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Water in Australia 2019–20

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2019–20

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Cover: Lake Oberon, New South Wales (zetter, iStock)

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FOREWORD

Water is vital to life and plays a critical role in the health of our communities, economy, and ecosystems. Freshwater resources in Australia are very limited and year-to-year fluctuations are considerable due to high variability in our rainfall. Coupled with population and economic growth this presents unique challenges for water resources management in Australia. Reliable and transparent information on the state of our water resources is essential to address these challenges.

Under the *Commonwealth Water Act 2007*, the Bureau of Meteorology is responsible for compiling and delivering comprehensive water information across Australia. More than two hundred organisations across Australia collect data on water availability and use relevant to water management. This is provided to the Bureau of Meteorology, which analyses and integrates the information, and makes it openly available in a range of online products.

Water in Australia 2019–20 is the seventh report in a series and covers the period from 1 July 2019 to 30 June 2020. It pulls together the latest data and analysis from across the Bureau to provide an up-to-date assessment of the water situation at a national level in Australia in the context of longer-term trends and climatic influences. The information in the report will be of value to government agencies, policymakers, researchers, industry, educators, students and members of the public looking for insight into the key water issues faced across the country during 2019–20.

Water in Australia provides information at a national level while more detailed information for eleven nationally significant water management regions is provided in the *National Water Account*. Together, these complementary products provide a broad picture of the water resources situation in Australia.

I acknowledge everyone involved for their valuable contributions to this report, including the many agencies who collected and provided their data to the Bureau along with the many experts responsible for the analysis. I would appreciate your feedback so that we can continue to improve our reporting.

Victoria Dodds
Manager Environmental Prediction Services-Water
Bureau of Meteorology

OVERVIEW

- **Dry conditions were experienced across most of Australia for the second successive year.**
- **Combined water storage across Australia on 30 June 2020 was 46 per cent of capacity, similar to the previous year.**
- **Total water taken in Australia for consumptive use was 14 270 GL, six per cent less than the previous year.**

CLIMATE AND WATER

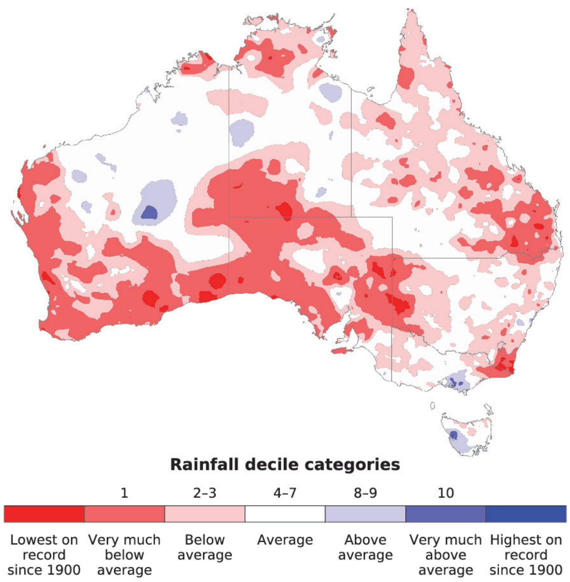


Figure I. Annual rainfall during 2019–20 compared with historical records (1900–2020)

- Australia's total annual rainfall in 2019–20 was 347 mm, well below the mean value of 457 mm (1900–2020).
- This was the second consecutive year of very low rainfall. Over the previous two years, Australia has experienced its driest 24-month period on record.
- Rainfall was very low during the latter half of 2019 due to a positive phase of the Indian Ocean Dipole, one of the strongest on record, that influenced Australia's climate during this period (see the Bureau's 2019–20 Climate Report for more information).
- There was some rainfall relief during the early part of 2020, including very heavy rainfall associated with a coastal trough that impacted the east coast in February 2020.
- Dry conditions over much of Australia during the latter half of 2019 contributed to generally below average streamflow across the whole country in 2019–20.

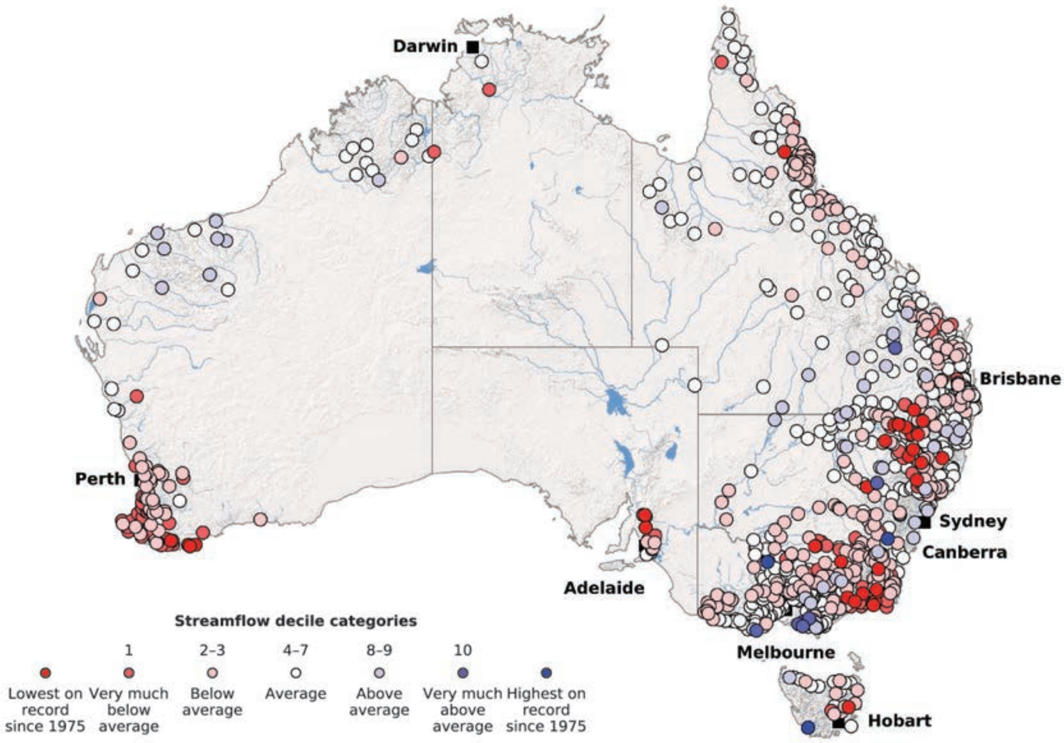


Figure II. Streamflows during 2019–20 compared with historical records (1975–2020)

- Annual flow in some rivers across southern Australia were the lowest on record, particularly in parts of New South Wales.
- In the Murray–Darling Basin, flow in most of the rivers had reached record low levels by December 2019. Above-average rainfall across large areas of New South Wales and Victoria in the early part of 2020, particularly during February to April, resulted in some recovery, with flows occurring in all the major rivers within the Murray–Darling Basin.
- Flow in the lower Darling River reconnected with the River Murray in mid-April 2020 for the first time since January 2018. In February 2020, the first major flows in eight years occurred from the Lower Balonne River into the Ramsar-listed Narran Lakes wetland system.
- The streamflows in southwest Western Australia were predominantly below average in 2019–20 due to very much below-average winter rainfall.
- Total accessible surface water storage for Australia on 30 June 2020 was 23 140 GL or 46 per cent full, similar to the previous year.
- Most of the storages across southeastern Australia remained low, particularly in the northern part of the Murray–Darling Basin where storages were less than 20 per cent of capacity on 30 June 2020.

- In the Murray–Darling Basin, storage volumes increased after February 2020 for the remainder of the 2019–20 year following higher rainfall across the region during February–April 2020; however, many areas have experienced prolonged dry conditions and, by the end of 2019–20, significant follow-up rainfall was needed to replenish these storages.
- Storage volumes in northwestern Australia declined for the third consecutive year. On 30 June 2020, Lake Argyle was at its lowest end-of-year level in almost 30 years.
- Storage volumes in Sydney increased markedly following heavy rainfall associated with a coastal trough that crossed the region in early-February 2020. Total storage almost doubled in 10 days between 8–18 February 2020, the first significant rise in storage since June 2016.

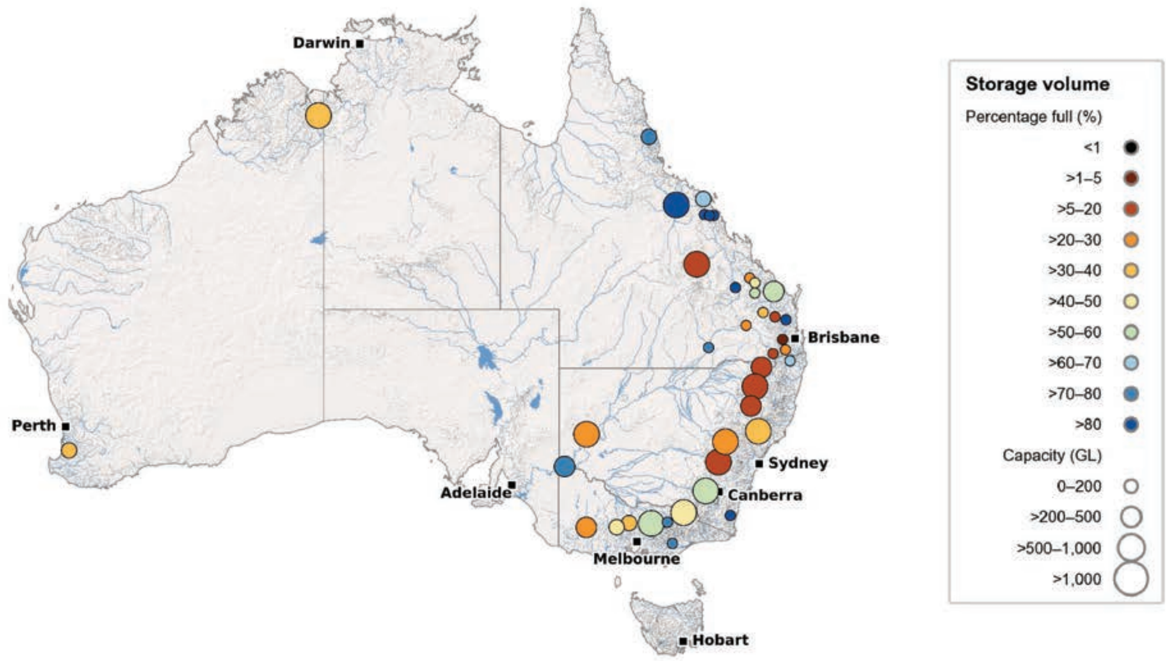


Figure III. Status of rural storage systems on 30 June 2020

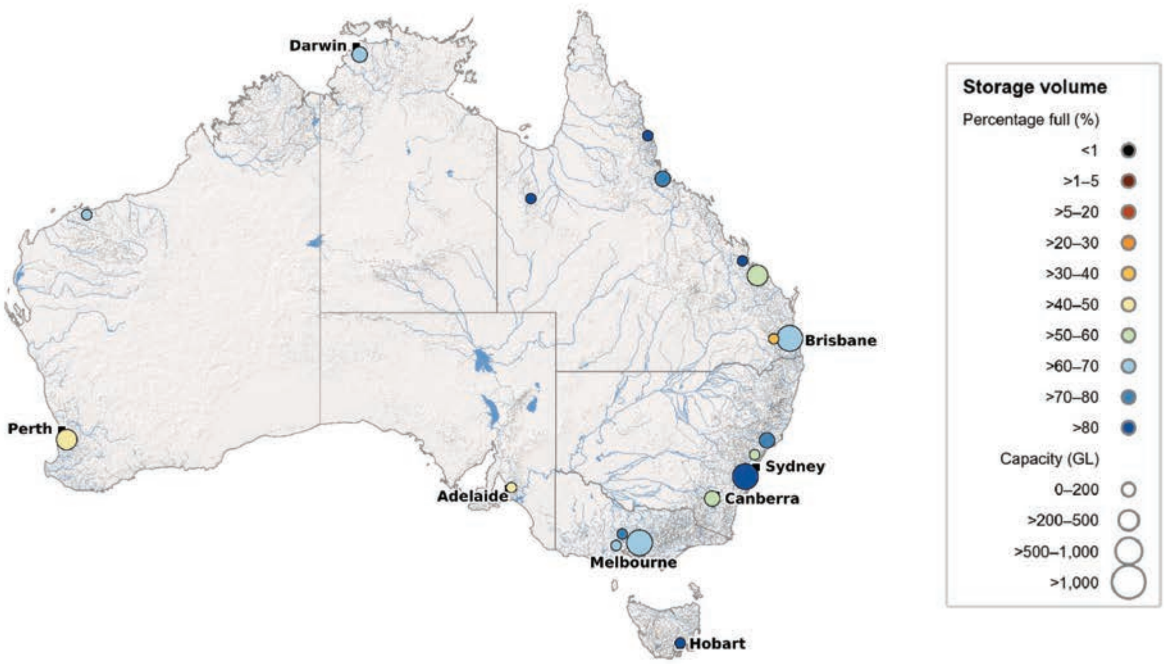


Figure IV. Status of urban storage systems on 30 June 2020

WATER SOURCES AND SUPPLY

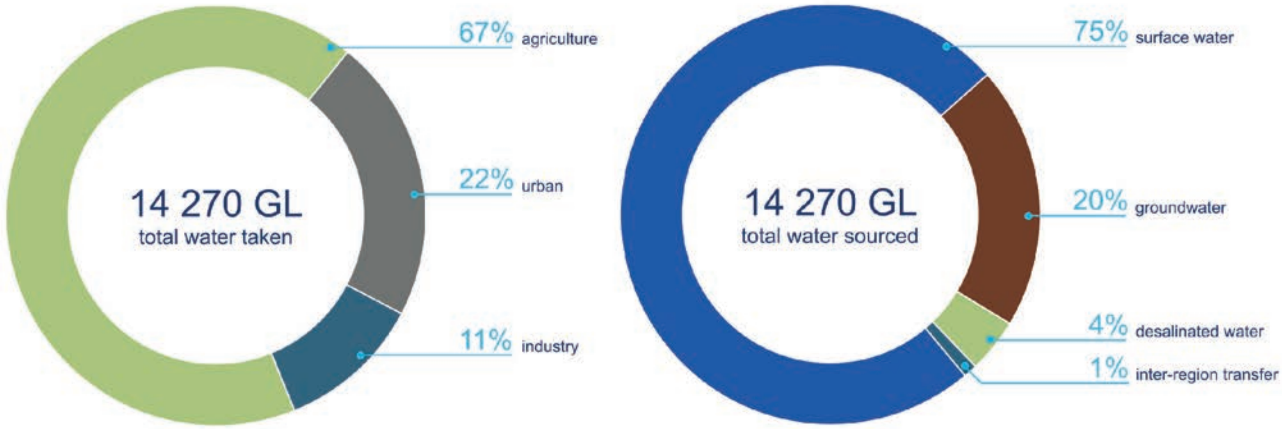


Figure V. Water taken by use category and source in 2019–20

- Total water taken for consumptive water use in 2019–20 was 14 270 GL, six per cent lower than the previous year.
- Surface water was the primary water source, particularly for agriculture, due to ease of access and low abstraction cost.
- Total water taken for agricultural use decreased by 11 percent from 2018–19, largely due to the continued dry conditions and low water availability across the Murray–Darling Basin.
- In 2019–20, desalinated water made up four per cent of total water supply compared to one per cent in the previous year. The very dry conditions during the year, particularly in the latter half of 2019, meant urban utilities opted to reduce pressure on their surface water resources and increase their reliance on desalinated water supply to meet urban demand.
- About 22 per cent of total water taken was for urban water supply. More information on Australia's urban systems is available from the Bureau's National Performance Report 2019–20.
- In 2019–20, water market turnover in Australia was $7 billion, a 39 per cent increase from the previous year. This increase was driven by record entitlement and allocation prices due to low water availability and high demand during the latter half of 2019. More information on water trade across Australia is available from the Bureau's Australian Water Markets Report 2019–20.

