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Bureau of Meteorology

# Water in Australia
2017–18

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Cover: Aerial view of Werribee river, Victoria (tsvibrav, iStock)

Foreword: Sheep (Jamesbowyer, iStock)

Page 5: Goulburn River entering Lake Eildon, Victoria (tsvibrav, iStock)

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# FOREWORD

Water is essential to human life and plays a critical role in our economy and the health of the environment. Australian weather is extremely variable, with low average annual rainfall and a variety of climate influences across the nation. Increasing water demands from a growing population and associated agricultural and industrial development are intensifying pressure on Australia's water resources. Increasing awareness of environmental needs means more water is being put aside to care for this important asset.

More than two hundred organisations across Australia collect data on water resources and use. 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 these organisations. The Bureau of Meteorology integrates the data and makes them available across the nation in a range of online water information products.

*Water in Australia 2017–18* is the fifth report in this series of annual reports and covers the period from 1 July 2017 to 30 June 2018. 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 in the context of long-term patterns and climatic influences. The report is designed to help the Australian community understand the past and improve the decisions needed to secure water for future generations.

Contributions from the various organisations who have collected and supplied the data are gratefully acknowledged. I also thank the many specialists in hydrology, hydrogeology, ecology and climatology who have contributed to the writing and reviewing of various sections of this report.

**Dr Robert Argent**
**General Manager Water**
**Bureau of Meteorology**

# OVERVIEW

## BELOW-AVERAGE RAINFALL AND STREAMFLOW CONDITIONS IN THE EAST

Australia's mean rainfall for the year 2017–18 was 441 mm, which is 4 per cent below the July 1911 to June 2018 mean of 461 mm and 26 per cent lower than the mean rainfall for the 2016–17 year (592 mm). There was a contrast in rainfall from the west to east. Rainfall in the country's west was generally average to above average while rainfall in most of the east was lower than average.

Rainfall was lower than average across much of the southeast of the continent, covering large parts of New South Wales, South Australia, southern Queensland and Victoria. Parts of these areas experienced serious to severe rainfall deficiencies. Rainfall was higher than average for much of the Northern Territory Top End, the eastern part of Western Australia and neighbouring areas of western South Australia.

The spatial distribution of annual streamflow conditions mostly follows annual rainfall (Figure I). Average to lower-than-average annual flows were dominant in all States and Territories except the Northern Territory. Five per cent of gauges across the country recorded their lowest flows since 1975; most of these gauges were in New South Wales. Average to higher-than-average flows were mostly recorded in the tropical north and along the northeast coast. In Queensland, average to higher-than-average flows were observed in the north and lower-than-average flows were prominent in the south.

Stream water quality was fresh (median salinity <500 mg/L) at 61 per cent of the monitoring sites analysed in 2017–18. These sites were mostly located in areas with higher rainfall, along the east coast. In contrast, many streams in Western Australia and South Australia had high salinities.

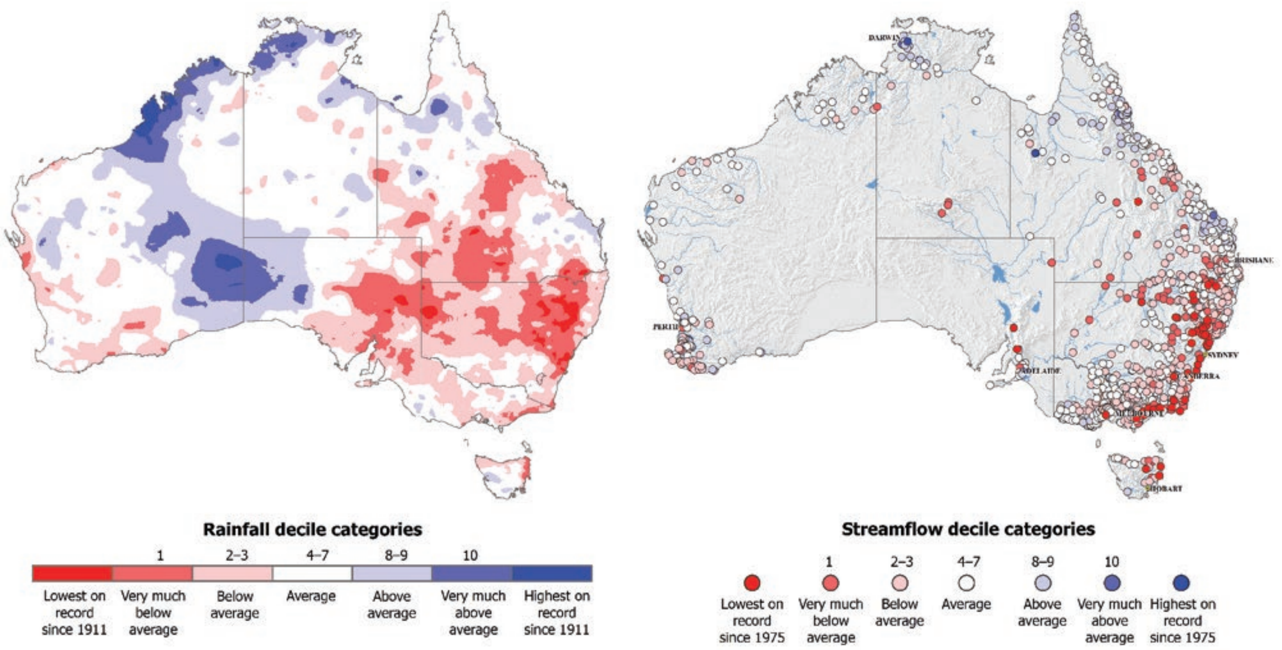



Figure I. Annual rainfall and streamflow deciles for 2017–18

*Water in Australia 2017–18* **draws on a range of Bureau information to describe the characteristics of Australia's water resources availability and use for the period 1 July 2017 to 30 June 2018.**

## DROUGHT IN THE MURRAY–DARLING BASIN

The Murray–Darling Basin climate has large natural variability, but recently there has been a shift towards drier conditions across much of the basin including a reduction in annual rainfall.

The 2017–18 year was particularly dry for the Murray–Darling Basin with an annual rainfall of 340 mm, which was 28 per cent below the long-term mean. About half of the basin experienced deficiencies in rainfall. The most affected areas were in New South Wales and much of southern inland Queensland (Figure II). Three-quarters of the basin had soil moisture deficiencies, especially in the north. Fifty-six per cent of the basin's streamflow gauges recorded lower-than-average streamflows, and very few exceeded the average condition.

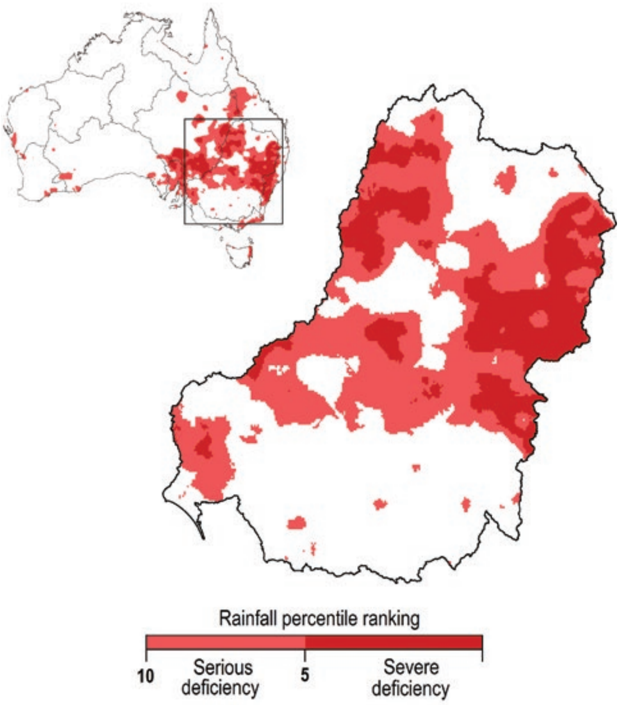



**Figure II. Rainfall deficiency in the Murray–Darling Basin for 2017–18**

Very-much-below-average flows were prominent in the northern part of the basin. In some areas, groundwater levels were also significantly depleted because of low recharge volumes.

The most severely affected drought areas within the Murray–Darling Basin were the Border Rivers, Gwydir, Namoi, Macquarie, Castlereagh, Darling, Paroo and Warrego catchments, all of which are in the Darling River Basin.

## DECLINE IN PUBLIC WATER RESERVES

The combined accessible storage volume of surface water available across Australia for direct water supply decreased due to dry conditions and extractions in 2017–18. The accessible storage volume dropped by 14 percentage points (from 77 to 63 per cent) during 2017–18.

Urban systems were filled to 69 per cent of capacity at the end of 2017–18; this was 6 percentage points lower than at the start of the assessment year. Due to lower-than-average inflows, the accessible storage volume was lower at the end of the year than at the start in 14 out of 19 urban supply systems.

The combined accessible storage volume of urban systems decreased in all States and Territories except Queensland during 2017–18. The combined accessible storage volume of urban systems in Queensland increased from 77 per cent of capacity to 83 per cent, mainly due to an increase in accessible storage volumes in the Townsville and Brisbane systems. The largest decrease was in New South Wales, where the combined accessible storage volume dropped from 92 per cent of capacity to 69 per cent.

The Perth system, although having increased its storage volume over the year (from 25 to 37 per cent of capacity), had the lowest proportional storage volume at the end of June 2018 because of persistent dry conditions over recent years.

The combined accessible water volume in rural storages across the nation decreased from 78 to 61 per cent of capacity. Out of 40 major rural storage systems in Australia, accessible water volumes rose in five systems, remained stable in 11 and dropped in 24. There were large decreases in accessible storage volumes in the Ord system and the Murray–Darling Basin due to lower-than-average inflows in 2017–18.

Across the country, monitored groundwater levels in upper aquifer bores were generally below average to average with most having declining or stable trends. Groundwater levels of middle and lower aquifer monitoring bores were mainly below average to average with declining trends. Compared with the 2016–17 assessment, 2017–18 recorded a higher percentage of bores across Australia with below-average status.

## CONTINUED WATER TRADING WITH RECORD NUMBER OF TRADES

Australian water markets experienced record numbers of entitlements and allocations trades in 2017–18, highlighting the increasing role that water markets play in sustainable management across the country. The total turnover of water market trade doubled in 2017–18 compared to the previous year, up to around $2.4 billion. The southern Murray–Darling Basin accounted for around $1.4 billion of this total and a significant increase in allocation trades contributed to this turnover. In 2017–18, the total entitlement trade volume in Australia (1598 GL) decreased by 23 per cent compared to the previous year, but the total allocation trade volume (7527 GL) increased by 7 per cent.

In 2017–18, the total available allocation volume for the country was around 8 per cent lower than the previous year, but this was the second highest of the past eight years. The drop in allocation volume from the previous year was mainly due to the drop in allocation of regulated surface water in New South Wales.

Similar volumes of surface water entitlements (around 500 GL) were traded in both the southern and northern Murray–Darling Basin, with a higher entitlement price in the southern basin than the northern. The long-term trend shows a slow increase in entitlement trade outside the Murray–Darling Basin.

The southern Murray–Darling Basin had a much larger volume of allocation trade than the northern Murray–Darling Basin, with a record high volume of water (6643 GL) traded in 2017–18. Environmental trade made up a quarter of this total allocation trade in 2017–18.

Unlike entitlement prices, allocation trade prices were generally lower in the southern Murray–Darling Basin than in the northern basin. However, allocation prices were significantly higher in the southern basin than they were in 2016–17. Limited water availability and increased demand saw upward movement on water prices during 2017–18. The high prices in some of the northern water systems, such as the Gwydir, Namoi and Macquarie–Castlereagh, reflect the response to lower rainfall amounts in those regions.

## INCREASE OF TOTAL WATER ABSTRACTIONS

The estimated total volume of water abstractions across Australia was 16 870 GL in 2017–18. This is 7 per cent higher than the figure reported for 2016–17.

The water abstracted for agricultural use accounted for 72 per cent of this total (12 150 GL), an increase of 9 per cent from 2016–17. Surface water abstractions for agriculture increased by 3 per cent but groundwater extractions increased by 37 per cent compared with 2016–17. Low surface water allocations during the year in many States and Territories in response to the dry conditions resulted in farmers supplementing surface water allocations with groundwater. However, surface water remains the primary source for agriculture, contributing about 78 per cent of the total due to its easy accessibility and low abstraction cost.

About 19 per cent (3200 GL) of the total abstractions was provided for urban water supply; this was a small increase of 2 per cent. Recycled water use increased in most of the urban centres except for South East Queensland and Canberra.

Total environmental water delivered to wetlands, rivers and lakes (environmental assets) in 2017–18 from all environmental water holders and managers in the southern Murray–Darling Basin was just over 2846 GL, while the total for the northern basin was 285 GL. In the previous year, environmental water volumes delivered were 2825 GL and 565 GL in the southern and northern basins, respectively.

## REDUCED STORAGE VOLUMES AT THE START OF 2018–19

In the Murray–Darling Basin, storage volumes had dropped significantly in most rural storage systems by July 2018. The dry conditions in 2017–18 meant that irrigators had used most of their carryover, resulting in relatively low volumes being carried over into 2018–19. The decreased storage volumes at the start of 2018–19, and the persistent dry climatic conditions observed across the basin since June 2018, will have influenced the water resource decisions of irrigators for 2018–19.

# 1 INTRODUCTION

**Australia's climate, water availability and water quality are highly variable across the country. Competition for water resources is growing, with increasing demands from agricultural, urban, industrial and environmental sectors. Periodic assessment and reporting provide essential insight into the use of Australia's limited water resources.**

The Bureau of Meteorology is responsible for compiling and delivering comprehensive information about water resources across 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 Australia's water resources and usage of those resources in the context of long-term patterns and climatic influences.

*Water in Australia 2017–18* is the fifth 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 2017 to 30 June 2018.

Chapter 2 of this report provides an overview of water resources availability in Australia during 2017–18. It gives a summary of climatic conditions and drivers during the year together with the resultant annual and monthly streamflows. An overview of groundwater resources is presented in terms of three main aquifer groups. The contributions from climate-independent water sources, such as desalination and recycling, are also reported. The chapter examines streamflow salinity and discusses how this may constrain water use. It also explores the drought in the Murray–Darling Basin.

Chapter 3 of the report considers major water uses and how these have changed over time. The chapter starts with an overview of water allocation and trade. Agricultural, urban, industrial and environmental water uses are explored and compared to past uses.

Water stress in Australia is estimated and reported using the United Nation's Sustainable Development Goal indicator of water stress (SDG 6.4.2). Groundwater extractions are summarised in management areas, 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.[1] The information presented in this report is based on the best data available at the time of publication. Datasets used in this report are available for download through two complementary information sources.

- Regional Water Information[2] 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[3] 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 various products.

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

Other specific types of water information are also available[4] and were used to generate this national report.

- Climate Resilient Water Sources is an inventory of desalination and water recycling plants across Australia (www.bom.gov.au/water/crews/introduction.shtml).
- Groundwater Information Suite provides data on bore water levels and trends, and associated data on hydrogeology and groundwater management (www.bom.gov.au/water/groundwater/index.shtml).
- Australian Landscape Water Balance provides Australia-wide information on key landscape water balance components, including soil moisture, runoff, evapotranspiration, deep drainage and precipitation in near real time (www.bom.gov.au/water/landscape).
- National Water Account is a detailed annual accounting of water assets and liabilities for 11 key water-use regions (www.bom.gov.au/water/nwa/2018).
- Urban National Performance Reports provide annual benchmarking of the performance of 80 urban water utilities and councils and five bulk water authorities (www.bom.gov.au/water/npr/index.shtml).
- 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 (www.bom.gov.au/waterdata).
- 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 (www.bom.gov.au/water/dashboards/#/water-storages/summary/state).
- 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 (www.bom.gov.au/water/market).

4 www.bom.gov.au/water

# 2 WATER RESOURCES

**This chapter provides an overview of water resources availability in Australia during 2017–18. Section 2.1 provides a summary of climatic conditions and drivers during the year together with the resultant annual and monthly streamflows. Section 2.2 shows the effects of these patterns on water storage. Section 2.3 examines the salinity of the streamflow and discusses how this may constrain water use. An overview of groundwater resources is presented in terms of three main aquifer groups in section 2.4. The contributions from climate-independent water sources, such as desalination and recycling, are reported in section 2.5. Section 2.6 explores the drought in the Murray–Darling Basin.**

## 2.1 CLIMATIC CONDITIONS, RAINFALL AND STREAMFLOW

### 2.1.1 National rainfall

The area-averaged annual rainfall across Australia for 2017–18 was 441 mm, which is 4 per cent below the July 1911 to June 2018 mean of 461 mm and 26 per cent lower than the very-much-above-average 2016–17 mean (592 mm).

There was a strong contrast between the west and the east despite near-average annual rainfall for the country as a whole. Rainfall in the country's west was generally average to above average while rainfall across eastern Australia was below average to very much below average over large areas (Figure 1). The rainfall deciles maps are based on the long-term reference period (since July 1911).

Rainfall was close to average for much of the northern and western parts of Australia. Rainfall was above average for much of the Northern Territory Top End, eastern areas of Western Australia and neighbouring areas of western South Australia.

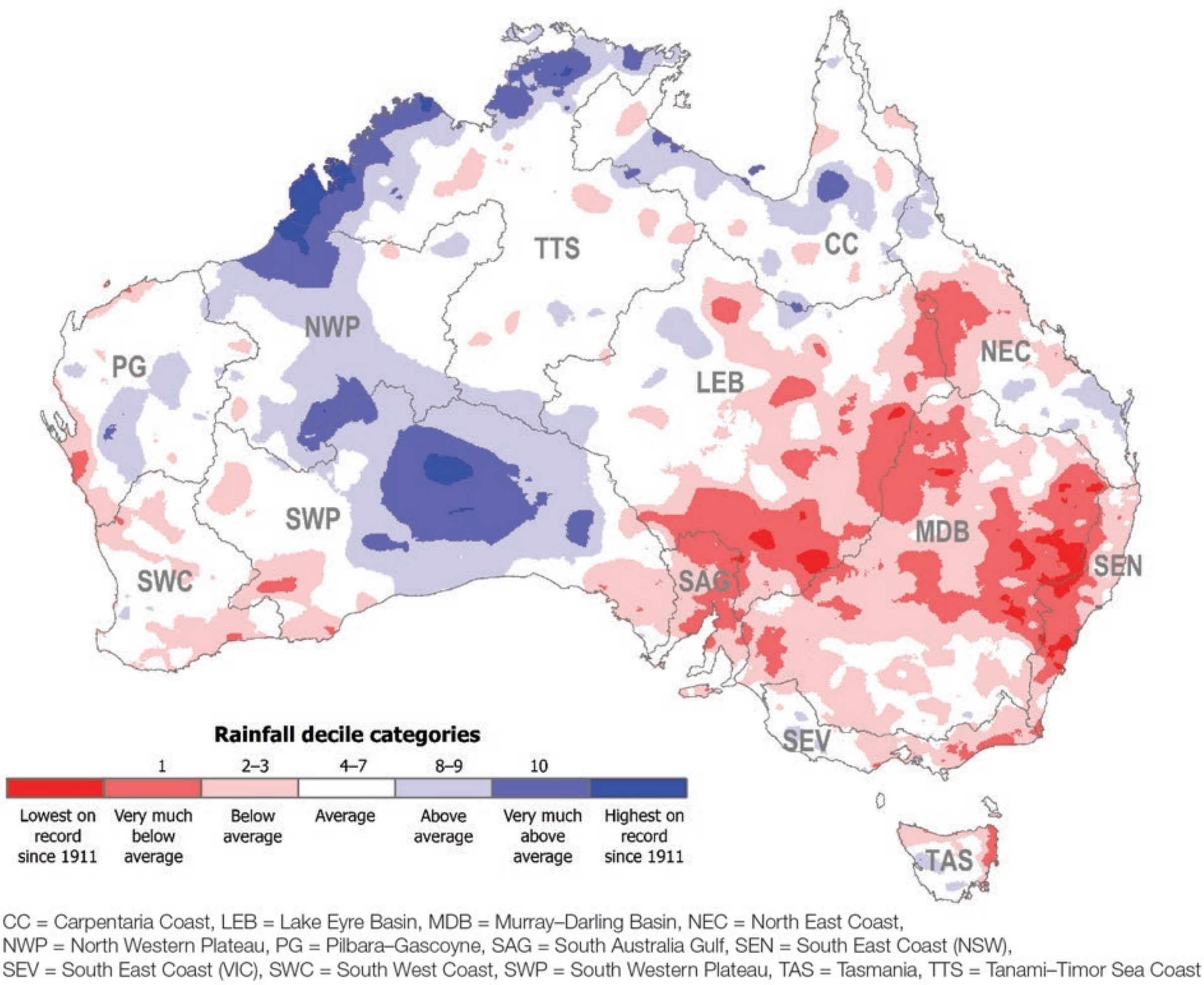



**Figure 1. Rainfall deciles map for 2017–18, showing the major surface drainage systems**

Rainfall was less than the long-term average for much of the southeast, covering southern Queensland, Victoria, New South Wales and northern Tasmania. In New South Wales, annual rainfall was less than average for 86 per cent of the area, with 38 per cent of the area very much below average (Figure 2). This was the lowest annual rainfall recorded for the State since 2002–03. Rainfall in the Murray–Darling Basin was 28 per cent below the long-term mean.

### 2.1.2 Important climate drivers of 2017–18

The climatic conditions in 2017–18 were dominated by intra-seasonal drivers rather than strong influences from the Pacific or Indian oceans.

The year began with a neutral El Niño–Southern Oscillation (ENSO) (Figure 3a), one of the main climate drivers for Australia. At the same time, a positive Southern Annular Mode (SAM) existed, shifting strong westerly winds south towards Antarctica, and a strong subtropical ridge suppressed rain-bearing low pressure systems and cold fronts. This resulted in below-average winter 2017 rainfall.

Another key driver of Australia's climate, the Indian Ocean Dipole (IOD), was also in a neutral condition during 2017–18 (Figure 3b). Despite this, there was a temperature gradient across the Indian Ocean with cooler surface waters close to the Australian continent throughout the year. This limited the supply of moisture to the atmosphere and contributed to the low winter rainfall.

During spring, this temperature gradient across the Indian Ocean persisted, with sea surface temperatures that were near average to cooler than average around Western Australia south of the Kimberley. This temperature gradient probably contributed a weak drying influence on Australia's climate as it limited the supply of moisture to the atmosphere across the country.

The Southern Annular Mode was positive during the winter and in late November to early December 2017. A positive Southern Annular Mode has opposite effects on summer and winter rainfall: while it contributed to low rainfall during the winter months, it contributed to increased rainfall during December 2017 in southeastern Australia (Figure 3c).

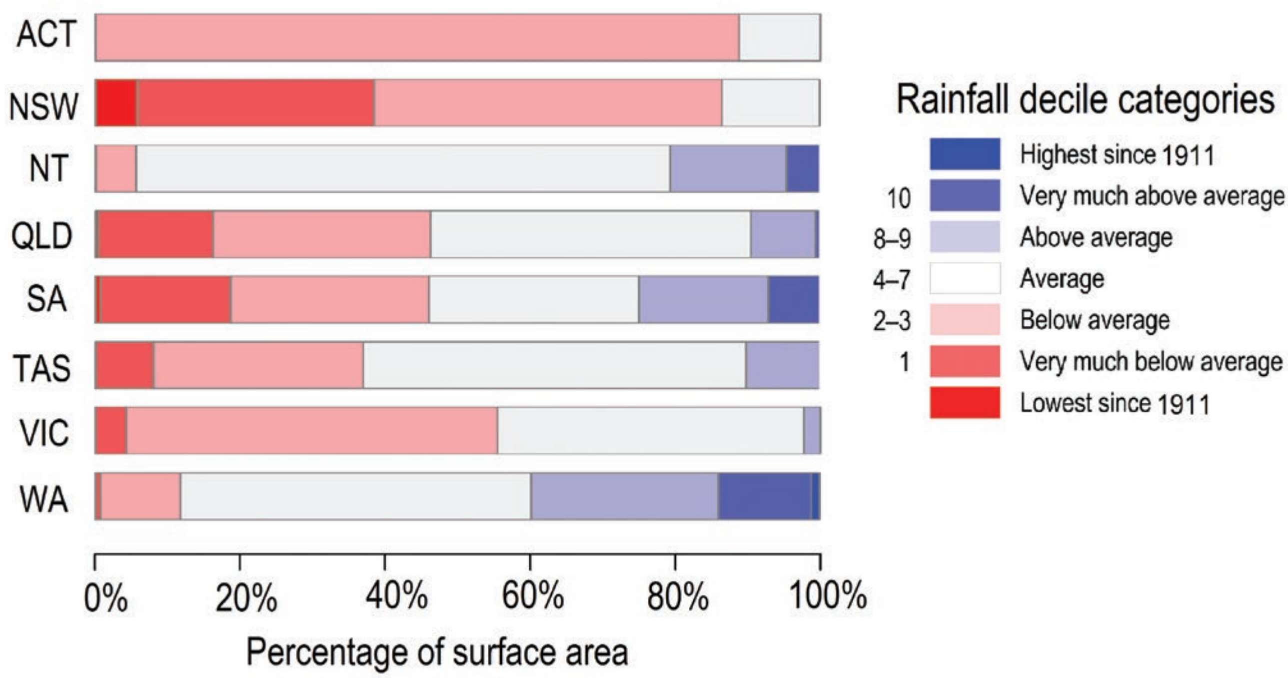



**Figure 2. Rainfall deciles by State or Territory in 2017–18**

The tropical Pacific Ocean cooled steadily from midwinter, and La Niña was declared at the start of December 2017, which was unusually late for La Niña to develop. La Niña declined during February 2018 and ended in early March. This late and short-lived La Niña had little effect on rainfall patterns during the 2017–18 summer but may have contributed to above-average temperatures in the far southeast of the country.

During warmer times of the year, the subtropical ridge is located to the south of the continent (Figure 3d), suppressing the (cold) frontal activity in southern parts of the continent and allowing the monsoon trough to move over the northern part of the continent.

In the southern winter, the ridge is located further north over central Australia and allows wintertime cold fronts to bring showery conditions over southern Australia (Figure 3e). During the autumn and winter of 2017–18, the subtropical ridge moved over inland Australia, and cold fronts associated with low pressure systems began to extend further into southern Australia. However, the more southerly than average position of the ridge in winter suppressed rain-bearing low pressure systems and cold fronts, pushing them further south of the continent than usual. This reduced the number of frontal systems that travelled far into southern Australia and partially explains the dry conditions from March to June 2018.

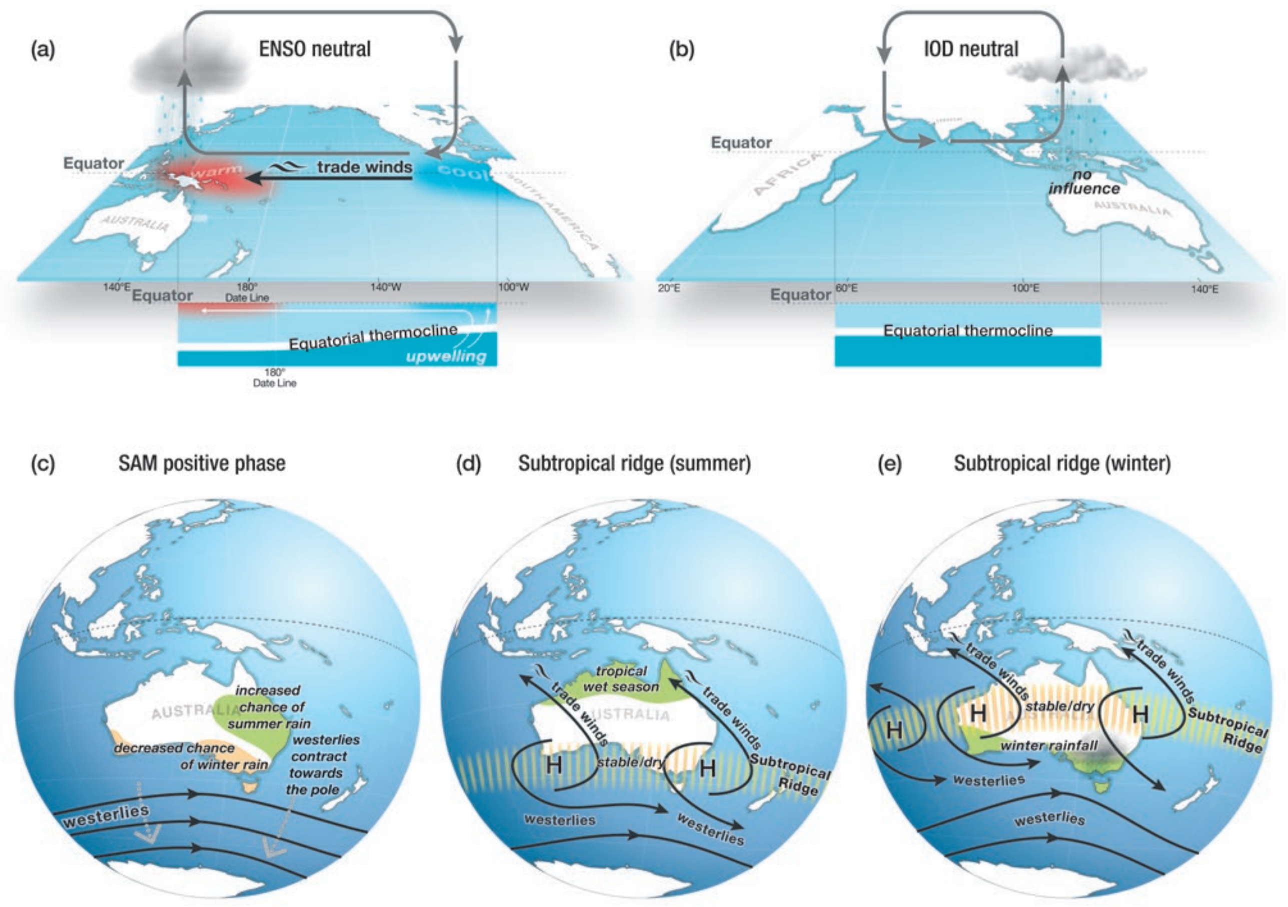



Figure 3. Conceptual diagram of important climate drivers and their influence on climatic conditions during 2017–18 (a) El Niño–Southern Oscillation neutral phase (b) Indian Ocean Dipole neutral phase (c) Southern Annular Mode positive phase (d) subtropical ridge during summer (e) subtropical ridge during winter

### 2.1.3 Monthly rainfall

Rainfall during the northern wet season often makes a major contribution to Australia's annual rainfall. The highest monthly rainfall (spatially averaged across Australia) for 2017–18 was recorded in January at 102 mm. Figure 4 shows monthly rainfall distributions compared with long-term data for the whole of Australia.

Monthly rainfall was below the long-term mean for July and September and average for August 2017. Low pressure systems, a series of cold fronts and associated surface troughs brought above-mean rainfall in October 2017. That was the first month in the 2017–18 reporting period in which the rainfall was well above the long-term mean (by 68 per cent). Rainfall for November was 25 per cent above the long-term mean, but in December it dropped to 18 per cent below the long-term mean. January rainfall was the highest in 2017–18 and was 32 per cent above the long-term mean. February and March rainfalls were lower than January and close to the long-term mean values for these months.

Under the influence of the Southern Annular Mode and the subtropical ridge, monthly rainfall for both April and May declined to 64 and 62 per cent below the monthly means, respectively.

April rainfall was the fifth lowest on record since 1911 and the lowest for that month since 1997. May 2018 was an exceptionally dry month for Australia. It was the driest May for Australia since 2008 and the fifth-lowest May rainfall on record. June rainfall was 29 per cent below the long-term mean. The total rainfall in these three months (the last quarter) of the year was less than half the historical mean for that quarter.

### 2.1.4 Patterns of annual rainfall and streamflow

The annual streamflow conditions for 2017–18 (Figure 5a) mostly followed the spatial distribution of annual rainfall in Figure 1. The differences between the State and Territory decile charts for rainfall (Figure 2) and streamflow (Figure 5b) can largely be attributed to the limited spatial distribution of streamflow monitoring sites. Annual and monthly streamflow deciles maps (July–June) are based on the long-term reference period (since July 1975). The year 1975 was chosen as a starting period that gave a good coverage of streamflow gauging stations across the country.

Average to lower-than-average annual flows were dominant in all States and Territories except the Northern Territory. Six per cent of gauges recorded their lowest flows since 1975; most of these gauges were in New South Wales.

