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Water in Australia
2015–16

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FOREWORD

Water is an essential element of our daily lives, and a key resource in Australia's ongoing good health and prosperity. It is a vital input to almost every industry in the nation's economy.

More than two hundred organisations across Australia collect data on water resources and uses relevant to water management. The Bureau of Meteorology integrates much of this information and makes it openly available in a range of online products.[1]

Water in Australia 2015–16 pulls together information from many of these products to provide an overview of Australia's water availability and use, analysed in the context of long-term records and climatic influences. This report is the third in a series that helps our customers track and understand changes over time—understanding the past will help us all plan for the future.

I thank everyone involved for their valuable contributions to this report, including the organisations that have collected and passed on data, and the specialists in climatology, hydrology and geohydrology who have written and reviewed this report.

Dr Robert Argent
General Manager Water
Bureau of Meteorology

1 www.bom.gov.au/water

OVERVIEW

This report builds on earlier assessments, integrating and summarising data and investigations from across the Bureau to provide a national overview. The reporting year, from 1 July 2015 to 30 June 2016, is the latest planning year for which national-level water-use data are available.

AVERAGE CONDITIONS WITH A WET WINTER ONSET

Mean rainfall for Australia for the year July 2015 to June 2016 was 464 mm, which is similar to the long-term mean, but 12 per cent higher than for 2014–15. Higher-than-average rainfall (this encompasses 'above average', 'very much above average' and record highs) occurred across large parts of northern Australia during a very strong monsoonal event in December, and in southern Australia during strong rainfall events in January. Much of the country had a very wet onset of the 2016 winter.

Annual rainfall was higher-than-average along the southern coast of Western Australia and in large parts of New South Wales and the interior. In contrast, many areas along the coast received lower-than-average annual rainfall (this encompasses 'below average', 'very much below average' and record lows). In addition to these annual conditions, lower-than-average rainfall was dominant throughout much of the country during spring 2015 and autumn 2016.

A lack of consistent rainfall throughout the year meant that lower-than-average streamflows were dominant in large parts of Australia (Figure 1). For each of the first 11 months of 2015–16, less than one-quarter of sites had streamflows that were higher than average. This changed in June 2016, with almost 50 per cent of sites having higher-than-average streamflows in that month.

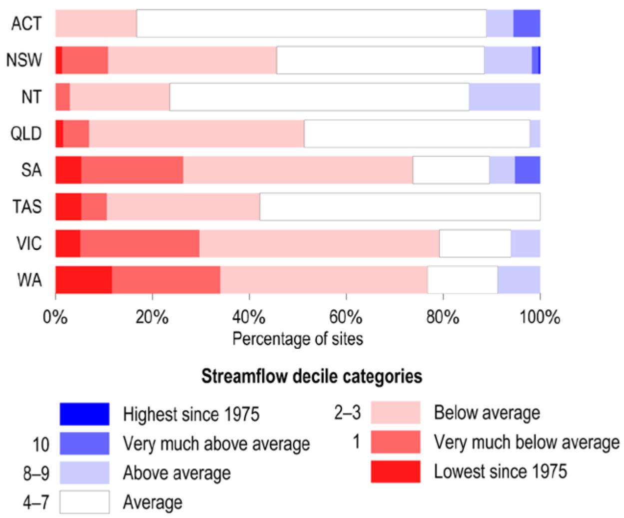


Figure 1. Annual streamflow conditions by State and Territory in 2015–16

CONTINUED DECLINE IN RESERVES

As streamflows in the areas where most urban centres are located were generally below the long-term mean, the combined storage volume of urban systems declined from 81 per cent of capacity at 30 June 2015 to 75 per cent at 30 June 2016. Storage systems in the Pilbara and Townsville showed the largest proportional declines, from about 50 to 30 per cent of accessible capacity. The Perth storage system had the lowest accessible storage volume (20 per cent), resulting from persistent dry conditions over the past few years.

Lower-than-average rainfall in many of the agricultural centres during the growing season resulted in high water demands and use. With lower-than-average streamflows during the first ten months of 2015–16, many rural storage volumes experienced a strong decline. Before the start of the 2016 winter rainfalls, most supply storages in the Murray–Darling Basin recorded their lowest volumes since the end of the Millennium Drought (1996–2010). Their combined volume at the end of April was 24 per cent

Water in Australia 2015–16 is the third in a series describing the availability and use of Australia's water resources in the context of long-term trends and climate influences. Quantities of key water resources recorded throughout 2015–16, including rainfall, surface water and groundwater, are examined in relation to past conditions. This is followed by an assessment of how much water has been extracted from these resources and how this has changed over time.

of capacity. With the arrival of the 2016 winter rainfalls, storages, particularly in the southeast of Australia, received a surge in inflows. At the end of the year, the combined storage volume of rural storages was at 52 per cent of capacity, 7 percentage points below the 59 per cent of capacity recorded at the start of the year.

Groundwater levels in upper, middle and lower aquifers were generally average to below average, with a predominantly declining trend since 2011.

CONTINUED WATER TRADING BUT LOWER WATER EXTRACTIONS

Volumes for water entitlements traded nationally were similar to 2014–15, totalling around 1700 GL for 2015–16. The total volume of surface water allocations traded during 2015–16 was 5800 GL, a marginal increase from the total allocation trade volume in 2014–15. Both types of trading occur predominantly in the southern Murray–Darling Basin.

The estimated total volume of water extractions for consumptive use across Australia was 15 900 GL in 2015–16 (Figure 2). This is 5 per cent lower than in 2014–15.

Water extracted for agricultural use accounted for 70 per cent of the total, or 11 200 GL, a decline from the 12 600 GL of agricultural water extractions in 2014–15. Declining storage volumes resulted in low allocations against the general security entitlements in New South Wales, which in turn caused this decline in water use. Twenty-one per cent of the total extractions (3300 GL) was sourced for urban water supply.

Total environmental water use, in the form of actual flow releases, in the southern Murray–Darling Basin (including the Lachlan basin) was just over 1000 GL, whereas the total for the northern basin was 66 GL. These volumes were significantly less than the 1600 GL and 145 GL of environmental water releases in the southern and northern basins, respectively, during 2014–15. Again, this decrease was due to lower allocations against the environmental water entitlements held by the environmental water holders.

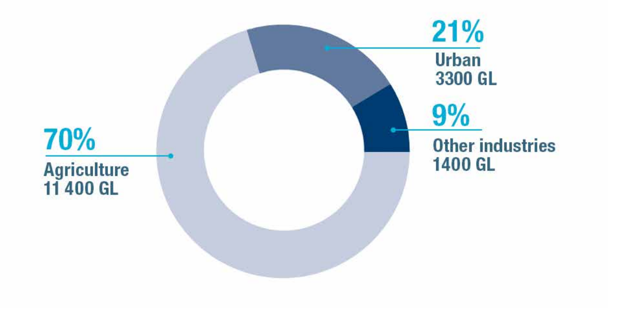


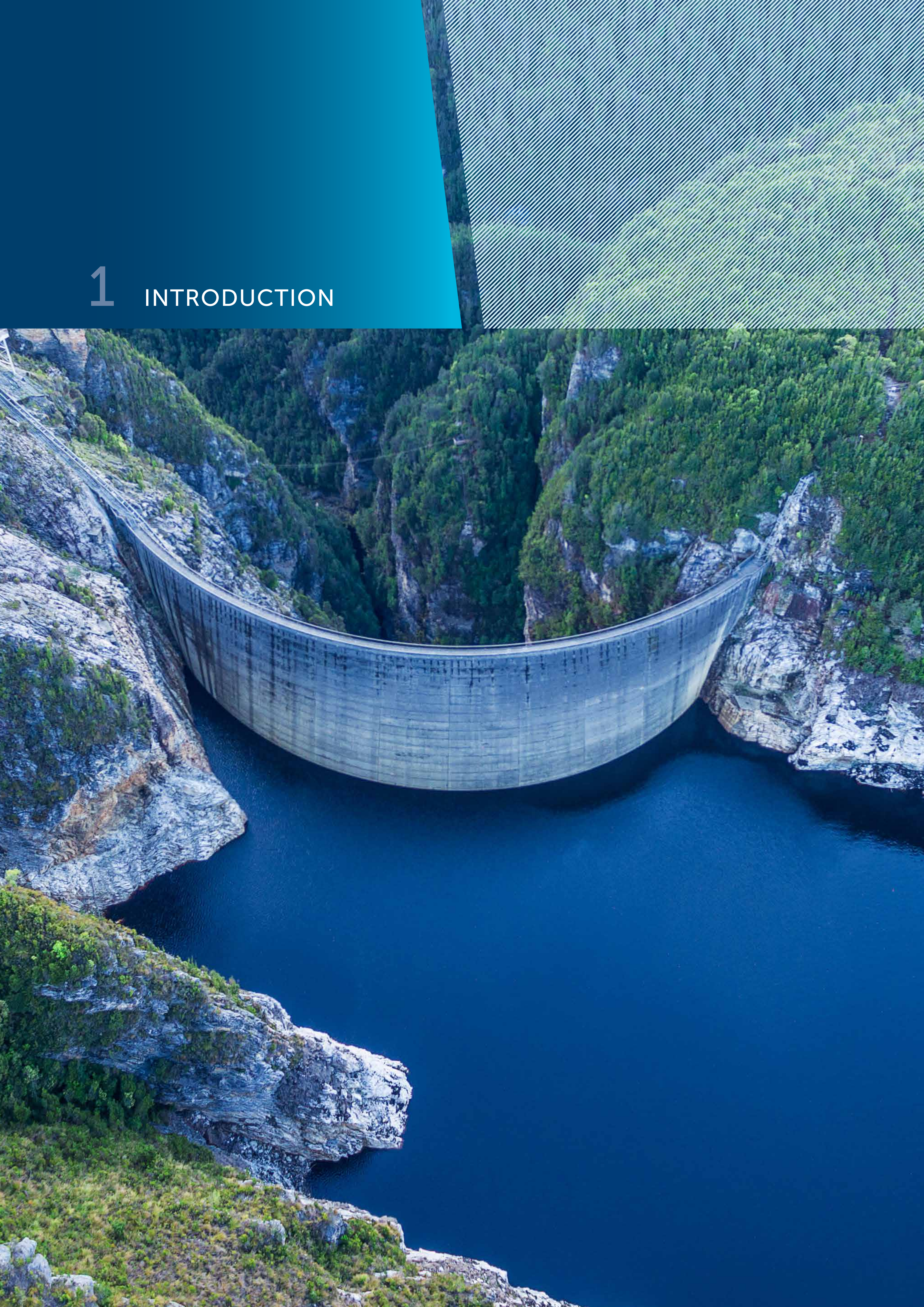
Figure 2. Total water extractions by industry sector in 2015–16

POSITIVE PROSPECTS FOR HIGHER WATER AVAILABILITY IN 2016–17

The strong onset of winter rainfall in Australia's southeast generated high streamflows and wet catchments. Most storage systems in the southern Murray–Darling Basin were rising quickly during June 2016. Total storage volumes in the Murrumbidgee and Lachlan basins were already substantially higher at the end of 2015–16 than at the start of the year.

With wet catchment conditions in June, the higher inflows into storages were likely to continue into July. No new allocations were announced against the regulated entitlements in June 2016 for the remainder of the 2015–16 water-accounting period. Water allocations carried over into 2016–17 were therefore at similar low levels to those at the start of 2015–16. However, with the already increased storage volumes and the positive prospects for further inflows, higher allocations in 2016–17 were likely, particularly for the general security entitlements in most areas of New South Wales.

1 INTRODUCTION



The Bureau of Meteorology is responsible for producing regular reports on water resources, availability and use in Australia to help inform decision-making by water managers and policymakers. As part of this role, the Bureau publishes an annual overview of Australia's surface water resources in the context of long-term trends and climatic influences.

Water in Australia 2015–16 is the third report in this series of annual reports. It integrates data and investigations from across the Bureau to provide a national overview for the period from 1 July 2015 to 30 June 2016.

Water in Australia and related resources are available on the Bureau's website.[2] Data used in the report are available for download through two complementary information sources.

- Regional Water Information[3] provides spatial information and summaries (from nationwide to the river region level) on the status of water resources and use.
- Monthly Water Update[4] provides a snapshot of monthly rainfall, streamflow, stream salinity and storage volumes for ten of Australia's 13 drainage divisions.

Other specific types of water information are also available[5], and were used to generate this national report.

- Climate Resilient Water Sources is an inventory of desalination and water recycling plants across Australia.
- Groundwater Information Suite provides data on bore water levels and trends, and associated data on hydrogeology and groundwater management.
- Hydrologic Reference Stations has comprehensive streamflow data from catchments that are unaffected by diversions and storages, showing flow histories with minimal effects from water resource development and land use change.
- National Water Account is a detailed annual accounting of water assets and liabilities for ten key water-use regions.
- Urban National Performance Reports provide annual benchmarking of the performance of 78 major urban water utilities and councils.
- Water Data Online provides streamflow and water storage information from approximately 4600 stations, many of which are updated daily.
- Water Storage dashboard lets you compare water levels and volumes for more than 300 publicly owned lakes, reservoirs and weirs in different States and Territories, and see how much water is available over the entire country.
- Water Markets dashboard lets you view and compare the volumes and prices of water entitlements and allocations being traded in Australia. You can also view the number and volume of entitlements that are on issue nationally.

2 www.bom.gov.au/water/waterassessments
3 www.bom.gov.au/water/rwi
4 www.bom.gov.au/water/monthly-water-update
5 www.bom.gov.au/water

2 WATER RESOURCES

This chapter provides an overview of surface and groundwater availability in Australia during 2015–16. National, regional and monthly patterns of rainfall and streamflow are explored in section 2.1, and the effect of these patterns on water storage is described in section 2.2. Section 2.3 covers Australia's groundwater resources.

2.1 RAINFALL AND STREAMFLOW

2.1.1 Total rainfall and streamflow

The mean rainfall for Australia in 2015–16 was 464 mm. This is on par with the long-term (1910–2015) national mean of 460 mm. However, rainfall varied greatly across Australia (Figure 3).

Large parts of the interior, the southern coast and the southeastern coast were relatively wet (Figure 3a). However, average to lower-than-average conditions prevailed in other coastal areas.

In some areas, these relatively dry conditions continued from previous years. Rainfall in western Victoria and Tasmania had been average or lower since 2014–15. Large parts of central Queensland had been dry for up to three years prior to 2015–16, and southwest Western Australia had experienced mainly lower-than-average rainfall for the previous 15 years.

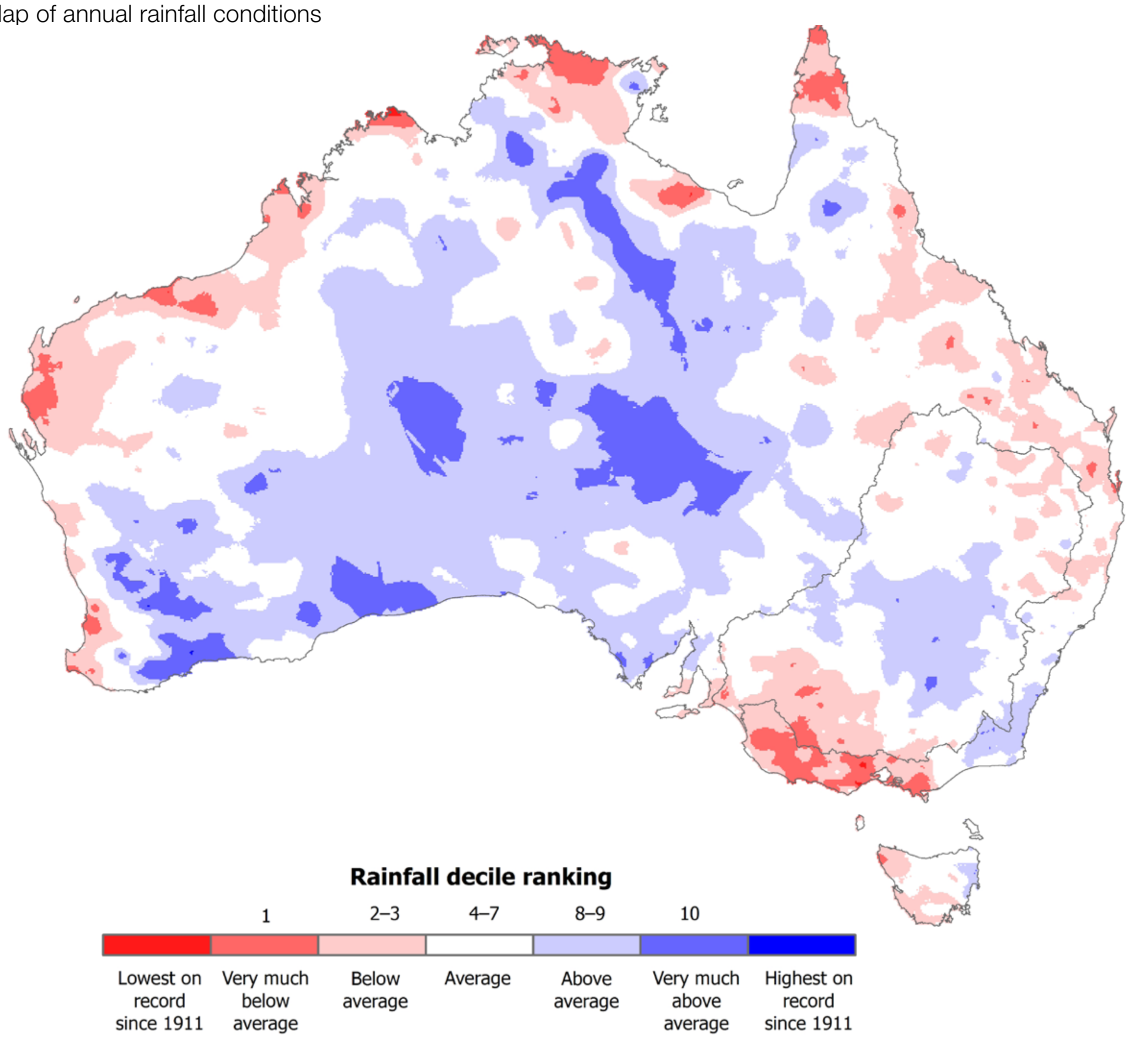
The streamflow data in Figure 4a reflect the spatial distribution of rainfall in Figure 3a—mostly average or lower along the coast except for part of the southeastern coast. The relationship between rainfall in Figure 3b and streamflow in Figure 4b is weak due to the different spatial coverage of data. The summary of streamflow data for States and Territories in Figure 4b shows that more than 85 per cent of sites recorded flows that were average or lower. Surface water availability in rivers for agricultural use was particularly low in the northern Murray–Darling Basin, western Victoria and southwest Western Australia.

The impact on streamflow in catchments with little disturbance from human activities can be assessed by looking at the Bureau's hydrologic reference stations.[6] These are unregulated sites with long-term, high-quality streamflow records managed by Australian and State water agencies, and are spread across contrasting hydro-climatic regions.

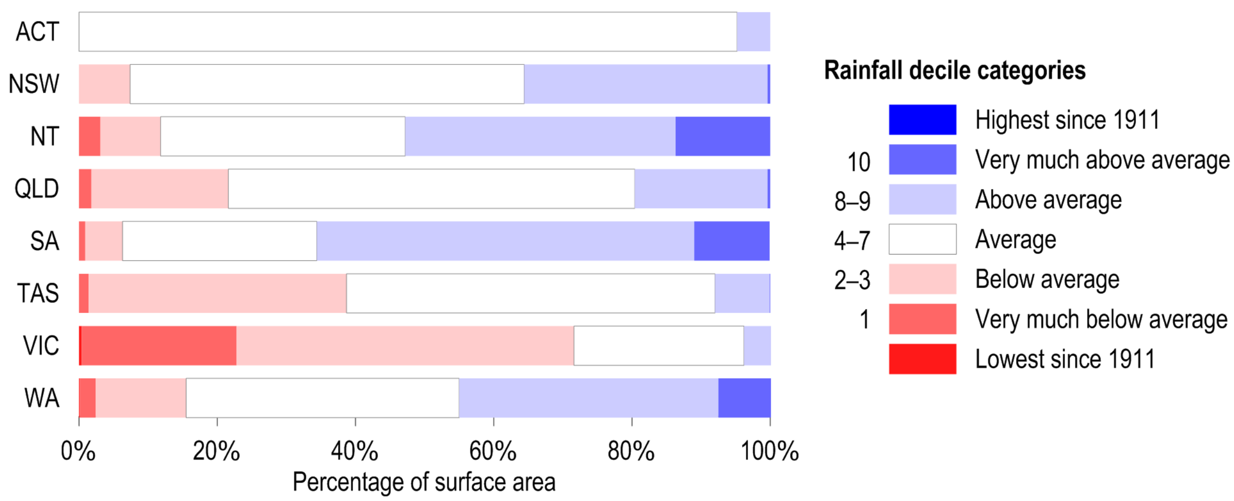
Figure 5 shows that 94 per cent of these sites had streamflows that were average or lower.

