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2016–17

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Cover: Hume Weir, Victoria (hypedesk, iStock)

Foreword: Farm dam, Gippsland, Victoria (Garry Radler, iStock)

Introduction: Lake Wivenhoe, Queensland (Robert Downer, iStock)

Page 8: Lake Windermere (Malcolm Watson)

Page 10: River (Alison Pouliot)

Page 37: Mound spring on the Oodnadatta Track, South Australia. (Luke Doherty)

Page 38: Cattle at farm dam, South Australia (Jane55-hogarth, iStock)

CONTENTS

FOREWORD

Water is a finite resource and is vital to human well-being. Australia's rainfall and streamflow are among the world's most variable, so it is an ongoing challenge to reliably supply water of suitable quality to meet the needs of our communities, industry, economy and environment.

The water information published by the Bureau of Meteorology, as mandated by the *Water Act 2007* and the Water Regulations 2008, is based on data supplied by more than two hundred organisations across Australia. The Bureau integrates much of this information and makes it openly available in a range of online products.[1]

Water in Australia 2016–17 is the fourth report in an ongoing series, and covers the period from 1 July 2016 to 30 June 2017. It integrates data and investigations from across the Bureau to provide a national overview of the status of water availability and use for the reporting year in the context of long-term trends and climatic influences. This report is designed to help readers understand and learn from the past so that they can make better decisions for the future.

Valuable contributions to the report have come from the various organisations who have collected and supplied the data, and the many specialists in climatology, hydrology and geohydrology who have written and reviewed this report. I thank these organisations and specialists for their significant role in telling Australia's water story.

Dr Robert Argent
General Manager Water
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1 http://www.bom.gov.au/water/

OVERVIEW

ABOVE-AVERAGE RAINFALL WITH HIGHER-THAN-AVERAGE STREAMFLOWS

Mean rainfall for Australia for the year July 2016 to June 2017 was 592 mm. The year 2016–17 was one of rainfall contrasts: largely wet conditions for the first nine months but a dry period from April to June. The 2016–17 mean rainfall was 28 per cent above both the long-term mean of 461 mm and the 2015–16 mean (464 mm).

It was the eighth-wettest year on record measured across the whole of Australia. Rainfall was very much above average across large parts of the north and centre of the country, as well as parts of the Northern Tablelands district of New South Wales and across southeastern South Australia and western Victoria. Average and drier conditions prevailed along the east coast and in much of the southwest.

The 2016 July to September period was the second wettest on record for the whole of Australia due to the influence of a strong Indian Ocean Dipole. During September 2016, rainfall was very much higher than average across much of the country, resulting in the second-wettest September on record (Figure 1). Summer rainfall was also the fourth highest on record for Australia as a whole, and contributed substantially to the above-average rainfall for Australia during 2016–17.

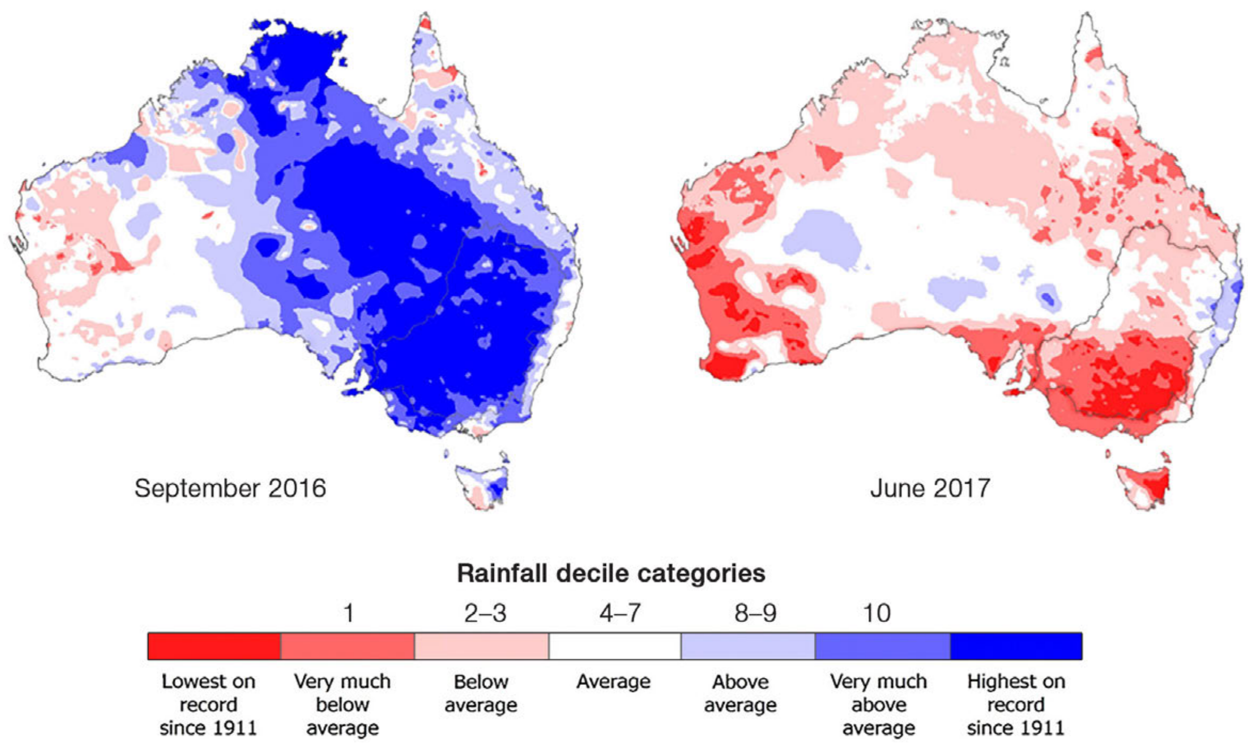


Figure 1. Rainfall deciles for September 2016 (second wettest on record) and June 2017 (second driest on record)

***Water in Australia 2016–17* draws on a range of Bureau information to describe the characteristics of Australia's water resources availability and use for the period 1 July 2016 to 30 June 2017.**

Autumn rainfall was slightly below average for Australia as a whole in 2017 but varied across the country. Ex–severe tropical cyclone *Debbie* made landfall on the central Queensland coast during March 2017. It tracked southeast towards the New South Wales border and beyond, causing rainfall anomalies of 400 mm above the long-term monthly mean over large parts of the coastal area. The remaining months of autumn had lower rainfall anomalies than the preceding months (December to March). The reporting period ended with Australia's second-driest June on record (Figure 1).

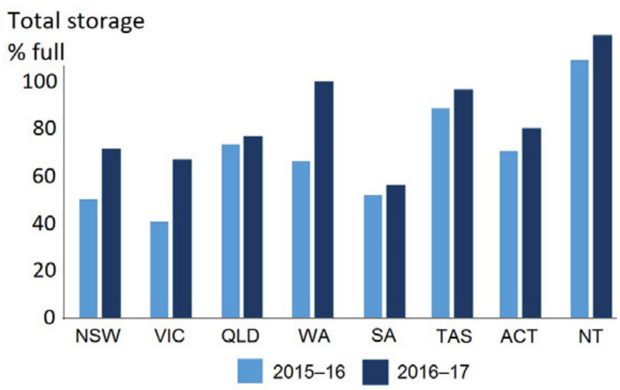
The annual streamflow conditions corresponded well with the spatial distribution of rainfall. Average to higher-than-average flows predominated across the country, with many higher-than-average flows in the tropical north (excluding Cape York) and the southeast, particularly in the southern Murray–Darling Basin. Average flows were recorded along the New South Wales coast and in most of Queensland. Matching the rainfall conditions, higher-than-average flows were recorded at 66 per cent of the gauging sites in September 2016. By June 2017 this had changed; almost 43 per cent of the gauges recorded lower-than-average flows in that month.

Streamflow was fresh (median salinity <500 mg/L) at about 60 per cent of the monitoring sites analysed in 2016–17. These sites were mostly located in areas with higher annual rainfall, particularly along the east coast. Sites in southeastern South Australia and southwest Western Australia had high salinities.

BOOST IN PUBLIC WATER RESERVES

Overall, the accessible storage volume of surface water totalled across Australia for direct water supply purposes increased due to the wetter-than-average conditions in 2016–17. The accessible storage volume at the beginning of the year was 57 per cent of capacity; by the end of the assessment period it had increased to 77 per cent of capacity. The combined accessible storage volume of urban and rural systems increased in all States and Territories by the end of 2016–17 in comparison to the beginning (Figure 2).

Despite some upward and downward movements in particular systems, the total accessible storage volume for urban systems was the same at the end of 2016–17 as it had been at the start of the year (75 per cent of capacity). The Toowoomba system showed the largest proportional decline, from 70 to 58 per cent of accessible capacity. The largest proportional increase in accessible storage capacity was recorded in the Pilbara system (from 31 to 93 per cent), followed by Coliban (from 41 to 73 per cent) and Barwon Geelong (from 40 to 70 per cent). At 30 June 2017, the Perth and Townsville water supply systems were the only two urban systems sitting below 50 per cent of capacity.



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

Figure 2. Storage status at the ends of 2015–16 and 2016–17 by State or Territory

The combined accessible water volume in rural storages across the nation increased from 52 to 78 per cent of capacity. The accessible storage volume in the Murray–Darling Basin and the Ord system increased significantly in 2016–17 due to the above-average inflows received during the year. In 2016–17, water allocation was the highest of the last seven years. Most water entitlement holders in the Murray–Darling Basin had received full allocations by the end of spring 2016.

Groundwater levels in the upper, middle and lower aquifers were generally average to below average with declining trends. The percentage of bores with below-average status was lower in 2016–17 than in the previous year.

INCREASED WATER TRADING

Entitlement and water allocation trade volumes increased in 2016–17 compared to the previous year. The volume of water entitlements traded nationally was 2100 GL, 23 per cent higher than in 2015–16. The total volume of surface water allocations traded during 2016–17 was 7000 GL, about 20 per cent higher than the previous year.

This year, the volume of entitlements traded in the northern Murray–Darling Basin exceeded the volume traded in the southern Murray–Darling Basin. Entitlement trade also increased outside the Murray–Darling Basin. The southern Murray–Darling Basin had a larger volume of allocation trading did northern Murray–Darling Basin, with a record-high volume traded in 2016–17. Improved water availability in 2016–17 also resulted in a significant drop in allocation prices.

Total water extractions in 2016–17 were slightly lower than the figures reported for 2015–16. The total volume of water extractions for consumptive use was estimated to be 15 670 GL.

Although the amount of water extracted for agricultural use in 2016–17 (70 per cent of the total) was similar to that of the previous year, the relative proportions of surface water and groundwater use differed. The increase in surface water availability resulted in increased surface water extraction for agricultural use in most regions, with a resulting drop in groundwater extractions. Thus, surface water extractions increased by 10 per cent whereas groundwater use dropped by 27 per cent.

About 20 per cent of the total extractions (3130 GL) was sourced for urban water supply, a 4 per cent reduction on the previous year's volume. The remaining 10 per cent was consumed by other industries. Recycled water use dropped in most of the major urban centres except Sydney and Canberra.

Most of the environmental water releases occurred in the southern Murray–Darling Basin. Total environmental water releases held under regulated water entitlements in the southern Murray–Darling Basin were just over 1900 GL, while the total for the northern basin was 168 GL. Both these volumes were much higher than the releases during 2015–16. Outside the Murray–Darling Basin, about 200 GL of environmental water was released in 2016–17.

HIGH STORAGE VOLUMES AT THE START OF 2017–18

The above-average rainfall conditions in 2016–17 facilitated a large increase in water volumes held in most of the public water storages. Despite a dry May and June 2017, storage volumes were high at the end of the year. In all the systems in the Murray–Darling Basin except the Gwydir, the total water in store for 2017–18, including the carryover and non-allocated volume, was more than 50 per cent of the accessible storage capacity. At the beginning of 2017–18, the likelihood of good allocations in that year was high due to this increased water in storage.

WATER RESOURCES WERE AT A LOW LEVEL OF STRESS

Water stress is estimated using the United Nation's Sustainable Development Goal indicator 6.4.2.[2] This is the ratio of freshwater withdrawn by major economic sectors and the total renewable freshwater resources, after allowing for environmental water requirements.

In Australia, this water stress indicator was 4.1 per cent in 2016–17, 5.9 per cent in 2015–16 and 7.4 per cent in 2014–15. These values are well below the initial water stress level of 25 per cent identified by the United Nations.

2 http://www.fao.org/sustainable-development-goals/indicators/642/en/

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. Under Part 7 of the *Water Act 2007*, the Bureau of Meteorology is required to collect, hold, manage, interpret and disseminate Australia's water information. As part of this role, the Bureau publishes an annual overview of water resources, availability and use across Australia in the context of long-term trends and climatic influences.

Water in Australia 2016–17 is the fourth report in this series of annual reports. It integrates data and investigations from across the Bureau to provide a national overview of the status of Australia's water resources availability and use for the period from 1 July 2016 to 30 June 2017.

Chapter 2 of this report provides an overview of water resources availability in Australia during 2016–17. It provides a summary of climatic conditions and rainfall during the year, and the resultant annual and monthly patterns of streamflow. Australia's groundwater resources and the contribution from climate-independent sources, such as desalination and recycling, are reported. The chapter examines the salinity of the streamflows, which may constrain water use. It also explores the effect of a historical decline in rainfall and streamflow on Perth's water storages. Renewable water resources in Australia are reported on a per capita basis.

The report then considers major water uses and how these have changed over time. Chapter 3 starts with an overview of water allocation and trade. Water use across Australia, including agricultural, urban, industrial and environmental water uses, is explored and compared to past use data. Water stress in Australia is estimated and reported using the United Nation's Sustainable Development Goal (SDG) indicator 6.4.2. Groundwater extractions in groundwater management areas are summarised, and water availability and use are compared for major supply systems across the country.

Water in Australia and related resources are available on the Bureau's website.[3] The information presented in this report is based on the best data available at the time of publication. Data used in the report are available for download through two complementary information sources.

- Regional Water Information[4] provides spatial and temporal information and summaries (from nationwide to the river region level) on the status of water resources and use.
- Monthly Water Update[5] provides a snapshot of monthly rainfall, streamflow, stream salinity and storage volumes for ten of Australia's 13 drainage divisions.

Rainfall values reported in *Water in Australia* are obtained from Regional Water Information, and were correct at the time of the analysis. Values may differ from those shown in other Bureau of Meteorology products due to later updates and small differences in geographical boundaries used in different products.

Other specific types of water information are also available[6] 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 contains 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.

3 http://www.bom.gov.au/water/waterassessments/

4 www.bom.gov.au/water/rwi/

5 www.bom.gov.au/water/monthly-water-update/

6 www.bom.gov.au/water/

- Urban National Performance Reports provide annual benchmarking of the performance of 79 major urban water utilities and councils and five bulk water authorities.
- Water Data Online provides watercourse level, watercourse discharge, storage level, storage volume, electrical conductivity, turbidity, pH and water temperature information from approximately 5000 water monitoring stations across Australia, many of which are updated daily.
- Water Storage dashboard allows comparison of water levels and volumes for more than 300 publicly owned lakes, reservoirs and weirs in different States and Territories, and shows how much water is available over the entire country.
- Water Markets dashboard allows viewing and comparison of the volumes and prices of water entitlements and allocations being traded in Australia. One can also view the number and volume of entitlements that are on issue nationally.

2 WATER RESOURCES

This chapter provides an overview of Australia's water resources from July 2016 to June 2017. It first describes the climatic conditions and rainfall experienced across the country over the year (section 2.1) and the resultant annual and monthly patterns of streamflow (section 2.2). Section 2.3 shows the effects of these patterns on water storage and looks in detail at historical changes to Perth's water storages. Section 2.4 looks at stream salinity, which affects the suitability of water for agriculture, drinking and other uses. Australia's groundwater storage aquifers are described in section 2.5. The contribution of water resources created by desalination and recycling is explored in section 2.6, and renewable water resources are discussed in section 2.7.

2.1 CLIMATIC CONDITIONS AND RAINFALL

The average annual rainfall across Australia for 2016–17 was 592 mm. This is 28 per cent above the long-term mean (from July 1911 to June 2017) of 461 mm and the previous year's average of 464 mm. Over the whole of Australia, 2016–17 was the eighth-wettest year on record.

Rainfall was very much above average across large parts of the north and centre of the country (Figure 3). Generally, average to above-average rainfall occurred across much of eastern Australia and in parts of the southwest away from the coast. Some parts of the southwest had lower-than-average rainfall.

A strong negative Indian Ocean Dipole influenced Australia's climate from June to November 2016 (monthly rainfall conditions are shown in Figure 7), resulting in the second-wettest July to September on record for the whole of Australia. Rainfall was higher than average across much of the country during September 2016, resulting in the second-wettest September on record for Australia. Record winter warm ocean water northwest of Australia resulted in moist air being distributed by a succession of troughs over most of the country. The negative Indian Ocean Dipole began to weaken in October 2016 and dissipated by late November 2016, bringing a return of more average rainfall patterns across Australia.

December 2016 and January 2017 were wetter than average (the fifth and fourth wettest on record, respectively), contributing substantially to the above-average rainfall for Australia for 2016–17 (Figure 4). Several tropical lows tracked across northern Western Australia (the Kimberley) and the Northern Territory during these months. Rainfall received in February and March added to the total with continued monsoonal activity in northern Australia.

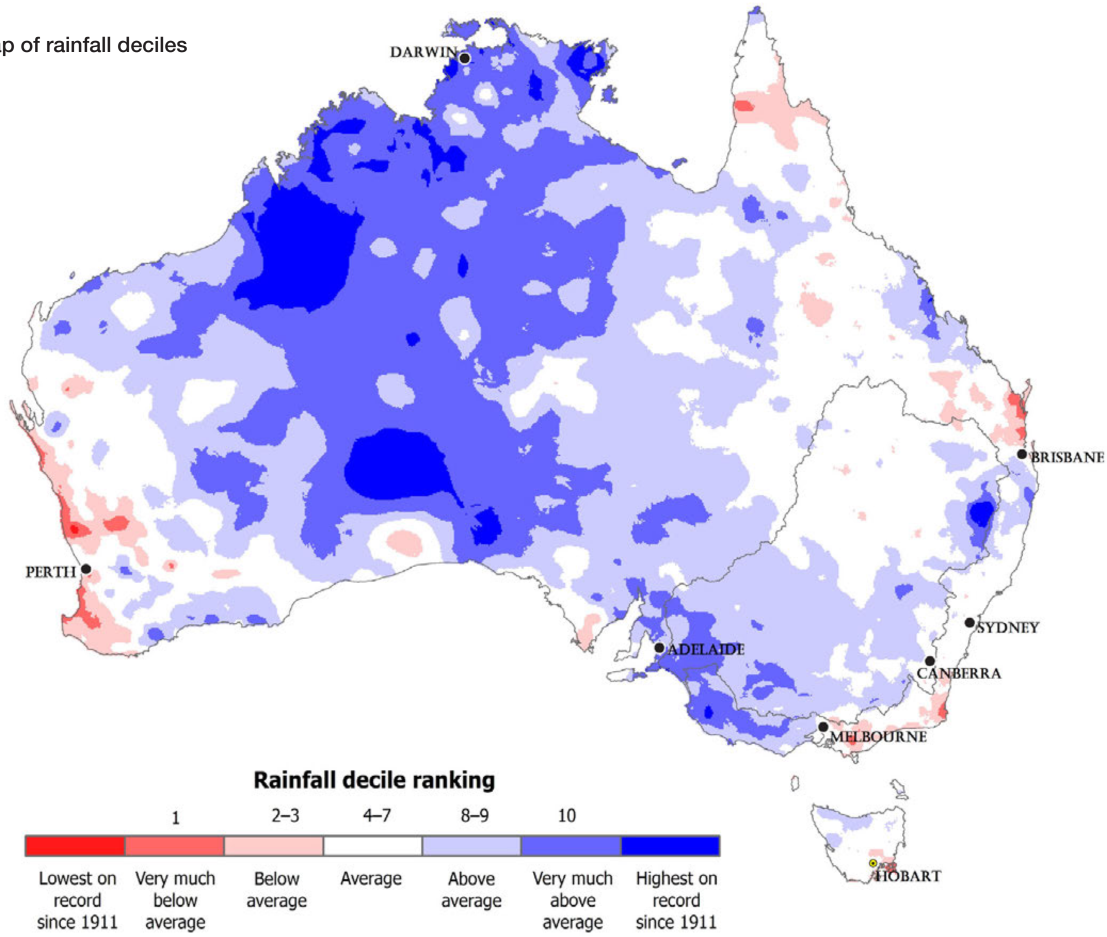
March was the month when ex–severe tropical cyclone *Debbie* made landfall on the central Queensland coast. It tracked southeast towards the Queensland – New South Wales border and beyond, causing rainfall anomalies over 400 mm above the long-term monthly mean (Figure 5).

In April 2017, a band of higher-than-average rainfall stretched from the northwest to the southeast of the country while the rest of the country, particularly across the northeast and southwest, experienced mainly below-average rainfall. During the remainder of the year, these drier conditions extended to most of the country. June 2017 was the second-driest June on record (a contrast from June 2016 which was the second wettest on record).

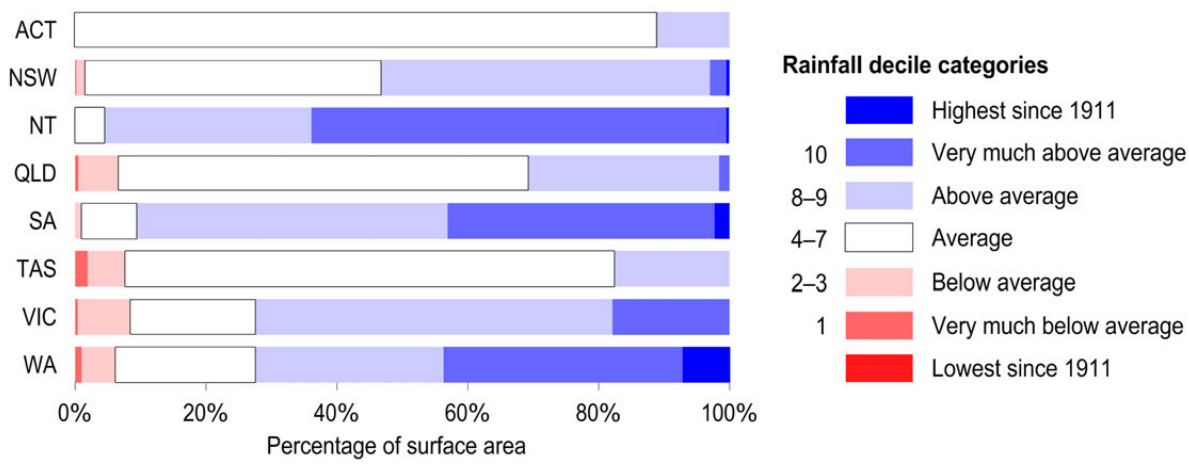
In some areas across the country, the relatively wet conditions in 2016–17 were a welcome change from previously dry years. Rainfall in western Victoria and Tasmania had been largely average or lower since 2014–15. However, during the particularly wet winter of 2016, record-high rainfalls were observed throughout large areas of Australia. By September 2016, soil moisture levels in these regions rose to above average, resulting in favourable conditions for generating runoff and growing crops. Large parts of central Queensland, which had been dry for up to four years before 2016–17, experienced mainly higher-than-average rainfall; this provided some relief to the drought.

In contrast, southwest Western Australia, which has experienced mainly lower-than-average annual rainfall since 1970, continued that trend. The Darling Ranges, where most of the State's urban and rural supply storages are located, also received below-average rainfall.

