class entitlement types in the Barwon-Darling River to carryover an unlimited amount of water (see Table 29 for a full list of entitlement types) (but there is a 300 per cent annual use limit, and 100 per cent annual AWD limit). Since the commencement of the WSP in 2012, Unregulated River entitlement licence holders have carried an average of 712,700 ML forward into the next year. While there was nearly 800,000 ML of carryover during the first year of the Plan (2012–13), in the following year (2013–14) carryover dropped by over a quarter. For 2014–15 and 2015–16, average annual carryover was 747,974 ML.

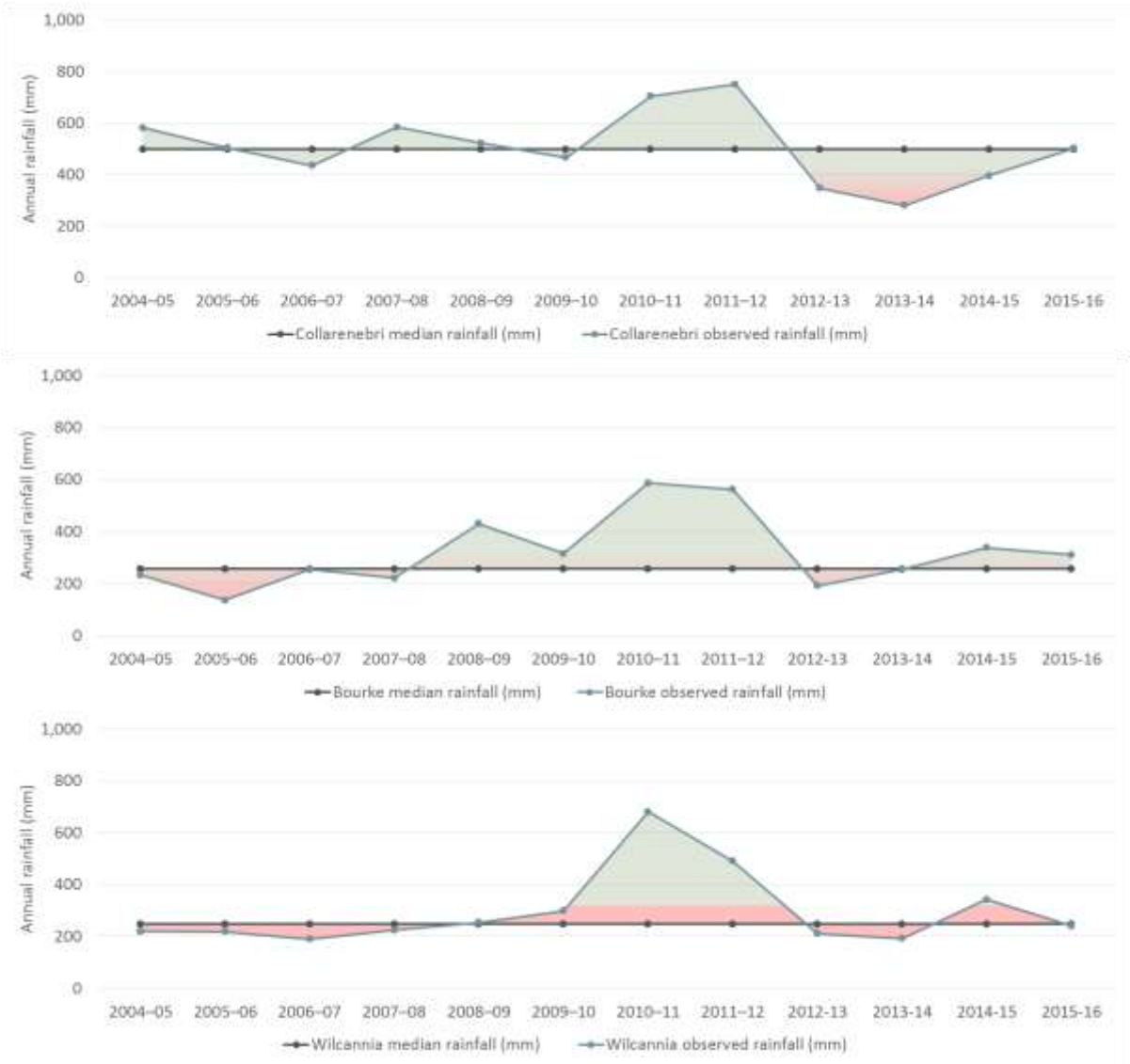


Source: Aither 2016. Based on data from NSW DPI Water 2016.