6 www.bom.gov.au/water/hrs

(a) Map of annual rainfall conditions



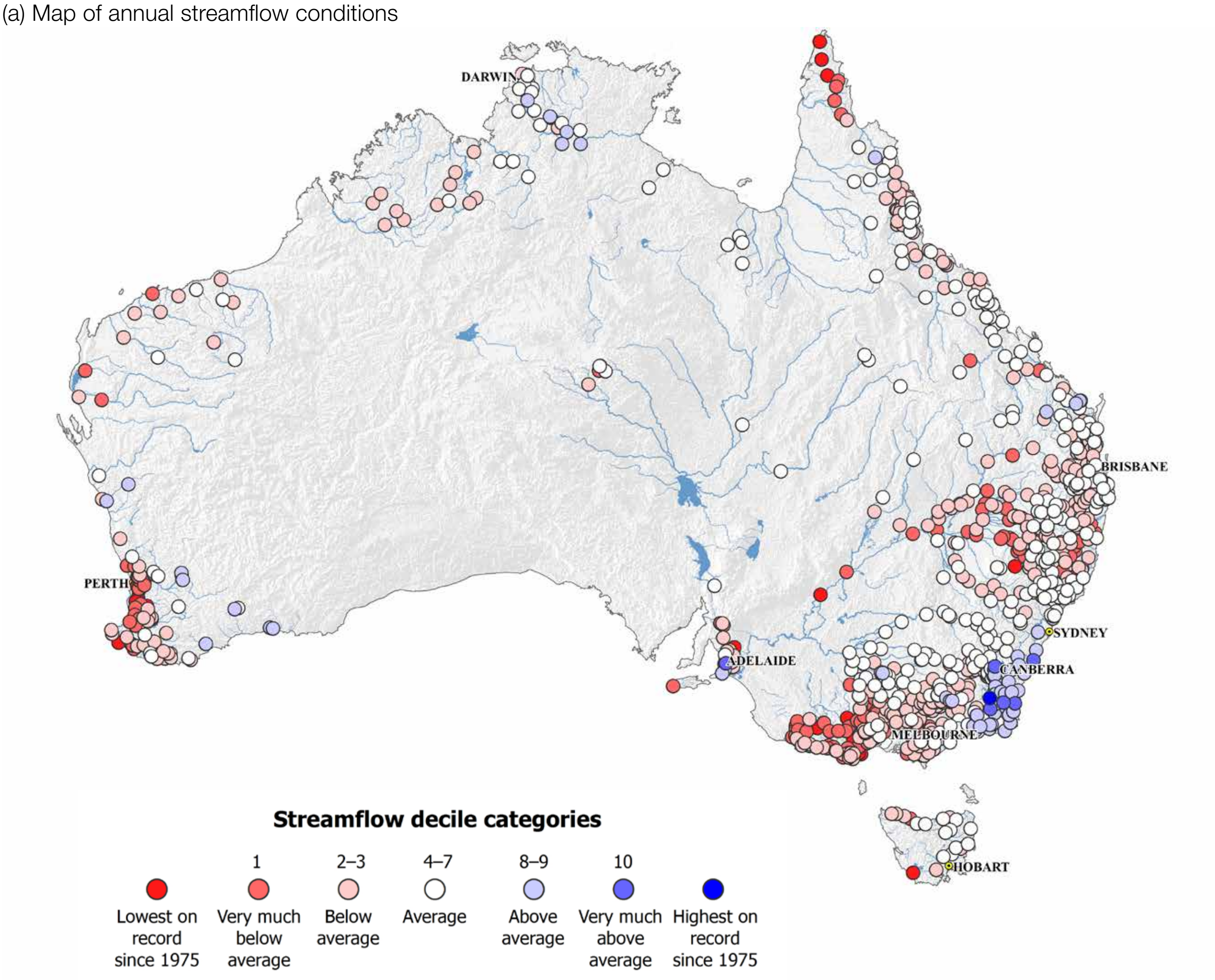
(b) Annual rainfall conditions by State or Territory



ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; QLD = Queensland; SA = South Australia; TAS = Tasmania; VIC = Victoria; WA = Western Australia

Figure 3. Annual rainfall conditions in 2015–16 (a) map with Murray–Darling Basin outline (b) by State or Territory

(a) Map of annual streamflow conditions



(b) Annual streamflow conditions by State or Territory

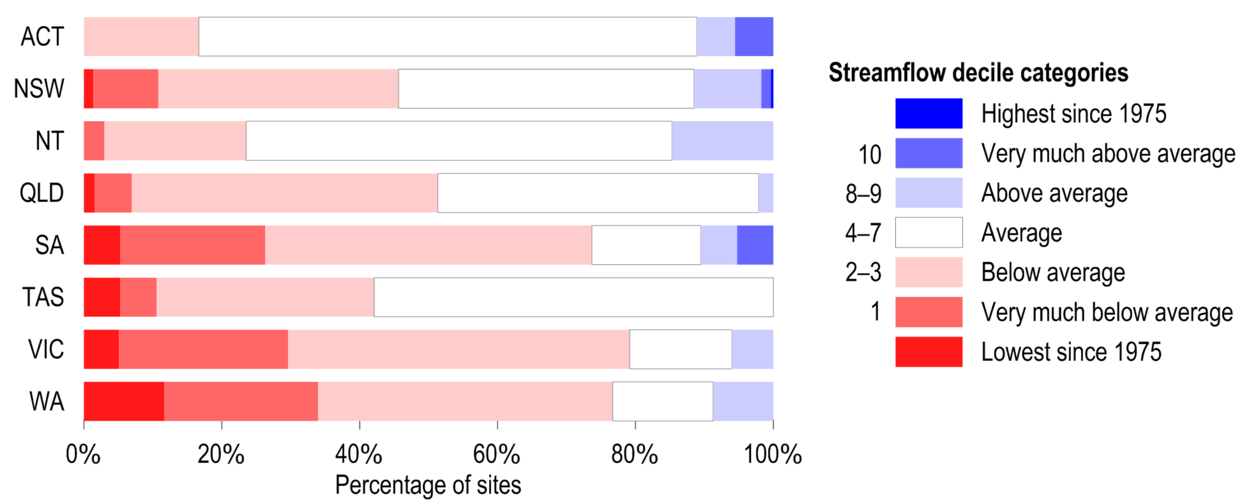
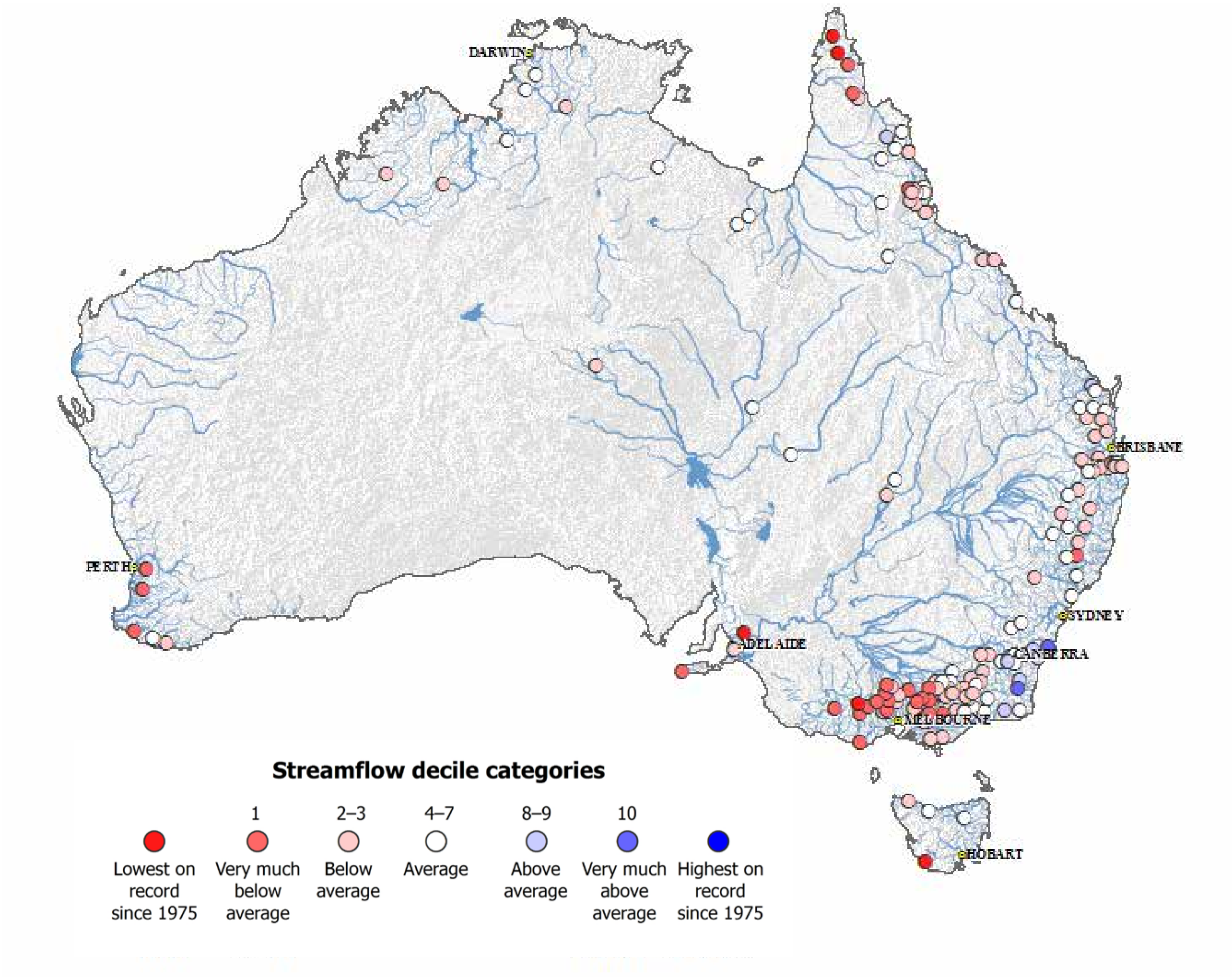


Figure 4. Annual streamflow conditions in 2015–16 (a) map (b) by State or Territory

(a) Map of annual streamflow conditions at hydrologic reference stations



(b) National streamflow conditions at hydrologic reference stations

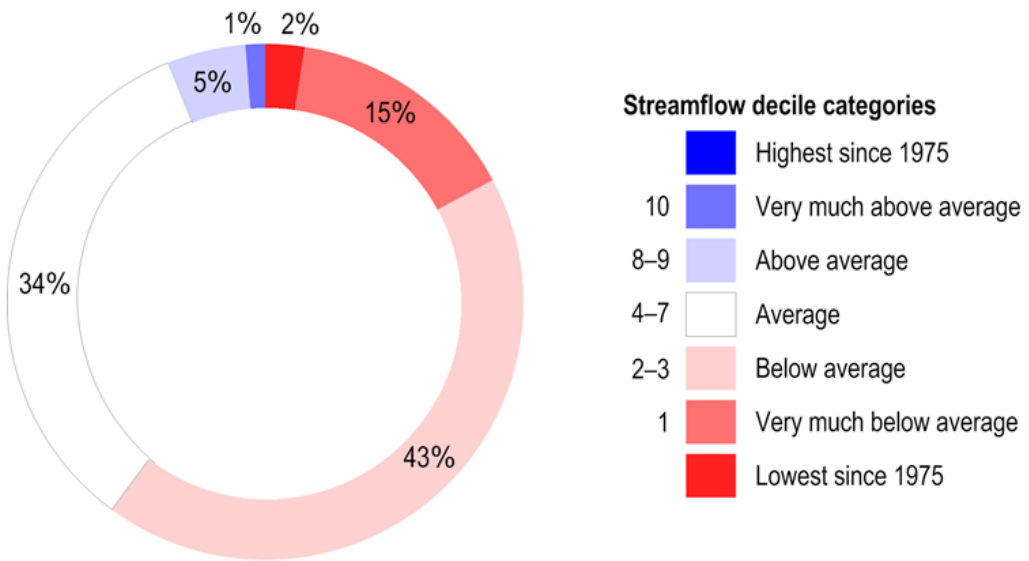


Figure 5. Streamflow conditions at the Bureau's hydrologic reference stations in 2015–16 (a) map (b) national conditions

2.1.2 Rainfall and streamflow patterns

Driven by various climatic conditions, rainfall and streamflow varied greatly over the 2015–16 year. Figures 6 and 7 summarise monthly rainfall and streamflow conditions, respectively, for the whole country, and Figure 8 provides a spatial overview of rainfall and streamflow responses for each month.

The first half of 2015–16 (July to December 2015) saw a dry period in the east, especially for Victoria and Tasmania. An El Niño event was firmly in place in the Pacific Ocean by the end of May 2015, and continued until approximately early May 2016. In the Indian Ocean, a positive Indian Ocean Dipole was in place between late August and mid-November, reaching a peak in October.

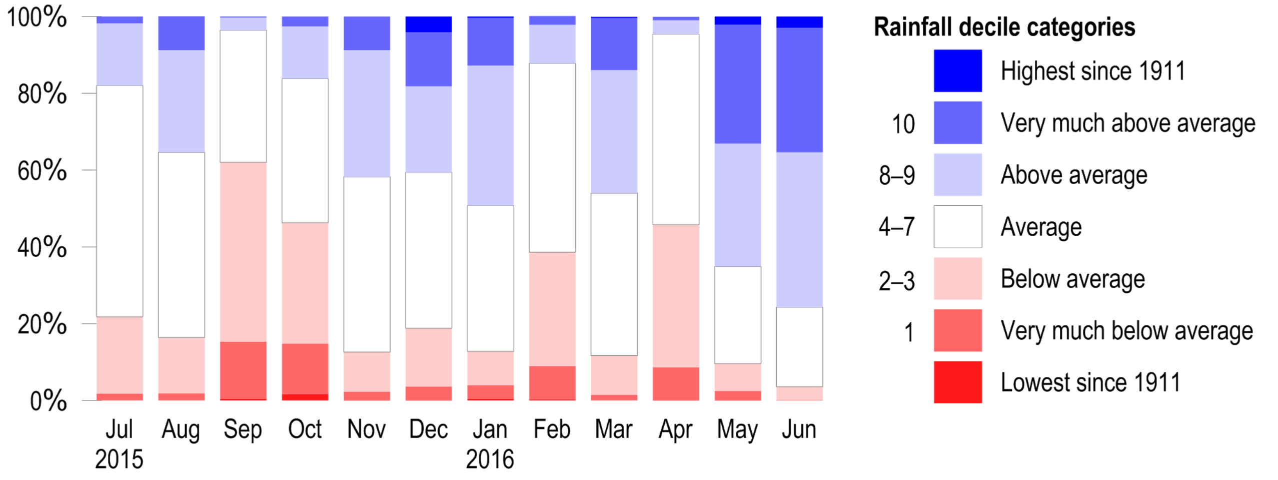


Figure 6. National rainfall conditions in 2015–16 by month

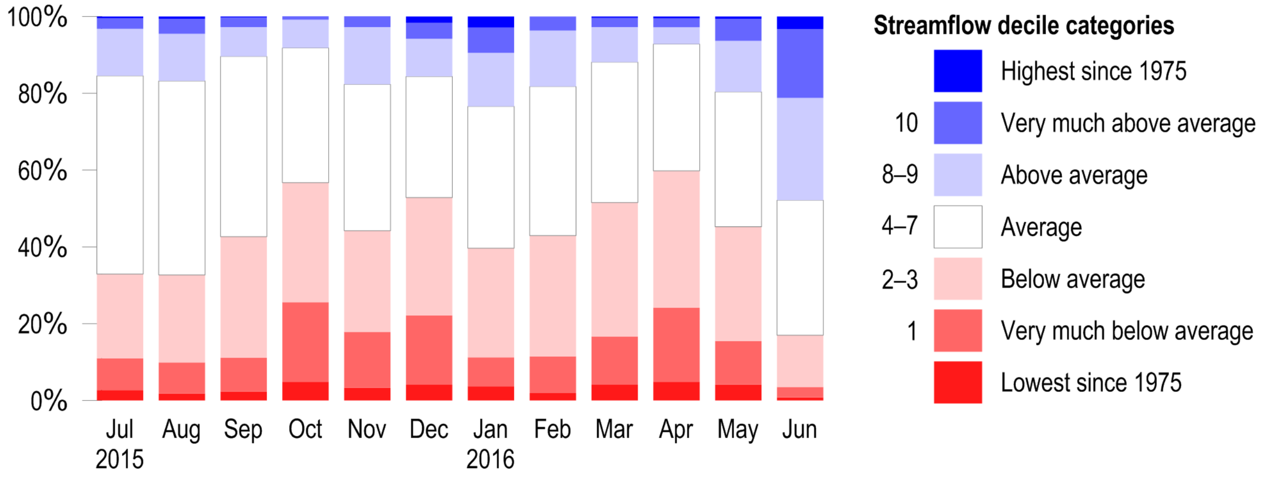


Figure 7. National streamflow conditions in 2015–16 by month

These climate influences contributed to lower-than-average rainfall over much of eastern Australia. Almost all of Tasmania, most of Victoria, southeastern South Australia and southwest Western Australia recorded lower-than-average rainfall and streamflows. Many locations in these regions registered their driest October on record. In southeastern New South Wales, streamflows generally decreased from average or higher flows in July to average or lower flows in December.

The northern Australian wet season (October 2015 to April 2016) experienced average to lower-than-average rainfall, but with very high intra-seasonal variability. After a very dry build-up, the first, and most significant, period of monsoonal activity for the Northern Territory came in late December. Rainfall between 21 and 29 December produced the wettest December on record for the Northern Territory. That month, 33 per cent of the sites in the Northern Territory recorded their highest flow since 1975. The wet weather, however, did not last through the season; the January to April period was particularly dry across the tropical north. High streamflows only lasted into January, with average to lower-than-average streamflows dominating in February and March. In Queensland, wet season rainfall was below the long-term mean and most of streamflow sites recorded average to lower-than-average streamflows.

February 2016 saw dry conditions return to the east. This persisted until April, with drought conditions across large areas of Tasmania, Victoria, New South Wales and Queensland. The majority of the streamflow sites in these States recorded flows that were lower than average.

As the 2015–16 El Niño broke down during autumn and a negative Indian Ocean Dipole developed in May, conditions turned dramatically wetter. After Australia's ninth-driest April on record, May came in as sixth wettest and June as second wettest. Many locations in southern Queensland and New South Wales registered record high rainfall for June, and daily totals were unprecedented for any month across several locations in the northern half of Tasmania. Major flooding occurred across Tasmania's northern river basins as a result of daily rainfalls in excess of 200 mm. Flooding also occurred in many rivers in southeastern Queensland, eastern New South Wales and eastern Victoria.

In southwestern Australia, high January rainfall was followed by average to higher-than-average rainfall conditions throughout autumn. Many streamflow sites maintained their above-average flows until a return to mostly average flows in June.