(a) Map of rainfall deciles



(b) Rainfall deciles by State or Territory



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

Figure 3. Rainfall deciles in 2016–17 (a) map with Murray–Darling Basin outline (b) by State or Territory

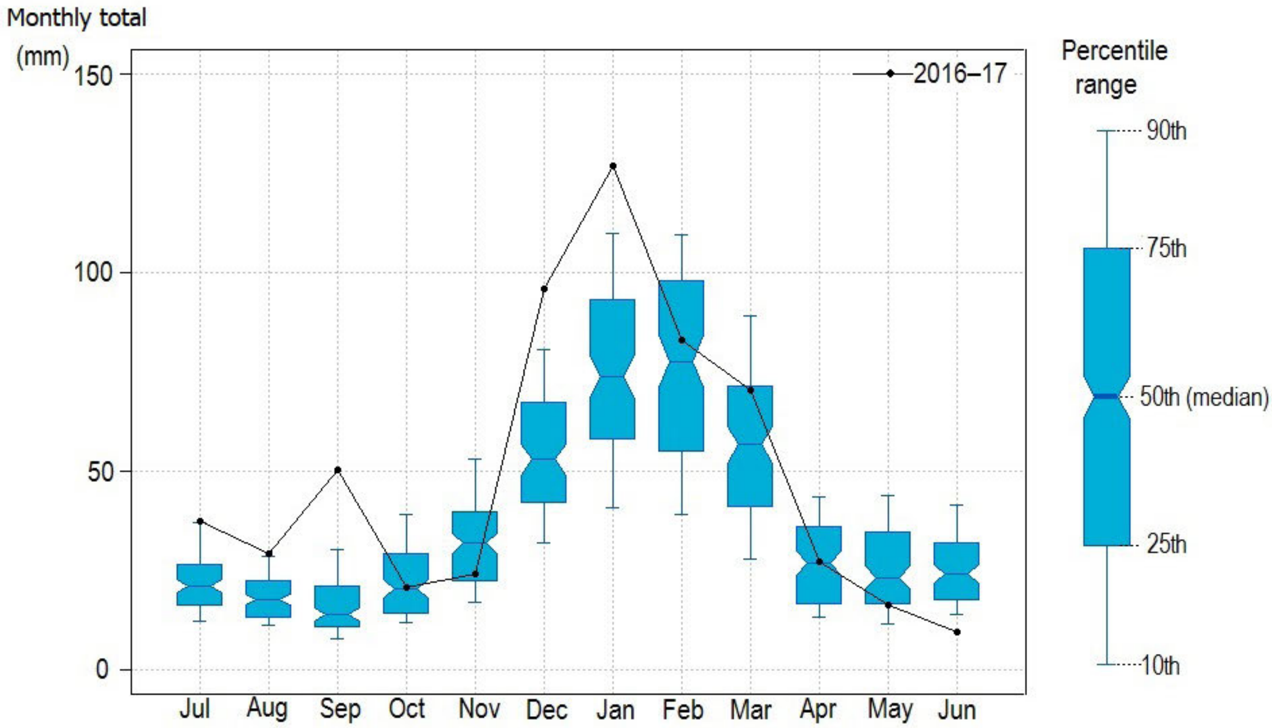


Figure 4. Monthly rainfall in 2016– 17 compared to the rainfall statistics for Australia, July 1911 – June 2017

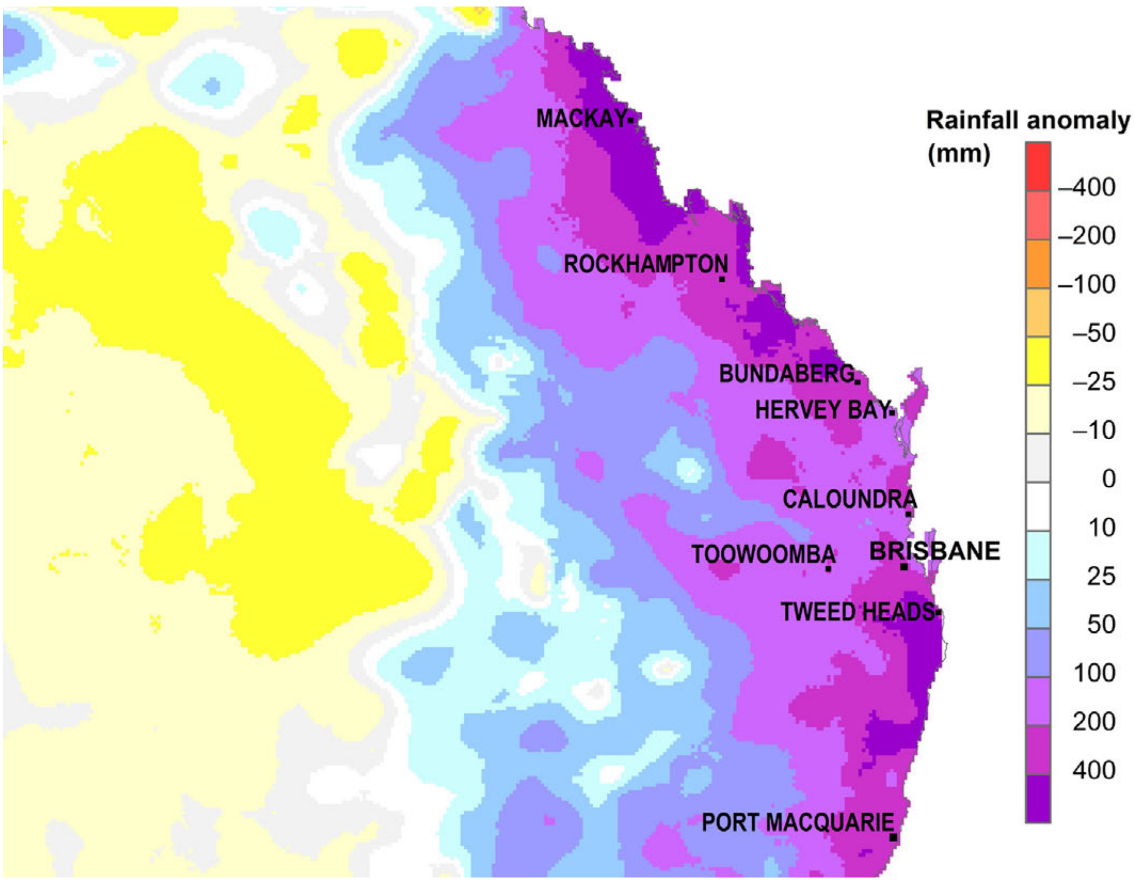


Figure 5. Rainfall anomalies in March 2017 caused by ex–severe tropical cyclone *Debbie*

2.2 STREAMFLOW

The annual streamflow conditions in Figure 6 correspond well with the spatial distribution of annual rainfall in Figure 3; the differences in the figures can largely be attributed to the limited spatial distribution of the streamflow monitoring sites. Figure 6a shows a pattern of mostly average streamflows along the east coast, except for parts of the Queensland coast where ex–severe tropical cyclone *Debbie* added to the annual total rainfall and streamflow. Average to higher-than-average flows predominated in all States and Territories (Figure 6b).

Figures 7 and 8 provide an overview of monthly rainfall and streamflow in 2016–17. The year started with wet conditions throughout much of Australia following relatively high rainfalls in May and June 2016, with the exception of southwest Western Australia. July and August 2016 continued to provide higher-than-average rainfall over much of the country, resulting in higher-than-average flows in the southern Murray–Darling Basin and on the central Queensland coast.

Even though rainfall was above average in large parts of the northwest (Pilbara–Gascoyne), streamflows in this region rarely exceeded average. Although conditions were wetter than average, the rainfall was not enough to overcome the dry antecedent conditions and produce substantial flows.

With vast areas of highest-on-record rainfall in September 2016, and with the already wet conditions in large parts of the Murray–Darling Basin, streamflow in many rivers of the basin reached 40-year highs for September. Higher-than-average flows were recorded at 90 per cent of the gauging sites in the Murray–Darling Basin. From the perspective of water use, high flows in the Murray–Darling Basin were very welcome, especially upstream of the storages.

However, the high winter–spring flows also had their downside. Substantial damage was caused by widespread flooding in many of the sub-catchments of the Murray–Darling Basin. In some parts of the Murray and Murrumbidgee rivers, the floods also triggered a blackwater event. In this event, floodwaters during spring mobilised large amounts of organic matter, such as leaves and wood, from the floodplains; the decay of this organic matter resulted in low dissolved oxygen levels, which in turn caused stress and fish deaths.

Before the winter of 2016, the combined volume of all agricultural supply storages in the Basin was at 26 per cent of capacity. By the end of November 2016, these storages had reached 86 per cent of capacity, levels not seen over the previous four years.

Tasmania had so far been spared from significant rainfall after the widespread floods of June 2016. However, in early October 2016 heavy rainfall caused some flooding, particularly in the northern river catchments. The rest of Australia experienced rainfall conditions that were closer to average, and this continued into November 2016. Streamflows remained above average in the southeast as most rivers were still processing the floodwaters.

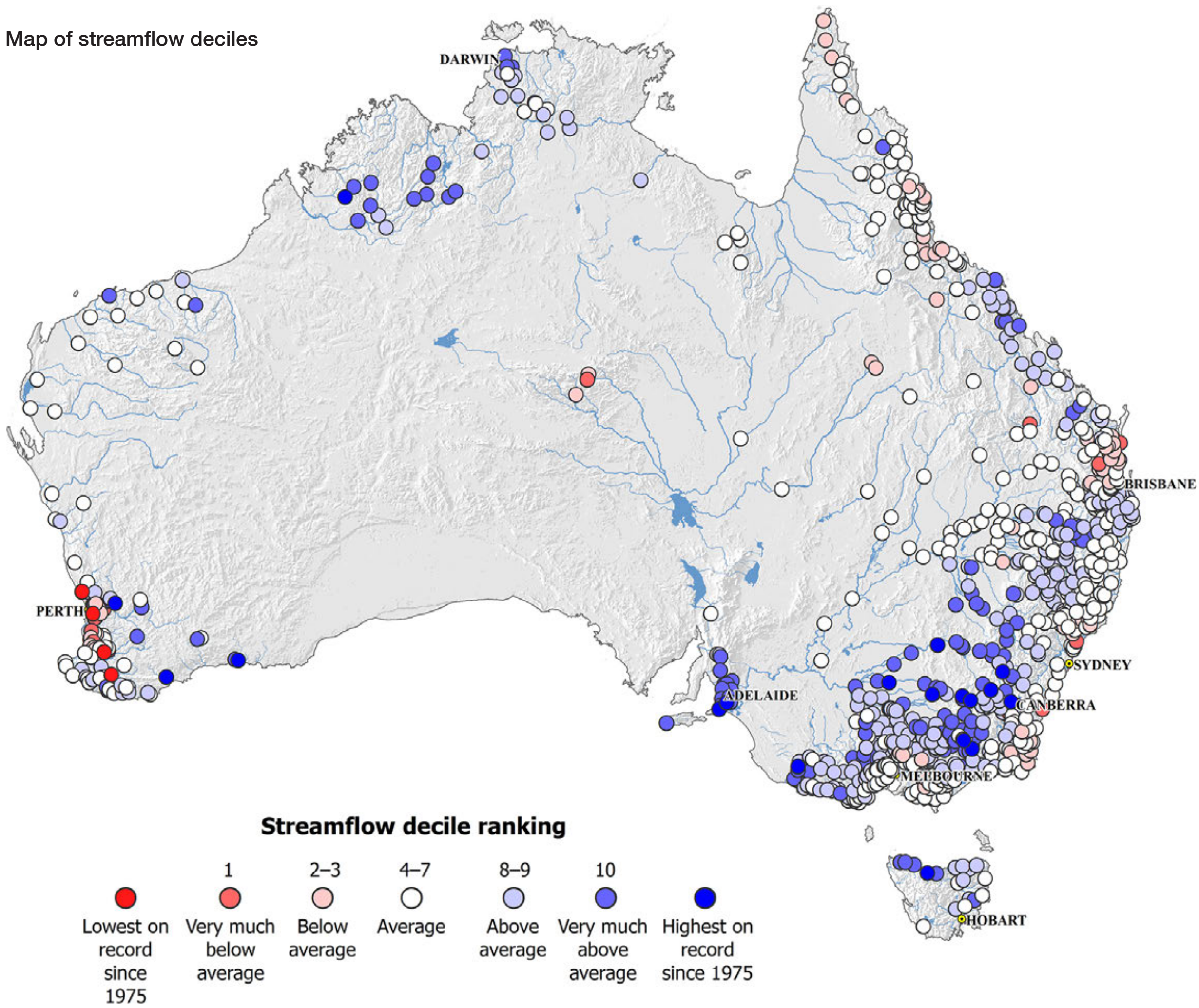
December 2016 marked the start of the monsoon in the tropical north (Figure 7). It brought heavy rainfall to large parts of the Kimberley, the Northern Territory and South Australia. Low-pressure systems across the continent brought tropical moisture through to southern South Australia, resulting in South Australia experiencing its highest December rainfall on record. A similar pattern of rainfall continued for January 2017, and the majority of flow-monitoring sites around Adelaide continued to record higher-than-average flows up to February 2017.

The wet season in the tropical north resulted in higher-than-average flood levels in the region.

In February 2017, there was a distinct contrast in rainfall between the east and west of the country. In the west, rainfall brought a welcome change to the dry catchments around Perth. The total rainfall for Western Australia (109 mm) was very much above the mean (58 mm) for the normally dry summer month of February. As a result, the February flows were the highest on record for 24 per cent of the gauges in Western Australia, and above average for 63 per cent. In the eastern part of Australia, rainfall was largely below average, causing some of the fast-reacting coastal rivers to have lowest-on-record February flows, particularly in southeastern Queensland and northeastern New South Wales.

In March, ex–severe tropical cyclone *Debbie* made landfall on the central Queensland coast. It moved slowly southeast to northeastern New South Wales, causing most coastal rivers to reach major flood levels. Unfortunately, this also resulted in a number of casualties and major damage to

(a) Map of streamflow deciles



(b) Streamflow deciles by State or Territory

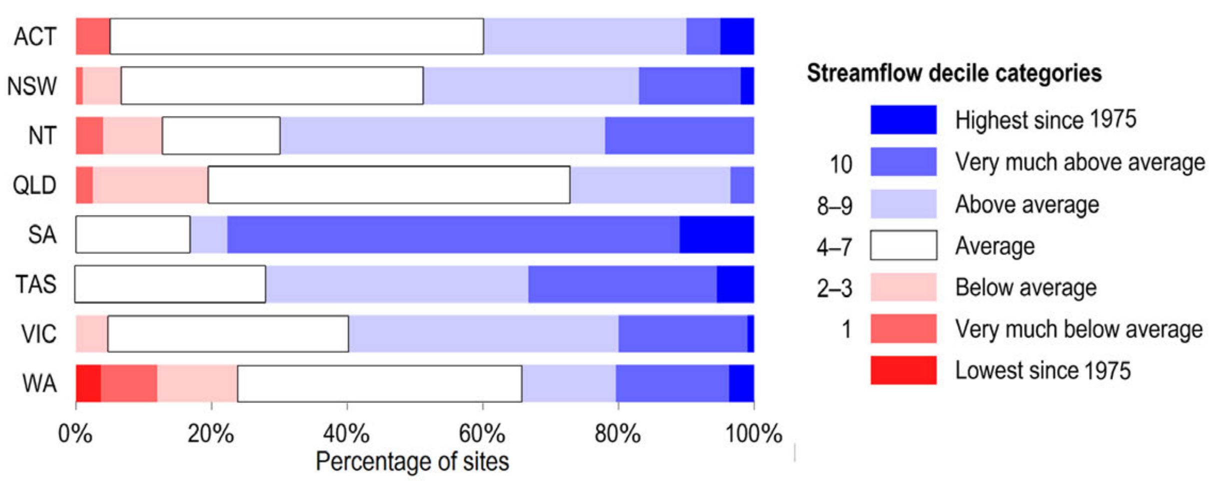


Figure 6. Streamflow deciles at long-term monitoring stations throughout Australia in 2016–17 (a) map (b) by State or Territory

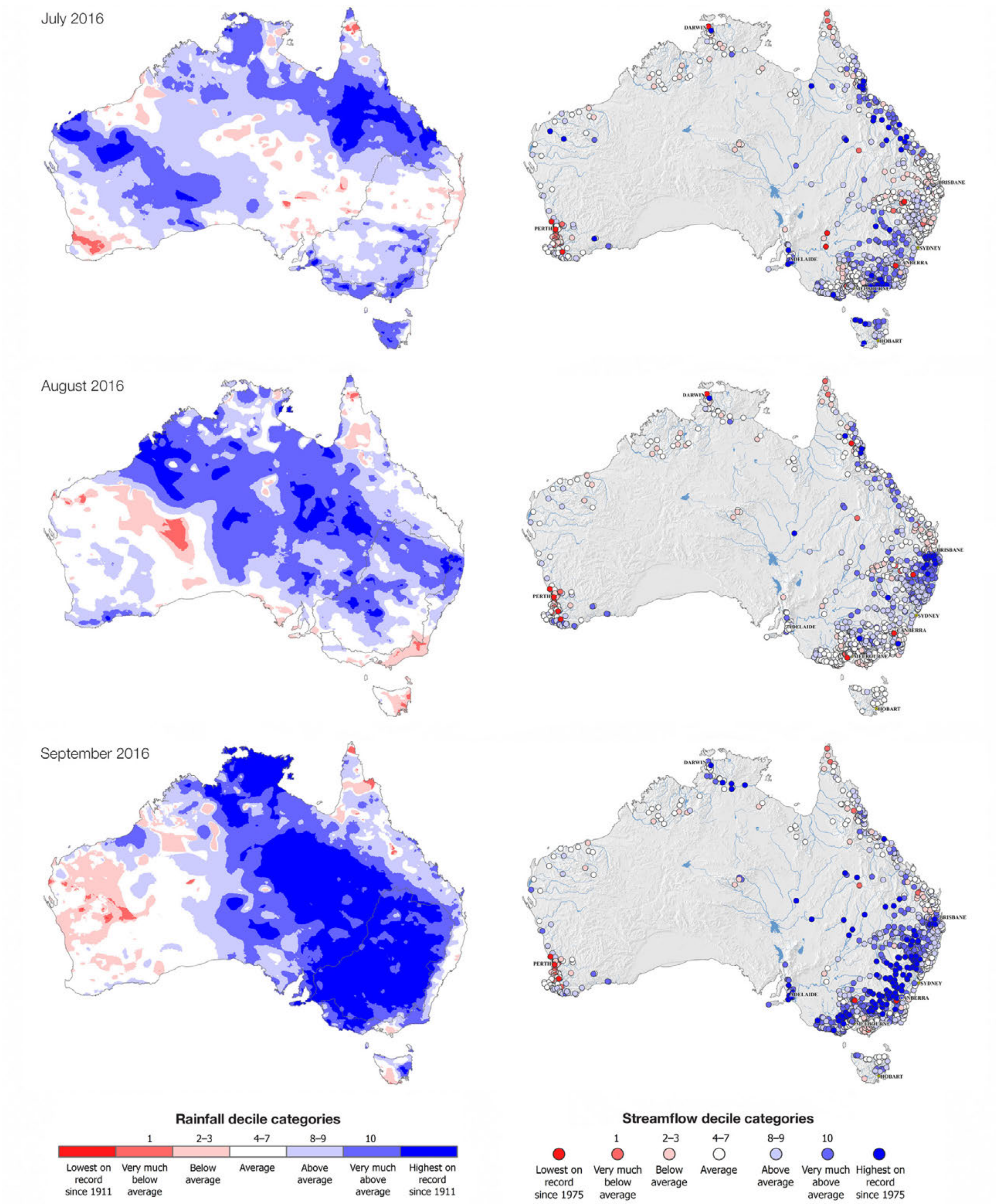


Figure 7. Monthly rainfall and streamflow deciles in 2016–17

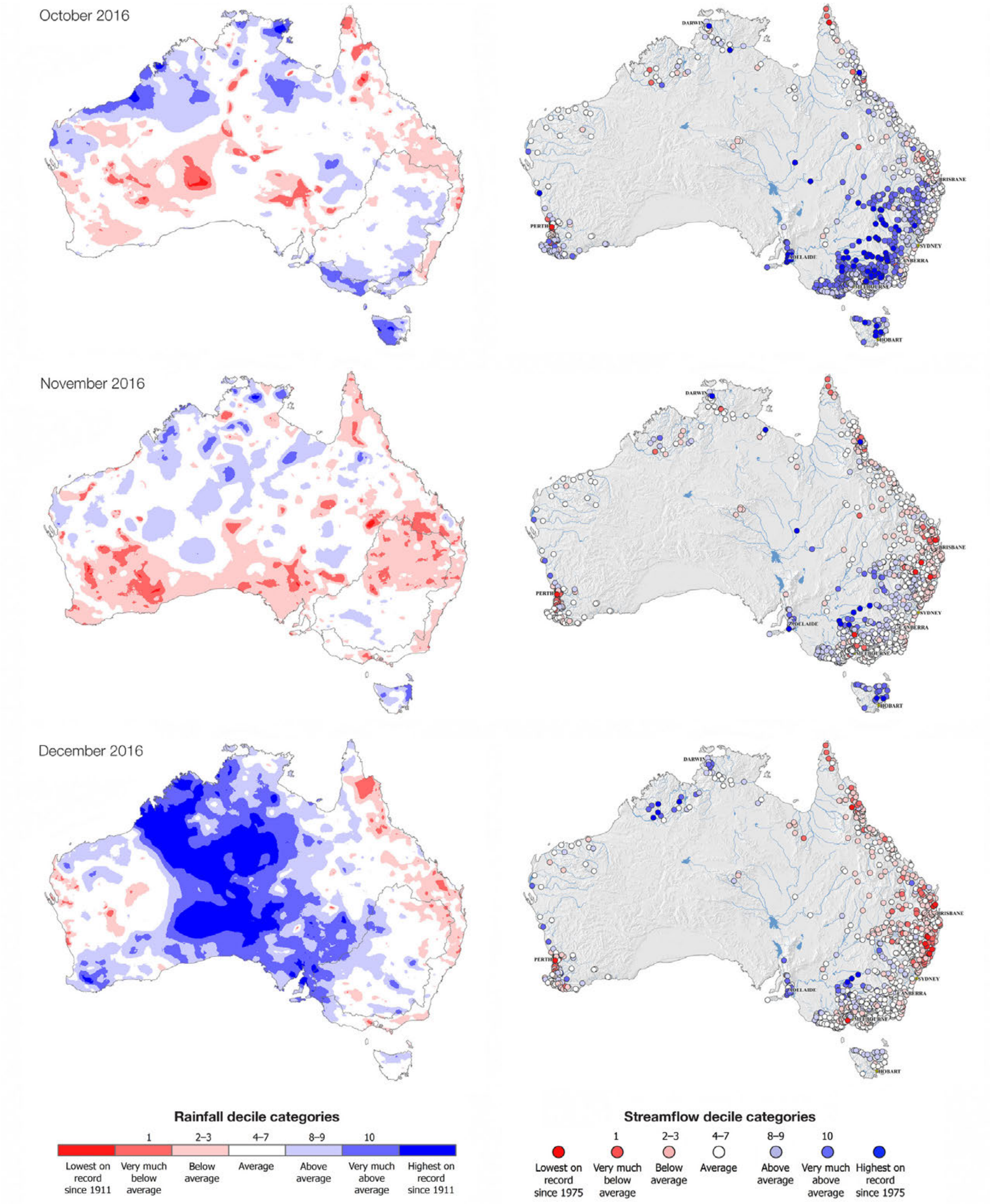


Figure 7. (continued) Monthly rainfall and streamflow deciles in 2016–17

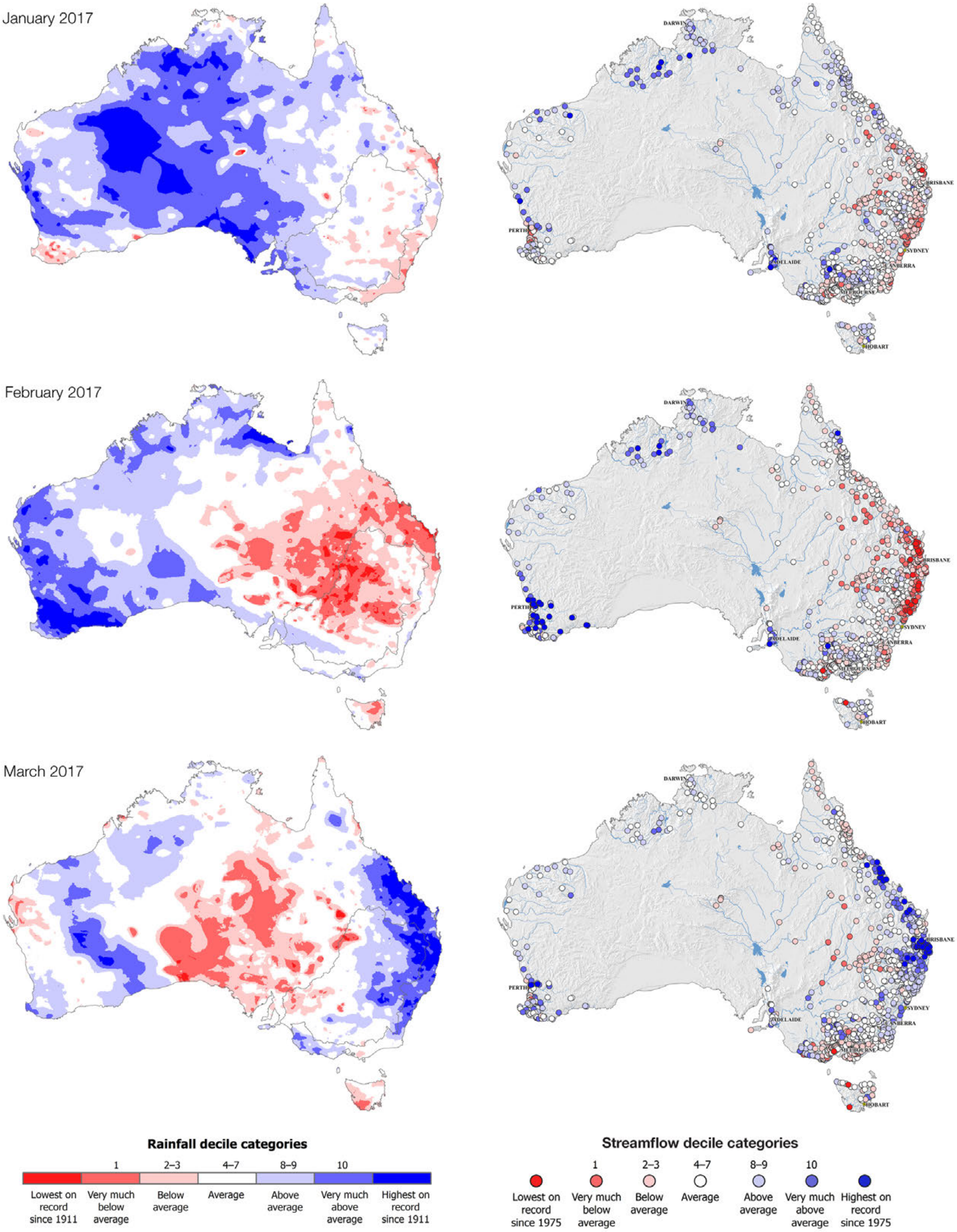


Figure 7. (continued) Monthly rainfall and streamflow deciles in 2016–17

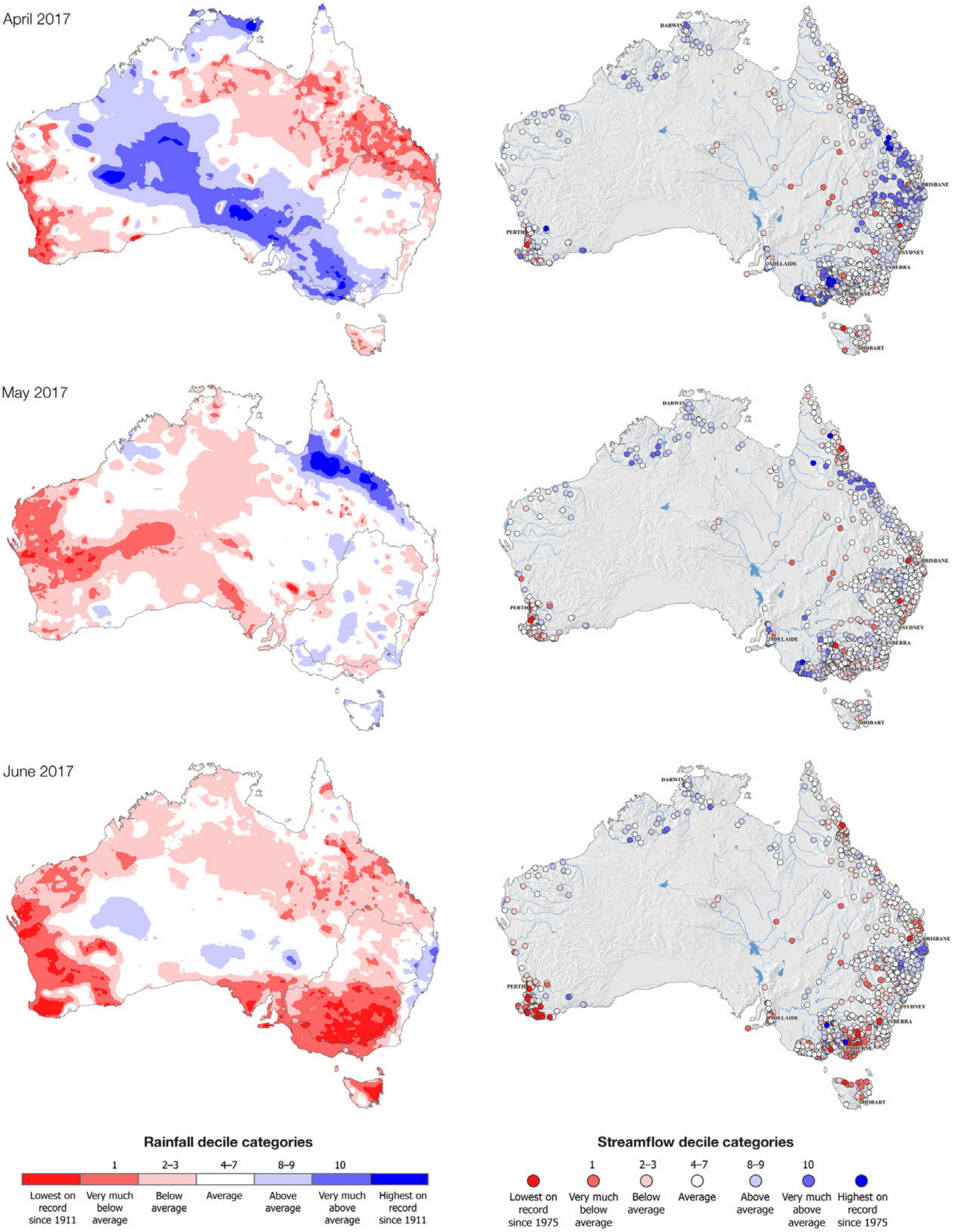


Figure 7. (continued) Monthly rainfall and streamflow deciles in 2016–17

infrastructure, property, crops and livestock. The hardest hit rivers included the Fitzroy River, where Rockhampton is located in the downstream floodplain, and those in northern New South Wales.