Figure 170 Unregulated River entitlement carryover in the Barwon-Darling Regulated River, 2004–05 to 2014–15

Rainfall

In-crop rainfall is a major input for irrigated agriculture producers and has a strong influence on decisions to participate in water markets. Total levels of annual rainfall can vary across the Barwon-Darling region given different climatic regions; for example, the median in Collarenebri is over 580 mm per annum compared to 249 mm in Wilcannia. Figure 171 presents annual median rainfall in Collarenebri, Bourke, and Wilcannia from 2004–05 to 2015–16. Annual rainfall between Bourke and Wilcannia across this period is strongly correlated – with the 10 out of 12 of the same years above and below median rainfall. Observed rainfall patterns in Collarenebri shares some of the same years above and below median rainfall as Bourke and Wilcannia, but is not as highly correlated.



Source: Aither 2016. Based on Bureau of Meteorology 2016.

Figure 171 Rainfall across the Barwon-Darling catchment, 2004–05 to 2015–16

Water storages

The Barwon-Darling is considered an unregulated river above the Menindee Lakes. There are several large government regulated headwater storages located in tributaries of the Barwon-Darling River, including the Border Rivers, Gwydir Namoi and Macquarie catchments. However, these dams are too far upstream to regulate flow in the Barwon-Darling River. In addition, these storages are not resources for the Barwon-Darling water source, which reflects legislative impediments in addition to physical feasibilities. As a result, irrigators rely on large on-farm storages to manage irrigation demands. In the Barwon-Darling the estimated volume of on-farm storages is 298 GL. However, no reliable data exist to determine how much water is held in these storages on a year to year basis.[77]

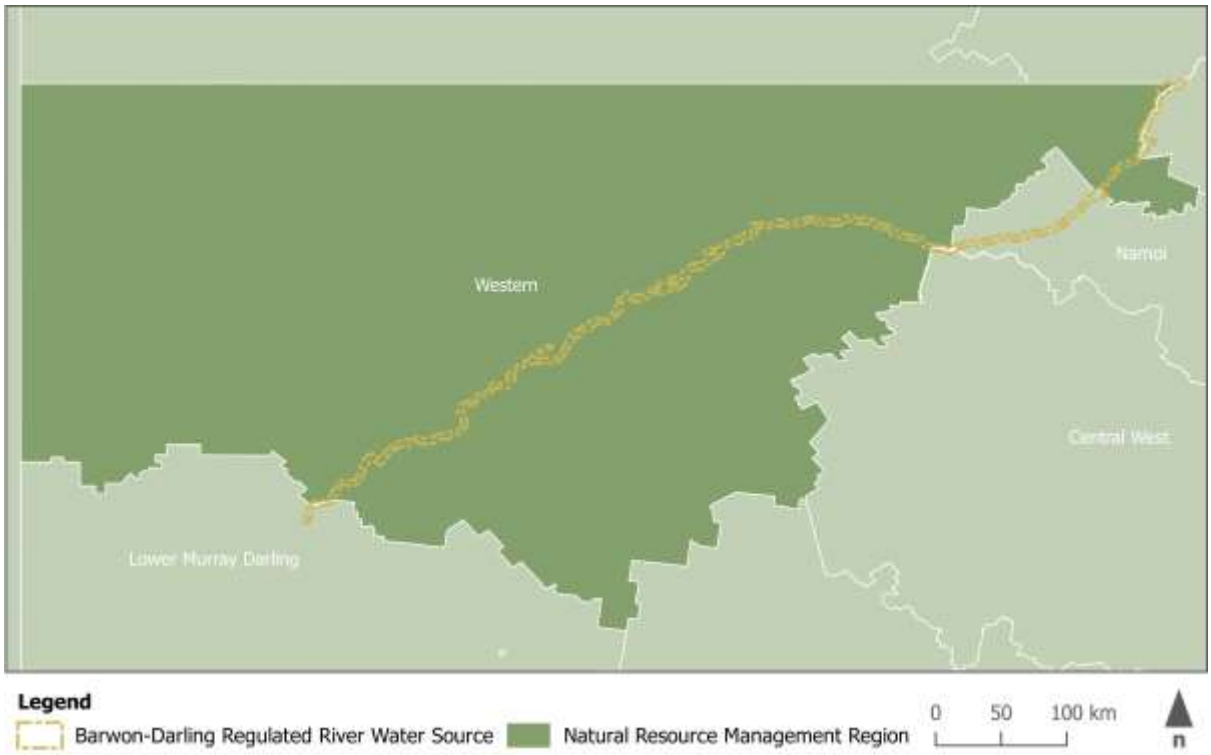
[77] See Murray-Darling Basin Commission 2007, On-farm water use efficiency in the northern Murray-Darling Basin, http://www.mdba.gov.au/sites/default/files/archived/mdbc-NRM-reports/21_NBP_On-farm_water_use_efficiency.pdf . State government agencies may keep pumping data, but this is not necessarily aligned with what is held in storage.