More information on the monthly rainfall and streamflow conditions can be found in the Bureau's Monthly Weather Review[7], the Monthly Water Update[8] and Regional Water Information.[9]

7 www.bom.gov.au/climate/mwr
8 www.bom.gov.au/water/monthly-water-update
9 www.bom.gov.au/water/rwi

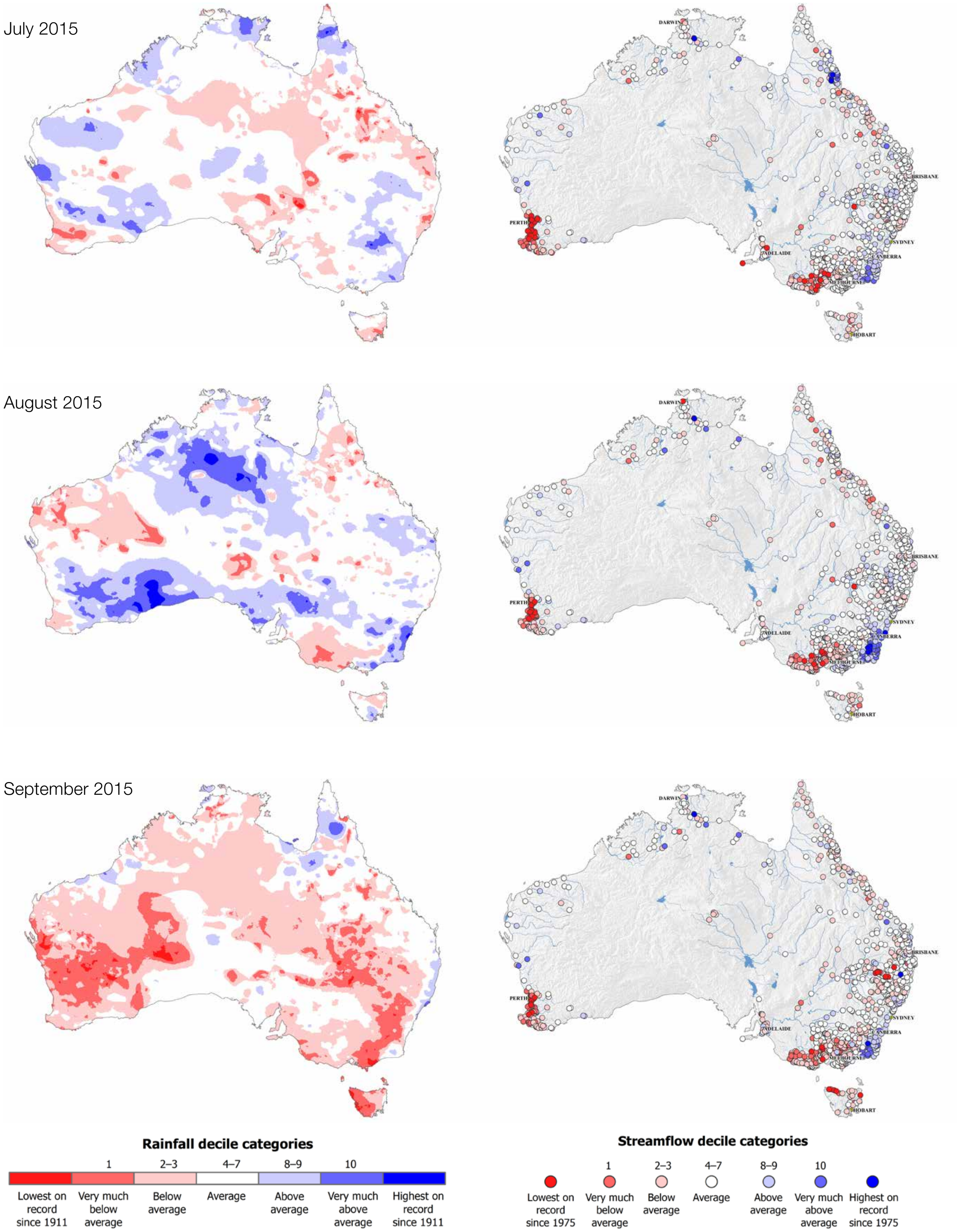


Figure 8. Monthly rainfall and streamflow conditions in 2015–16

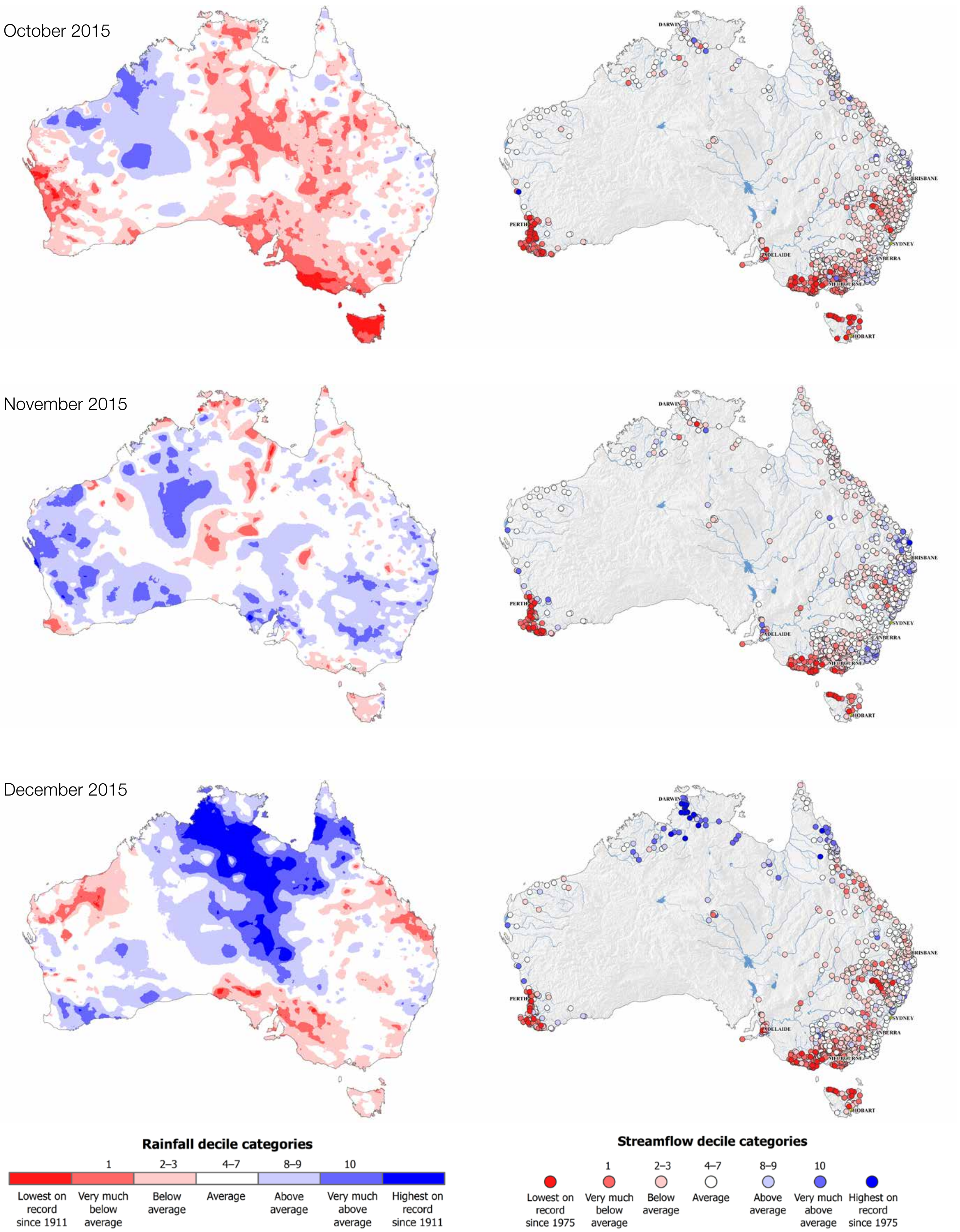


Figure 8. (continued) Monthly rainfall and streamflow conditions in 2015–16

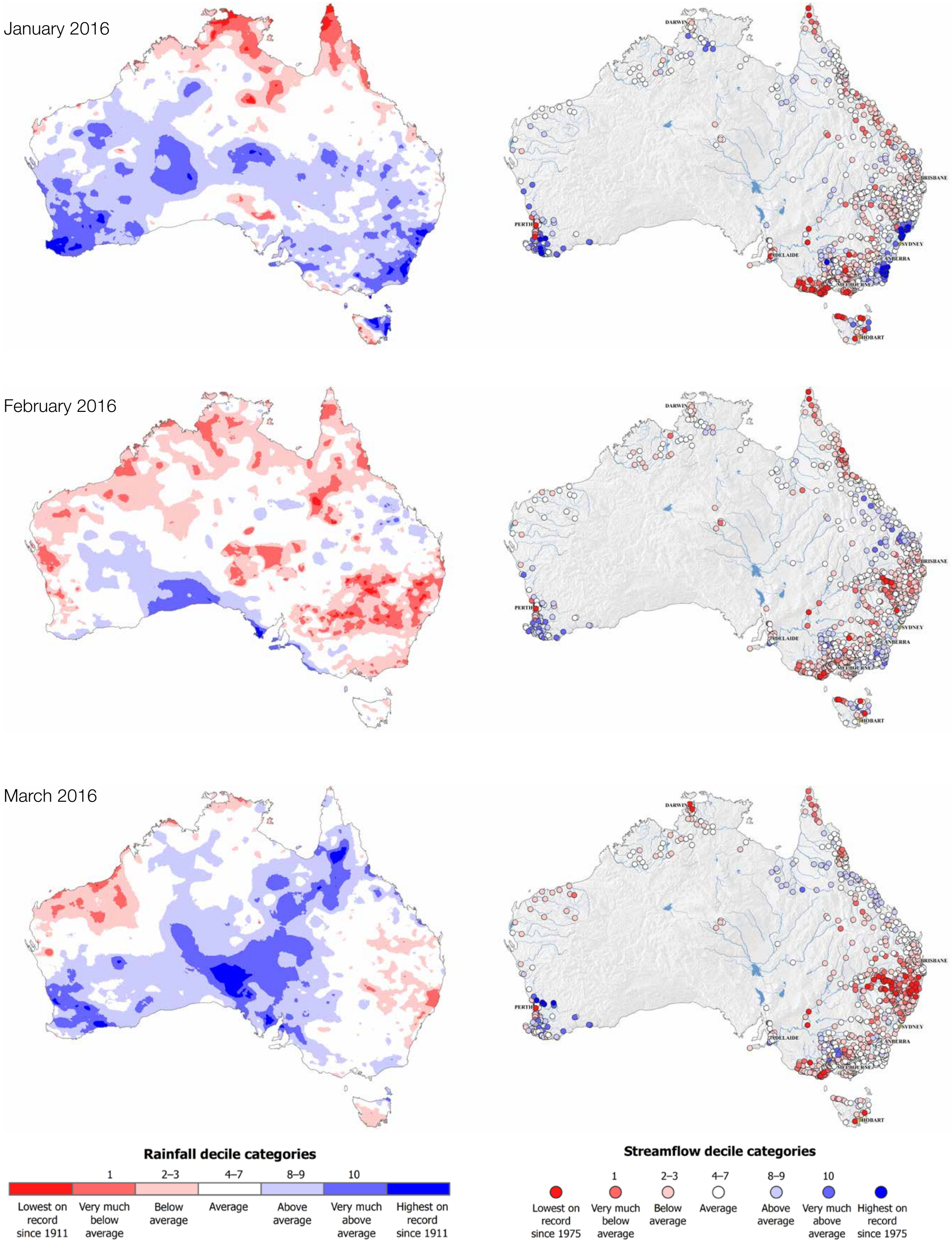


Figure 8. (continued) Monthly rainfall and streamflow conditions in 2015–16

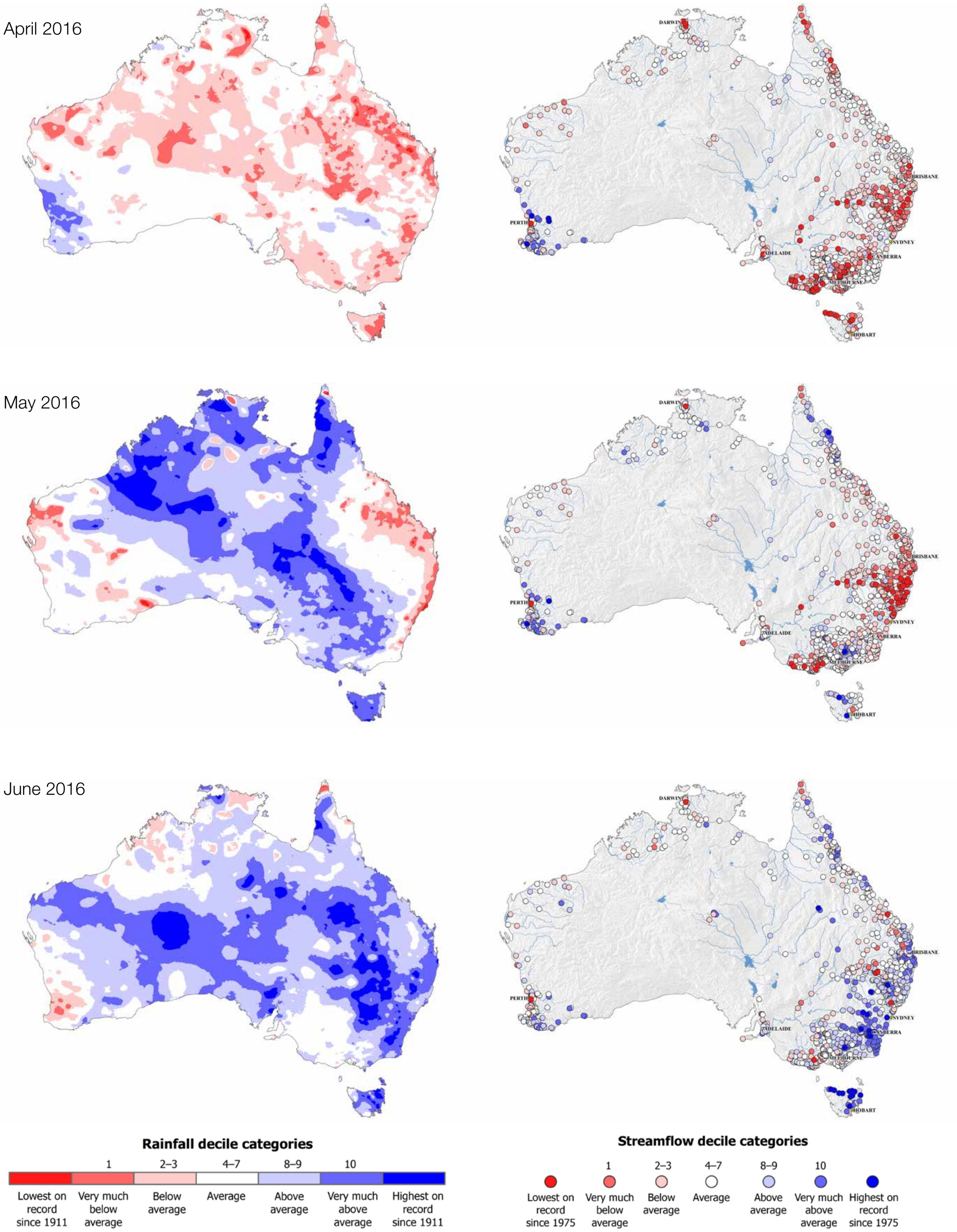


Figure 8. (continued) Monthly rainfall and streamflow conditions in 2015–16

2.2 WATER STORAGES

2.2.1 National view

Australia's total accessible public storage capacity is close to 80 000 GL. Around 36 per cent is part of the large hydro-electric power generation schemes located in Tasmania (Hydro Tasmania), and in New South Wales and Victoria (Snowy Mountains Hydro-Electric Scheme). The remainder is mostly used for direct water supply, including agricultural, urban and industrial uses, as well as for environmental releases. Some storage capacity is available for flood mitigation and small-scale hydro-electric power generation.

The accessible storage volume for direct water supply purposes at the beginning of 2015–16 was 64 per cent of capacity. Over the 12-month period, this declined by 7 percentage points to 57 per cent, slightly less than in 2014–15, when the decline was from 73 to 64 per cent.

In 2015–16, the reduction in total accessible storage for urban systems was 6 per cent of capacity, while that for major rural systems was 7 per cent.

2.2.2 Urban storages

The distribution and status of urban storage systems are shown in Figure 9, and their capacities and storage volumes are given in Table 1. One-quarter of the systems saw increases (up to 5 percentage points) in their storage volume during 2015–16; these were Adelaide, Canberra, Central Coast NSW, Mount Isa, Rockhampton and Sydney. Accessible storage volumes declined in all other systems.

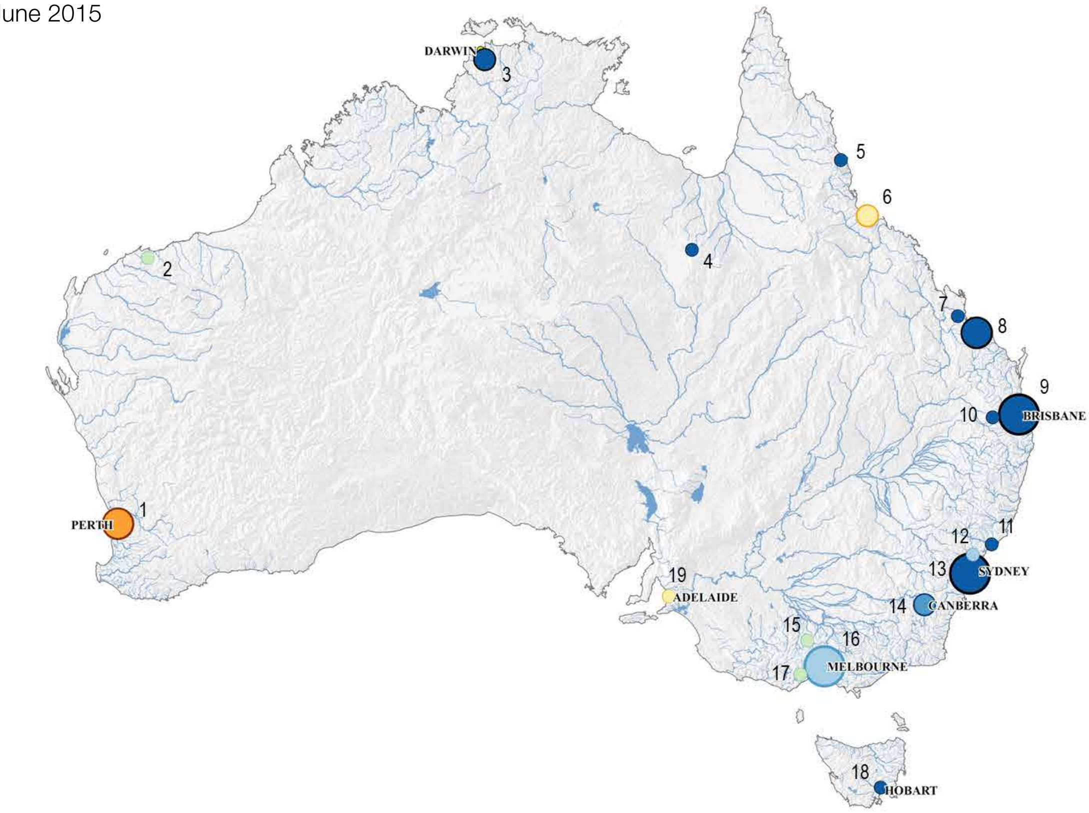
The combined urban storage volume declined from 81 per cent of capacity at 30 June 2015 to 75 per cent at 30 June 2016. Storage systems in Townsville and the Pilbara showed the largest proportional declines, from about 50 to 30 per cent of accessible capacity. Urban storage systems in Perth had the lowest percentage of accessible storage volume, following persistent dry conditions over much of the past few years.