In April 2017, rainfall and streamflow conditions showed contrasting patterns across the country. Whereas the rivers in southeastern Western Australia, the tropical north and the Queensland and New South Wales coast were still processing above-average volumes of water from the previous month, rainfall in these regions was mostly below average.

May 2017 brought mainly average to below-average rainfall, with an exception in parts of northern Queensland. Streamflow levels also started falling throughout the country. June 2017 was the second-driest June on record (for monthly rainfall), and streamflow conditions at the start of the 2017 winter were largely average to below average. This was particularly the case in the southwest and southeast of the country, where large areas experienced very-much-below-average flows.

More information on the monthly climatic, 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]

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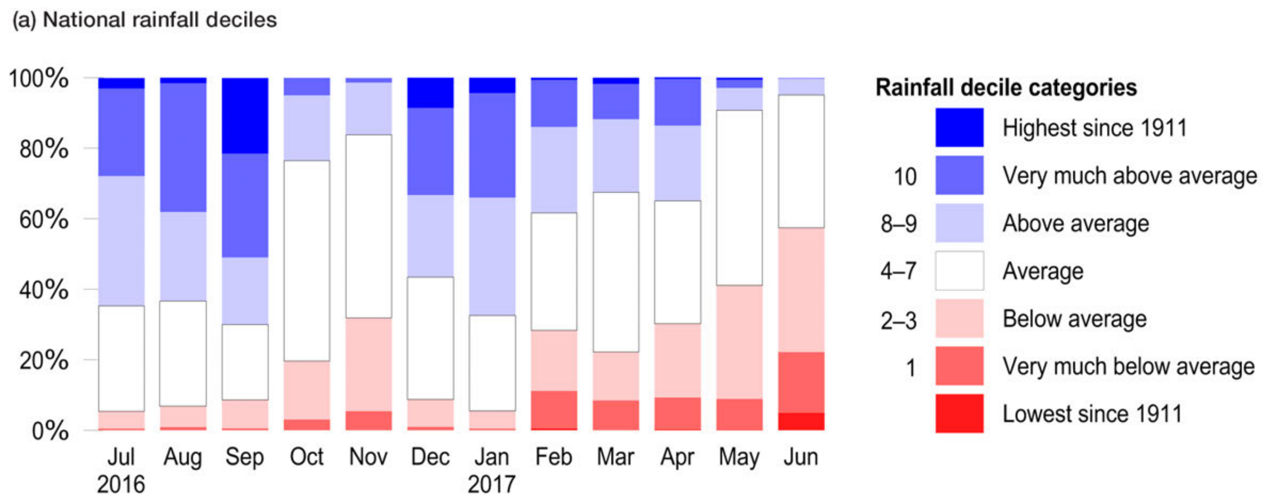
7 www.bom.gov.au/climate/mwr
8 www.bom.gov.au/water/monthly-water-update
9 www.bom.gov.au/water/rwi



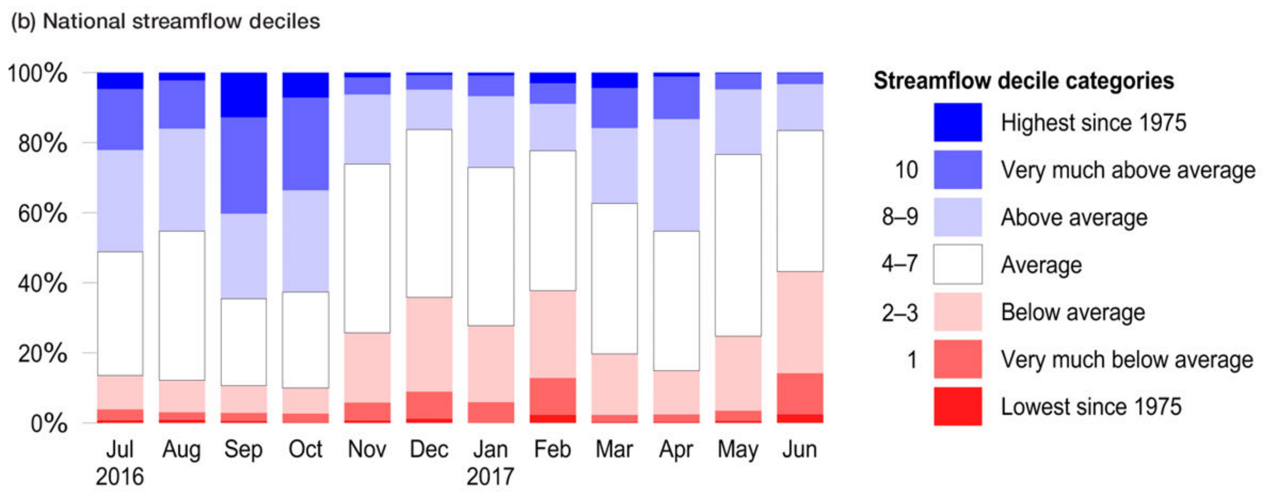


Figure 8. National rainfall and streamflow deciles by month in 2016–17 (a) rainfall (b) streamflow

2.3 WATER STORAGES

2.3.1 National view

Australia's total accessible public storage capacity is just over 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 2016–17 was at 57 per cent of capacity. Mostly because of the wet winter of 2016, this increased by 20 percentage points to 77 per cent of capacity by the end of 2016–17.

At the end of 2016–17, the total accessible storage for urban systems was at the same volume it had been at the start of the year, at 75 per cent of capacity. Total accessible storage for major rural systems had increased by 26 percentage points from the start of the year, up from 52 to 78 per cent of capacity.

2.3.2 Urban storages

The distribution and status of urban storage systems are shown in Figure 9, and their capacity and storage volumes are given in Table 1.

The combined accessible storage volume of urban systems in Western Australia increased from 21 per cent of capacity at 30 June 2016 to 32 per cent at 30 June 2017. However, the two urban water supply systems in the State (Perth and Pilbara) had sharply contrasting patterns of change. The Perth storage supply system continued to have the lowest percentage capacity storage volumes, even though it increased from 20 to 25 per cent of capacity over the year. The Perth system rose to 29 per cent of capacity at the end of the winter, and then dropped to 25 per cent of capacity at the end of 2016–17. The Pilbara storage (Harding), on the other hand, experienced a sharp increase over the

Table 1. Urban systems storage capacity and volume at 30 June 2016 and 30 June 2017

Map reference (Figure 9)	System	Accessible capacity (GL)	Number of storages	Per cent full 30 June 2016	Per cent full 30 June 2017	Change (percentage points)*
1	Perth	597	9	20	25	▲ +5
2	Pilbara	63	1	31	93	▲ +62
3	Darwin	235	1	102	119	▲ +17
4	Mount Isa	99	1	91	89	-2
5	Cairns	37	1	91	97	▲ +6
6	Townsville	222	2	26	27	+1
7	Rockhampton	59	1	100	102	+2
8	Gladstone	662	1	87	96	▲ +9
9	Brisbane	2282	13	83	76	▼ -7
10	Toowoomba	127	3	70	58	▼ -12
11	Newcastle	204	2	96	93	+3
12	Central Coast NSW	190	1	75	73	-2
13	Sydney	2606	10	97	93	-4
14	Canberra	278	4	82	84	+2
15	Coliban	75	3	41	73	▲ +32
16	Melbourne	2032	14	53	58	▲ +5
17	Barwon Geelong	156	9	40	70	▲ +30
18	Hobart	4	1	88	96	▲ +8
19	Adelaide	197	10	52	56	+4

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

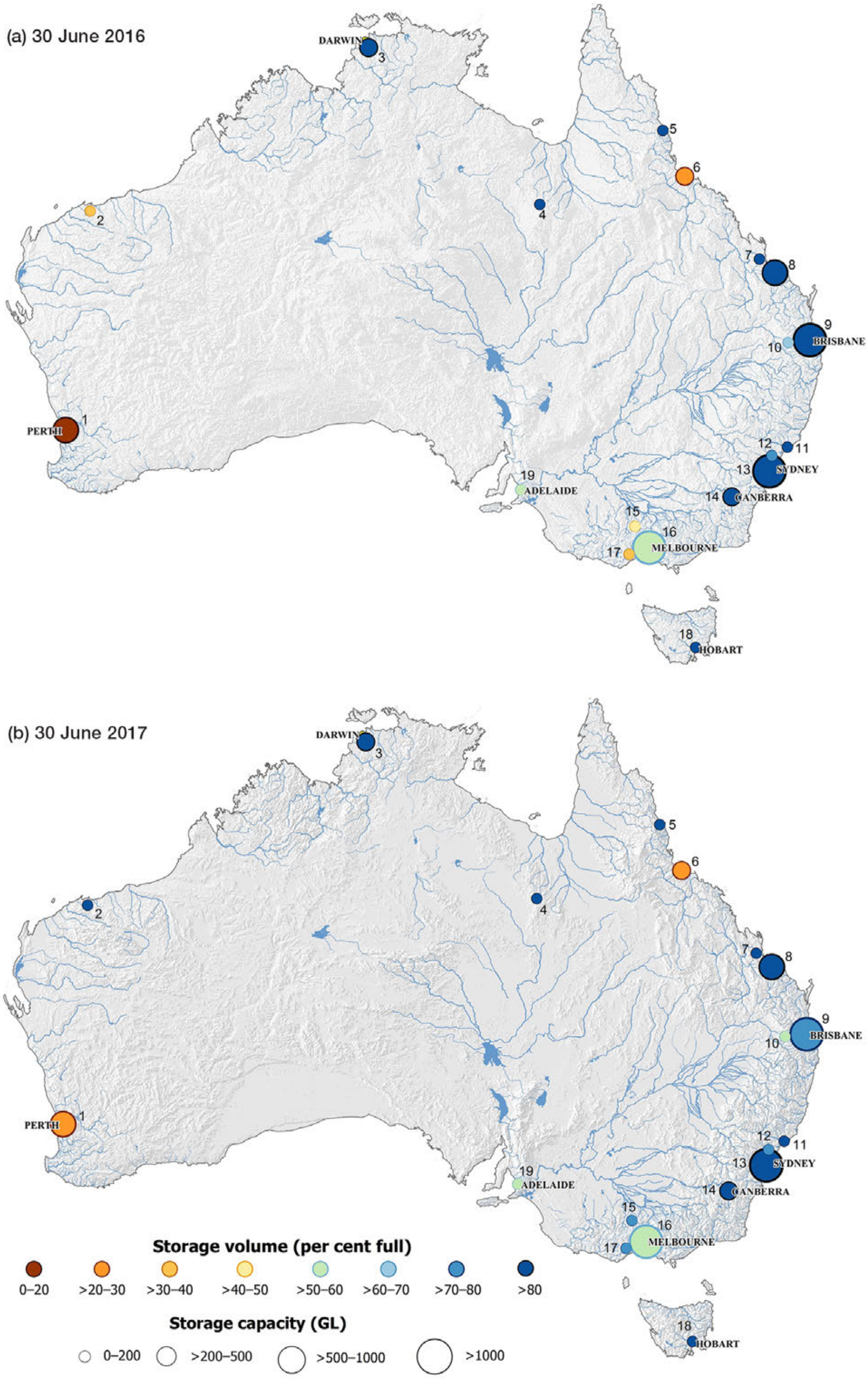


Figure 9. Distribution and storage status of urban storage systems (a) 30 June 2016 (b) 30 June 2017

monsoon period due to the above-average rainfall, going from 22 per cent of capacity in December 2016 to full in April 2017, only to drop back to 93 per cent of capacity at 30 June 2017.

The Townsville supply system is the only supply system apart from Perth that was sitting below 50 per cent capacity at the end of 2016–17. The Toowoomba system showed the largest proportional decline over the year, from 70 to 58 per cent of accessible capacity. The Coliban and Barwon Geelong supply systems experienced major increases in storage volumes. Both systems are located in the west of Victoria, where the ongoing dry conditions since 2012 were broken by the 2016 winter rainfall and the additional above-average rainfall during the summer of 2016–17.

The combined storage volume of the ten urban storages for Adelaide started the year at 52 per cent of capacity. By the end of the wet winter–spring period, storage volumes almost reached full capacity (97 per cent at 31 October 2016). However, due to the high water availability in these storages, more water was diverted from these storages and less from other sources (such as River Murray transfers, groundwater and desalinated water) over the following months, so storage volumes fell back to 56 per cent of total capacity by 30 June 2017.

2.3.3 Rural storages

The distribution and status of rural storage systems are shown in Figure 10, and their capacity and storage volumes are given in Table 2.

The wet winter of 2016 saw water volumes in many storage systems in the southeast of the country (including the Murray–Darling Basin) increase by about half of their total capacity or more by October 2016. Allocation announcements quickly followed, giving most water entitlement holders full allocations by the end of spring.

The above-average wet season rainfall caused spilling from one of Australia's largest storages, Lake Argyle (Ord system), from January 2017 onwards. In contrast, the average to below-average flows into the Collie–Harvey–Waroona system south of Perth resulted in marginally lower storage volumes at the end of 2016–17.

A relatively small corridor of below-average rainfall occurred in southeastern Queensland, just north of the high winter 2016 rainfall area. This below-average rainfall region includes the Leslie storage in the Upper Condamine supply system, all storages in the Lockyer Valley supply system and the Bjelke-Petersen storage in the Barker–Barambah supply system. Even though this region was in the path of ex–severe tropical cyclone *Debbie*, its storages were not boosted.

Most other storage systems went through a general regime of filling in their respective wet season and emptying during their drier season. This saw most of them return to volumes similar to their volumes at the start of the year.

2.3.4 Historical changes in inflow into Perth storages

Perth is Australia's fourth most populous city, with an estimated population of 2.1 million. It is located in the South West Coast drainage division (Figure 11). The climate drivers for the South West Coast region are the subtropical ridge, monsoon frontal systems and the west coast trough.

The region has a temperate climate with warm dry summers and cool winters. Long-term mean annual rainfall for the region is 441 mm, and most of this rainfall (up to 80 per cent) occurs from May to October. Most rainfall occurs along the coast with reduced rainfall further inland (annual rainfall varies from 1200 mm in the west to 335 mm in the east).

Perth is in one of the regions in Australia most affected by climate change.[10] Long-term analysis of the region's mean annual temperature (from 1900 to 2017) shows a statistically significant trend of increased temperatures and increased intensity of hot spells.[11] As global temperatures rise, the hydrological cycle intensifies and atmospheric circulation patterns change, the tropical belt widens and subtropical dry zones move towards the poles.[12] Rainfall in the South West Coast region is affected by these changes.

Reductions in rainfall in this region are evident from the beginning of the reliable historical record in 1911. From 1911 to 1974, rainfall was slightly higher (3 per cent) than the long-term mean. Then the annual rainfall declined by about 2 per cent for the1975 to 2000 period. Rainfall from July 2001 to June 2010 was 10 per cent lower than the

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10 http://www.water.wa.gov.au/water-topics/waterways/threats-to-our-waterways/climate-change-and-waterways

11 https://www.agric.wa.gov.au/climate-change/climate-trends-western-australia

12 https://researchlibrary.agric.wa.gov.au/bulletins/43/

Table 2. Rural systems storage capacity and volume at 30 June 2016 and 30 June 2017

Map reference (Figure10)	System	Accessible capacity (GL)	Number of storages	Per cent full 30 June 2016	Per cent full 30 June 2017	Change (percentage points)*
1	Collie–Harvey–Waroona	334	4	40	38	-2
2	Ord	10 432	1	69	106	▲ +37
3	Mareeba–Dimbulah	438	1	55	49	▼ -6
4	Burdekin–Haughton	1852	1	91	97	▲ +6
5	Bowen–Broken	111	1	100	100	0
6	Proserpine	490	1	63	78	▲ +15
7	Pioneer Valley	139	1	90	100	▲ +10
8	Eton	62	1	100	98	-2
9	Nogoa–Mackenzie	1289	1	39	42	+3
10	Callide	148	2	80	88	▲ +8
11	Dawson Valley	50	4	77	76	-1
12	Three Moon Creek	88	1	88	97	▲ +9
13	Upper Burnett	163	1	92	98	▲ +6
14	Bundaberg	872	3	92	97	▲ +5
15	Mary Valley	46	1	90	82	▼ -8
16	Boyne–Tarong	196	1	48	54	▲ +6
17	Barker–Barambah	134	1	41	22	▼ -19
18	Lockyer Valley	62	3	10	8	-2
19	Warrill Valley	86	1	88	96	▲ +8
20	Chinchilla	10	1	30	87	▲ +57
21	Upper Condamine	104	1	12	17	▲ +5
22	St George	90	2	67	86	▲ +19
23	Border Rivers	632	3	32	90	▲ +58
24	North Coast NSW	11	1	100	102	+2
25	Gwydir	1343	1	16	49	▲ +33
26	Namoi	873	3	14	55	▲ +41
27	Macquarie–Castlereagh	1523	2	27	78	▲ +51
28	Hunter Valley	1031	2	83	86	▲ +6
29	Lachlan	1253	2	53	88	▲ +35
30	Murrumbidgee	2633	2	62	73	▲ +11
31	South Coast NSW	9	1	101	100	-1
32	NSW and VIC Murray	6821	3	42	74	▲ +32
33	Gippsland (eastern Victoria)	183	1	42	23	▼ -19
34	Ovens	32	2	74	64	▼ -10
35	Goulburn–Broken	3598	3	34	60	▲ +26
36	Campaspe	304	1	21	89	▲ +68
37	Loddon	213	2	12	73	▲ +61
38	Wimmera–Mallee	662	8	31	43	▲ +12
39	Menindee	1555	4	3	28	▲ +25
40	SA Murray	577	1	59	56	-3

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

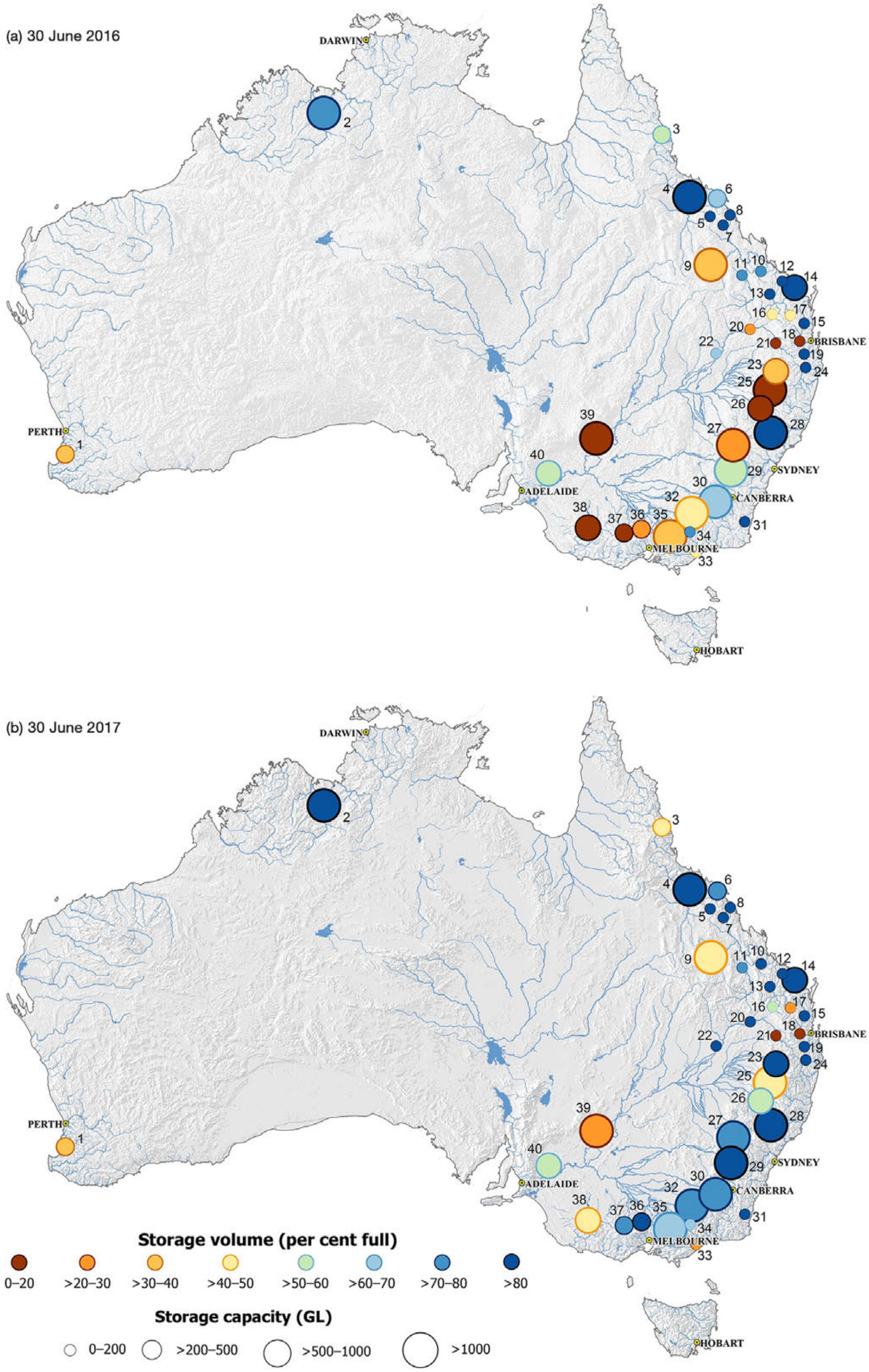


Figure 10. Distribution and storage status of rural storage systems (a) 30 June 2016 (b) 30 June 2017

long-term mean, and was close to the lowest recorded for any ten-year period since 1911.

A trend analysis of the mean annual rainfall shows a declining trend since 1911. The declining trend in rainfall is more evident before 1975 than later (1975–2016). A more detailed analysis across the 14 river regions of the South West Coast drainage division also confirmed a declining trend in all river regions except for Esperance Coast.

Perth's urban water supply storages are located in two river regions: Murray River (WA) (70 per cent of Perth's water storage capacity) and Swan Coast – Avon River (30 per cent of capacity). Rainfall reductions since 1974 have been more prominent in these two regions than in most other river regions in the South West Coast drainage division. From 1975 to 2000, the mean annual rainfall in these river regions was 4 per cent less than the long-term mean (Figure 12a). However, the biggest decline was from 2001 to 2010, when the mean annual rainfall was 13 per cent lower than the long-term mean, which is the lowest recorded for any ten-year period since 1911. The mean annual rainfall for 2010 to 2016 was 8 per cent lower than the long-term mean.

Reflecting the decline in rainfall, a trend analysis of annual streamflows from 1975 of the South West Coast region shows a decline in 70 per cent of the gauges; in 46 per cent of the gauges the declines are statistically significant. Statistically significant increases in streamflows have been observed at only 9 per cent of the gauges. Following the rainfall pattern, streamflow reduction trends are particularly prominent in the Murray River (WA) and Swan Coast – Avon River regions, where 80 per cent of the gauges showed a reduction in streamflow since 1975 and 56 per cent showed a significant decline. Only three gauges out of 62 in these river regions showed a statistically significant increase since 1975.