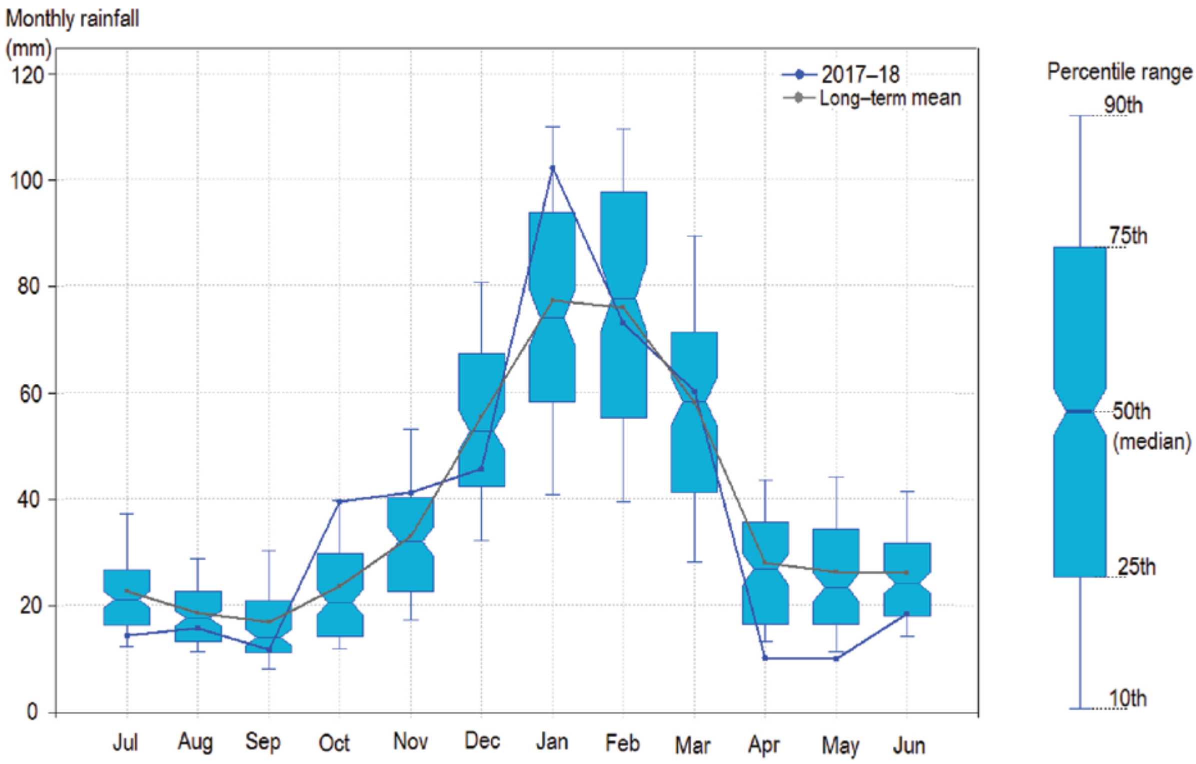
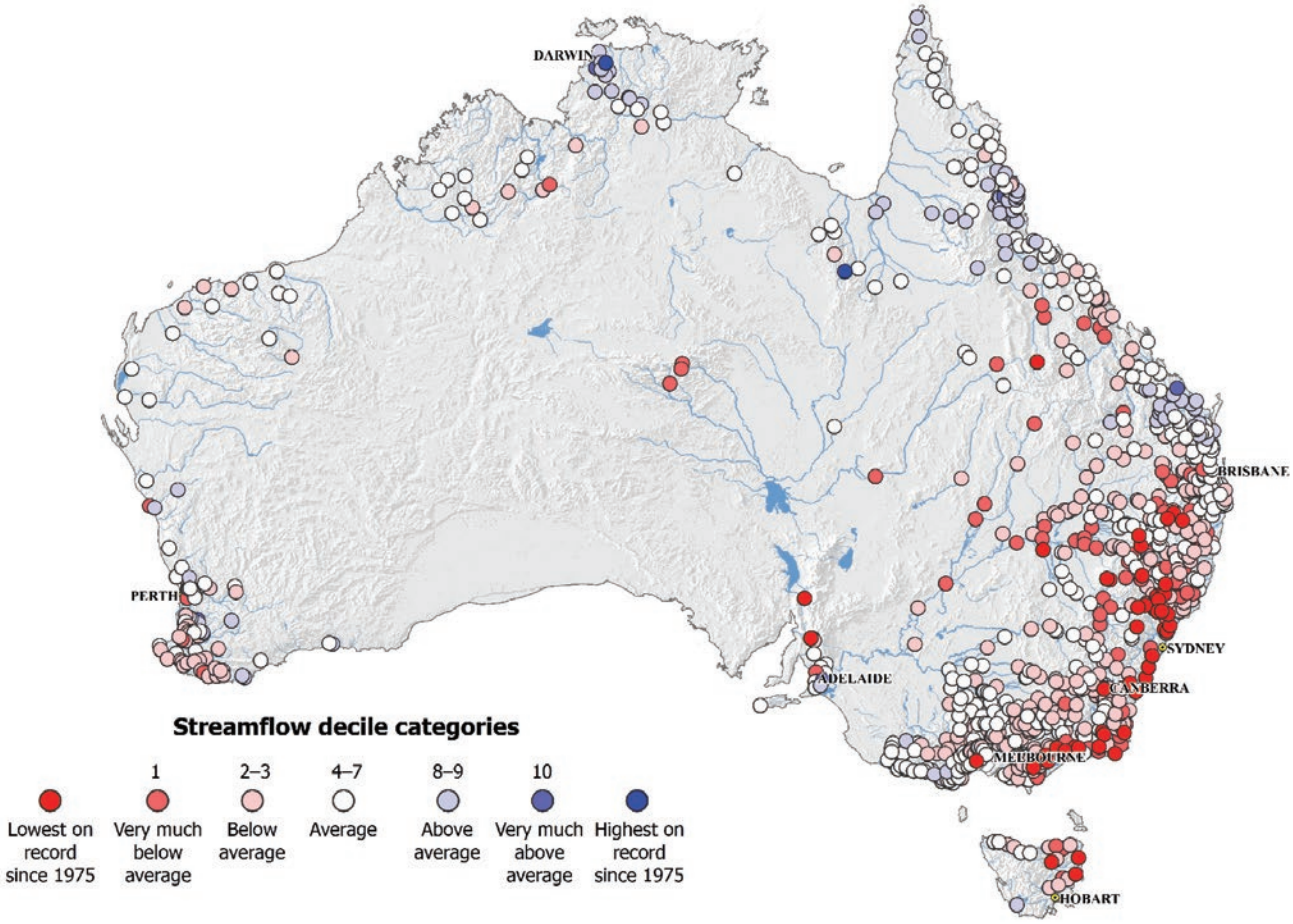



**Figure 4. Monthly rainfall in 2017–18 compared to the median monthly rainfall and range for Australia, July 1911 to June 2018**



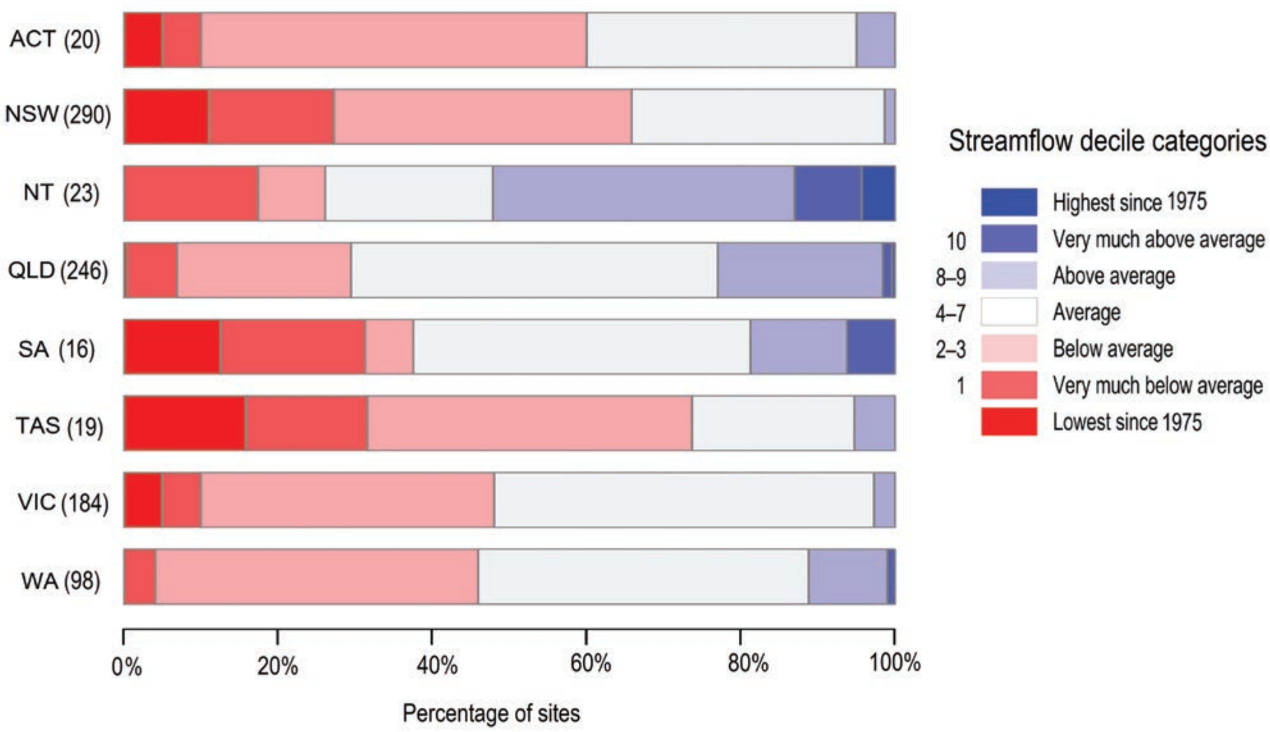




Figure 5. Streamflow deciles at long-term monitoring stations throughout Australia in 2017–18 (a) map (b) by State or Territory

Average to higher-than-average flows were dominant in the tropical north and along the northeast coast. Average annual flows were dominant in Queensland; average to higher-than-average flows were experienced in the northern part of the State whereas lower-than-average flows were dominant in the south (Figure 5a).

Lower-than-average flows were dominant in the Murray–Darling Basin, as well as along the South East Coast (VIC) and South East Coast (NSW) drainage divisions.[5] In the South East Coast (NSW) drainage division, 19 per cent of gauges recorded their lowest flows since 1975.

In New South Wales, lower-than-average annual flows were dominant. Flows along the coast and in the north were generally very much below average, while average to below-average flows were dominant in the south. In the Hunter River region in the South East Coast (NSW) drainage division, rainfall was very much below average, which resulted in lower-than-average flows in 88 per cent of gauges. Forty per cent of these recorded their lowest value since 1975.

Average to lower-than-average flows were dominant in Victoria. Lowest flows since 1975 were measured in many gauging stations in the far east along the East Gippsland and Mitchell–Thomson river basins. Average flows dominated in rivers in the west of Victoria.

In Tasmania, lower-than-average annual flows were dominant over the east whereas average flows predominated in the west.

In South Australia, average to lower-than-average annual flows were dominant. With gauges largely concentrated around Adelaide, no clear indication can be given for the whole State. The low flow conditions were due to the predominance of lower-than-average rainfall in the east, covering about 45 per cent of the State.

In Western Australia, average to lower-than-average annual flows were dominant. This is partially because no gauging stations were located in the area where rainfall was higher than average (northwest coastline and the north and south western plateaus).

Lower-than-average flows were dominant in the southwest while average to lower-than-average flows were dominant along the coast north of Perth. In the South West Coast, streamflows were lower than average in more than 50 per cent of gauging stations, mainly due to average to lower-than-average rainfall received. Even though rainfall was average in large parts of the northwest (Pilbara–Gascoyne), streamflows were mostly average to lower than average.

Lower-than-average annual streamflows were recorded at three of the five gauges in the Ord system, mainly due to lower-than-average rainfall in the upstream catchments. The low streamflows contributed to the drop in accessible storage volume in the Lake Argyle storage from 106 to 78 per cent.

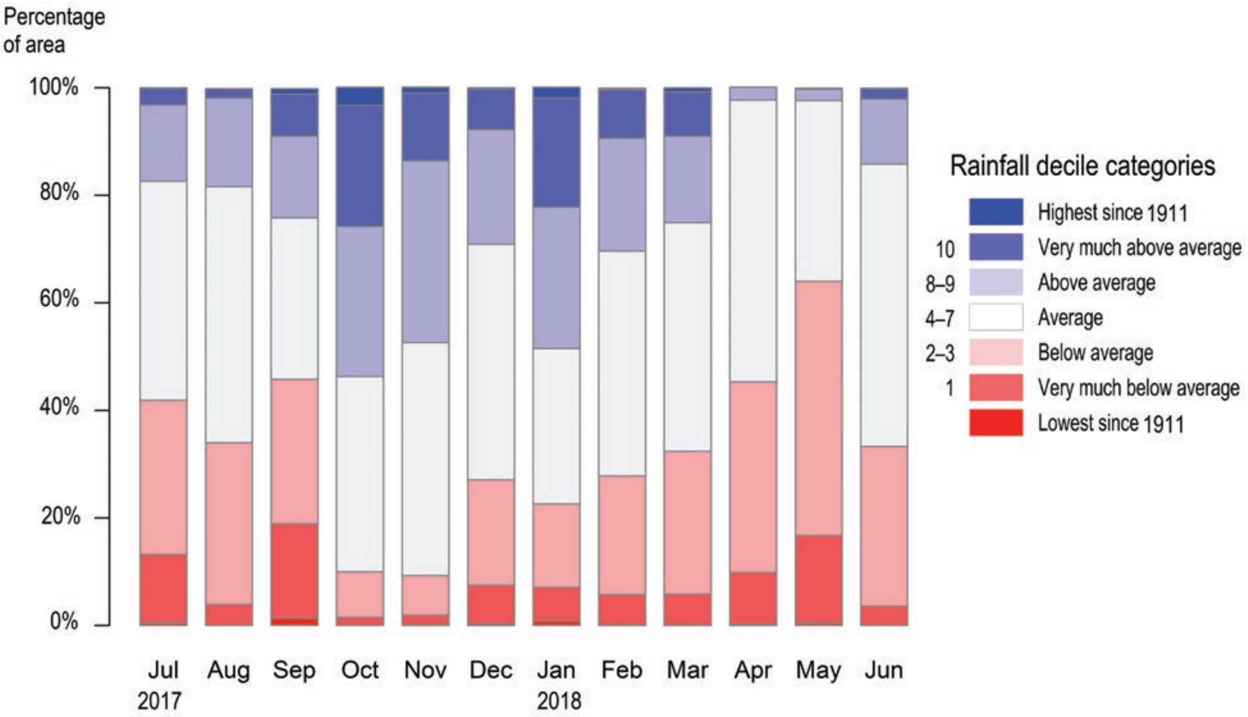
### 2.1.5 Patterns of monthly rainfall and streamflow

Figure 6 provides an overview of monthly rainfall and streamflow deciles in 2017–18. From July to September 2017, rainfall was average or lower for most of the country. From October 2017 to January 2018 it was average or higher for more than 70 per cent of the country. After this, average to lower-than-average conditions again dominated.

Streamflow varied in a similar fashion but was dominated by average and lower flows for the entire year. The proportion of lower-than-average streamflow was highest in June 2018 (50 per cent), followed by May (49 per cent).

5 See Figure 1 for the drainage division boundaries

(a) National rainfall deciles




(b) National streamflow deciles

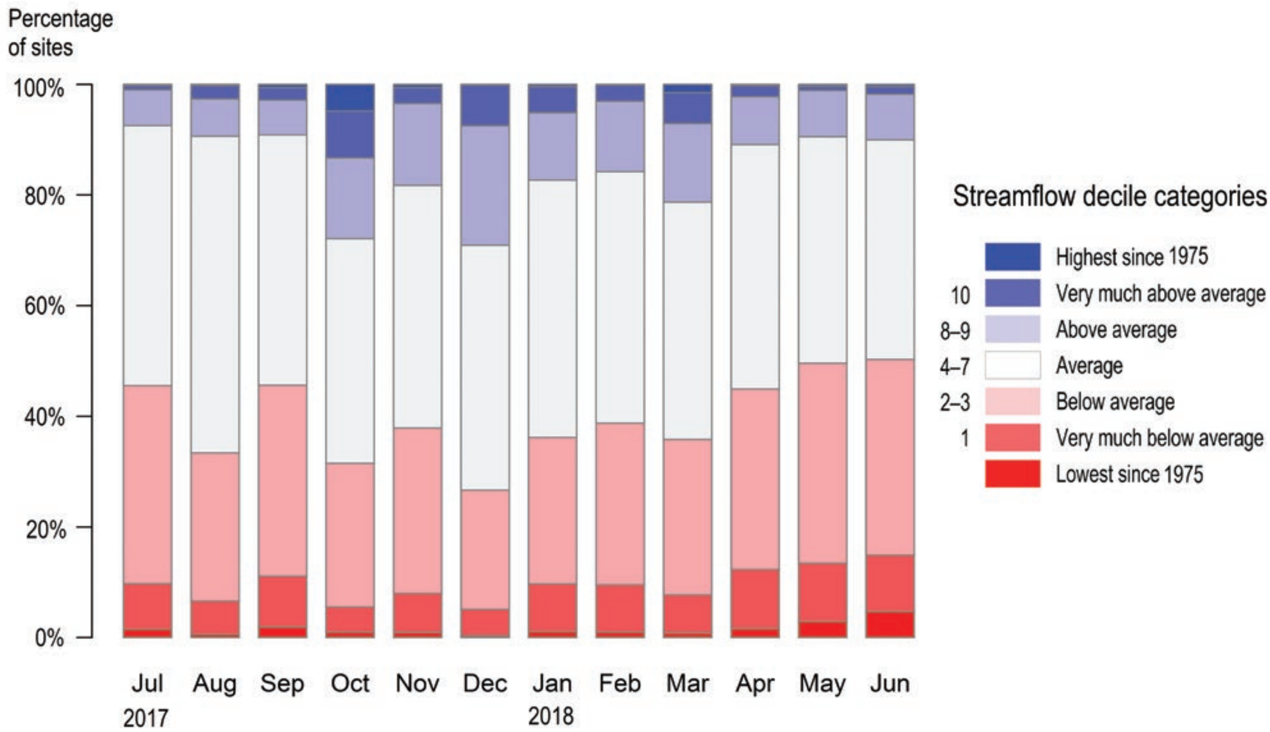



Figure 6. National rainfall and streamflow deciles by month in 2017–18 (a) rainfall (b) streamflow

Throughout much of Australia, the start of the year was dry following relatively low rainfalls in May and June 2017. Figures 6 and 7 provide an overview of monthly rainfall and streamflow in 2017–18. From July to September 2017, rainfall was average or lower for most of the country, especially in the southeast. The Northern Territory and northwest Queensland recorded higher-than-average rainfall in July, but rainfall over large areas of the southern mainland was below to very much below average. In July, most gauges recorded average or lower flows with the lower flows predominating in the south. This dry situation continued in the east during August and September 2017.

August rainfall was lower than average over central Australia, much of Queensland and northeast New South Wales, and average or lower flows occurred in these regions. In contrast, about 45 per cent of sites in the South West Coast recorded higher-than-average flows in August 2017. This was mainly due to higher-than-average August rainfall over more than three-quarters of the drainage division.

With lower-than-average rainfall in September 2017 and dry antecedent conditions in the eastern parts of the continent, streamflows in about 46 per cent of the country's gauges were lower than average. September rainfall was the lowest since 1911 for New South Wales and the Murray–Darling Basin as a whole. For Queensland, it was the tenth-driest September since 1911. An unseasonal rainfall event at the end of September 2017 resulted in higher-than-average monthly rainfall across central and western Australia. Even though rainfall was above average in large parts of the South West Coast in September 2017, streamflow in this region rarely exceeded average due to the dry antecedent conditions.

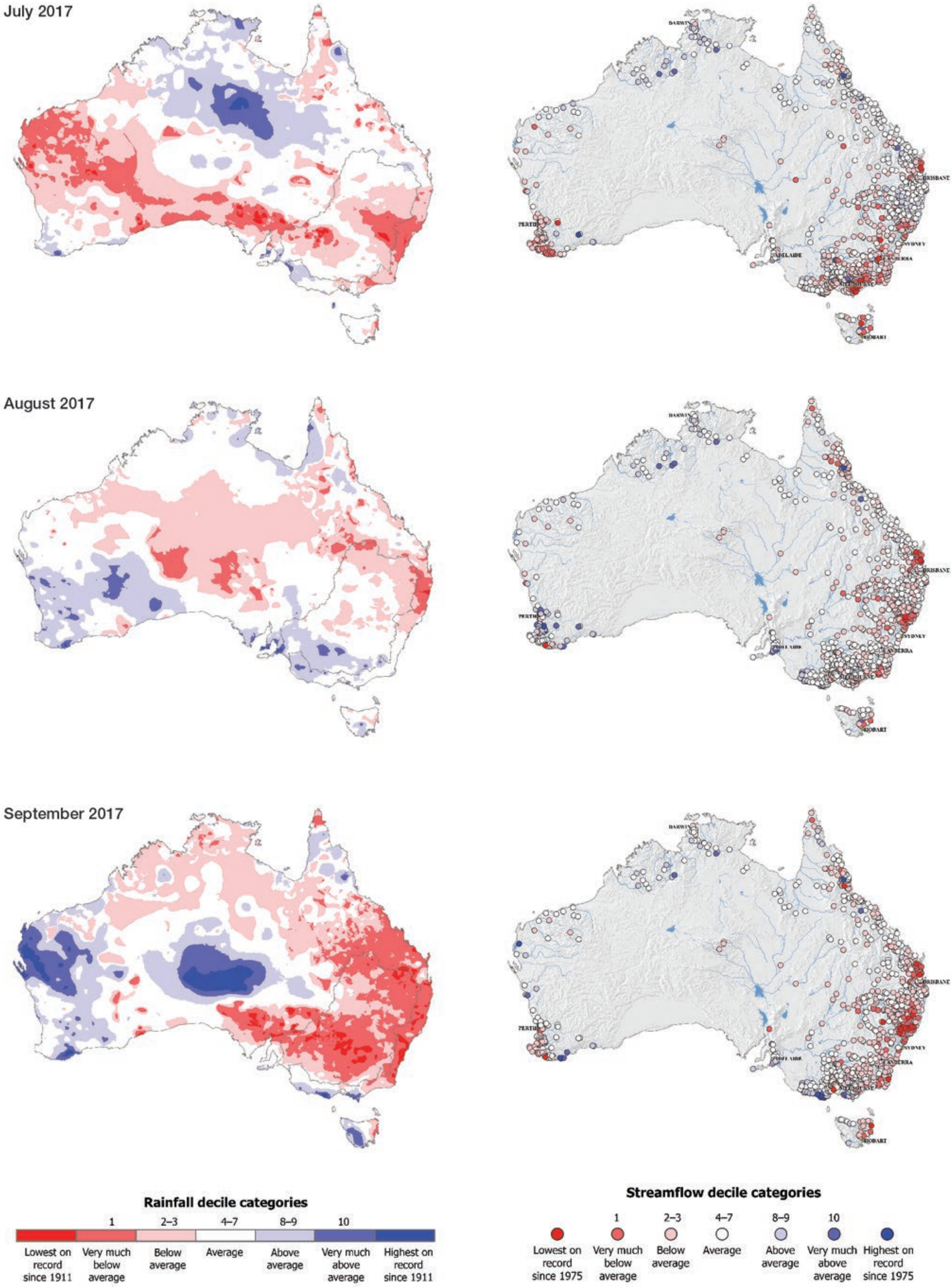



Figure 7. Monthly rainfall (left) and streamflow (right) deciles in 2017–18

Conditions changed dramatically in October, when large parts of Australia (26 per cent) were very much wetter than average. Eighty-nine per cent of Queensland had rainfall that was higher than average, resulting in 68 per cent of the State's gauges recording higher-than-average streamflow; 18 per cent of the State's gauges recorded their highest flows since 1975. Higher-than-average rainfall was also observed in the eastern areas of Western Australia, northern New South Wales and inland South Australia.

There was a contrast between streamflows in the northern and southern parts of the Murray–Darling Basin in October. In the north, rainfall brought a welcome change to the dry catchments in northern New South Wales. Rainfall was average to lower than average in the south. Average to higher-than-average streamflows dominated in the north whereas average to lower-than-average flows were dominant in the south.

During November 2017, a series of low pressure troughs over northern and central Australia generated heavy showers. The Northern Territory recorded its seventh-wettest November (75 mm) and was dominated by higher-than-average flows. In South Australia, rainfall was very much above average—about twice the long-term mean. Higher-than-average rainfall occurred mainly in the northwestern and southeastern parts of South Australia, and in parts of the Eyre Peninsula. Although this was the State's sixth-wettest November since 1911, it did not produce substantial flows at the stream gauging locations due to dry antecedent conditions in the vicinity of the sparsely distributed gauges. For Tasmania as a whole, November rainfall was the tenth lowest on record, and lower-than-average flows occurred at more than 90 per cent of gauges.

In December 2017, lower-than-average rainfall was observed for much of the Northern Territory and Queensland. Higher-than-average rainfall was recorded for northern and eastern Victoria, southern New South Wales, eastern Tasmania, southern South Australia, the west coast of Western Australia and a strip from the western Kimberley region to southeast Western Australia. Streamflow patterns followed the rainfall, and average to below-average flows were dominant in the Northern Territory and Queensland. In the Murray–Darling Basin, about 40 per cent of gauges recorded higher-than-average streamflows due to very-much-above-average rainfall in the southern part of the basin.

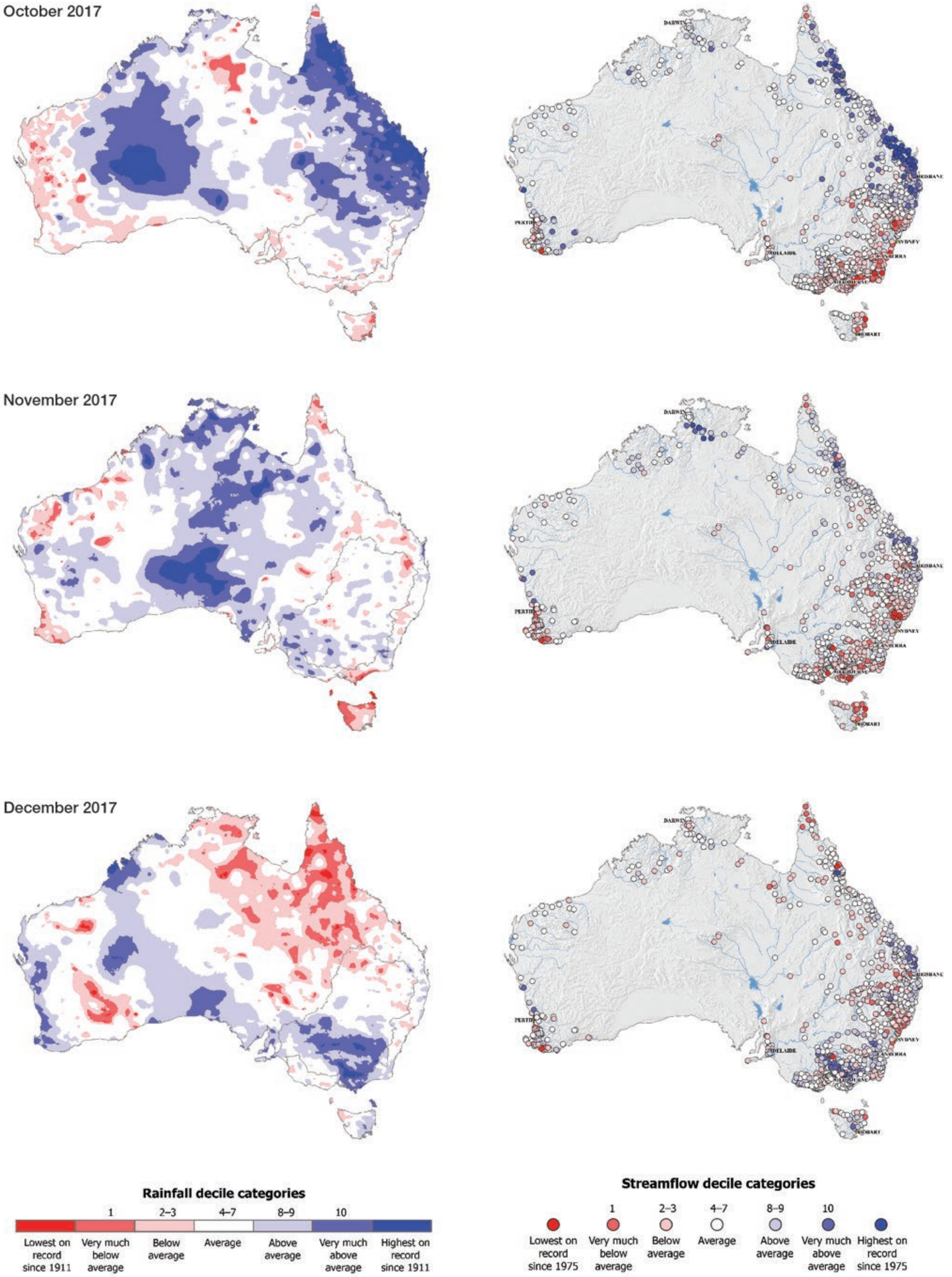



Figure 7 (continued). Monthly rainfall (left) and streamflow (right) deciles in 2017–18

January 2018 saw a contrast to the previous month in the Northern Territory, with wet conditions and higher-than-average flows. Highest-on-record flows were recorded at 13 per cent of the Territory's gauges. Major flooding occurred in the Daly River due to highest-on-record January rainfall. Higher-than-average flows were recorded at nine out of ten gauges in the Daly River, with two gauges recording their highest flows since 1975.

Most of Queensland, northeastern New South Wales, western Tasmania and western Victoria recorded lower-than-average January rainfall. Average or lower flows were dominant in Queensland, New South Wales and Victoria whereas more than 90 per cent of gauges in Tasmania recorded lower-than-average flows. Higher-than-average flows were recorded at about 40 per cent of gauges in Western Australia as tropical cyclone *Joyce* and tropical low 11U produced widespread rainfall across the State.

February 2018 rainfall was higher than average in southeastern Queensland and much of Western Australia, particularly in the Kimberley and the southeast due to tropical cyclone *Kelvin*. Streamflows were higher than average in southeastern Queensland. Average flows were dominant in Western Australia as there are no gauging stations in the areas that had high rainfall. Lower-than-average rainfall was recorded for the southeastern mainland, southwestern Queensland, northern Cape York Peninsula and parts of the Northern Territory. About 47 per cent of gauges in New South Wales and 41 per cent in Victoria recorded lower-than-average flows.

March rainfall was lower than average across most of southern mainland Australia. Tropical cyclone *Marcus* made landfall in March around 50 km northeast of Darwin but made little impact in terms of rainfall. Higher-than-average rainfall was reported in large parts of Queensland, resulting in 48 per cent of gauges recording higher-than-average flows and 5 per cent recording their highest since 1975. The situation changed in Tasmania during March 2018, which had more sites with high flows than the previous month. Forty-five per cent of the State's sites had higher-than-average flows, mainly due to the higher-than-average rainfall received during this month. Average to lower-than-average flows dominated in the rest of the States and Territories.

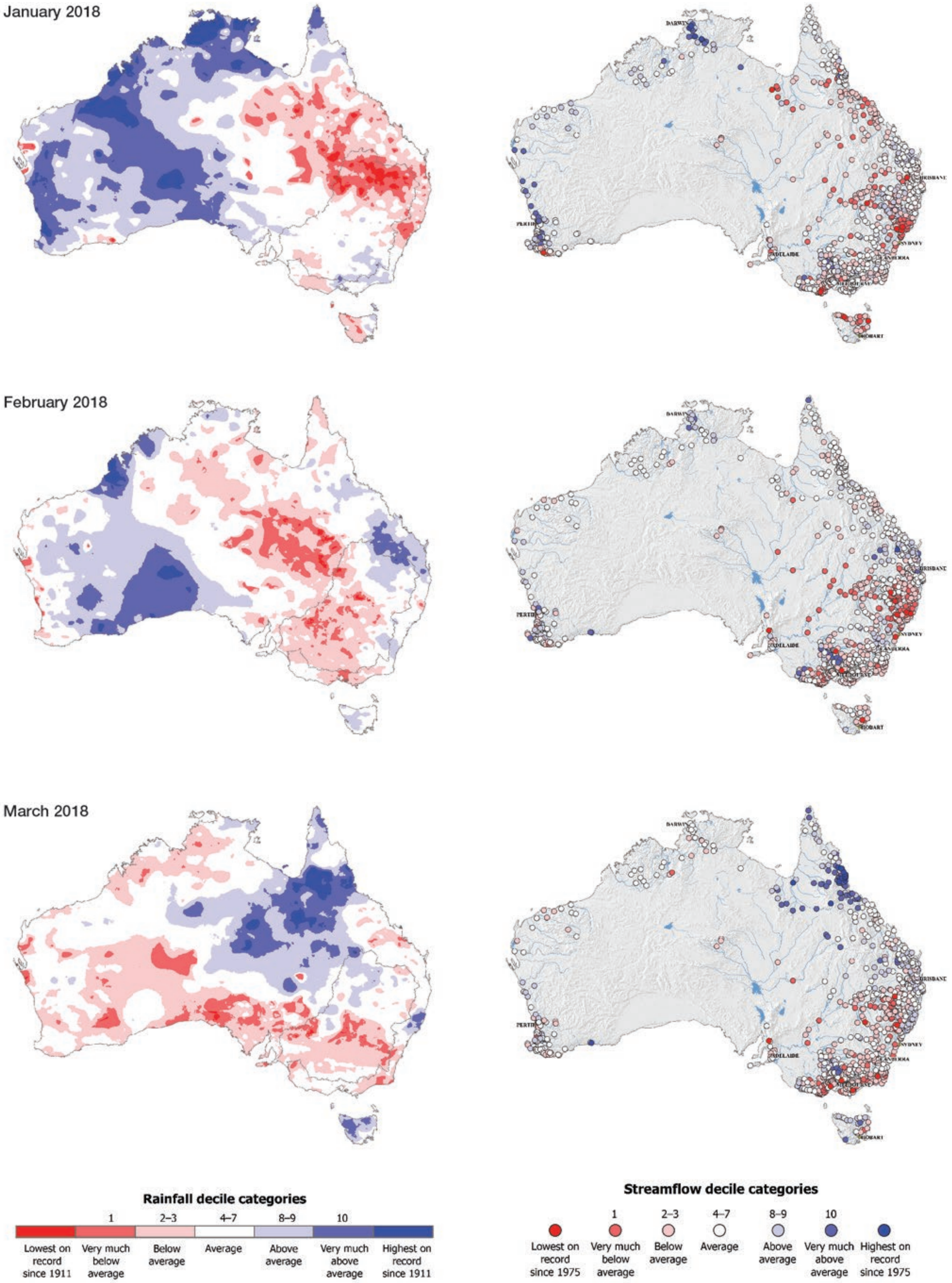



Figure 7 (continued). Monthly rainfall (left) and streamflow (right) deciles in 2017–18

Australia's rainfall was very much below average for April and May 2018. May 2018 was an exceptionally dry month for Australia, with lower-than-average rainfall across most of the country except parts of southeast. Lower-than-average flows occurred in most States and Territories during these months.

In June 2018, rainfall was average or lower for most of Australia and lower-than-average flows were dominant. Large areas of higher-than-average rainfall occurred only in northwest Western Australia and western Queensland. Due to the persistent dry conditions since January 2018, streamflows declined progressively in the Murray–Darling Basin. About 60 per cent of gauges recorded lower-than-average flows in June 2018.

Within the month-by-month variation described above, streamflow conditions in the States and Territory were characterised by some stable conditions.

- The Northern Territory was dominated by above-average flows in July and November 2017, and January and February 2018. In all other months except December, average flows were dominant.
- In Queensland, average to lower-than-average flows occurred in all months except October and November 2017, and March and April 2018.
- In New South Wales, average to lower-than-average flows were dominant in all months. More than 50 per cent of the State's gauges recorded lower-than-average flows in the final three months of the year; many recorded their lowest flows since 1975. In the Hunter River catchment, lower-than-average flows predominated in all months of the year.
- In Victoria, average to lower-than-average streamflow occurred in all months except December 2017.
- In Tasmania, average to below-average flows were experienced in all months except March 2018. More than 50 per cent of the State's gauges recorded lower-than-average flows in July, September and November 2017, and January and February 2018.
- In South Australia, average to lower-than-average flows occurred in all months except August, September and December 2017.
- In Western Australia, average to lower-than-average flows dominated in all months except August 2017 and January and February 2018.

More information on the monthly climatic conditions, rainfall and streamflow can be found in the Bureau's Monthly Weather Review[6], the Monthly Water Update[7] and Regional Water Information.[8]

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

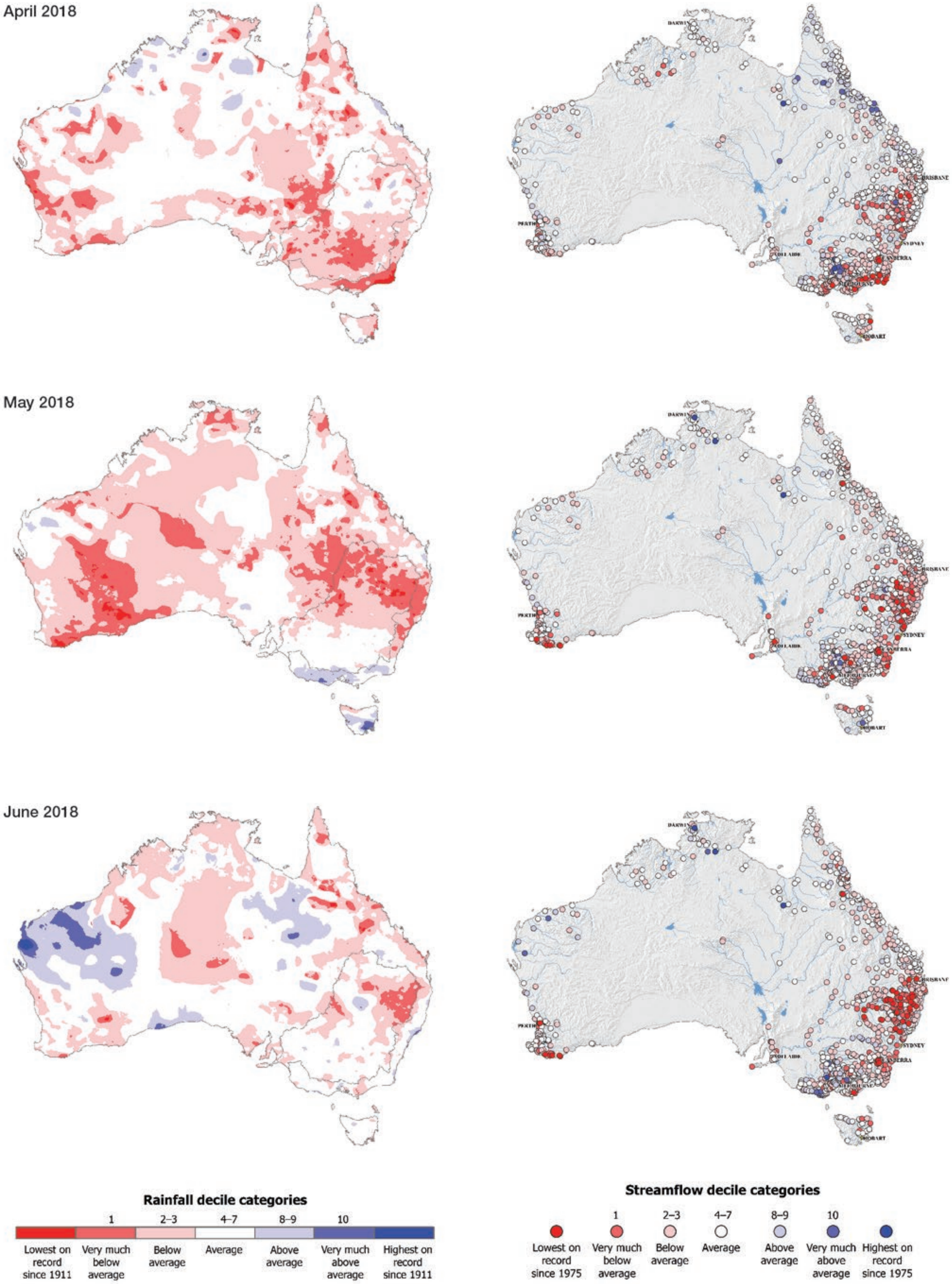



Figure 7 (continued). Monthly rainfall (left) and streamflow (right) deciles in 2017–18

## 2.2 WATER STORAGES

### 2.2.1 National view

Australia has over 500 major storages, several thousand small storages and in excess of two million farm dams. Large storages are essential for coping with the highly variable rainfall and high temperatures that are prevalent in much of Australia. The total accessible storage capacity is about 81 000 GL (Department of Agriculture and Water Resources, 2018) which is equivalent to a per capita surface water storage capacity of about 3250 $m^3$— relatively high on a country by country comparison. Per capita storage capacities across countries are highly uneven (for example, Canada 23 414 $m^3$, United States of America 2287 $m^3$ and United Kingdom 81 $m^3$).[9]

Tasmania has a number of large storages primarily to provide water for hydro-electric power generation. On the mainland, storages are concentrated mainly in the southeast where the largest irrigation areas and most of the major urban centres are located. Here, water is mostly used for direct water supply, including agricultural, urban and industrial uses, as well as for environmental releases.