1 INTRODUCTION

Australia's climate is highly variable both across the country and from year to year. For many areas the frequency and intensity of extreme events, such as droughts and floods, are important characteristics of the climate. Highly variable rainfall has a significant impact on the availability of water resources. With much of the country arid or semi-arid, Australia has a high reliance on water in storage and groundwater to sustain communities, industries and agriculture. Competition for resources is growing with increasing demands from various sectors including the environment. Periodic assessment and reporting of water availability and use is therefore important to provide insights into the use of these limited resources.

The Bureau of Meteorology is responsible for compiling and delivering comprehensive and transparent information about water resources across Australia to help inform decision-making by water managers and policymakers. Under Part 7 of the *Water Act 2007 (Cwlth)*, 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 use in the context of long-term patterns and climatic influences.

Water in Australia 2019–20 is the seventh in a 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 2019 to 30 June 2020. Water in Australia provides information at a national level while more detailed information for eleven nationally significant water management regions is provided in the *National Water Account*.

Chapter 2 of this report provides an overview of water resources availability in Australia during 2019–20. It provides a summary of climatic conditions and drivers during the year together with the resultant annual and monthly streamflows. The salinity of the streamflow is discussed and how this may constrain water use. An overview of groundwater resources is then presented in terms of three main aquifer groups. The chapter concludes with contributions from climate-independent water sources, such as desalination and recycling.

Chapter 3 of the report begins with an overview of water trading and then summarises water taken for agricultural, urban and industrial uses. Water stress in Australia is estimated using a United Nation's indicator. Water use by environmental water holders and Aboriginal cultural water needs are then discussed.

The information presented in this report is based on the best data available at the time of writing. Values may differ from those shown in other Bureau of Meteorology products due to subsequent updates. Datasets used to generate this report are available for download through specific information sources available at the Bureau of Meteorology website.

- Regional Water Information provides spatial and temporal information and summaries (from nationwide to the river region level) on the status of water resources and use (http://www.bom.gov.au/water/rwi/). The statistics provided in the RWI portal are based on the information available shortly after the end of each financial year.
- Monthly Water Update provides a snapshot of monthly rainfall, streamflow, stream salinity and storage volumes for ten of Australia's 13 drainage divisions (http://www.bom.gov.au/water/monthly-water-update/).
- Groundwater Information Suite provides data on bore water levels and trends, and associated data on hydrogeology and groundwater management (http://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 (http://www.bom.gov.au/water/nwa/2020/).
- 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 each States and Territory, 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).
- Water Reporting Summaries for sixteen Murray–Darling Basin Catchments provide fortnightly summaries of water storage status and commitments (http://www.bom.gov.au/water/nrtwreporting/)
- Climate trends and extremes tracker provides rainfall data sets and statistics from 1900. These data sets are carefully curated from weather station sites with long-records and subjected to complex quality control to address inconsistencies and errors (http://www.bom.gov.au/climate/change/#tabs=Tracker)

2 WATER RESOURCES

This chapter provides an overview of water resources availability in Australia during 2019–20. 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 storages. 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.

2.1 RAINFALL AND STREAMFLOW

2.1.1 National rainfall

The area-averaged annual rainfall across Australia for 2019–20 was 347 mm, 24 per cent less than the mean value (based on data from 1900–2020) of 457 mm. This was the second consecutive year of very low rainfall. Over the previous two years, Australia has experienced its driest 24-month period on record.

Annual rainfall was below average or lower (in the lowest 30 per cent) for sixty per cent of Australia in 2019–20, of which 26 per cent was very much below average (lowest ten per cent of such periods on record). The first half of the financial year (July 2019 to June 2020) was drier than the second half. Rainfall was lower than average in the first six months with lowest on record rainfall (since 1911–12) in November and December 2019. The national area-averaged rainfall was closer to average for the first five months of 2020 and very much below average in June 2020.

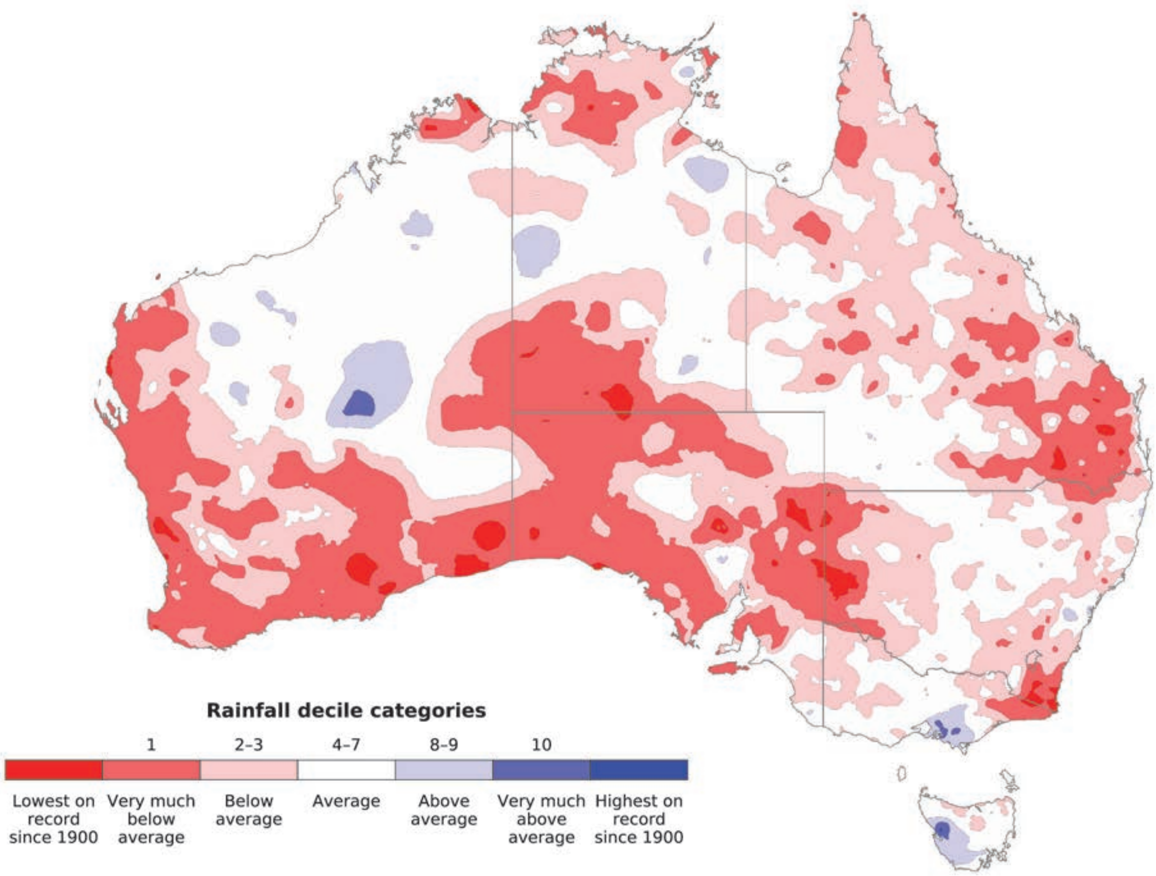


Figure 1. Rainfall deciles map for 2019–20

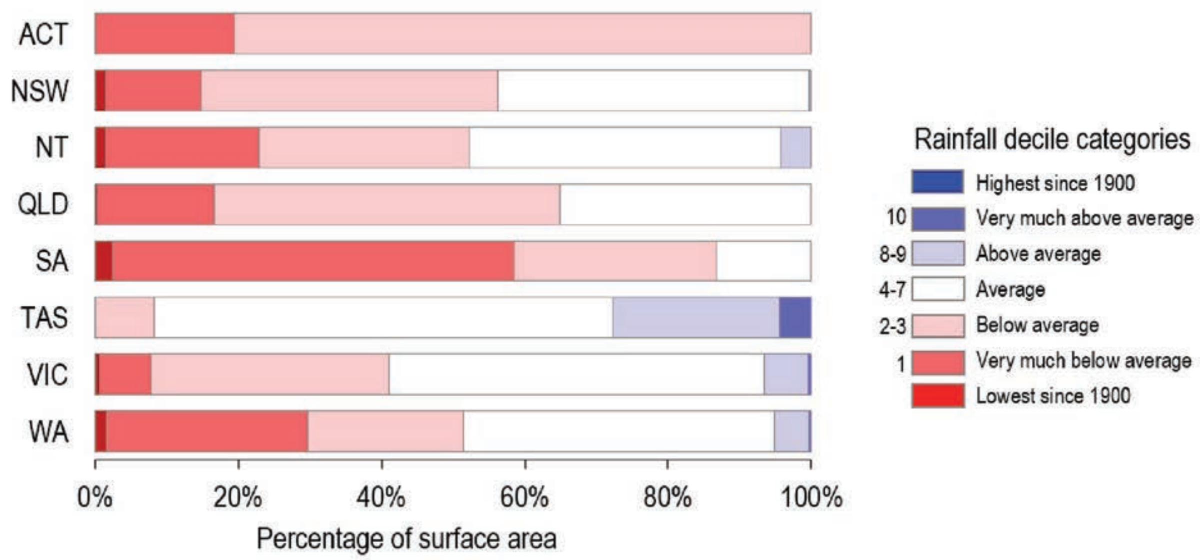


Figure 2. Percentage of each State and Territory in the different rainfall decile categories in 2019–20

After a very dry end to 2019 over much of eastern Australia, the first six months of 2020 saw average to above average rainfall across many rainfall deficient areas and this provided a better start to the winter cropping season in many regions. Rainfall deficiencies have affected most of the New South Wales, Queensland and South Australian parts of the Murray–Darling Basin since early 2017, therefore recovery will be a slow process. Rainfall was above average across large areas of New South Wales and Victoria from January to April, but the 12 months ended with Australia's fourth-driest June on record.

Very much below average rainfall was recorded in the west and south of Western Australia, much of South Australia, the far south and north of the Northern Territory, southeastern Queensland, western New South Wales and far eastern Victoria. Rainfall was higher than average in western Tasmania, and in isolated patches in northern and central Western Australia, the Northern Territory and southeastern Victoria.

The Murray–Darling Basin continued to experience below average rainfall as it had for the last two years. Annual rainfall was 374 mm, 20 per cent lower than the long-term mean (based on data from 1900–2020) of 467 mm. Fifty-seven per cent of the Basin experienced below average rainfall or drier, of which 17 per cent was very much below average.

Northern Australia was also relatively dry with a delayed monsoon onset contributing to a below-average wet season. This was the second consecutive year that the transition of the Southwest Indian Monsoon into the southern hemisphere was later than average.

Annual rainfall was below average or very much below average for more than half of the surface area in most States and Territories (Figure 2). In South Australia, more than half of the surface area experienced very much below average rainfall.

In contrast, Victoria and Tasmania were the only States where average to very much above average rainfall occurred over at least half of the surface area, though for Victoria the area of below average conditions was larger than the area with above average rainfall. Above average to very much above average rainfall occurred over more than one-quarter of Tasmania.

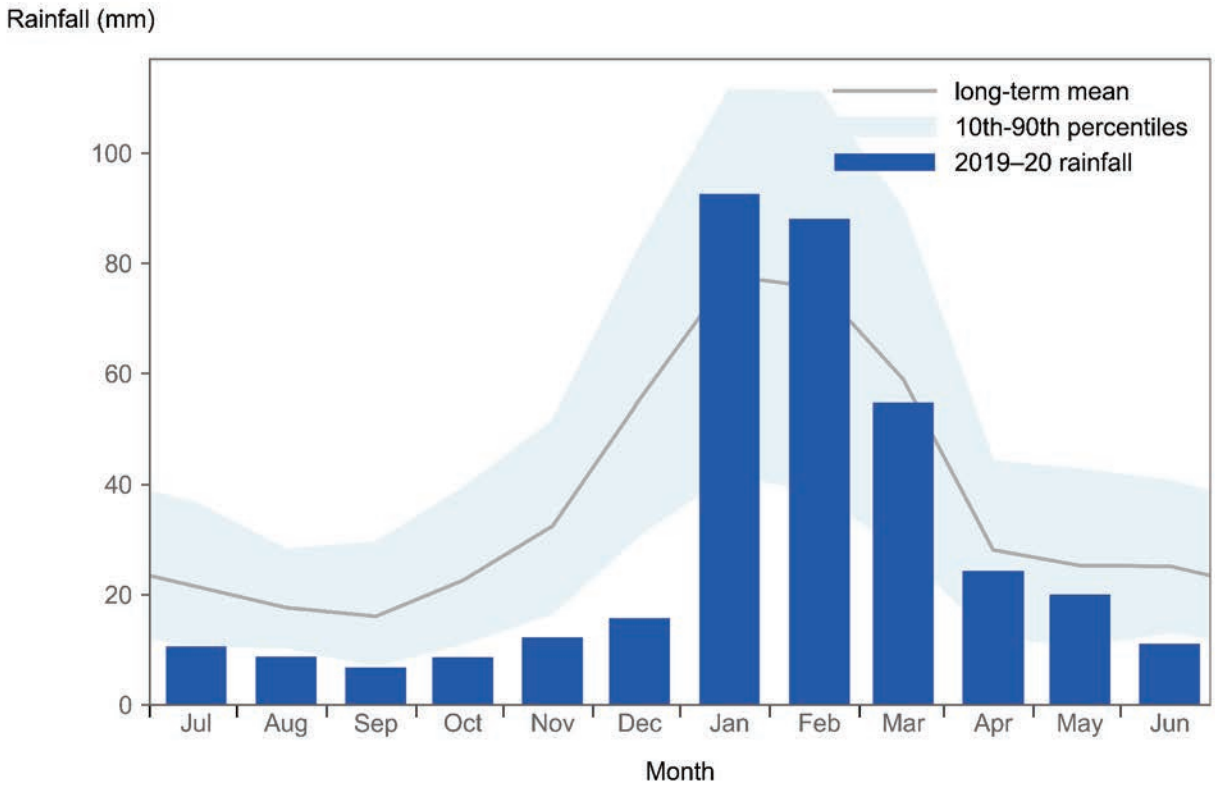


Figure 3. Australian monthly rainfall in 2019–20 compared with the long-term mean and the 10th to 90th percentile range (1900–2020)

2.1.2 Climate drivers

The Indian Ocean exerted a strong influence on Australia's climate during much of 2019–20. A positive Indian Ocean Dipole (IOD) was active during the spring of 2019 and contributed to the very dry conditions that persisted over much of Australia during the latter half of 2019 (Figure 3). The IOD index reached its highest weekly recorded value (for the week ending 13 October 2019) for the available dataset, which extends from 2001. In early 2020, the IOD returned to neutral and warmer than average sea surface temperatures off the northwest coast of Australia saw tropical moisture make its way south across the continent, often interacting with cold fronts from the south, to produce good rainfall for many parts of eastern Australia.