Table 1. Urban systems storage capacity and volume at 30 June 2015 and 30 June 2016

Map reference (Figure 9)	System	Accessible capacity (GL)	Per cent full 30 June 2015	Per cent full 30 June 2016	Change (percentage points)*
1	Perth	597	23	20	-3
2	Pilbara	63	51	31	▼ -20
3	Darwin	235	111	102	▼ -9
4	Mount Isa	99	88	91	3
5	Cairns	37	101	91	▼ -10
6	Townsville	222	49	26	▼ -23
7	Rockhampton	59	99	100	1
8	Gladstone	662	95	87	▼ -8
9	Brisbane	2282	97	83	▼ -14
10	Toowoomba	127	82	70	▼ -12
11	Newcastle	149	135	128	▼ -7
12	Central Coast NSW	190	70	75	5
13	Sydney	2606	92	97	5
14	Canberra	278	79	82	3
15	Coliban	75	57	41	▼ -16
16	Melbourne	2032	63	53	▼ -10
17	Barwon Geelong	156	58	40	▼ -18
18	Hobart	4	98	88	▼ -10
19	Adelaide	197	47	52	5

* Red ▼ : a decline greater than 5 percentage points. Green ▲ : an increase greater than 5 percentage points.

(a) 30 June 2015



(b) 30 June 2016

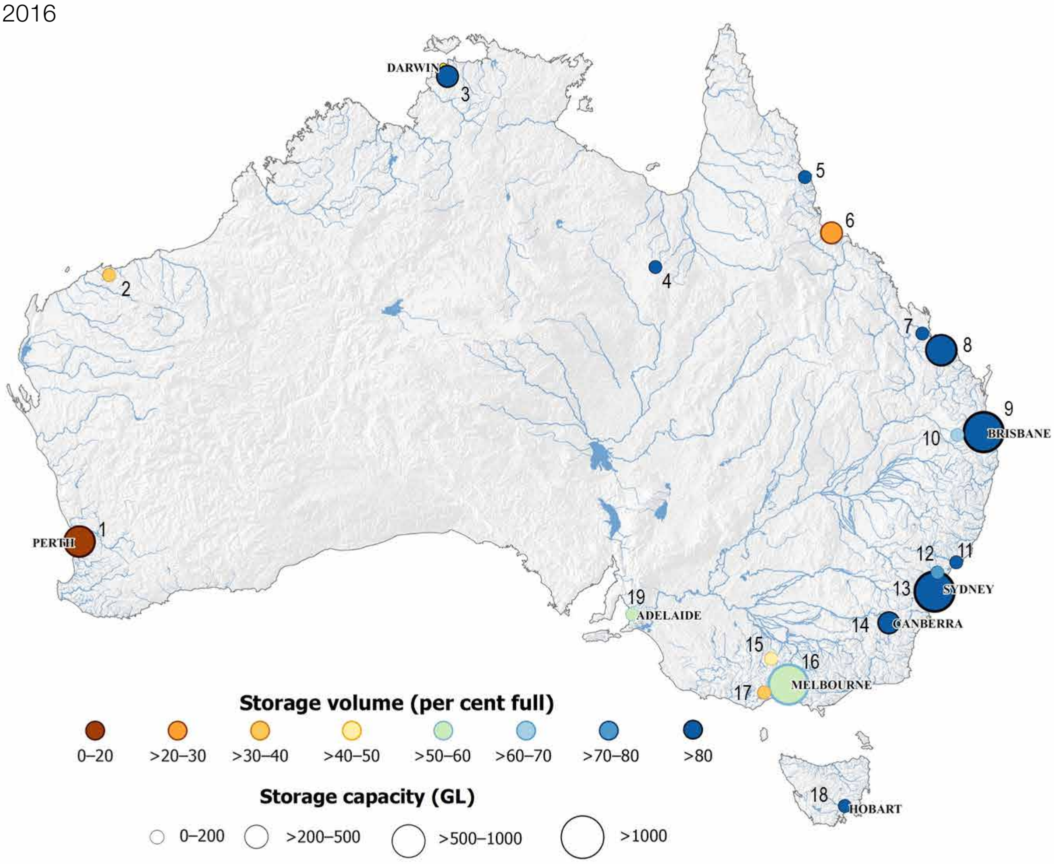


Figure 9. Distribution and storage status of urban storage systems (a) 30 June 2015 (b) 30 June 2016

Table 2. Rural systems storage capacity and volume at 30 June 2015 and 30 June 2016

Map reference (Figure 10)	System	Accessible capacity (GL)	Per cent full 30 June 2015	Per cent full 30 June 2016	Change (percentage points)*
1	Collie – Harvey Waroona	334	59	40	▼ -19
2	Ord	10 432	91	73	▼ -18
3	Mareeba–Dimbulah	438	88	55	▼ -33
4	Burdekin–Haughton	1852	73	91	▲ 18
5	Bowen–Broken	111	80	100	▲ 20
6	Proserpine	490	78	63	▼ -15
7	Pioneer Valley	139	86	90	4
8	Eton	62	74	100	▲ 26
9	Nogoa–Mackenzie	1289	51	39	▼ -12
10	Callide	148	87	80	▼ -7
11	Dawson Valley	50	92	77	▼ -15
12	Three Moon Creek	88	99	88	▼ -11
13	Upper Burnett	163	98	92	▼ -6
14	Bundaberg	872	98	92	▼ -6
15	Mary Valley	46	100	90	▼ -10
16	Boyne–Tarong	196	69	48	▼ -21
17	Barker–Barambah	134	50	41	▼ -9
18	Lockyer Valley	62	39	10	▼ -29
19	Warrill Valley	86	97	88	▼ -9
20	Chinchilla	10	94	30	▼ -64
21	Upper Condamine	104	22	12	▼ -10
22	St George	90	95	67	▼ -28
23	Border Rivers	632	31	32	1
24	North Coast NSW	11	101	100	-1
25	Gwydir	1343	18	16	-2
26	Namoi	873	9	14	5
27	Macquarie–Castlereagh	1523	21	27	▲ 6
28	Hunter Valley	1031	84	83	-1
29	Lachlan	1253	36	53	▲ 17
30	Murrumbidgee	2633	37	62	▲ 25
31	South Coast NSW	9	101	101	0
32	NSW and VIC Murray	6821	55	42	▼ -13
33	Gippsland	183	62	42	▼ -20
34	Ovens	32	72	74	2
35	Goulburn–Broken	3598	51	34	▼ -17
36	Campaspe	304	45	21	▼ -24
37	Loddon	213	34	12	▼ -22
38	Wimmera–Mallee	662	22	18	-4
39	Menindee	1555	5	3	-2
40	SA Murray	577	60	59	-1

* Red ▼ : a decline greater than 5 percentage points. Green ▲ : an increase greater than 5 percentage points.

(a) 30 June 2015

(b) 30 June 2016

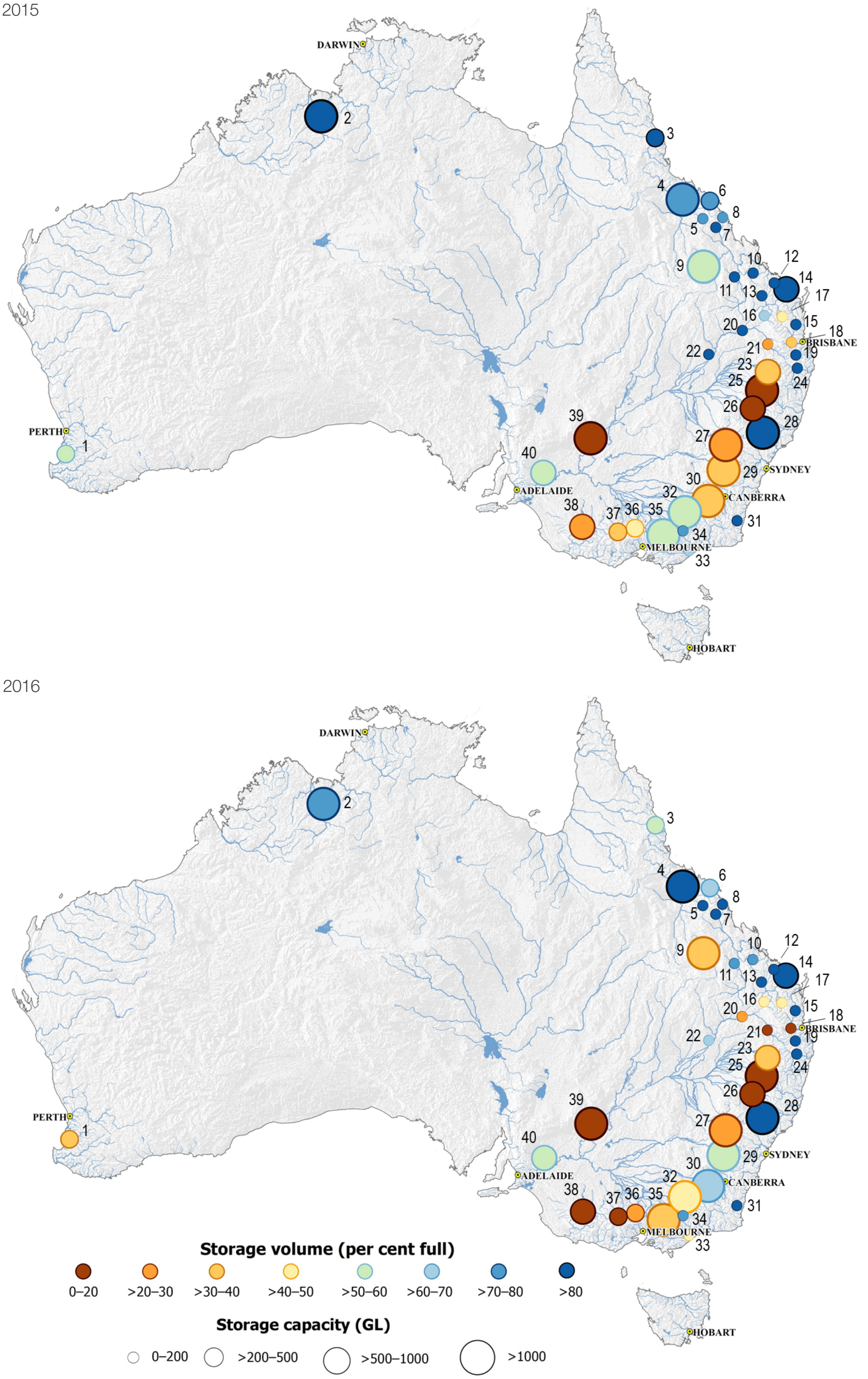


Figure 10. The distribution and storage status of rural storage systems (a) 30 June 2015 (b) 30 June 2016

2.2.3 Rural storages

The distribution and status of rural storage systems are shown in Figure 10, and their capacities and storage volumes are given in Table 2. Rural systems declined from 59 per cent of capacity to 52 per cent during 2015–16. One-quarter of the storage systems saw increases, the highest gains occurring in storage systems in northern Queensland, which had good inflows in February and March 2016; many of them finished the year close to full supply capacity. Small gains were made in some northern Murray–Darling Basin systems, due to low water use (resulting from low allocations) and the wet start to the 2016 winter.

Before the start of the 2016 winter rainfalls, most storages in the Murray–Darling Basin recorded their lowest volumes since the Millennium Drought. The largest declines during 2015–16 were in systems where annual allocations were high, such as the Victorian Murray and the Goulburn–Broken.

2.3 GROUNDWATER

Generally, the volume of groundwater stored in aquifers is very large compared with the volume of surface water. The accessibility and quality of the groundwater resources are, however, not always suitable for large-scale use. Long-term sustainable use of groundwater must balance extraction with recharge of the resource. One-fifth to one-third of the water used in Australia comes from groundwater. In areas with no nearby rivers or streams, groundwater is the only reliable and cost-effective water source available. Groundwater also supports aquatic ecosystems across the nation, as shown in the Groundwater Dependent Ecosystem Atlas.[10] However, the sustainability of groundwater systems is subject to the pressures of climate, development and population growth.

Aquifers are naturally occurring three-dimensional, water-bearing rocks and sediments; they vary by location and depth. The groundwater analysis presented here is a simplified representation of this three-dimensional medium—it only distinguishes between upper, middle and lower aquifer groups. The boundaries of these aquifer groups were recently updated by the Bureau to align with State and Territory aquifer definitions; thus, assessments presented in the previous *Water in Australia* reports are no longer comparable. However, to provide context, data for 2014–15 were re-analysed for this report, based on the new aquifer boundaries. The updated aquifer boundaries have been developed by aligning the existing aquifer boundaries, as presented in Australian Groundwater Insight[11], and grouping them based on the National Aquifer Framework.[12]

2.3.1 Groundwater levels

Groundwater levels measured from bores are one of the few direct measurements available to analyse changing groundwater resources. For this report, a five-year trend from July 2011 to June 2016 was chosen to identify meaningful changes in groundwater level. In addition, a status analysis compares the average groundwater level in 2015–16 with annual average levels for the previous 20 years. Examining trend and status data together is a useful way to give context to year-to-year changes in groundwater levels. The trends and status reflect several factors that influence groundwater, including climate, land use and extractions.

Figures 11 and 12 show the distribution of groundwater level status and trends at bores across Australia based on (a) upper, (b) middle and (c) lower aquifer groups, respectively. About 15 000 bores were used for the analyses, selected on the availability of groundwater level data.

10 www.bom.gov.au/water/groundwater/gde

11 www.bom.gov.au/water/groundwater/insight

12 www.bom.gov.au/water/groundwater/naf

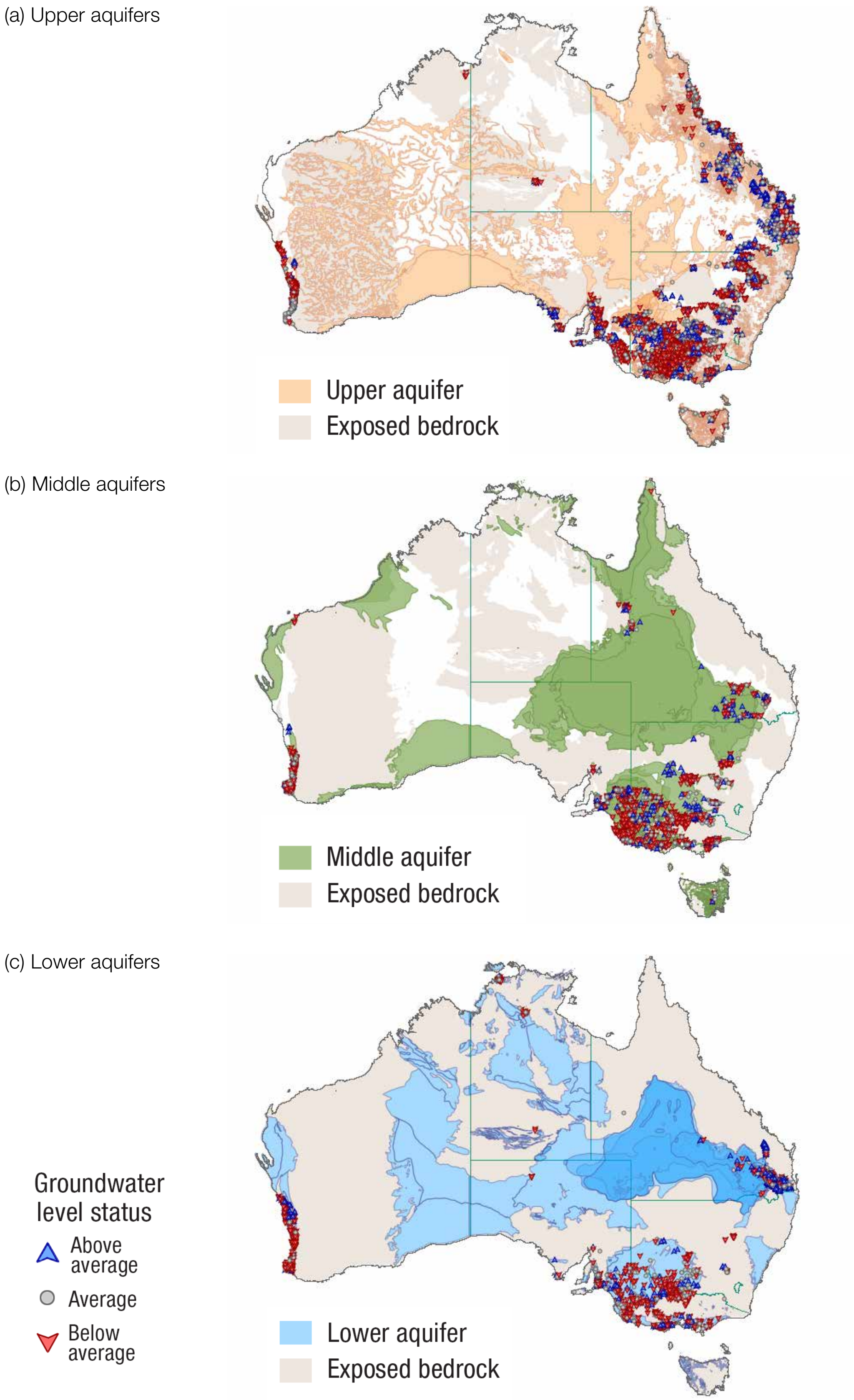
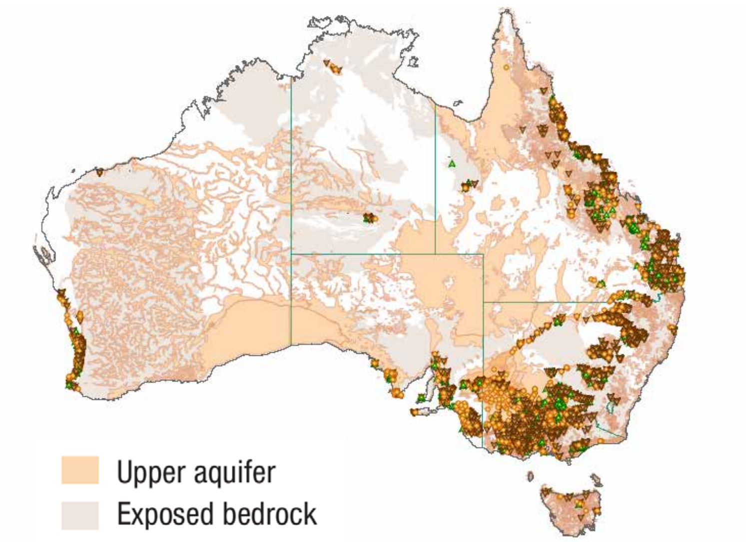
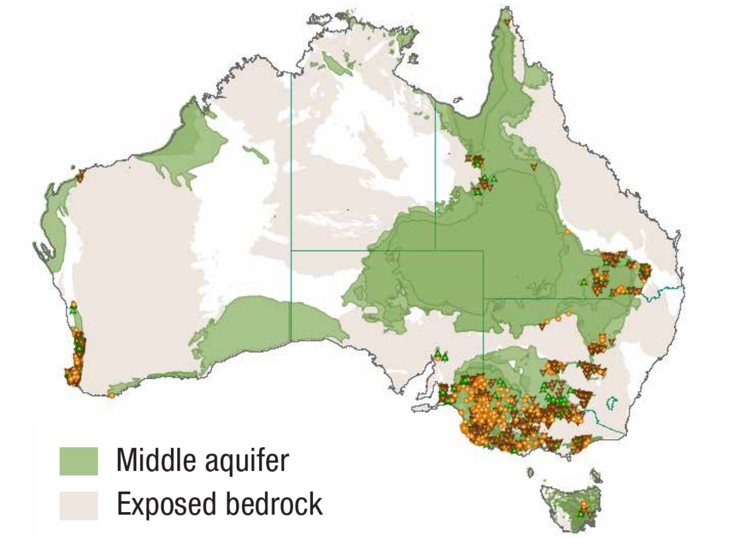


Figure 11. Groundwater level status in 2015–16 compared with the previous 20 years for (a) upper, (b) middle and (c) lower aquifers