The combined accessible storage capacity of major storages for direct water supply purposes across Australia at the beginning of 2017–18 was 53 600 GL. Urban systems are listed in Table 1 and rural systems in Table 2. The combined accessible storage volume started at 41 300 GL or 77 per cent of capacity at the start of the year. Due to dry conditions throughout much of Australia and continued extractions from these storages, the accessible storage volume decreased to 63 per cent of capacity by the end of 2017–18.

For urban systems, the total accessible storage was 69 per cent at the end of 2017–18, 6 percentage points lower than at the start of the year. Total accessible storage for major rural systems decreased from 78 per cent of capacity at the start of the year to 61 per cent of capacity at the end of the year.

9 www.fao.org/nr/water/aquastat/data

### 2.2.2 Urban storages

The distribution and status of urban storage systems are shown in Figure 8, and their capacity and storage volumes are given in Table 1.

At the start of the 2017–18 year, the combined accessible water volume in urban storages across the nation was 7617 GL (75 per cent of capacity), decreasing to 6995 GL (69 per cent of capacity) by the end of the year. Accessible storage volumes at the end of the year were lower than those at the start of the year in 14 of the 19 urban supply systems. The Pilbara supply system showed the largest proportional decline, followed by Sydney. Decreases occurred in all States and Territories except in Queensland.

The biggest decrease was in New South Wales, where the combined accessible storage volume dropped by 23 percentage points, from 92 per cent of capacity (2859 GL) at 30 June 2017 to 69 per cent (2144 GL) at 30 June 2018. The accessible storage volume dropped in all four storage systems in the State. Most of the decline can be attributed to the marked reduction (25 percentage points) in the accessible storage volume of the Sydney supply system, by far the largest system in the State. Newcastle supply system's accessible storage volume declined from 96 to 78 per cent (196 GL to 159 GL), while that for the Central Coast declined from 73 to 63 per cent of capacity (139 GL to 120 GL).

In the Australian Capital Territory, the combined accessible storage volume of the Canberra system decreased from 80 per cent of capacity (126 GL) at 30 June 2017 to 66 per cent (105 GL) at 30 June 2018. This was the first decrease in accessible storage volume over the year since 2012–13. While accessible storage volumes in the Cotter and Bendora storages returned to near start-of-year volumes (95 and 79 per cent of capacity, respectively), volumes in Corin storage dropped significantly, from 62 to 33 per cent of capacity.

The accessible storage volume dropped in all three urban systems in Victoria, decreasing from 59 per cent of capacity (1338 GL) at 30 June 2017 to 54 per cent (1232 GL) at 30 June 2018. The accessible storage volumes of the Melbourne system declined by 4 percentage points, while accessible storage volume in the smaller Barwon Geelong and Coliban supply systems decreased by 10 percentage points during the year.

The combined accessible water volume of Adelaide's ten urban storages started the year at 56 per cent of capacity (110 GL). By the end of the wet winter to early spring period (31 September 2017), storage volumes reached 88 per cent of capacity (175 GL). Volumes dropped to 46 per cent (91 GL) at the end of the year—the lowest in the last five years.

The small Pilbara storage system (Harding reservoir) experienced a sharp decline, from 93 per cent of capacity (59 GL) at the start of the year to 57 per cent of capacity (36 GL) at 30 June 2018.

In contrast to those decreases, system increases occurred in Queensland and the southern part of Western Australia.

The combined accessible storage volume of urban systems in Queensland increased from 77 per cent of capacity (2691 GL) at 30 June 2017 to 83 per cent (2888 GL) at 30 June 2018. Most of this change was due to an increase in accessible storage volumes in the Townsville and Brisbane systems. The accessible storage volume increased in four out of seven systems.

In Townsville, Brisbane, Mount Isa and Cairns supply systems, accessible storage volumes increased as a result of higher-than-average inflows, particularly in March 2018. The higher-than-average flows received during that month raised Queensland's accessible storage volume to a peak in March 2018. Four supply systems were at full capacity during this month.

Accessible volumes in the Townsville system increased from 24 per cent at the start of the year to 91 per cent at 30 June 2018, while the South East Queensland (greater Brisbane) system increased from 76 per cent of capacity to 80 per cent. The Toowoomba system showed the largest proportional decline (from 58 to 48 per cent of accessible capacity) followed by Gladstone (from 96 to 92 per cent). The remaining three supply systems operated at close to full capacity throughout the year.

The combined accessible storage volume of urban systems in Western Australia increased from 32 per cent of capacity (209 GL) at 30 June 2017 to 39 per cent (257 GL) at 30 June 2018.

**Table 1. Urban systems storage capacity and volume at 30 June 2017 and 30 June 2018**

| Map reference (Figure 8) | System | Accessible capacity (GL) | Number of storages | Fullness 30 June 2017 Volume in GL (per cent full) | Fullness 30 June 2018 Volume in GL (per cent full) | Change (percentage points)* |
|---|---|---|---|---|---|---|
| 1 | Perth | 597 | 9 | 150 (25) | 221 (37) | ▲ +12 |
| 2 | Pilbara | 63 | 1 | 59 (93) | 36 (57) | ▼ -36 |
| 3 | Darwin | 235 | 1 | 279 (119) | 275 (117) | -2 |
| 4 | Mount Isa | 99 | 1 | 88 (88) | 91 (92) | +4 |
| 5 | Cairns | 37 | 1 | 35 (97) | 36 (99) | +2 |
| 6 | Townsville | 222 | 2 | 52 (24) | 203 (91) | ▲ +67 |
| 7 | Rockhampton | 59 | 1 | 60 (102) | 57 (97) | ▼ -5 |
| 8 | Gladstone | 662 | 1 | 637 (96) | 607 (92) | -4 |
| 9 | Brisbane | 2282 | 13 | 1737 (76) | 1834 (80) | +4 |
| 10 | Toowoomba | 127 | 3 | 73 (58) | 60 (48) | ▼ -10 |
| 11 | Newcastle | 204 | 2 | 196 (96) | 159 (78) | ▼ -18 |
| 12 | Central Coast NSW | 190 | 1 | 139 (73) | 120 (63) | ▼ -10 |
| 13 | Sydney | 2606 | 10 | 2416 (93) | 1779 (68) | ▼ -25 |
| 14 | Canberra | 278 | 4 | 234 (84) | 192 (69) | ▼ -15 |
| 15 | Coliban | 75 | 3 | 54 (73) | 47 (63) | ▼ -10 |
| 16 | Melbourne | 2032 | 14 | 1175 (58) | 1093 (54) | -4 |
| 17 | Barwon Geelong | 156 | 9 | 109 (70) | 92 (59) | ▼ -11 |
| 18 | Hobart | 3.6 | 1 | 3.5 (96) | 3.1 (87) | ▼ -9 |
| 19 | Adelaide | 197 | 10 | 110 (56) | 91 (46) | ▼ -10 |

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

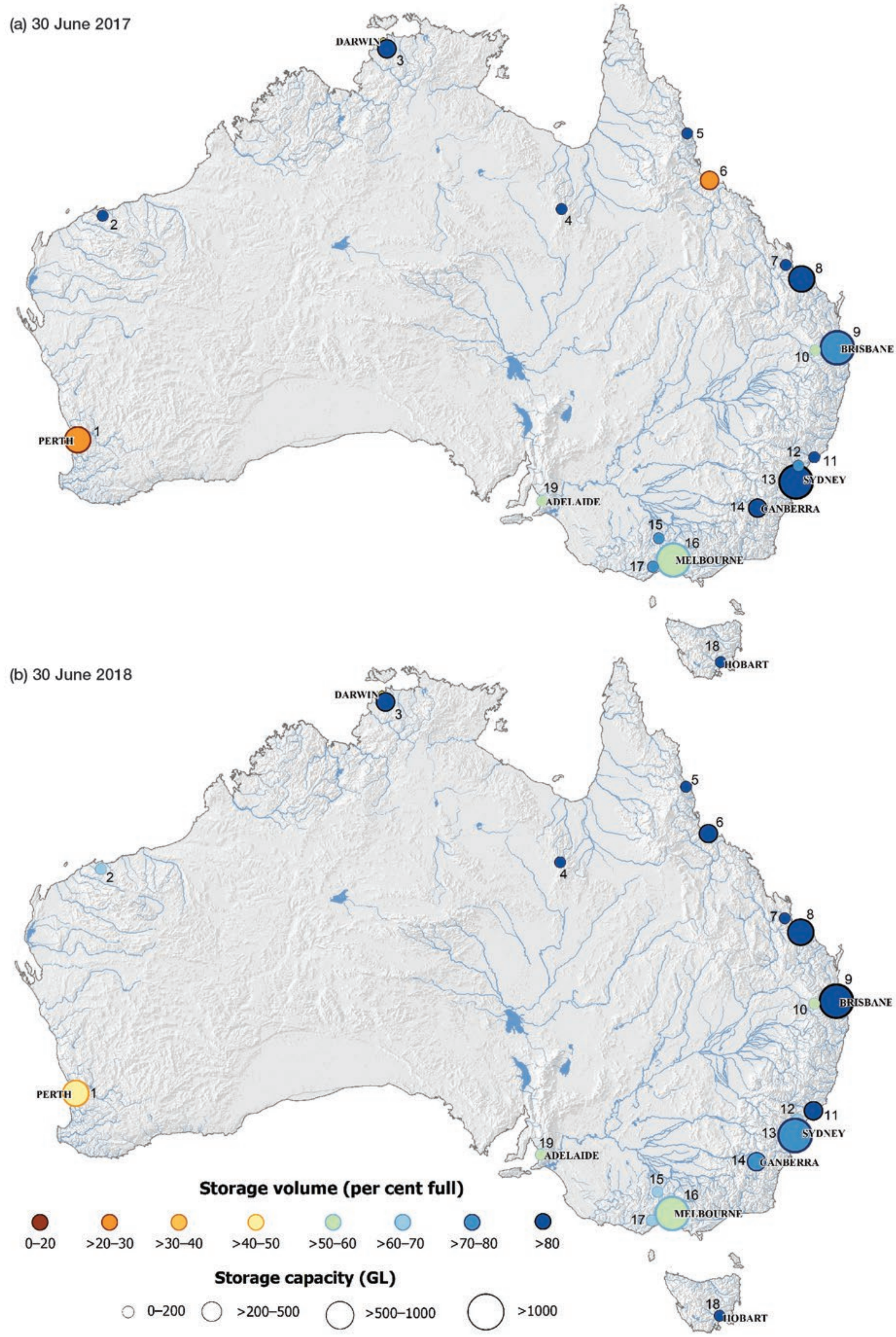



Figure 8. Distribution and storage status of urban storage systems (a) 30 June 2017 (b) 30 June 2018

Table 2. Rural systems storage capacity and volume at 30 June 2017 and 30 June 2018

| Map reference (Figure 8) | System | Accessible capacity (GL) | Number of storages | Fullness 30 June 2017 Volume in GL (per cent full) | Fullness 30 June 2018 Volume in GL (per cent full) | Change (percentage points)* |
|---|---|---|---|---|---|---|
| 1 | Collie–Harvey–Waroona | 334 | 4 | 127 (38) | 143 (43) | ▲ 5 |
| 2 | Ord | 10 432 | 1 | 11 022 (106) | 8181 (78) | ▼ -28 |
| 3 | Mareeba–Dimbulah | 438 | 1 | 216 (49) | 406 (93) | ▲ 44 |
| 4 | Burdekin–Haughton | 1852 | 1 | 1796 (97) | 1742 (94) | -3 |
| 5 | Bowen–Broken | 111 | 1 | 111 (100) | 110 (99) | -1 |
| 6 | Proserpine | 490 | 1 | 383 (78) | 341 (70) | ▼ -8 |
| 7 | Pioneer Valley | 139 | 1 | 139 (100) | 137 (98) | -2 |
| 8 | Eton | 62 | 1 | 61 (98) | 62 (99) | 1 |
| 9 | Nogoa–Mackenzie | 1289 | 1 | 540 (42) | 293 (23) | ▼ -19 |
| 10 | Callide | 148 | 2 | 130 (88) | 104 (70) | ▼ -18 |
| 11 | Dawson Valley | 50 | 4 | 37 (75) | 43 (86) | ▲ 11 |
| 12 | Three Moon Creek | 88 | 1 | 85 (97) | 83 (94) | -3 |
| 13 | Upper Burnett | 163 | 1 | 160 (98) | 157 (96) | -2 |
| 14 | Bundaberg | 872 | 3 | 843 (97) | 844 (97) | 0 |
| 15 | Mary Valley | 46 | 1 | 38 (82) | 46 (100) | ▲ 18 |
| 16 | Boyne–Tarong | 196 | 1 | 105 (54) | 69 (35) | ▼ -19 |
| 17 | Barker–Barambah | 134 | 1 | 29 (22) | 26 (19) | -3 |
| 18 | Lockyer Valley | 62 | 3 | 5 (8) | 2 (4) | -4 |
| 19 | Warrill Valley | 86 | 1 | 83 (96) | 71 (83) | ▼ -13 |
| 20 | Chinchilla | 10 | 1 | 8 (87) | 5 (49) | ▼ -38 |
| 21 | Upper Condamine | 104 | 1 | 17 (17) | 9 (8) | ▼ -9 |
| 22 | St George | 90 | 2 | 78 (86) | 62 (69) | ▼ -17 |
| 23 | Border Rivers | 632 | 3 | 566 (90) | 333 (53) | ▼ -37 |
| 24 | North Coast NSW | 11 | 1 | 11 (102) | 11 (100) | -2 |
| 25 | Gwydir | 1343 | 1 | 661 (49) | 358 (27) | ▼ -19 |
| 26 | Namoi | 873 | 3 | 484 (55) | 160 (18) | ▼ -37 |
| 27 | Macquarie–Castlereagh | 1523 | 2 | 1189 (78) | 562 (37) | ▼ -41 |
| 28 | Hunter Valley | 1031 | 2 | 891 (86) | 698 (68) | ▼ -18 |
| 29 | Lachlan | 1253 | 2 | 1104 (88) | 766 (61) | ▼ -27 |
| 30 | Murrumbidgee | 2633 | 2 | 1910 (73) | 1495 (57) | ▼ -16 |
| 31 | South Coast NSW | 9 | 1 | 9 (100) | 8 (87) | ▼ -13 |
| 32 | NSW and VIC Murray | 6821 | 3 | 5051 (74) | 4650 (68) | ▼ -6 |
| 33 | Gippsland (eastern Victoria) | 183 | 1 | 41 (23) | 38 (21) | -2 |
| 34 | Ovens | 32 | 2 | 21 (66) | 23 (71) | ▲ 5 |
| 35 | Goulburn–Broken | 3598 | 3 | 2163 (60) | 1837 (51) | ▼ -9 |
| 36 | Campaspe | 304 | 1 | 270 (89) | 184 (61) | ▼ -28 |
| 37 | Loddon | 213 | 2 | 156 (73) | 111 (52) | ▼ -21 |
| 38 | Wimmera–Mallee | 662 | 8 | 285 (43) | 247 (37) | ▼ -6 |
| 39 | Menindee | 1555 | 4 | 467 (30) | 184 (12) | ▼ -18 |
| 40 | SA Murray | 577 | 1 | 324 (56) | 265 (46) | ▼ -10 |

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

The Perth system rose to 41 per cent of capacity by the end of October 2017, and then dropped to 37 per cent of capacity at the end of 2017–18; the lowest proportional storage volume of all urban systems. This was due to persistent dry conditions during previous years. However, from 30 June 2017 to 30 June 2018, Perth's accessible storage volume increased by 12 percentage points, from 25 per cent (150 GL) to 37 per cent (221 GL). The increase arose from higher inflows due to improved average rainfall antecedent conditions, lower dependency on surface water and discharge of excess desalinated water into storages.

### 2.2.3 Rural storages

The distribution and status of rural storage systems are shown in Figure 9, and their capacity and storage volumes are given in Table 2. Out of 40 major rural storage systems in Australia, accessible water volumes rose in five systems, remained stable in 11 and dropped in 24.

The accessible storage volumes in most rural systems in Queensland declined during 2017–18, with a decrease of over 30 percentage points for the Border Rivers and Chinchilla systems. The Bundaberg system remained stable at 97 per cent (844 GL), while the accessible volume increased in the Mareeba–Dimbulah, Eton, Dawson Valley and Mary Valley systems. In the Burdekin–Haughton, the largest storage system in Queensland, the accessible volume dropped by 3 percentage points, from 97 per cent (1796 GL) in June 2017 to 94 per cent (1742 GL) in June 2018.

The combined accessible volume of storages in rural storage systems in New South Wales decreased from 67 per cent (9468 GL) to 42 per cent (5983 GL) of capacity over 2017–18. Volumes decreased in all systems during 2017–18. The largest proportional declines were in the Macquarie–Castlereagh and New South Wales Border Rivers systems, with decreases of more than 40 percentage points. Border Rivers catchment is located in both New South Wales and Queensland, and three dams regulate flows: Glenlyon and Coolmunda dams in Queensland and Pindari Dam in New South Wales. The decrease in combined accessible storage volume of all three storages in the Border Rivers system was 37 percentage points (Table 2).

In contrast, the accessible storage volumes along the North Coast New South Wales system were stable, and the South Australian Murray system declined by 10 percentage points. Accessible storage volumes in all rural systems in Victoria except Ovens decreased during 2017–18, with decreases of over 20 percentage points in the Campaspe and Loddon systems. In the Ovens system, accessible storage volume increased from 66 per cent (21 GL) to 71 per cent (23 GL) during this period.

In the Murray–Darling Basin, the accessible storage volume dropped from 67 to 51 per cent due to very-much-below-average rainfall. Accessible volumes in most storages in the Murray–Darling Basin were lower at the end of the year; exceptions were Dartmouth Reservoir (River Murray system), Toolondo Reservoir (Wimmera–Mallee), Lake William Hovell and Lake Buffalo (Ovens).

There was a large decrease in accessible volume in the Ord system. The lower-than-average flows contributed to the drop in accessible water in the Ord from 106 per cent of capacity (11 022 GL) to 78 per cent (8181 GL).

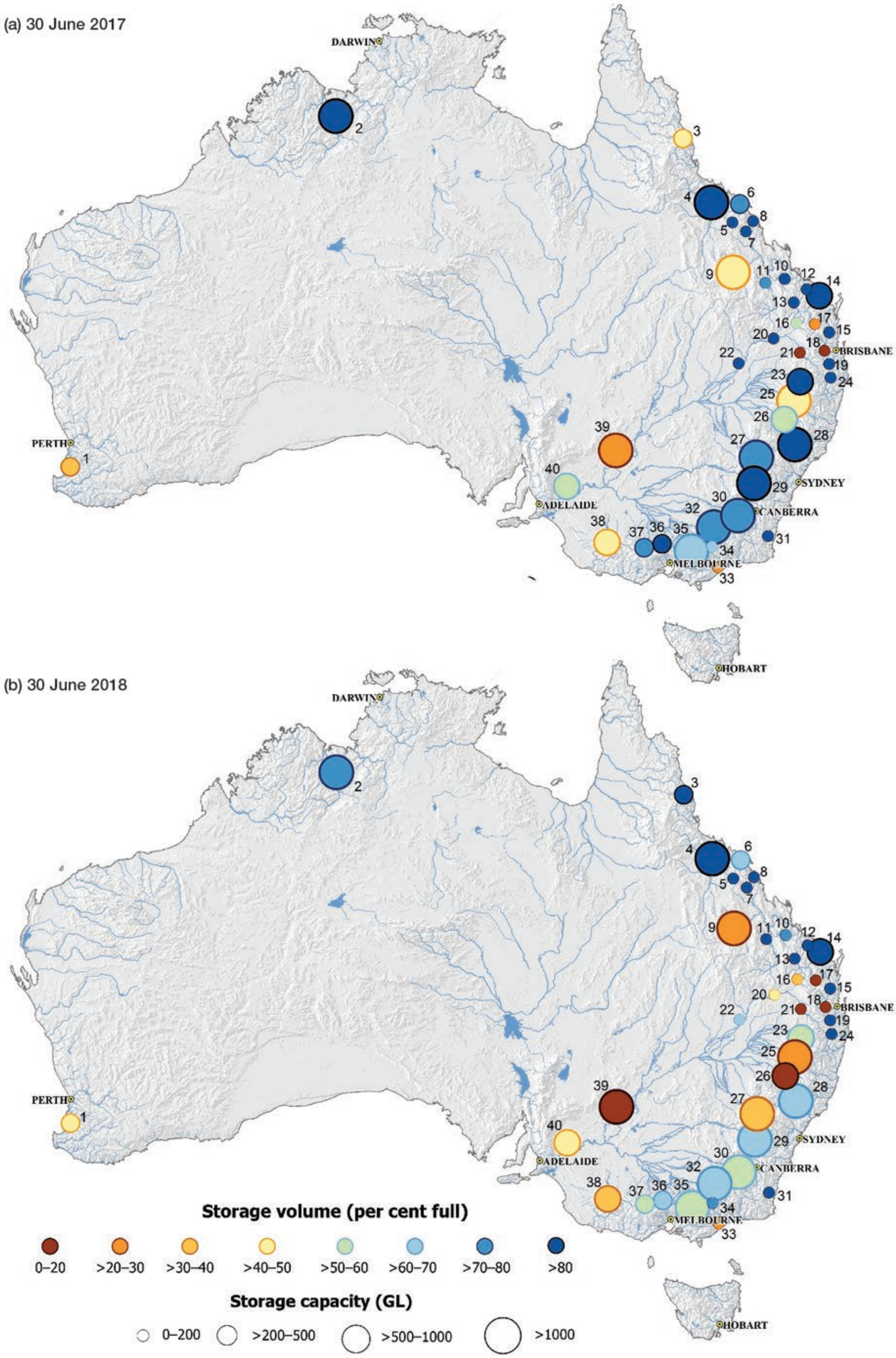



Figure 9. The distribution and storage status of rural storage systems (a) 30 June 2017 (b) 30 June 2018

## 2.3 STREAM SALINITY

### 2.3.1 Introduction

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, Western Australian streams are naturally more saline than streams in northern Australia and along the eastern divide, where greater rainfall dilutes salt concentrations. In many areas across Australia, dryland and irrigated agriculture and clearing of native, perennial vegetation have changed the catchment water balance. These changes in landscapes increased the mobilisation of highly soluble salts from saline aquifers or shallow water tables into streams. Increased stream salinity can present a risk to aquatic ecosystems and vegetation health, where not naturally occurring (Lake, 2003).

Within the Murray–Darling Basin and across many areas in Australia, salinity is increasingly managed and monitored through the implementation of jurisdictional Land and Water Management Plans that include water quality. These plans can provide the framework for setting salinity objectives and targets, as well as for developing on-ground measures to improve salinity conditions. Such measures include provision of adequate water flows, investing into re-vegetation, improving irrigation and dryland farming practices, and salt interception schemes that minimise the movement of salts.

To support water quality management and planning, an Australian Government initiative has created a Water Quality Australia website in partnership with State and Territory governments.[10] The website provides tools and resources to guide water managers, researchers, industry and State, Territory and local governments in developing and implementing water quality plans and strategies.

### 2.3.2 Median stream salinity

Stream salinity concentrations determine the suitability of water for various uses; for example, drinking and irrigation. They can also be an indication of impacts on ecosystems. The salinity categories for which water is considered fit for various uses, as well as indicating a possible impact on river health, are presented in Table 3.

Similar to in 2016–17, about 61 per cent of the Australia's river and stream sites were on average considered to be fresh and suitable for drinking (median salinity <500 mg/L).[11] For comparison purposes, these were based on sites with data available for both 2016–17 and 2017–18.

10 www.waterquality.gov.au

11 The Australian Drinking Water Guidelines – Updated August 2018 refer to a threshold of 600 mg/L TDS as good drinking water quality (www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines)

**Table 3. Water salinity and primary suitability for use[a,b]**

| Primary suitability for use | Fresh (0–500 mg/L TDS) Good-quality water suitable for drinking and all irrigation | Marginal (500–1000 mg/L TDS) Fair- to poor-quality drinking water; most irrigation; adverse effects on ecosystems may become apparent[c] | Brackish (1000–3000 mg/L TDS) Unacceptable-quality drinking water; useful for most livestock; irrigation limited to certain crops | Saline (>3000 mg/L TDS) Unacceptable drinking water quality; use may be limited for certain livestock |
|---|---|---|---|---|
| Potable | | | | |
| Irrigation | | | | |
| Industry | | | | |

mg/L = milligrams per litre; TDS = total dissolved solids or salts

[a] Colours in the table match those used in Figure 10.

[b] Additional threshold and trigger values for drinking, recreational and ecological health purposes can be obtained from the revised Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2018 (www.waterquality.gov.au/guidelines/anz-fresh-marine) and for

- Aquatic Ecosystems: www.waterquality.gov.au/anz-guidelines/Documents/ANZECC-ARMCANZ-2000-guidelines-vol2.pdf
- Primary industries purpose: www.waterquality.gov.au/anz-guidelines/Documents/ANZECC-ARMCANZ-2000-guidelines-vol3.pdf
- Recreational Water Quality and Drinking Water: www.waterquality.gov.au/anz-guidelines/Documents/ANZECC-ARMCANZ-2000-guidelines-vol1.pdf

[c] Nielsen et al. (2003)

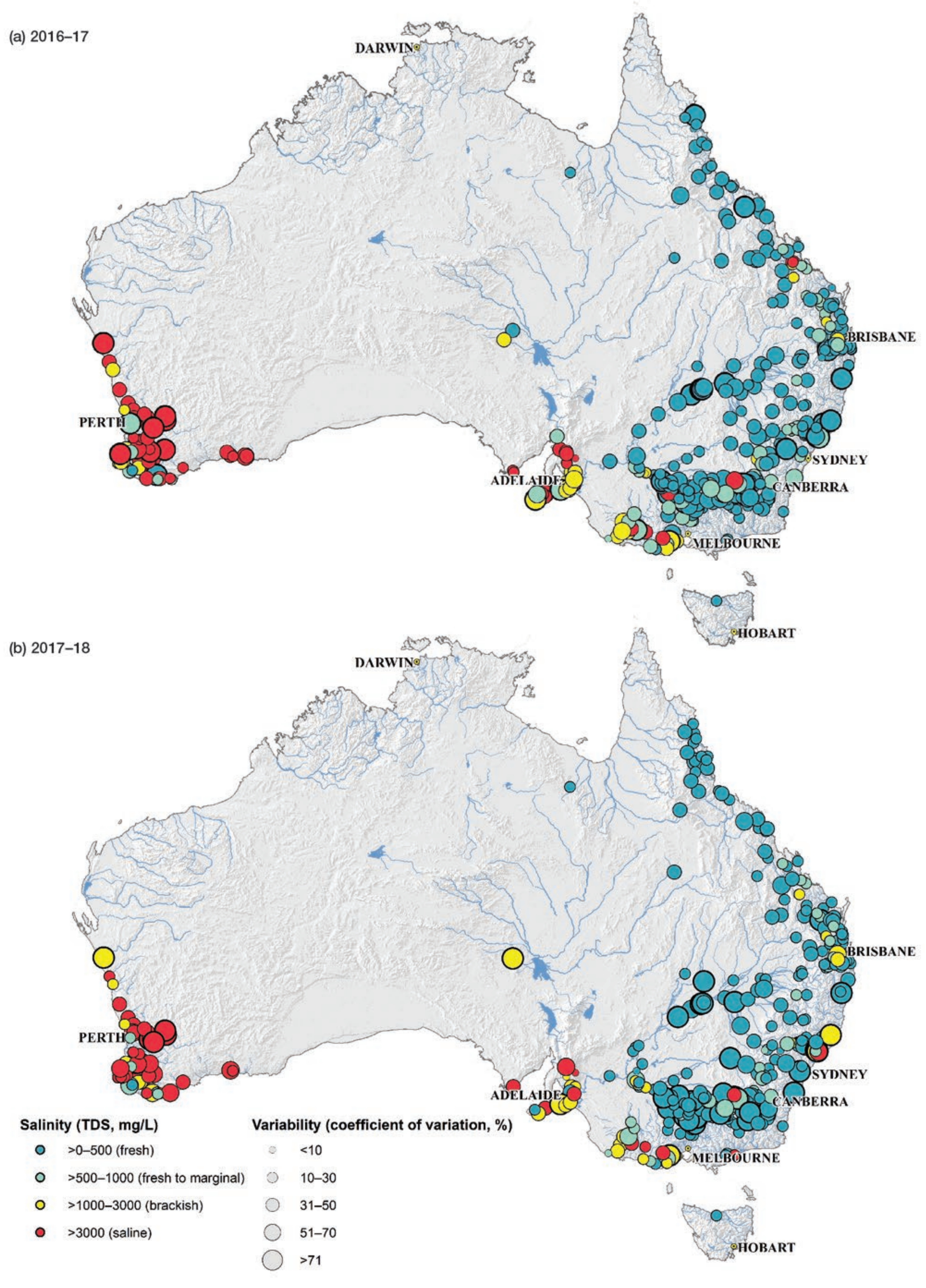



Figure 10. Distribution of median annual stream salinity and variability across Australia (a) 2016–17 (b) 2017–18

However, other characteristics can further affect the suitability of the water for particular purposes; for example, pH, alkalinity, nutrient levels, metals, presence of algae or the interactions between constituents.

As with previous years, the sites with fresh median water salinities were mostly located in areas with higher rainfall, along the east coast (Figure 10). Eighty per cent of the 164 sites in New South Wales and the 97 sites in Queensland had fresh median water salinities.

Like last year, median streamflow salinities within the Murray–Darling Basin were mostly fresh. Salinities tended to be higher in the lower reaches of the River Murray.

In contrast, many streams in Western and South Australia were brackish or saline. In Western Australia, the majority of flows at the analysed monitoring sites continued to be brackish or saline in 2017–18. About 64 per cent were saline, with total dissolved solids (TDS) higher than 3000 mg/L, and 19 per cent were brackish, with TDS concentrations between 1000 and 3000 mg/L.

Similarly to 2016–17, 27 per cent of the 18 sites analysed in South Australia recorded saline water and 44 per cent recorded brackish water. Such salinities (>1000 mg/L TDS) can restrict water use, affect crop yield and reduce land productivity. They could also pose risks to infrastructure and streamflow ecology, and incur significant costs associated with improving water quality.

### 2.3.3 Changes in median stream salinity

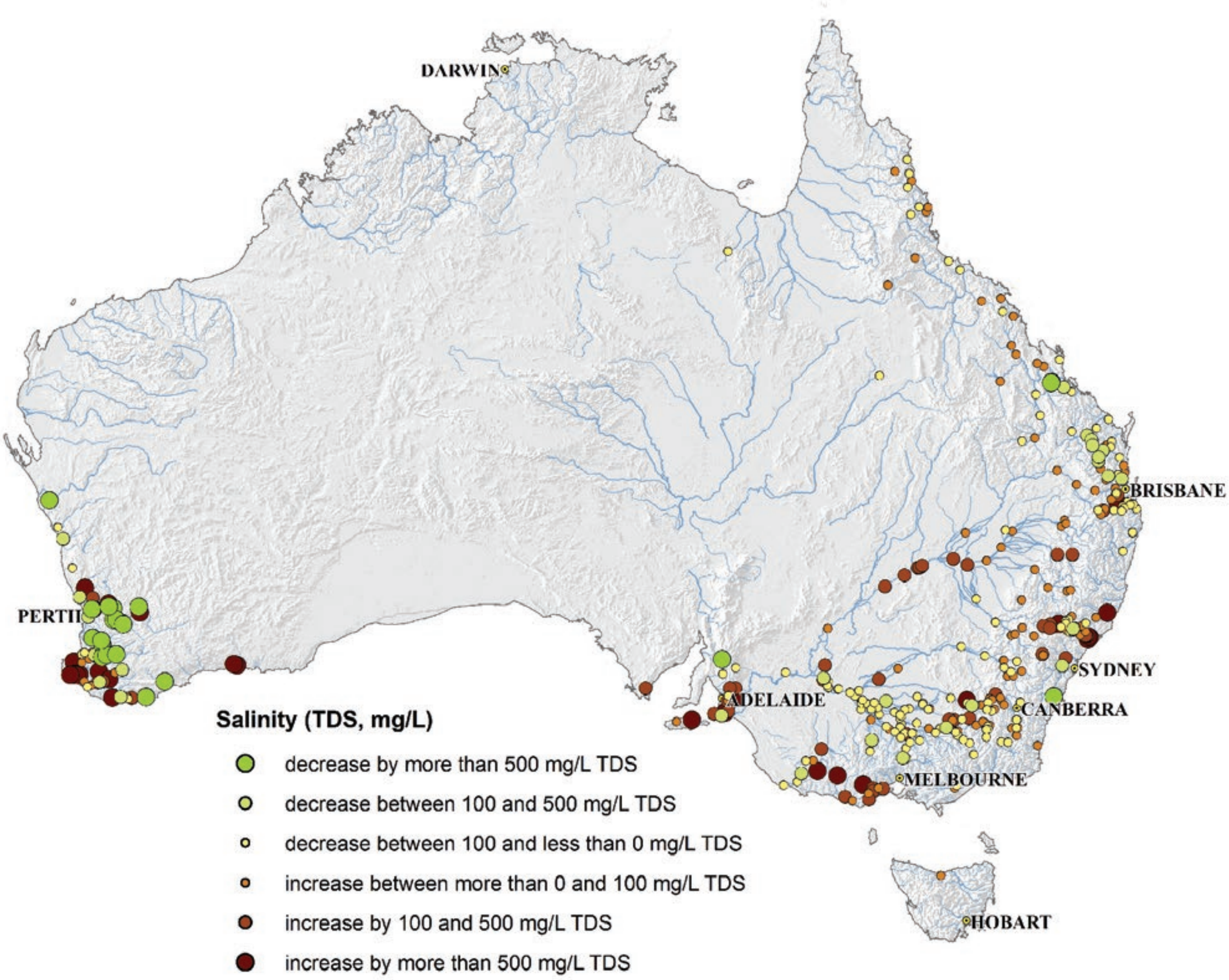
At individual sites, streamflow salinity typically changes over time due to complex flow and salinity dynamics. The variability index shown in Figure 10 gives an indication of the varying nature of the streamflow–salinity relationship. Broadly, the variability of stream salinity was high along the River Murray and Darling River and some of their headwaters as well as in some rivers in Western and South Australia and the southern parts of East Coast. The extent of the variability of stream salinity depends heavily on the relationship between the build-up and availability of sources of salinity and the frequency and nature of flushing events. The dynamics are also affected by the fluctuations in river flow and thus hydro-climatic drivers, groundwater–surface water interactions and groundwater salinity that result from interactions between climate and water use.

While an example of the changing streamflow–salinity relationship due to the dry conditions is shown in Figure 12, the attribution of driving factors is subject to site-specific investigations and beyond the scope of this report.

Figure 11 shows the changes in median streamflow salinity from 2016–17 to 2017–18. Data used for the comparison were from 364 gauging stations that had reliable data for both years. Compared with 2016–17, in 2017–18 there were eight fewer sites with median salinities that were fresh, or fresh to marginal, and six more sites that were saline.

Twenty-seven per cent of the sites showed a decrease of 100 mg/L TDS or less. A decrease in stream salinity of more than 500 mg/L TDS was observed at only five per cent of the monitoring sites. An increase of up to 100 mg/L TDS was observed for 29 per cent of monitoring sites. Nine per cent, or 31 sites, displayed an increase of more than 500 mg/L TDS.

Typically, prolonged dry periods can alter the natural flow regime and patterns of water quality constituents. Broadly, with less water available in 2017–18, streamflow salinity increased within the rainfall-deficient areas of the Darling River catchment as well as in some headwater catchments of the River Murray and the Hunter River (Figure 11a). Increased median stream salinities were generally the result of more frequent occurrences of higher salinity concentrations. They also corresponded with the lack of high, diluting flows.