The annual mean streamflows into Perth water storages (Figure 12b) have halved three times since 1911, and distinct step changes have been observed over the last four decades. The annual mean inflow to Perth storages from 1911 to 1974 was 338 GL. Inflow from 1975 to 2000

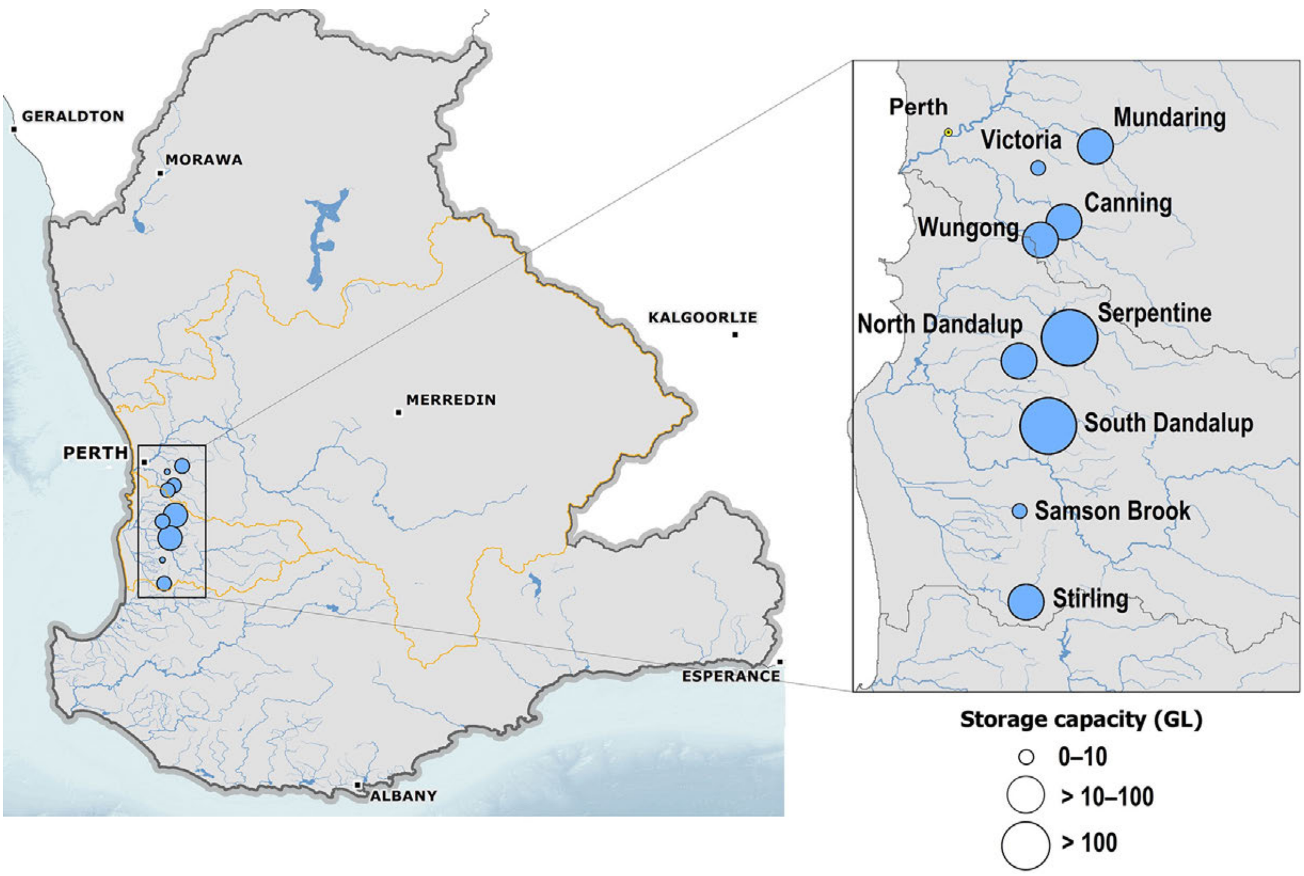


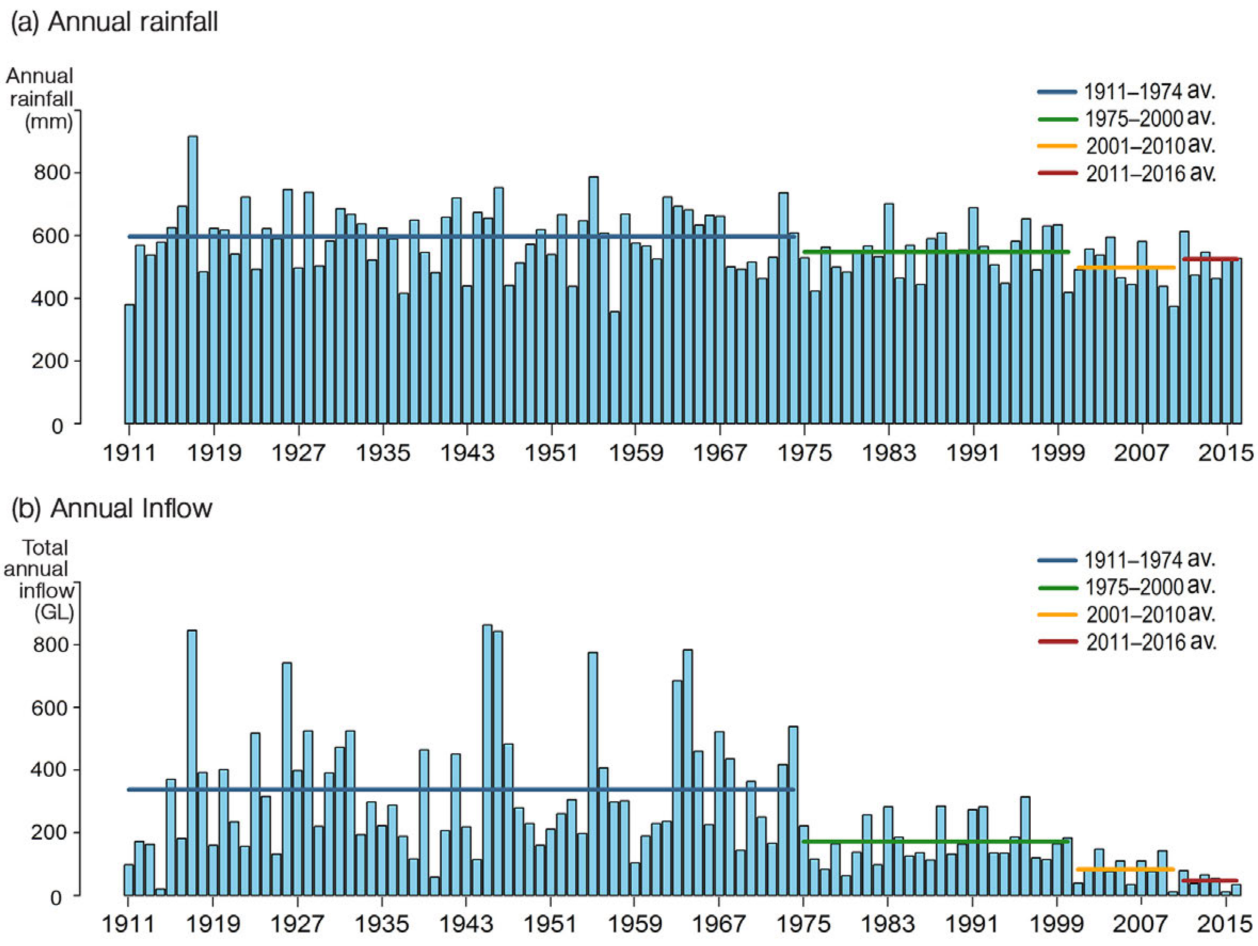
Figure 11. Urban water storages of the South West Coast drainage division

was 172 GL, 49 per cent lower than the long-term mean. Streamflow further declined by 52 per cent during the period 2001 to 2010, to 84 GL. From 2010 to 2017, mean inflows to Perth dams again declined, this time by 44 per cent to 47 GL (Figure 12b).

The prolonged and stepwise reduction in streamflow can best be explained by changes in the catchment's response to rainfall. These changes could arise from the decoupling of groundwater and surface water, and changes in land use. A detailed analysis of catchment rainfall runoff processes is needed to understand the causes of this decline.

2.4 STREAM SALINITY

In many parts of Australia, soils, surface water and groundwater have a high salt content as a natural consequence of Australia's dry climate and highly weathered landscape. For example, streams in Western Australia are naturally higher in salinity than streams in northern and eastern Australia where higher rainfall dilutes salts. Native vegetation clearing and dryland and irrigated agriculture have changed the water balance of catchments, increasing the mobilisation of salts from saline aquifers or shallow water tables into streams in many areas across Australia.



Note: To provide an accurate historical comparison, streamflows from Stirling and Samson Brook dams are not included in these data because those dams only came online in 2001. Since the early 1980s, inflows have been estimated using the water balance technique.

Source: Historical streamflow data are sourced from the Water Corporation website.[13]

Figure 12. (a) Annual rainfall in the in the Murray River (WA) and Swan Coast – Avon River regions and (b) annual inflow into water supply reservoirs in Perth (excluding Stirling and Samson Brook dams). Straight lines are average values for the specific periods

13 https://www.watercorporation.com.au/water-supply/rainfall-and-dams/streamflow/streamflowhistorical

Table 3. Water salinity and use [a]

Primary suitability for use	Fresh (0–500 mg/L TDS) good-quality drinking water	Fresh to marginal (500–1000 mg/L TDS) fair- to poor-quality drinking water	Brackish (1000–3000 mg/L TDS) unacceptable-quality drinking water	Saline (>3000 mg/L TDS) unacceptable-quality drinking water
Potable				
Irrigation				
Industry				

mg/L = milligrams per litre; TDS = total dissolved solids or salts
[a] Colours in the table match those used in Figure 13.
Source: Based on Government of Western Australia Department of Water (2014)[14]

Stream salinity concentrations determine the suitability of the water for various uses. The salinity categories in which water is considered fit for various uses are presented in Table 3.

About 60 per cent of Australia's river and stream sites analysed in 2016–17 were on average in fresh condition (median salinity <500 mg/L), which is considered suitable for drinking. Additional factors (for example, pH, alkalinity, nutrient levels, particular element concentrations and their ratios, and the presence of algae and pathogens) can further affect the suitability of the water for particular purposes. Data used for this analysis are based on continuous monitoring of electrical conductivity at 443 gauging stations across Australia with reliable data for 2016–17. For 2015–16, 273 sites were analysed of which 44 per cent were in fresh condition (Figure 13a).

The sites with low median water salinities are mostly located in areas with higher rainfall, particular along the east coast (Figure 13b). Within the Murray–Darling Basin, streams were mostly in fresh condition. However, salinity tends to be higher towards the lower reaches and certain tributaries of the River Murray unless flow is sufficient to flush the salt downstream and out the River Murray mouth. In the inland Murray–Darling Basin, two locations had saline conditions (>3000 mg/L): Houlaghans Creek near Wagga Wagga and Barr Creek in northern Victoria.

In Western Australia, 60 per cent of the 73 sites analysed had saline water conditions and 23 per cent of sites were in brackish condition (1000–3000 mg/L).

Thirty per cent of 30 sites analysed in South Australia recorded saline water conditions and 43 per cent had brackish water. Such salinities (>1000 mg/L) can restrict water use and affect crop yield and land productivity. They could also pose risks to infrastructure and stream ecology, and incur significant costs associated with improving water quality.

Within the Murray–Darling Basin, and across many areas in Australia, salinity has been, and continues to be, managed, accounted for and monitored through the implementation of jurisdictional water quality and salinity management plans. These plans provide the framework for setting salinity objectives and targets as well as for developing on-ground measures to improve salinity conditions. Such measures include salt interception schemes, provision of adequate water flows, investing into revegetation, and improving irrigation and dryland farming practices to minimise the movement of salts.

14 http://www.water.wa.gov.au/water-topics/water-quality/managing-water-quality/understanding-salinity

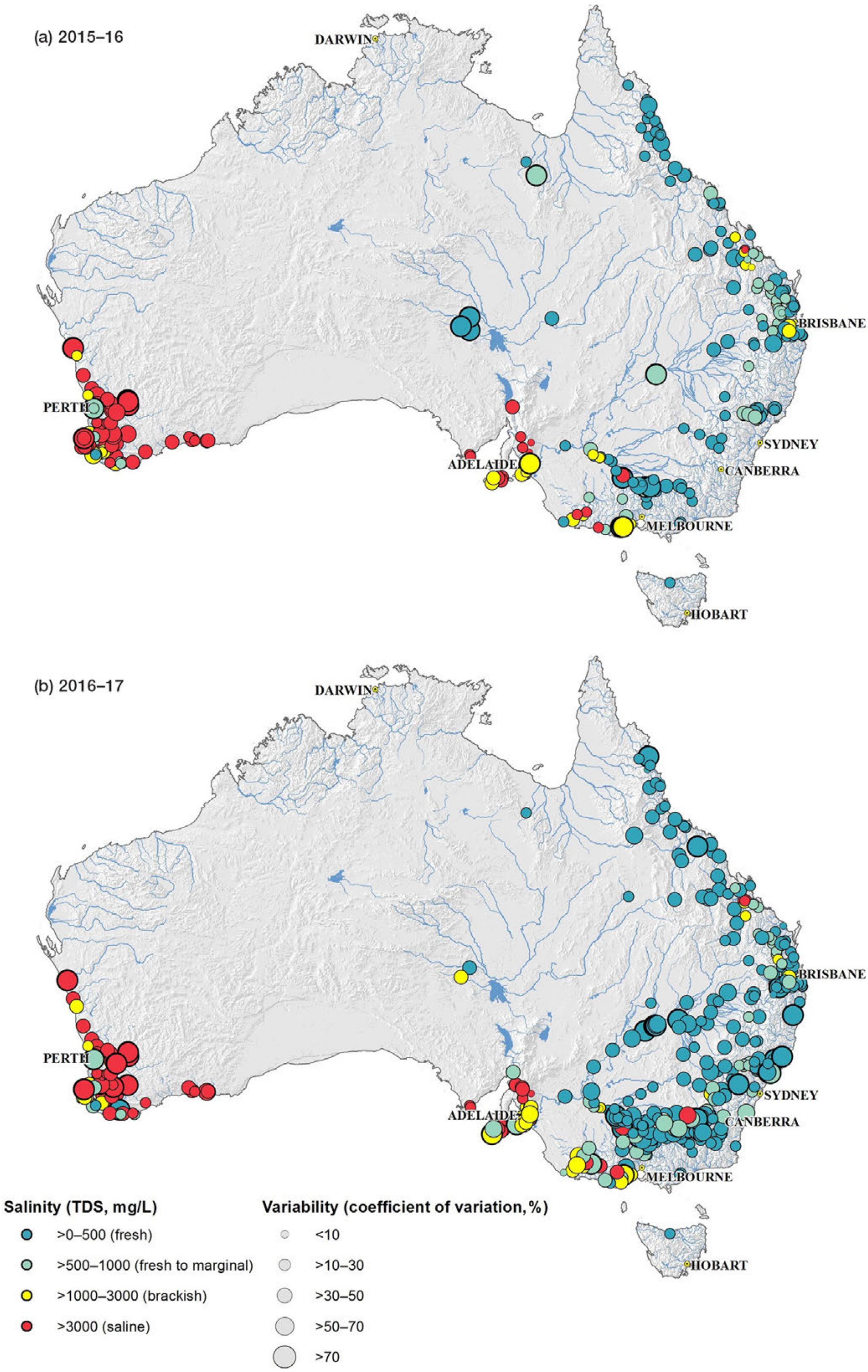


Figure 13. Distribution of median annual stream salinity across Australia (a) 2015–16 (b) 2016–1

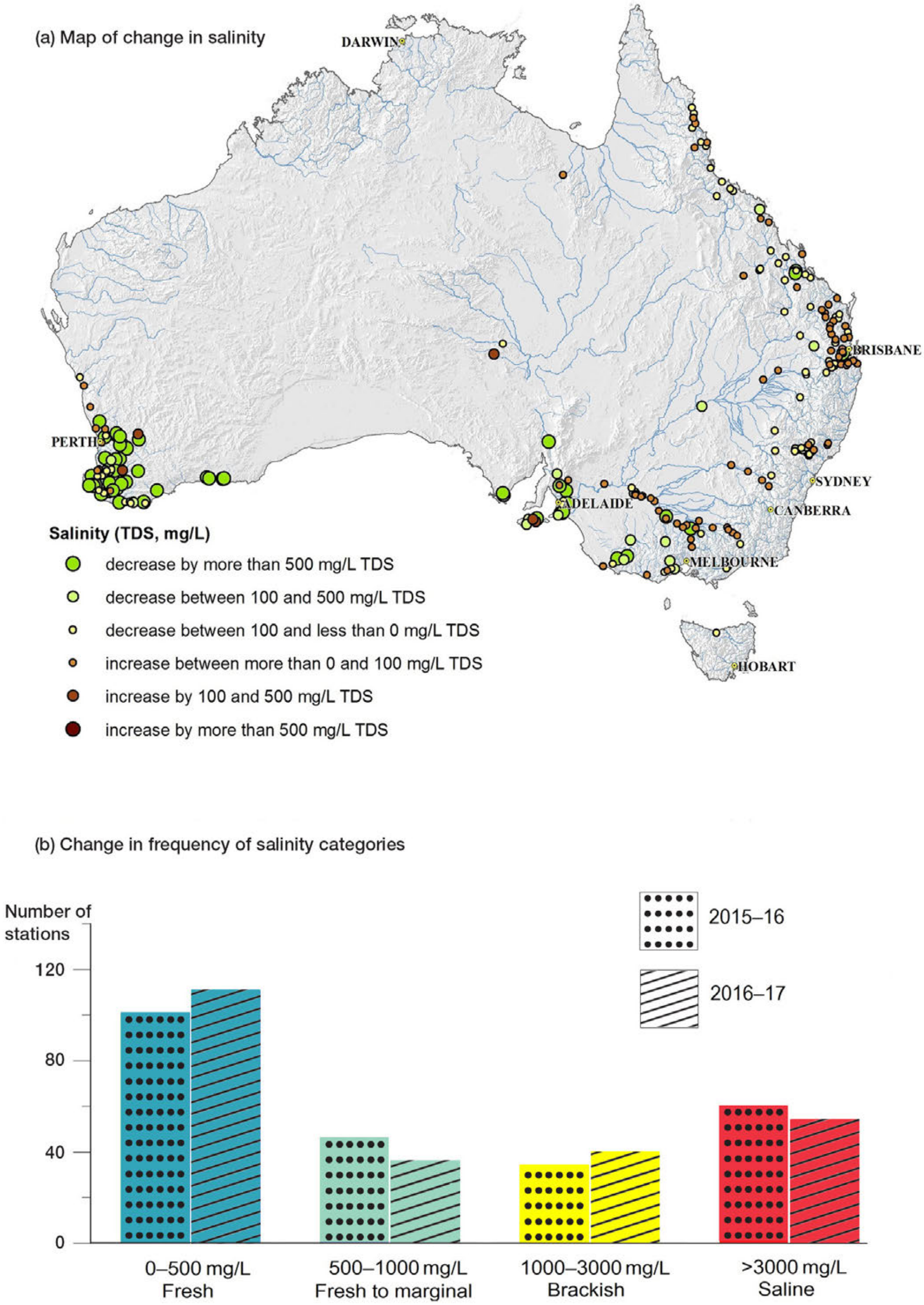


Figure 14. Changes in median streamflow salinity at 241 monitoring sites from 2015–16 to 2016–17 (a) map (b) by salinity category

For the 241 monitoring sites with data available for both years, the median streamflow salinity decreased from 2015–16 to 2016–17 (Figure 14); ten more sites were in fresh condition and six fewer sites had saline water in 2016–17.

Due to wetter hydro-climatic conditions in 2016–17, median streamflow salinity broadly improved in areas with high salinities in southwestern Victoria, South Australia and southwest Western Australia. Compared to the previous year, the higher streamflow from winter to early spring (section 2.2) provided enough water to strongly dilute the streamflow salinity in these areas.

Figure 15 shows that salinity concentrations for the Collie River during 2016–17 were roughly one-third to one-fifth those in 2015–16.

Many gauging stations along the east coast had higher salinity concentrations during 2016–17 than in 2015–16, particularly during the low flow period. This might be due to salt accession, activation and release of more saline groundwater as a response to the relatively large high-flow events in 2016–17. Nevertheless, median salinity concentrations generally increased by less than 100 mg/L at gauging stations along the east coast, particularly in Queensland and New South Wales, and along the River Murray (Figure 14). Most gauging stations in those areas remained in fresh or fresh-marginal condition (Figure 13).

Flow and salinity dynamics at individual sites can be complex. They depend heavily on the relationship between the build-up of salinity sources and the frequency and nature of flushing events, and thus the fluctuations in river flow, groundwater–surface water interactions and groundwater salinity that result from variations in climate and water use. The coefficient of variation shown in Figure 13 gives an indication of the varying nature of salinity at different sites.

2.5 GROUNDWATER

The volume of groundwater in aquifers is very large compared to that of surface water (excluding sea and ice). Global estimates put the volume of groundwater at around 13 times higher than the volume of all surface water, including lakes, rivers and wetlands. In Australia, this ratio is likely to be even higher given the arid nature of much of the continent. However, groundwater resources are not always suitable for large-scale or long-term use. Sustainable extraction of groundwater must balance against the recharge of the resource. Recharge rates are typically very small compared to the volumes in the aquifer. Groundwater is often saline, which reduces its suitability for use.

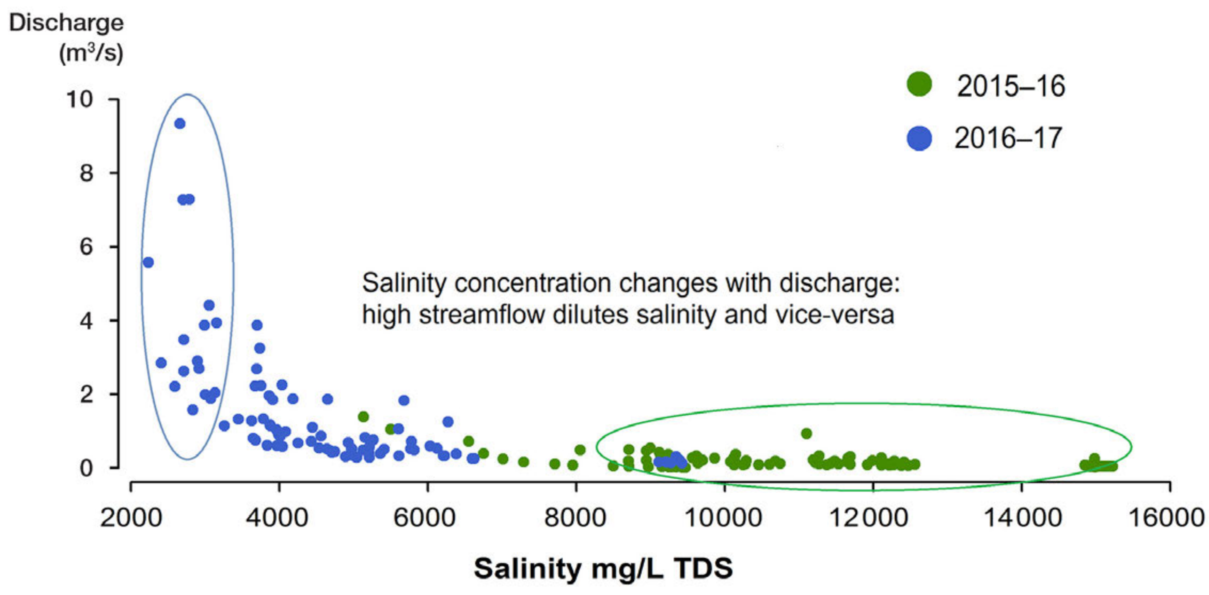


Figure 15. Streamflow and salinity records from July to October in 2015–16 and 2016–17 at Collie River – Buckingham Mill station (ID 612038), Western Australia

One-fifth to one-third of the water used in Australia comes from groundwater. It is extracted for agriculture, urban supply, industries and many other uses. Groundwater also supports aquatic ecosystems across the nation, as shown in the Groundwater Dependent Ecosystem Atlas.[15] The sustainability of groundwater systems is subject to the pressures of climate, extractions 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 groundwater systems across Australia—it only distinguishes between upper, middle and lower aquifer groups. The boundaries of these aquifer groups align to the existing aquifer boundaries as presented in Australian Groundwater Insight[16], and are grouped in accordance with the National Aquifer Framework.[17]

2.5.1 Groundwater levels

Groundwater levels measured from bores are one of the few direct measurements available to analyse changing groundwater resources. Groundwater typically responds slowly to climatic changes, especially in comparison to surface water. This report uses a five-year trend from July 2012 to June 2017 because this period represents a meaningful change in groundwater level rather than just seasonal variation. In addition, a status analysis compares the average groundwater level in 2016–17 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 2012–17 trends reflect the low rainfall experienced in the previous five years, while the status reflects the above-average rainfall in 2016–17. The contrasting pattern of these two variables reflects several factors that influence groundwater, including climate, land use and extractions. It is worth noting that the results presented are influenced by the distribution of bores across Australia. Monitoring bores are typically located at aquifers, or portions of aquifers, that have high extractions or that may be under stress due to climate, land use and extractions.

15 www.bom.gov.au/water/groundwater/gde
16 www.bom.gov.au/water/groundwater/insight
17 www.bom.gov.au/water/groundwater/naf

Figure 16 shows the distribution of groundwater level status and Figure 17 shows the distribution of groundwater level trends at bores across Australia based on (a) upper, (b) middle and (c) lower aquifer groups, respectively. Over 19 000 bores were used for the analyses. Seventy per cent of groundwater levels in upper aquifer bores were below average to average across most of Australia. The five-year trends in upper aquifer groundwater levels were mostly declining (51 per cent) or stable (39 per cent). Only 9 per cent of upper aquifer bores showed a rising trend.

Similarly, groundwater levels of middle and lower aquifer bores were mainly below average to average with declining trends. Compared with 2015–16 data, the percentage of bores across Australia with below-average status decreased from 40 to 26 per cent in the upper aquifer, from 52 to 34 per cent in the middle aquifer, and from 41 to 30 per cent in the lower aquifer. This reflects higher-than-average rainfall in recent years, which leads to less extraction from groundwater and potentially higher recharge.

While the data show a change towards rising groundwater levels, these results vary spatially. For example, groundwater status in the southwest of Australia was average to below average in 91 per cent of assessed bores, and 90 per cent had a stable or declining trend. This reflects the ongoing dry climate experienced in southwest Western Australia. Areas with high levels of groundwater extraction show below-average status with declining trends. Such areas include the middle aquifer near the Victoria – South Australia border, and the upper aquifers in the Namoi and Shepparton regions.

Figure 18 summarises groundwater level and status by aquifer group for each State and Territory, for 2015–16 and 2016–17. The data show a shift in 2016–17 towards more bores with above-average status and fewer bores with a declining trend. This is most prominent in Victoria, South Australia and Tasmania, which all show a large change from 2015–16. Queensland, New South Wales and the Northern Territory show a similar, yet less prominent, shift. Bores in Western Australia were more likely to have average or above-average groundwater status in 2016–17 than in 2015–16. However, this was due to changes in levels in the upper and middle aquifers, the lower aquifer remained predominantly below average and declining.