A sudden stratospheric warming, the strongest event since 2002, began at the end of August. This contributed to the prolonged negative phase of the Southern Annular Mode (SAM) from late spring to early summer which resulted in a reduction in rainfall over parts of eastern Australia due to reduced onshore flow, but with wetter conditions in western Tasmania due to the enhanced westerly winds.

The SAM was positive for much of May and June 2020; during winter a positive SAM typically means less rainfall for southwest Western Australia, southern Victoria, and Tasmania. The dry conditions over much of southern Australia during June were consistent with a winter-time positive SAM.

2.1.3 Rainfall distribution

The first half of the financial year (July–December 2019) was particularly dry across most of the southern half of Australia and followed several years of below average rainfall over parts of Queensland and New South Wales. Rainfall was generally lower than average over large areas of the country and was particularly low over mainland southern Australia from July to December (Figure 4). This resulted in strong early season demand for irrigation water in the winter cropping areas of New South Wales, Victoria, South Australia and Western Australia. Warm and windy conditions during spring to early summer led to repeated periods of severe fire weather, with very large bushfires affecting eastern Australia from September, with many fires continuing to burn after the end of 2020.

Nationally, each month from July through December was amongst the ten driest on record for their respective month. November and December were exceptionally dry (Figure 3), the lowest on record for their respective months.

Near-to or above-average rainfall returned to many parts of Australia from January onwards. January rainfall was average for Australia as a whole and was 16 per cent above the long-term mean. Rainfall was above to very much above average for much of the west and northeast extending from the Pilbara to South Australia and beyond to central Victoria, as well as from the eastern Northern Territory to central Queensland.

January rainfall helped to reduce the severity of uncontrolled bush fires across parts of eastern Australia. Two tropical cyclones (*Claudia and Blake*) contributed to higher-than-average rainfall in parts of northern Australia. Tropical cyclone *Claudia* generated locally heavy rainfall across the western Top End. Tropical cyclone *Blake* produced above average rainfall across southwestern Kimberly and parts of the Pilbara.

Much of eastern New South Wales experienced heavy rain in February, while there was more widespread and consistent rain throughout many parts of eastern Australia from February to April. February rainfall was above to very much above average for much of the western part of Western Australia, central and southeastern South Australia, Victoria, central to eastern New South Wales, southeastern Queensland, and parts of the central Northern Territory. A slow-moving trough delivered 392 mm of rainfall over four days in Sydney in early February which is the heaviest four-day rainfall since 1990. Tropical cyclone *Esther* generated above average rainfall along a track extending from the Gulf of Carpentaria through central Northern Territory into central Kimberly in Western Australia. Heavy rainfall at the end February and in early March, partly associated with the remnants of tropical cyclone *Esther*, led to widespread flooding in Queensland and heavy rainfall as far south as Victoria.

The rainfall during the autumn months of April and May are critical for sowing and establishing of winter crops in southeastern Australia. During April, above average rainfall occurred in much of southeastern Australia, northwest Northern Territory and parts of the Kimberley. Victoria and Tasmania recorded the tenth wettest April on record. Rainfall for May was below to very much below average for most of the southern half of Western Australia, most of South Australia, the far south of the Northern Territory, western to central New South Wales and eastern and northern Tasmania.

For Australia as a whole June rainfall was the fourth lowest on record. Rainfall was lower than average for most of Australia and for the Murray–Darling Basin, rainfall was 43 per cent below the long–term mean.

The tropical north depends on rainfall during the northern wet season, which is usually from October through to April. In 2019–20, wet season rainfall was below average for much of northern Australia for the second consecutive year. A near-record strong positive Indian Ocean Dipole (IOD) saw lower than average rainfall at the start of the wet season with a delayed onset of the monsoon contributing to the low rainfall total for the season. The arrival of the monsoon was 6 weeks later than average and the latest on record. Below average tropical low/cyclone activity during 2019–20 also contributed to the relatively dry conditions.

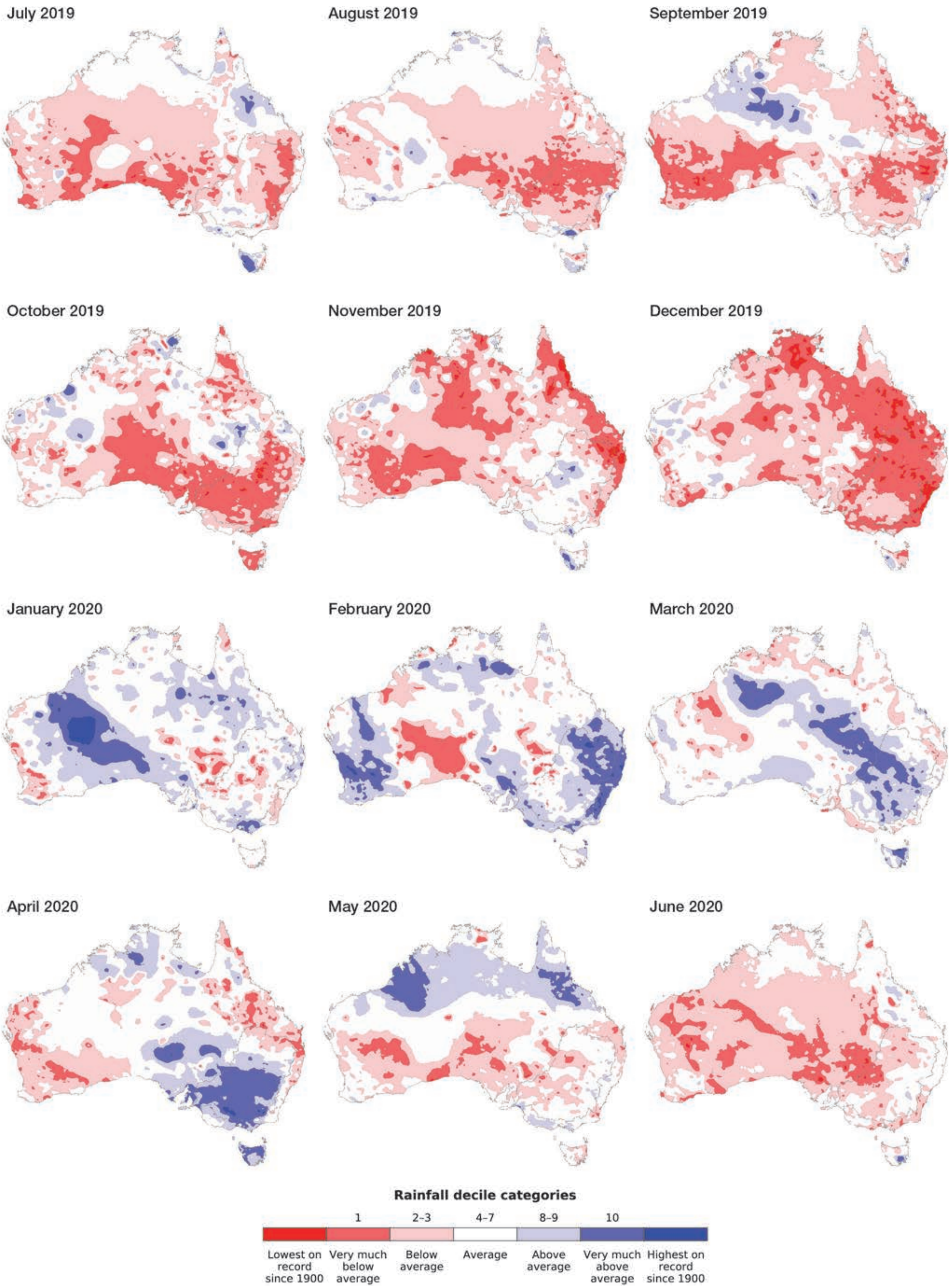


Figure 4. Monthly rainfall decile maps for 2019–20

2.1.4 Streamflow

The annual streamflow deciles for 2019–20 (Figure 5) mostly followed the spatial distribution of the rainfall deciles (Figure 1). The differences between the percentages shown in the State and Territory decile charts for streamflow (Figure 6) and rainfall (Figure 2) are largely due to the limited spatial distribution of the streamflow monitoring sites.

Poor rainfall and dry soils over much of Australia during the first six months of 2019–20 contributed to average to lower than average annual streamflow across the whole country. In 2019–20, forty-eight per cent of the 933 streamflow gauges recorded average flows and 45 per cent recorded lower than average flows.

Lower than average flows were dominant during the year in the southern part of Australia whereas both average and lower flows were dominant in the north. Four per cent of the gauges recorded the lowest flows on record (since 1975); most of these gauges were in New South Wales.

In the Murray–Darling Basin (the Basin), flows in most of the rivers reached very low levels in December 2019. Most of the rivers in the Basin recorded lower than average flows (87 per cent) in December 2019 of which 17 per cent were lowest flows on record. Very few rivers across the northern part of the Basin were flowing at all with more than 30 per cent of the gauges recording the lowest flows on record. Above average rainfall across large areas of New South Wales and Victoria during the first six months of 2020 resulted in some recovery, with flows occurring in all the major rivers within the Murray–Darling Basin (particularly during February to April). In February 2020, the first major flows in eight years occurred from the Lower Balonne River into the Ramsar-listed Narran Lakes wetland system. Flow in the lower Darling River reconnected with the River Murray in mid-April 2020 for the first time since January 2018.

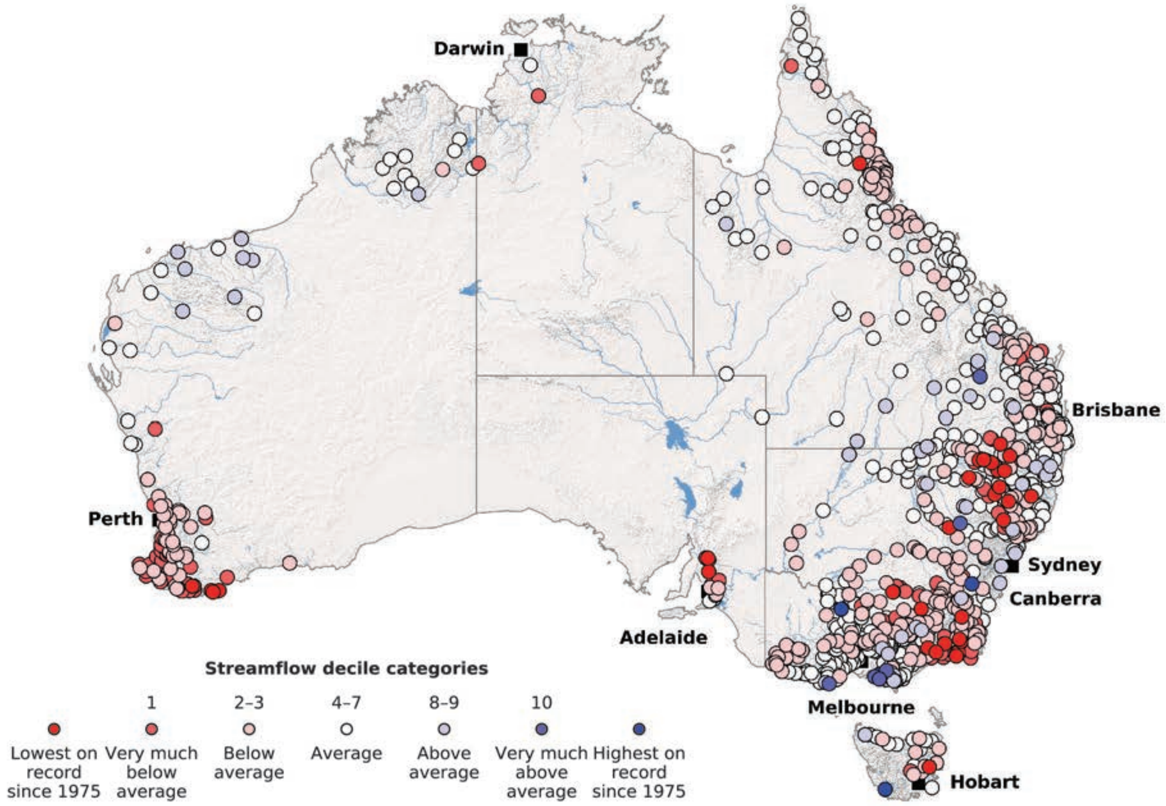


Figure 5. Streamflow deciles map at long-term monitoring stations throughout Australia in 2019–20

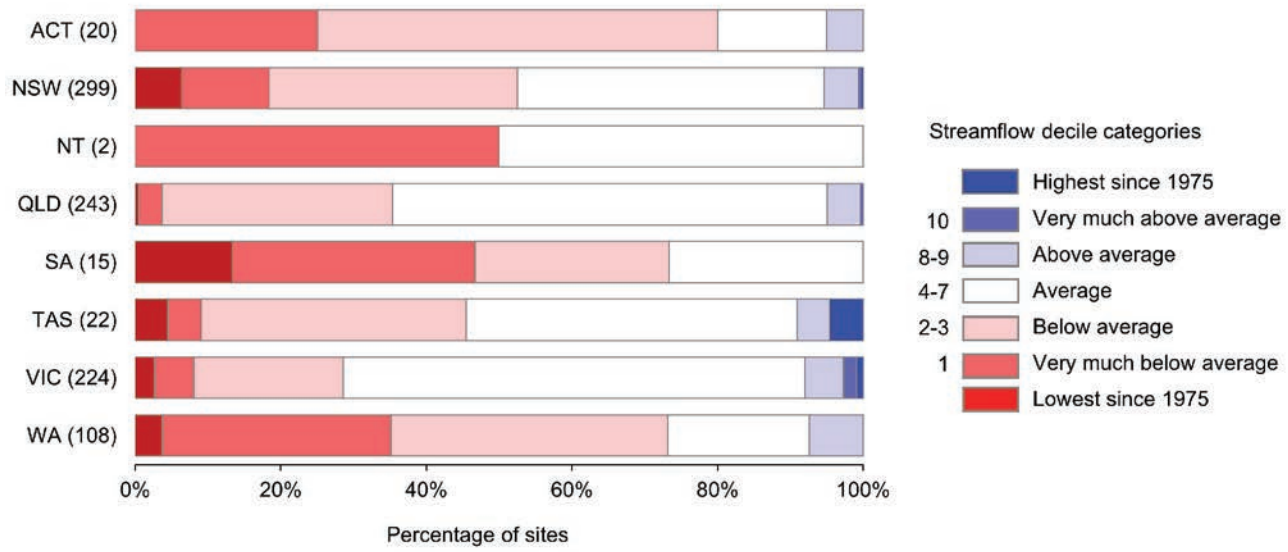


Figure 6. Streamflow deciles by number of gauges in each State or Territory

The delayed onset of the monsoon period contributed to the predominance of average to lower flows in rivers across most of northern Australia, particularly in northern areas of Queensland. The streamflows in southwest Western Australia were predominantly below average in 2019–20 due to lower than average winter rainfall.