(b) Number of sites in each salinity category

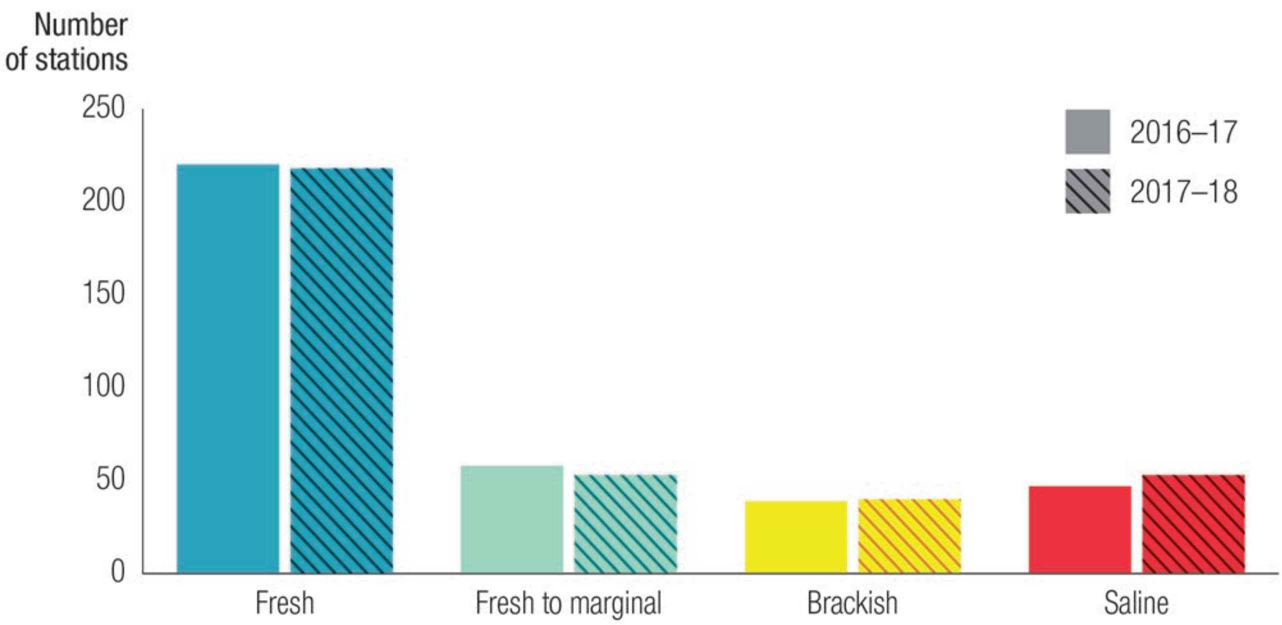



**Figure 11. Changes in median streamflow salinity at 364 monitoring sites from 2016–17 to 2017–18 (a) map (b) by salinity category**

Figure 12 illustrates this effect in the upper Hunter River catchment, which discharges to the sea at Newcastle. Figure 12 compares the discharge–salinity relationship during the prolonged dry conditions in 2017–18 with the wetter 2016–17. Flows from three headwater catchments of the unregulated Goulburn River (site 210006), the Merriwa River (site 210066) and the Wybong Creek (site 210040) exhibited a high variability in salinity. During low flow conditions, salinity was much higher in 2017–18 than in 2016–17. For example, in the Goulburn River the maximum salinity increased from 825 mg/L TDS in 2016–17 to 1625 mg/L TDS in 2017–18.

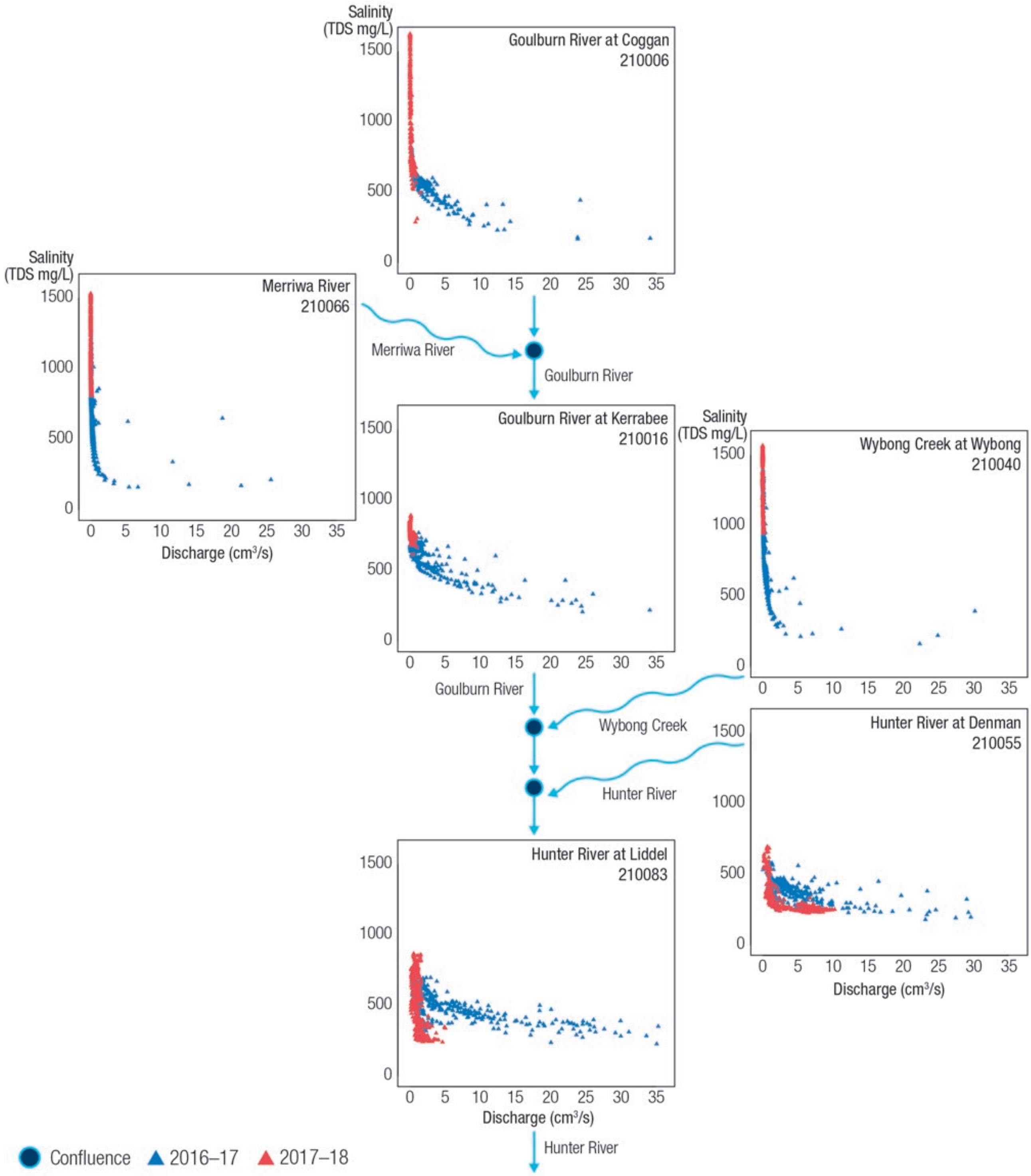



**Figure 12. Propagation of streamflow salinity in the upper Hunter River catchment—comparison between the years 2016–17 (in blue) and 2017–18 (in red)**

The latter year also lacked high flows to dilute the high salinity. However, salinity did decrease further downstream on the Hunter River due to storage releases from Glenbawn Dam (site 210055) despite the lack of natural high-flow events.

Similarly, rivers in South Australia, such as the North Para River and rivers contributing to Lake Alexandrina and the Murray Mouth, showed a large increase in salinity over the year, possibly due to larger contributions of salty groundwater inflows. Large increases in stream salinity also occurred in southwestern Victoria in areas where streams are naturally salty. Reduced flows caused salinity increases in the Dundas, Hopkins and Woady Yaloak rivers.

Low winter rainfall and streamflow also caused the salinity of some southern Western Australian rivers to increase (such as the Blackwood River and some tributaries of the Collie River). However, more rainfall and streamflow contributed to a decrease in salinity in the inland parts of this area (for example, the Avon River flowing into the Swan River).

Record high rainfall in many parts of Queensland in October 2017, together with the above-average summer rainfall, resulted in salinity decreases in the Brisbane and Burnett rivers. Slight decreases in salinity along the Murrumbidgee River, the Coleambally River and the River Murray arose from heavy summer rainfalls, particularly in December 2017. For some parts of the River Murray, higher-than-average streamflows continued for much of the summer.

### 2.3.4 Exceedance of 500 mg/L salinity

Figure 13 shows exceedance of 500 mg/L TDS at stream monitoring sites in 2016–17 and 2017–18. Broadly, areas with a decrease in stream salinity from 2016–17 to 2017–18 showed more frequent exceedance of the 500 mg/L TDS in 2017–18; for example, some streams north of Brisbane. Along the Darling River as well as in southern Victoria, the dry conditions also meant more frequent occurrences of less fresh water.

For Western Australia and some parts around Adelaide, the reduced stream salinity only marginally corresponded with better water quality as the water is naturally salty.

## 2.4 GROUNDWATER

### 2.4.1 Overview

Globally, the volume of groundwater is estimated to be 13 times 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, while Australians know about the water in our lakes and rivers, many are unaware of the vital role groundwater plays in Australia's water supply. In many regions, groundwater is the only reliable water source. Numerous townships, farms and mines, particularly in the outback, rely almost completely on groundwater. 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. It also supports groundwater-dependent ecosystems across the nation, as shown in the Groundwater Dependent Ecosystem Atlas.[12]

The sustainability of groundwater use is subject to the pressures of climate, extractions and population growth. Sustainable extraction of groundwater must balance against the recharge of the resource and interaction with groundwater-dependent ecosystems. Recharge rates are typically very small compared to the volumes in the aquifer. Also, groundwater is often saline, which reduces its suitability for use. Consequently, desalination of groundwater is becoming more common across the country.

Over time, water from rain and rivers travels through the ground and collects in underground rock fractures or between grains of sediment. The layering and structure of aquifers and aquitards makes up the groundwater system and dictates how water flows below the ground and interacts with rivers, wetlands and vegetation at the surface. The groundwater analysis presented here is a simplified representation of the three-dimensional groundwater systems across Australia—they are aggregated into upper, middle and lower aquifer groups, as presented in Australian Groundwater Insight.[13]

12 www.bom.gov.au/water/groundwater/gde/map.shtml
13 www.bom.gov.au/water/groundwater/insight

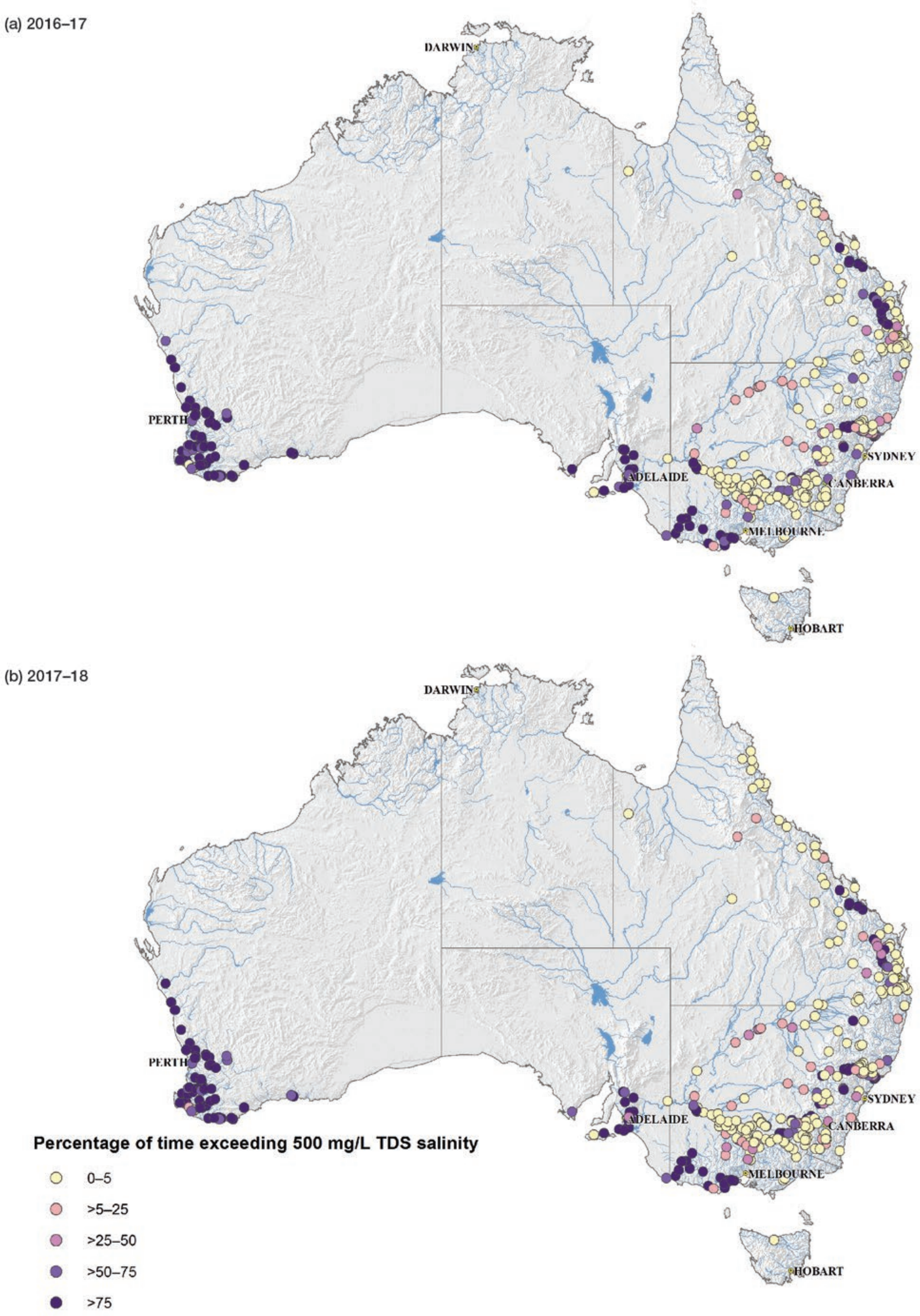



Figure 13. Exceedance of 500 mg/L TDS at stream monitoring sites (a) 2016–17 (b) 2017–18

### 2.4.2 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 2013 to June 2018 to assess changes in groundwater level. In addition, a status analysis compares the average groundwater level in 2017–18 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 2013–18 trends reflected several factors that influence groundwater, including climate, land use and extractions. Areas that have experienced wetter conditions, such as southwestern Australia and Queensland's east coast, had a higher number of bores with above-average levels and rising trends in 2017–18 than in 2016–17. Areas that experienced drier conditions, such as the Murray–Darling Basin, had a higher number of bores with below-average levels and declining trends. Areas of high groundwater extraction (for example the upper and middle alluvial aquifers in the east of the Murray–Darling Basin) tended to show declining trends and below-average status regardless of climate. 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.

Figure 14 shows the distribution of groundwater level status and Figure 15 shows the distribution of groundwater level trends at bores across Australia based on upper (a), middle (b) and lower (c) aquifer groups, respectively. Over 17 000 bores were used for the analyses, a decrease from the over 19 000 bores used in the 2016–17 assessment. This decrease, in part, reflects decreased monitoring frequency as States rationalise their monitoring program.

Across Australia, 72 per cent of upper aquifer bores had below-average to average status. The five-year trends in upper aquifer groundwater levels were mostly stable (46 per cent) or declining (36 per cent). Only 17 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 the 2016–17 assessment, the percentage of bores across Australia with below-average status increased in 2017–18. This increase was from 26 to 28 per cent in the upper aquifer, 34 to 38 per cent in the middle aquifer, and 30 to 43 per cent in the lower aquifer. This change reflected recent lower-than-average rainfall across much of the eastern States, which led to higher extraction from groundwater and potentially lower recharge.

While the data showed a change towards declining groundwater levels, the results varied spatially. For example, groundwater status in the southwest of Australia showed a shift from declining to stable trends, and from below-average to average status, when compared to the 2016–17 results. This is most pronounced in the upper aquifer, where 24 per cent of bores had below-average status compared to 34 per cent in the 2016–17 assessment. This change reflected the recent higher rainfall experienced in southwest Western Australia.

Similarly, bores in the Darwin Rural Water Control District showed a uniform change from below-average status and declining trends to above-average status and increasing trends, despite lower-than-average rainfall in the top end. This change may be due to changes in the licensing of stock and domestic bores in the region. It may also be due to a late wet season making the data appear higher at the end of the assessment period and influencing the trend analysis.

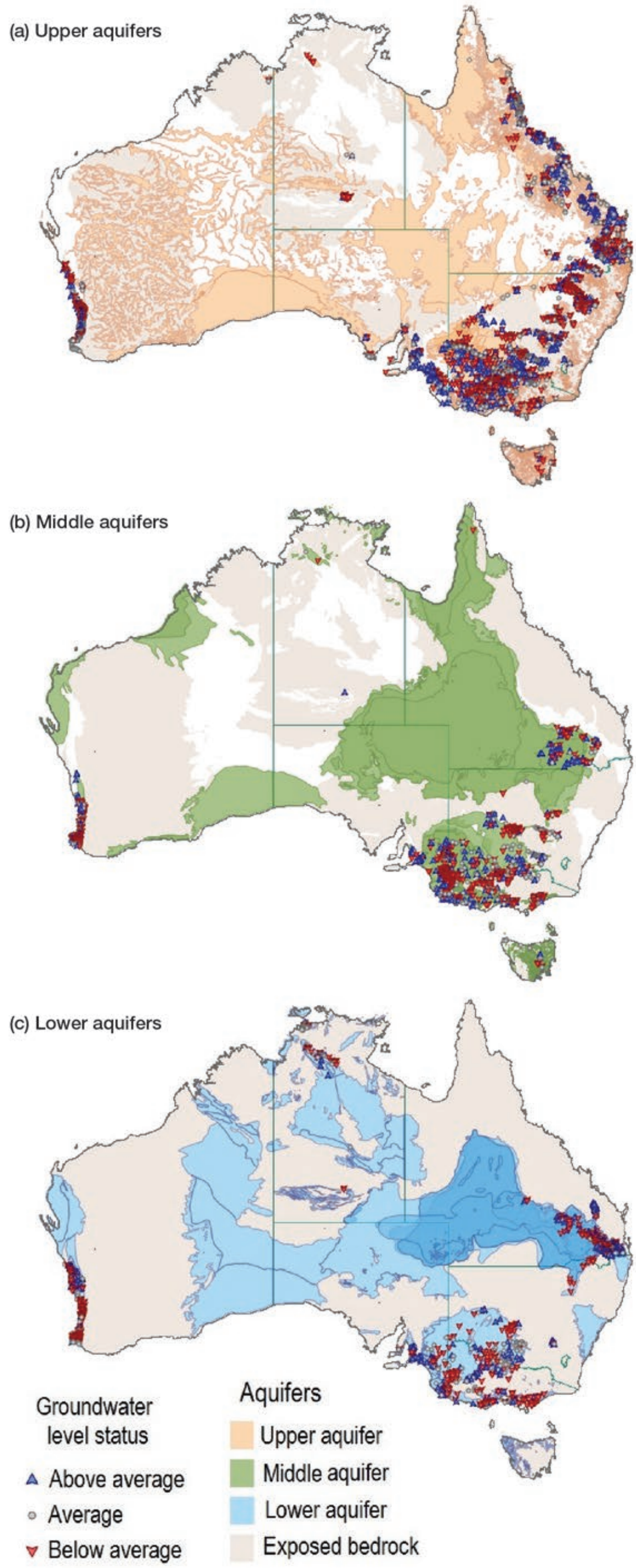



Figure 14. Groundwater level status in 2017–18 compared with previous 20 years for (a) upper, (b) middle and (c) lower aquifers

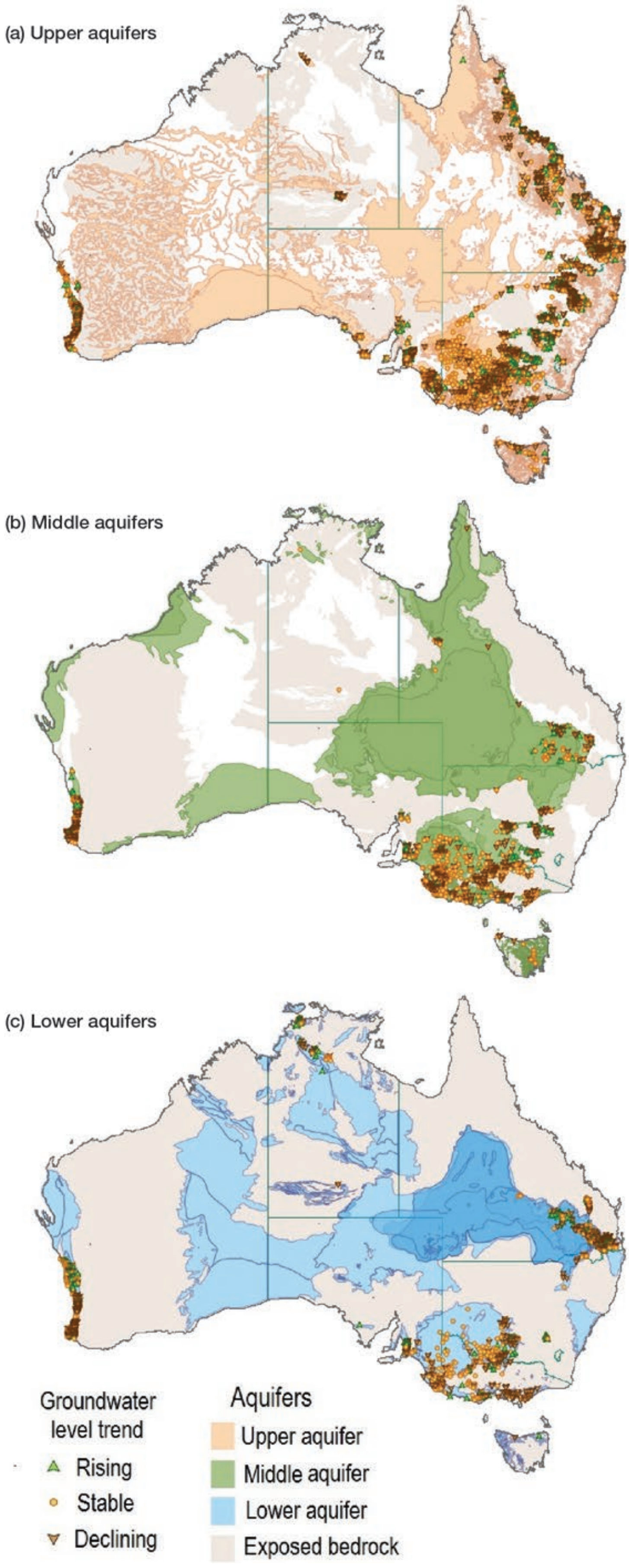



Figure 15. Groundwater level trends from July 2013 to June 2018 for (a) upper, (b) middle and (c) lower aquifers

Figure 16 summarises groundwater level and status by aquifer group for each State and Territory, for 2016–17 and 2017–18. The change in distribution across these years varied by State and aquifer. New South Wales, Queensland and South Australia all showed similar distributions in both years, with a slightly higher proportion of bores showing a stable trend or average status in 2017–18 compared to 2016–17. Victoria showed a shift towards more bores having below-average status, especially in the middle aquifer in 2017–18. Western Australia showed far fewer bores with below-average status, as well as fewer with declining trends.

This reflected the wetter conditions experienced in southwest Western Australia, which eased pressure on groundwater resources. The Northern Territory showed a great increase in the number of bores in the lower aquifer that had a rising trend and average status. Many of these bores were located in rural Darwin and reflected the late wet season in 2018 and later than usual groundwater recharge peak. The upper aquifer in the Northern Territory showed a dominant trend of below-average status and declining trends. However, unlike the other States, more bores were available for the 2017–18 analysis in the Northern Territory, so the two datasets are not directly comparable.

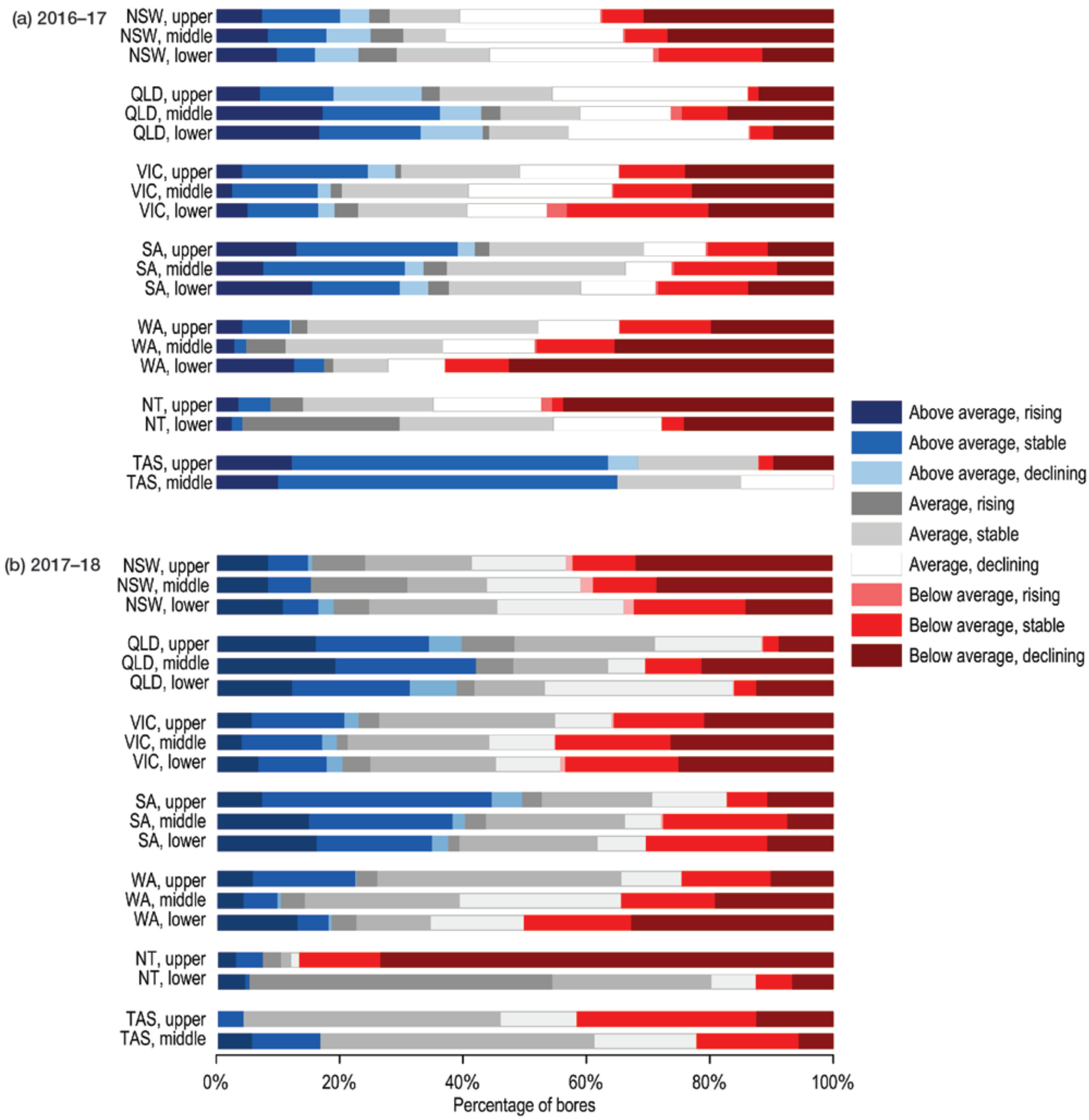



**Figure 16. Summary of groundwater level status and trends by State and Territory (a) 2016–17 (b) 2017–18**

## 2.5 ALTERNATIVE WATER SOURCES

### 2.5.1 Desalinated water

Urban centres across Australia face the challenges of growing populations and dwindling storage volumes. Climate-resilient water sources such as seawater desalination and water recycling have been introduced to improve the security of urban water supplies in dry periods.

Australia has around 270 desalination plants, mostly small scale, to desalinate marine and brackish water for various uses.[14] The five major urban centres in Australia have a total seawater desalination capacity of 534 GL per year (Table 4).

Due to a steady decline in streamflows to Perth water storages over the past four decades, a major desalination plant was built in 2006 followed by a second in 2013. In 2017–18, both plants were running slightly over the rated capacity with about 149 GL desalinated water being sourced. Perth now relies less on surface water storages, and desalination and groundwater are the major sources of urban water supply.

Adelaide sourced around 4 GL of desalinated water, which accounted for 3 per cent of the total urban water sourced and was similar to last year.

In Victoria, desalinated water was first sourced in 2016–17. The contribution from the desalination plant in 2017–18 was 15 GL, in comparison to 46 GL in 2016–17. The plant has a capacity to deliver 150 GL per year. Melbourne Water has issued a non-binding forecast of the volume of desalinated water required by 2019–20 and 2020–21 as 100 GL and 125 GL, respectively, based on their future streamflow projections (Melbourne Water, 2018a).

The Sydney supply system desalination plant at Kurnell produced water from 2010 to 2012 and was not used again up to the end of June 2018 due to improved water availability in the urban water storages. In fact, the plant was unable to operate following significant storm damage in 2015, which had not yet been fully repaired. Even if the repair had been completed before June 2018, the desalination plant would not have been activated despite the fall in the accessible storage from 93 to 68 per cent of capacity. The plant is only brought into operation when the storage volume drops below 60 per cent.

In South East Queensland, 2.8 GL of desalinated water was produced—about 1 per cent of total urban water sourced and about 6 per cent of the plant's capacity.

14 www.water.vic.gov.au/water-grid-and-markets/victorian-desalination-project/desalination-background/desalination-history

**Table 4. Desalination plants located in major urban centres[15]**

| Urban centre | Built | Approximate capacity (GL/year) | Supply in 2017–18 | | Comments on plant operation |
|---|---|---|---|---|---|
| | | | (GL) | (% of total urban water sourced)[16] | |
| Perth: Seawater Desalination Plant | 2006 | 45 | 149 | 52 | Both desalination plants were running close to their capacity in 2017–18 and supply was similar to that of the previous year. |
| Perth: Southern Seawater Desalination Plant | 2013 | 100 | | | |
| Adelaide | 2012 | 100 | 4.3 | 3 | In 2017–18 the desalination supply was similar to that of previous year. |
| Melbourne | 2012 | 150 | 15 | 3 | Desalinated water was ordered for the first time in 2016–17. The contribution from desalination declined in 2017–18. |
| Sydney | 2010 | 90 | 0 | 0 | The plant operates when the storage capacity falls below 60 per cent.[17] No desalinated water has been used to meet requirements since 2012. |
| Gold Coast | 2009 | 49 | 2.8 | 1 | Operates in a 'hot' standby mode. |

15 www.awa.asn.au

16 www.bom.gov.au/water/nwa/2018

17 www.sydneydesal.com.au

### 2.5.2 Water recycling

Water recycling involves treating wastewater to a suitable standard so that it can be used for beneficial uses such as irrigation of public places, non-potable domestic uses, agricultural irrigation, industrial uses and groundwater recharge. Water recycling is attractive in situations where available sources cannot meet the growing demand. Another advantage is its reliability of supply: water is consistently available throughout the year as it is produced from wastewater flow from the cities. Water recycling also protects the environment by reducing the amount of treated wastewater discharged to the receiving waters. However, reuse of recycled water can vary significantly based on its end use applications.

Recycled water use in 2017–18 was over 60 per cent greater than the 70 GL used in 2010–11 in the major urban centres, which clearly indicates that the demand for recycled water is increasing. This demand will grow as new housing estates in many metropolitan growth corridors are now adopting dual pipe systems to supply recycled water.

In 2017–18, recycled water use increased in most of the urban centres in comparison to 2016–17; the exceptions being South East Queensland and Canberra. The total volume of recycled water sourced for the major urban centres was 112 GL, an 8 per cent increase from the previous year's total. Recycled water use increased by 34 and 31 per cent in Adelaide and Perth, respectively. In Canberra and South East Queensland, on the other hand, water recycling declined by 47 and 33 per cent, respectively. Among all the major urban centres, Melbourne had the highest recycled water use of 44 GL, about 40 per cent of the total recycled water use of all the major urban centres.

As reported in *Water in Australia 2016–17*, stage 1 of Perth's Groundwater Replenishment Scheme commenced in 2017–18. It has already recharged more than 7 GL of recycled water, purified to Australian drinking water standards, into the groundwater system for future reuse. The scheme has the capacity to recharge up to 14 GL of water into Perth's groundwater system. The expansion of the system to double its capacity to 28 GL is currently under way. It is expected that 20 per cent of Perth's water supply will be supplied from groundwater replenishment by 2060 (Water Corporation, 2017).

### 2.5.3 Stormwater

Stormwater harvesting and reuse technology is recognised as providing an important urban water resource that has excellent potential to boost urban water supply volumes. While some large-scale operations are operated by utilities, such as the managed aquifer recharge systems of the South Australian Water Corporation (SA Water) around Adelaide, most stormwater capture and reuse systems are operated by local council bodies.[18]

Metering, measuring and reporting stormwater reuse volumes, therefore, falls outside the national water resource reporting systems. Consequently, there is no national set of consistently measured, collected or reported data on urban stormwater capture or reuse.

Very few stormwater or recycled water systems have performance data systematically collected or reported. Exceptions include the managed aquifer recharge and aquifer storage and recovery systems around Adelaide, which are reported on by SA Water. During 2017–18, 202 ML of stormwater was identified as reused or returned to groundwater across four systems: Mawson Lakes, Airport, Barker Inlet and Lochiel Park. This 202 ML represented just 0.1 per cent of the volume supplied to Adelaide in 2017–18.[19] Approximately 58 per cent (118 ML) was recharged into groundwater, 41 per cent (83 ML) was reused for commercial and industrial purposes, and the remainder (about 1 ML) from the Mawson Lakes system was used for residential purposes.

While the 202 ML of stormwater use reported for 2017–18 represents just 0.1 per cent of the total volume of water supplied to Adelaide in that year, stormwater reuse through the managed aquifer recharge and aquifer storage and recovery systems is expected to increase in future. The capacity of these four systems is estimated at 20 GL per year, which is about 10 per cent of the total amount currently supplied to Adelaide per year. The target is to increase the full capacity of stormwater reuse to 60 GL per year, or 30 per cent of the total volume of water supplied to Adelaide.

18 https://research.csiro.au/mar/using-managed-aquifer-recharge [Accessed 25 February 2019]

19 www.environment.sa.gov.au/topics/water/resources/stormwater [Accessed 25 February 2019]

## 2.6 THE 2017–18 DROUGHT IN THE MURRAY–DARLING BASIN

### 2.6.1 Overview

The Murray–Darling Basin (Figure 17) covers 14 per cent of Australia and is home to two million people. It has a highly variable climate and hydrological conditions that differ greatly across both time and space. Drought, a familiar phenomenon in the Murray–Darling Basin, presents a risk to ecosystems, agriculture, industry and communities. One of the longest and most severe droughts in the observed recorded history of the basin was the Millennium Drought from 1998 to 2009, with a peak from 2001 to 2009 (Bureau of Meteorology, 2015). The basin also experienced drought conditions in 2017–18.

The Murray–Darling Basin has a highly variable rainfall pattern that is strongly influenced by climate drivers. Despite this large natural variability, underlying long-term trends are evident and there has been a shift towards drier conditions across much of the basin. Changes in rainfall patterns and the coincidence of low rainfalls have led the Basin into drought. The contributing factors are a mixture of consistently rising temperatures and deficits in rainfall (which have placed additional moisture stress on many systems within the region), lower-than-average streamflows and declining groundwater levels.

Soil moisture, streamflows and groundwater levels all reflect the impact of the 2017–18 drought and how this year and the preceding six years (July 2013 to June 2018) compare to the peak Millennium Drought. In some areas the impacts of the 2017–18 drought were more severe than those of the Millennium Drought. These factors and impacts are discussed in the following subsections.