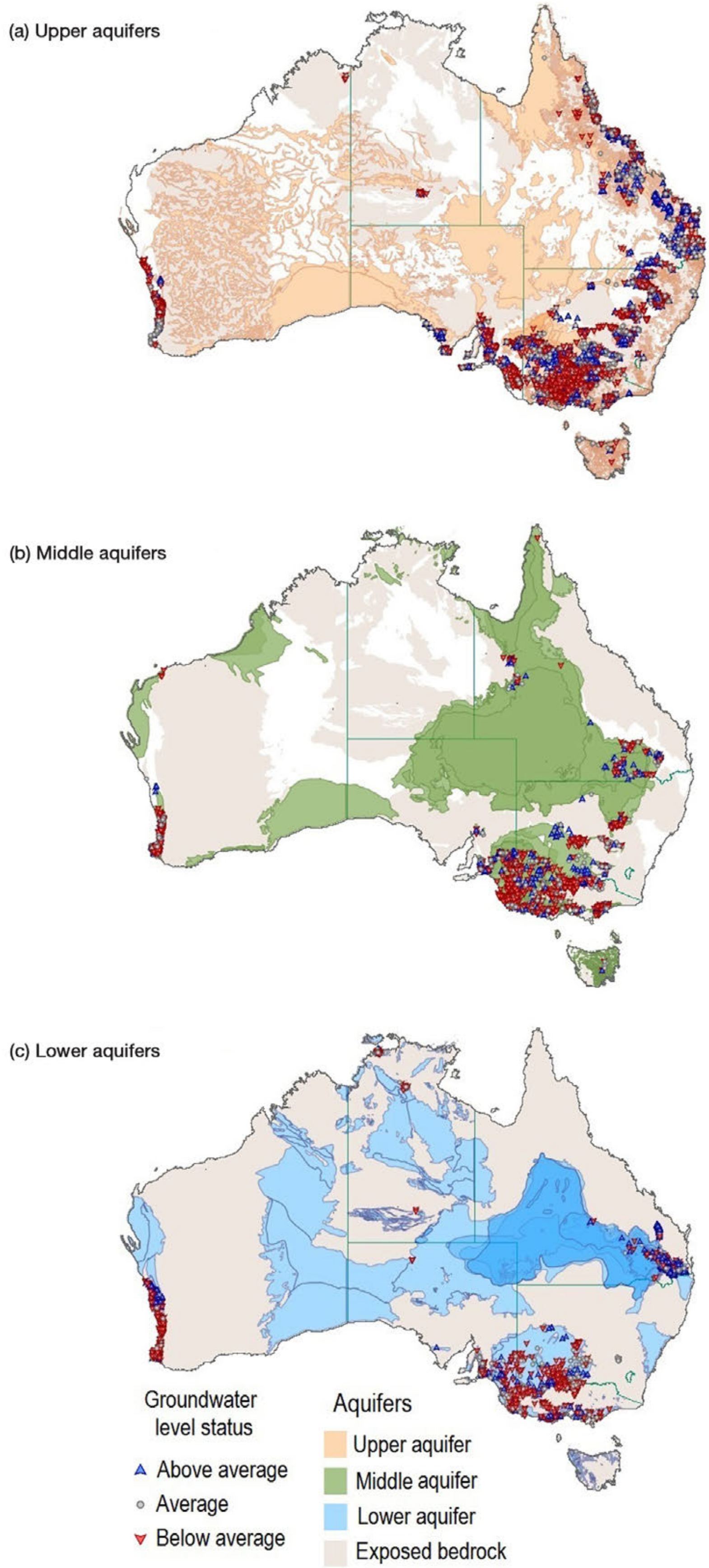


Figure 16. Groundwater level status in 2016–17 compared with the previous 20 years for (a) upper, (b) middle and (c) lower aquifers

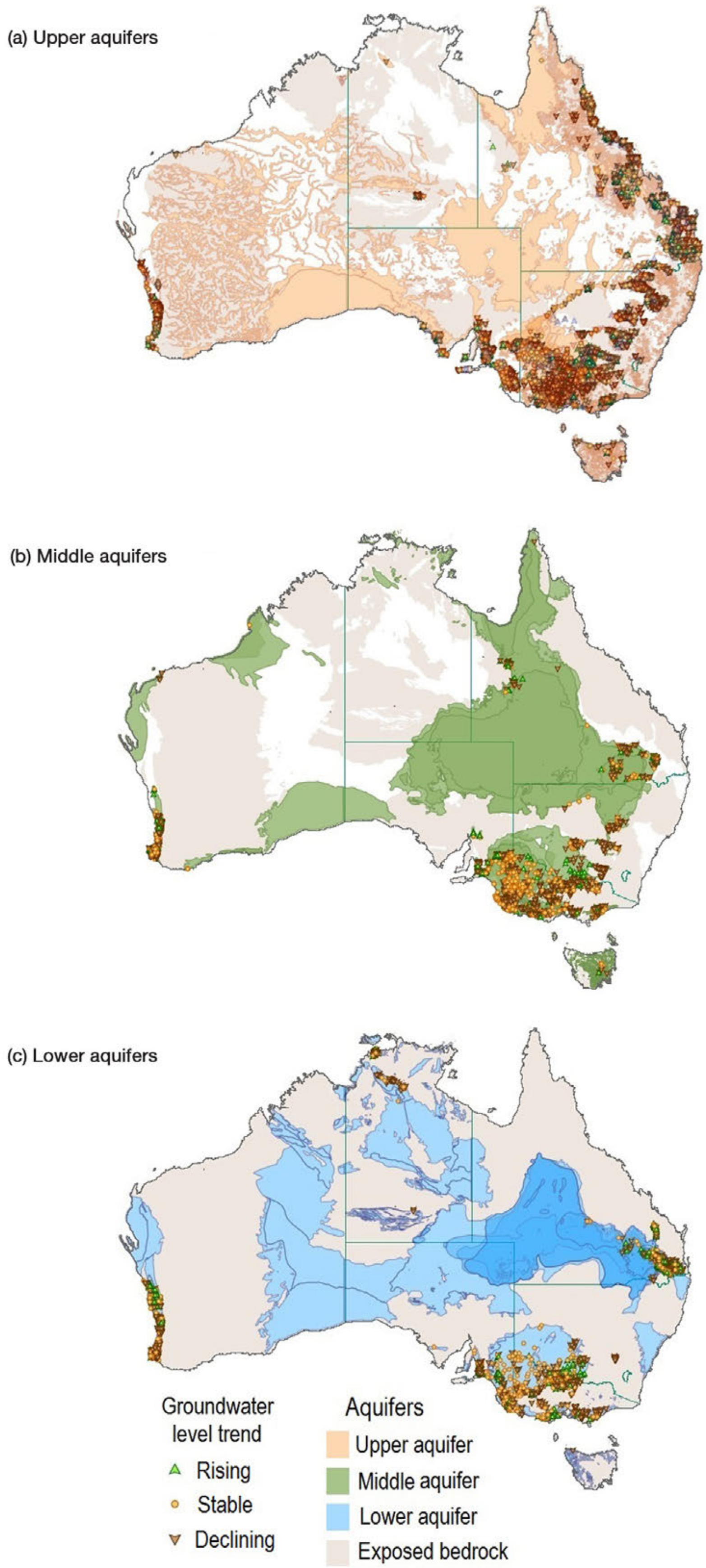
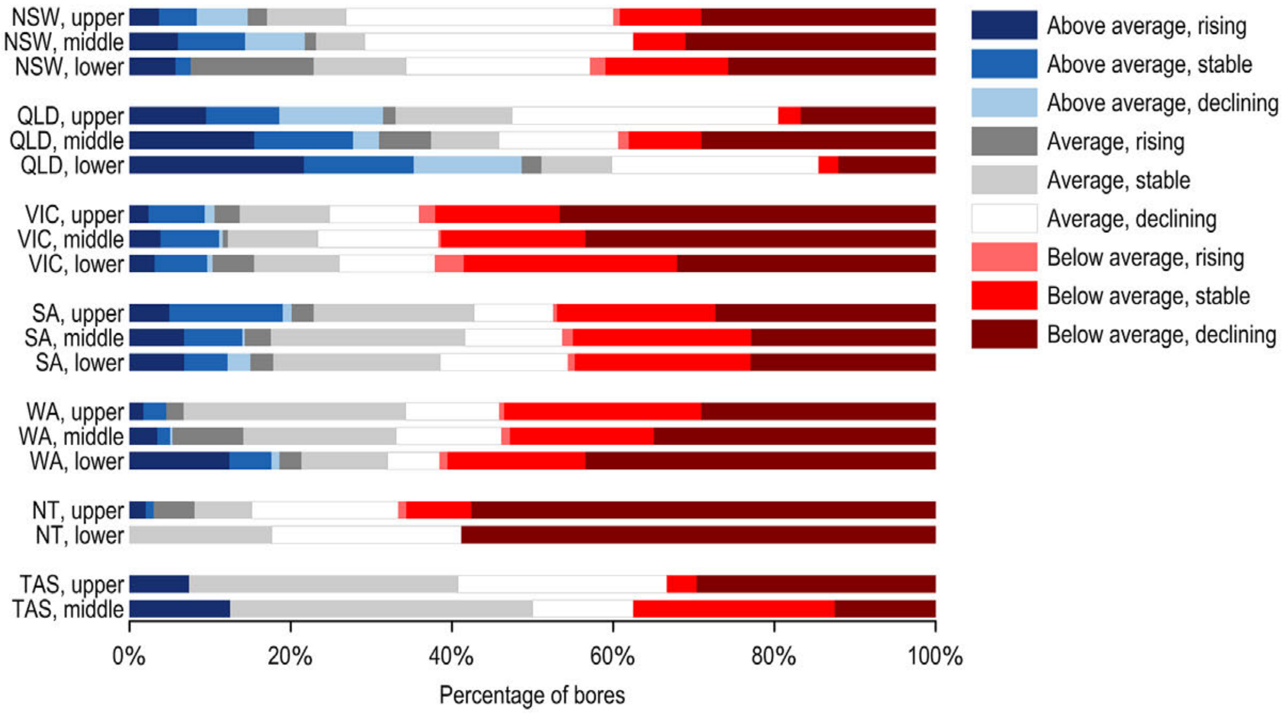


Figure 17. Groundwater level trends from July 2012 to June 2017 for (a) upper, (b) middle and (c) lower aquifers

(a) 2015–16



(b) 2016–17

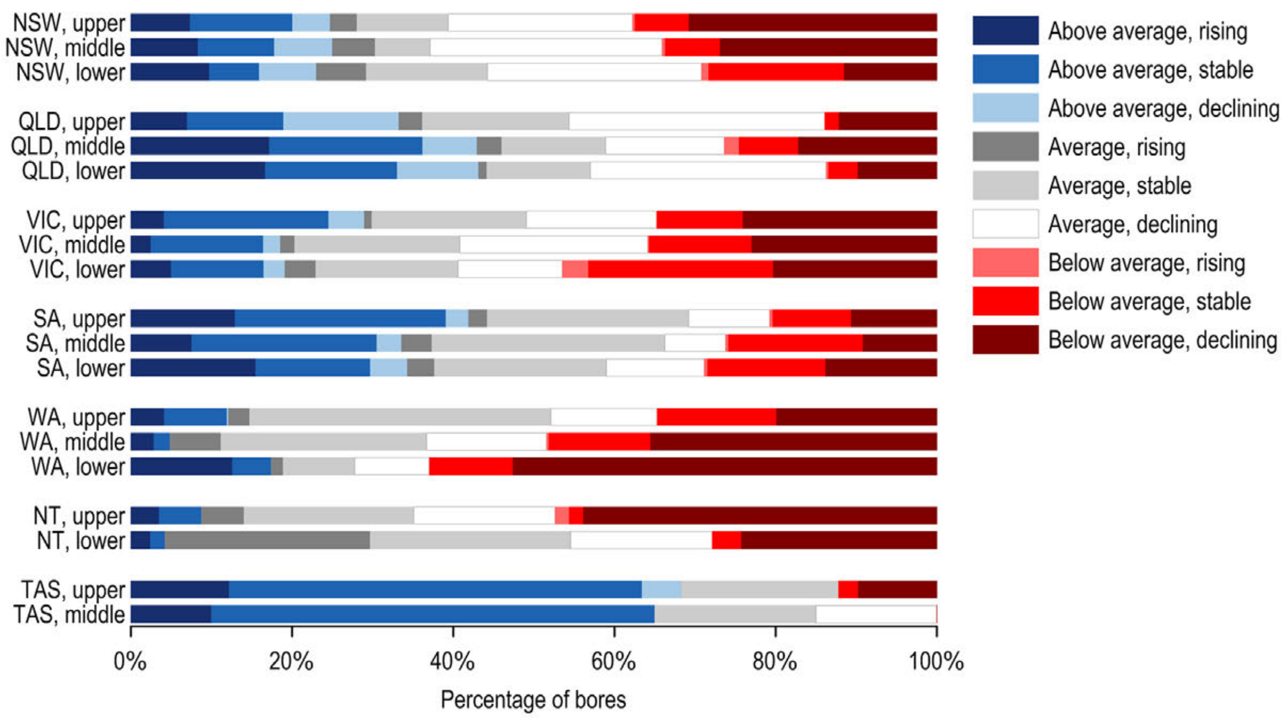


Figure 18. Summary of groundwater level status and trends by State and Territory (a) 2015–16 (b) 2016–17

2.6 DESALINATED AND RECYCLED WATER

Australia's climate is highly variable, with low annual mean rainfall and high interannual variability. Traditionally, Australian cities have relied on surface or groundwater sources to meet their water needs. The Millennium Drought that occurred between 1997 and 2009 raised concerns about the security of urban water supply from these traditional sources. To improve the security of supply under a changing climate and growing population, climate-resilient sources such as seawater desalination and water recycling have been introduced.

The five major urban centres in Australia have a total seawater desalination capacity of 535 GL per year (Table 4).

In addition to these major plants, several smaller desalination plants provide purified water to industries and mines. Many of these are already running close to capacity.

Recycled water from wastewater treatment plants is generally used year-round to take advantage of the consistent flows. Recycled water is mainly used for non-potable purposes, such as irrigation and toilet flushing. Industrial use of recycled water is also growing because water for potable use has become expensive, and there is growing awareness about fit-for-purpose use given scarcity of traditional water resources. The total volume of recycled water supplied decreased in all urban centres apart from Sydney and Canberra in 2016–17 compared to 2015–16, mainly due to wet conditions during the irrigation season.

In order to secure Perth's water supply, the Perth Groundwater Replenishment Scheme, which can produce 14 GL of water each year, was commissioned in late 2017. In this scheme, treated wastewater is further purified to drinking water standards and then recharged into Perth's confined aquifer. The water stored in the aquifer can be taken out later and supplied to the drinking water system after further treatment.

Table 4. Desalination plants located in major urban centres [18, 19]

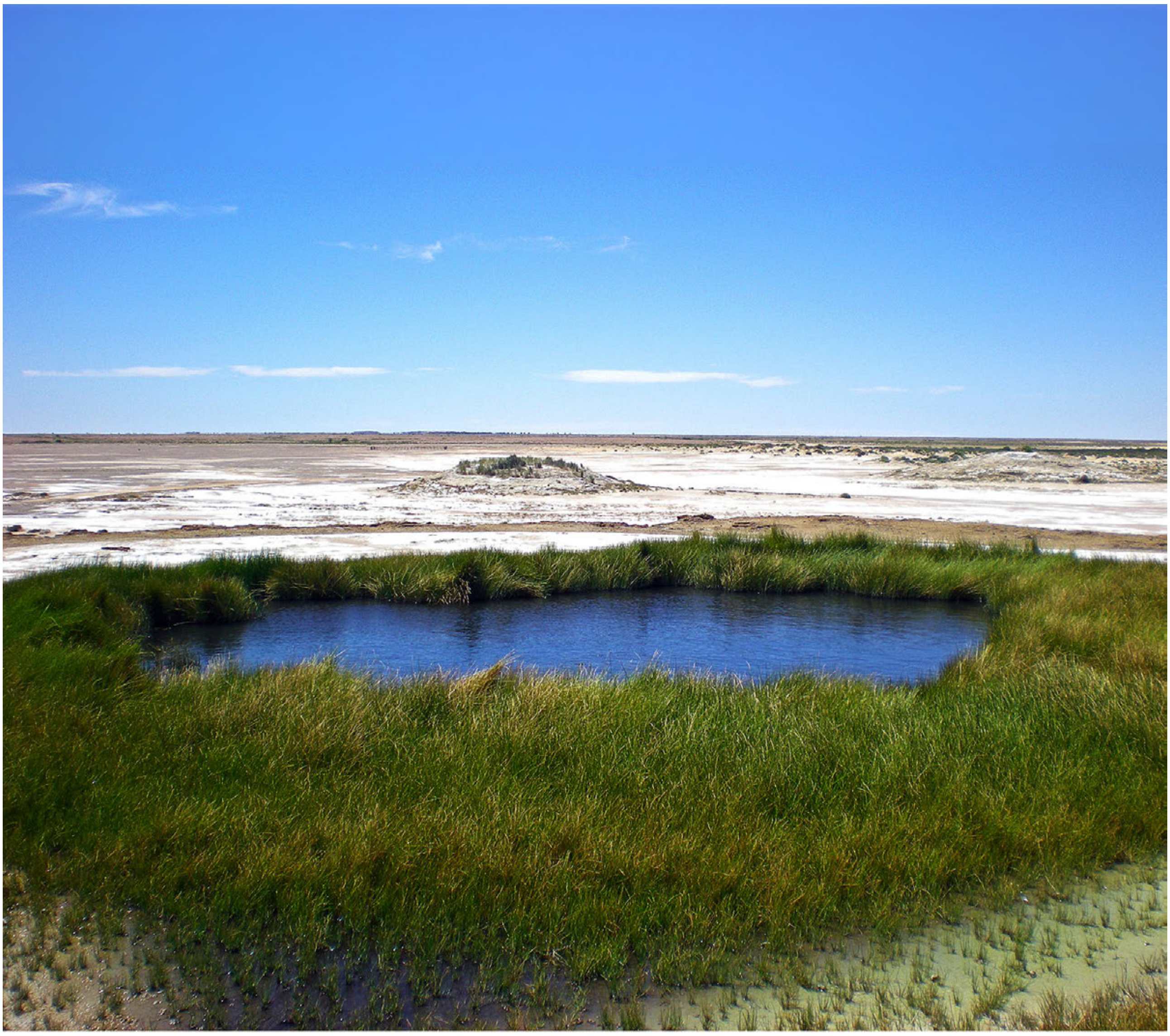
Urban centre	Built	Approximate capacity (GL/year)	Supply in 2016–17		Comment
			GL	% of city's supply[19]	
Sydney	2010	90	0	0	The plant will operate when the dam level falls below 60 per cent[20]
Melbourne	2012	150	46	11	Desalinated water was sourced for the first time in 2016–17
Perth: Seawater Desalination Plant	2006	45	149	53	Steadily increasing trend since 2006
Perth: Southern Seawater Desalination Plant	2013	100			
Gold Coast	2009	49	2	< 1	Operates in standby mode
Adelaide	2012	100	4	3	The 2016–17 desalination supply was the lowest volume since 2012

18 http://www.awa.asn.au
19 http://www.bom.gov.au/water/nwa/2017/
20 http://www.sydneydesal.com.au

2.7 RENEWABLE WATER RESOURCES

Renewable water resources refer to water that is continuously renewed by the hydrological cycle, such as streams and reservoirs fed by runoff, and aquifers fed by groundwater recharge. Australia's long-term average rainfall is 461 mm but only a small portion of this becomes renewable resources. On average, 9 per cent of this rainfall becomes runoff and about 2 per cent becomes recharge to groundwater (Prosser, 2011). Based on this, the long-term average per capita renewable water resource for Australia is 43 kL/day, and the average for 2016–17 was 56 kL/day.

Although the total volume of fresh water available in Australia is less than in many other countries, Australia has high per capita water resources because of the low population density. The regional distribution of resources is highly uneven, with abundant water resources in the northern regions compared with the middle part of the continent. Also, large year-to-year rainfall variability, including seasonality, affects water availability in the Murray–Darling Basin. This high spatial and temporal variability in water distribution makes the water diffcult to use.



3 WATER TRADING AND USE

This chapter begins with a summary of water made available in 2016–17 (section 3.1). An overview of the impact of water trading on the availability of water to licence holders is presented in section 3.2. 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 3.3). Section 3.4 summarises the water extractions for rural (mainly agricultural), urban and other industrial uses, and compares these to past use. Section 3.5 considers groundwater extractions in Australia's groundwater management areas. Section 3.6 examines water availability versus use in Australia's major rural surface water supply systems.

3.1 WATER MADE AVAILABLE

Water that is allocated or made available from groundwater and regulated and unregulated surface water is shown in Figure 19.

- For regulated systems, available water is the total annual allocations made against most major entitlements types, including carryover from the previous water year; it excludes supplementary entitlements (which are available only in New South Wales).
- For unregulated surface water and groundwater, where it is not typical for allocation to be formally announced, available water was assumed to equal licensed entitlement volumes; this approach is consistent with National Water Account methodology.[21]

Available allocations in 2016–17 were more than in any of the previous six years (Figure 19). This is mainly due to large allocations for general security licence holders in New South Wales, made possible by large inflows into storages, and to a lesser extent by increasing entitlements for groundwater and unregulated surface water. These increasing entitlements for groundwater and unregulated surface water have been driven by increased irrigation entitlements in Tasmania (up from 1711 GL in 2010–11 to 2178 GL in 2016–17), and an expansion of unregulated water licensing in states such as Queensland and Western Australia. These two states combined account for an increase of around 2000 GL since 2010–11. This increase in entitlements does not necessarily mean that more groundwater water has been used. It could simply reflect more water being subject to licensing arrangements and/or continual improvements in reporting of the volumes of water licensed.

21 http://www.bom.gov.au/water/nwa/document/companion-guide.pdf

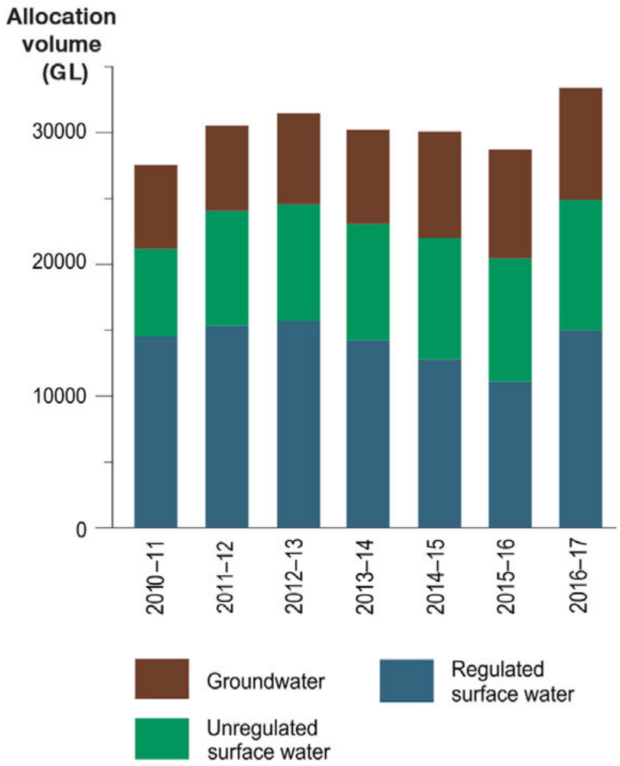


Figure 19. Available allocations: groundwater and regulated and unregulated surface water, 2010–11 to 2016–17

New South Wales has a high proportion of water holders with low reliability water entitlements (such as general security entitlements) (see Figure 20). These water holders are more exposed to volatility in water made available to them than are water holders with the more secure high reliability or groundwater entitlements. This volatility is reflected in the changes in the regulated surface water volumes allocated from year to year (Figure 19).

3.2 WATER TRADE

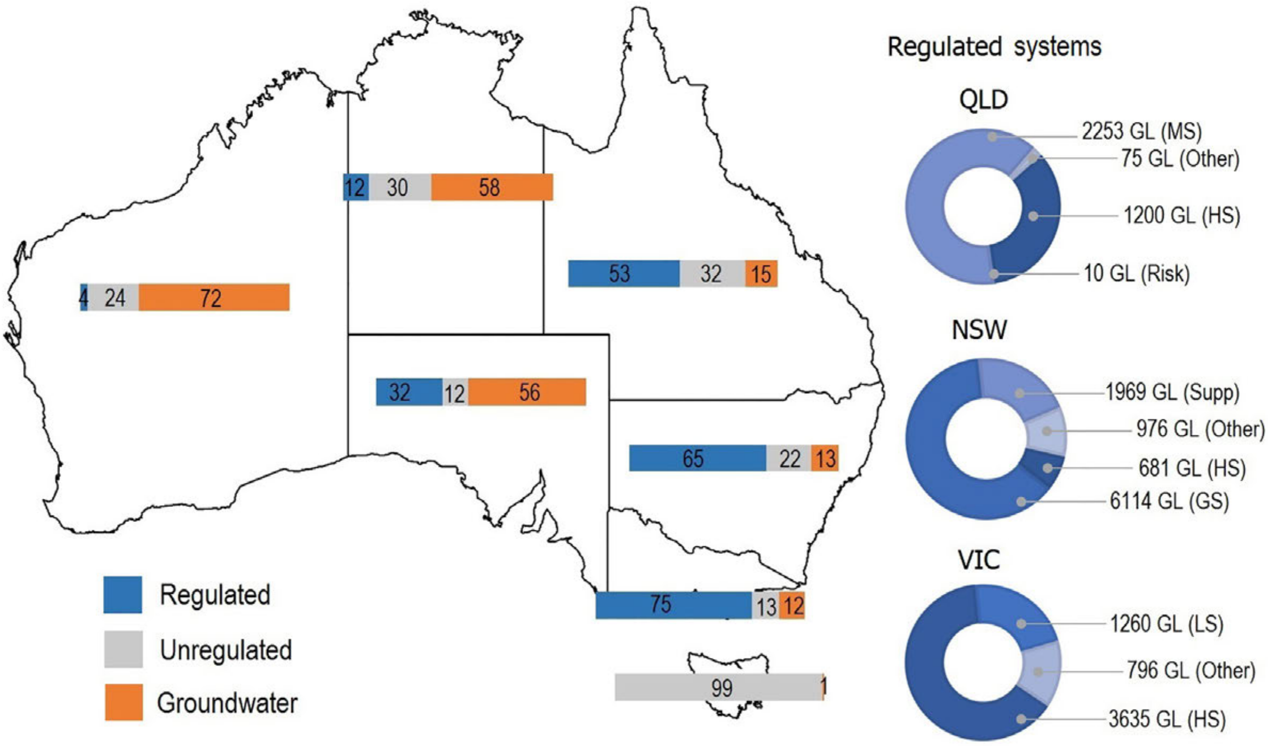
Australia's water market facilitates the buying and selling of water entitlements and allocations to allow water to move between various urban, agricultural and environmental uses. Entitlement trades involve permanent transfers of a water access entitlement. Allocation trades involve the buying and selling of allocated water during a particular year. Market turnover for 2016–17 was estimated at just over $1 billion.[22]

3.2.1 Entitlement trading

Entitlement trading predominantly occurs in the Murray–Darling Basin, which accounts for about 75 to 90 per cent of total entitlement volume traded. The volume of national trade for entitlements in 2016–17 was 23 per cent higher than the previous year (Figure 21). This was driven by a 48 per cent increase in trade outside the Murray–Darling Basin in Queensland, South Australia and coastal New South Wales. Trade outside the Murray–Darling Basin was the highest of the last seven years; this was largely due to two large entitlement trades as part of property sales. Trade within the Murray–Darling Basin increased by 17 per cent over the previous year.