(a) Upper aquifers



(b) Middle aquifers



(c) Lower aquifers

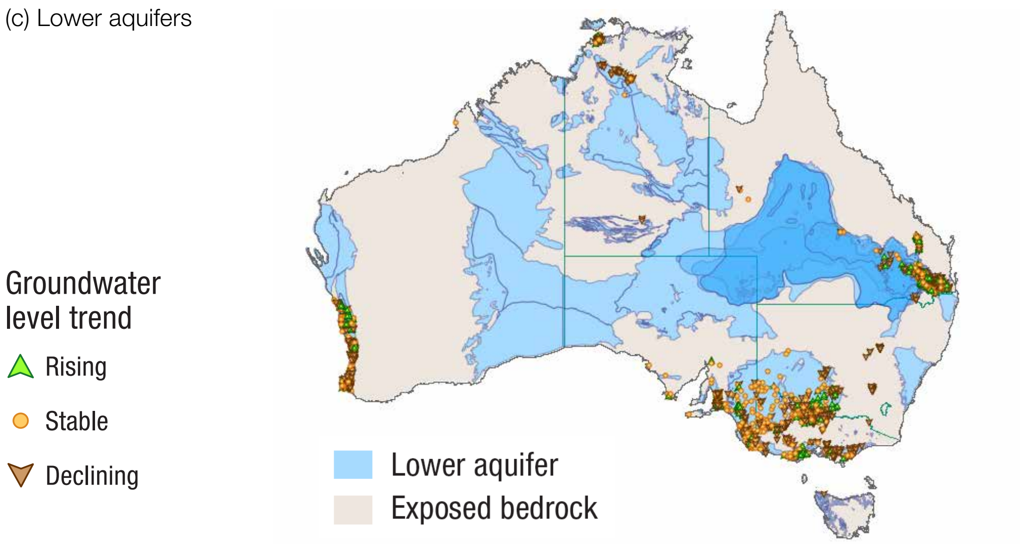
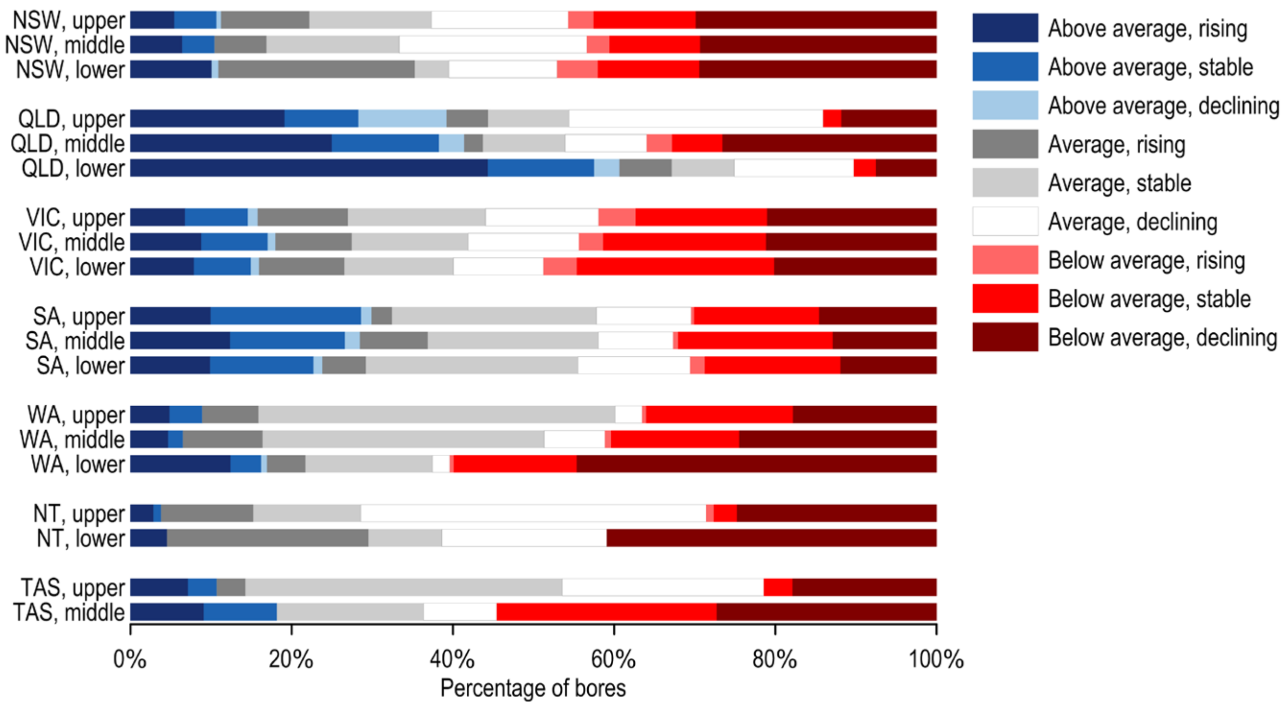


Figure 12. Groundwater level trends 2011 to 2016 for (a) upper, (b) middle and (c) lower aquifers

a) 2014–15



b) 2015–16

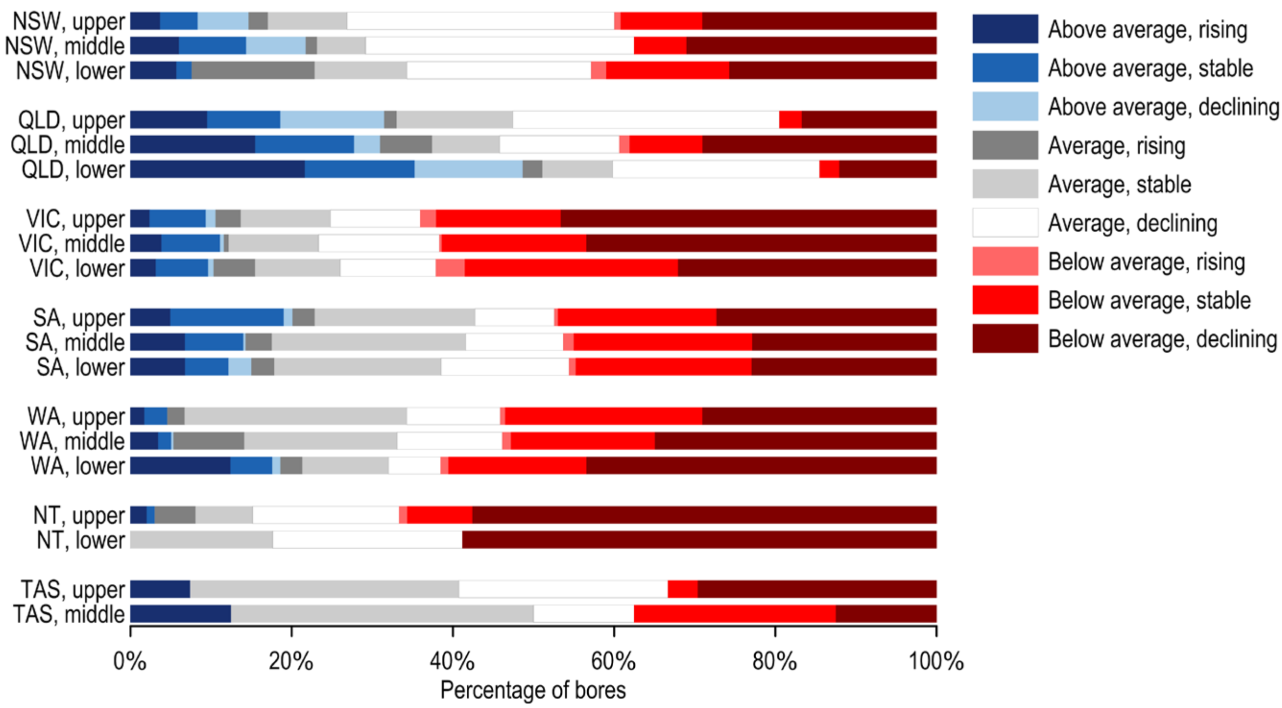


Figure 13. Summary of groundwater level status and trends by State or Territory (a) 2014–15 (b) 2015–16

Eighty per cent of groundwater levels in upper aquifer bores were below average to average across most of Australia, although this varied spatially. The five-year trends in groundwater levels were mostly declining (59 per cent) or stable (33 per cent). Similarly, groundwater levels of middle and lower aquifer bores were mainly below average to average with declining trends. Compared with 2014–15 data, across Australia the percentage of bores with below-average status increased from 32 to 40 per cent in the upper aquifer, from 39 to 52 per cent in the middle aquifer and from 34 to 41 per cent in the lower aquifer. This reflects continuing low to average rainfall and average to below-average streamflow in many areas where bores are located (Figures 3 and 4, section 2.1.1), and therefore continued reliance on groundwater extractions.

Notable exceptions were the aquifers in southeastern Queensland, where the majority of the bores had above-average to average groundwater levels, and the lower aquifers north of Perth, where the majority of bores had above-average groundwater levels.

Figure 13 summarises groundwater level status and trends by aquifer group for each State and Territory, for 2014–15 and 2015–16. The data for 2015–16 clearly highlight the average to above-average status of groundwater levels in Queensland, particularly in the lower aquifer group. Most groundwater levels in Tasmania were stable in 2015–16. Across Australia, a comparison of the 2015–16 data with the 2014–15 data shows an overall decrease in above-average levels and a general increase in below-average levels with a declining trend.

3 WATER TRADING AND USE

State and Territory governments use licences on water use to control the volume of water that can be extracted from their systems. Their decisions are based on the physical availability of water in the key water resources covered in chapter 2. The licences that water users hold come with a large variety of conditions, that often vary between each State and Territory. The most commonly issued licences for large volumes of water use are regulated entitlements, which have an annual allocation announced against their total entitlement volume.

This chapter starts with an overview of the impact of water trading on the availability of water to the licence holders (section 3.1). This is followed by an assessment of how the water made available to the environmental water holders was used throughout the year, and how cultural needs were addressed (section 3.2). Section 3.3 summarises the water extractions for agricultural, urban and industrial uses, and compares these to past Australian use and to other countries. Section 3.4 looks at groundwater extractions in Australia's groundwater management areas. Section 3.5 looks at water availability versus use in Australia's major rural surface water supply systems.

3.1 WATER TRADE

Australia's water market facilitates the buying and selling of water entitlements and allocations to allow water to move between various urban, agricultural and environmental uses. Entitlement trades involve permanent transfers of a water access entitlement. Allocation trades involve buying and selling allocated water within a particular year.

The following water trade data are sourced from the Bureau's Water Markets dashboard.[13]

3.1.1 Entitlement trading

Entitlement trading allows for structural changes in water-use distribution. The volume of water entitlements traded nationally is shown in Figure 14. During 2015–16, 1700 GL was traded, a minor decrease from 1800 GL in 2014–15.

The largest trade volumes involved New South Wales' general security surface water entitlements (included in 'Regulated—other' in Figure 14), although the high trading figures in 2013–14 were also influenced by 381 GL of supplementary entitlements secured by the Australian Government in the Murrumbidgee water system.

13 www.bom.gov.au/water/dashboards/#/water-markets

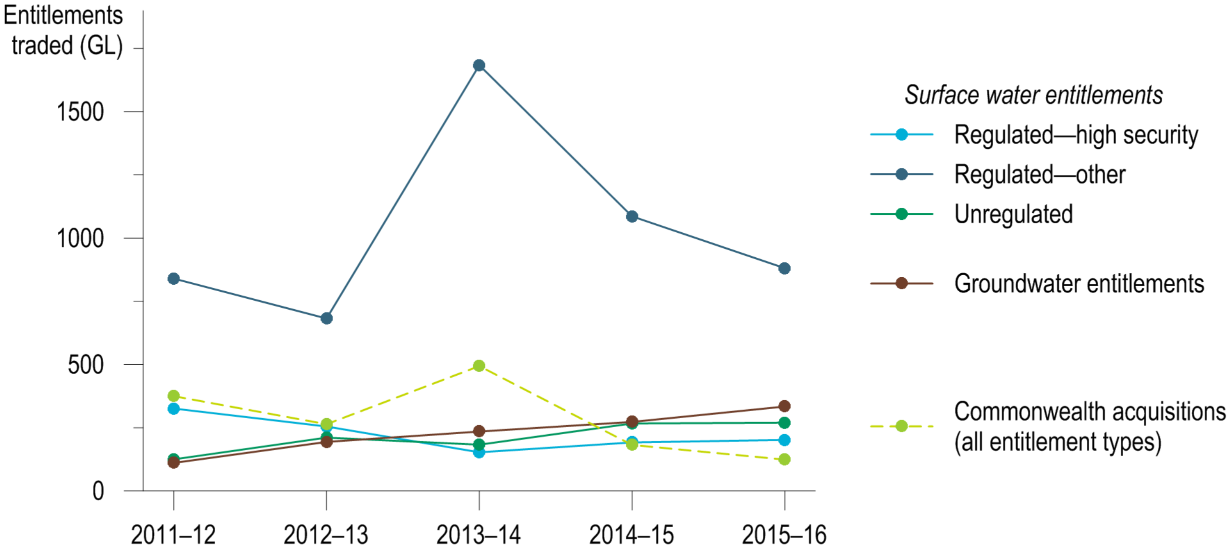


Figure 14. Volume of water entitlements traded nationally, 2011–12 to 2015–16

Entitlement trading predominantly occurs in the Murray–Darling Basin, which accounts for about 80 to 90 per cent of the total volume traded. Of this, about two-thirds occurs in the southern Murray–Darling Basin (including the Lachlan system).

Figure 15 shows the volume of surface water entitlement trades and the price of entitlement water for the southern and northern Murray–Darling Basin.

The southern basin shows a trend of rising prices since 2013–14, corresponding with conditions becoming drier and storage volumes declining. The trade price reflects increased demand relative to supply, with fewer entitlements (by volume) being traded for a higher price.

The trend in the northern basin follows a contrasting pattern, which can be related to the intrinsic value of an entitlement. The actual yield (average annual allocation) for most allocated entitlements in the northern basin is generally lower than in the southern basin, due to the absence of multiple major storages. In the last two to three years, many entitlements in the northern basin yielded close to zero water, reducing the value of those entitlements and putting downward pressure on trade prices.

In markets outside the southern Murray–Darling Basin, lack of connectivity between the rivers means that trading zones act more as separate markets, with different trading rules and characteristics. As these markets generally have fewer trades, large individual trades can have a strong impact on average prices. This results in greater price volatility, as shown for the northern Murray–Darling Basin in Figure 15.

In 2012–13, the Australian Government started to shift its focus from acquisitions to transfers of entitlements arising from water savings achieved through infrastructure projects. In 2015, the government introduced a cap on federal government buybacks, which further encouraged a decline in acquisitions in the Murray–Darling Basin.

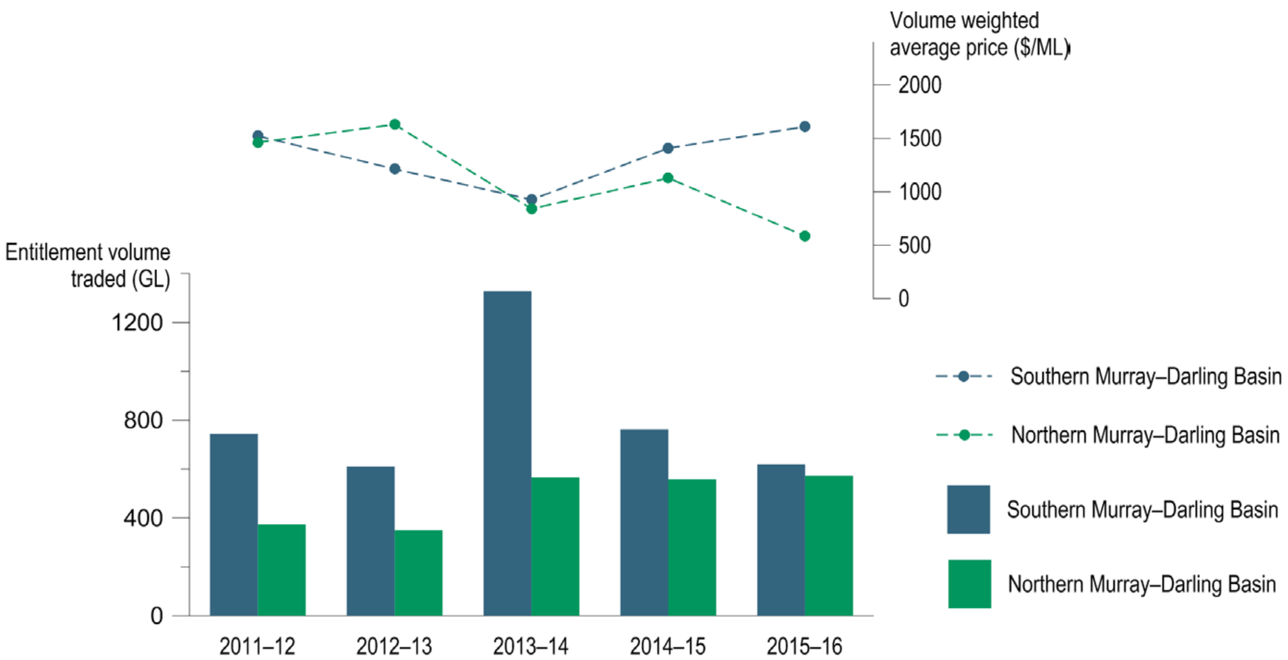


Figure 15. Surface water entitlement trade volumes and prices in the southern and northern Murray–Darling Basin, 2011–12 to 2015–16

3.1.2 Allocation trading

In 2015–16, 5800 GL of surface water allocation volume was traded, a marginal increase from the total allocation trade volume in 2014–15. Annually, about 80 to 90 per cent of all surface water allocation trading occurs in the southern Murray–Darling Basin (Figure 16). This is mainly because of the large amounts of allocated water being available in this market, compared to the northern basin or outside the basin.

For many irrigators and other water managers, water trading has become a normal business tool that helps them manage water availability for present and future crop demand. Additionally, environmental water holders have acquired a large volume of entitlements over the past years, and they can transfer the allocated water between different catchments in the southern Murray–Darling Basin to facilitate environmental watering events. These transfers are registered as trades.

Four of the larger trading areas in the southern Murray–Darling Basin are the Murrumbidgee River, New South Wales River Murray, the Victorian River Murray and the Goulburn River systems. Allocation prices for water sold in these river systems have increased steadily since 2011–12 (Figure 17). During 2012–13, there was a sharp decline in announced allocations for general security entitlements in the Murrumbidgee and New South Wales River Murray systems, which put upward pressure on prices in these two New South Wales systems. Prices in the Victorian River Murray and the Goulburn River systems also rose due to downstream users shifting more of their purchases to these two Victorian systems.

Average allocation prices started off at about $240/ML in July 2015, but at the end of the year they decreased to about $160/ML as water flowed into storages, increasing the prospects for higher allocation announcements in 2016–17. During 2015–16, prices in the Murrumbidgee River system were lower than prices in other systems in the southern Murray–Darling Basin because capacity constraints restricted their ability to trade outside the system.

3.1.3 Internal and interstate allocation trade

Although allocation trades in the southern Murray–Darling Basin are dominated by internal (intrastate) trades, about 22 per cent of the total allocation trade volume (more than 1100 GL) was traded over State borders (Figure 18).

Large volumes of water were transferred into South Australia to facilitate environmental watering along the River Murray and into the lower lakes. Over 600 GL of Commonwealth environmental water was provided from upstream to the South Australian Murray to support in-channel, wetland and low-elevation floodplain habitat.

A small amount of interstate trade took place between New South Wales and Queensland in the Border Rivers region.