During the latter half of 2019, most of the streamflow gauges (Figure 7) recorded lower than average monthly flows reflecting the dry conditions across Australia during this 6-month period. In July 2019, 48 per cent of the gauges recorded lower than average flows and, following record low rainfalls throughout November–December, this rose to more than 80 per cent of the gauges by the end of 2019.

By December 2019, root-zone soil moisture was the lowest on record in many areas, including along parts of the eastern seaboard, southeastern Queensland, scattered parts of southwest Western Australia, and in the Top End of the Northern Territory after a late start to the monsoon. The dry conditions across most of the southern half of Australia in the first six months of the financial year, contributed to a predominance of lower than average streamflow in the first seven months (Figure 8) and a strong demand for irrigation water during the 2019 winter–spring season.

Near-to-average rainfall and above returned to most of Australia after January 2020 (Figure 4). Above to very-much-above average rainfall extended from the Pilbara to South Australia covering much of the west and northeast. Another band of high rainfall extended from the eastern Northern Territory to central Queensland. These high rainfalls generally resulted in higher than average flows. Lower than average streamflows were dominant in gauges in New South Wales and Victoria due to lower than average rainfall.

Widespread heavy rainfall during the first half of February across much of Queensland and along the east coast of Australia contributed to both riverine and flash flooding in some areas of New South Wales and Queensland. Renewed heavy rainfall at the end February and in early March, partly associated with the remnants of tropical cyclone Esther, led to further widespread flooding in Queensland and heavy rainfall as far south as Victoria. Higher than average flows were recorded in more than 60 per cent of the gauges in New South Wales and 40 per cent of the gauges in Victoria during February 2020.

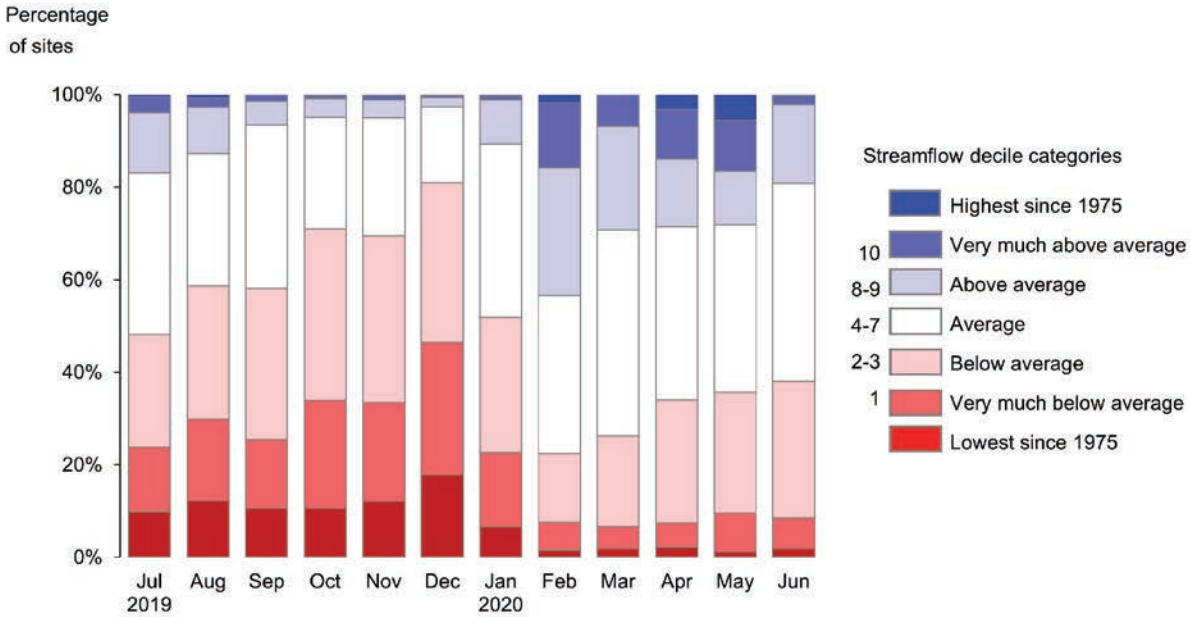


Figure 7. National monthly streamflow deciles

A slow-moving trough that delivered 392 mm of rainfall to Sydney within one week (7–10 February 2020), produced enough streamflow to almost double the amount of water stored in the urban storages of Sydney – from 42 per cent on 8 February to 81 per cent on 18 February.

April 2020 rainfall was higher than average for much of southeastern Australia, leading to above average inflows into many southern Murray–Darling Basin water storages. With lower than average rainfall across much of the southern half of Australia during May and June, there was a strong demand for irrigation water for winter cropping early in the season. Most of New South Wales, South Australia and southwest Western Australia recorded average to lower than average streamflow during May and June.

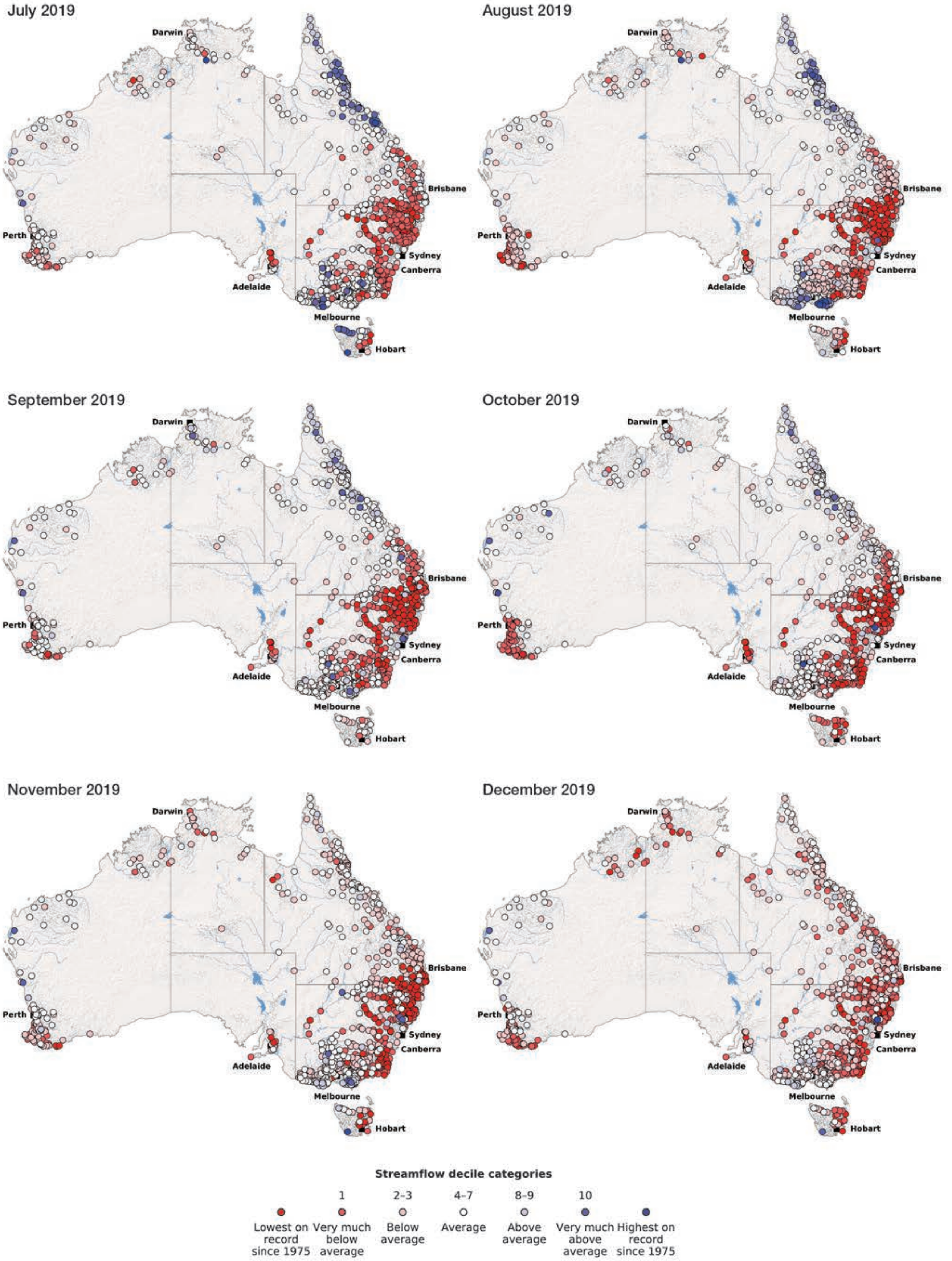


Figure 8. National maps of monthly streamflow deciles in 2019–20

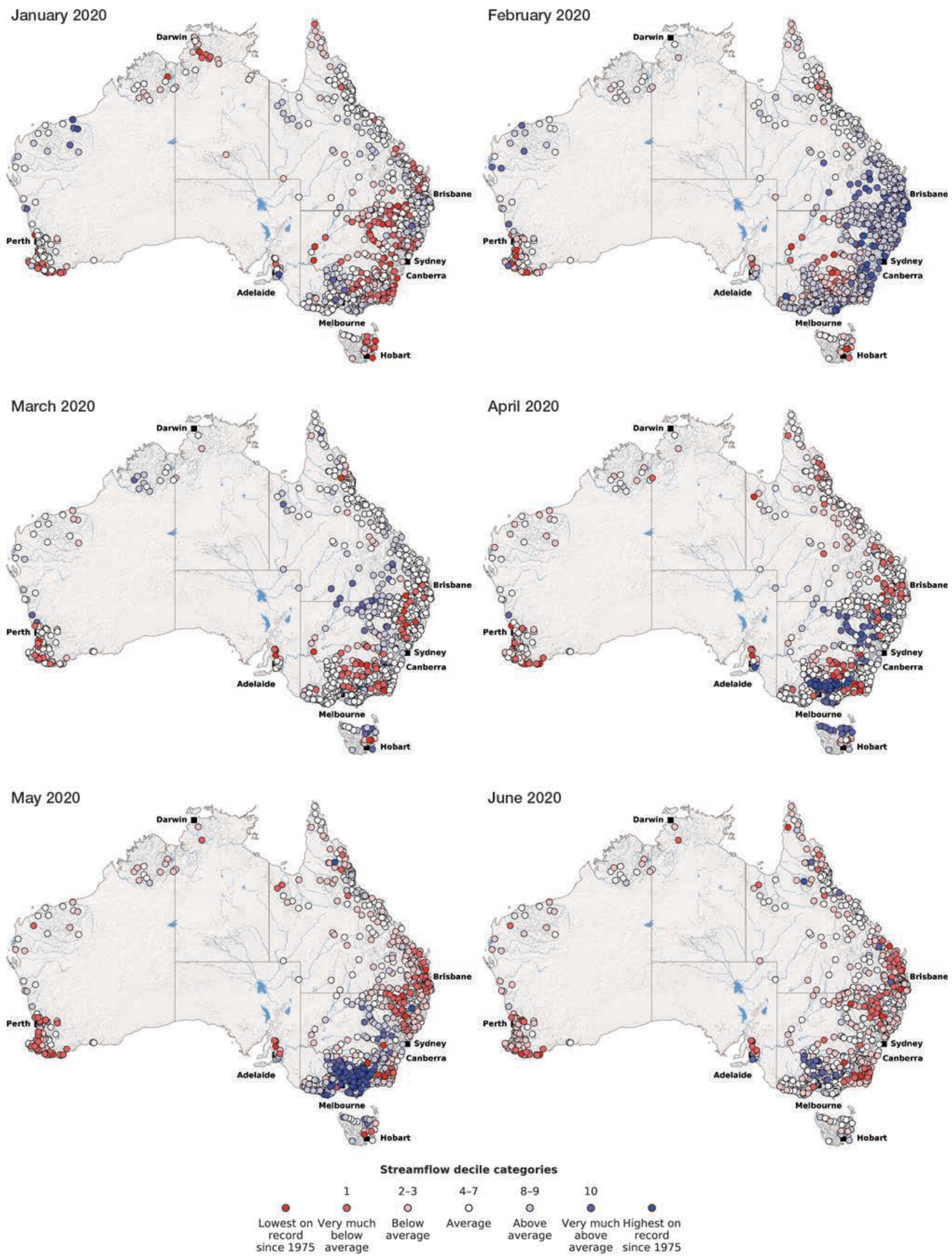


Figure 8 (continued). National maps of monthly streamflow deciles in 2019–20

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 (Bureau of Meteorology, 2020), which is equivalent to a relatively high national per capita surface water storage capacity of about 3.25 ML.

Tasmania has 54 large storages primarily to provide water for hydro-electric power generation. On the Australian 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.

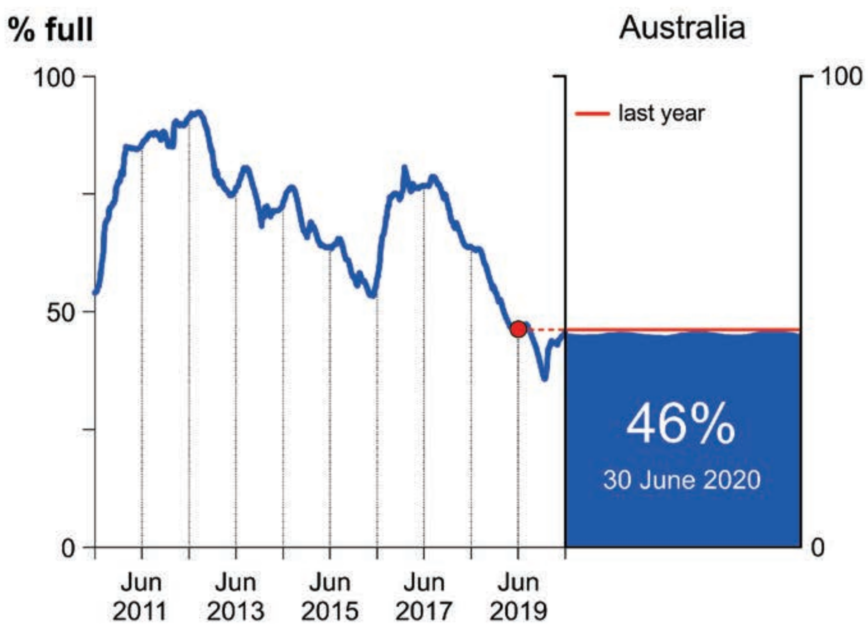


Figure 9. Time series of storage volume as a percentage of capacity for combined urban and rural storages

The combined accessible storage capacity of major storages for direct water supply purposes across Australia at the beginning of 2019–20 was 50 500 GL. The combined accessible storage volume at the start of the year was 23 140 GL, or 46 per cent of capacity. Due to dry conditions throughout much of Australia during the latter half of 2019 and continued diversions from these storages, the accessible storage volume decreased to 36 per cent of capacity by January 2020, the lowest level in more than 10 years. The combined accessible storage volume recovered after February 2020 following higher rainfall across southeastern Australia and regained the same proportional fulness as at the start of the year, 46 per cent (Figure 9).