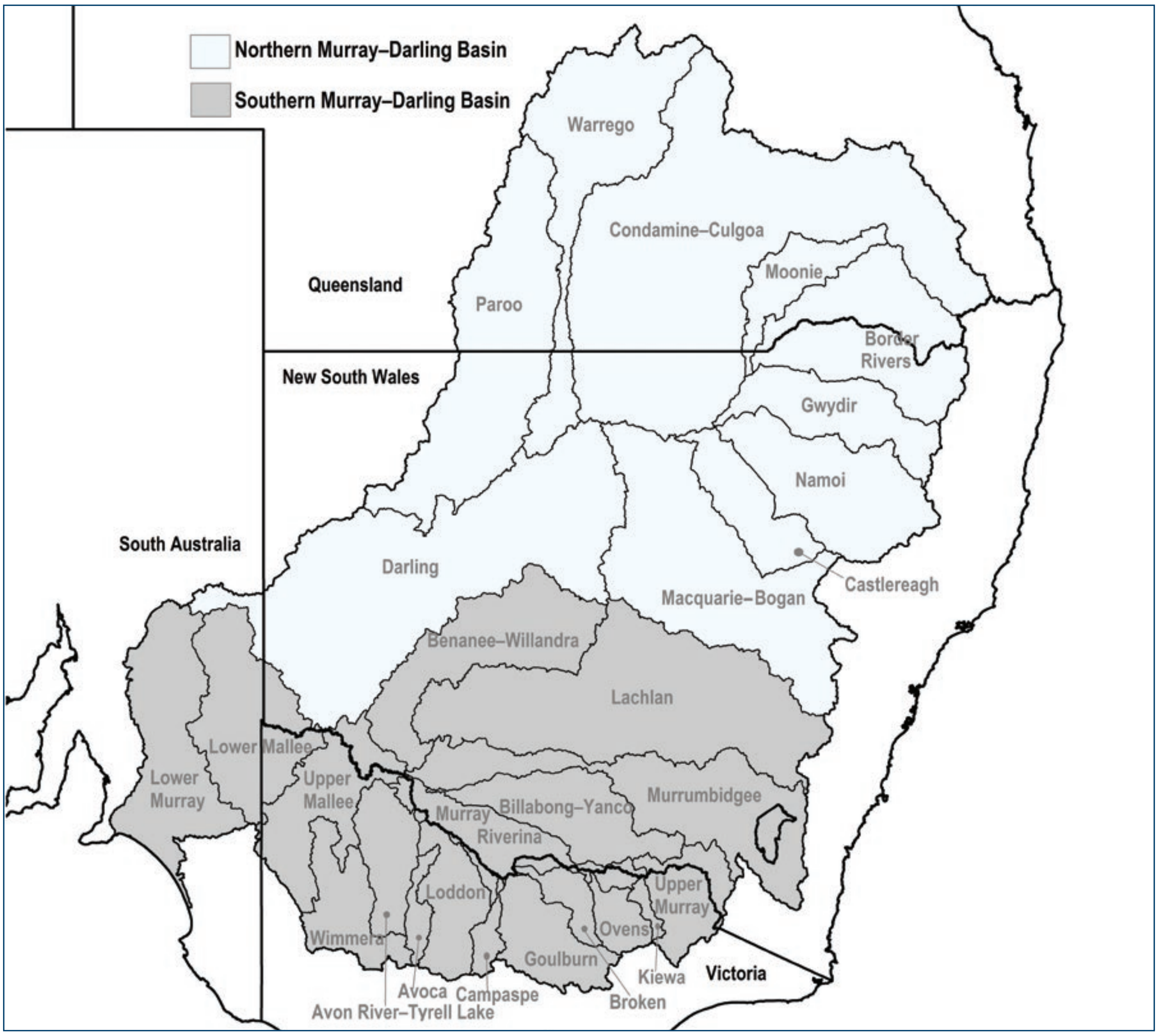



Figure 17. Northern and southern Murray–Darling Basin and sub-basins

## 2.6.2 Rainfall

Dry conditions started to develop in many parts of the Murray–Darling Basin from late 2016. The year 2017–18 was especially dry across much of the basin. The annual rainfall was 340 mm, 28 per cent below the long-term mean of 469 mm (Figure 18). This was the eighth-lowest rainfall on record since 1911 and the lowest since the Millennium Drought.

The 2017–18 year was part of a dry period between 2012–13 and 2017–18 with low mean annual rainfall (417 mm) that was close to the mean rainfall for the peak period (411 mm) of the Millennium Drought (2001–2009) (Bureau of Meteorology, 2015).

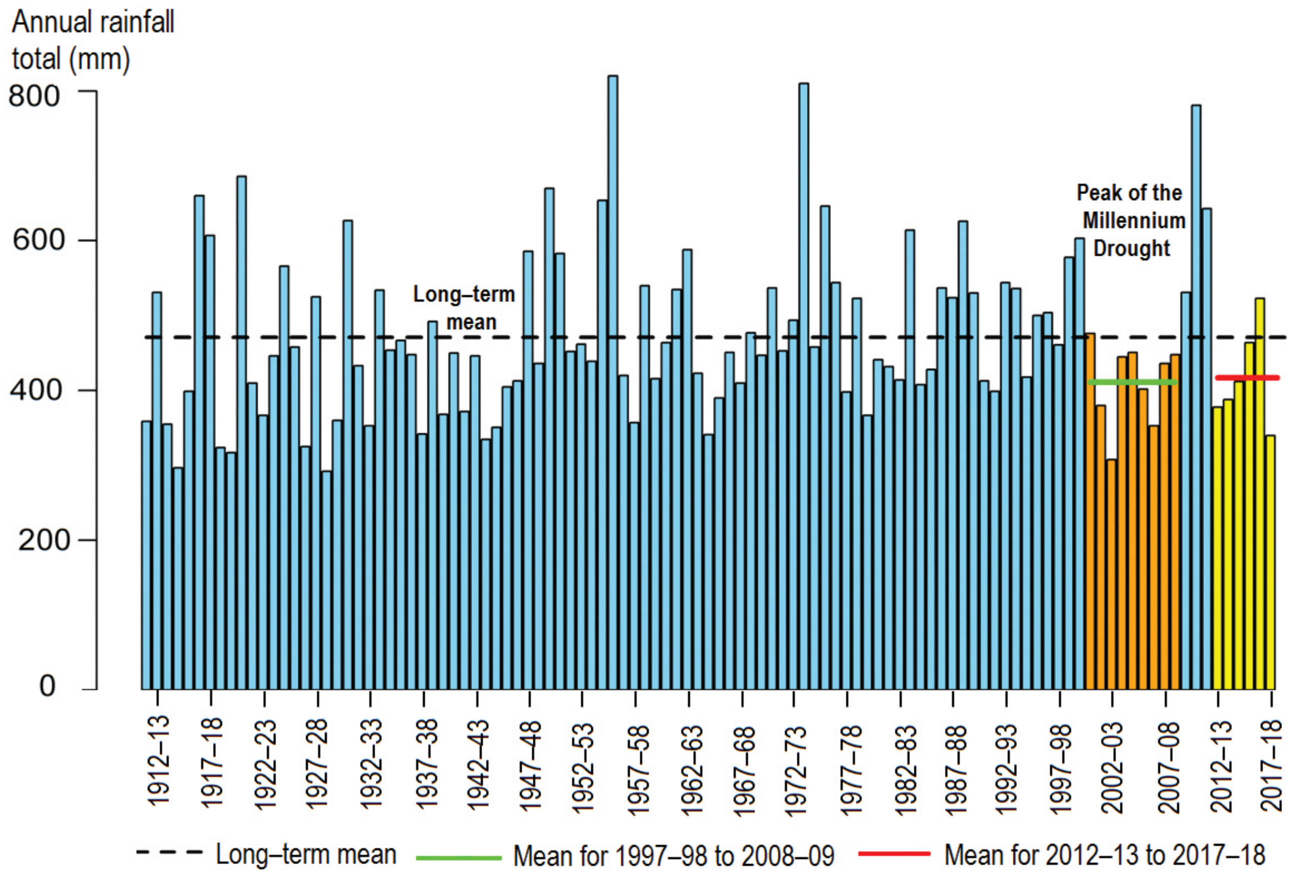



Figure 18. Annual rainfall totals in the Murray–Darling Basin, July 1911 to June 2018

One way to measure the extent and severity of drought is in terms of rainfall deficiencies. During 2017–18, rainfall was very much below average and around half the Basin observed rainfall deficiencies. Figure 19a shows that severe rainfall deficiencies (in the lowest five per cent) were observed across 16 per cent of the basin, and an additional 32 per cent of the area had serious deficiencies (in the lowest five to ten per cent). The most affected areas extended over most of New South Wales and much of southern inland Queensland. Deficiencies were mostly concentrated in the north and did not affect the Victorian part of the basin.

The combination of several dry years from 2012–13 with a very dry 2017–18 had resulted in long-term rainfall deficiencies. During this 72-month dry period (July 2012 to June 2018), severe rainfall deficiencies extended across 16 per cent of the basin, and an additional 28 per cent of the basin experienced serious deficiencies (Figure 19b).

The affected areas were more widespread in the southern part of the basin than in 2017–18. They covered two large parts of inland Queensland (the Paroo and Warrego catchments and the upstream part of the Condamine catchment), parts of New South Wales (Lachlan and Murrumbidgee catchments), and much of central and western Victoria (Upper Murray and the Upper and Lower Mallee catchments).

The spatial pattern of the rainfall deficiencies for the July 2012 to June 2018 dry period is very similar to that of the peak of the Millennium Drought (Figure 19c), having severe and serious deficiencies across 23 and 22 per cent of the basin, respectively. These very dry conditions were most intense in Victoria and southern New South Wales.

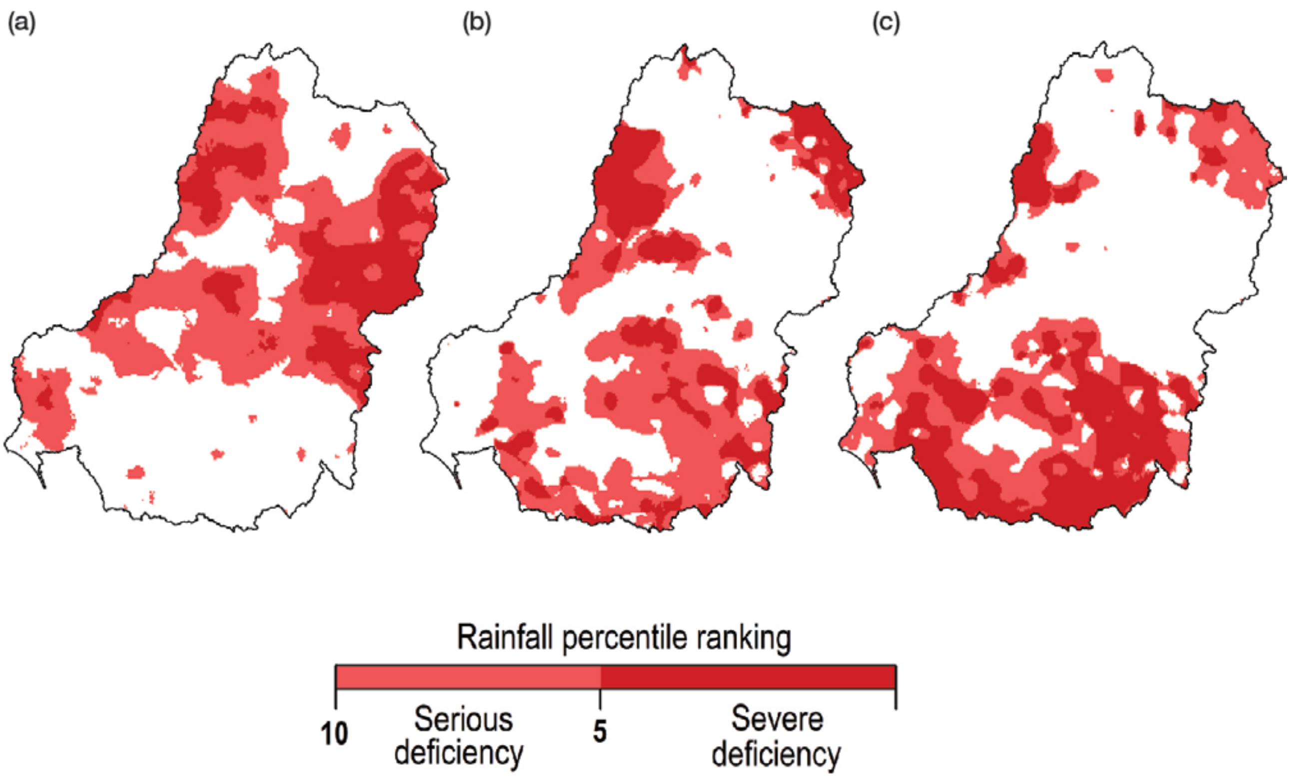



**Figure 19. Rainfall deficiency in the Murray–Darling Basin (a) 2017–18 (b) July 2012 to June 2018 (c) peak period (2001–2009) of the Millennium Drought**

### 2.6.3 Soil moisture

In 2017–18, the Murray–Darling Basin experienced a strong decline in root zone soil moisture content (estimated using the Australian Landscape Water Balance[20] daily soil moisture data from 10 to 100 cm of the soil profile), which is a direct impact of low rainfall.. The deficiency extended over most of the basin except large areas in the northern Condamine basin and most of Victoria (Figure 20). The deficiency in root zone soil moisture followed the trend of the rainfall but was more intense as soil moisture deficits accumulate over time.

Thirty-three per cent of the basin, mostly in New South Wales, suffered from severe soil moisture deficiencies and another 41 per cent experienced serious deficiencies. The most affected catchments were Border, Gwydir, Namoi, Castlereagh, Macquarie, Darling, Paroo and Warrego; these catchments were also found to have lower-than-average streamflow (section 2.6.4).

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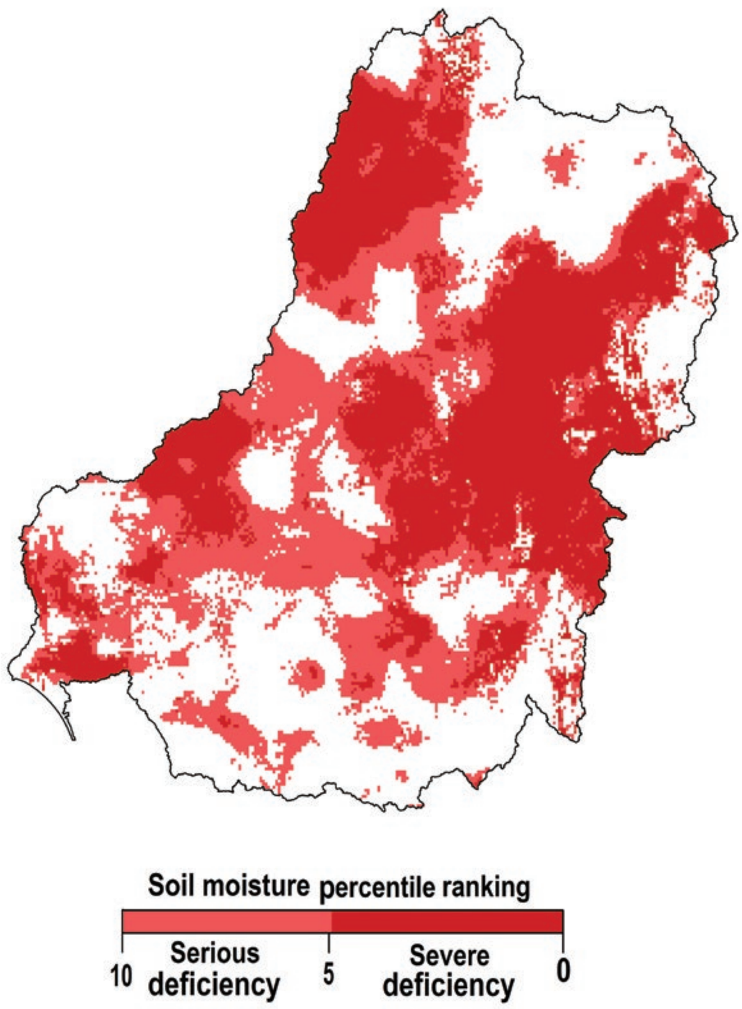



**Figure 20. Annual root zone soil moisture deficiency map for the Murray–Darling Basin in 2017–18**

### 2.6.4 Streamflow

Low rainfall in the last few months of 2016–17 led to dry antecedent conditions that continued until a record dry September 2017. This dry antecedent condition affected both the soil moisture levels and runoff generation in 2017–18, eventually resulting in a dominance of lower-than-average streamflow.

Fifty-six per cent of the streamflow gauged in the Murray–Darling Basin during 2017–18 recorded lower-than-average streamflow, and very few gauges exceeded the average decile category. During the previous six years, except for 2016–17, there was a gradual decline in the percentage of gauges exceeding average decile rankings (Figure 21). In three of the four years since 2013–14, lower-than-average flows were recorded at more than 50 per cent of the streamflow gauges.

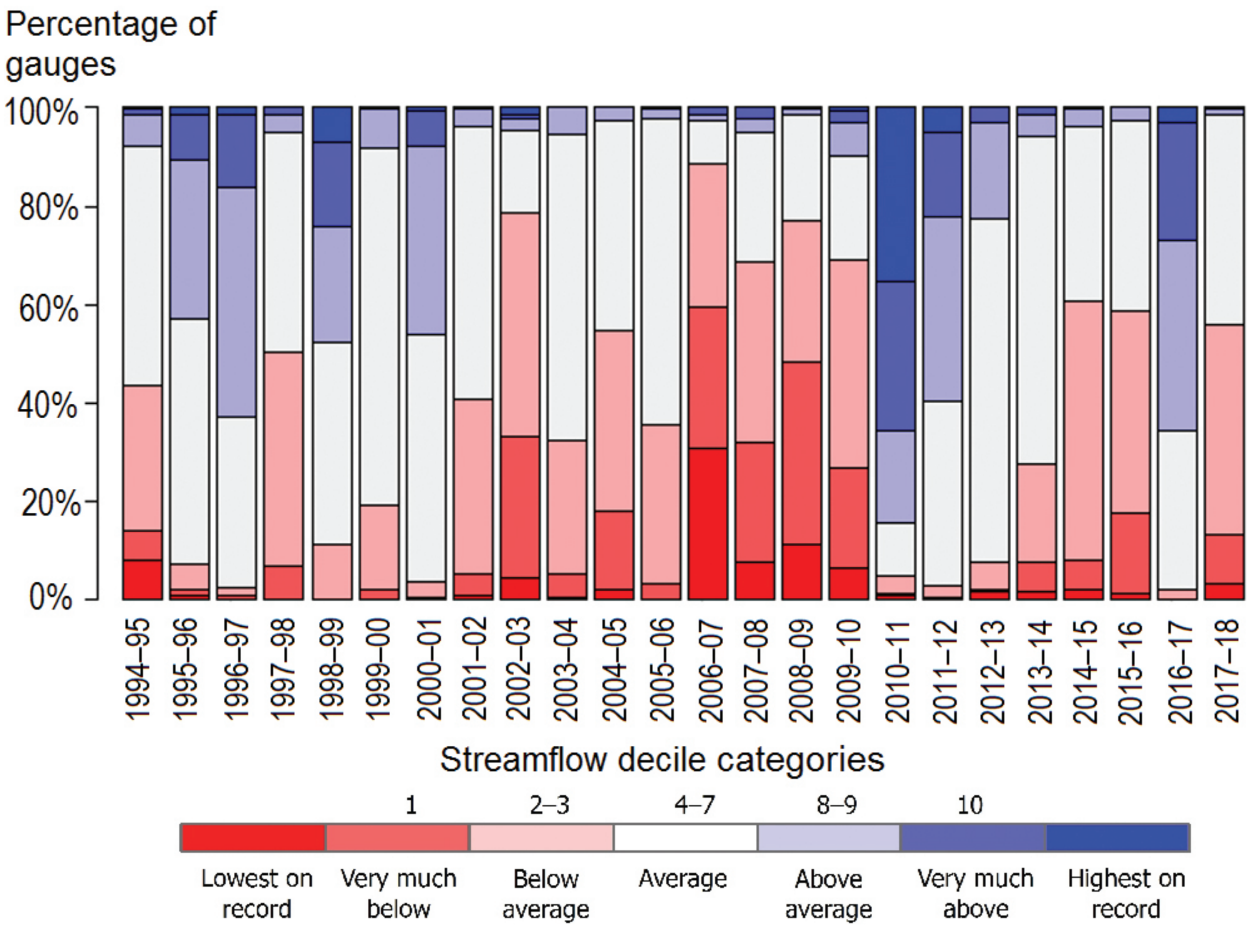



**Figure 21. Distribution of streamflow gauges in Murray–Darling Basin based on decile ranking categories, 1994–95 to 2017–18**

In 2017–18, below-average flows were evenly distributed across the basin and most of the very-much-below-average flows were in the northern part of the basin (Figure 22a). There was a wider range of streamflow decile categories during the dry period July 2012 to June 2018 (Figure 22b), but the general patterns were similar to 2017–18. The most affected areas recording lower-than-average flows in the northern basin were Border, Gwydir, Namoi, Macquarie, Castlereagh, Darling, Paroo and Warrego catchments, and mostly in their headwater areas. The affected areas in the southern basin were the Goulburn, Campaspe, Murrumbidgee and Ovens catchments. In the Namoi, 88 per cent of gauges recorded very-much-below-average flows between July 2012 and June 2018, while lower-than-average flows were recorded in one-third of gauges in the Murrumbidgee catchment.

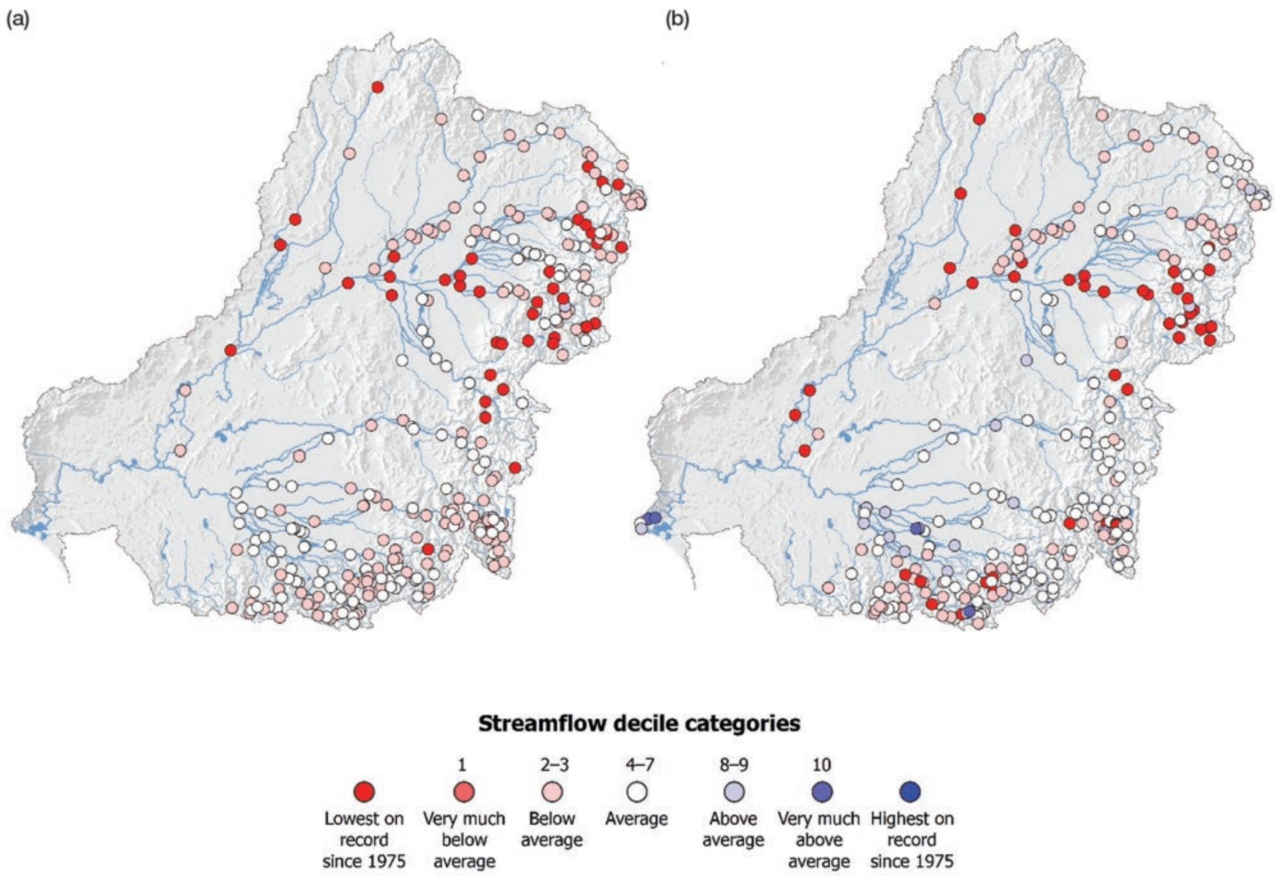



**Figure 22. Streamflow deciles in the Murray–Darling Basin (a) 2017–18 (b) July 2012 to June 2018**

The daily streamflow decile plot for the gauge at Wilcannia on the Darling River depicts the historical flow pattern since 1971–72; the Millennium Drought and the dry period over the past six years are quite distinct (Figure 23). Except for a very brief period of 2017–18, decile rankings were very much below average throughout the year, which continued the previous few years' dry condition, excluding 2016–17. In general, the Millennium Drought was more severe and extended over several years. However, a closer look reveals some difference in the timing of lower-than-average flow conditions.

During the Millennium Drought, low flow conditions were more common in cool season months (May to November), but this shifted towards the warm months (September to April) for the July 2012 to June 2018 period. This change in seasonal pattern can have a significant impact on stream and aquatic health. The low flows in warmer months are more likely to coincide with high temperatures that may lead to thermal stratification in stagnant water; a situation in which a warmer surface layer of water sits above a cooler, deeper layer of water with very low dissolved oxygen.

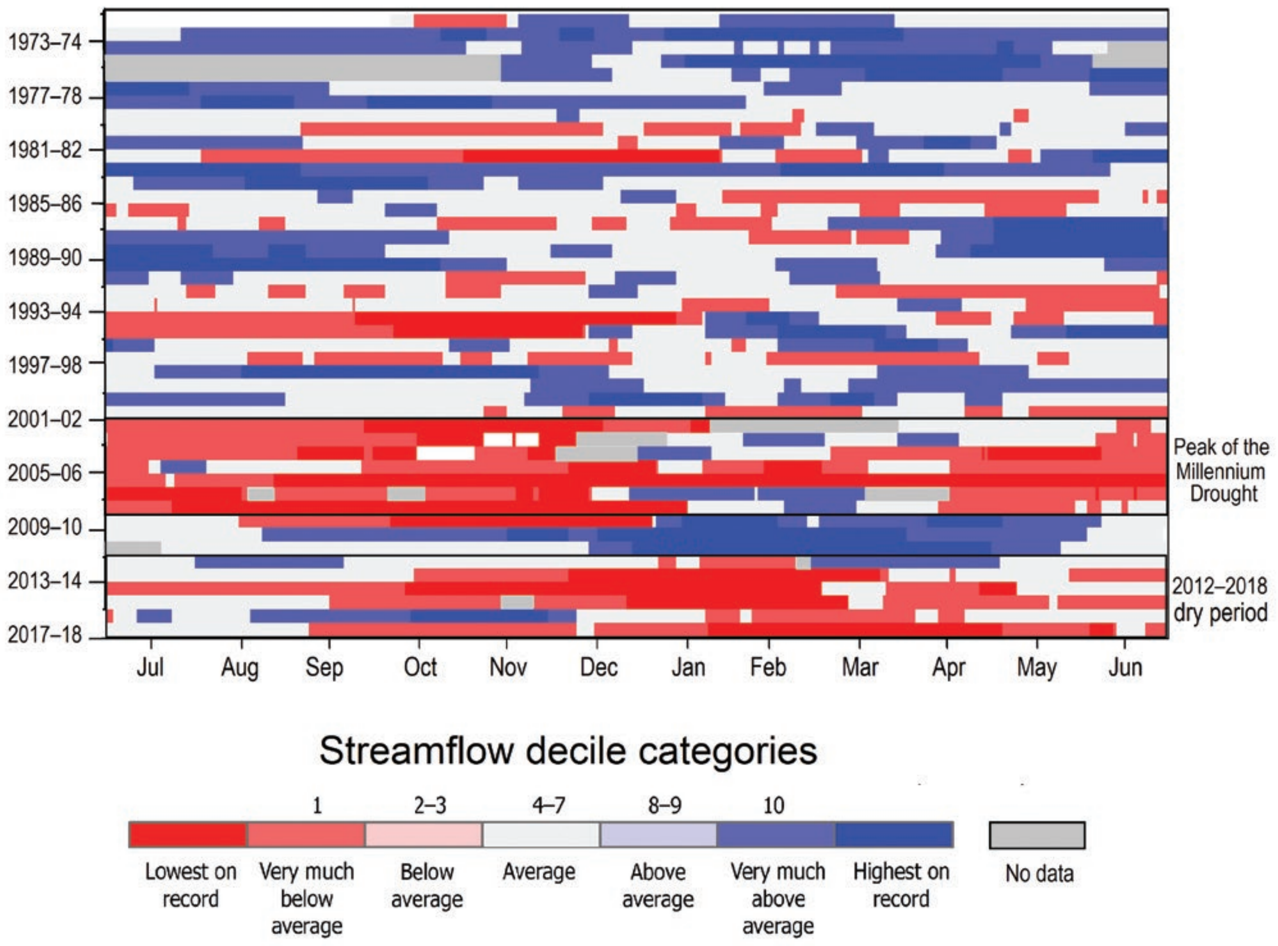



Figure 23. Daily streamflow deciles for inflows from upstream catchments measured at Wilcannia on the Darling River

### 2.6.5 Groundwater

Drought can also directly affect groundwater levels through reduced recharge from rainfall or surface water, and from increased groundwater extraction. Groundwater level recovery was assessed to understand the 2017–18 impact of the drought on groundwater in the Murray–Darling Basin.

Figure 24 shows the decile rankings of maximum groundwater levels across the basin during and after the spring of 2018. These decile rankings were created for each bore by identifying the maximum annual recovery peak in 2018 and comparing it to each recovery peak over the assessment period (1992–2018). Across all aquifers, 52 per cent of bores in 2017–18 were ranked lower than average, 20 per cent of these were ranked the lowest for the assessment period. Another 40 per cent ranked as average and only 8 per cent of bores ranked above average. This distribution of the bore status is broadly consistent across upper, middle, and lower aquifer groups.

Given the spatial correlation of low groundwater levels to areas of known extraction, it is likely that the primary impacts of the 2012–2018 dry period on groundwater levels of the Murray–Darling Basin arise from increased groundwater pumping rather than direct climate drivers. While both factors can decrease groundwater levels, recharge is far more likely to affect shallow aquifers, whereas pumping will affect all three aquifer groups.

The spatial variability of this ranking provides insights into the combined impact of dry conditions and extractions on groundwater recovery. Groundwater levels are also influenced locally by practices such as irrigation and salt interception, which may influence the data shown in Figure 24. Bores in the southeast of the Murray–Darling River Basin, such as Murrumbidgee and Murray–Riverina, tended to be lower overall, with many rankings the lowest for the assessment period. In these bores, the maximum recovery level is lower than at any time since 1992. This finding aligns with long-term rainfall deficiencies and lower-than-average streamflow patterns in the areas described above rather than directly with the 2017–18 rainfall. This pattern is consistent with groundwater responding to the longer term drivers (dry conditions before 2017–18) and the influence of groundwater extractions.

Bores in the alluvial aquifers of the Darling River Basin also had lower-than-average rankings, especially in the Macquarie, Namoi, Gwydir and Border catchments. Thirty per cent of these bores were ranked as lowest on record. Since these alluvial aquifers in the Darling River Basin are also known areas of groundwater extraction, from the inspection of hydrographs in these areas, it is highly likely that groundwater levels in these aquifers were influenced by both increased extraction and reduced recharge over several years.

Areas with high groundwater salinity and less groundwater extraction, such as the Mallee and in the vicinity of the Murray River Mouth, had fewer bores in the lower rankings. The exception was the Condamine catchment in the northeast where the rankings were more evenly spread from very high to very low. However, in the Central Condamine Alluvial Aquifers (northwest of Toowoomba), where the major extractions occur, bores were mostly ranked below average, indicating the impact of high extractions.

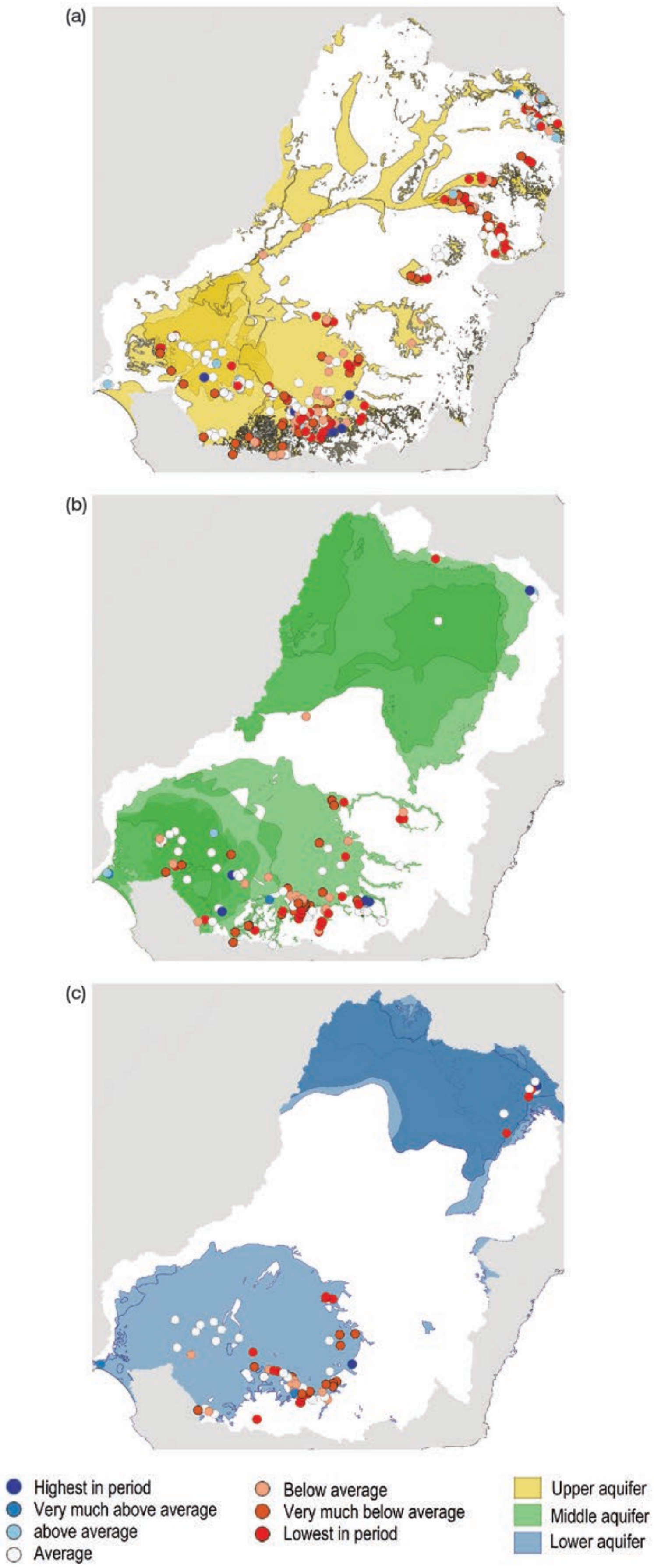



Figure 24. Decile ranking of annual maximum groundwater levels for (a) upper, (b) middle and (c) lower aquifers in the Murray–Darling Basin, June 2018 to January 2019 compared to 1992–2018 recovery peaks

# 3 WATER TRADING AND USE

**This chapter begins with an overview of the impact of water trading on the availability of water to licence holders (section 3.1). Usage of available water by environmental water holders is discussed in section 3.2, and how Aboriginal cultural water needs were addressed is discussed in 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 examines water stress in Australia and section 3.6 considers groundwater extractions in Australia's groundwater management areas. Water availability compared to usage in Australia's major rural surface water supply systems is investigated in section 3.7.**

## 3.1 WATER TRADE

### 3.1.1 Background

Water markets facilitate the buying and selling of water entitlements and allocations to allow water to move between various urban, agricultural and environmental uses. A trade is defined as a transfer of ownership from one legal entity to another with or without a change of location. Trades include commercial trades between unrelated parties, trades between related parties, and environmental trades or transfers to facilitate environmental water deliveries. Entitlement trades (or permanent trades) involve permanent transfers of a water access entitlement, while allocation trades (or temporary trades) involve buying and selling allocated water during a particular year.

Water trading occurs at various locations and water systems across Australia, the Murray–Darling Basin being a major component. In Australia, most water trade occurs between agricultural users. The connected systems in the southern Murray–Darling Basin are important and active water markets that account for 80 to 90 per cent of all trading activity in Australia. The southern Murray–Darling Basin has a high degree of hydrological connectivity, allowing for relatively unconstrained water trading between sub-systems and across State boundaries. It comprises 40 to 50 per cent of all Australian irrigated agriculture and accounts for 40 to 50 per cent of water used on Australian farms.