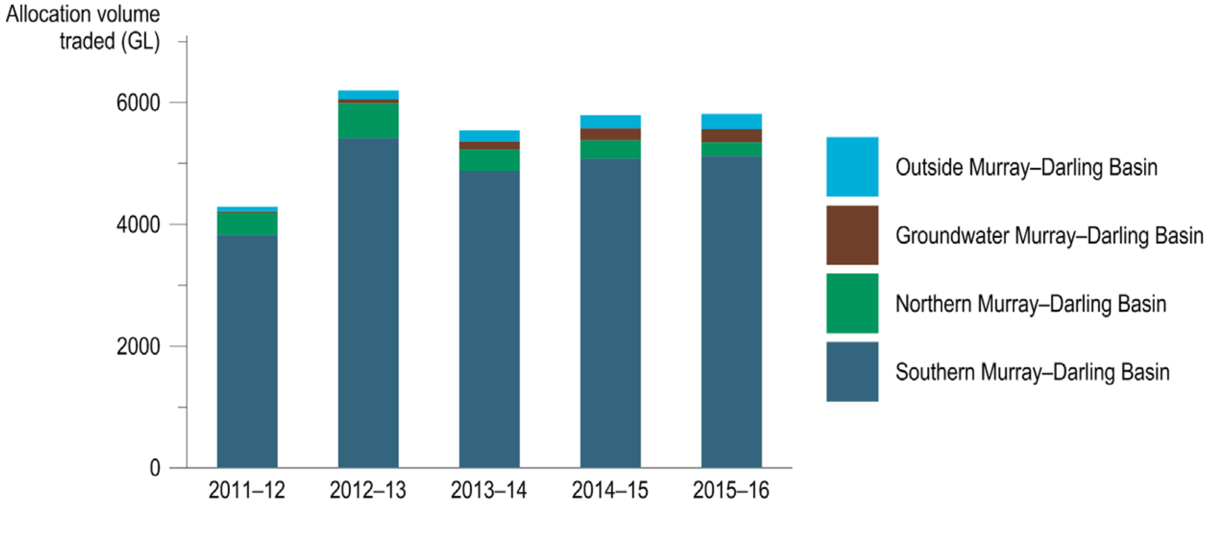


Figure 16. Volume of water allocations traded nationally, 2011–12 to 2015–16

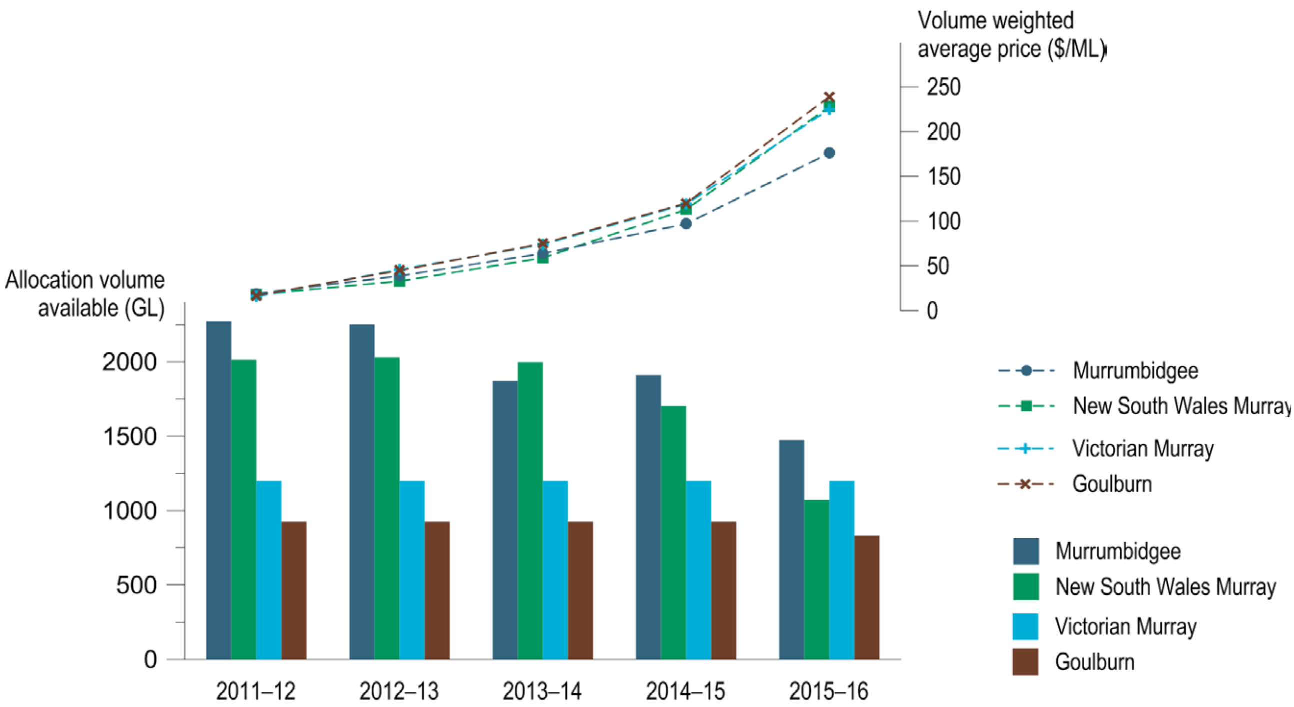


Figure 17. Surface water allocation trade volumes and prices of water sold in the southern Murray–Darling Basin, 2011–12 to 2015–16

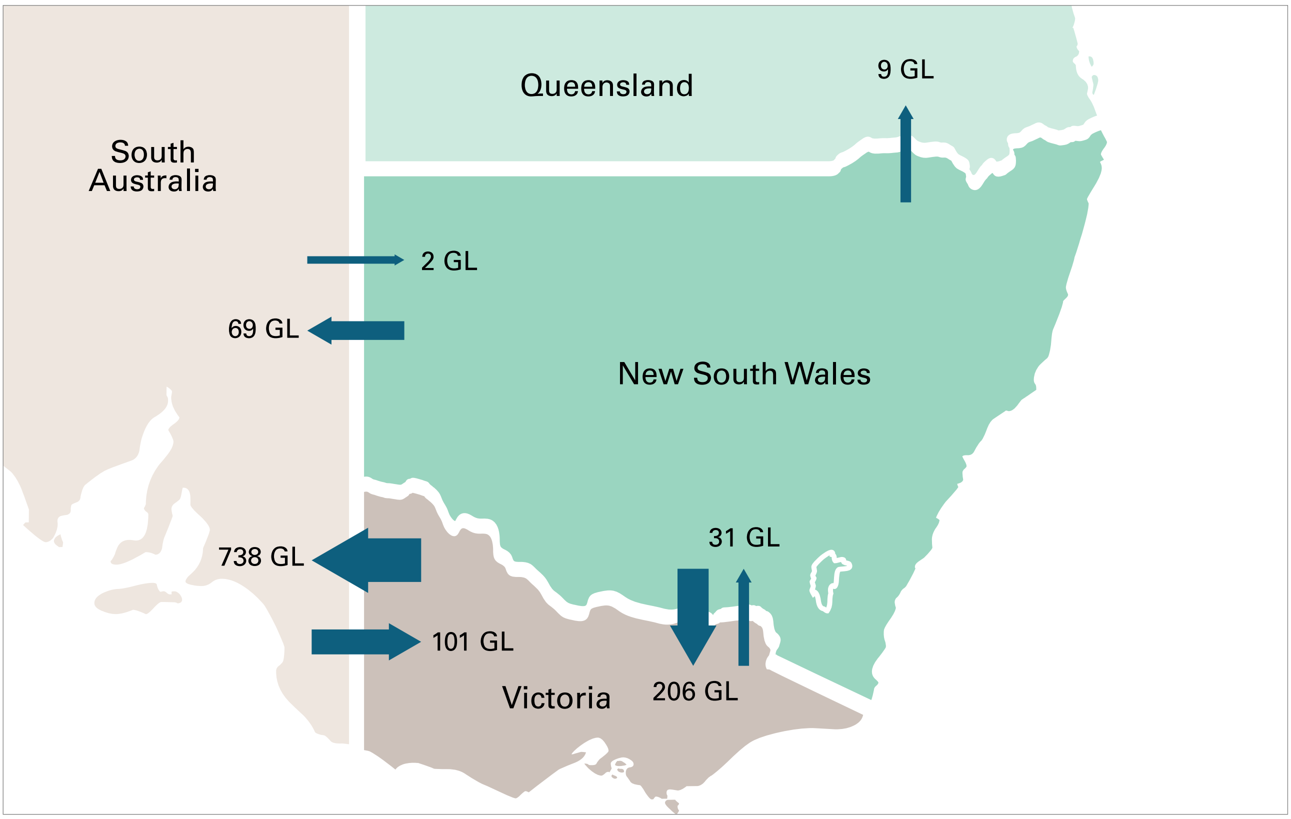


Figure 18. Interstate allocation trades in 2015–16

3.2 ENVIRONMENTAL WATER

Environmental water is a general term for water that is used to maintain the health of ecosystems fed by surface water or groundwater. Licences for this type of water use are held by various government agencies. The largest volume of environmental water licences held are surface water entitlements.

3.2.1 Environmental surface water use

The acquisition of surface water entitlements by a number of Australian Government, State and local environmental water holders since 2004 has substantially changed the way river and wetland health can be managed, particularly in the Murray–Darling Basin. The total volume of these acquisitions plateaued in 2015–16, as the total purchased entitlement yield approached the maximum limit of 1500 GL, which was set by the federal government in September 2015 following concerns about the social impacts of the water buyback program.

Total water releases from storages of environmental water held under regulated water entitlements in the southern Murray–Darling Basin were just over 1000 GL, while the total for the northern basin was 66 GL. These volumes were significantly less than the 1600 GL and 145 GL of environmental water releases in the southern and northern basins, respectively, during 2014–15. Lower allocations against the general security entitlements in New South Wales in 2015–16 were the main cause for this drop in environmental water use.

All environmental water releases made in the southern Murray–Darling Basin at the request of Commonwealth and Victorian environmental water holders and the Murray–Darling Basin Authority in 2015–16 are summarised in Table 3. As in 2014–15, much of the 2015–16 environmental allocation was used to improve ecological conditions along the River Murray, from Hume Dam to the Coorong – River Murray mouth. A key objective was to enhance fish reproduction, particularly of silver and golden perch, by increasing flow variations along the river. Another objective was to flood a number of wetlands.

All environmental water releases in the northern Murray–Darling Basin in 2015–16 are summarised in Table 4. Most of the 66 GL was released into the Macquarie River to support the health of permanent and semipermanent wetlands in the Macquarie Marshes. The only other major releases in the northern Murray–Darling Basin occurred in the Gwydir catchment. These supplemented high flows to enhance hydrological connectivity, refuge pools and water quality in many of the rivers and creeks.

Table 3. Environmental flow releases in the southern Murray–Darling Basin in 2015–16

Region	Released volume (GL)	Target
Mid-Murray and Lower Murray–Darling	635	Coorong – Lower Lakes barrage flows, Murray River flow variability increase for fish spawning, local wetlands and creeks watering
Goulburn–Broken	258	Riparian vegetation condition, native fish reproduction and condition, hydrological connectivity and water quality
Murrumbidgee	85	Mid-Murrumbidgee creeks and wetlands and Lowbidgee core wetland sites
Lachlan	36	In-channel fish reproduction and watering the Great Cumbung Swamp
Campaspe	14	In-stream base flows and a few short high-flow pulses to support native fish reproduction, hydrological connectivity and dispersal of biota
Loddon	9	In-stream base flows and high-flow pulses to support native fish reproduction, hydrological connectivity and water quality

Source: Commonwealth Environmental Water Office[14] and Victorian Environmental Water Holder (2016)

14 www.environment.gov.au/water/cewo/catchment

Table 4. Environmental flow releases in the northern Murray–Darling Basin in 2015–16

Region	Released volume (GL)	Target
Macquarie	53	Two flow pulses to avoid the loss, and maintain the resilience of permanent and semipermanent wetlands in core refuge areas of northern and southern Macquarie Marshes
Gwydir	13	Hydrological connectivity of in-stream habitat across the catchment, the persistence of pools as refuge and reduction in the risk of degrading water quality conditions

Source: Commonwealth Environmental Water Office[15]

Outside the Murray–Darling Basin, the total volume of environmental water releases in 2015–16 was about 200 GL. Total environmental water releases in the Snowy River reached 148 GL, less than previous years as a result of lower allocations. The released water was mainly used to enhance sediment movement in the river and fish reproduction. The general aim of the Snowy River Increase Flows program is to return the river to flow levels equivalent to at least 21 per cent of pre-development levels.[16] Some smaller volumes were released in other parts of Victoria; the Victorian Environmental Water Holder used its allocated water to support hydrological connectivity and fish reproduction in the southern Victorian rivers.

3.2.2 Water for Aboriginal cultural use

One environmental water release stood out for its cultural connection, namely, the watering of Carrs, Capitts and Bunberoo creeks and Backwater Lagoon in southwestern New South Wales. These wetlands are located between Frenchmans Creek and the River Murray west of Wentworth. The Commonwealth Environmental Water Holder provided 1.3 GL in April 2016 to support the rejuvenation of the threatened river red gum and black box trees in the area, as well as fauna within these creeks and the lagoon.

The area is currently Crown land managed by the New South Wales National Parks and Wildlife Service. However, processes have begun to hand over this land to the traditional Aboriginal owners, the Barkindji people, who are represented by the Tar-Ru Lands Board of Management. This board and the Traditional Owners will be the key stakeholders in the monitoring program that is being conducted to evaluate the ecological and cultural outcomes of this watering event.

Other environmental water releases also considered Aboriginal cultural values, but the evaluations of these events were largely restricted to environmental outcomes. A lot of work is in progress to better link the ecological and natural values of wetland and river health with their social and cultural values. This will eventually help to guide future environmental water releases towards better triple bottom line results.

15 www.environment.gov.au/water/cewo/catchment

16 www.water.nsw.gov.au/water-management/water-recovery/snowy-initiative

3.3 WATER EXTRACTIONS FOR CONSUMPTIVE USE

3.3.1 Total water extractions

The total volume of water extractions for consumptive use is defined as all licensed water extractions from rivers, storages, high-yielding aquifers, and recycling and desalination plants that are not used for environmental and cultural purposes. The estimated total volume of water extractions across Australia was 15 900 GL in 2015–16. This is 5 per cent lower than the estimated 16 700 GL of water extracted in 2014–15. Water extracted for agricultural purposes accounted for 70 per cent (11 200 GL) of the total, followed by water extractions for urban use at 21 per cent (3300 GL) (Figure 19).

The estimate of 1400 GL of self-extracted water used for industrial purposes is based on 2014–15 estimates of self-extracted water for the mining, manufacturing, electricity and gas supply, and other industry categories in the Water Account, Australia, 2014–15 (Australian Bureau of Statistics, 2016). Self-extracted water for these industries had remained stable at about 1400 GL since 2012–13.

Compared to neighbouring countries, countries with similar climatic conditions and most large countries, Australia appears to be using an average amount of water per capita (Figure 20). The data in this figure (and Figures 22, 23, and 25) were extracted from the Food and Agriculture Organization (FAO) of the United Nations' AQUASTAT database[17], which is an assembly of the latest available data, mostly dating from before 2015–16. The data for Australia have been updated with the 2015–16 data as presented in this report.

In the United States of America, water use per capita is more than double that of Australia, particularly driven by the large difference in industrial self-extraction of water. New Zealand has higher water use in all categories, mostly due to much higher availability, which allows them to have major high-use industries such as forestry, dairy and water bottling. Iran, Argentina, Egypt and Spain all have major rivers to feed large irrigation areas, as does Australia. However, Australia's relatively low flow volumes and proportionately high urban population mean Australia has a moderate per capita water use.

17 www.fao.org/nr/water/aquastat/data/query/index.html

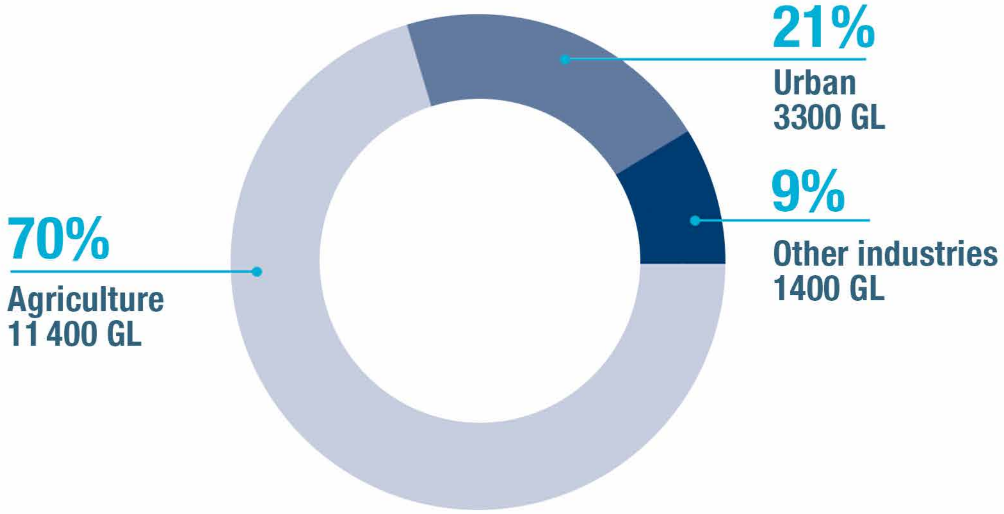


Figure 19. Total water extractions by industry sector in 2015–16

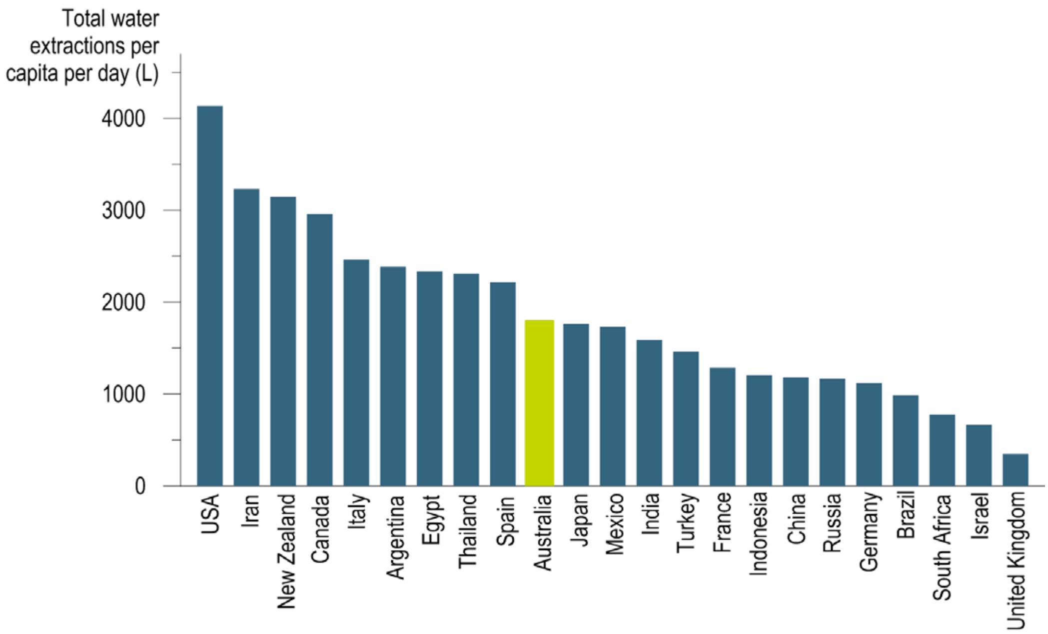


Figure 20. Total daily water extractions per capita for Australia and comparable countries

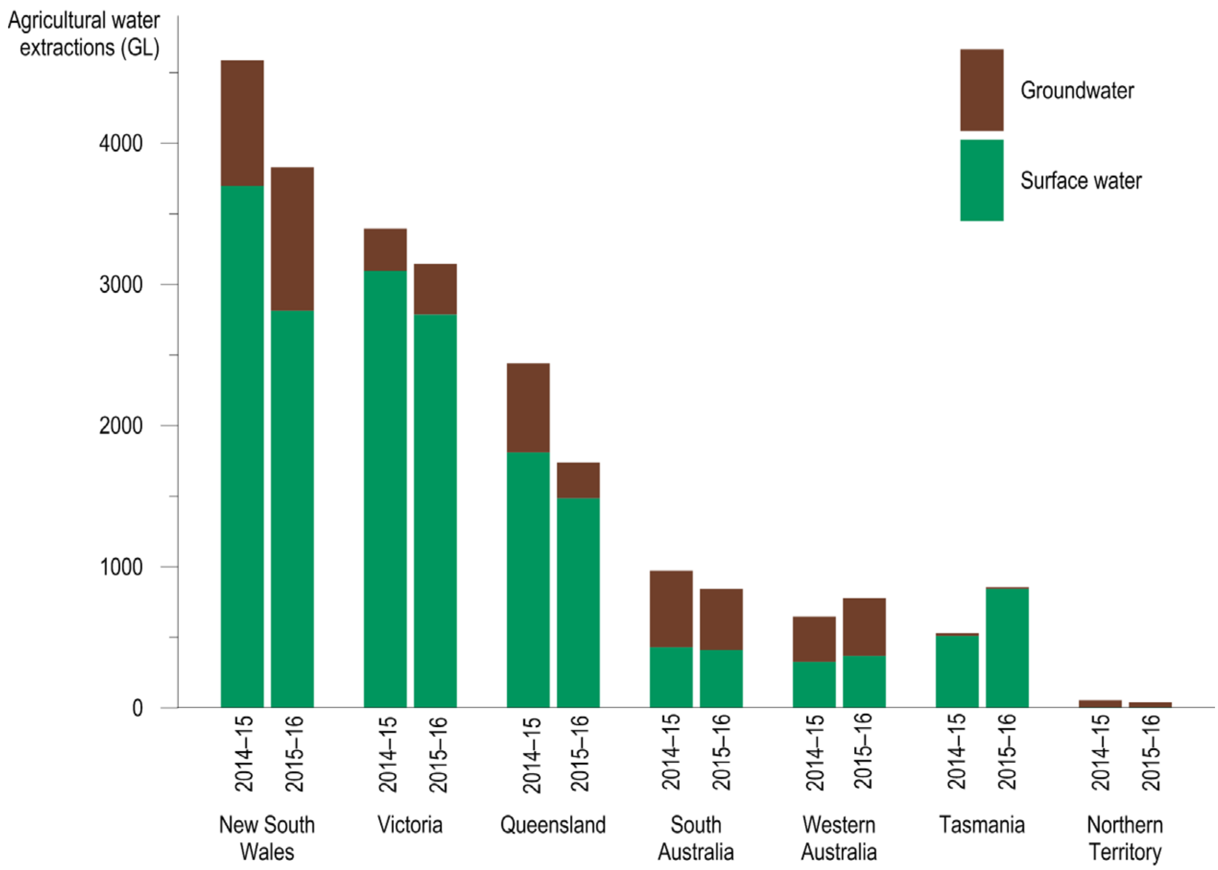


Figure 21. Volume of agricultural water extractions from surface water and groundwater in each State and Territory, 2014–15 and 2015–16

3.3.2 Agricultural water extractions

The total water extracted for agricultural use in Australia in 2015–16 is estimated at 11 200 GL, of which 8700 GL was sourced from surface water and 2500 GL from groundwater.