After the end of the Millennium Drought (mid-2009) the combined accessible storage volume had risen to 90 per cent in March 2012. The storage volume then slowly dropped to 54 per cent of capacity in May 2016 and then rose to 80 per cent of capacity in February 2017 due to wet weather throughout much of Australia during 2016–17. It then gradually dropped to its lowest volume in more than 10 years during January 2020.

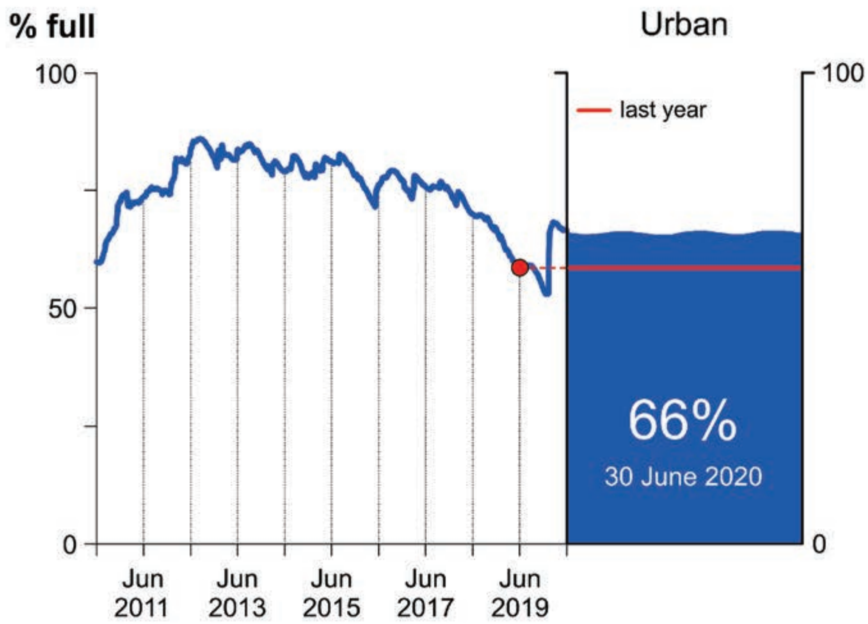


Figure 10. Time series of storage volume as a percentage of capacity for combined urban storages

2.2.2 Urban storages

At the start of the 2019–20 year, the combined accessible water volume in urban storages across Australia was 5847 GL (59 per cent of capacity), increasing to 6640 GL (66 per cent of capacity) by the end of the year (Figure 10). The combined accessible storage volume of urban storages dropped to its lowest volume (53 per cent of capacity) in January 2020, the lowest level since the end of the Millennium Drought. Rainfall relief during the early part of 2020 resulted in storage increases in most urban storage systems, particularly in southeastern Australia.

The accessible storage levels increased in most of the major urban storage systems in southeastern Australia during the 2019–20 financial year except for Canberra. Accessible storage levels declined in the Perth, Darwin and South East Queensland systems (Figure 11). The Hobart system showed the largest proportional increase followed by Sydney, Melbourne and Adelaide. By contrast, the Darwin system showed the largest proportional decrease, followed by South East Queensland and Canberra.

In the east of the country, generally wet conditions from January to April saw many urban water storages start to recover. The storage volume in the Canberra system increased from 45 per cent in February to 55 per cent by the end of June 2020 and the South East Queensland from system from 55 per cent in January to 67 per cent in March 2020.

In Adelaide, despite below average rainfall for most of the year, storage volumes increased from 47 per cent of capacity on 30 June 2019 to 49 per cent on 30 June 2020 due to the high rainfall in late autumn 2020. The storage volume reached a low of 39 per cent in May 2020, the lowest in more than 10 years.

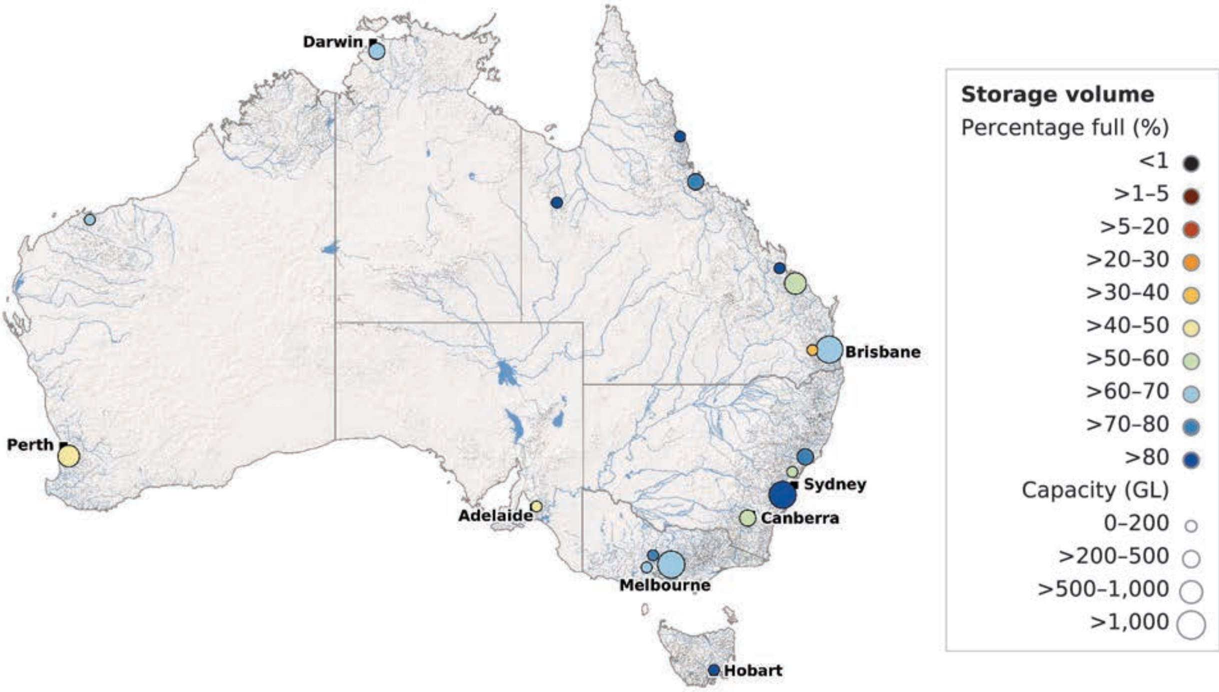
In Melbourne, the storage volume of the system increased from 50 per cent on 30 June 2019 to 68 per cent on 30 June 2020. The storage volume peaked in November 2019 following rainfall during the winter months and was the highest since November 2017 (Figure 12).

The Sydney water supply system saw a year of contrasts with the accessible storage volume dropping to 42 per cent in January and filling to 81 per cent by the end of the year (Figure 12). The system had seen a steep decline during the previous few years to January 2020, from near full in April 2017. Level 2 water restrictions were introduced in December 2019 which limit how and when water can be used outdoors (Under level 2 restrictions garden can only be watered using a can or using smart irrigation systems). At this time Sydney's desalination plant was operating at full capacity to reduce the use of surface water supply.

The slow-moving trough that delivered almost 400 mm of rain to Sydney during the second week of February produced enough runoff to almost double the amount of water in storage; the accessible water in the Sydney storages increased from 42 per cent on 8 February to 81 per cent on 18 February. Warragamba, the largest storage in the system, increased by 800 GL, almost enough water to fill the Sydney Harbour twice over. The volume of runoff was likely enhanced by low vegetation mass following bushfires across 35 per cent of the catchment during summer season. Water restrictions were lowered to Level 1 on 1 March 2020 following the high rainfall in February (under Level 1 restrictions drinking water can only be used to water gardens with a hand-held hose, sprinklers or standard watering systems, top up pools and spas, wash vehicles with a pressure washer).

The storage volumes in the Canberra system dropped steadily in the first eight months of 2019–20. The Canberra system has experienced a steady decline in storage levels from October 2016, when storages were almost at capacity, to February 2020, the lowest level in almost 10 years (46 per cent). Higher rainfall during February–April 2020 resulted in a rise in storage levels, the first significant rise in storage since June 2016.

(a) On 30 June 2020



(b) Change from 30 June 2019 to 30 June 2020

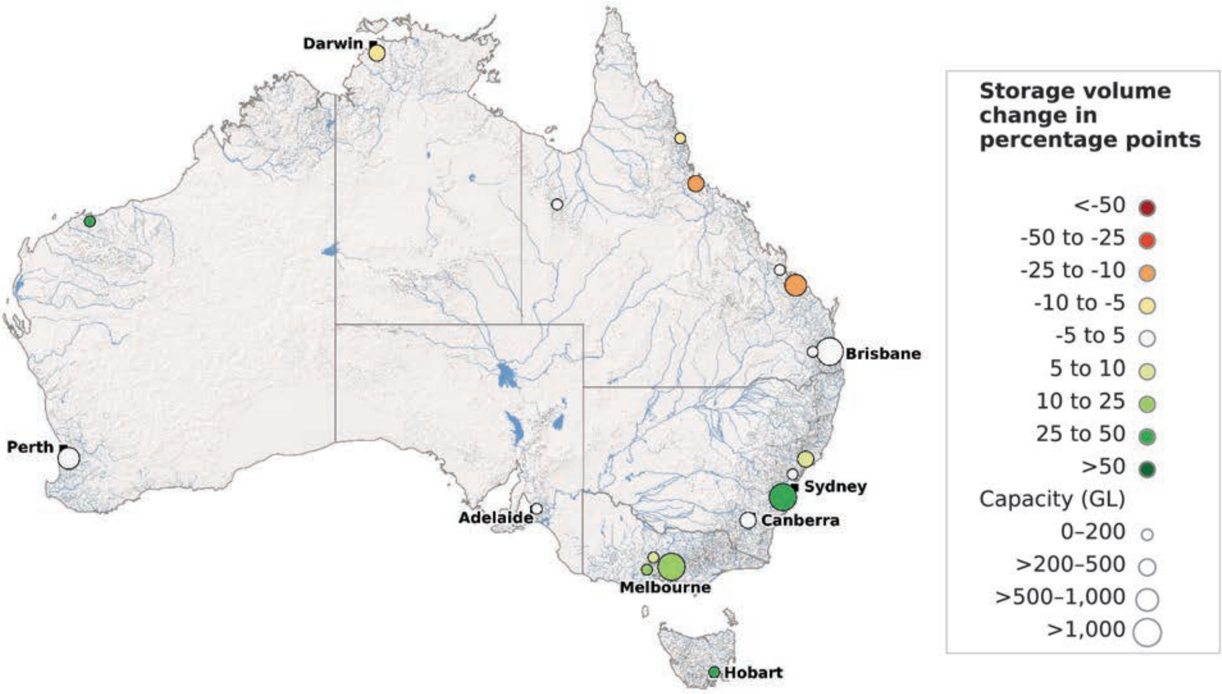


Figure 11. The distribution and status of urban storage systems (a) On 30 June 2020 (b) Change from 30 June 2019 to 30 June 2020

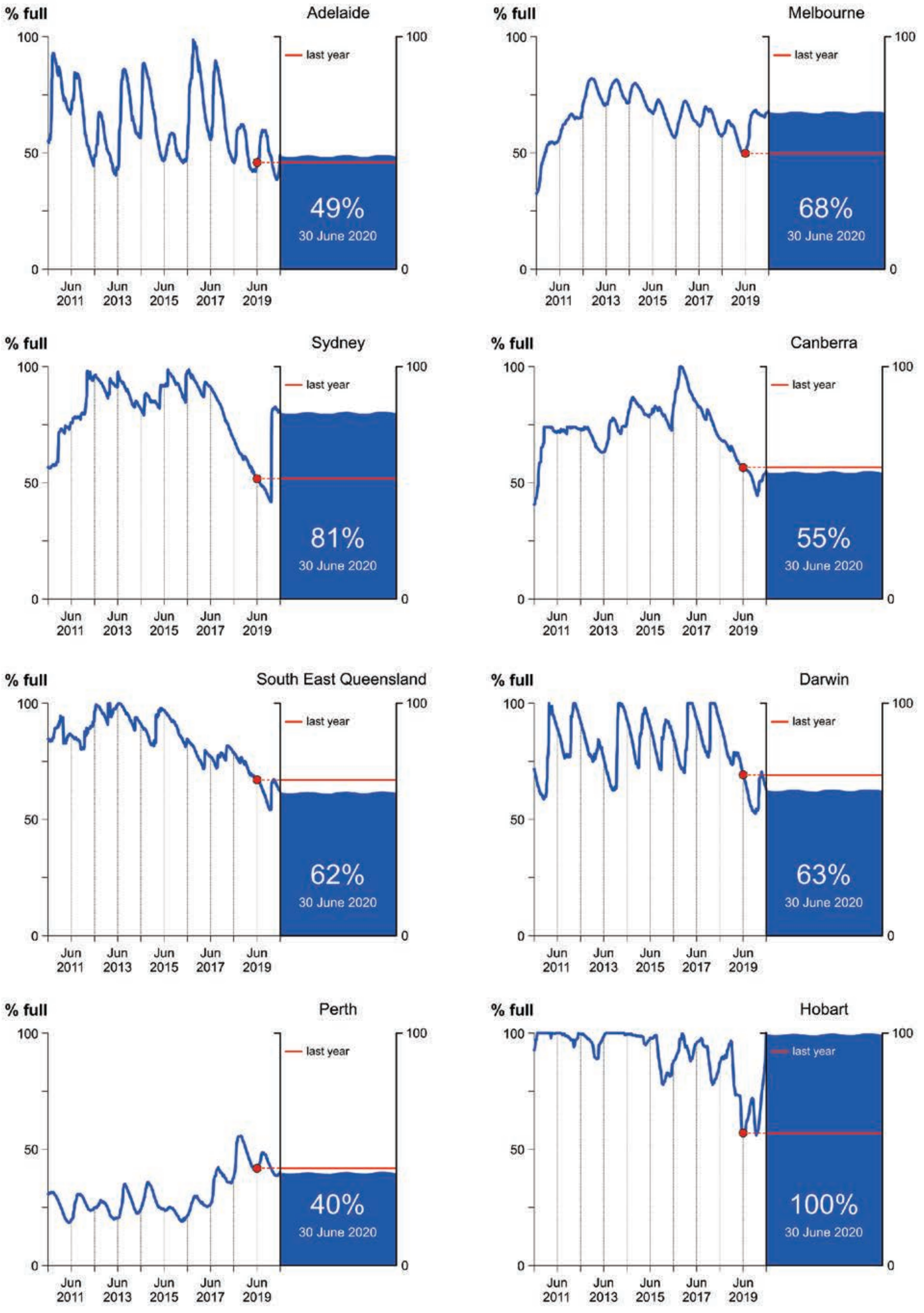


Figure 12. Time series of storage volume as a percentage of capacity for urban storages

The combined accessible storage volume dropped in South East Queensland, in comparison to the previous year due to below average rainfall across the region (Figure 12). Water use and below average streamflow resulted in a steady decline in accessible storage volume from April 2018 to a low of 55 per cent of capacity in January 2020, the lowest level in more than 10 years. The combined accessible storage volumes recovered from February 2020 to reach a peak of 67 per cent of capacity in March 2020 following higher rainfall across the region. The storage volume then dropped to 62 per cent of capacity by the end of the financial year.