Recent records from the Australian Bureau of Statistics (2016, 2017, 2018) highlight the intensity of water use (3800–4500 GL) over the approximately one million hectares of land comprising the southern Murray–Darling Basin.

Water trade volumes and prices are driven by a variety of supply-side (water availability) and demand-side (water pricing and market) factors. High water storage levels and carryover from 2016–17 were major drivers for low water allocation prices early in 2017–18. However, dry climate conditions during the year influenced water trading, with high prices for allocations and entitlements. Although Australia's water market has a relatively short history, it has grown rapidly in the past 20 years and it is considered a world leader in the use of market-based mechanisms for water management. In 2017–18, the total estimated turnover of the water market in Australia (entitlement and allocation trade) doubled from the previous year to around $2.4 billion, with entitlement trade comprising 73 per cent of the total for 2017–18. Water traded in the southern Murray–Darling Basin accounted for around $1.4 billion of the total. A significant increase (from $0.11 to $0.58 billion) in allocation trade in the southern Murray–Darling Basin contributed to this turnover.

### Water made available

The amount of water made available for use or trade in Australia is governed by entitlements on issue (or water licences), and how much water is allocated to these entitlements each year. In 2017–18, 38 674 GL of water entitlements were on issue in Australia, which was similar to 2016–17. These entitlements were distributed between regulated and unregulated surface water systems and groundwater systems (Figure 25). The Murray–Darling Basin accounted for 77 per cent of Australia's regulated surface water entitlements, 24 per cent of unregulated surface water entitlements and 28 per cent of groundwater entitlements. The connected systems in the southern Murray–Darling Basin are important and active water markets where the majority of water trade activity occurs.

The amount of water allocated against entitlements on issue during 2017–18 across Australia was 31 586 GL, sourced from groundwater and surface water (regulated and unregulated). Available water from regulated systems is the total of annual allocations made against most major entitlements types, including carryover from the previous water year. For unregulated surface water and groundwater, available water generally refers to licensed entitlement volumes with various rules on extraction times or restrictions on locations where water can be traded. The amount of allocated water is a key driver for allocation trades.

Though the total available allocation volume in 2017–18 was around 8 per cent lower than the previous year, it was the second-highest allocation in the past eight years (Figure 26). The total allocation volume from unregulated surface water and groundwater systems was similar to that of 2016–17. The drop in the total allocation volume was primarily due to a reduced allocation of regulated surface water in New South Wales, due in turn to reduced water availability.

New South Wales has a high proportion of water license holders with general security entitlements, and the end-of-season allocations to this entitlement type were lower than in 2016–17. Opening water allocations were higher in 2017–18 than in 2016–17, but the end-of-season allocations were lower or similar.

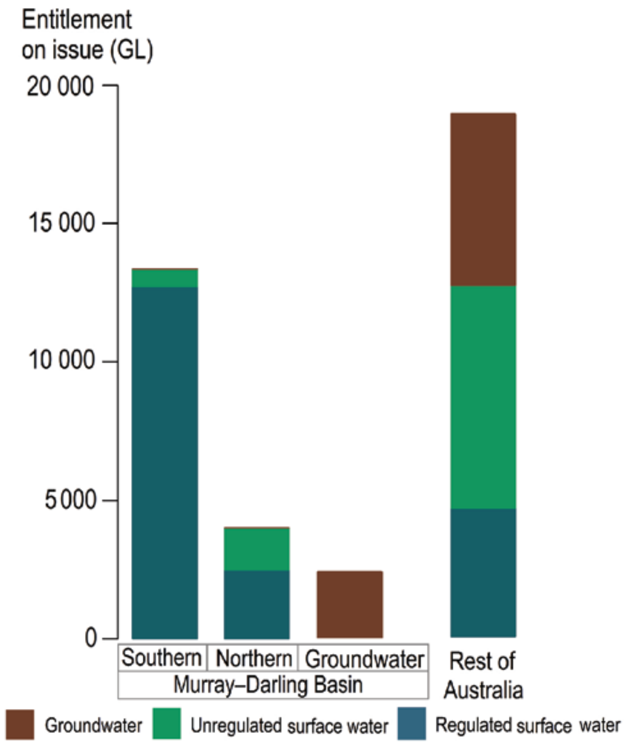



Figure 25. Volume of water entitlements on issue by region and type in 2017–18

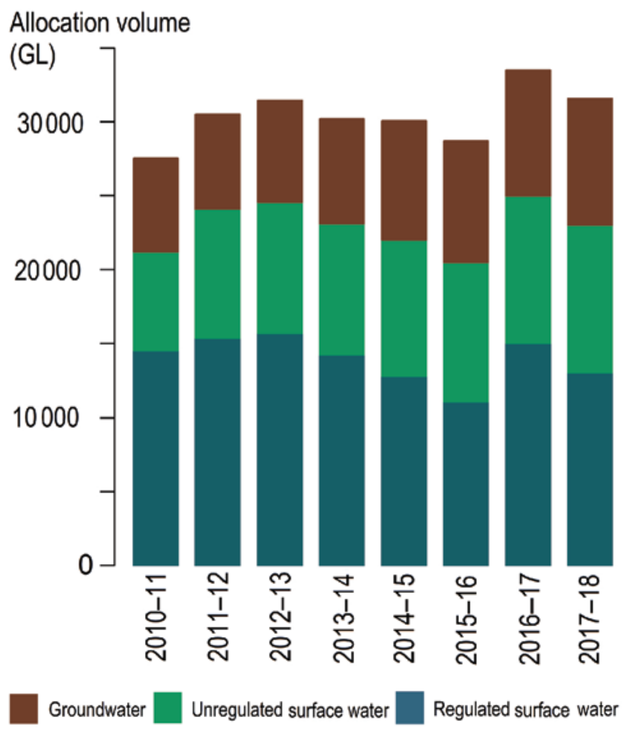



Figure 26. Available allocations from groundwater and regulated and unregulated surface water systems in Australia, 2010–11 to 2017–18

### 3.1.2 Entitlement markets

#### National overview

The number and total volume of entitlement trades across Australia increased significantly between 2007–08 and 2017–18 (Figure 27). Entitlements were traded in record numbers in 2017–18 (with a 6 per cent increase from 2016–17), despite a 23 per cent decrease in the total volume (2062 GL to 1598 GL) of entitlement trades from 2016–17 to 2017–18. The volume decrease occurred in surface water entitlement trades; the volume of groundwater entitlement trades increased by 9 per cent.

Spikes in volumes traded in 2008–09, 2009–10 and 2013–14 reflect a significant increase in the volume of water traded to the Commonwealth in the southern Murray–Darling Basin as part of Murray–Darling Basin Plan water recovery. Water recovery prior to 2011–12 was predominantly achieved through direct purchase, but the 2013–14 spike is associated with infrastructure upgrades. The long-term trend shows increasing entitlement trade. This has resulted in trade volumes close to doubling over the last decade.

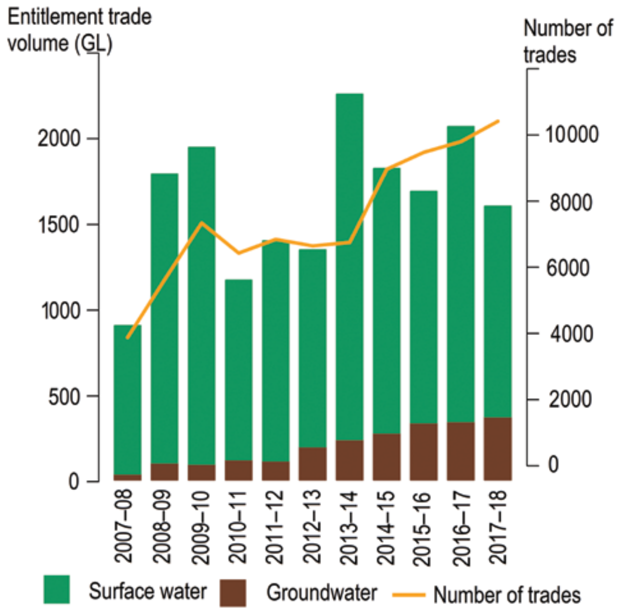



**Figure 27. Volume and number of entitlement trades nationally by source, 2007–08 to 2017–18**

During 2017–18, the largest volumes of surface water entitlement trade occurred in the surface waters of the southern and northern Murray–Darling Basin, with similar trade volumes in these two regions (Figure 28).

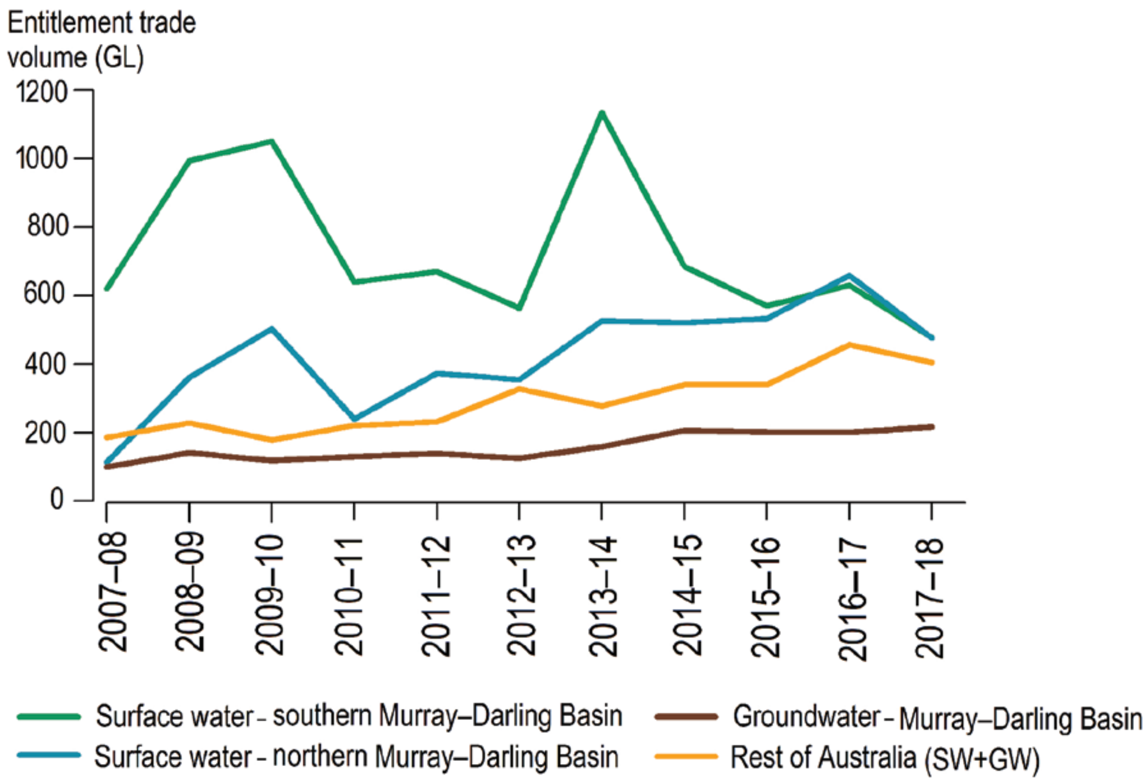



**Figure 28. Volume of water entitlement trade by region, 2007–08 to 2017–18**

Volumes of entitlement trades are trending upwards in the northern Murray–Darling Basin surface waters, as are volumes of entitlement trades in the Murray–Darling Basin groundwater. A slow increase is also evident in the rest of Australia. This pattern could reflect entitlement trading being seen increasingly as a business tool for irrigators to manage water availability. It could also be due to structural changes to agricultural businesses, such as farm consolidations. Participation in water trading in markets outside the Murray–Darling Basin (such as Tasmania) is growing. In the southern Murray–Darling Basin, which is a relatively more mature and established market, trade volumes fluctuate in line with the long-term availability of water for trade.

### Surface water entitlement trade in various water systems

In 2017–18, significant trade activity in surface water entitlements took place in the Macquarie–Castlereagh and New South Wales Border Rivers systems of the northern Murray–Darling Basin (Table 5). However, a small number of large transfers dominated in both regions. In the Macquarie–Castlereagh, the large volume of trade is the result of an accounting practice for the Trangie–Nevertire Irrigation Scheme, but it does represent actual commercial transactions.

The southern Murray–Darling Basin recorded significant entitlement trade in the Murrumbidgee, New South Wales Murray, Victorian Murray and Goulburn systems.

Outside the Murray–Darling Basin, the most significant activity was in the Tasmania, Burdekin, Hunter, Burnett, Fitzroy and Thomson systems.

Average surface water entitlement prices in the northern and southern Murray–Darling Basin from 2007–08 to 2017–18 are shown in Figure 29, along with average rainfall deciles for each year. Unfortunately, very few data are available on entitlement prices outside the Murray–Darling Basin.

Prices in the northern basin have a decreasing long-term trend and southern basin prices have an increasing trend since 2013–14; however, surface water entitlement prices increased in both parts of the basin during 2017–18. In the southern basin, record low volumes of surface water entitlements were traded during 2017–18 (Figure 28), with a record high average price since 2007–08 (Figure 29).

Prices for entitlement trading showed a general decline from 2009–10 to 2013–14, reflecting the high water availability across the Murray–Darling Basin for this period (as shown by the rainfall deciles in Figure 29). Many water entitlement prices showed a sharp increase from 2013–14, reflecting decreasing water availability with drying conditions. The most significant increases in prices from 2013–14 to 2017–18 were for the Murrumbidgee high and general reliability entitlements, and for New South Wales high-reliability entitlements, which all saw increases of more than 100 per cent in four years.

**Table 5. Volume of surface water entitlement trade in water systems with greater than 5 GL trade in 2017–18**

| Entitlement volume traded (GL) | Northern Murray–Darling Basin | Southern Murray–Darling Basin | Others |
|---|---|---|---|
| 150–250 | Macquarie–Castlereagh | Murrumbidgee | |
| 100–150 | New South Wales Border Rivers | New South Wales Murray | |
| 50–100 | Gwydir | Goulburn | |
| 20–50 | Queensland Border Rivers, Namoi, Condamine–Balonne | Victorian Murray, South Australian Murray, Lower Darling, Lachlan | Tasmania, Burdekin Basin, Hunter |
| 5–20 | | | Burnett Basin, Fitzroy Basin, Thomson Basin, Gulf, Barron, Pioneer Valley, North Coast, Mary Basin, Sydney South Coast |

Water entitlement prices are specific to each water system, resource type and reliability class. Comparing the prices for high-security (a) and general and low-security (b) entitlements in Figure 30 showed that improved water reliability led to higher prices: high-security entitlement prices were higher than general security entitlement prices, which were higher than low-security entitlement prices. High-security entitlement prices were generally similar for all water systems but tended to be higher in New South Wales. This is because high-security entitlements in New South Wales are among the most reliable in the southern Murray–Darling Basin.

Prices of individual entitlement types are also affected by the location of the entitlement, catchment-specific rules, carryover rights that the entitlement affords, trade restrictions and the value of crops grown in the region. In 2017–18, high and general security entitlement prices increased compared to 2016–17 in the New South Wales Murray and Murrumbidgee as irrigators secured water for high-value crops, such as horticultural trees and cotton. All other major entitlement types experienced stable prices between 2016–17 and 2017–18.

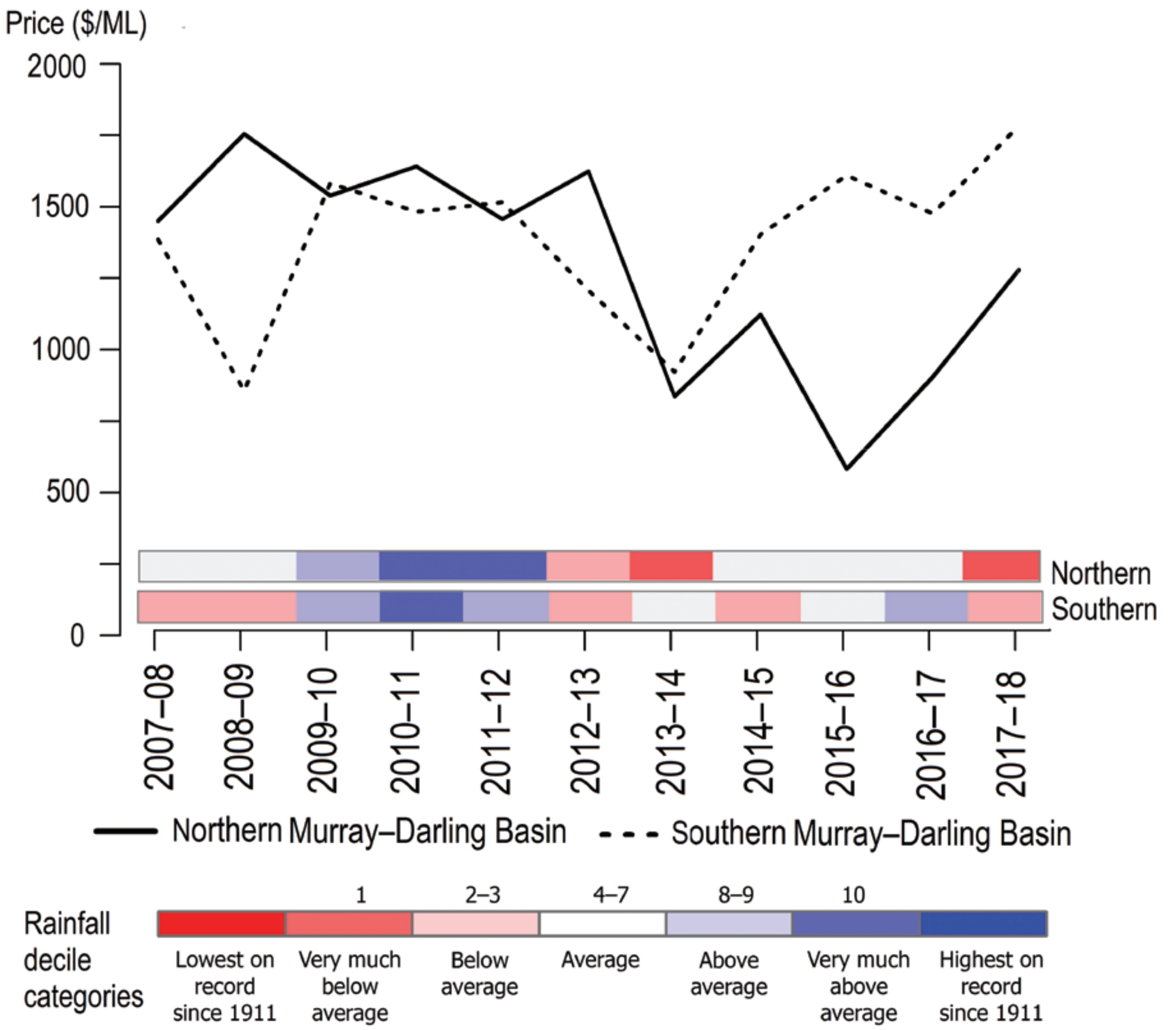
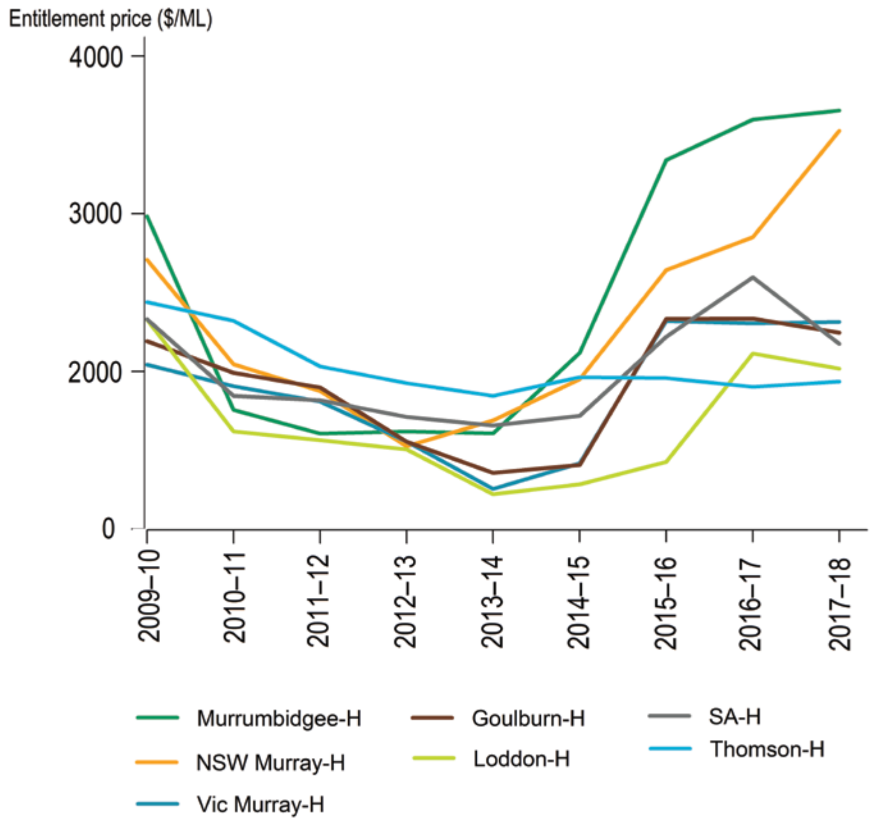



Figure 29. Average surface water entitlement prices in northern and southern Murray–Darling Basin together with the annual rainfall deciles for the Murray–Darling Basin, 2007–08 to 2017–18

(a) High-security (H) entitlements




(b) General (G) and low-security (L) entitlements

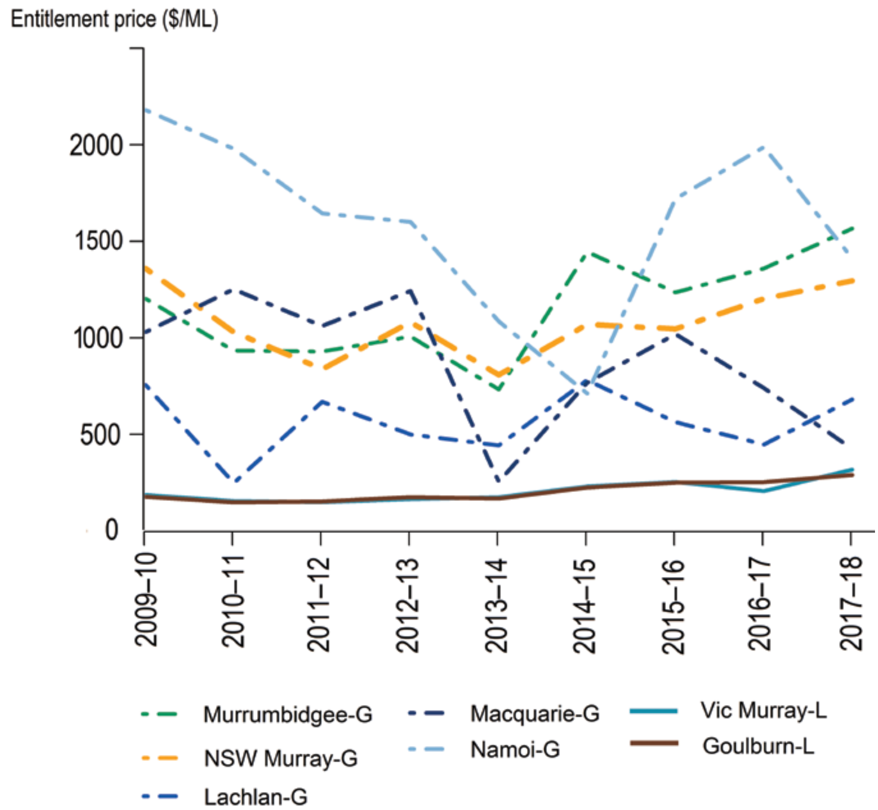



Figure 30. Trade prices for selected systems (a) high-security (H) (b) general (G) and low-security (L) entitlement classes, 2009–10 to 2017–18

### 3.1.3 Allocation markets

#### National overview

The total volume of allocation trade in 2017–18 was 7527 GL, a 7 per cent increase from 2016–17 and the highest volume since 2008–09 (Figure 31). Surface water trade continued to dominate, accounting for 97 per cent (7290 GL) of allocation trade. The volume of groundwater allocation traded was 236 GL. The total number of trades rose by 32 per cent from 2016–17.

The volume of allocation trade in Australia has grown substantially since 2008–09 (Figure 32). Most allocation trade continues to be for surface water in the southern Murray–Darling Basin (6643 GL or 88 per cent of the total). Surface water environmental trade in the southern Murray–Darling Basin makes up 27 per cent of the allocation trade in the southern basin in 2017–18 and has almost doubled since 2011 (Figure 32). This sector is growing faster than other allocation trades and dominates the allocation trade growth in the southern Murray–Darling Basin.

High volumes of allocations were traded with the Commonwealth Environmental Water Office in 2017–18. These are transfers within and between water systems to achieve environmental watering objectives. They have no financial component but are included on trade registers along with market activity. In 2017–18, environmental transfer volumes in the southern Murray–Darling Basin accounted for 24 per cent (1791 GL) of all allocations traded in Australia.

In 2017–18, the greatest water allocation trade volumes occurred in the Murray, Murrumbidgee and Goulburn water systems in the southern Murray–Darling Basin. Table 6 shows the volume of surface water allocation trades in various water systems. These regions also accounted for the bulk of environmental transfers. Outside the southern Murray–Darling Basin, the most significant trade volumes were recorded in the Fitzroy, Barron and Burdekin water systems in northwest Queensland (Table 6).

Prices were generally lower in the southern Murray–Darling Basin than in the northern basin, where they ranged from $171/ML in the New South Wales Border Rivers to $293/ML in the Gwydir (Figure 33).The high prices in some of the northern Murray–Darling Basin water systems like Gwydir, Namoi and Macquarie–Castlereagh reflect this year's lower rainfall amounts in the region.

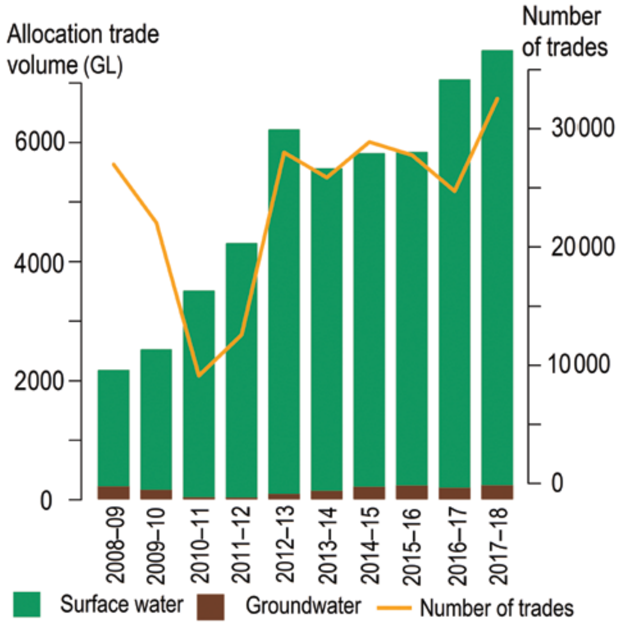



Figure 31. Volume and number of water allocation trades, 2008–09 to 2017–18

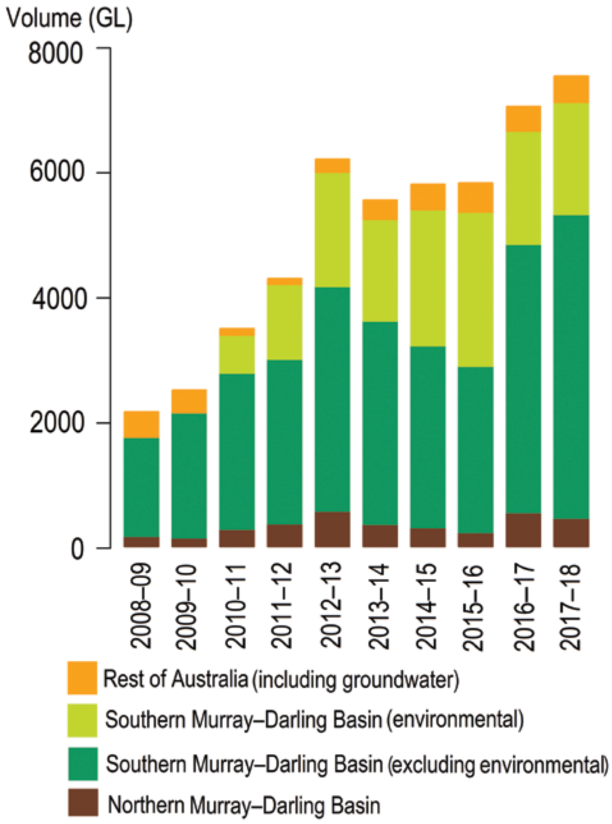



Figure 32. Volume of surface water allocation trade by region, 2007–08 to 2017–18

Table 6. Volume of surface water allocation trades in water systems with greater than 10 GL of trade in 2017–18

| Allocation volume traded (GL) | Northern Murray–Darling Basin | Southern Murray–Darling Basin | Others |
|---|---|---|---|
| 1500–2000 | | Victorian Murray, Murrumbidgee | |
| 1000–1500 | | Goulburn, New South Wales Murray | |
| 100–500 | Macquarie–Castlereagh, | South Australian Murray, Lachlan, Lower Darling | |
| 50–100 | Gwydir, Queensland Border Rivers | | Fitzroy Basin |
| 10–50 | Namoi, New South Wales Border Rivers, Condamine–Balonne | Campaspe, Loddon | Barron, Burdekin Basin, Thomson Basin, Hunter, Burnett Basin |

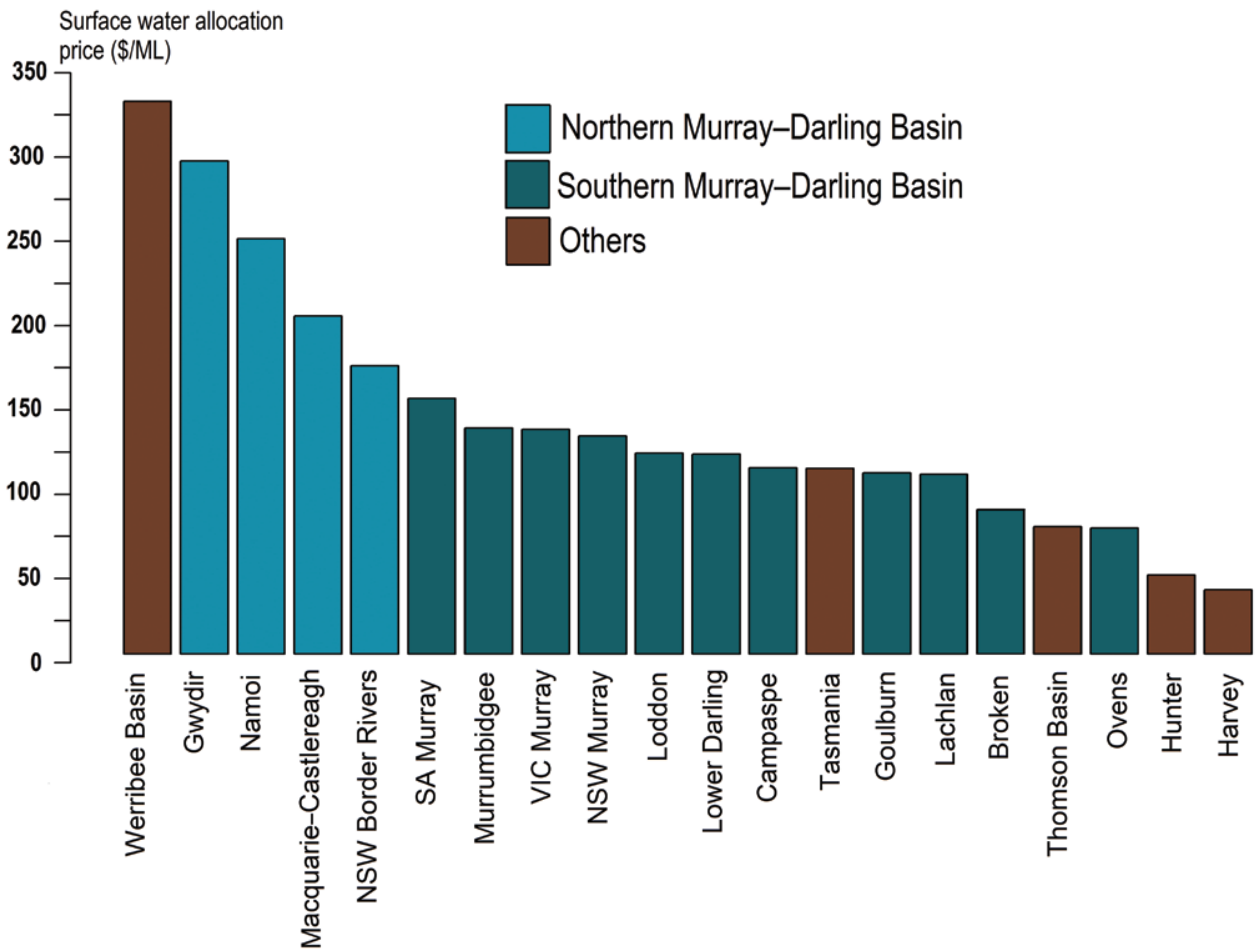



Figure 33. Average surface water allocation price by water system in 2017–18

Water allocation prices in the southern Murray–Darling Basin were significantly higher in 2017–18 than in 2016–17 (Figure 34), reflecting the decreasing rainfall totals since 2012–13 (except for 2016–17). The imposition of water trade restrictions (section 3.1.6), especially those relating to trade into the Murrumbidgee water system, contributed to notable price differences between parts of the southern Murray–Darling Basin. Prices in many catchments increased by over 150 per cent compared to 2016–17. Trade restrictions and commodity prices may have combined with lower water availability in the later quarters of 2017–18 to drive water allocation prices above those of the previous year.

Improvements can still be made in reporting trade prices in some water markets. In 2017–18, 44 per cent of allocation transactions (excluding environmental trades) either did not report a price or reported a zero price.

Sixty-two per cent of entitlement trades did not report a price or reported a zero price. For the few systems outside the Murray–Darling Basin where allocation price data are available, prices ranged from $38/ML in the Harvey system to $328/ML in the Werribee Basin (Figure 33).

### Allocation markets in the southern Murray–Darling Basin

Against the backdrop of an overall drier 2017–18, the southern Murray–Darling Basin observed low end-of-year allocations, particularly for general security entitlements, compared to full allocations in 2016–17. A number of trade restrictions were imposed, limiting the water that could be traded between certain catchments. Water requirements increased due to larger areas of mature or high-value crops. Limited water availability and increased demand saw upward pressure on water prices during 2017–18 (Figure 34).

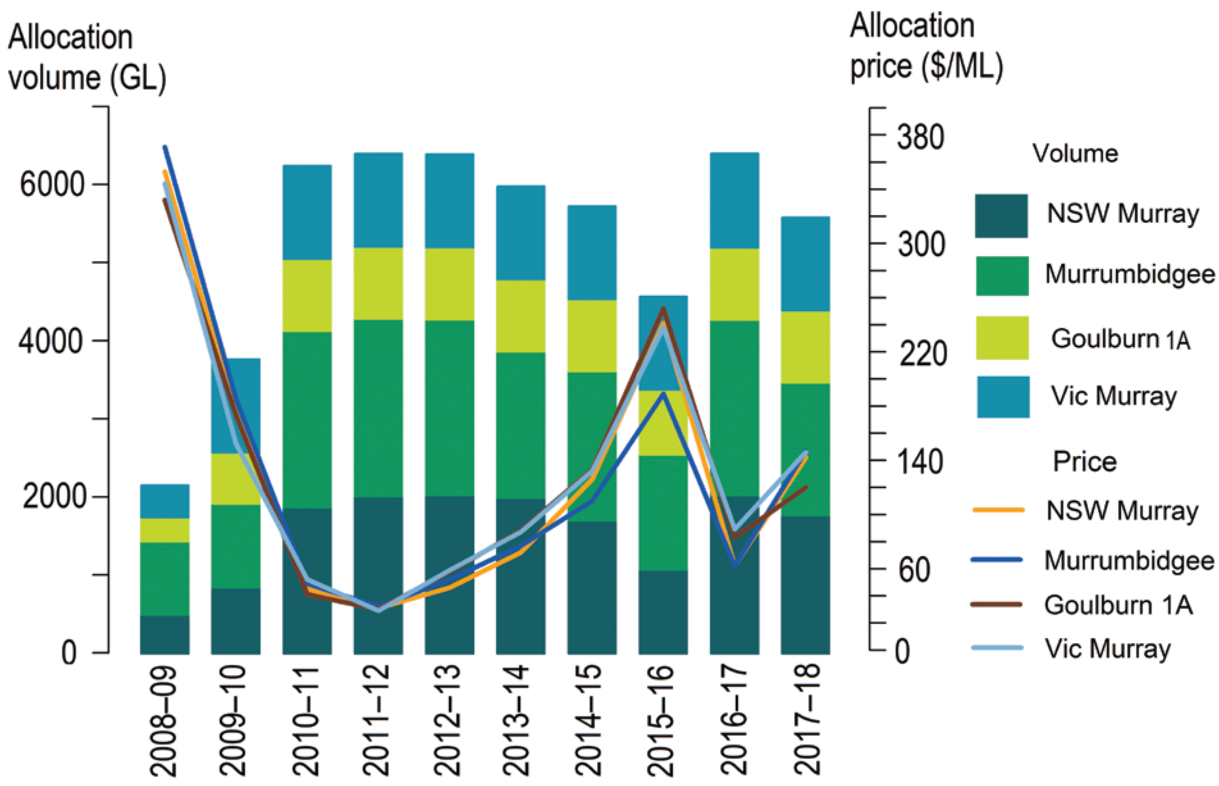



**Figure 34. Allocation volume and allocation price in selected southern Murray–Darling Basin catchments in 2017–18**

Restrictions in 2017–18 contributed to the Murrumbidgee allocation prices being around $20/ML higher than in the New South Wales and Victorian Murray by the end of the water year. The combined influences of lower allocations in the Murrumbidgee and higher demand from the growth in area under cotton drove these prices higher. In contrast, in 2016–17, restrictions on water traded out of the Murrumbidgee, and lower within-catchment demand, contributed to allocation prices in the Murrumbidgee being around $18/ML lower than in the southern connected system.