The annual total dropped by about 11 per cent from the previous year. Lower allocations for general security entitlements in New South Wales (Figure 21) contributed significantly to this reduction, and were counterbalanced to some extent by increased use of groundwater in New South Wales and a substantial increase in surface water use in Tasmania, following the drier conditions during the growing season.

Nationally, surface water extractions for agricultural use decreased by about 12 per cent (1200 GL), whereas groundwater extractions decreased by about 7 per cent (200 GL) compared with 2014–15.

These data were based on non-urban diversions in the National Water Account 2016[18], and supplemented by data sourced online or received directly from State data providers for regions outside the National Water Account regions.

Comparing agricultural water use with other countries (using FAO data), Australia again appears to be using an average amount of agricultural water per capita (Figure 22). Countries with per capita agricultural water use higher than Australia are the countries with similar climate and agricultural irrigation practices, as mentioned earlier, and intensive rice growing countries like Thailand and India.

18 www.bom.gov.au/water/nwa/2016

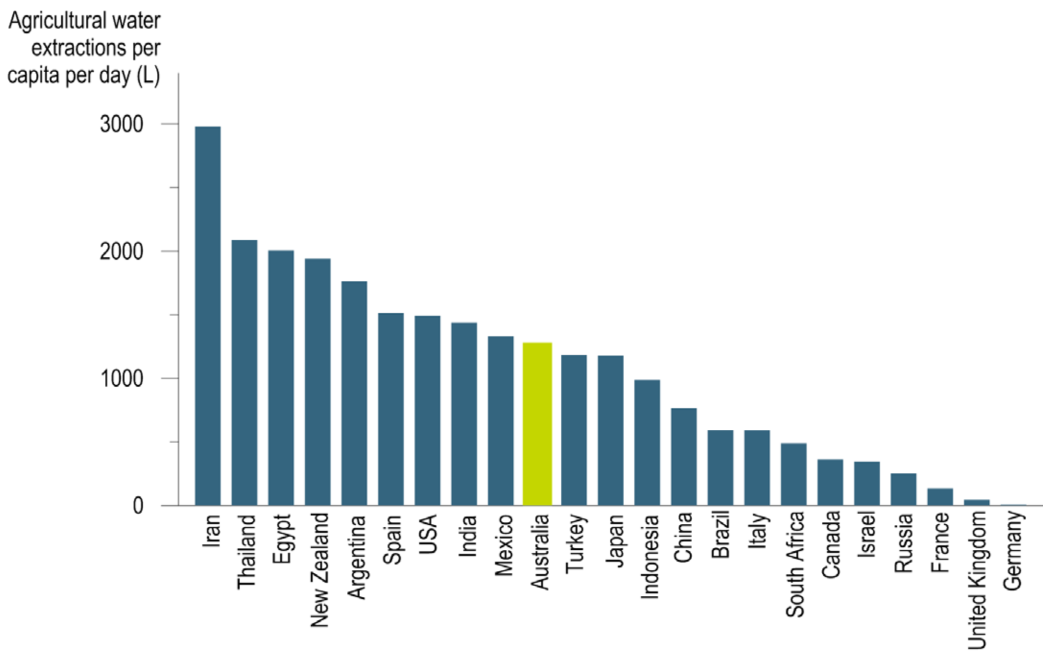


Figure 22. Daily agricultural water extractions per capita for Australia and comparable countries

3.3.3 Water sourced by urban utilities

In 2015–16, urban utilities extracted 3300 GL of water (Bureau of Meteorology, 2017), which includes recycled water used for urban purposes. In 2014–15, total urban water sourced by utilities was around 3100 GL. The slight increase in 2015–16 can be largely attributed to drier climatic conditions around the major urban centres, population growth and the inclusion of one additional utility (Central Coast Council) in the dataset. Just over 22 million people are connected to a distributed water supply network in Australia, and another two million people either extract their water themselves or are connected to a local rural town water supply system.

The security of water for urban users has improved in recent years with the construction of large-capacity marine water desalination plants in most major urban centres in Australia. Additionally, much effort has gone into raising awareness in the urban population of the importance of water security, strengthened by the introduction of permanent water conservation measures. This effort has resulted in a stabilising of per capita water use for residential purposes (at around 190 L per person per day) over the past four years.

If non-residential urban uses are included, urban per capita water use increases to 366 L per person per day. Figure 23 compares this number to that for other countries, using FAO data. In this comparison, Australia has a relatively high total urban per capita water use. One factor is the high living standards of Australian residents, with spacious urban design, large properties and irrigated parks and golf courses. In addition, the high urban concentration of Australia's population results in many other water-use activities, such as manufacturing and services, being located within the urban supply system networks and thus contributing to this moderately high urban use figure.

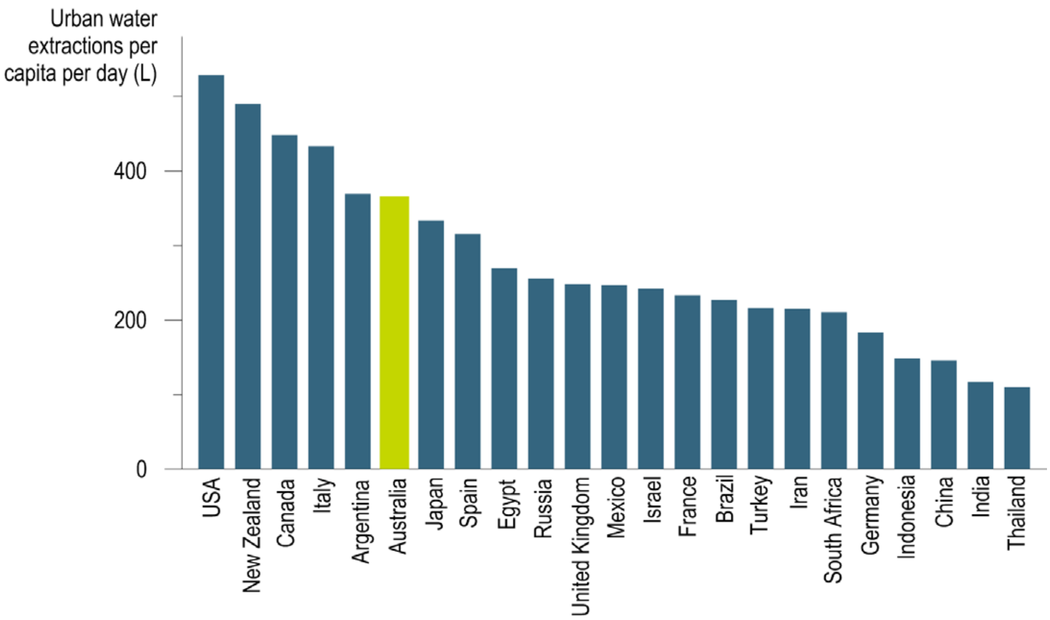
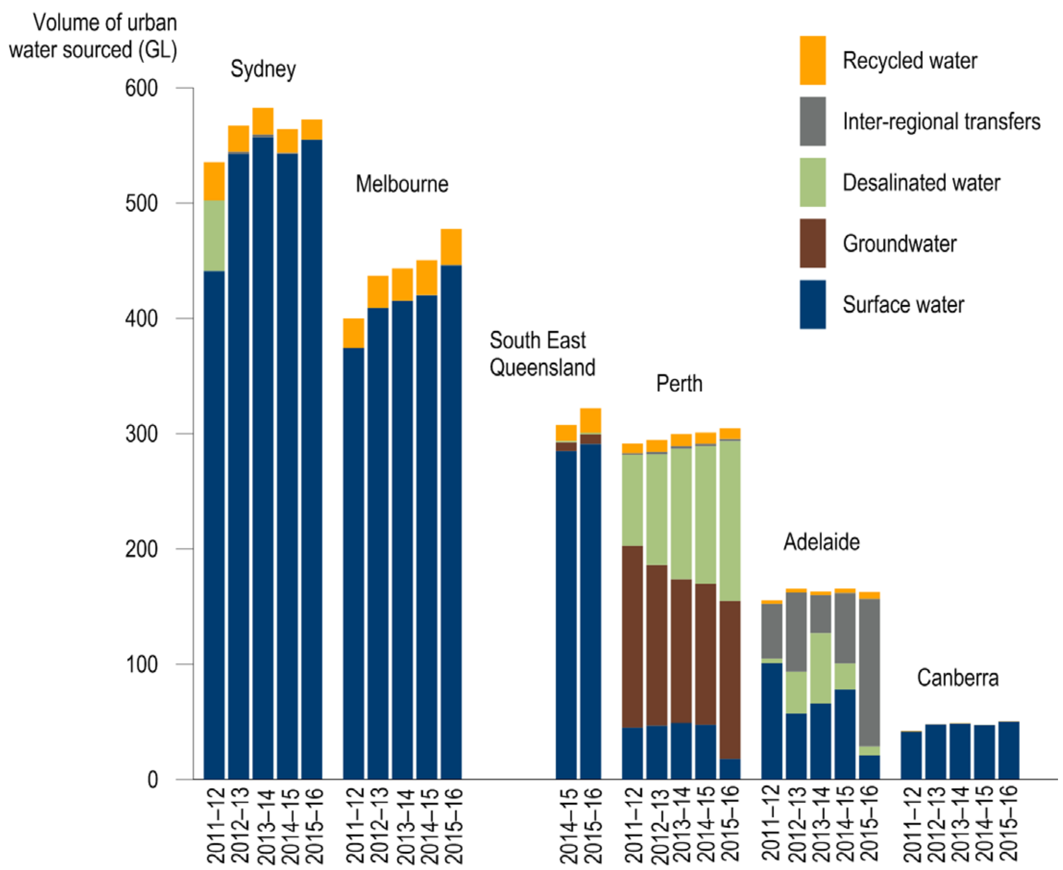


Figure 23. Daily urban water extractions per capita for Australia and comparable countries

3.3.4 Sources of water for major urban centres

Surface water sourced from local reservoirs is the most cost-effective and flexible, and therefore preferred, option for water supply in the eastern urban centres of Sydney, Melbourne, South East Queensland and Canberra. Recycling provides a secondary contribution to the total supply (Figure 24). The use of desalinated marine water has been temporarily suspended since the wet La Niña years of 2010–11 and 2011–12. Each of these urban centres sourced more water in 2015–16 than in 2014–15, driven by population growth and below-average rainfall.

Adelaide and Perth are on a different path. Between 2012–13 and 2014–15, as part of the commissioning phase of its new desalination plant, Adelaide sourced more desalination water than it did in 2015–16. Since the plant has been largely turned off, supply in 2015–16 was sourced mainly from the River Murray (on which the city relies for inter-regional transfers). Local reservoirs provided some additional water. Perth is taking increasing volumes of water from its large desalination capacity. Natural reservoir inflows remained low throughout 2015–16, which limited the use of surface water. Groundwater extractions grew slightly in 2015–16, breaking the declining trend of the previous four years.



Source: National Water Account 2016[19]

Notes: 1. The South East Queensland area boundary was altered in 2014–15, making comparisons with earlier years less valuable.
2. All water for Melbourne that the National Water Account 2016 treats as inter-regional transfer has been treated as arising from local surface water resources.

Figure 24. Volumes and sources of urban water used in Australia's major urban centres, 2011–12 to 2015–16

19 www.bom.gov.au/water/nwa/2016

3.3.5 Self-extracted water by other industries

Previous *Water in Australia* reports included an estimate of mining water use and water supplied to thermal power generators. This report re-evaluates the historical data available in the Bureau's National Water Accounts to calculate a more comprehensive estimate of extractions for consumptive use occurring outside the agricultural and urban supply systems. This also aligns more directly with the FAO data.

The estimate of 1400 GL of self-extracted water used for industrial purposes is based on 2014–15 estimates of self-extracted water for the mining, manufacturing, electricity and gas supply, and other industry categories in Water Account, Australia, 2014–15 (Australian Bureau of Statistics, 2016). Of the total, mining represents about 700 GL, manufacturing and other industries about 500 GL, and thermal power generation about 200 GL.

Australia's industrial water extraction rate is relatively low on a per capita basis compared with other countries (Figure 25). Even the relatively large contribution of water used in the mining industry does not compare to the high water volumes used in manufacturing in many of the major industrial countries.

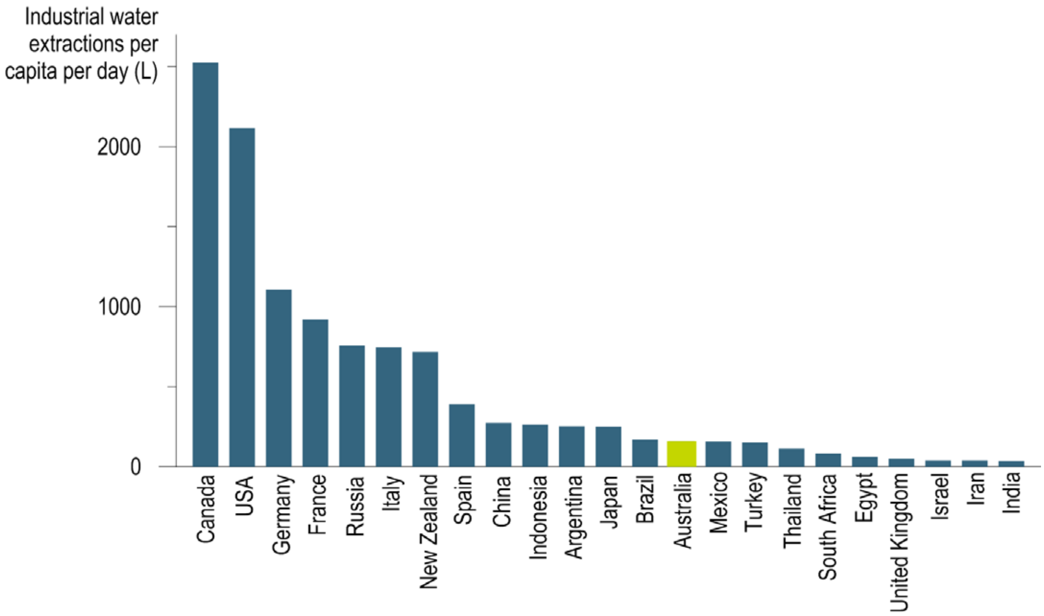


Figure 25. Daily industrial self-extractions of water per capita for Australia and comparable countries

3.4 GROUNDWATER EXTRACTIONS IN GROUNDWATER MANAGEMENT AREAS

In 2015–16, about 4900 GL of groundwater was extracted from groundwater management areas across Australia where groundwater use is reported as either measured or estimated. Groundwater management usually occurs in areas with a high density of groundwater users.

Groundwater extraction also occurs outside groundwater management areas throughout Australia, but data for these areas are not always reported. For example, Victoria estimated the volume of groundwater extractions for these areas to be about 7 per cent of the State's total extraction volume. Queensland also has groundwater licences that are 'not assigned' to a groundwater management area, but these represent less than 1 per cent of that State's total extraction.

In 2015–16, for the first time, the Bureau received groundwater extraction data reported by groundwater management area. Western Australia stands out as having high extraction volumes (Table 6). Large volumes in some of the Western Australian groundwater management areas, like the Pilbara and Goldfields regions, reflect groundwater extractions for mining. Extraction volumes by mining companies account for up to half of all groundwater extractions in Western Australia. In other States, groundwater extractions related to mining activities are not fully reported.

Table 5 shows the areas in each State and Territory with the highest groundwater extractions. Tasmania is not shown as it has only one groundwater management area, in the north of the State, although groundwater extractions occur throughout the State.

Overall, Australia extracted an estimated 63 per cent of the total groundwater entitlement volume during 2015–16. Table 6 shows groundwater extraction volumes and percentage use compared to entitlements within groundwater management areas. In Western Australia, where metering is not universally required for licensed extractions, most groundwater extractions were reported to be 100 per cent of the groundwater entitlement on issue and, therefore, may be overestimated.

Table 5. Areas with highest extractions in each State

State	Groundwater management areas with highest extractions
Queensland	Condamine and Burdekin groundwater management areas
New South Wales and Australian Capital Territory	Namoi, Lachlan and Murrumbidgee groundwater management areas
South Australia	Limestone coast groundwater management areas
Victoria	Shepparton Irrigation Region
Northern Territory	Darwin district
Western Australia	Pilbara and Goldfields mining regions, and Gingin groundwater management area north of Perth

Table 6. Groundwater extraction volumes and percentage use compared to entitlement within groundwater management areas

State or Territory	Extracted volumes in groundwater management areas (GL)	Average extraction by groundwater management areas as percentage of entitlement (%)
Western Australia	2540	87
New South Wales	950	54
South Australia	540	36
Victoria	430	54
Queensland	350	60
Northern Territory	90	40
Tasmania	6	100

3.5 WATER AVAILABILITY VERSUS USE IN MAJOR RURAL SURFACE WATER SUPPLY SYSTEMS

Analyses of Australia's major rural regulated supply systems show the differences in extractions for consumptive use between regions and years. Comparing physical water availability (storage volumes at the start of the year plus estimated inflows during the year), water-use permissions (carryover from last year and total allocations announced during the year) and actual water use (the total regulated diversions during the year) indicates how different supply systems reacted to variations in water availability. This information and their status in 2015–16 are provided for the major northern supply systems (Figure 26) and the Murray–Darling Basin (Figure 27). To provide a comprehensive overview, the data in Figures 26 and 27 include both extractions for consumptive use and environmental water availability. Inflows into dams are modelled, with the runoff estimated by the Australian Water Resources Assessment[20] modelling system.