The normal filling and spilling of the Darwin River storage did not occur for a second year in a row due to the low wet-season rainfall across northern Australia. The accessible volume declined steadily during the first six months of the year and reached 53 per cent of capacity in December 2019, the lowest level in more than 10 years. The 2019–20 wet season did bring some inflows, but not enough to fill the storage. Darwin receives the most seasonally variable rainfall among all capital cities and the storage volume generally peaks towards the end of the wet season (October to April). Since 2011, the storage volume has been more than 90 per cent of capacity during March and April except in 2012–13, 2018–19 and 2019–20 when it was below 70 per cent full (Figure 12) due to a poor wet season in these years.

In Perth, the storage volume of the system decreased for the first time in four years (from 42 per cent on 30 June 2018 to 40 per cent on 30 June 2019) (Figure 12). The decrease in 2019–20 was influenced by below-average streamflow in southwest Western Australia due to below-average 2019 winter rainfall.

The accessible storage volume of the Hobart system (Risdon Brook storage) with a capacity of 4 GL, was close to full capacity for large periods each year during the previous decade (Figure 12). Below average streamflow resulted in a decline in accessible storage volumes from October 2018 to a low of 57 per cent of capacity in June 2019, the lowest level since 2010. The volume gradually increased to 72 per cent of capacity during November 2019, but below average streamflow resulted in a decline in accessible storage volume to a further low of 56 per cent of capacity in January 2020. The storage volume then increased steadily to full storage capacity by the end of the financial year due to above average rainfall from March to June 2020.

2.2.3 Rural storages

At the start of the 2019–20 year, the combined accessible volume in rural storages across Australia was 17 490 GL (43 per cent of capacity), decreasing to 16 500 GL (41 per cent of capacity) by the end of the year (Figure 13). The combined accessible storage volume of rural storages across Australia showed a steady decline between July 2019 – January 2020.

Immediately after the end of the Millennium Drought in 2009 the storage volume steadily increased and reached 80 per cent full in February 2011. The combined accessible storage volume further increased and reached 94 per cent full in September 2012 before it started to decline. The storage volume then dropped to a low of 49 per cent at the end of 2015–16 before rising to 82 per cent during 2016–17. It then declined to 43 per cent at the beginning of 2019–20 and by February 2020, the storages were at 32 per cent, the lowest level since the end of the Millennium Drought. Due to the improved rainfall conditions in the latter half of the year, the storage volume increased to 41 per cent of capacity by the end of year.

The dry conditions and below-average streamflows across southeastern Australia in 2019–20 meant that storage levels throughout most of the Murray–Darling Basin (where most of Australia's rural storage systems are) remained low, particularly in the northern part of the Basin (Figure 14a). Although the storages remained low across the Basin, the storage volumes at the end of June 2020 were generally higher than at the same time during the previous year (Figure 14b). Storage volumes increased in response to higher rainfall across the region during February–April 2020; however, many areas of the Basin had experienced prolonged dry conditions and by the end of June 2020, significant additional rainfall was needed to replenish many storages.

In the Murray–Darling Basin the combined accessible storage volume increased from 30 per cent at the start of the year to 37 per cent at the end of June 2020 (Figure 15). In early 2020, the accessible storage volume declined to its lowest level (24 per cent) since the end of Millennium Drought and thereafter storage levels in the Basin recovered due to higher-than-average rainfall from February 2020, particularly in the southern Basin where the majority of the water is stored.

Water storage in the northern Murray–Darling Basin reached a record low of 5.4 per cent of combined capacity in mid-January 2020 (Figure 16), 3 per cent lower than at any point during the Millennium Drought and was 18 per cent at the end of 2019–20.

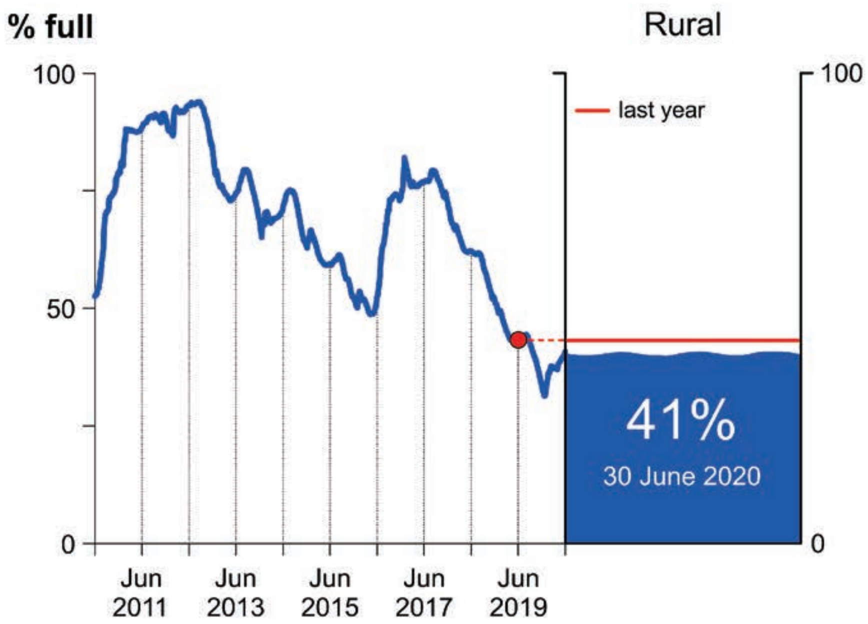
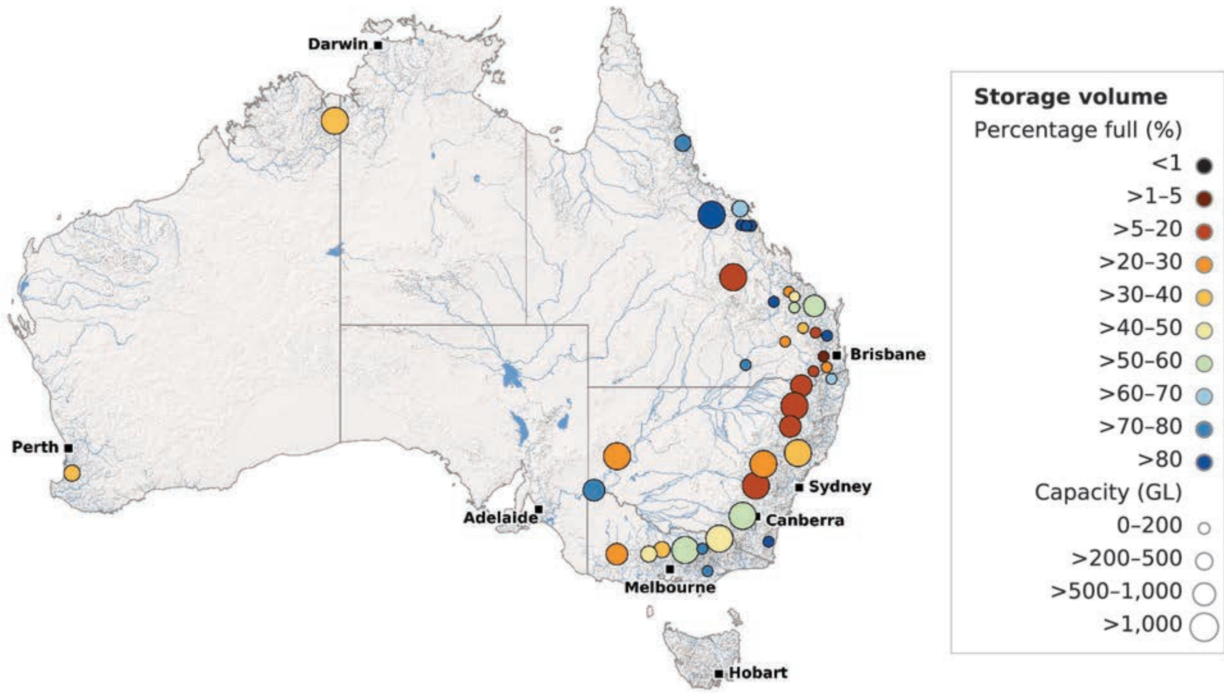


Figure 13. Time series of combined rural storage volume as a percentage of capacity for Australia

(a) 30 June 2020



(b) Change from 30 June 2019 to 30 June 2020

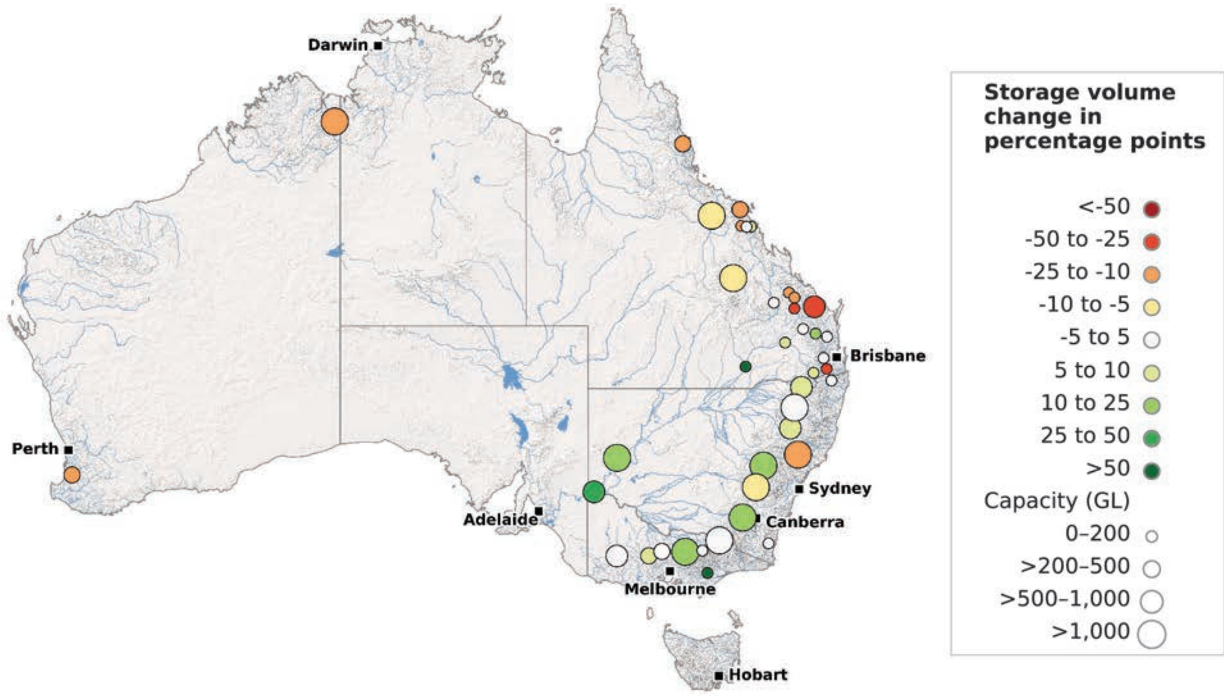


Figure 14. The distribution and storage status of rural storage systems (a) 30 June 2020 (b) Change from 30 June 2019 to 30 June 2020

The storage volumes of the rural supply systems across northern Queensland declined in 2019–20 due to the dry conditions across the region. Despite a drop in storage, most of these storages were above 80 per cent of capacity at the end of 2019–20 (Figure 14a) as the storage capacity is small compared to the annual inflows.

The water storage levels in Lake Argyle, one of Australia's larger reservoirs, continued to decline during 2019–20. Lake Argyle traditionally fills every few years, if not every year, during the northern wet season. This seasonal filling and spilling of the lake did not occur in 2019–20 for the third successive year. The storage was 55 per cent full at the start of 2019–20 and, despite a small increase in February–March following rainfall associated with ex-tropical cyclone *Esther*, dropped to 38 per cent full on 30 June 2020, the lowest level since 1993.

In the Collie–Harvey–Waroona system, which supplies water to Western Australia's Harvey Water Irrigation Scheme, storage volume decreased for the first time in three years. The decrease in 2019–20 was influenced by low storage inflows following a very dry winter and spring in 2019.

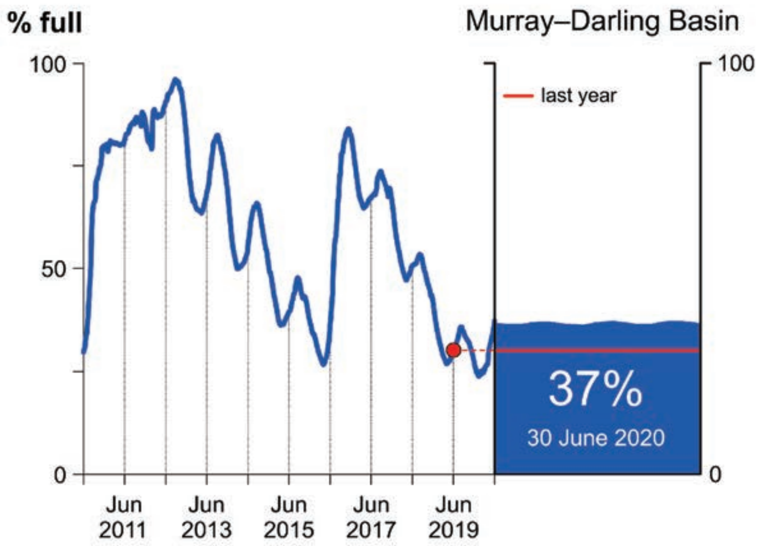


Figure 15. Time series of combined rural storage volume as a percentage of capacity for Murray–Darling Basin

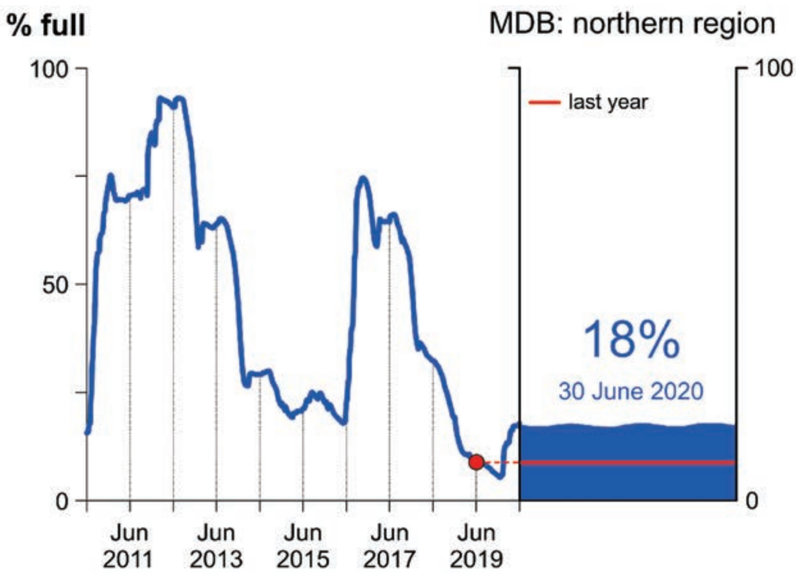


Figure 16. Time series of combined rural storage volume as a percentage of capacity for northern Murray–Darling Basin

2.3 STREAMFLOW SALINITY

In many parts of Australia, soils, surface water and groundwater have a high salt content due to the 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.