### 3.1.4 Internal and interstate allocation trade

The growth in Australia's water market is evident in trade activities within the systems and across the States. The total volume of internal and interstate trade was 6643 GL in the southern Murray–Darling Basin, an increase of 9 per cent from the previous year and the highest since records began in 2008–09 (Figure 35). In 2017–18, interstate trade volume increased 44 per cent: 1082 GL was traded compared with 753 GL in 2016–17.

In 2017–18, the total amount of water moving between systems in the southern Murray–Darling Basin increased by 7 per cent compared to 2016–17. This was less than the national increase in trade volume (9 per cent), due in part to the number of trade restrictions in place in the southern basin throughout the year.

#### Commercial interregional trades

In 2017–18, the Victorian Murray region was a large net exporter of water allocations, with net outward trade of around 247 GL, excluding identified environmental trades (Figure 36). South Australia Murray was the largest net importer in 2017–18 with net trade (excluding environmental trade) of around 290 GL. In contrast to 2016–17, the Murrumbidgee and the New South Wales Murray were net importers of water allocations in 2017–18, reflecting the strong demand for water to produce crops such as cotton and horticulture. In fact, the Murrumbidgee's inter-valley trade limit restricted water trade imports in 2017–18, in contrast to 2015–16 and 2016–17 when trade restrictions limited the volumes of exports from the Murrumbidgee.

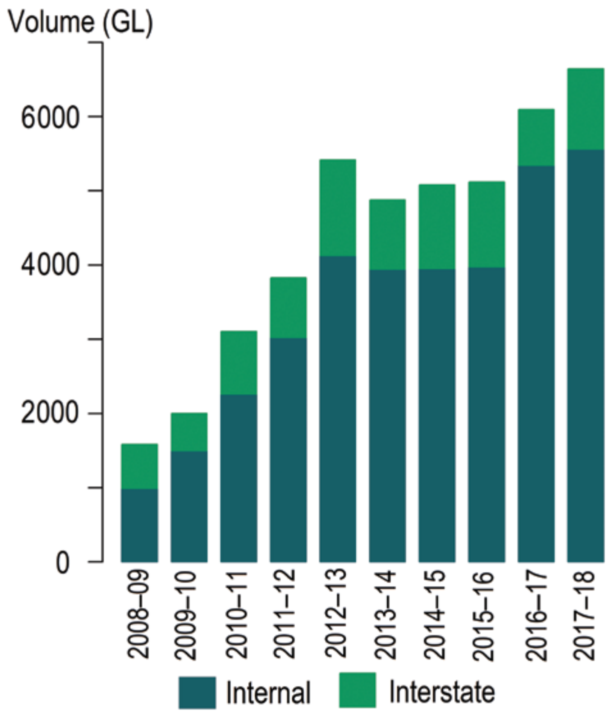



Figure 35. Interstate and internal trade flows in southern Murray–Darling Basin, 2008–09 to 2017–18

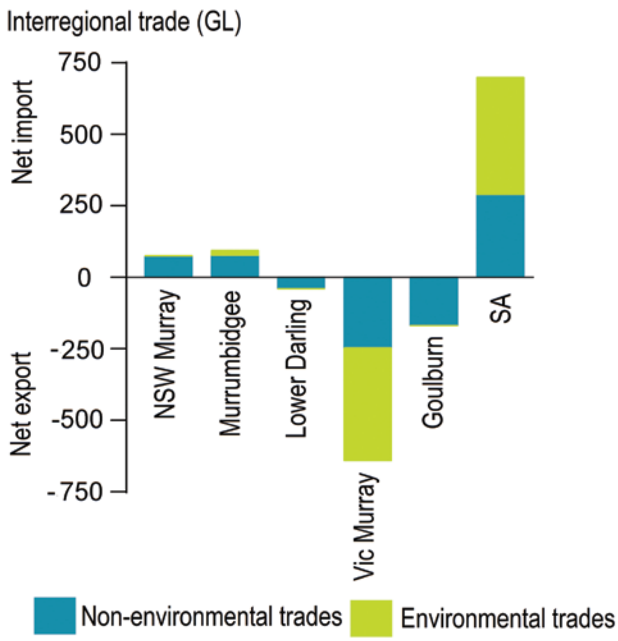



Figure 36. Net interregional trade flows of surface water allocations for the southern Murray–Darling Basin in 2017–18

### Environmental trades

Identified environmental trades (or transfers) accounted for around 29 per cent of total interregional water trade in 2017–18. Environmental transfers tend to move in a downstream direction, with large volumes flowing out of the Victorian Murray region and into the South Australian Murray (Figure 36). Environmental trades within the southern Murray–Darling Basin facilitate the use of water to improve the health of rivers, floodplains and wetlands, with decisions guided by the Murray–Darling Basin Plan environmental watering strategy.

### Interstate trade

South Australia was the largest net importer of water through allocation trade, with a net 700 GL imported (Figure 37), mostly from Victoria (whose total net export to South Australia was 697 GL). This is a significant increase from 2016–17, which saw 226 GL of net imports to South Australia, largely for environmental purposes, and similar to that of 2015–16 (704 GL).

In 2017–18, Victoria exported a net 116 GL of water allocations to New South Wales, and New South Wales exported a net 7 GL to Queensland.

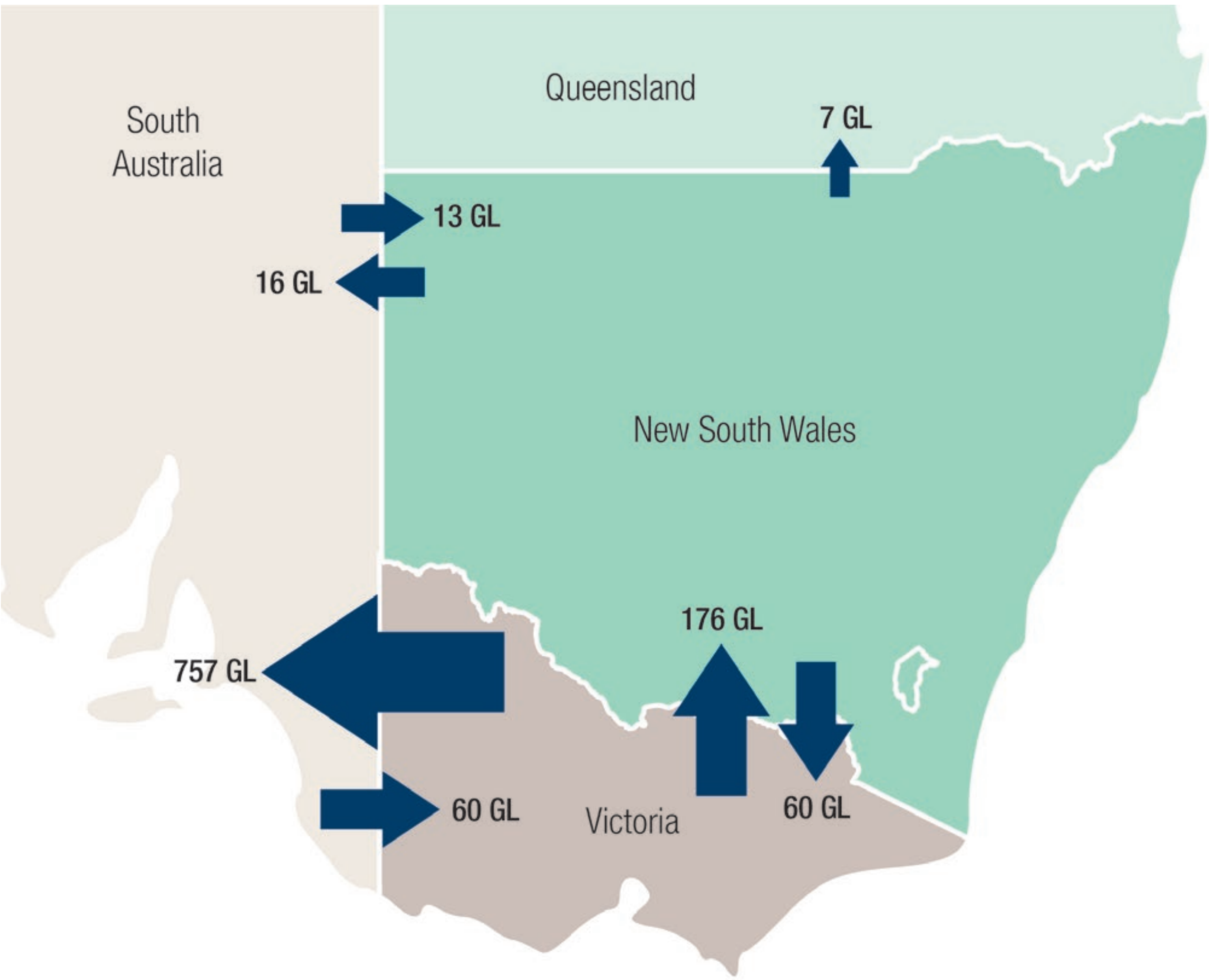



Figure 37. Surface water allocation interstate trade in 2017–18

### 3.1.5 Trade restrictions

In the southern Murray–Darling Basin, restrictions stopped water trading for significant periods during 2017–18. Trade restrictions were placed on the Barmah Choke[21] and the Goulburn system[22], the Murrumbidgee system (inter-valley trade limit), and on trade from New South Wales to Victoria.[23] This results in a restriction in the volume of water that can be traded from one catchment to another. Trade restrictions were imposed to guard against third-party impacts, such as environmental harm, or when physical or hydrological limitations within the interconnected river system are reached and become binding. While trade is restricted, catchments are separated from the rest of the interconnected system. Separated catchments can experience price differentials reflecting underlying supply and demand factors, which can drive prices to higher or lower levels than the remainder of the system. Increased water demand in the downstream Victoria and New South Wales Murray regions, due to the expansion crops such as almonds, could exacerbate the impact these trade restrictions have on water prices.

## 3.2 ENVIRONMENTAL WATER

The natural flow regimes of most rivers in Australia are highly variable, and this variability is critical to the functioning of their ecosystems and the maintenance of their biodiversity. Constructing weirs or dams in the river system for diverting water for human uses disrupts the natural flow cycle and can affect the health and condition of rivers and their ecosystems. Environmental water is water that is allocated and managed to protect and restore water-dependent ecosystems. Environmental watering objectives can be met by all water in the system, including uncontrolled flows from significant rain events, water that is en route for consumptive purposes such as irrigation, and specific environmental water releases from dams.

Environmental water is made available as either held or planned environmental water. Held environmental water is water that has been recovered for the environment by the Commonwealth or States and Territories through the purchase of water entitlements or other mechanisms (such as savings from irrigation efficiency projects). Water entitlements provide those holding a licence to use a share of water that is subject to water allocation decisions made by the States in accordance with the licence type and the amount of water available. Water allocated to environmental water holders is often held in public storages and is available for release on request of the owner (Murray–Darling Basin Authority, 2019). The release of held environmental water from dams is managed in line with environmental water planning processes which aim to optimise the environmental outcomes. River systems without dams may also have held environmental water. This water generally becomes available to entitlement holders when flows reach certain specified levels in the river.

Planned environmental water refers to water in river systems that has been committed for environmental outcomes in State laws (for example, sharing arrangements in water plans, conditions on water licences). These instruments set out rules and arrangements which dictate when and how water can be taken, so that water remains in the system for environmental outcomes. Such rules might, for example, ensure there is a minimum flow in a river to ensure ecological objectives and outcomes are achieved, or rules may be designed to protect flows from being extracted for a period of time following a heavy rainfall event.

### 3.2.1 Environmental surface water entitlements in the Murray–Darling Basin

Under the Water Act and the Murray–Darling Basin Plan, the Commonwealth Government acquires water entitlements for the environment to restore and protect the health and condition of the rivers and water-dependent ecosystems within the Basin. Following a number of amendments to the Basin Plan in 2018 (Murray–Darling Basin Authority, 2019), the current water recovery target is for a long-term average annual yield of 2075 GL per year plus 450 GL per year of efficiency measures by June 2024. As at 30 June 2018, the total Commonwealth environmental water holdings were 2706 GL of registered entitlements, with a long-term average annual yield of 1859 GL. In 2017–18, 1307 GL of Commonwealth environmental water was called on in the Murray–Darling Basin from the carryover volume of 612 GL from 2016–17 and total annual allocation of 1198 GL.

21 www.mdba.gov.au/managing-water/water-markets-trade/interstate-water-trade/barmah-choke-trade-balance [Accessed 1 November 2018]

22 https://waterregister.vic.gov.au/about/news/218-understanding-goulburn-to-murray-trade-limit [Accessed 13 December 2018]

23 https://waterregister.vic.gov.au/about/news/195-understanding-the-nsw-to-victoria-trade-limit [Accessed 13 December 2018]

The State and Commonwealth environmental water holders and the Murray–Darling Basin Authority plan and prioritise how held environmental water will be used over a given water year. The planning process involves collaboration between the Commonwealth and States with a range of stakeholders, including catchment managers, river operators, scientists, local communities and Traditional Owners. Both the Murray–Darling Basin Authority and the States produce annual environmental watering plans that identify the environmental watering priorities for the year ahead. The respective plans are released by the start of each water year. With these plans in hand, environmental water holders (State and Commonwealth) then come together with the stakeholders—such as the catchment management authorities, Traditional Owners, or those who may be affected by an environmental watering event—to make decisions about when, where and how much water will be released to meet the environmental objectives and targets. River operators deliver the water according to these decisions.

### 3.2.2 Environmental water delivered

A coordinated approach to water planning and delivery for multiple uses and to multiple sites along the river system can result in significant water savings. A coordinated approach, involving water holders and managers as well as stakeholder groups, has the potential to deliver multiple benefits from a volume of water that is released. For example, 'return flow' is water that returns to the river system after it has been used for a specified purpose. Environmental or consumptive flows from floodplains and wetlands that re-enter the system to flow downstream can be used again for other purposes (Murray–Darling Basin Authority, 2019).

Thus, water that is used for one purpose and returned to the river can be used to meet other environmental or consumptive needs along the system. In 2017–18, coordinated planning by water managers in the Murray–Darling Basin resulted in the reuse of return flows, delivering multiple benefits for communities, industries and the environment.

Total environmental flows delivered to rivers, lakes and wetlands (environmental assets) in 2017–18 from all environmental water holders and managers in the southern Murray–Darling Basin were just over 2846 GL (2566 GL held and 280 GL planned), while the total for the northern basin was 285 GL (149 GL held and 136 GL planned). In the previous year, environmental water volumes delivered were 2825 GL (2560 GL held and 265 GL planned) and 565 GL (222 GL held and 343 GL planned) in the southern and northern basins, respectively.

Table 7 summarises the 2017–18 environmental water delivered in the southern Murray–Darling Basin at the request of the Commonwealth, New South Wales and Victorian environmental water holders, the Murray–Darling Basin Authority and water managers.

In the southern Murray–Darling Basin, the largest volume delivered was in the South Australian Murray; about 1371 GL of environmental water was delivered to support various environmental assets. The next largest delivery was in the Goulburn system (355 GL) followed by Victorian Murray (354 GL). In the New South Wales Murray and Lower Darling catchments, 334 GL of water was delivered to the rivers, creeks and wetlands, and the Murrumbidgee catchment received 270 GL of environmental water.

Environmental water delivered in the northern Murray–Darling Basin totalled 285 GL in 2017–18; these flows are summarised in Table 8. More than 47 per cent (134 GL) of the total was delivered into the Macquarie River, and the next largest environmental delivery occurred in the northern unregulated rivers (58 GL). Another major delivery was in the Gwydir catchment where 47 GL was delivered to support various environmental assets.

Table 7. Environmental flow delivered in the southern Murray–Darling Basin in 2017–18

| Catchments | Delivered volume (GL) | Primary watering aims |
|---|---|---|
| New South Wales Murray and Lower Darling | 334 | To connect wetlands with the river to support native fish feeding, breeding and movement; to support the recovery of wetlands to provide habitat feeding and breeding opportunities; to provide foraging opportunities for waterbirds; to replenish wetland refuges; to support salinity and water levels in the Coorong. |
| Lachlan | 54 | To support breeding, feeding, habitat and movement of native fish; to ensure the release of nutrients throughout the system; to boost the aquatic food web and support wetland plants; to avoid rapid drops in water level; to support the pelican breeding colony at Lake Brewster; to stimulate frog and waterbird habitat recovery; and to connect increased river flows to creeks. |
| Murrumbidgee | 270 | To connect the floodplain wetlands with the river to support feeding, breeding and movement of native fish; to release essential nutrients to boost the aquatic food web; to support the re-establishment of wetland plants to provide habitat, feeding and breeding opportunities; to provide habitat for wetland-dependent fauna in the Toogimbie area. |
| Victorian Murray | 354 | Range of actions to wetlands and river reaches to support a number of outcomes for vegetation, waterbirds, fish and productivity. |
| Ovens River | 0.12 | To freshen water quality; to provide variability in river height to help native fish and other aquatic animals to find food sources; to maintain native fish movement and in-stream and bank vegetation. |
| Broken River | 43 | To support habitat for native fish, local wetlands and waterbirds; to maintain water quality by maintaining dissolved oxygen level above 5 mg/L; to facilitate native fish passage. |
| Goulburn River | 355 | To maintain in-stream and bank vegetation; to support native fish and macroinvertebrate populations; to support connectivity along the river and with the River Murray system through South Australia's Coorong estuary. |
| Campaspe | 31 | To maintain river red gum; to support the survival of endangered native fishes like silver perch, rainbow fish and golden perch; to support connectivity along the river. |
| Loddon River | 19 | To support the migration of native fishes like Murray cod, silver perch and golden perch; to improve river habitat and the connectivity of waterways. |
| Wimmera–Mallee | 17 | To support native fish and waterbug habitat; support connectivity between water pools; to improve water quality. |
| South Australian Murray | 1371 | To maintain and improve vegetation in specific South Australian wetlands and floodplain; to maintain connectivity between the Lower Lakes and Coorong; to provide suitable habitat conditions (both salinity and water levels) in the Coorong for estuarine fish and vegetation species; to enable fish migration; to support waterbird nesting. |

Source: Murray–Darling Basin Authority (2019); Victorian Environmental Water Holder (2019); Office of Environment and Heritage[24]; Department of the Environment and Energy[25]

24 www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/water-for-environment-outcomes-2017-18

25 www.environment.gov.au/water/cewo/about-commonwealth-environmental-water

Outside the Murray–Darling Basin, about 516 GL of environmental water was released during 2017–18 in Victoria. Environmental releases for the Snowy River totalled 206 GL; this was the largest volume of environmental water ever released to the Snowy River from Lake Jindabyne in one year. Five high-flow events were delivered in winter and spring with peak flows up to 8 GL per day to support ecological processes in the Snowy River below the Jindabyne Dam. The Victorian Environmental Water Holder released 251 GL, 31 GL and 28 GL for Gippsland, Central and Western regions of the State, respectively, to enhance the health of the rivers.

**Table 8. Environmental flow delivered in the northern Murray–Darling Basin in 2017–18**

| Catchments | Delivered volume (GL) | Target |
|---|---|---|
| Moonie | 2.3 | To support native fish populations and waterbirds abundance and diversity. |
| Border Rivers | 35 | To provide stable base flows to support a range of native fish during peak periods of reproduction in Dumaresq River (3252 ML) and Severn River (8684 ML); to provide a connecting flow to the the Barwon–Darling and to improve tributary conditions of Mungindi (4 GL); to protect and restore water-dependent ecosystems in the Macintyre and Dumaresq rivers (292 ML) and in the Lower Macintyre River (641 ML); to support native fish in the Border Rivers Water Management Area (15 GL); to enhance longitudinal connectivity to the Macintyre Brook Water Supply Scheme (3 GL). |
| Gwydir | 47 | To support core water-dependent wetland communities; to support native fish breeding in the Gwydir River and connected waterways of the Mehi River and Carole Creek; to create opportunities for native fish to feed, breed and move. |
| Namoi | 8 | To support the conservation stocking of silver perch fingerlings; to provide connectivity for fish movement, condition and dispersal; to maintain connection between pools, improve vegetation condition and water quality. |
| Macquarie | 134 | To boost standing water in channels and shallow groundwater levels; to provide a minimum of 90 days inundation of key wetlands in the Macquarie Marshes; to support the recruitment of semi-permanent wetland vegetation; to provide benefits for native fish, such as Murray cod and freshwater catfish, and waterbirds. |
| Northern unregulated rivers (Barwon–Darling; Condamine–Balonne; Warrego) | 58 | To improve flow regimes and connectivity to support native fish in the Barwon–Darling river system (11 GL); to support naturally variable flow regimes and to improve resilience of native plants and animals in the Condamine–Balonne catchment (3986 ML); to improve longitudinal connectivity in Lower Balonne (39 GL); to support native fish populations and provide hydrologic connectivity in the Lower Warrego catchment and fringing wetlands (4300 ML). |

Source: Murray–Darling Basin Authority (2019), NSW Office of Environment and Heritage[26]; Department of the Environment and Energy[27]

26 www.environment.nsw.gov.au/topics/water/water-for-the-environment/planning-and-reporting/water-for-environment-outcomes-2017-18
27 www.environment.gov.au/water/cewo/about-commonwealth-environmental-water

## 3.3 WATER FOR ABORIGINAL CULTURAL USE

Cultural flows are water entitlements that are legally owned and managed by Aboriginal people to improve the spiritual, cultural, environmental, social and economic conditions of the Aboriginal Nations (Murray and Lower Darling Rivers Indigenous Nations, 2007). Over the past decade, water managers have been identifying opportunities for shared environmental and cultural benefits through environmental watering. Methods for the explicit provision and accounting of water for use by Aboriginal people are currently being developed in many parts of Australia. It is not possible to provide a nationwide overview of Aboriginal cultural water use, given the current lack of agreed methods to manage and account for it. However, *Water in Australia* is able to describe case studies (below) that illustrate the significant progress being made across Australia in the provision of water for Aboriginal cultural use.

### 3.3.1 Bolin Bolin Billabong

One environmental water release in 2017–18 that provided cultural benefits to Indigenous people was the watering of the Bolin Bolin Billabong in the Yarra River catchment in Victoria. The Bolin Bolin Billabong is one of the few remaining billabongs in Melbourne and is an ecologically and culturally important site to the Wurundjeri people (Melbourne Water, 2018b). It is considered a sacred site that was an important gathering location for Wurundjeri and Kulin Nation peoples and it used to have a large eel population. It is also an important element of the Yarra flood plain and is used for many recreational activities. Urban development has changed the quantity and quality of water that the billabong receives, and changes in flows in the Yarra River have reduced the frequency of filling.

In October 2017, the Victorian Environmental Water Holder and Melbourne Water, in partnership with other stakeholders, delivered environmental water to the Bolin Bolin Billabong from the Yarra River (Victorian Environmental Water Holder, 2018). The watering improved wetland vegetation and wildlife habitat and provided cultural benefits to the Wurundjeri people.

### 3.3.2 National Cultural Flows Research Project

The National Cultural Flows Research Project, driven by and for Aboriginal people, was undertaken to develop methodologies to quantify water requirements to meet Aboriginal cultural flow needs (National Cultural Flows Research Project, 2017). The project aimed to secure a future where Aboriginal water allocations are embedded within the country's water planning and management regimes so as to deliver cultural, spiritual, social and economic benefits to communities in the Murray–Darling Basin and beyond.[28]

A team of expert hydrologists, ecologists and social scientists developed and implemented methodologies to describe and measure cultural water uses and values in selected study sites. Hydrologic and hydraulic modelling were undertaken to quantify the volumes of water required to meet the cultural values and needs. The research partners also developed and implemented a monitoring plan, which included establishing objectives of watering, key evaluation questions and indicators. The research approach, monitoring methodology and evidence base developed in this project can support the development and implementation of cultural flows in other areas of the country.

The National Cultural Flows Research Project concluded in 2018, and Aboriginal Nations in the Murray–Darling Basin are now starting to implement the assessment methodology developed in the project.

## 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 16 870 GL in 2017–18. This is 7 per cent higher than the figure reported for 2016–17.

28 http://culturalflows.com.au

Water abstracted for agricultural purposes (12 150 GL) accounted for 72 per cent of the total, followed by water abstractions for urban use (3200 GL, 19 per cent) (Figure 38). Water abstractions rose primarily as a result of an increase in water used for agricultural purpose.

Water abstracted for other industrial purposes (1520 GL) is based on 2016–17 estimates of water consumed by the mining, manufacturing, electricity and gas supply, and other industry categories in *Water Account, Australia, 2016–17* (Australian Bureau of Statistics, 2019).

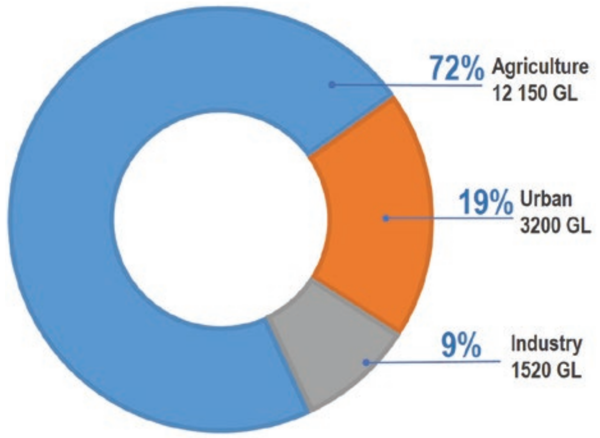



**Figure 38. Total bulk water abstractions by category in 2017–18**

### 3.4.2 Agricultural water abstractions

The total water abstracted for agricultural use in Australia in 2017–18 is estimated at 12 150 GL, of which 9500 GL (78 per cent) was sourced from surface water and 2650 GL (22 per cent) from groundwater. The annual total increased by 9 per cent from 2016–17. Nationally, surface water abstractions increased by 3 per cent and groundwater extractions by 37 per cent compared with 2016–17. In all States and Territories except the Northern Territory, surface water diversions were higher than groundwater diversions to satisfy the irrigation demands.

In the Northern Territory, groundwater extractions were 97 per cent of the total (42 GL).

In New South Wales, 4590 GL of water was abstracted for agricultural water in 2017–18; this is about 38 per cent of the total water abstracted for agricultural purposes in Australia (Figure 39). Victoria and Queensland were the next highest, accounting for 26 and 17 per cent of the total agricultural abstractions, respectively. Water abstraction for agricultural purposes was the lowest in the Northern Territory (0.4 per cent), followed by Tasmania (4 per cent), Western Australia (7 per cent) and South Australia (8 per cent).

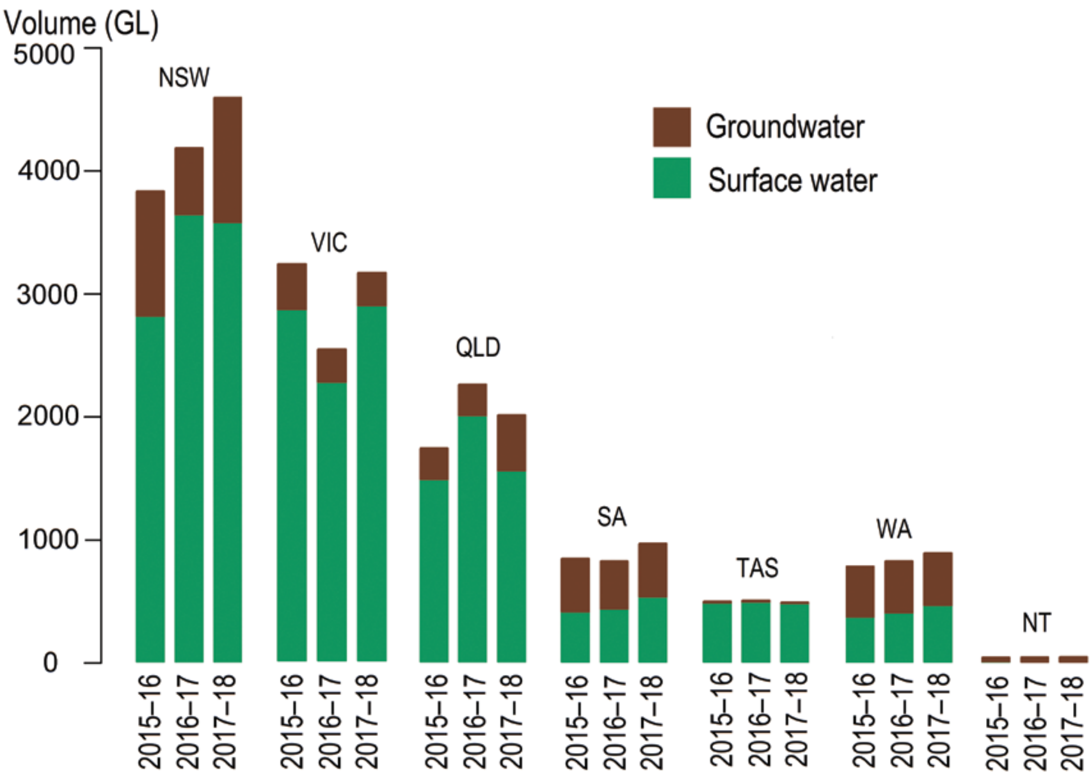



**Figure 39. Volume of agricultural water abstractions from surface water and groundwater in each State and Territory, 2015–16 to 2017–18**

Low surface water allocation due to the dry conditions during the year in many States in the southern mainland resulted in farmers supplementing allocations with carryover, trade and groundwater. In New South Wales, total water abstraction for agricultural use in 2017–18 was about 10 per cent higher than in 2016–17; surface water abstractions decreased by 2 per cent but groundwater extractions increased by 88 per cent. Higher water allocations announced at the start of the year due to large carryover volumes from 2016–17 led farmers to increase cropping areas at the beginning of the irrigation season. However, low water availability during the year due to the dry conditions in the State resulted in farmers supplementing allocations with carryover and groundwater. This caused the significant increase in groundwater extractions. Surface water abstractions in Queensland dropped during 2017–18 by 22 per cent (from 2002 GL in 2016–17 to 1555 GL in 2017–18), but groundwater extractions increased by 77 per cent.

In Victoria, surface water abstractions increased by about 27 per cent and groundwater extractions were similar to that of the previous year. Both surface and groundwater use were low in 2016–17 due to the wet conditions experienced during that year. In the Northern Territory, abstractions from surface water in 2017–18 were 38 per cent higher than in 2016–17, whereas groundwater extractions were similar to the previous year. In Tasmania, surface and groundwater abstractions dropped by 2 per cent and 23 per cent, respectively.

Surface water use in Western Australia increased from 401 GL in 2016–17 to 463 GL in 2017–18. This was mainly due to a 21 per cent increase in surface water abstraction from Lake Argyle in the Ord River basin due to the dry conditions and the Stage 2 irrigation expansion in the Goomig Farmlands. Groundwater use in 2017–18 in Western Australia was similar to that of the previous year (425 GL). In Western Australia, surface and groundwater abstractions accounted for 52 per cent and 48 per cent, respectively, of the total water sourced. In 2016–17, the comparable figures were 48 and 52 per cent.

In South Australia, surface and groundwater abstractions increased by 23 per cent and 11 per cent, respectively, in comparison to 2016–17. Surface water contributed 55 per cent of the total water sourced in 2017–18; the remaining 45 per cent came from groundwater.

These data were based on non-urban diversions in the National Water Account 2018[29], 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

In 2017–18, urban utilities across Australia extracted 3200 GL from surface water, groundwater and desalinated water. Surface water contributed about 86 per cent, similar to that of the previous year. Groundwater and desalination supplies contributed about 8 per cent and 6 per cent, respectively. Total urban water sourced in 2016–17 was around 3130 GL. The 2 per cent increase in 2017–18 is attributed to the dry weather conditions experienced in major parts of the continent.

The average annual volume of residential water supplied per property in major urban areas was 211 kL in 2017–18, 3 per cent higher than the previous year. The increase is mainly due to dry periods with low rainfall in many areas. Average residential water use per property increased in all major urban centres in 2017–18 in comparison to previous year except in Perth (2 per cent decline), Melbourne (1 per cent decline) and South East Queensland (2 per cent decline).[30] Average residential water supplied in Perth has declined steadily over the past five years, from 254 kL/property in 2013–14 to 219 kL/property in 2017–18. Adelaide reported the largest increase (14 per cent), followed by Hobart (8 per cent). Average annual residential water use increased by 4 per cent in Canberra, from 190 kL per property in 2016–17 to 197 kL in 2017–18. Water use in Darwin increased by 2 per cent, from 361 kL per property in 2016–17 to 368 kL in 2017–18. Sydney recorded an increase of 4.4 per cent.

Darwin had the highest average urban water use per property (368 kL), followed by Perth (219 kL). Average residential water supplied was the lowest in Melbourne (148 kL), reflecting ongoing water saving measures.

29 www.bom.gov.au/water/nwa/2018

30 www.bom.gov.au/water/npr/index.shtml

### 3.4.4 Urban Water restrictions

Urban water restrictions are any constraints placed on water use by a water agency, local council or State or Territory government.[31] Water restrictions are declared in times of drought or water scarcity to manage water demand. The restrictions are mainly imposed on non-essential uses, like watering gardens, washing vehicles and using hoses. In 2017–18, most Australian capital cities and major urban centres had permanent water savings rules, water efficiency programs and demand management strategies in place. Melbourne, Sydney, Canberra, Perth and Adelaide all had permanent water conservation measures in place (Table 9). These permanent strategies were put in place in the late 2000s, following the lifting of temporary restrictions of varying severity that had been issued during the extended period of the Millennium Drought.

In 2017–18, some temporary water restrictions were in place in the Eurobodalla and Walgett areas of New South Wales, but most areas remained under existing, permanent measures.

Brisbane, Hobart and Darwin did not have permanent water restrictions regimes in place in the same manner as the other capitals. In South East Queensland during the Millennium Drought, water conservation measures were put in place across the region through a set of permanent water conservation measures from the Queensland Water Commission. These measures came into effect during 2009 and 2010 and were lifted on 1 January 2013. Since then, South East Queensland Water (SEQ Water) has been working under a Drought Response Plan for the region as part of *Water for Life: South East Queensland's Water Security Program 2016–2046*[32].