High trading figures in 2013–14 were influenced by a large increase in the volume traded in the Murrumbidgee water system. This included one transaction where the Australian Government secured 381 GL of supplementary entitlements related to the Nimmie–Caira water saving project. With a greater focus on water savings from infrastructure projects, the rate of direct entitlement purchases by the Australian Government for environmental watering has slowed since 2013–14.

22 http://www.agriculture.gov.au/abares/research-topics/water/aust-water-markets-reports



GS: General security; MS: Medium security; HS: High security; LS: Low security; Supp: Supplementary

Figure 20. Entitlements on issue for groundwater and regulated and unregulated surface water, and entitlement security levels in regulated systems in Queensland, New South Wales and Victoria, 30 June 2017

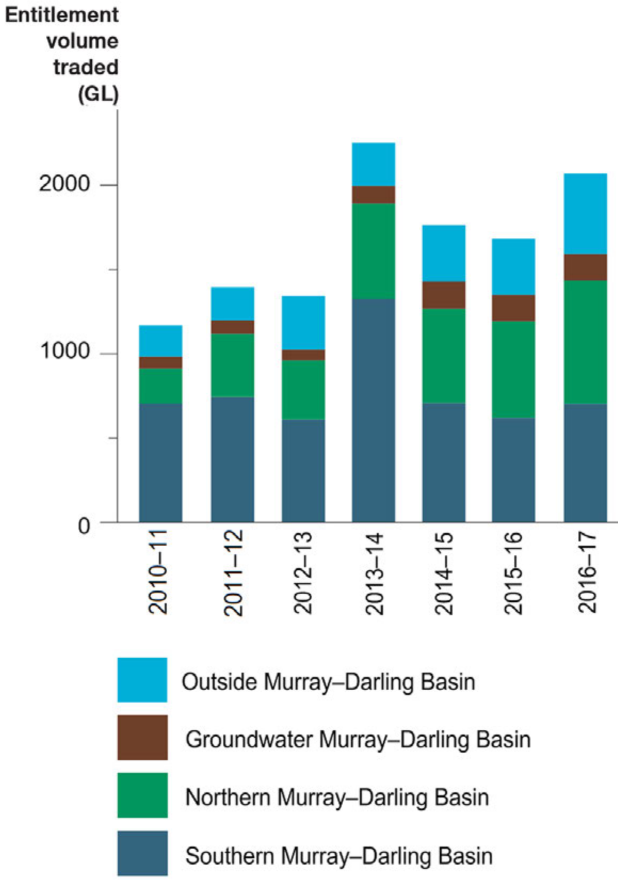


Figure 21. Entitlement trade volumes, 2010–11 to 2016–17

In 2016–17, the volume of surface water entitlements traded in the northern Murray–Darling Basin exceeded trade in the southern Murray–Darling Basin. Surface water trade in the northern Murray–Darling Basin increased by 27 per cent in 2016–17 over the previous year, and was the highest of the last seven years. In the southern Murray–Darling Basin, 704 GL of surface water entitlements were traded during the year, a 14 per cent increase from 2015–16.

Figures 22 and 23 show average prices for high and general security entitlements, respectively, for selected surface water systems. Robust trading data are only available for a limited number of water supply systems. Prices for entitlement trading show a general decline from 2009–10 to 2013–14, reflecting the high water availability across southeastern Australia in this period. Many of the high security entitlement examples provided show a sharp increase from 2014–15, reflecting decreasing water availability with drying conditions.

On the other hand, high security entitlement prices in 2016–17 returned to a level similar to 2009–10 and 2010–11, which was at the end of a period of very low water availability during the Millennium Drought. The increase in prices since 2014–15 may have been driven

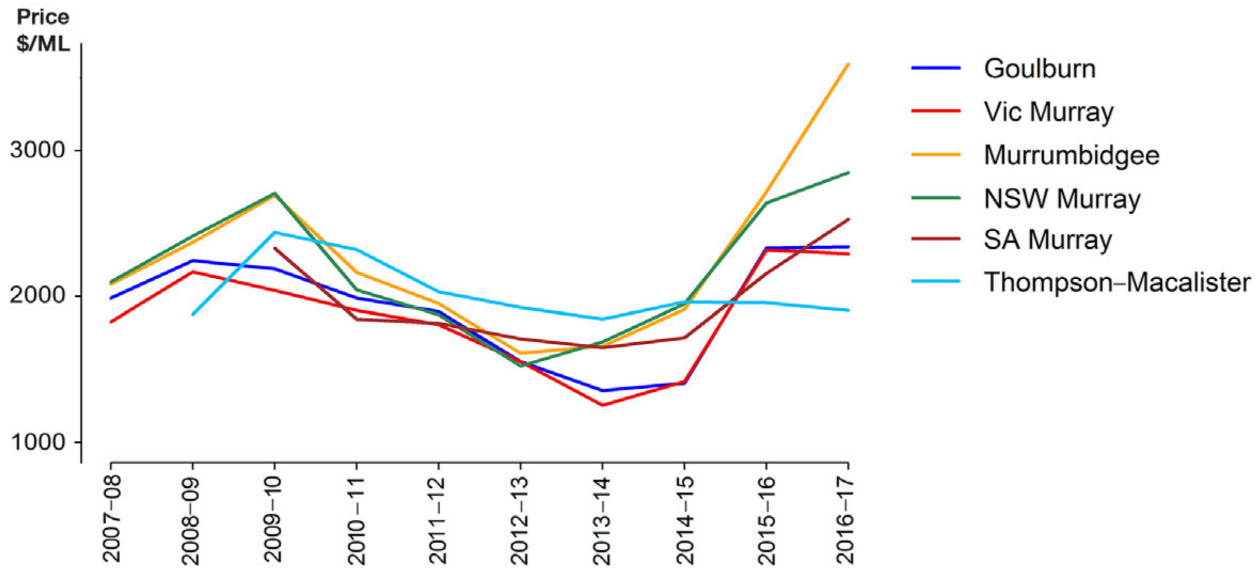


Figure 22. Surface water entitlement (high security) trade prices in selected systems, 2007–08 to 2016–17

by irrigators looking to secure water with a dry outlook for 2014–15 and the first half of 2015–16. However, in the last months of 2015–16 and during the first half of 2016–17 there was a dramatic turnaround in climatic conditions. For example, storages in Northern Victoria increased by 210 per cent (1078 GL to 3350 GL accessible volume) and the Murrumbidgee system rose by 138 per cent (1060 GL to 2530 GL) from April 2016 to December 2016. This may explain why prices steadied for high security entitlements in Northern Victoria (Goulburn and Victorian Murray in Figure 22) and general security entitlements in the Murrumbidgee system (Figure 23). The increase in price for Murrumbidgee high security entitlements could also reflect increased competition for water from expanded cotton production, or irrigators willing to pay a premium for what is one of the most reliable entitlement products in the southern Murray–Darling Basin (ABARES, 2018).

For the Hunter region, announced allocation levels have been consistently around full allocations, making general security entitlements more akin to high security in terms of price paid. In markets outside the southern Murray–Darling Basin, such as the Hunter and the northern Murray–Darling Basin (for example, the Namoi and Macquarie systems), lack of hydrological connectivity means trading zones act as separate markets, with different trading rules and characteristics. These systems may also have fewer trades, which means large individual trades can more easily influence average prices.

Overall, entitlement prices tend to be less volatile than allocation prices because trading entitlement is driven by longer term changes, such as climate, structural changes to farming enterprises and long-term yield (that is, expected available water for the entitlement holder).

3.2.2 Allocation trading

The southern Murray–Darling Basin dominates in terms of the volume of allocation trading with a record high in 2016–17 (Figure 24). In 2016–17, the total volume of allocation trade in the southern Murray–Darling Basin was 6096 GL, which is 19 per cent higher than the previous year and represents 87 per cent of total allocation trade in Australia.

For many irrigators and other water managers, water trading has now become a normal business tool that helps to manage both low and high water availability. For example, water trading volumes increased between 2008–09 and 2009–10 as irrigators sought to secure more water

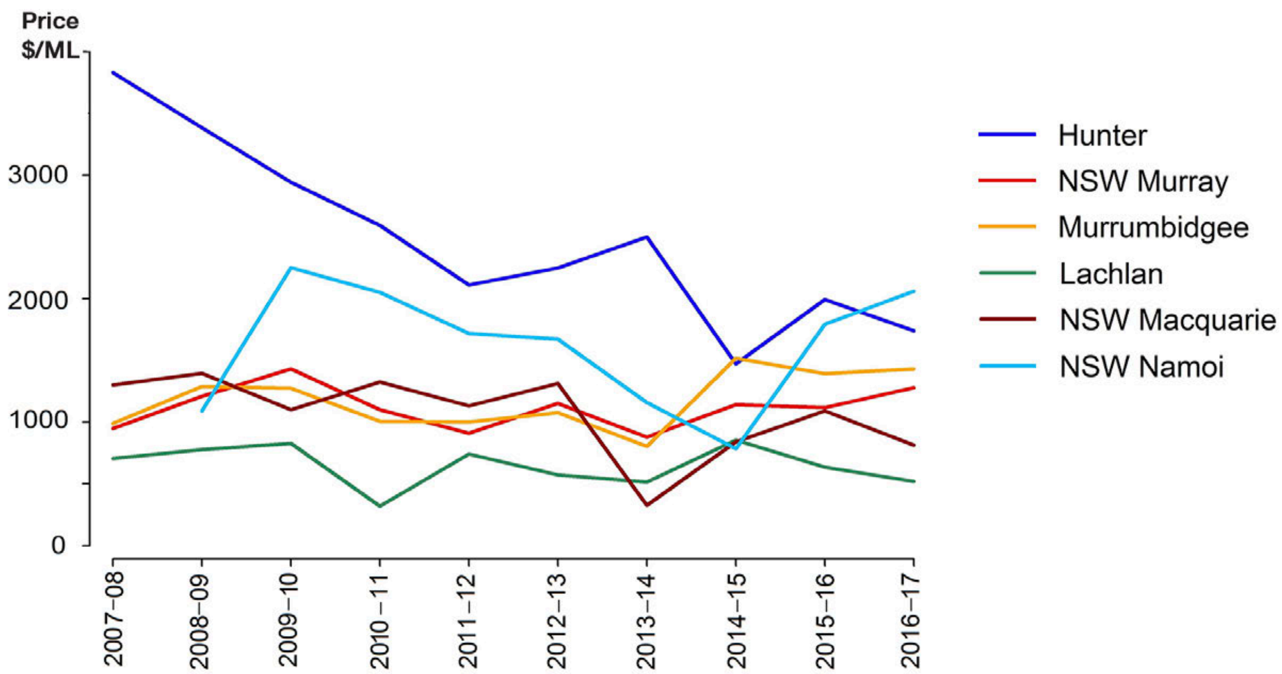
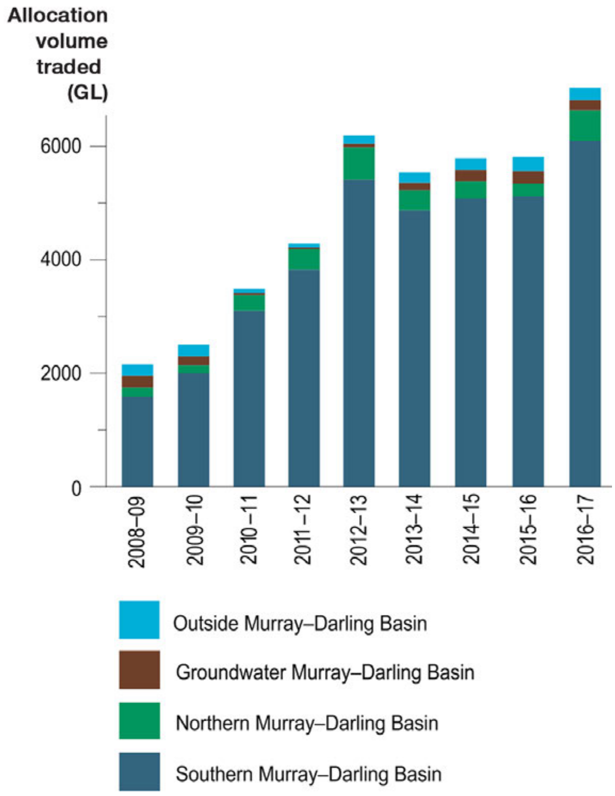


Figure 23. Surface water entitlement (general security) trade prices in selected systems, 2008–09 to 2016–17



Note: For this graph, the southern Murray–Darling Basin includes the Lachlan River, which is intermittently connected to other catchments in the southern Murray–Darling Basin.

Figure 24. Volume of water allocations traded nationally, 2008–09 to 2016–17

during drought conditions. As water availability improved from 2010–11 to 2012–13, and in 2016–17, irrigators purchased water to expand production, and environmental water managers transferred water within and between various catchments in the Murray–Darling Basin to facilitate environmental watering events.

Figure 25 shows that allocation prices fell sharply following the end of the drought in 2009–10, but started to increase in 2012–13 as the volume of announced allocations declined sharply for lower security entitlements (particularly in the Murrumbidgee and New South Wales Murray systems). Declining water availability between 2013–14 and 2015–16 put upward pressure on prices in both the southern and northern Murray–Darling Basin. Prices rose to as high as $300/ML in parts of the southern Murray–Darling Basin in November 2015 before sharply decreasing. The similar price pattern shown across systems in the southern Murray–Darling Basin reflects the connected nature of that market.

Improved water availability in 2016–17 saw prices drop back to levels not seen since 2012–13. Across the southern Murray–Darling Basin, high storage levels and high allocation announcements in 2016–17 saw allocation prices

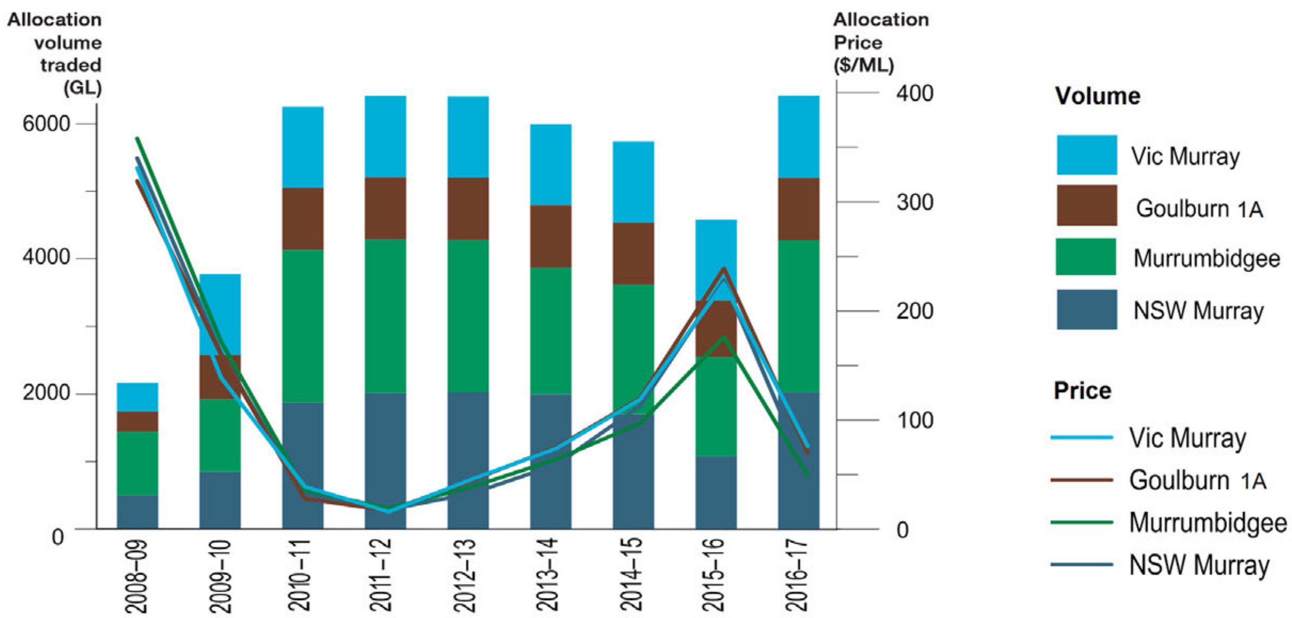


Figure 25. Water availability and allocation prices in the southern Murray–Darling Basin, 2008–09 to 2016–17

decrease from $214/ML in 2015–16 to $61/ML in 2016–17. These low prices enabled the expansion of seasonal crops such as rice and cotton in the Murrumbidgee Irrigation Area (ABARES, 2018).

The northern Murray–Darling Basin followed a similar average price pattern to that of the southern basin between 2008–09 and 2016–17, but the lack of hydrological connectivity between catchments in the northern basin meant that prices varied significantly between catchments because of differences in water demand and supply.

3.2.3 Internal and Interstate allocation trade

As discussed in section 3.2.2, most allocation trade occurs in the southern Murray–Darling Basin. This is a hydrologically connected market covering southern New South Wales, northern Victoria and the River Murray in South Australia. Allocation trades in the southern Murray–Darling Basin are dominated by internal (intrastate) trades (88 per cent, Figure 26). It is noteworthy that interstate trade only occurs in the southern Murray–Darling Basin and between New South Wales and Queensland. Interstate trade in the southern Murray–Darling Basin dropped by 34 per cent in 2016–17 compared to 2015–16 whereas internal trade increased by 35 per cent. Most of the 337 GL traded interstate from northern Victoria to South Australia in 2016–17 was to facilitate environmental watering along the River Murray and into the lower lakes (Figure 27).

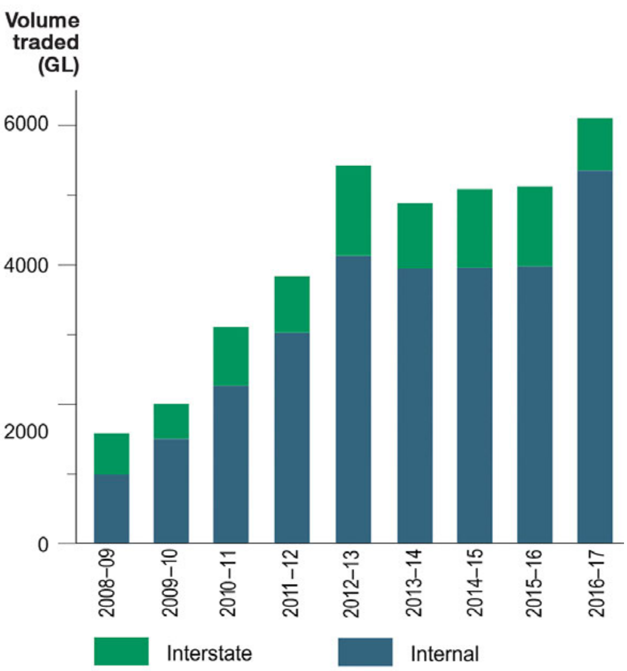


Figure 26. Intrastate (internal) and interstate allocation trades in the southern Murray–Darling Basin, 2008–09 to 2016–17

South Australia was the largest net importer of water through allocation trade, with a net import volume of 225 GL (Figure 27), which came mostly from Victoria (net import of 187 GL). This import volume is significantly less than that of 2015–16, when South Australia imported net 704 GL, largely for environmental purposes (Bureau of Meteorology, 2017).

In 2016–17, a net volume of 50 GL was traded interstate from Queensland to New South Wales in the Border River regions.

3.2.4 Groundwater trade

Trading of groundwater entitlements and allocations tends to be more limited than surface water trading. Typically, trading is only permitted within a small hydrologically connected groundwater management area. Each groundwater resource is managed separately, and allowing trade between groundwater areas can have third-party impacts. For example, changing volume and location of groundwater extraction could affect groundwater levels for other water users in the area.

Groundwater trading accounted for about 16 per cent of entitlement trades and about 3 per cent of allocation trades in 2016–17. Groundwater entitlement trading is particularly important for South Australia and Western Australia, which account for 39 and 72 per cent of entitlement trades, respectively. This reflects the fact that groundwater is the predominant water resource licensed in these states.

3.3 ENVIRONMENTAL WATER

Environmental water is water legally set aside to protect or restore the health of ecosystems fed by surface water or groundwater. This surface water is held in storages and is released to meet specific needs of the environment. There are two categories of environmental water: planned and held. Held environmental water is in the form of licences and has been recovered by the Australian Government through improving irrigation infrastructure or water buy-backs. These licences are owned by the Commonwealth

Environmental Water Holder or State environmental water holders. Planned environmental water is the water allocated through water sharing plans and is managed by various State agencies. Environmental water is largely held in surface water entitlements. Depending on the river operating rules, flow constraints and climatic conditions, environmental water can be used, held and carried over to the next year, or traded for equal or greater environmental benefit. The volume of available environmental water thus varies from year to year.

3.3.1 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 Commonwealth Environmental Water Holder plans and delivers environmental water throughout the basin, in consultation with State environmental water holders, river operators, the Murray–Darling Basin Authority and local community members. The Australian Government recovers water through direct purchases, infrastructure investments and other water recovery programs. As of 30 June 2017, the total Commonwealth water holdings were 2562 GL of registered entitlements with a long-term average annual yield of 1780 GL.[23] At 30 June 2016, the carryover of the Australian Government's regulated entitlements was 361 GL and the total annual allocation for 2016–17 was 1721 GL.

Total environmental water releases in 2016–17 from all environmental water holders and managers in the southern Murray–Darling Basin were just over 1900 GL, while the total for the northern basin was 168 GL. These volumes were significantly higher than the 1000 GL and 66 GL of environmental water releases in the southern and northern basins, respectively, during 2015–16.

All environmental water releases made in the southern Murray–Darling Basin at the request of the Commonwealth, New South Wales and Victorian environmental water

23 http://www.environment.gov.au/water/cewo/about-commonwealth-environmental-water

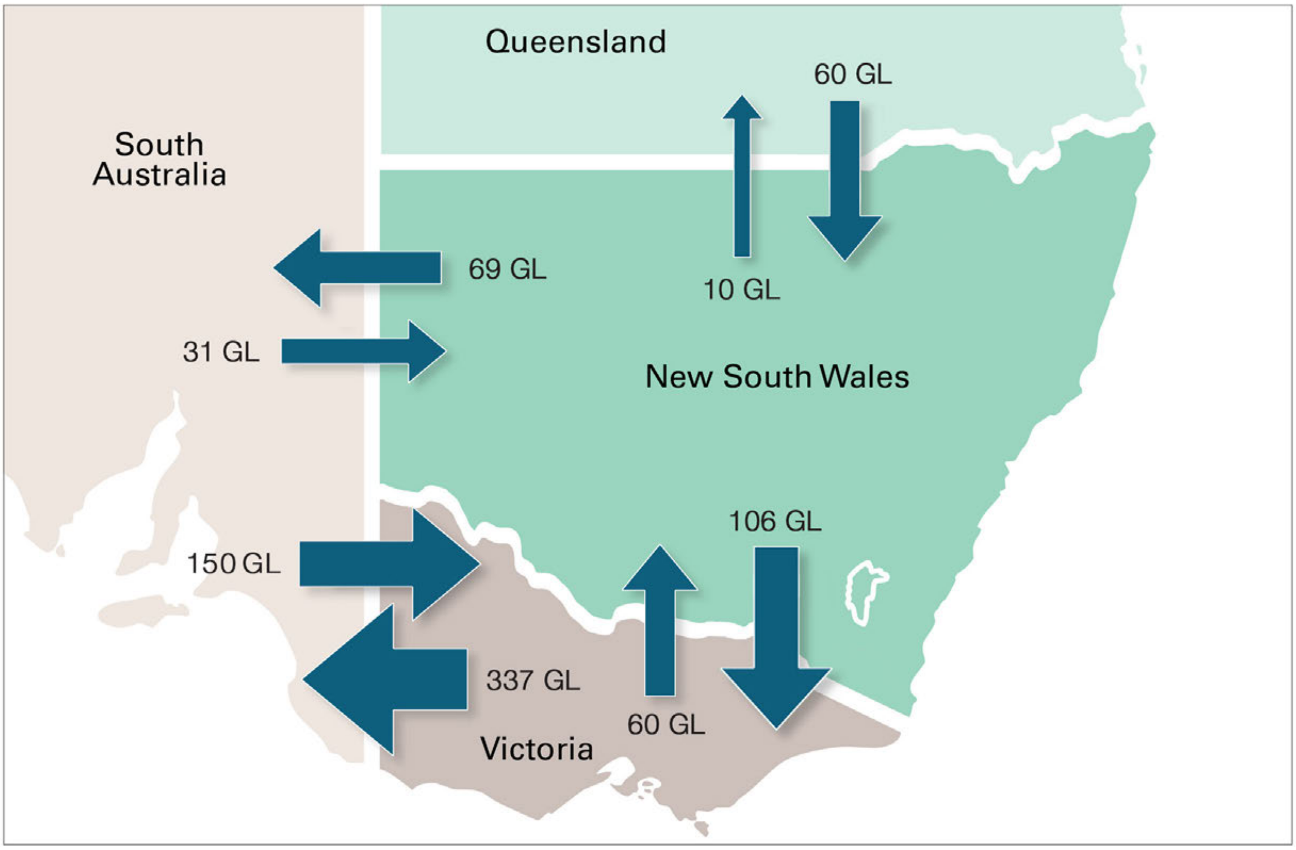


Figure 27. Interstate allocation trade in the Murray–Darling Basin in 2016–17

Table 5. Environmental flow releases in the southern Murray–Darling Basin in 2016–17

Region	Released volume (GL)	Target
New South Wales Murray and Lower Darling	683	To create fish refuges during a blackwater event; provide habitat for native fish species in Gunbower Forest; support spawning, recruitment and movement of Murray cod; maintain nesting and foraging habitat for waterbirds
Lachlan	41	To support colonial waterbird breeding at the Booligal Wetlands; improve early stage recovery of river red gum woodland and refuge flows for native fish during a blackwater event
Murrumbidgee	530	To manage flood recession rate to slow discharge of blackwater into the river channel; support bird-breeding events; improve the health of wetlands
Victorian Murray	197	To improve the conditions of plants and animals in four iconic sites in Victoria: Hattah Lakes; Lindsay–Walpolla and Mulcra islands; Gunbower Forest; and Barmah Forest
Ovens River	0.07	To foster the growth of the food chain from the bottom up to support endangered fish populations
Goulburn River	230	To stabilise riverside vegetation; reduce erosion and bank slumping; trigger fish breeding; improve water quality in the river after a blackwater event
Broken River	36	To improve water quality after major flooding in River Murray; enable native fish to pass along the Broken Creek outside the irrigation season
Campaspe	6	To provide summer irrigation flows downstream of Lake Eppalock to help fish, platypus and native water rats survive; support fish migration into the Campaspe and Goulburn rivers
Loddon River	15	To support the survival of native river blackfish; improve river habitat and the connectivity of waterways
South Australia Murray	199	To maintain and improve vegetation in specific South Australian wetlands and floodplain; maintain connectivity between the Lower Lakes and Coorong; provide suitable habitat conditions (both salinity and water levels) in the Coorong for estuarine fish and vegetation species

Source: State of New South Wales and Office of Environment and Heritage (2017)[24] and Victorian Environmental Water Holder (2017)[25]

24 http://www.environment.nsw.gov.au/research-and-publications/publications-search/use-of-water-for-the-environment-in-nsw-outcomes-2016-17
25 http://www.vewh.vic.gov.au/__data/assets/pdf_file/0010/445564/Reflections-Water-for-the-Environment-2016-2017.pdf

holders, and managers and the Murray–Darling Basin Authority in 2016–17 are summarised in Table 5. More than 680 GL of water was delivered in the New South Wales Murray and Lower Darling catchments to strategically support widespread catchment flooding to enhance native fish, waterbird and plant responses, and to provide refuge for native fish during a blackwater event.