Across Australia, dryland and irrigated agriculture and clearing of native, perennial vegetation have changed the catchment water balance. These changes in landscapes increase the mobilisation of highly soluble salts from saline aquifers or shallow water tables into streams. This unnatural increase in salinity can present a risk to aquatic ecosystems and vegetation health (Lake, 2003).

Within the Murray–Darling Basin and in several other 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 provide a 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 in 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 the Water Quality Australia website in partnership with State and Territory governments.[1] 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.

2.3.1 Median 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 broad salinity categories for which water is considered fit for various uses are provided in Table 1.

In 2019–20, 61 per cent of Australia's river and stream sites were on average *fresh* and suitable for drinking while 13 per cent of sites were *marginal*. The remaining 26 per cent of the sites were *brackish* or *saline*. For the previous year, 73 per cent sites were fresh, 9 per cent were marginal and the remaining 18 per cent were brackish or saline.

1 www.waterquality.gov.au/

Table 1. Water salinity and primary suitability for use

Salinity category	TDS concentration (mg/L)	Suitability for use
Fresh [2]	0–500	Good-quality water suitable for drinking and all irrigation
Marginal	500–1 000	Fair- to poor-quality drinking water; most irrigation; adverse effects on ecosystems may become apparent
Brackish	1 000–3 000	Unacceptable-quality drinking water; useful for most livestock; irrigation limited to certain crops
Saline	3 000–35 000	Unacceptable drinking water quality: use may be limited for certain livestock
Hyper-saline	>35 000	Seawater salinity or greater, undrinkable, some mining and industrial uses

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

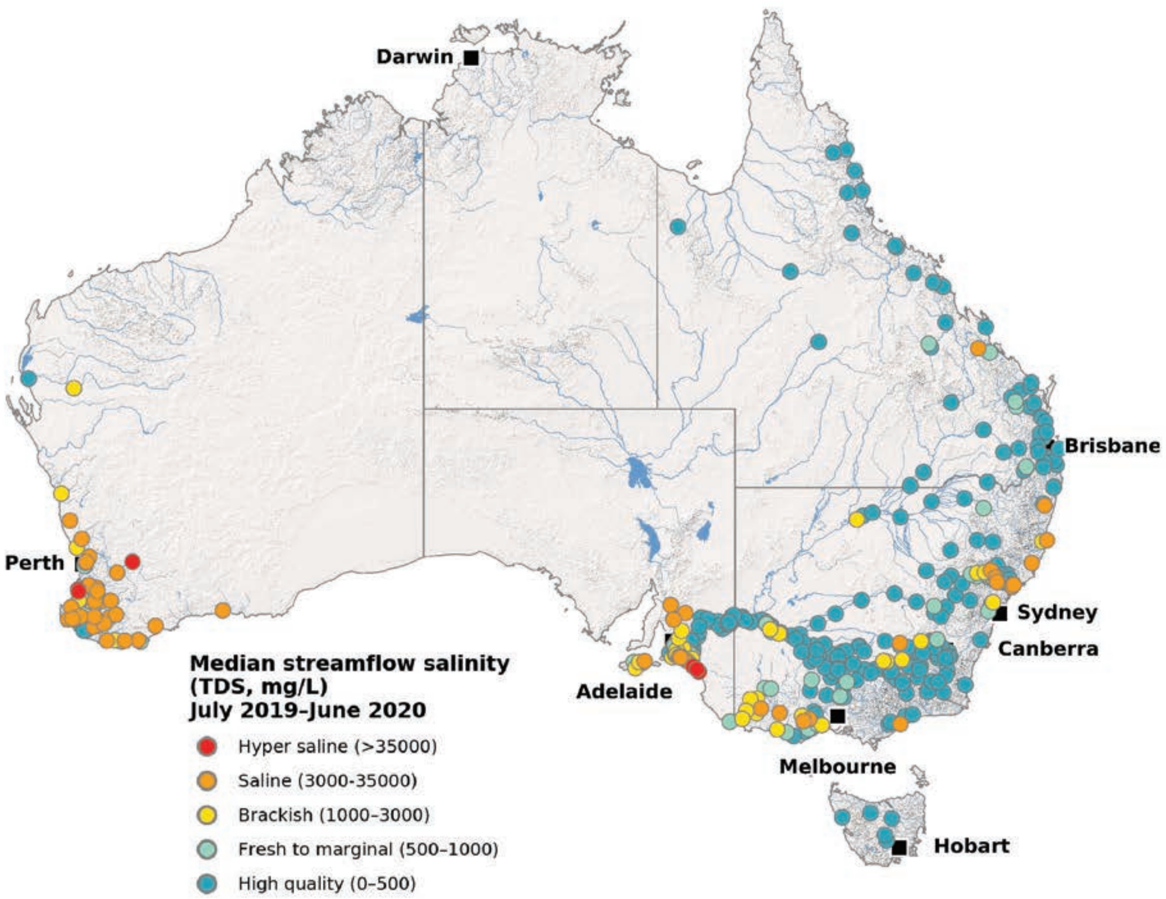


Figure 17. Distribution of median annual streamflow salinity across Australia in 2019–20

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

The sites with fresh median water salinities were mostly located in areas with high rainfall, along the east coast (Figure 17). Seventy-five per cent of the 143 sites in New South Wales and 85 per cent of the 40 sites in Queensland had fresh median water salinities. In the Murray–Darling Basin, median streamflow salinities were mostly fresh but tended to be higher in the lower reaches of the River Murray.

In contrast, most flows at the analysed monitoring sites in Western Australia continued to be saline in 2019–20. Fifty-seven per cent were saline and 21 per cent were brackish. In South Australia about a quarter of the sites recorded brackish or saline flows. 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 require significant treatment costs to improve the water quality.

2.3.2 Changes in median salinity

At individual sites, streamflow salinity typically changes over time due to complex flow and salinity dynamics. Data used for the comparison were from 407 gauging stations that had reliable data for 2018–19 and 2019–20.

Streamflow salinity increased within the rainfall-deficient areas in 2019–20, particularly the sites in New South Wales, Queensland, and Western Australia. Around 50 per cent of the 407 gauging sites had an increase in median streamflow salinity in 2019–20. An increase of more than 500 mg/L TDS was observed at nine per cent of the monitoring sites and an increase of up to 100 mg/L TDS was observed for 32 per cent of monitoring sites. Increases were between 100 mg/L TDS and 500 mg/L TDS in seven per cent of sites.

A decrease in stream salinity of more than 500 mg/L TDS was observed at only 6 per cent of the monitoring sites. A decrease of more than 100 mg/L TDS was observed for 11 per cent of monitoring sites. Most of these larger decreases occurred in southern Australia (Figure 18), due to the occurrence of near-to or above-average rainfall during the second half of the financial year.

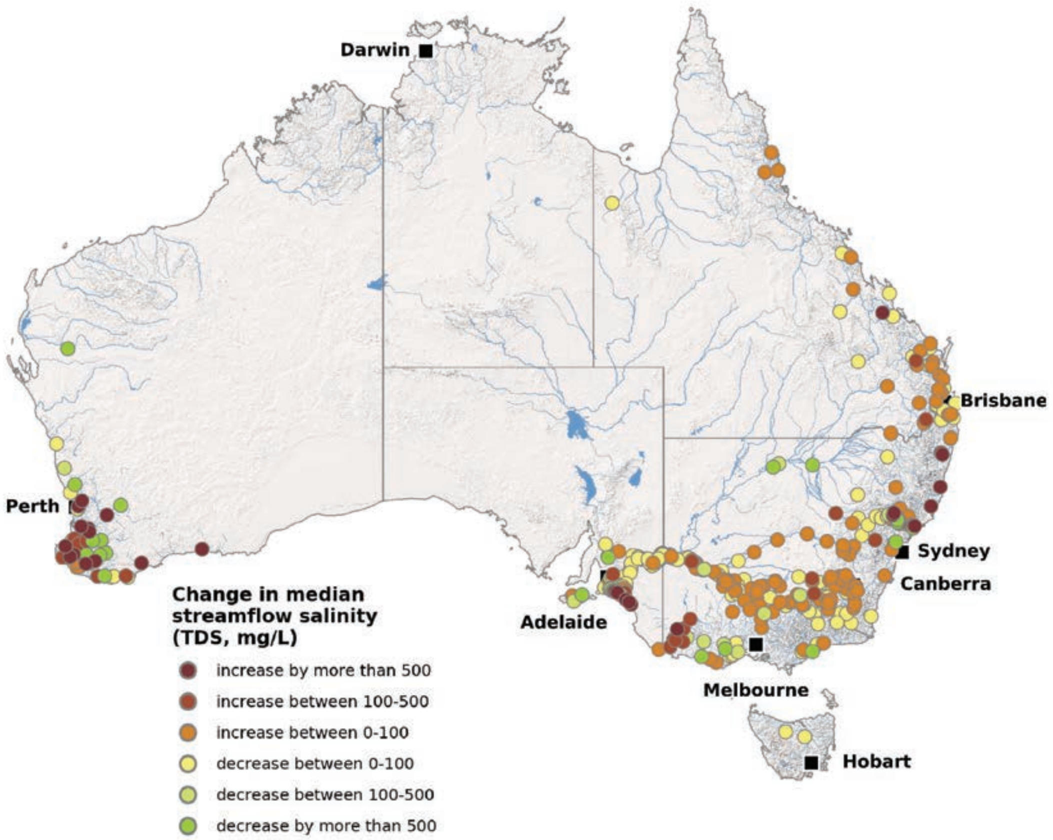


Figure 18. Changes in median streamflow salinity from 2018–19 to 2019–20

2.4 GROUNDWATER

2.4.1 Overview

In many regions across Australia, groundwater is the only reliable water source. Numerous towns, farms and mines, particularly in the outback, rely almost completely on groundwater. Depending on the annual climatic conditions, about one-fifth to one-third of the annual water used in Australia comes from groundwater.

The sustainability of groundwater use is subject to the pressures of climatic conditions and extractions. Recharge rates are typically very small compared to the volumes in the aquifer. 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 sustains rivers, wetlands and vegetation at the surface. The groundwater level analysis presented here uses a simplified representation of the three-dimensional groundwater systems across Australia aggregating them into upper, middle and lower groups, as presented in Australian Groundwater Insight.[3]

2.4.2 Groundwater levels

Groundwater levels measured from bores are one of the few direct measurements available to understand changing groundwater conditions. Groundwater typically responds slowly to direct climatic variability, especially in comparison to surface water. This report uses groundwater level status and a five-year trend to assess the effects of changes to groundwater levels in 2019–20. Examining trend and status data together is a useful way to give context to year-to-year fluctuations.

The groundwater level status for a bore is a decile ranking of the recovery peak for 2019–20 against all annual recovery peaks in a bore's historical record (based on data from the period 1997–2020)[4]. The groundwater level recovery peak is defined as the maximum groundwater level observed in a bore during the financial year. Recovery peaks occur through natural groundwater recharge and/or pressure recovery in the non-pumping season. The five-year trend in annual recovery peaks indicates whether groundwater levels at a bore are rising, stable or declining from July 2015 to June 2020. Figure 19 shows the distribution of groundwater level status and Figure 20 shows the distribution of groundwater level trends at bores across Australia for (a) upper (b) middle and (c) lower aquifer groups.

The lower than average groundwater levels experienced in 2018–19 in many parts of Australia persisted in 2019–20 for all aquifer groups (Figure 19). Just over half of the upper aquifer bores had a below average groundwater level status; while 30 per cent had an average status and only 16 per cent had an above average status. The five-year trend in upper aquifer groundwater levels ranged from stable (41 per cent) to declining (30 per cent) and rising (29 per cent) (Figure 20). Similarly, the majority of bores in the middle and lower aquifers, where most extraction occurs, had below average groundwater levels (56 and 54 per cent respectively) with generally stable or declining trends.

3 http://www.bom.gov.au/water/groundwater/insight/

4 Tasmania has a shorter reference period (2008–2020) due to data availability. This means that the status results for Tasmania are not directly comparable to the rest of the country.

In south eastern Australia, including the Murray–Darling Basin and south-eastern Queensland, most bores had below average groundwater levels and stable or declining trends (Figures 19 and 20). Areas of high groundwater extraction (for example, the alluvial aquifers in the northeast of the Murray–Darling Basin, such as the Namoi) were particularly affected. The low groundwater levels in the Murray–Darling Basin and south-eastern Queensland reflect limited aquifer recharge due to the low rainfall experienced across the region over the previous three years. Rainfall conditions started to improve in early 2020 with above average rainfall in February – April 2020, and groundwater extraction decreased as surface water started to become more available. Despite the rainfall and reduced extraction, groundwater levels did not recover completely.

Similarly, bores in the Darwin and Daly–Roper water control districts in the Northern Territory had below average groundwater levels and declining trends (Figures 19 and 20). For the second consecutive year, the normal increase in groundwater levels during the wet season did not occur due to poor wet season rainfall. In contrast, areas that experienced wetter conditions in 2018–19, such as Queensland's northeast coast, were able to maintain average to above average levels with rising trends (Figures 19 and 20) despite low rainfall in 2019–20.

In southwest Western Australia, groundwater levels have generally been in decline for the previous 40 years due to decreasing rainfall (Bureau of Meteorology, 2018) and increasing groundwater demand. Overall, in 2019–20, there were more bores with below average groundwater levels than in 2018–19 (Figure 21) because of the continuing drying trend in rainfall and recharge. Managed aquifer recharge and measures to reduce and redistribute groundwater extraction have been undertaken to slow the rate of groundwater level decline,[5] with groundwater trends in the previous 5 years being mostly stable (Figure 20).

Groundwater level conditions varied across Victoria and Tasmania reflecting the variability in rainfall and/or extraction (Figures 19 and 20). For example, groundwater levels in the deep aquifers of Victoria's Gippsland Basin were typically below average and declining due to dewatering for coal mining and offshore oil and gas extraction. In eastern Tasmania, low rainfall resulted in below average to average groundwater levels with declining trends, elsewhere in the State average levels and stable trends were associated with higher rainfall and low extractions.