Demand drivers

Changes in irrigated agricultural production are an important driver of water market activity. Two proxy indicators of changes in production include land use and water use associated with different crop types.

For this regional summary, Aither has not presented a comparison of land use and water use in the Barwon-Darling using ABS data about irrigated agricultural water use. This is because the ABS data is aggregated by a much larger Natural Resource Management (NRM) region (Western) that does not align with the Barwon-Darling Water Sharing Plan boundary – as shown in Figure 172.

In addition, ABS data for water and land use in the Barwon-Darling is incomplete, meaning that land and water use cannot be meaningfully compared between different land use categories and for different years. For these reasons, using ABS data for the Western NRM region would not provide an accurate representation of land use and water use changes over time in the Barwon-Darling WSP area.



Source: Aither 2016. Based on National NRM Regions and WSP boundaries provided by NSW DPI Water 2016.

Figure 172 Alignment of NRM Regions and WSP boundaries – Barwon-Darling

Agricultural activity in the Barwon-Darling Catchment is primarily beef and sheep grazing on pastoral land, with a small amount of irrigated production occurring on western plains next to the river. Irrigated production is predominantly cotton. Although agriculture is economically vital to the Barwon-Darling region, dryland and irrigated cropping together cover less than 1 per cent of the land area of the catchment.

Institutional and policy

Trade rules

Water trade in New South Wales is governed by rules that reflect specific physical, temporal or administrative constraints for each region. [78]

Of particular interest of the Barwon-Darling Unregulated River are restrictions on entitlement and allocation trades within the water source. In general, allocation and entitlement trade is only permitted between access licences that are subject to equivalent or more stringent cease to take conditions. This provision prevents water users from trading to licences with more favourable access conditions, as this would have third party impacts on other water users in the system. An exception to this rule exists where dealings are permitted to a C class licence with a less stringent access condition to reinstate the pre-Cap average history of extraction attached to that specific licence.[79] However, stakeholders have suggested that in practice, these rules do not appear to have a significant impact on their ability to trade water as and when required.

The WSP for the Barwon-Darling Unregulated and Alluvial Water Sources also contains provisions for concessional conversions of access licence category. However such conversions are largely completed. This provision permits licence holders who have insufficient Cap share to convert their licences under section 71O of the Act to reinstate their historical extraction rate. 71O trades can only occur for the first five years of the WSP, which is significant for future valuation of licences.

Other policy issues

All unregulated river water sharing plans allow individual daily extraction limits (IDELs) to be imposed as a way to share water between licence holders and the environment within a flow class on a daily basis. In the Barwon-Darling, they are proposed as a mechanism with a twofold purpose. IDELs are intended to limit extraction rates to current extraction rates permitted through authorised pumps to minimise third party and environmental impacts whilst supporting trade. They also provide greater equity of water sharing when there is low access to flow. Some stakeholders have suggested that trade under the existing WSP could have environmental or third party impacts if it continues from downstream to upstream without daily limits in place.

Under the WSP, IDELs can be established for access licences when there are appropriate administrative and management systems in place. Crucial to this, is an ability to meter stream flow in real time. At the commencement of the WSP, there were no IDELs established for access licences in the Barwon-Darling River. Uncertainty about the implementation of IDELs is a potential policy issue that may impact trade because entitlement holders may potentially be concerned about losing (or gaining) pumping capacity through dealings, although trade in water does not necessarily mean a change to IDELs. If IDELs are established this is likely to require further discussion about the potential for trade in IDELs.

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[78] This analysis is not a comprehensive stocktake of all trade rules. Please see the NSW Access Dealing Principles Order 2004 and relevant Water Sharing Plan for a comprehensive account of all rules governing trade.

[79] See the Background document to the WSP for the Barwon-Darling Unregulated and Alluvial Water Sources 2012 http://www.water.nsw.gov.au/__data/assets/pdf_file/0006/549024/wsp_barwon_darling_background_document.pdf

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