The Murrumbidgee catchment received 530 GL of environmental water, and about 70 per cent of this allocation was used to improve dissolved oxygen levels in refuges for native fish.

Environmental water releases in the northern Murray–Darling Basin totalled 168 GL in 2016–17; these are summarised in Table 6. More than 50 per cent (89 GL) of the total released into the Macquarie River was used to support the health of permanent and semi-permanent wetlands, waterbird breeding in the Macquarie Marshes, and connectivity between the Macquarie and Barwon rivers for fish.

In 2016–17, Macquarie Marshes received more than 1000 GL of gauged inflows. This includes natural flows from rainfall and releases for environmental needs. The other major environmental release in the northern Murray–Darling Basin occurred in the Gwydir catchment where 47 GL was delivered to support the health of semi-permanent wetlands, enhance hydrological connectivity and create refuge pools.

Outside the Murray–Darling Basin, about 200 GL of environmental water was released in 2016–17. The environmental releases for the Snowy River totalled 132 GL, which was less than previous years because natural flooding from heavy rainfall made some planned high-flow environmental releases unnecessary.[27] About 54 GL was delivered in six high-flow events in winter, spring and early summer to maintain the opening of the Snowy River estuary and reduce salinity in the upper reaches. The Victorian Environmental Water Holder released 21 GL, 28 GL and 14 GL for Gippsland, Central and Western regions of the State, respectively, to boost the health of the rivers.

27 http://www.vewh.vic.gov.au/rivers-and-wetlands/gippsland-region/snowy-river

Table 6. Environmental flow releases in the northern Murray–Darling Basin, 2016–17

Region	Released volume (GL)	Target
Gwydir	47	To provide hydrological connectivity to in-stream habitat across the catchment; make water available for critical refuge habitat during dry conditions; support the highly water-dependent semi-permanent wetland
Macquarie	89	To support colonial waterbird breeding at the Macquarie Marshes; provide opportunities for post-spawning dispersal of native fish; provide fish connection between the Macquarie and Barwon rivers
Border Rivers	23	To protect and restore water-dependent ecosystems in the Seven River (683 ML) and in the Macintyre and Dumaresq rivers (22 GL)
Namoi	9	To provide movement cues for fish; support fish movement from Barwon River to Namoi River; increase the food supply by 'flushing' nutrients off the low in-channel sediment bars

Source: State of the New South Wales and Office of Environment and Heritage (2017)[26]

26 http://www.environment.nsw.gov.au/research-and-publications/publications-search/use-of-water-for-the-environment-in-nsw-outcomes-2016-17

3.3.2 Water for Aboriginal cultural use

Traditional Aboriginal custodians have cultural, spiritual and economic connections to land and water resources. Any environmental water release in Aboriginal areas is thus of special significance. One environmental water release in 2016–17 that stood out for its cultural connection was the watering of Toogimbie Indigenous Protected Area near Hay in the Murrumbidgee catchment.[28] Toogimbie Indigenous Protected Area covers around 46 000 ha of an area that is owned and managed by the Nari Nari Tribal Council. One gigalitre of Commonwealth environmental water was delivered to wetlands in this area, during autumn and winter 2017, to provide habitat for native animals and wetland-dependent fauna, and improve the condition of vegetation. The watering event was managed by the Nari Nari Tribal Council's rangers, who ensure that the water and land are cared for in accordance with cultural protocols.

Another environmental release, which provided an opportunity for Traditional Owners to reconnect with the river, was the water release in the Glenelg River. This river is one of the longest in Victoria and one with which Aboriginal people have a close connection. The 'Towards Cultural Flows' project provided an opportunity to identify the interests and priorities of the Traditional Owners and establish better linkages to environmental water planning.[29] In March 2017, environmental water was released from the Rocklands reservoir to support both cultural and ecological values.

A lot of work is in progress to better link cultural values to environmental release priorities. The Aboriginal Waterways Assessment Program[30] aims to develop a tool to help Traditional Owners assess the cultural health of waterways and rivers and set environmental water delivery priorities. This program is a collaborative partnership between the Murray–Darling Basin Authority, the Murray Lower Darling Rivers Indigenous Nations and the Northern Basin Aboriginal Nations. The tool has been adapted from a Maori Cultural Health Index to suit the needs of Traditional Owners. It allows them to assess cultural values and waterway health based on quantitative and qualitative indicators. Pilot projects using this tool to document cultural values and to set environmental priorities have been initiated in Victoria, South Australia and the Australian Capital Territory.[31]

3.4 WATER ABSTRACTIONS FOR CONSUMPTIVE USE

3.4.1 Total water abstractions

The total volume of water abstractions for consumptive use is defined as all licensed water abstractions from rivers, storages, high-yielding aquifers and desalination plants that are not used for environmental or cultural purposes. The estimated total volume of water abstractions across Australia was 15 670 GL in 2016–17, which is slightly lower than the figure reported for 2015–16. Water abstracted for agricultural purposes (11 010 GL) accounted for 70 per cent of the total, followed by water abstractions for urban use (3130 GL, 20 per cent) (Figure 28).

Water used for other industrial purposes (1530 GL) is based on 2015–16 estimates of water consumed by the mining, manufacturing, electricity and gas supply, and other industry categories in Water Account, Australia, 2015–16 (Australian Bureau of Statistics, 2017).

3.4.2 Agricultural water abstractions

The total water abstracted for agricultural use in Australia in 2016–17 is estimated at 11 010 GL, of which 9180 GL was sourced from surface water and 1830 GL from groundwater (Figure 29). The annual total abstracted was similar to that of the previous year, but surface water abstractions increased by 10 per cent whereas groundwater use dropped by 27 per cent. This was due to increased surface water availability in 2016–17, which led farmers to increase their use of surface water rather than groundwater, which is usually more expensive to extract.

Higher regulated surface water allocations in New South Wales contributed significantly to the increased surface water abstractions in 2016–17. Surface water abstraction for agricultural use increased by about 43 per cent in New South Wales whereas groundwater extraction decreased

28 http://www.environment.gov.au/water/cewo/catchment/murrumbidgee/history

29 http://www.vewh.vic.gov.au/news-and-publications/stories/yarns-on-the-western-rivers

30 https://www.mdba.gov.au/publications/mdba-reports/aboriginal-waterways-assessment-program

31 http://www.mldrin.org.au/what-we-do/aboriginal-waterways-assessment/

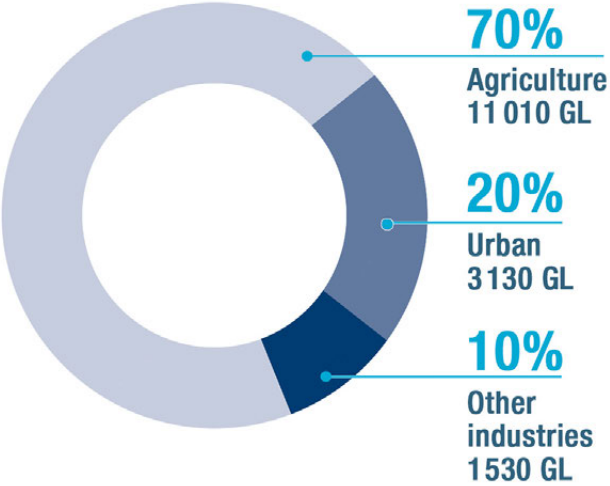


Figure 28. Total bulk water abstractions by category in 2016–17

by about 45 per cent in comparison to the previous year. Surface water and groundwater use in Victoria both dropped substantially (to about 29 per cent and 45 per cent of the previous year, respectively) due to wet conditions during the growing season. In Queensland, extractions from both surface water (up by 29 per cent) and groundwater (up by 53 per cent) increased significantly compared with 2015–16. Surface water abstractions in Tasmania were similar to that of the previous year. In South Australia, the abstractions from surface water and groundwater in 2016–17 were 11 and 50 per cent lower, respectively, than in 2015–16.

In all States and Territories except Western Australia and the Northern Territory, more surface water than groundwater was diverted to satisfy the demands from agriculture (Figure 29). In Western Australia, groundwater contributed 52 per cent of the total water sourced. In the Northern Territory, the groundwater extractions (41 GL) were 98 per cent of the total.

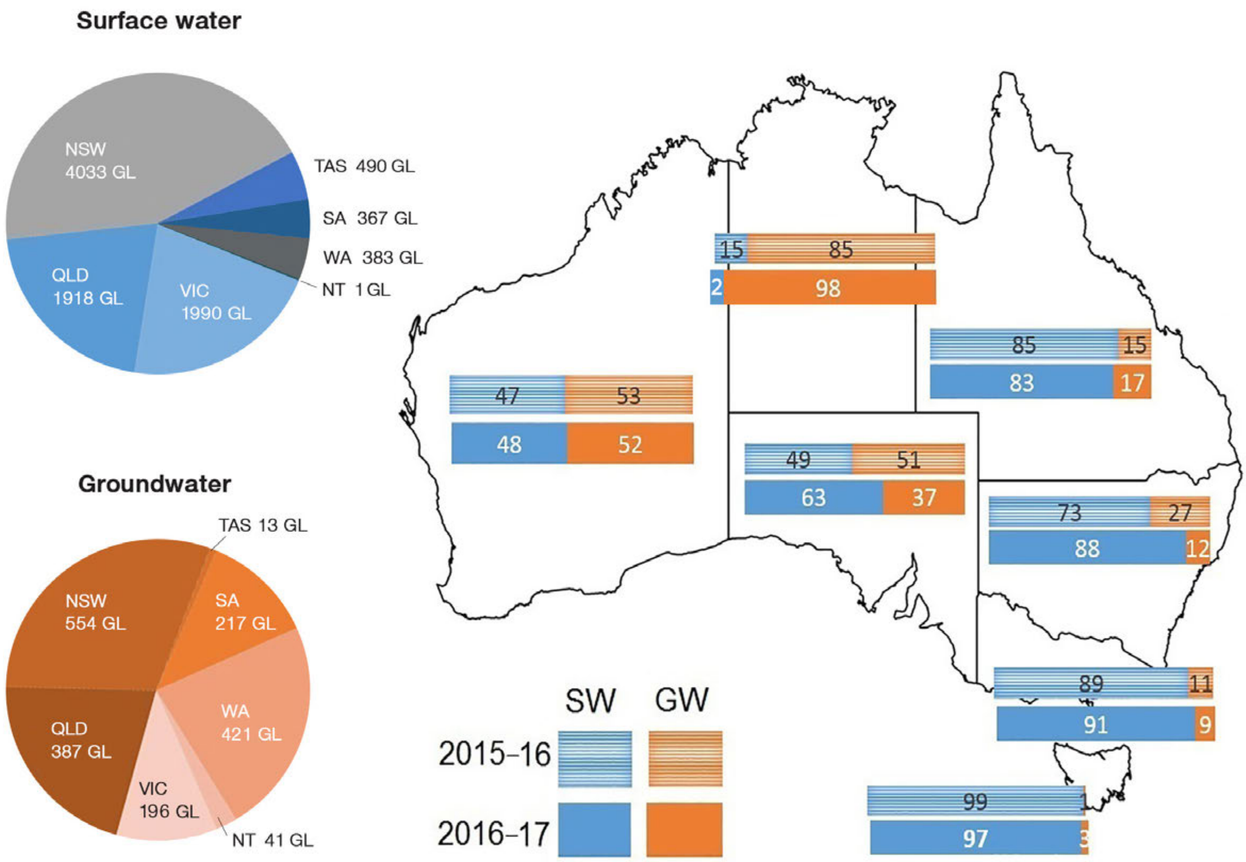


Figure 29. Proportions of surface water (SW) and groundwater (GW) in agricultural water abstractions in each State and Territory, 2015–16 and 2016–17, and surface and groundwater abstractions by State and Territory for 2016–17

These data were based on non-urban diversions in the National Water Account 2017[32], and supplemented by data sourced online or received directly from State data providers for regions outside the National Water Account regions.

3.4.3 Water sourced by urban utilities

The total volume of water extracted by utilities in 2016–17 was 3130 GL, 4 per cent less than the previous year's total. The decrease in water use in 2016–17 can be attributed to wet climatic conditions around the major urban centres.

Water utilities supplied an average of 204 kL per property in major urban areas, 5.6 per cent less than the previous year.[33] Average residential water use per property dropped in all major urban centres except for Sydney and Hobart. Darwin had the highest average urban water use per property (361 kL), followed by Perth (223 kL). Despite this relatively high use, both Darwin and Perth had lower water use per property (by 10 and 7 per cent, respectively) than in the previous year. The lowest urban water use per property in 2016–17 was in Melbourne and South East Queensland (148 kL and 158 kL, respectively).

During the last decade, there has been a declining trend in per capita residential water use in major urban centres. This reduction in use is mainly due to the introduction of water-demand management programs (including water restrictions) and changes in user behaviour due to increased awareness of water scarcity.

Urban water supplies traditionally rely on surface water from reservoirs, which are highly susceptible to variability in rainfall. Major urban centres in Australia have used various supply- and demand-side management strategies to respond to both increased water demand due to population growth and reduced water availability arising from both climatic variability and lessening rainfall. In recent years, the construction of large-capacity seawater desalination plants has improved water security for urban users.

Natural inflows into Perth storages have greatly diminished over the past few decades due to the impacts of climate change. In June 2017, Perth's water storage was at 25 per cent of capacity, up from 20 per cent of capacity at the same time the previous year. Water supply in Perth is currently sourced from groundwater, desalination, recycling and surface water storages. With the introduction of climate-independent sources of water (desalination and groundwater replenishment), the security of Perth's water supply has significantly improved.

3.4.4 Sources of water for major urban centres

Surface water was the main source of urban water supply in all major urban centres except Perth. Surface water diversion for urban use went up in all cities except Perth and Canberra in 2016–17 (Figure 30).

Total water sourced is calculated as the sum of surface water, groundwater, desalinated and interregional transfers. In terms of supply, recycled water is internally sourced from existing water, rather than a separate resource.

In Sydney, the majority of the supply was met from surface water (564 GL), a 2 per cent increase from the previous year. About 6 per cent of the total supply was recycled.

In Melbourne, 437 GL of water (excluding recycled) was sourced for urban water supply in 2016–17, 2 per cent less than the previous year. In 2016–17, the Victorian Government ordered 50 GL of desalinated water from the Victorian Desalination Project. In response to that, 46 GL of desalinated water (11 per cent of the city's total supply) was delivered to the Cardinia Reservoir, where it was mixed with surface water from Melbourne catchments. Surface water and interregional transfers together contributed about 89 per cent of the city's supply, though the latter decreased by 64 per cent from the previous year. This was because surface water was available to meet demand due to improved rainfall conditions in Melbourne catchments, reducing the need for interregional transfers from Thomson Reservoir.

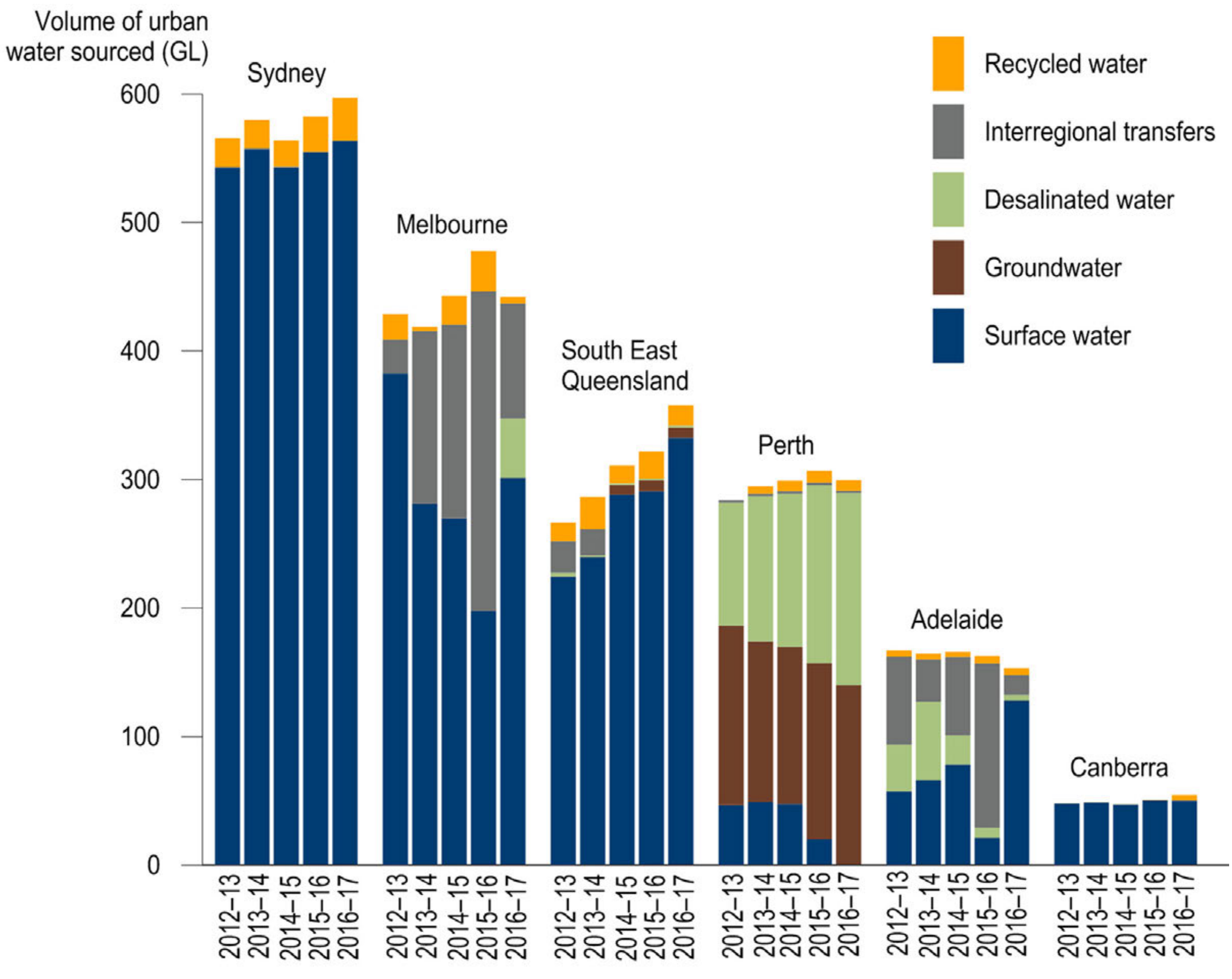
Total water sourced in South East Queensland (excluding recycled) in 2016–17 was 342 GL, an increase of 14 per cent from the previous year. This was the highest increase for all of the major urban centres. About 97 per cent of the water sourced was supplied from surface water along with a minor (2 per cent) contribution from groundwater. The contribution from desalination was less than 1 per cent.

32 http://www.bom.gov.au/water/nwa/2017/
33 http://www.bom.gov.au/water/npr

Water sourced for urban use in Perth decreased by 5 per cent in 2016–17 compared to the previous year. Most of the urban water supply for Perth was met from desalination (about 150 GL) and groundwater (about 140 GL). The net surface water diversion, which is the difference between the total diversion from surface water storages (91.3 GL) and the supply system discharge into the storages (99.8 GL), was 8.5 GL in 2016–17. That is, Perth's water supply system received more water than it needed to deliver, due to low water demand during the wet summer conditions. The excess water produced during wet periods was discharged into the surface water storages, resulting in increases in surface water storage during the year.

In Adelaide, 148 GL of water (excluding recycled) was sourced for urban water supply in 2016–17, 6 per cent less than the previous year. About 87 per cent of the water sourced came from surface water and 10 per cent through interregional transfers from the River Murray. In the previous year, the reliance on interregional transfer was greater, and it constituted 82 per cent of Adelaide's water supply. Due to increased surface water inflows into urban storages in 2016–17, only 4 GL of desalinated water (3 per cent of the total use) was sourced for urban use.

In Canberra, the total inflow into the urban water system was 50 GL, which is similar to the previous year. About 9 per cent of the total urban water used was recycled water.



Source: National Water Account 2017[34]

Figure 30. Volumes and sources of urban water used in Australia's major urban centres, 2012–13 to 2016–17

34 http://www.bom.gov.au/water/nwa/2017/

In 2016–17, recycled water use decreased in most of the urban centres, the exceptions being Sydney and Canberra. In 2016–17, the total volume of recycled water sourced for the major urban centres was 73 GL, a 24 per cent decrease from the previous year's total.

3.4.5 Water use by other industries

Agricultural and urban water users are the main bulk water extractors in Australia. Other water users include mining, manufacturing, electricity production and service industries.

The latest data available for non-agricultural industries are for 2015–16. The total water used for industrial purposes is estimated to be 1526 GL.[35] Of this total, mining water use is estimated to be 661 GL, manufacturing to be 577 GL and electricity and gas to be 288 GL. Electricity generation mostly uses surface water, with many large power plants having a high security entitlement.

Water use by other industries, especially service industries, is estimated as 1084 GL, and this component is included in the extractions for urban use (Australian Bureau of Statistics, 2017).

Though water consumption by non-agricultural industries decreased across Australia in general, some States and Territories experienced increases. Extraction for mining and other industries increased significantly in South Australia in 2015–16 compared with 2014–15.

3.4.6 Water stress

Globally, water extractions for human consumption are increasing day by day, and water scarcity has become widespread because the resources are finite. Water stress can be estimated using the United Nation's Sustainable Development Goal indicator 6.4.2.[36] This is estimated as the ratio between the total volume of freshwater withdrawn by major economic sectors and the total renewable freshwater resources, after taking into account environmental water requirements.

The purpose of this indicator is to show the degree to which water resources are being withdrawn to meet the demand. This indicator provides an estimate of sustainability of water usage in various countries. For Australia this indicator was estimated at 4.1 per cent in 2016–17, 5.9 per cent in 2015–16 and 7.4 per cent in 2014–15. These values are well below the initial water stress level of 25 per cent identified by the United Nations.

Various indicators presented in the Food and Agriculture Organizations' AQUASTAT database have been estimated and presented in Appendix A. These include various water resources and water use statistics for Australia.

3.5 GROUNDWATER EXTRACTIONS

3.5.1 Licensed extractions

In 2016–17, the reported extraction of groundwater from within management areas was about 4300 GL. Unlike in the 2015–16 report, this year only licensed extractions across Australia were reported due to poor data availability for non-licensed extractions. Groundwater management areas are declared to assist in the ongoing management of the resource, including the management of licensed entitlements. Groundwater extraction also occurs outside groundwater management areas throughout Australia, but data for these areas are sparsely reported.

2016–17 is the second year that the Bureau has received and published groundwater extraction data from lead State agencies. This allows the Bureau, for the first time, to compare groundwater extraction from year to year (Table 7). Interactive extraction data within management areas are available online in the Bureau's Groundwater Insight product.[37]

Table 7 shows that groundwater extractions in the Northern Territory, Queensland and Western Australia increased slightly (less than 10 per cent) from 2015–16 to 2016–17. This may represent an actual increase in extractions or result from improved reporting.

In New South Wales, South Australia, Tasmania and Victoria, licensed extractions decreased considerably from 2015–16 to 2016–17. This reduction in extraction volumes can be related to the above-average rainfall in 2016–17 in some key groundwater areas in these states, as shown in Figure 3 (section 2.1). Areas like South Australia's Lower Limestone Coast groundwater management areas and

35 http://www.abs.gov.au/ausstats/
36 http://www.fao.org/sustainable-development-goals/indicators/642/en/
37 http://www.bom.gov.au/water/groundwater/insight

Table 7. Groundwater extraction volumes, 2015–16 and 2016–17

State or Territory	Licensed extractions in groundwater management areas (GL) 2015–16	Licensed extractions in groundwater management areas (GL) 2016–17	Per cent change
NSW	836	618	–26
NT	49	51	+4
QLD	276	288	+4
SA	543	388	–29
TAS	6	4	–33
VIC	356	257	–28
WA	2544	2708	+7

central and western Victoria had up to 200 mm more rainfall than the previous year. The New South Wales Murray–Darling Basin streamflows were also higher than average at most of the gauging stations in 2016–17 (Figure 6a, section 2.2).

With higher rainfall and easier access to surface water, farmers rely less on groundwater, which usually is more expensive to access.

3.5.2 Non-licensed extraction

Water can be taken for domestic use or stock water purposes as a non-licensed entitlement. Bores constructed for these purposes are far more numerous than licensed entitlements; however, the volumes extracted per bore are much lower. Most stock and domestic use falls between zero and 10 ML per year, and the volume of groundwater that users may extract under this right varies from State to State. Estimates of non-licensed use volumes are submitted to the Bureau, but there are still many gaps in the data.

In most groundwater management areas, licensed use significantly outstrips domestic and stock use. However, in some groundwater management areas, non-licensed extraction can make up a large percentage of the extraction. State agencies identify these areas and manage this extraction within their planning rules.

Table 8 shows examples of areas where non-licensed extractions are a high percentage of the total extraction based on data reported to the Bureau of Meteorology under Category 5 (Water takes, supplies and returns) of the Regulations.

3.6 WATER AVAILABILITY VERSUS USE

Australia's greatest water use occurs in regulated rural supply systems that source water from large storages. The amount of water extracted from these systems for consumptive and environmental use varies between years. The combined accessible storage volume in rural storages across the nation increased from 52 per cent of capacity in June 2016 to 78 per cent in June 2017. The accessible storage volumes in the Murray–Darling Basin and the Ord system increased significantly during the year. A comparison of physical water availability, water-use permissions and actual water use provides insights into how different supply systems reacted to variations in water availability.