**Table 9. Permanent water savings programs in place in capital cities in 2017–18**

| Location | Water savings program | Date commenced | Description |
|---|---|---|---|
| Melbourne | Permanent Water Savings Rules—'Target 155' | December 2012 | • Issued by the Department of Environment, Land, Water and Planning<br>• Implemented by utilities and retailers<br>• Aims for 155 L/p/d<br>• www.water.vic.gov.au/liveable-cities-and-towns/using-water-wisely/t155 |
| Sydney | Permanent Water Wise Rules | June 2009 | • Issued by Sydney Water<br>• Includes encouragement for leak repair and installation of devices rated under the Water Efficiency Labelling Standards (WELS)<br>• www.sydneywater.com.au/SW/water-the-environment/what-we-re-doing/water-wise-rules/index.htm |
| Canberra | Permanent Water Conservation Measures | November 2010 | • Issued by Icon Water<br>• Applies to potable water supply only<br>• Penalties for non-compliance<br>• www.iconwater.com.au/my-home/saving-water/when-can-i-water/permanent-water-conservation-measures.aspx |
| Perth | Permanent Water Efficiency Measures | October 2007 | • Issued by Western Australian Department of Water and Water Corporation<br>• Focuses on best practice outdoor water use<br>• Penalties exist for non-compliance<br>• www.watercorporation.com.au/home/faqs/saving-water/what-is-the-difference-between-water-restrictions-and-permanent-water-efficiency-measures |
| Adelaide | Permanent Water Wise Measures | December 2010 | • Issued by SA Water<br>• Provides guidelines for efficient water use<br>• Penalties exist for non-compliance<br>• www.sawater.com.au/residential/water-in-your-home-and-garden/when-can-i-water |

31 www.bom.gov.au/water/restrictions

32 www.seqwater.com.au/waterforlife

Table 9 (continued)

| Location | Water savings program | Date commenced | Description |
|---|---|---|---|
| Brisbane | No permanent restrictions in place<br>South East Queensland Drought Response Plan | January 2013 | • Issued by SEQ Water and implemented by retailers and councils<br>• First level of Drought Response Plan (70 per cent capacity) almost triggered in 2017 but not required<br>• www.seqwater.com.au/waterwise |
| Hobart | No permanent restrictions in place | - | • The only reports of restrictions in Tasmania for the 2017–18 year are temporary restrictions in the Currie area |
| Darwin | No permanent restrictions in place<br>Darwin Living Water Smart<br>Katherine Living Water Smart | - | • Restrictions and demand management implemented by Power Water<br>• Restrictions in place through the Living Water Smart Katherine and Living Water Smart Darwin programs<br>• Other parts of the Northern Territory subject to ongoing demand management and efficiency programs, but not water restrictions<br>• www.livingwatersmart.com.au |

The program sets out different restriction regimes that will be applied when combined storages reach triggers of 70 per cent, 50 per cent, 25 per cent and 10 per cent. In South East Queensland during 2017, the 70 per cent trigger for drought readiness was triggered twice—once in March and once in October. On both occasions, however, rainfall boosted water supplies and additional measures were not required.

The Northern Territory had no temporary water restrictions in place during the 2017–18 period. The only restrictions in place were for the town of Katherine, through the Living Water Smart Katherine Program.[33] This program imposes compulsory water conservation measures on the town, including a restriction on household garden watering to three days per week and a ban on watering hard surfaces. The program also includes rebates to fix leaks, and shower head swap programs for hotels, motels and caravan parks. Ongoing demand management and efficiency programs for other areas of the Northern Territory, including a Living Water Smart program for the Darwin region, are implemented by Power Water on an ongoing basis.

No permanent water savings rules are in place in Tasmania. Temporary water restrictions put in place for the Currie area were the only restrictions reported in 2017–18.

### 3.4.5 Sources of water for major urban centres

Urban water supplies traditionally rely on surface water from reservoirs and, to a lesser extent, on groundwater resources, both of which are highly susceptible to variability in rainfall. Due to increased demand and changes in the reliability of traditional water sources, cities have adopted a variety of approaches, including extending their water supply catchment areas to the hinterlands, investing in non-traditional sources such as desalination and recycling, and exploring options for stormwater and rainwater harvesting.

In 2017–18, surface water sourced from local reservoirs was the main source of urban water supply in all major urban centres in Australia except Perth. In all major urban centres except South East Queensland, surface water diversions increased in 2017–18 compared with 2016–17 (Figure 40).

Total water sourced is considered here as the sum of surface water, groundwater, desalinated and interregional transfers. Recycled water is not included in the total water sourced as it is obtained internally from water already sourced from elsewhere. In Figure 40, recycled water volumes are shown on top of the total water sourced.

In Sydney, 607 GL was sourced from surface water, an 8 per cent increase from the previous year.[34] The increase was mainly due to the very dry conditions in the region. About 2 per cent of the total sourced was recycled.

33 www.livingwatersmart.com.au [Accessed 25 February 2019]

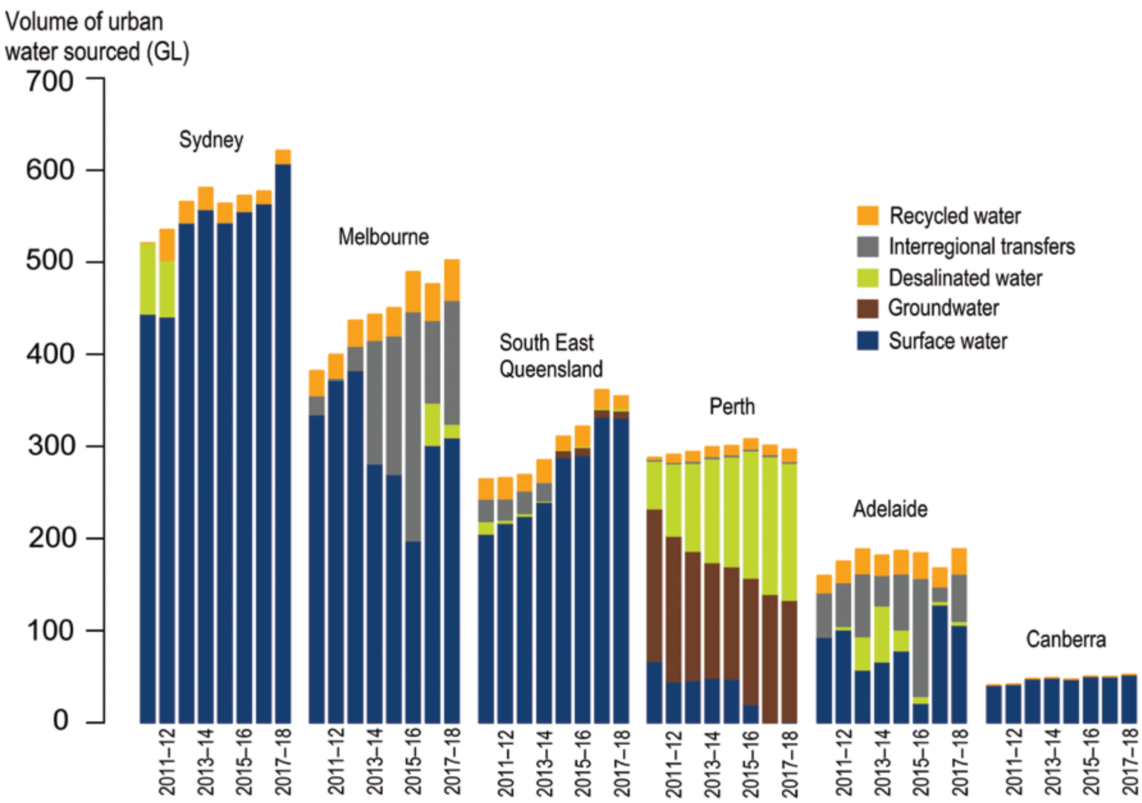
34 www.bom.gov.au/water/nwa/2018

Total water sourced for urban use in Melbourne in 2017–18 was 459 GL, a 5 per cent increase from 2016–17. Surface water contributed 67 per cent of that sourced and 29 per cent was from interregional transfers from Thomson Reservoir. The interregional transfer increased by 50 per cent from 2016–17 to 2017–18. This increased reliance on interregional transfers was mainly due to improved availability of water from the Thomson system, reducing the need for desalinated water. In 2017–18, the Victorian Government ordered only 15 GL of desalinated water, about 70 per cent less than the 50 GL ordered the previous year. About 10 per cent of the total water sourced into Melbourne was recycled in 2017–18.

In South East Queensland, the total water sourced was 342 GL in 2017–18, which was similar to 2016–17. About 97 per cent of the total was supplied from surface water. Groundwater contributed 2 per cent and the contribution from desalination was minimal. About 4 per cent of the total water sourced was recycled.

Water sourced for urban use in Adelaide increased by 9 per cent from 2016–17 to 2017–18, the highest increase of all the major urban centres. About 66 per cent of this was sourced from surface water and 32 per cent through interregional transfers from the River Murray compared with 87 per cent from surface water and 10 per cent through interregional transfers in 2016–17. This increase in interregional transfers from the River Murray was mainly due to reduced water availability arising from below-average rainfall in the catchments of the urban storages. The contribution from desalination was similar to the previous year: about 3 per cent of total water sourced. About 17 per cent of the total water sourced was recycled.

In Canberra, 52 GL of water was sourced for urban use, which is 5 per cent higher than in 2016–17. Most of it was sourced from surface water (>99 per cent) and less than 0.5 per cent was provided by interregional transfers (from Braidwood Dam).




Source: National Water Account 2018[35]
Note: Total water sourced is the sum of the sum of surface water, groundwater, desalinated and interregional transfers
**Figure 40. Volumes and sources of urban water used in Australia's major urban centres, 2010–11 to 2017–18.**

35 www.bom.gov.au/water/nwa/2018

The volume of water sourced for urban use in Perth in 2017–18 was similar to that of 2016–17. About 99 per cent supply was met from two sources: desalination (about 150 GL) and groundwater (about 132 GL). The contribution from desalination was similar to that of the previous year but groundwater extraction was 5 per cent less. About 5 per cent of the total urban water sourced was recycled. Excess groundwater and desalinated water produced during low-demand periods were discharged into the surface water storages, so the combined net diversion from the storages contributed about 0.5 per cent of the total supply.

### 3.4.6 Water use by other industries

The largest water user in Australia is agriculture, followed by urban users and industry. Industrial water use encompasses a broad range of sectors, including mining, manufacturing, electricity production and service industries.

The latest data available for non-agricultural industries are for 2016–17. The total water consumed in Australia for industrial purposes (estimated to be 1522 GL) was similar to that of 2015–16.[36] Of this total, mining was estimated to use 693 GL (2 per cent increase), manufacturing to use 558 GL (2 per cent decrease) and electricity and gas to use 271 GL (2 per cent increase). In-stream use by the hydro-electric industry is not included. Water consumption by other industries, especially service industries, is estimated as 1137 GL (Australian Bureau of Statistics, 2018) and is included in the extractions for urban use.

Electricity generation mostly uses surface water, with many large power plants having a high-security entitlement, whereas mining water demand is sourced from surface water, groundwater and/or desalinated water.

## 3.5 WATER STRESS

Water is essential for human activity and ecosystem functioning. Global freshwater supplies are increasingly under pressure as water demand increases steadily with population growth, economic development and changes in consumption patterns due to improved living standards. Water availability and use vary around the world. Water stress affects many regions, and more than two billion people live in countries experiencing high levels of water stress.

To assess whether freshwater is a constraint in meeting the basic needs of humans and economic development, a number of indicators have been developed over the past few decades to assess the relationship between water availability and water use. The United Nations Sustainable Development Goal (SDG) indicator 6.4.2 was developed by the Food and Agricultural Organization (FAO) of the UN to compare estimates of the sustainability of water use across the world.[37] Indicator 6.4.2 estimates the level of water stress as the ratio between the total volume of freshwater withdrawn by major economic sectors and the total renewable freshwater resources, after considering environmental water requirements. This indicator shows the degree to which water resources are being withdrawn to meet the demand.

Values for the SDG 6.4.2 water stress indicator for Australia for 2015–16 to 2017–18 are shown in Table 10. Although the value has increased since 2015–16, the estimates are well below the initial water stress level of 25 per cent identified by the United Nations.

These figures suggest that water stress is low for Australia on a national level but make no assessment of sub-national water shortages, which is critical considering the high volumes and low use in northern Australia, compared to the high use in southern Australia.

**Table 10. Water stress indicator values for Australia, 2015–16 to 2017–18**

| **Year** | 2015–16 | 2016–17 | 2017–18 |
|---|---|---|---|
| **SDG 6.4.2 indicator** | 5.9% | 4.1% | 6.8% |

36 www.abs.gov.au/ausstats/abs@.nsf/mf/4610.0

37 www.fao.org/sustainable-development-goals/indicators/642/en

## 3.6 GROUNDWATER EXTRACTIONS

### 3.6.1 Licensed extractions

Groundwater management areas are declared to assist in the ongoing management of groundwater, including the management of licensed entitlements. Groundwater is also extracted outside groundwater management areas across Australia, but in many jurisdictions data for these areas are sparsely collected and reported.

This is the third year the Bureau has received and published groundwater extraction data from lead State agencies. The data delivery and quality of data have improved with time. Interactive visualisation of extraction data within management areas boundaries is available through Bureau's Groundwater Insight application.[38]

In 2017–18, extraction of about 5300 GL groundwater was reported from within management areas, an increase of about 1000 GL (23 per cent) from the previous year. This increase was partly due to improvements in data reporting and partly due to changes in environmental conditions. Large increases in groundwater extraction in New South Wales and South Australia are linked to decreased rainfall and surface water flows (Table 11).

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

In regions where users have the option of groundwater or surface water, groundwater is generally harder and more expensive to access, so it will only be used when surface water and its allocation is reduced. This probably explains the additional 171 GL of groundwater used in the Lower Murrumbidgee Deep Groundwater Source in New South Wales in 2017–18 compared with 2016–17. In areas where groundwater is the dominant source of water, lower rainfall may also give rise to increased extraction for irrigation—such as the 26 GL increase in extraction in the Lower Limestone Coast Prescribed Wells Area in South Australia. Smaller increases (less than 10 per cent) occurred in parts of Western Australia and Victoria.

In 2017–18, the Northern Territory and Queensland were able to provide more extensive data, which improved the estimates of licensed groundwater extraction. However, given the continual uplift in data extent and quality, direct comparisons between years do not provide a realistic representation of the actual change.

It is important to note that, due to legislative differences at the State and Territory level, volumes of water extracted for mining are not always included in the water information collected under the requirements of the Water Act. This means that the numbers below may not contain mining-related groundwater extractions, particularly for mine dewatering.

**Table 11. Groundwater extraction volumes, 2015–16 to 2017–18**

| State or Territory | Licensed extractions in groundwater management areas (GL) | | | Comment |
|---|---|---|---|---|
| | 2015–16 | 2016–17 | 2017–18 | |
| NSW | 836 | 618 | 1062 | Increase in 2017–18 is due to low surface water availability and its substitution by more available groundwater. Nearly half the total increase (171 GL) is from the Lower Murrumbidgee Deep Groundwater Source. |
| NT | 49* | 51[a] | 99 | Changes in management rules have required licences for large domestic and stock use in the Darwin Rural Area over the past few years. The increase is most likely due to improved reporting from these new licences. |
| QLD | 244[a] | 253[a] | 626 | Improved data delivery has seen a more accurate representation of extraction. |
| SA | 543 | 388 | 432 | Increase in extraction (26 GL) in the Lower Limestone Coast Prescribed Wells Area in South Australia. |
| TAS | 6 | 4 | 3 | |
| VIC | 356 | 257 | 271 | |
| WA | 2544 | 2708 | 2756 | |

[a] Not directly comparable with the 2017–18 extraction.

### 3.6.2 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 bores for 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 the data still have many gaps. 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 12 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 Water Regulations 2008.

**Table 12. Example areas with a high proportion of non-licensed extraction (domestic and stock) in 2017–18**

| Region | Licensed entitlements (GL/year) | Estimated non-licensed extraction (GL/year) | Non-licensed extraction as a proportion of total use (per cent) |
|---|---|---|---|
| Northern Territory portion of the Great Artesian Basin | 0.09 | 3.5 | 97 |
| Draft Howard Water Allocation Plan Area (within the Darwin Rural Water Control District) | 8 | 25 | 76 |
| Water Sharing Plan for the New South Wales Murray–Darling Basin Fractured Rock Groundwater – Lachlan Fold Belt | 71 | 75 | 52 |
| Shepparton Irrigation District | 191 | 80 | 29 |

Non-licensed extraction also occurs outside defined groundwater management areas, and excessive extraction can also pose problems for streamflow, groundwater-dependent ecosystems and nearby groundwater users. In many jurisdictions these non-managed areas are being identified and incorporated into more formal groundwater management frameworks to reflect the impact that extraction has on the condition and availability of the resource.

## 3.7 WATER AVAILABILITY VERSUS USE

### 3.7.1 Overview

Rainfall and runoff vary greatly across both time and space in Australia. Streams and rivers are the major sources of water for irrigation in the country. Storages in regulated rural water supply systems assist in redistributing water to make it available to farmlands when it is required.

The combined accessible storage volume across the nation decreased from 78 per cent of capacity in June 2017 to 60 per cent in June 2018. The accessible storage volumes in both the Ord and Murray–Darling systems dropped significantly during the year. Analyses of physical water availability, water-use permissions and actual water use help us understand how a water supply system responds to water availability.

### 3.7.2 Hydrological variables

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 into the storages are estimated using the catchment runoff modelled using the Australian Water Resources Assessment modelling system.[39]

Note: This section (3.7) is drafted using the best data available at the time of publication of the report

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

Water-use permissions are the sum of total allocations announced during the year and carryover from last year. Actual diversions (water use) are the total regulated diversions during the year for agricultural, urban and environmental purposes.

The status of physical water availability, water-use permissions and actual water use for the last five years is shown in Figure 41 for the major northern supply systems and in Figure 42 for the Murray–Darling Basin.

### 3.7.3 Northern supply systems

The northern regions in Australia receive high rainfall and have high physical water availability relative to use throughout the year. Total annual rainfall and runoff vary considerably from year to year. River flows are strongly seasonal with major flows occurring during the rainy season from October to April. Storing this water is essential for meeting the needs of crops during the dry winter season. As physical water availability is generally much greater than water needs, water-use permissions and actual diversions vary little between years. The major supply systems include the Ord, Mareeba–Dimbulah, Burdekin, Nogoa–Mackenzie and Bundaberg systems (Figure 41).

In 2017–18, inflow into the Ord system was 1560 GL, the lowest in the past five years and 88 per cent lower than the 2016–17 inflow. This reduction was mainly because of the lower-than-average rainfall received in the catchment. Inflow analysis of the Ord system for the past five years showed that inflow variability is quite high.

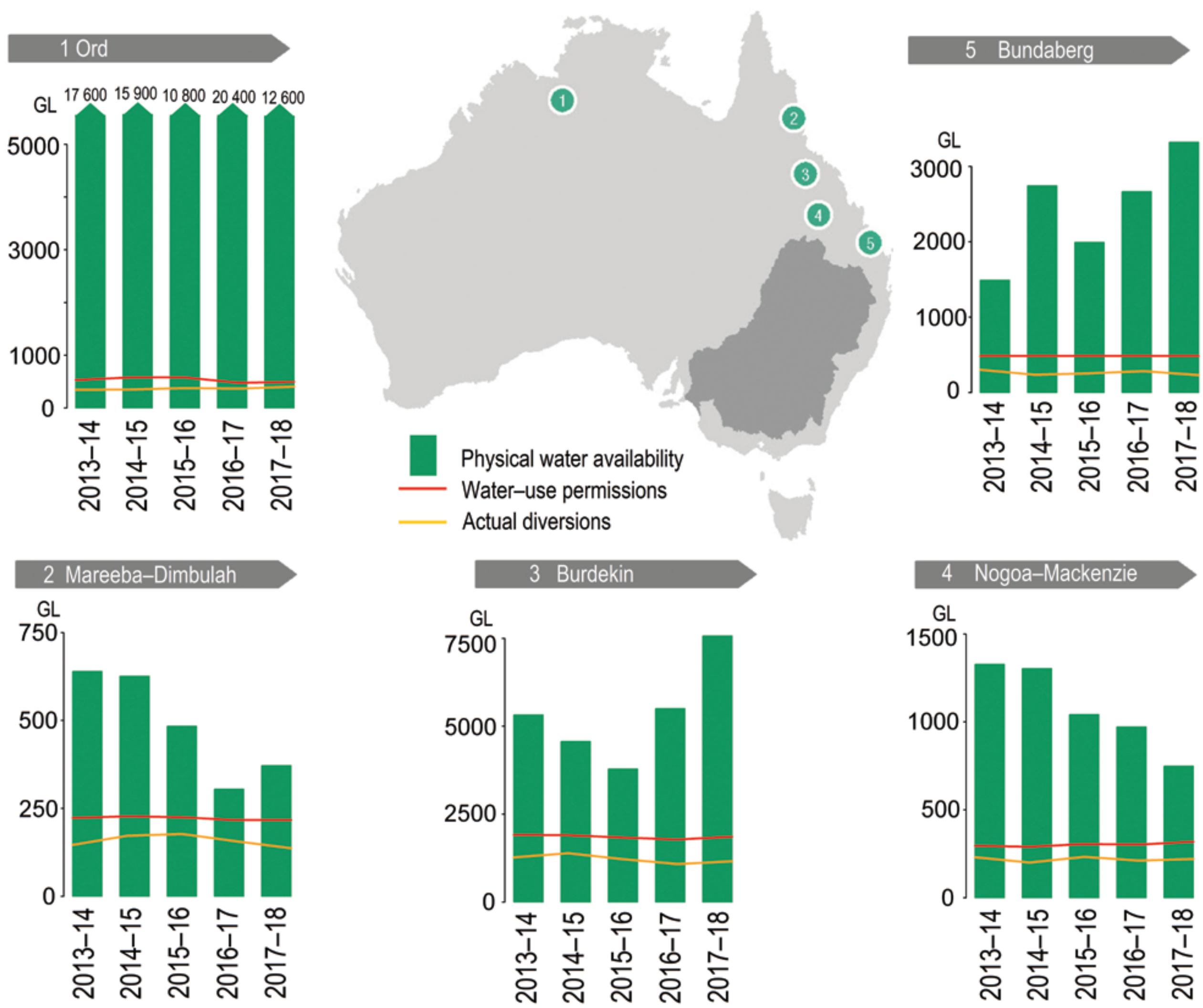



Figure 41. Volume of surface water available in northern Australia, volume of water-use permissions and volume of actual diversions in regulated systems (with more than 100 GL of annual use), 2013–14 to 2017–18

Physical water availability (sum of storage and inflow) dropped by 39 per cent from 2016–17 to 2017–18. The Ord reservoir was 90 per cent full in February 2018 and dropped to 78 per cent of capacity by the end of June 2018. Water use in 2017–18, was 239 GL, 21 per cent higher than last year. This increase in water use is mainly attributed to the dry conditions in the region and the Stage 2 irrigation expansion in the Goomig Farmlands.

Water availability improved in the Mareeba–Dimbulah system from 2016–17 to 2017–18, while water use dropped by 15 per cent. This drop was mainly due to the low allocations announced at the start of the year for medium-priority water allocations, but the announced allocations for medium-priority water reached 100 per cent in February 2018.

In the Burdekin system, physical water availability increased by 37 per cent from 2016–17 to 2017–18, resulting in the highest water availability of the past five years. This was mainly due to the higher-than-average flows received during February and March 2018. The combined storage volume of reservoirs in the Burdekin region was 106 per cent and 111 per cent full in February and March 2018, respectively. Both water-use permissions and water use increased in 2017–18 compared with 2016–17. Water use was 636 GL, 9 per cent higher than in 2016–17.

The Nogoa–Mackenzie system recorded its lowest water availability of the past five years in 2017–18 due to the lower-than-average flows received. Water use was 179 GL, 6 per cent higher than 2016–17. The increase was mainly due to the early (September 2017) announcement of full allocation of medium-priority water during the water year.

In the Bundaberg system, physical water availability increased by 25 per cent in 2017–18 compared to 2016–17, mainly due to the above-average rainfall received in the catchments of the Burnett and Kolan rivers. But water use dropped by 20 per cent from 2016–17 to 2017–18, mainly due to low demand from farmers for irrigation resulting from increased rainfall received in the region.

### 3.7.4 Murray–Darling Basin supply systems

In the Murray–Darling Basin, physical water availability is much closer to water requirements than in the northern supply systems, and water-use permissions and actual diversions can vary greatly between years.

In 2017–18, there were both increases and decreases in physical availability across the system. Water-use permissions increased in the south and showed mixed trends in the north.

In five of the eight systems of the Murray–Darling Basin, physical water availability increased from 2016–17 to 2017–18 (Figure 42) due to the high end-of-year storage volume in June 2017 following higher-than-average rainfall in 2016–17. The exceptions were the New South Wales and Victorian Murray, Macquarie and Murrumbidgee systems, where physical water availability decreased in comparison to the previous year.

Variation in physical water availability over the past five years has been higher in the systems in the northern Murray–Darling Basin (regions 1 to 4 in Figure 42) than in the southern basin systems (regions 5 to 8 in Figure 42). In 2017–18, the Border Rivers system had its highest physical water availability of the past five years. Inflows dropped 50 to 70 per cent in all systems in the northern basin from 2016–17 to 2017–18. Despite only a small decline in physical water availability (Figure 42), the accessible storage volume in the Macquarie–Castlereagh system showed the largest decline —it dropped by 41 percentage points, from 78 per cent of capacity in June 2017 to 37 per cent by the end of June 2018 (see Table 2).

In the northern Murray–Darling Basin systems in 2017–18, the annual volume of water-use permissions declined in two systems and increased in two, but actual water use increased in all four systems. This reduced the gap between water-use permissions and actual water use and left little carryover into 2018–19.

In the southern Murray–Darling Basin catchments, physical water availability increased in the Lachlan and Northern Victoria (Ovens, Broken, Goulburn, Campaspe and Loddon) systems but dropped in the New South Wales and Victorian Murray and Murrumbidgee systems. Physical water availability and water use in 2017–18 were the highest of the past five years in the Lachlan system. Though water availability and water-use permissions both increased in the Northern Victoria system, water use has dropped. Both physical water availability and water use dropped in the Murrumbidgee system although permissions increased. The gap between the water-use permissions and actual use increased in the southern basin systems except for the Lachlan.

### 3.7.5 Allocation carryover

When water allocations are not fully used within the water year, carryover gives entitlement holders the flexibility to take allocations into the next water year. At the end of the water year, the carryover rules in each water system determine the amount of allocation that can be carried over and used in the following water year. For environmental water holders, this flexibility of carryover is important to satisfy environmental needs, such as watering wetlands or floodplains or providing an in-stream pulse early in a water year. Non-environmental carryover is the unused portion of allocations for agricultural and urban use.

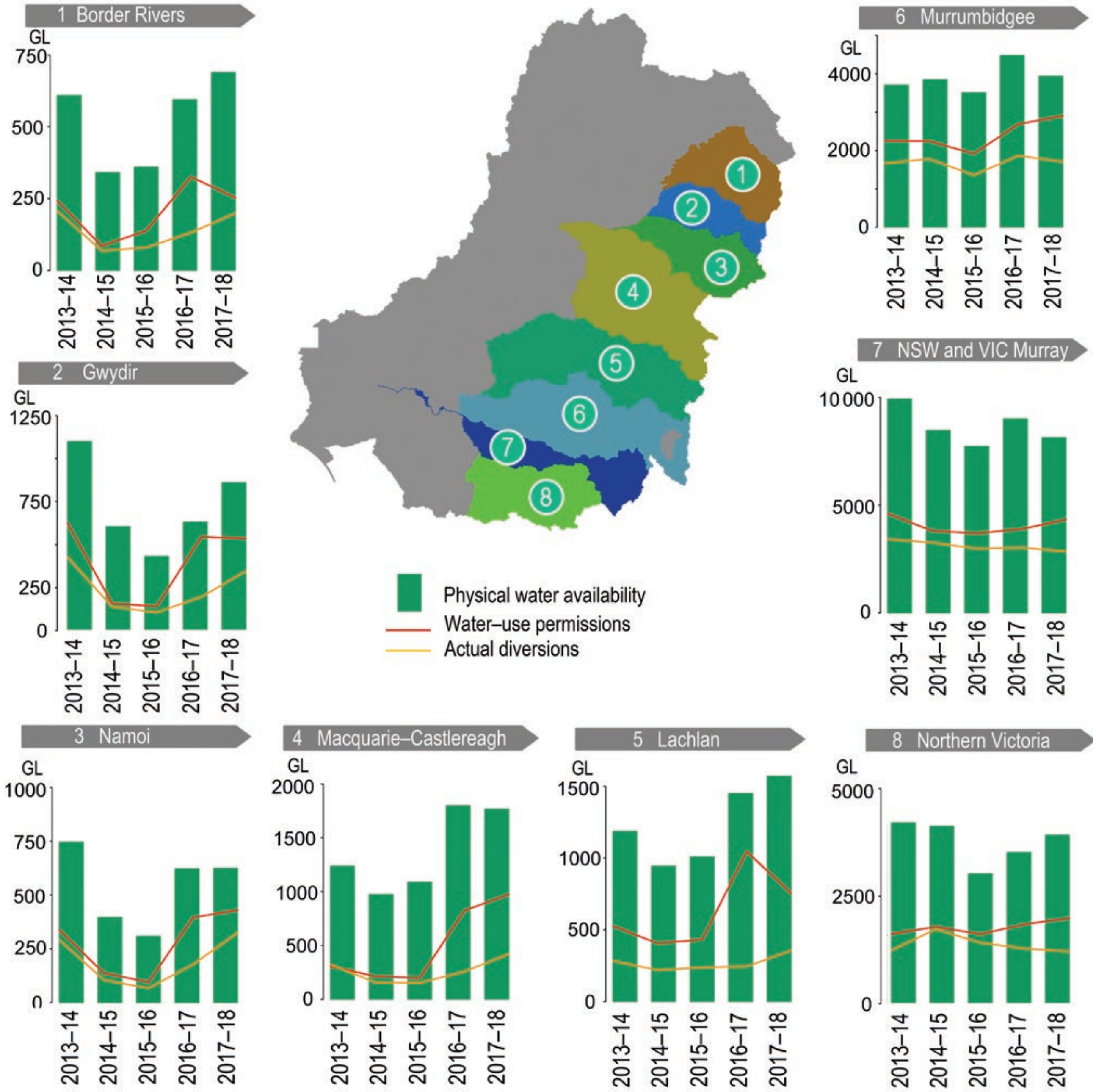



Figure 42. Volumes of surface water available, water-use permissions and actual diversions in Murray–Darling Basin regulated systems (with more than 100 GL of annual use), 2013–14 to 2017–18

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.

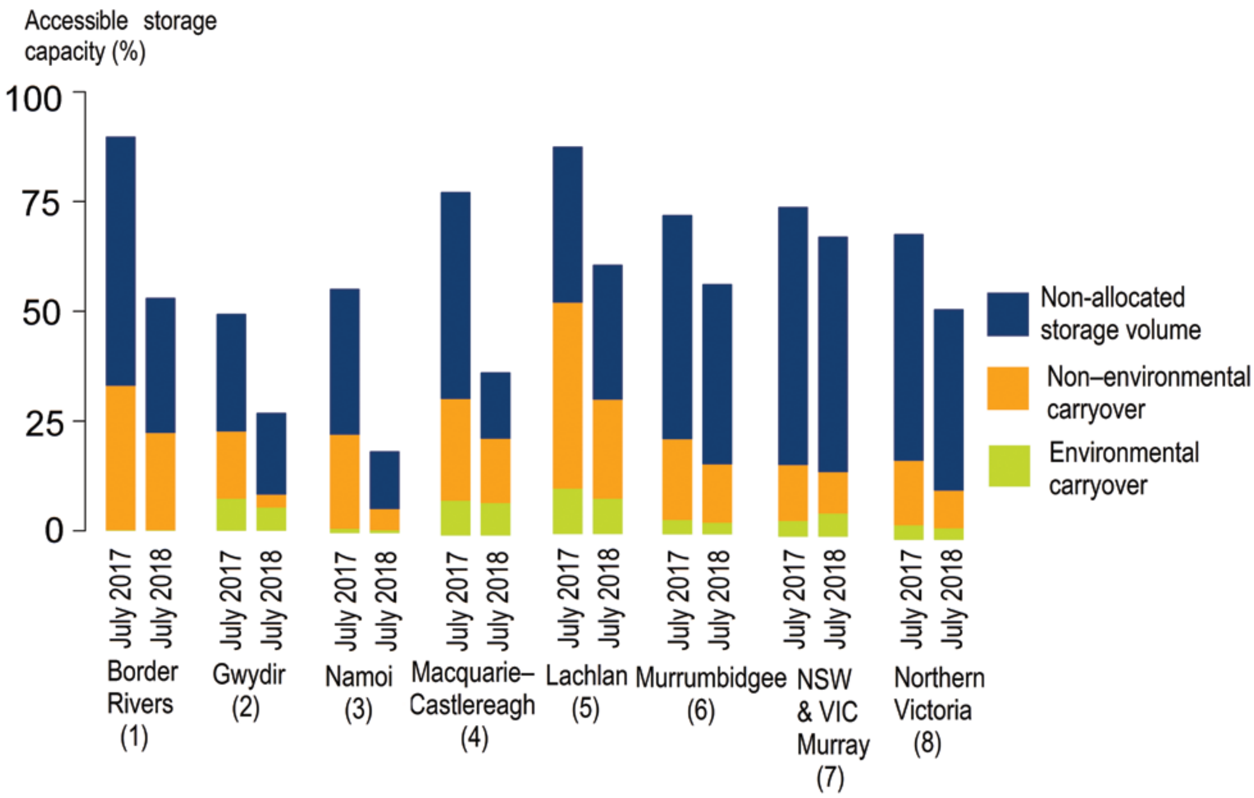
The low carryover volumes into 2018–19 reflected the dry conditions in 2017–18. The opening announced allocations were high at the start of 2017–18 due to high storage volume at the start of the season. Carryover volumes into 2017–18 were also quite high due to the wet conditions that existed in 2016–17, resulting in farmers not using their full allocation during the year.

The volumes of environmental and non-environmental water carried over into 2018–19 were lower than the carryover into 2017–18 in most of the Murray–Darling Basin catchments (Figure 43) due to the dry conditions in 2017–18. The New South Wales and Victorian Murray had the highest carryover volume into 2018–19 at 1005 GL which was about 17 per cent of accessible storage capacity. The next highest carryover volumes occurred in the Northern Victoria (463 GL), the Murrumbidgee (420 GL) and the Lachlan (384 GL) systems.

The sum of environmental and non-environmental carryover at the beginning of 2018–19 in the Lachlan system was about 31 per cent of accessible storage capacity; in the Macquarie system it was about 22 per cent.

The Gwydir and Namoi supply systems had a significantly decreased carryover into 2018–19 compared with the carryover into 2017–18. This was due to due to irrigators using their carryover because of the dry climatic conditions in 2017–18.

Allocation carryover allows irrigators and other water users to better plan their resources for achieving the best outcome. It gives irrigators the flexibility to plan agricultural activities in a dry year when the announced allocations are low. The depletion of carryover levels at the start of 2018–19, and the dry conditions expected across the basin, will influence the production decisions of irrigators for 2018–19.




Note: The catchment numbers on this graph match the system numbers in Figure 42.

**Figure 43. Storage volumes at 1 July 2017 and 1 July 2018, showing carryover from the previous year in the Murray–Darling Basin**

# 4 GLOSSARY

| | |
|---|---|
| **abstraction** | The removal of water from reservoir, river, pond or channel for use. |
| **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. |
| **aquifer** | An underground layer of saturated rock, sand or gravel that absorbs water and allows it to pass freely through pore spaces. |
| **aquitard** | A geological formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients. May function as a confining bed. |
| **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 www.bom.gov.au/watl/about-weather-and-climate/australian-climate-influences.shtml?bookmark=iod |
| **Internal trade** | A transaction to transfer a water right (www.bom.gov.au/water/awid/id-629.shtml) from one legal entity to another within a specified area. The area can be a trading zone, irrigation district or water resource plan area (www.bom.gov.au/water/awid/id-626.shtml) as defined in respective State and Territory legislation. |
| **interstate trade** | A transaction to transfer a water right from one legal entity to another in a different State or Territory. |
| **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. |
| **river region** | Produced as part of the Australian Hydrological Geospatial Fabric (Geofabric) (www.bom.gov.au/water/awid/id-1087.shtml). These regions align with, and are nested within, the revised drainage divisions (www.bom.gov.au/water/awid/id-860.shtml). |
| **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. |
| **severe rainfall deficiency** | Describes the situation of an area where the total rain received for three months or more is within the lowest five per cent of recorded rainfall for that area |
| **serious rainfall deficiency** | Describes the situation of an area where the total rain received for three months or more is between the lowest five to ten per cent of recorded rainfall for that area |
| **security licence** | A permission to use water at a prescribed level of reliability.<br>High-security licences provide greater reliability for special needs, such as household water, electricity generation, some industry and some perennial high-value crops.<br>On-channel general security licences have lower reliability, which means that these licence holders—usually irrigators of annual crops—are more susceptible to reductions in water availability. |
| **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. |

| | |
|---|---|
| **stormwater** | Surface runoff from rainfall events that may enter drains, creeks or streams. It can carry contaminants that may cause pollution in watercourses. |
| **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 access entitlement type** | Water right types as defined in State and Territory legislation which include bundled and unbundled water rights (www.bom.gov.au/water/awid/id-629.shtml) and bulk water access entitlements (www.bom.gov.au/water/awid/id-584.shtml). |
| **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 six metres. |

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