3.5.1 Northern supply systems

Australia's northern regions have high physical water availability throughout the year. Storages mainly act as intra-annual buffers to overcome crop water shortages during the drier winters. Water-use permissions and actual use vary little between years, with generally full allocations announced against the entitlements. The total annual use in these regions is more a function of crop demand, following varying climatic conditions during the growing season, than of allocated water availability. In 2015–16, the Burdekin and Nogoa–Mackenzie systems recorded their lowest water availability of the last five years, but, even under these drier conditions, announced allocations at the end of the year were 100 per cent.

A correction to the data has been applied for the Ord supply system, where the *Water in Australia 2014–15* report incorrectly stated that the annual water entitlement volume for the newly developed Goomig Farmlands was 120 GL instead of 47 GL.

3.5.2 Murray–Darling Basin supply systems

The downward trend in water availability and use in the southern Murray–Darling Basin since 2011–12 persisted into 2015–16 in the Murrumbidgee, New South Wales and Victorian Murray, and Northern Victoria (Figure 27). Despite the strong June 2016 rainfall and inflows into the storages, total physical water availability dropped. This was very noticeable in Northern Victoria, where storage volumes at the start of 2015–16 and inflows during 2015–16 were lower than those of 2014–15.

Water use remained high in these systems, although the marginal widening of the gap between the total water-use permissions and actual water use in these years suggested that licence holders held back more water as carryover into 2016–17 than they did at the end of 2014–15. With drying conditions, carryover is a valuable tool in managing continuity of water supply.

20 www.bom.gov.au/water/landscape

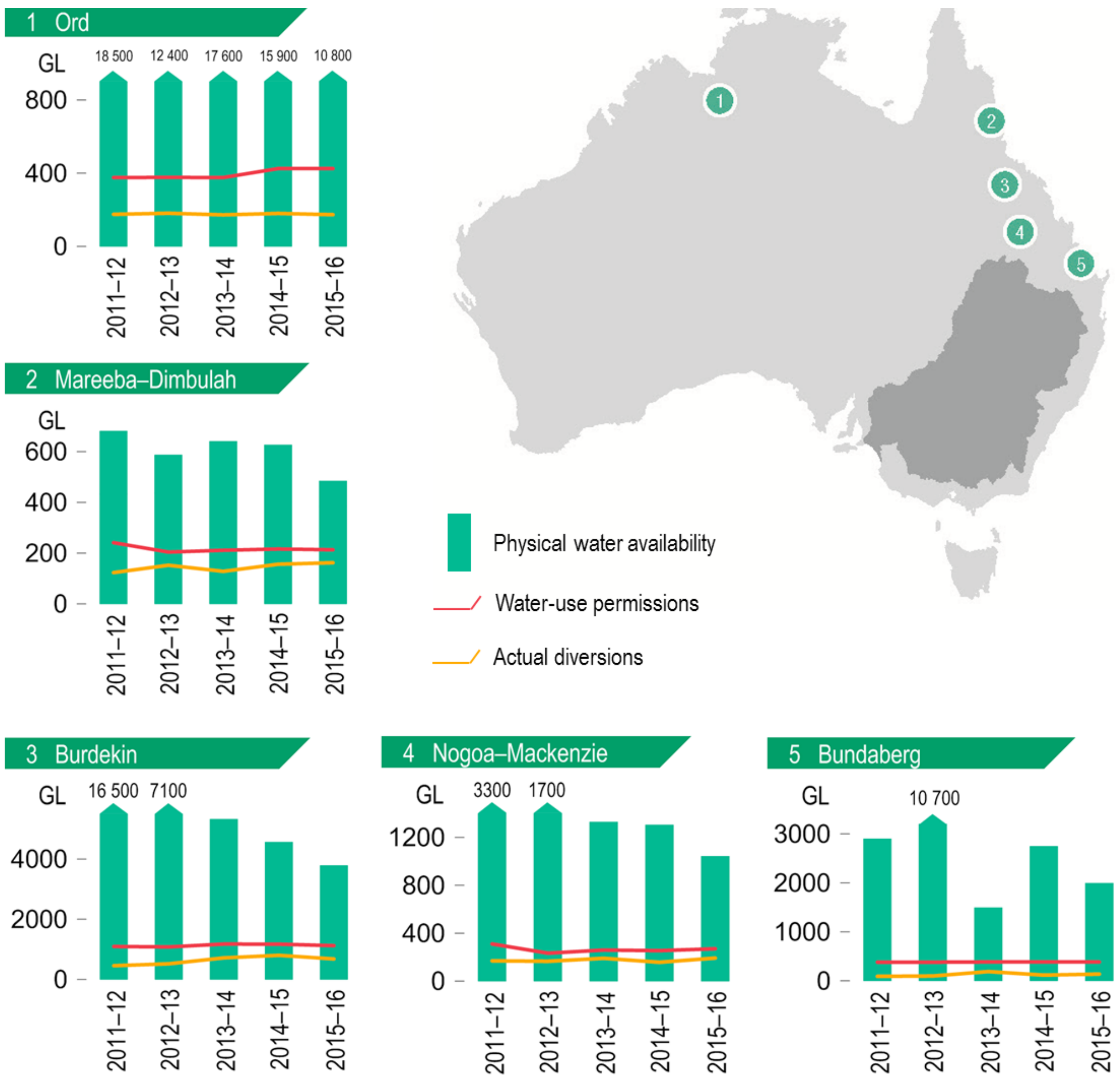


Figure 26. Volume of surface water available in northern Australia, volume of water permissions and volume of actual diversions in regulated systems (with more than 100 GL of annual use), 2011–12 to 2015–16

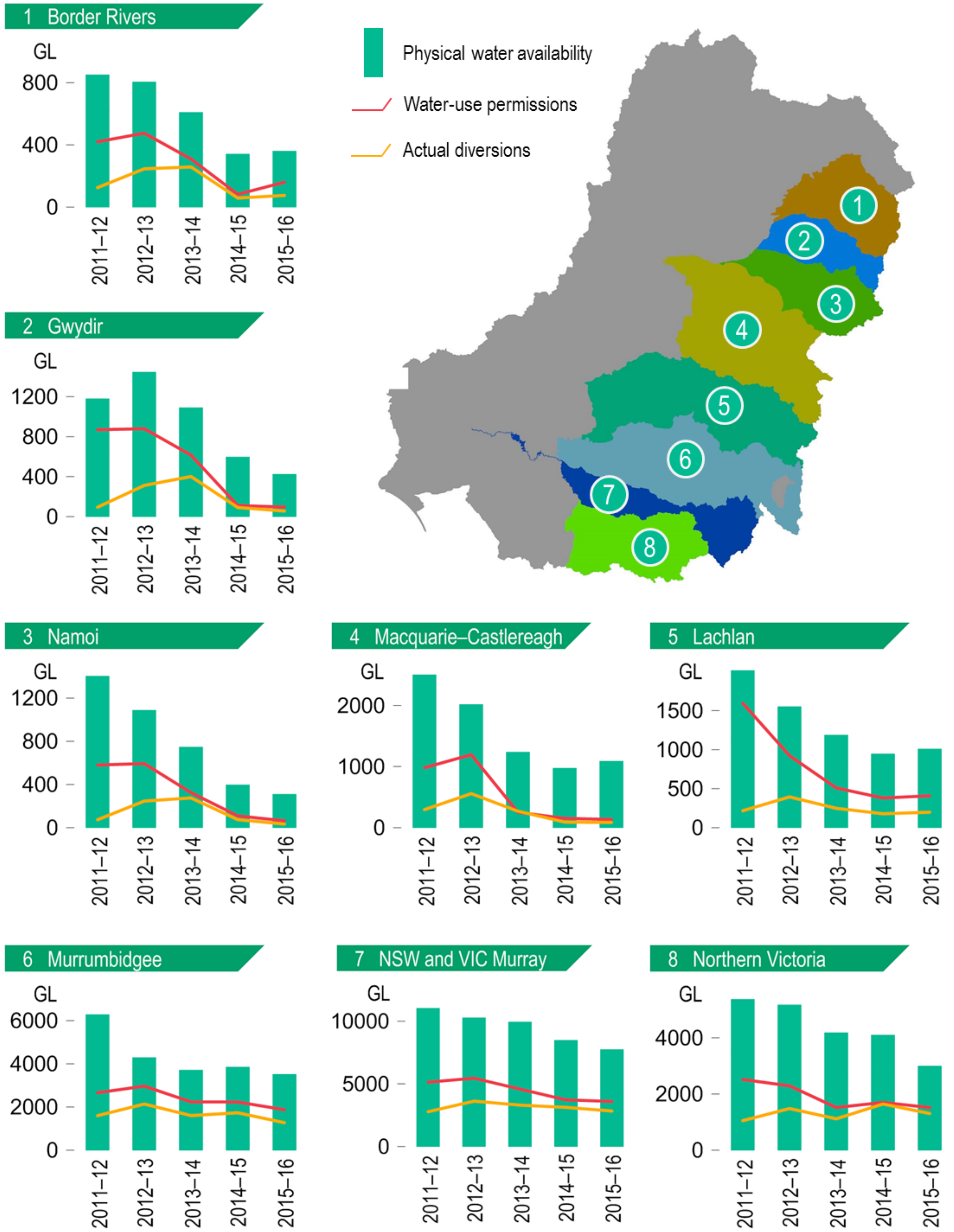


Figure 27. Volume of surface water available in the Murray–Darling Basin, volume of water permissions and volume of actual diversions in regulated systems (with more than 100 GL of annual use), 2011–12 to 2015–16

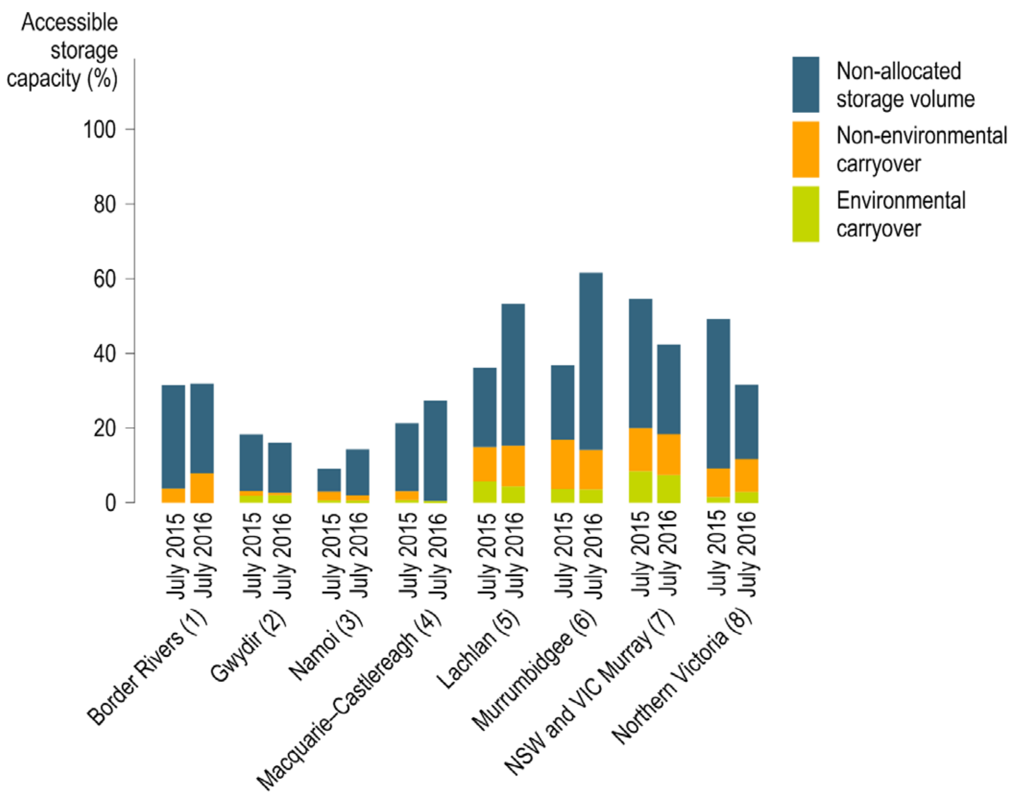
3.5.3 Allocation carryover

Allocation carryover occurs when water allocations are not fully used within the allocation period and are permitted to be transferred to the next period. Because the high rainfall in the major supply systems (that facilitate carryover) occurred so late in the water-accounting year, no new allocations were announced. As the rules on carryover are based on the volumes of allocated water remaining from the previous year, the carryover volumes into 2016–17 (Figure 28) reflect the dry conditions before the high inflows of June 2016.

The Border Rivers supply system had higher carryover into 2016–17 than into 2015–16, due to better inflows into its storages during 2015–16 than in the previous year, resulting in higher allocation announcements in 2015–16. This allowed irrigators to save more water for the 2016–17 growing season.

The security of water entitlements in Northern Victoria is generally higher than in all other regions. In this region, storage volumes further reduced during 2015–16 due to low inflows and normal use, as their allocation announcements remained high. The increase in carryover into 2016–17 is probably a result of conservative business approaches to counterbalance anticipated lower allocation announcements for 2016–17.

In all other supply systems, carryover volumes into 2016–17 were similar to or lower than the carryover volumes into 2015–16. These systems were all located in New South Wales, where most entitlements on issue are general security entitlements, which had rather low allocation levels in 2015–16. Most water available in 2015–16 was needed on the farms and for the environment, leaving little opportunity to carry over more water to 2016–17 than had been carried over into 2015–16. However, with the increased storage volumes and the positive prospects for further inflows due to wet catchment conditions, the likelihood of higher allocations in 2016–17 were good, particularly for the general security entitlements, in most areas of New South Wales.



Note: The numbers on this graph match the catchment numbers in Figure 27.

Figure 28. Storage volumes at 1 July 2015 and 1 July 2016, showing carryover from the previous year

4 GLOSSARY

accessible storage capacity	The volume of water that a water storage can hold between the minimum supply level and full supply level. It is the sum of this capacity that is reported for a collection of water storages.
aquifer	An underground layer of saturated rock, sand or gravel that absorbs water and allows it to pass freely through pore spaces.
bore	A hole drilled in the ground, a well or any other excavation used to access groundwater. May be used for observation of groundwater (including water level, pressure or quality).
catchment	The land area draining to a point of interest, such as a water storage or monitoring site on a watercourse.
climate	The average long-term weather conditions in a particular area. See the Bureau's climate webpage for more information. www.bom.gov.au/climate/glossary/climate.shtml
decile	One of a series of threshold values that divides a set of ordered data into ten groups with an equal number of data points in each. See the Bureau's decile page for more information. poama.bom.gov.au/climate/glossary/deciles.shtml
desalination	The process of removing salt from brackish or saline water.
drought	A long period of abnormally low rainfall, especially one that adversely affects agriculture and other human activities. See the Bureau's climate webpage for more information. www.bom.gov.au/climate/glossary/drought.shtml
ecosystem	A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.
El Niño	The extensive warming of the central and eastern Pacific Ocean that leads to a major shift in weather patterns across the Pacific. In Australia (particularly eastern Australia), El Niño events are associated with an increased probability of drier conditions. See the Bureau's webpage on El Niño for more information. www.bom.gov.au/watl/about-weather-and-climate/australian-climate-influences.shtml?bookmark=elnino
entitlement security	The frequency with which water allocated under a water access entitlement is able to be supplied in full.
environmental flow	The streamflow required to maintain appropriate environmental conditions in a waterway or water body.
environmental water	Water that is available, or preserved, to achieve environmental outcomes, including ecosystem function, biodiversity, water quality and water resource health.
environmental water release	Release of water from infrastructure, such as a surface water storage, for the benefit of the environment.
floodplain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding.
groundwater	Subsurface water in soils and geological formations that are fully saturated.
groundwater level	The level of groundwater in an aquifer, typically measured in a groundwater bore. In the case of an unconfined aquifer, the groundwater level is equal to the watertable level.
groundwater management plan	A document providing information about groundwater access for users. It may include rules about transferring licence entitlements, and arrangements that allow carryover of groundwater entitlements. It may also outline water sharing arrangements during times of water shortage.
La Niña	The extensive cooling of the central and eastern Pacific Ocean. In Australia (particularly eastern Australia), La Niña events are associated with an increased probability of wetter conditions. See the Bureau's webpage on La Niña for more information. www.bom.gov.au/watl/about-weather-and-climate/australian-climate-influences.shtml?bookmark=lanina
Millennium Drought	The prolonged period of dry conditions experienced in much of southern Australia from late 1996 to mid-2010.
rainfall	The total liquid product of precipitation or condensation from the atmosphere, as received and measured in a rain gauge.
recycled water	Treated sewage effluent, including water extracted by sewer mining and subsequently treated; it does not include treated urban stormwater.

regulated river	River on which a licensed entitlement regime exists with centralised allocation, and from which orders may be placed for upstream release of a licensed allocation. A necessary, but not sufficient, condition for a river to be regulated is that it is located downstream of a surface water storage. Note: the term 'river' can be replaced with 'channel' and retain the same meaning.
residential water	The total amount of metered and estimated non-metered, potable and non-potable water supplied to residential properties.
storage	A pond, lake or basin, whether natural or artificial, for the storage, regulation and control of water.
storage system	A water storage or group of water storages from which releases and diversions are the main source of water for users within the boundaries of a particular region, normally aligning with a river catchment.
storage volume	The volume of water stored at a particular time and date, including only the volume of water that can be accessed under normal circumstances without the installation of additional infrastructure.
streamflow	The flow of water in streams, rivers and other channels.
surface water	Water in a watercourse, lake or wetland and any water flowing over or lying on land, having precipitated naturally or having risen to the surface naturally from underground.
unregulated river	A river where there is no entitlement system at all or where there is an entitlement system that does not allow orders to be placed for upstream release of a licensed allocation. Note: the term 'river' can be replaced with 'channel' and retain the same meaning.
urban water	The total residential, commercial, municipal, industrial and other water supplied by urban water utilities.
water access entitlement	A perpetual or ongoing entitlement to exclusive access to a share of water from a specified consumptive pool, as defined in the relevant water plan.
water access entitlement trade	A transaction to buy, sell or lease a water right, in whole or in part, from one legal entity to another.
water allocation	The specific volume of water allocated to water access entitlements in a given season or given accounting period, and defined according to rules established in the relevant water plan.
water allocation trade	A transaction to transfer a water allocation from one legal entity to another, with or without a change in location, for the remaining water year (by default) or for a specified term that may be less than the end of the water year or carried over to subsequent years (i.e. lease).
water quality	The physical, chemical and biological characteristics of water. Water quality compliance is usually assessed by comparing these characteristics with a set of reference standards. Common standards used are those for drinking water, safety of human contact and the health of ecosystems.
water resource	All natural water (surface water and groundwater) and alternative water sources (such as recycled or desalinated water) that has not yet been abstracted or used.
water resource plan	A plan for the management of a water resource.
water sharing plan	A legislated plan that establishes rules for managing and sharing water between ecological processes and environmental needs of the respective water source (river or aquifer). It manages water access licences, water allocation and trading, extraction, operation of dams and the management of water flows, and use and rights of different water users.
water-use right	A right that allows use of water by specifying location of the use (plot) and/or purpose of the use.
watertable	The groundwater surface in an unconfined aquifer or confining bed at which the pore pressure is atmospheric. It can be measured by installing shallow wells extending a few metres into the saturated zone and then determining the water level in those wells.
water year	1 July to 30 June.
wetland	An area of land whose soil is saturated with moisture either permanently or intermittently. Wetlands are typically highly productive ecosystems. They include areas of marsh, fen, parkland and open water. Open water can be natural or artificial; permanent or temporary; static or flowing; and fresh, brackish or salt. Wetlands may include areas of marine water, as long as the depth at low tide does not exceed six metres.

5 REFERENCES

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