The status of physical water availability, water-use permissions and actual water use for the last five years is

Table 8. Some areas with a high proportion of non-licensed extraction (domestic and stock) in 2016–17

Region	Licensed entitlements (ML/year)	Estimated non-licensed extraction (ML/year)	Non-licensed extraction as proportion of total use (%)
Northern Territory portion of the Great Artesian Basin	96	3500	97
Draft Howard Water Allocation Plan Area (within the Darwin Rural Water Control District)	8021	25 000	76
Water Sharing Plan for the NSW Murray–Darling Basin Fractured Rock Groundwater	73 070	75 460	51
Shepparton Irrigation District	191 432	80 000	29

provided for the major northern supply systems (Figure 31) and the Murray–Darling Basin (Figure 32).

Physical water availability is calculated as the sum of storage volumes at the start of the year and estimated inflows into storages during the year. Inflows are calculated using estimates for runoff modelled by the Australian Water Resources Assessment modelling system.[38] Water-use permissions are the sum of total allocations announced during the year and carryover from last year. Actual diversions (water use) is the total regulated diversions during the year for agricultural, urban and environmental purposes.

3.6.1 Northern supply systems

Australia's northern regions have high physical water availability relative to use throughout the year. These regions receive most of their rainfall during the wet season, from November to April. Due to dry climatic conditions in winter, irrigation is essential to provide for the water needs of the crops. Storages act mainly as intra-annual buffers to overcome crop water shortages during the drier winter months.

With generally full allocations announced against the entitlements, water-use permissions and actual use vary little between years. The total annual use in these regions is more a function of crop demand, influenced by climatic conditions during the growing season, than of allocated water availability.

In 2016–17, the Ord system benefited from higher-than-average monsoonal rainfall, resulting in the highest water availability of the last five years. The Ord reservoir reached maximum accessible storage volumes of close to 150 per cent of capacity in February 2017, and dropped back to 106 per cent of capacity by the end of June 2017. Water use in 2016–17, was 198 GL, 6 per cent less than the previous year.

In the Burdekin system, physical water availability increased by 45 per cent in 2016–17 compared to the previous year. This is mainly due to the higher-than-average flows received in March, caused by heavy downpours from ex–severe tropical cyclone *Debbie*. Total surface water use was down by 15 per cent from last year due to increased rainfall resulting in less demand from farmers for irrigation.

In 2016–17, the Mareeba–Dimbulah and Nogoa–Mackenzie systems recorded their lowest water availability of the last

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

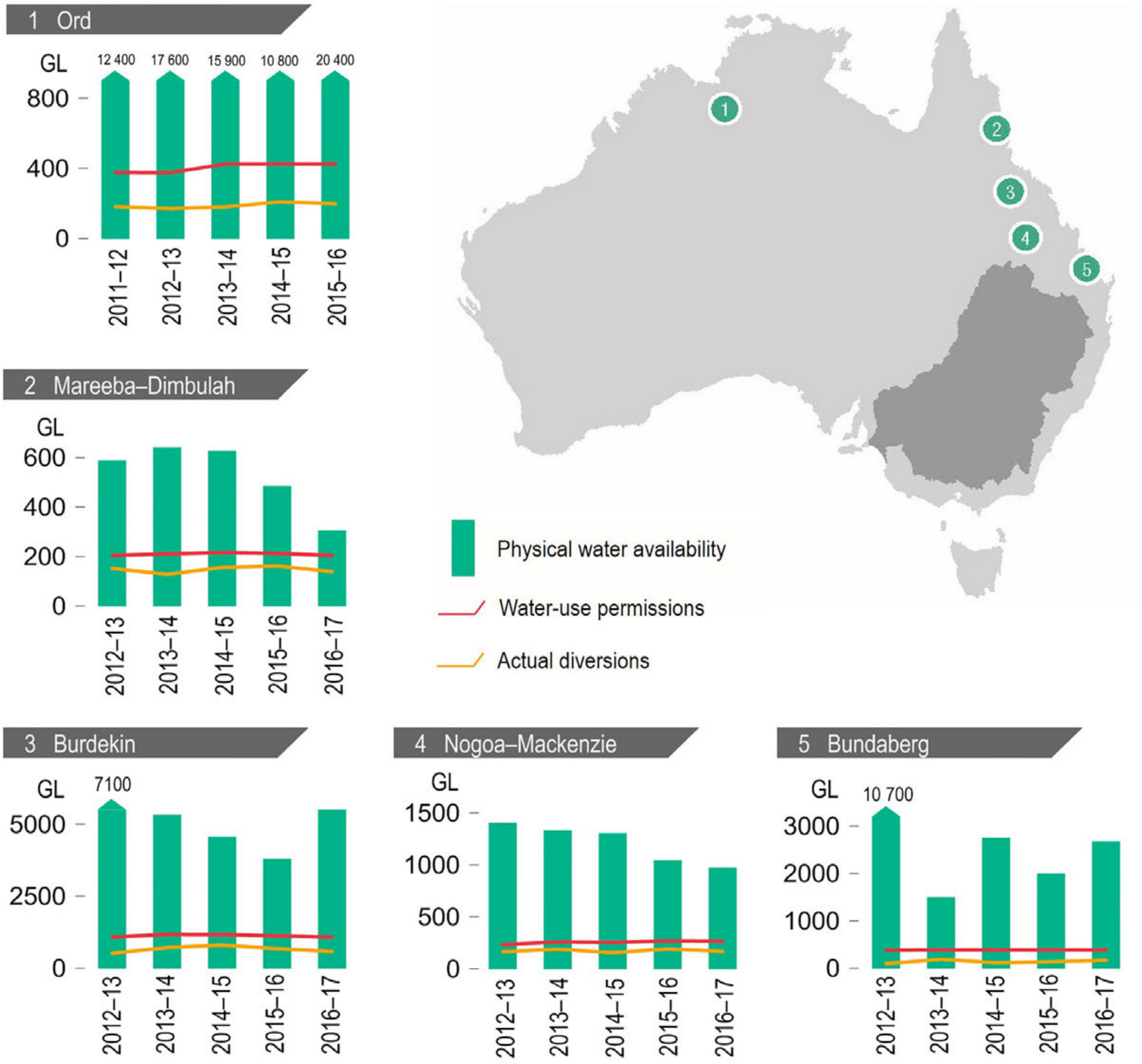


Figure 31. Volume of surface water available in northern Australia, volume of water-use permissions and volume of actual diversions in regulated systems (with more than 100 GL of annual use), 2012–13 to 2016–17

five years, but the announced allocations at the end of the year were 100 per cent and water use was slightly lower than last year. In the Bundaberg system, both physical water availability and water use increased in 2016–17 compared to the previous year.

3.6.2 Murray–Darling Basin supply systems

There were significant increases in accessible storage volumes in 2016–17 in the Murray–Darling Basin, fed by the higher-than-average winter rainfall. The physical water availability in all catchments of the Murray–Darling Basin increased in 2016–17 compared to the previous year. The largely downward trend in water availability over the previous three years was also reversed in 2016–17.

In the northern Murray–Darling Basin catchments (regions 1 to 4 in Figure 32), there was a relatively large increase in physical water availability. Water-use permissions and actual use also increased. The accessible storage volume in the Macquarie–Castlereagh system was 109 per cent of capacity in September 2016, and dropped to 78 per cent of capacity in June 2017.

The accessible storage volumes in all large systems increased during 2016–17, with rises of over 30 percentage points for the New South Wales and Victorian Murray and the Lachlan, and over 60 percentage points for small catchments like the Campaspe and Loddon. The physical water availability in the Murrumbidgee system was the highest of the last five years. Water use increased in all the systems except Northern Victoria where water use dropped due to decrease in demand from irrigators.

Despite the high physical water availability and allocation in the Murray–Darling Basin, the gap between water-use permissions and actual water use widened in many systems between 2014–15 and 2016–17. The Lachlan had the lowest ratio of actual diversion to water-use permission followed by the Macquarie–Castlereagh and Gwydir. It seems that, with the wetter catchments, licence holders were able to hold back much of the additional water as carryover into the next year.

3.6.3 Allocation carryover

Carryover gives entitlement holders the flexibility to access unused water allocation the following water year. Carryover rules vary between water systems depending on the size of storage and the volume of entitlements. For environmental water holders, this flexibility of carryover is important to satisfy environmental needs, such as the watering of wetlands or floodplains or provision of an in-stream pulse early in a water year. Non-environmental carryover is the unused portion of allocations for agricultural and urban use.

Carryover volumes are supplied from the available storage in each catchment. At the start of a year, the storage volume in excess of carryover is the non-allocated storage volume for each catchment.

The above-average rainfall conditions in 2016–17 for most of the major supply systems facilitated carryover into 2017–18. With above-average rainfall early in the water year, the announced allocations in 2016–17 were significantly higher than that of the previous year. As the carryover is based on unused volumes of allocated water remaining at the end of the year, the carryover volumes into 2017–18 (Figure 33) reflect the wet conditions present in most systems.

The New South Wales and Victorian Murray system had the highest carryover volume into 2017–18 (1116 GL). The next highest carryover volumes occurred in the Lachlan (661 GL) and the Murrumbidgee (571 GL) systems. In the Lachlan, the sum of environmental and non-environmental carryover was about 50 per cent of accessible storage capacity at the beginning of 2017–18. Carryover into 2017–18 was higher in the Murrumbidgee catchment than carryover into 2016–17, and average to higher-than-average streamflow in 2016–17 resulted in a significant increase in non-allocated water storage for 2017–18.

The Border, Gwydir and Namoi supply systems had a significantly higher carryover into 2017–18 than into 2016–17 due to the higher allocation announcements in 2016–17. This allowed irrigators to save more water for the 2017–18 growing season.

In Northern Victoria, the entitlement holders generally hold higher security entitlements than do entitlement holders in other regions. The low use against the high allocation announcements in 2016–17 resulted in only a slightly higher carryover into 2017–18.

Despite the higher carryover, non-allocated storage volume was more than 50 per cent of the accessible storage capacity in the Border, Macquarie–Castlereagh, Murrumbidgee, Northern Victoria, and New South Wales and Victorian Murray systems.

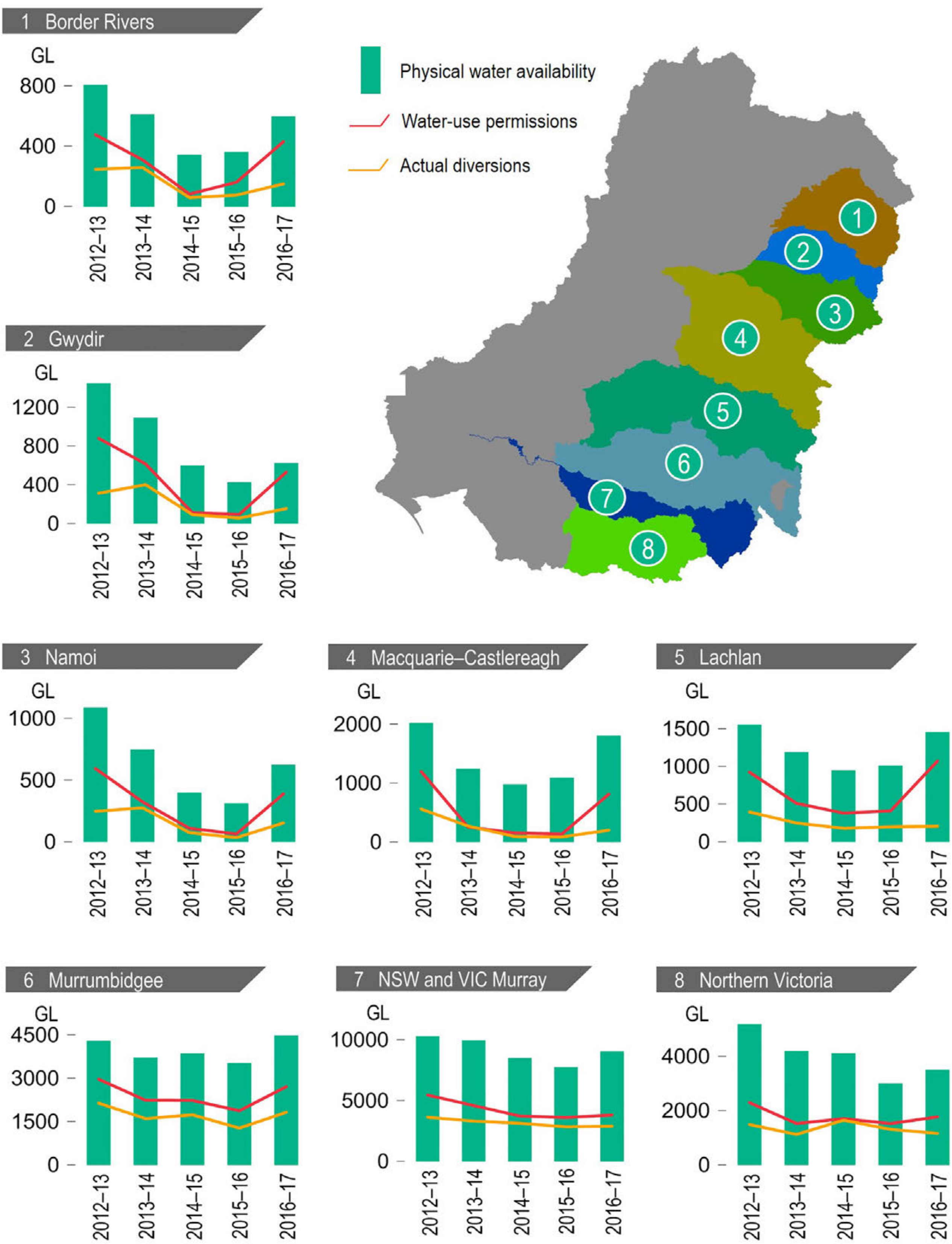
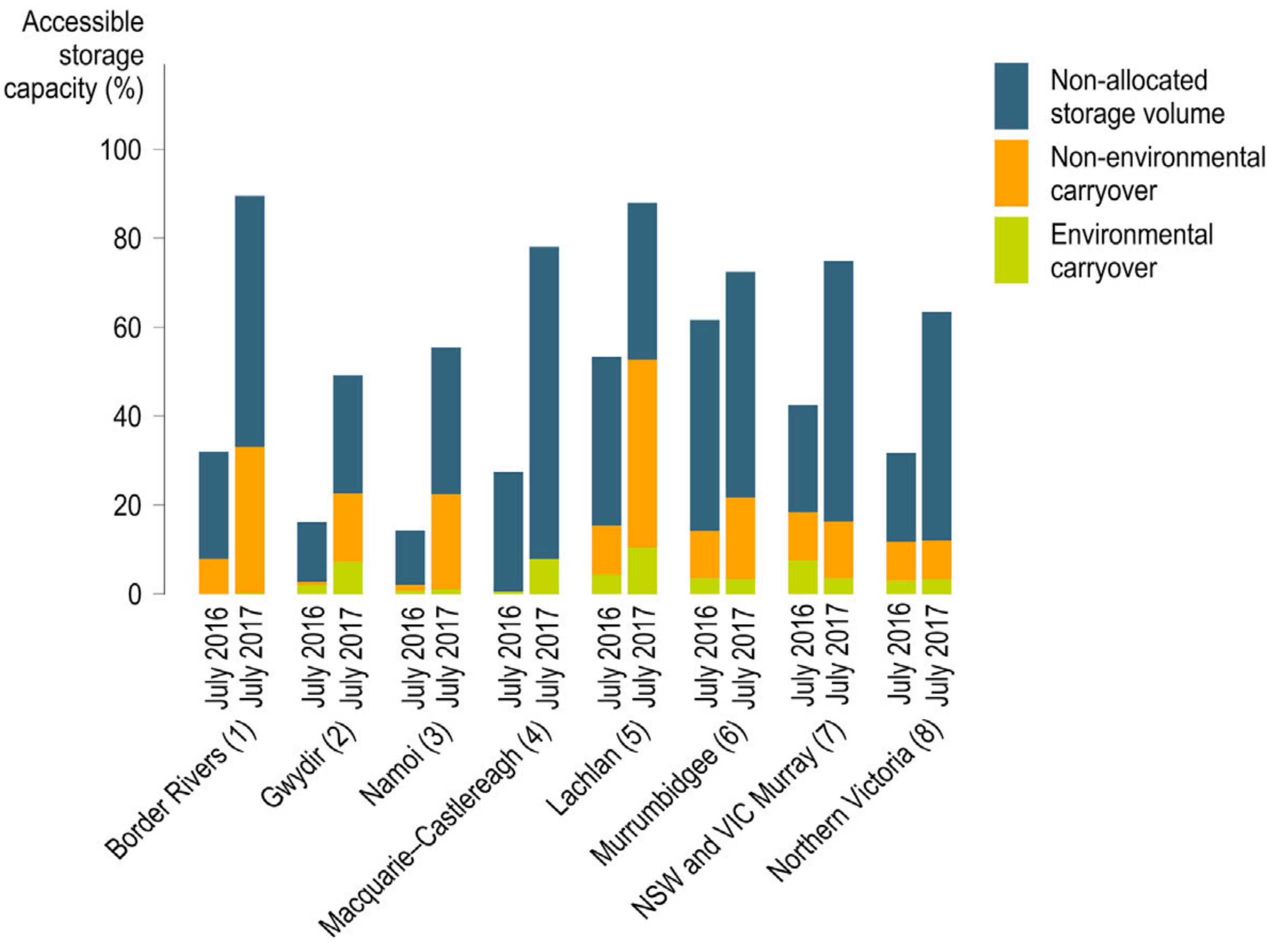


Figure 32. Volume of surface water available in the Murray–Darling Basin, volume of water-use permissions and volume of actual diversions in regulated systems (with more than 100 GL of annual use), 2012–13 to 2016–17

Macquarie–Castlereagh was the only system to use all its allocation for non-environmental purposes, leaving a small environmental carryover into 2017–18. The non-allocated storage volume going into 2017–18 was 70 per cent of the total accessible storage capacity.

The total water in store for 2017–18, including the carryover and non-allocated volume, was more than 50 per cent of the accessible storage capacity in all the systems except Gwydir. With the increased storage volumes and the positive prospects for further inflows due to wet catchment conditions, the likelihood of good allocations in 2017–18 is high, particularly for the general security entitlements in most areas of New South Wales.



Note: The catchment numbers on this graph match the system numbers in Figure 32.

Figure 33. Storage volumes at 1 July 2016 and 1 July 2017, showing carryover from the previous year in the Murray–Darling Basin

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.
allocation carryover	Water allocated during the water year of an entitlement that is yet to be accessed, abstracted or delivered at the end of the water year and is able to be carried over to the next water year. Where the water year coincides with the National Water Account reporting period, allocation carryover equates to allocation remaining.
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).
carryover	The option to hold in storage a portion of unused seasonal allocations for use at a later date.
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 at www.bom.gov.au/climate/glossary/climate.shtml for more information.
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.
desalination	The process of removing salt from brackish or saline water.
drainage division	Representation of the catchments of major surface water drainage systems, generally comprising a number of river basins. In Australia, 12 drainage divisions were first defined in the 1960s by the Australian Water Resources Council. Australian drainage division boundaries were revised by the Bureau in 2010 in line with the creation of the Australian Hydrological Geospatial Fabric (Geofabric) based on the 9 second Digital Elevation Model.
drought	A long period of abnormally low rainfall, especially one that adversely affects agriculture and other human activities. See the Bureau's climate webpage at www.bom.gov.au/climate/glossary/drought.shtml for more information.
ecosystem	A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit.
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.
held environmental water	Water available under (a) a water access right, (b) a water delivery right or (c) an irrigation right, for the purposes of achieving environmental outcomes (including water that is specified in a water access right to be for environmental use).
Indian Ocean Dipole	A major contributor to rainfall variability over Australia. When the dipole is in a positive phase, sea surface temperatures (SSTs) around Indonesia are cooler than average while those in the western Indian Ocean are warmer than average. The positive phase increases easterly winds across the Indian Ocean while convection in areas near Australia reduces. This results in suppressed rainfall over the Australian region. During a negative phase, warmer than average SSTs near Indonesia and cooler than average SSTs in the western Indian Ocean, result in more westerly winds across the Indian Ocean, greater convection near Australia and enhanced rainfall in the Australian region. See the Bureau's Weather and Climate page on Indian Ocean for more information http://www.bom.gov.au/watl/about-weather-and-climate/australian-climate-influences.shtml?bookmark=iod
Millennium Drought	The prolonged period of dry conditions experienced in much of southern Australia from late 1996 to mid-2010.
planned environmental water	Planned environmental water is committed in a water plan for achieving environmental outcomes.
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.
residential water	The total amount of metered and estimated non-metered, potable and non-potable water supplied to residential properties.
salinity	The concentration of soluble salts in a solution, soil or other medium.
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.
urban water	The total residential, commercial, municipal, industrial and other water supplied by urban water utilities.
water abstraction	The physical abstraction of water from a water resource for use. It excludes in-system uses of water and results, at least temporarily, in a depletion of the resource. Unless water is abstracted illegally, it is abstracted under a water right. Because the right specifies a volume of water that the water provider is liable to deliver to the water user, the exercise of the right through the abstraction effectively decreases the water liability of the provider.
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 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 (that is, a 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 have 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 stress	A condition where there is not enough water to meet needs, including the effective functioning of ecosystems.
water trade	A transaction to buy, sell or lease a water right, in whole or in part, from one legal entity to another.
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 6 metres.

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS' WATER RESOURCES INDICATORS[39]

Indicator	2016–17	Mean 2013–14 to 2016–17
Annual precipitation in depth (mm/year)	592	486
Annual precipitation in volume (1000 GL/year)	4 554	3 738
National Rainfall Index (NRI) (mm/year)	–	–
Surface water produced internally (1000 GL/year)	410	336
Groundwater produced internally (1000 GL/year)	91	75
Overlap between surface water and groundwater (1000 GL/year)	–	–
Total internal renewable water resources (IRWR) (1000 GL/year)	501	411
Total internal renewable water resources per capita (m^3/inhab/year)	20 529	16 853
Surface water: entering the country (total) (1000 GL/year)	0	0
Surface water: inflow not submitted to treaties (1000 GL/year)	0	0
Surface water: inflow submitted to treaties (1000 GL/year)	0	0
Surface water: inflow secured through treaties (1000 GL/year)	0	0
Surface water: total flow of border rivers (1000 GL/year)	0	0
Surface water: accounted flow of border rivers (1000 GL/year)	0	0
Surface water: accounted inflow (1000 GL/year)	0	0
Surface water: leaving the country to other countries (total) (1000 GL/year)	0	0
Surface water: outflow to other countries not submitted to treaties (1000 GL/year)	0	0
Surface water: outflow to other countries submitted to treaties (1000 GL/year)	0	0
Surface water: outflow to other countries secured through treaties (1000 GL/year)	0	0
Surface water: total external renewable (1000 GL/year)	0	0

39. http://www.fao.org/nr/water/aquastat/water_res/index.stm

Indicator	2016–17	Mean 2013–14 to 2016–17
Groundwater: entering the country (total) (1000 GL/year)	0	0
Groundwater: accounted inflow (1000 GL/year)	0	0
Groundwater: leaving the country to other countries (total) (1000 GL/year)	0	0
Groundwater: accounted outflow to other countries (1000 GL/year)	0	0
Water resources: total external renewable (1000 GL/year)	0	0
Total renewable surface water (1000 GL/year)	410	336
Total renewable groundwater (1000 GL/year)	91	75
Overlap: between surface water and groundwater (1000 GL/year)	–	–
Total renewable water resources (1000 GL/year)	501	411
Dependency ratio (%)	–	–
Total renewable water resources per capita (m^3/inhab/year)	20 529	16 853
Exploitable: regular renewable surface water (1000 GL/year)	261	261
Exploitable: irregular renewable surface water (1000 GL/year)	–	–
Exploitable: total renewable surface water (1000 GL/year)	–	–
Exploitable: regular renewable groundwater (1000 GL/year)	75	75
Total exploitable water resources (1000 GL/year)	336	336
Interannual variability (WRI)	–	–
Seasonal variability (WRI)	–	–
Total dam capacity (km^3)	80.82	80.82
Dam capacity per capita (m^3/inhab)	3 312	3 312
Agricultural water withdrawal (1000 GL/year)[40]	11.3	11.7

40 The agricultural, industrial and municipal water withdrawal is estimated as the average for the years 2014–15, 2015–16 and 2016–17

Indicator	2016–17	Mean 2013–14 to 2016–17
Industrial water withdrawal (1000 GL/year)	1.52	1.3
Municipal water withdrawal (1000 GL/year)	2.76	3.1
Total water withdrawal (1000 GL/year)	15.6	16.1
Irrigation water withdrawal (1000 GL/year)	11.3	11.7
Irrigation water requirement (1000 GL/year)	–	–
Agricultural water withdrawal (% of total water withdrawal)	72	73
Industrial water withdrawal (% of total water withdrawal)	10	8
Municipal water withdrawal (% of total withdrawal)	18	19
Total water withdrawal per capita (m^3/inhab/year)	639	658
Environmental flow requirements (1000 GL/year)[41]	120	120
Fresh surface water withdrawal (primary and secondary) (1000 GL/year)	–	–
Fresh groundwater withdrawal (primary and secondary) (1000 GL/year)	–	–
Total freshwater withdrawal (primary and secondary) (1000 GL/year)		
Desalinated water produced (1000 GL/year)[42]	0.21	0.14
Direct use of treated municipal wastewater (1000 GL/year)	0.12	0.13
Direct use of agricultural drainage water (1000 GL/year)	–	–
Produced municipal wastewater (1000 GL/year)	–	–
Collected municipal wastewater (1000 GL/year)	2.04	2.06
Treated municipal wastewater (1000 GL/year)	2.06	1.73
Number of municipal wastewater treatment facilities	673	633
Capacity of the municipal wastewater treatment facilities (1000 GL/year)	–	–

41 Source: FAO AQUASTAT (http://www.fao.org/nr/water/aquastat/main/index.stm)
42 http://www.bom.gov.au/water/npr/

Indicator	2016–17	Mean 2013–14 to 2016–17
Not treated municipal wastewater (1000 GL/year)	–	–
Treated municipal wastewater discharged (secondary water) (1000 GL/year)	–	–
Not treated municipal wastewater discharged (secondary water) (1000 GL/year)	–	–
Direct use of treated municipal wastewater (1000 GL/year)	0.12	0.13
Direct use of treated municipal wastewater for irrigation purposes (1000 GL/year)	0.102	0.102
Direct use of not treated municipal wastewater for irrigation purposes (1000 GL/year)	–	–
Area equipped for irrigation by direct use of treated municipal wastewater (1000 ha)	–	–
Area equipped for irrigation by direct use of not treated municipal wastewater (1000 ha)	–	–
MDG 7.5. Freshwater withdrawal as % of total renewable water resources (%)	3.1	3.9
Agricultural water withdrawal (% of total renewable water resources)	2.26	2.85
SDG 6.4.2. Water stress (%)	4.1	5.6

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