5 https://gnangara.dwer.wa.gov.au/status/

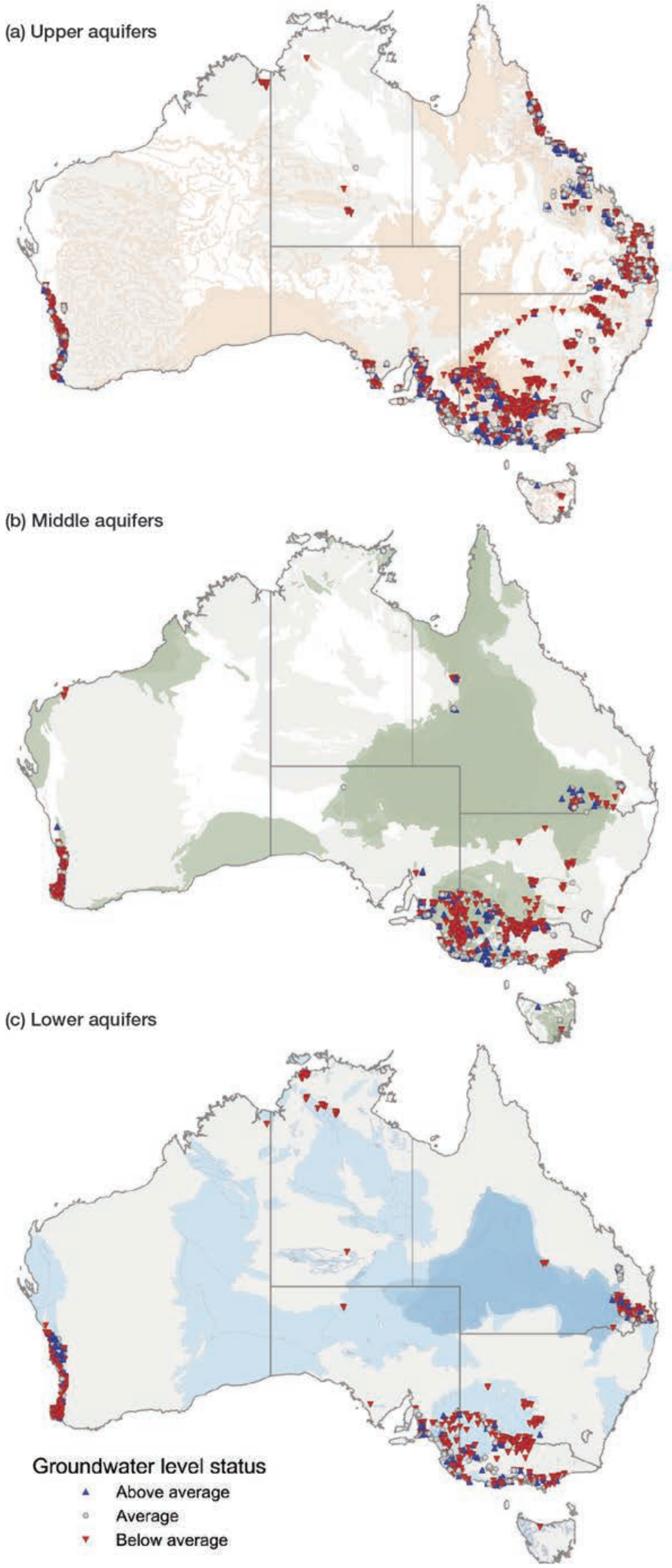


Figure 19. Groundwater level status in 2019–20 compared to the historical record (1997–2020) for (a) upper, (b) middle and (c) lower aquifers

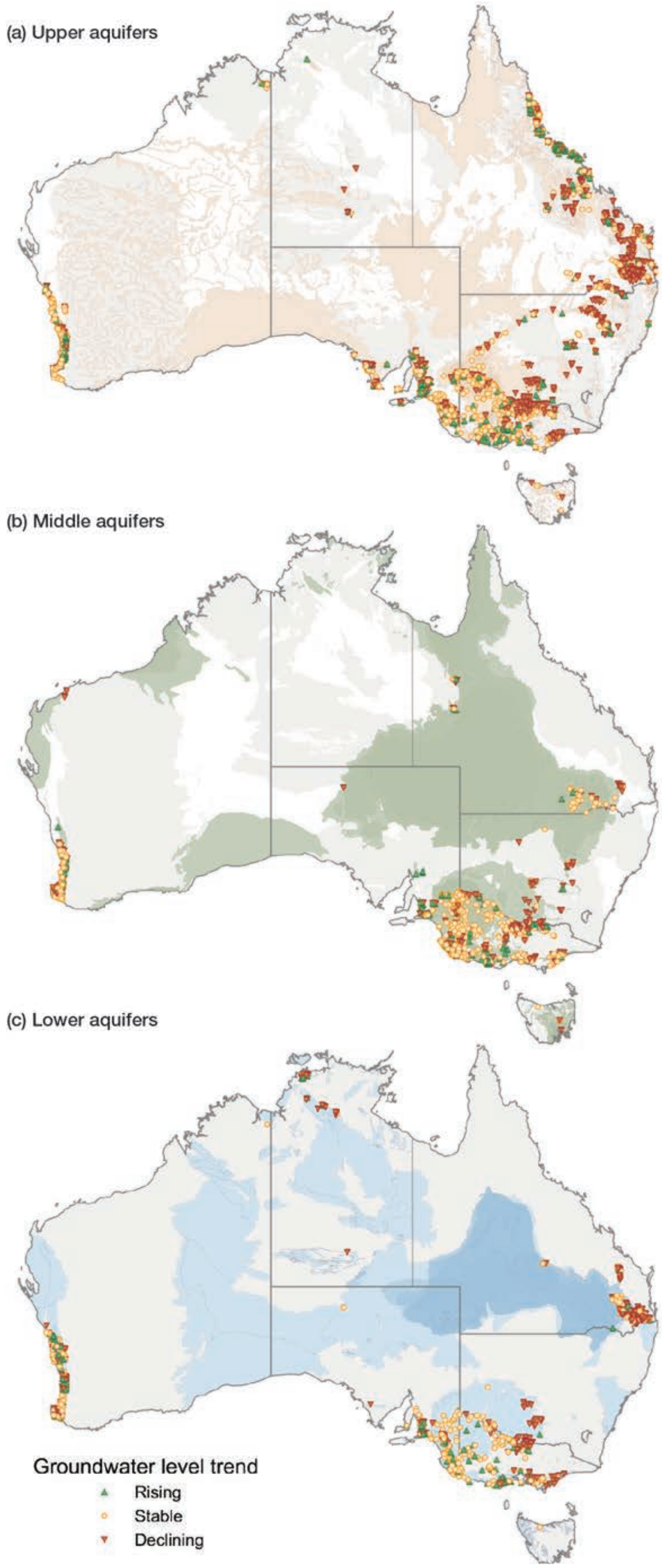


Figure 20. Groundwater level trends from July 2015 to June 2020 for (a) upper, (b) middle and (c) lower aquifers

Figure 21 summarises groundwater level status and trend by aquifer group for each State and Territory, for 2018–19 and 2019–20. Despite some rainfall relief in the first half of 2020, there has been an increase in the number of bores with below average levels and stable or declining trends across most Australian States and Territories as a result of the very dry conditions during the latter half of 2019.

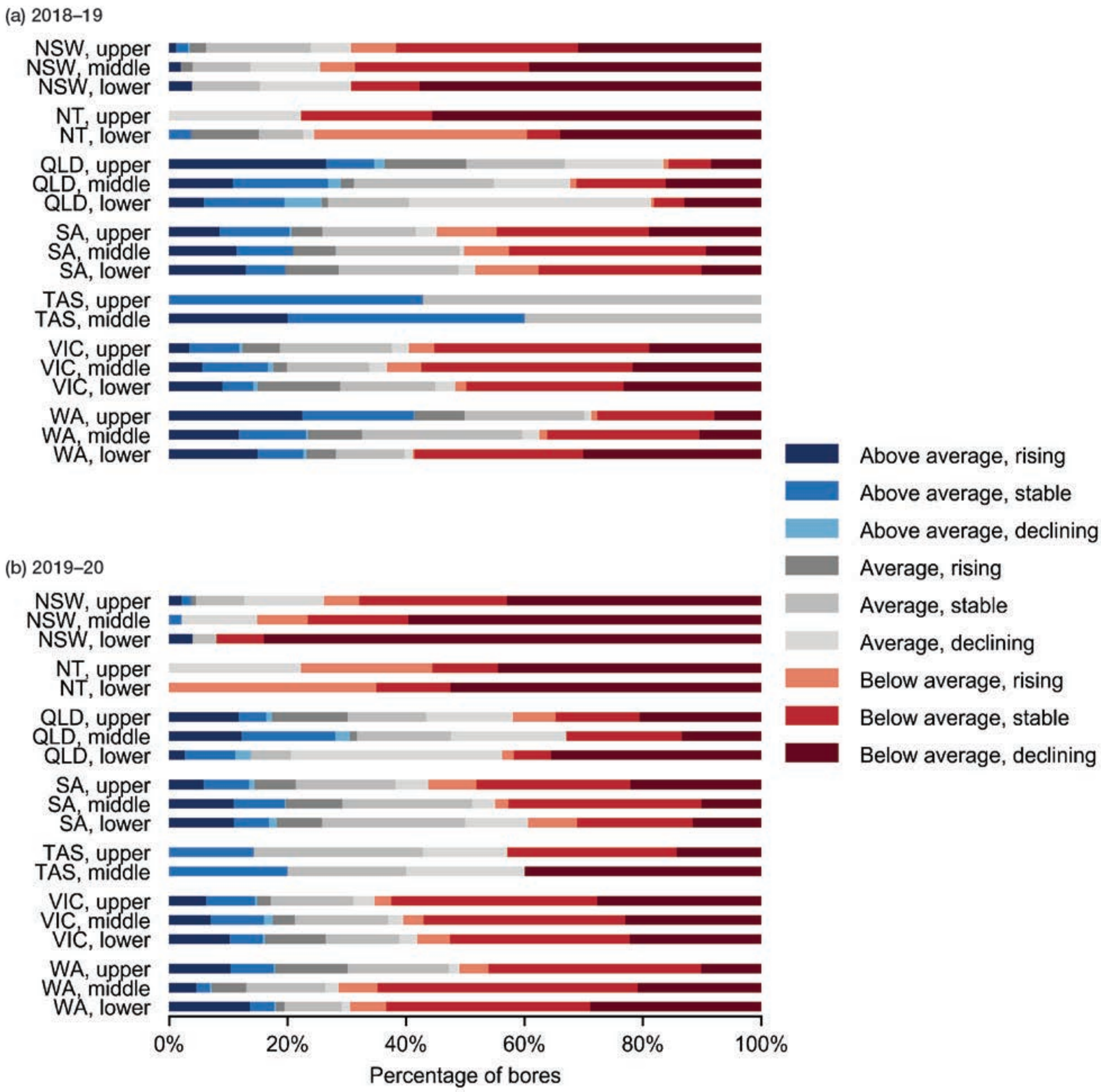


Figure 21. Summary of groundwater level status and trends by State and Territory (a) 2018–19 (b) 2019–20

2.5 ALTERNATIVE WATER RESOURCES

2.5.1 Desalinated water

Urban centres across Australia face the challenge of increasing water needs, due to population growth, and often also a declining reliability of existing water resources. This can arise from aging of assets, sedimentation of storages, changes to climate and a deterioration in water quality. Climate-resilient sources such as seawater desalination and water recycling have been introduced to improve the security of urban water supply and are brought into operation especially in dry periods.

Australia has around 270 desalination plants, mostly small scale, to desalinate marine and brackish water for various uses.[6] The total desalination capacity across Australia is about 880 GL of water per year. The five major urban centres in Australia have a total seawater desalination capacity of 534 GL per year.

Due to a steady decline in streamflows to the Perth water storages over the previous four decades, a major desalination plant was built in 2006, followed by a second in 2013. The combined production capacity of the two plants is 145 GL/year (Figure 22). During 2019–20 both plants were run near the rated capacity with about 140 GL of desalinated water being sourced. Desalination is the major individual source of urban water supply for Perth and contributed 47 per cent of Perth's water supply in 2019–20. Perth city now relies less on surface water storages and more on desalination and groundwater.

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

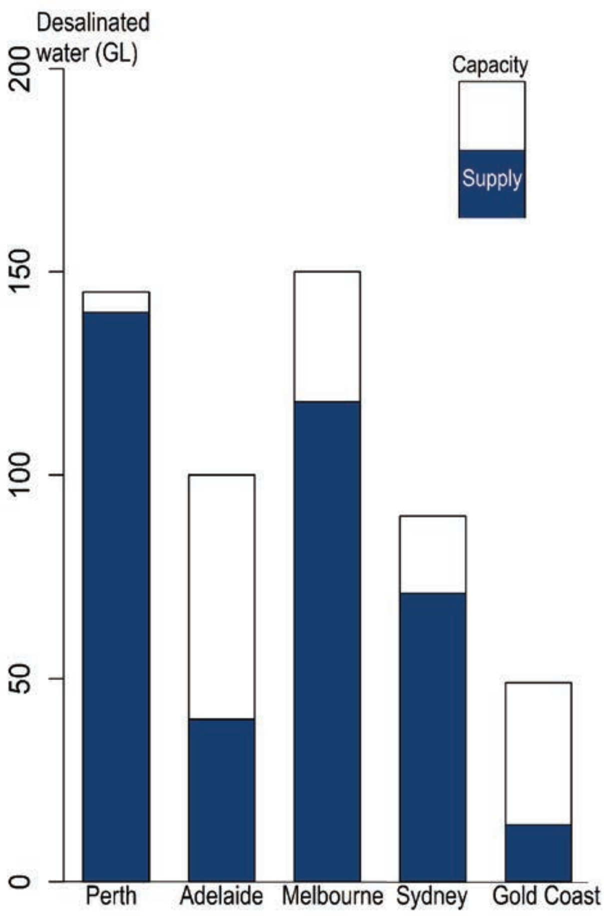


Figure 22. Desalination capacity (GL) and supply (GL) of major urban centres in 2019 20

Generally, Adelaide sources its water for urban use from local reservoirs, the River Murray and a desalination plant. During 2019–20, Adelaide would have used very little desalinated water had the Australian Government not been committed, under the Water for Fodder program, to pay the South Australian Government to produce up to 100 GL of desalinated water from Adelaide's desalination plant and to release the equivalent amount of water from the River Murray to farmers.[7] As per this arrangement 40 GL of water was delivered to the farmers in 2019–20 and Adelaide sourced the equivalent amount from the desalination plant. By utilizing the water that was released 25 470 hectares of fodder and pasture was planted by 800 farmers in the southern connected Murray–Darling Basin.[8]

In Melbourne, desalinated water was first provided in 2016–17 and a total of 84 GL of desalinated water had been supplied to the distribution system up to the end of 2018–19. The contribution from the desalination plant in 2019–20 was 118 GL compared to 22 GL in 2018–19. The Victorian Government placed an order of 125 GL of water from the desalination plant for 2020–21, "to improve the security of our water supplies to face the challenges of population growth and climate change" (Melbourne Water Corporation, 2020).[9]

In January 2019, Sydney's desalination plant commenced operation for the first time since 2012 when the supply system's total accessible storage capacity dropped below 60 per cent. An amount of 71 GL of desalinated water was supplied during 2019–20, equivalent to 13 per cent of Sydney's urban water supply. Desalination plant was operated at full production capacity from the end of July 2019 to the end of March 2020 and at a reduced production capacity thereafter.

In South East Queensland, 14 GL of desalinated water was produced in 2019–20 compared to 6.4 GL in 2018–19. The desalinated water produced in 2019–20 is equivalent to 4 per cent of the total urban water supply. The contribution of desalinated water to urban supply was the highest since 2010–11.

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 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.

Total recycled water used in major urban centres in Australia was 145 GL, more than double the 70 GL used in 2010–11. Recycled water is equivalent to eight per cent of the total water sourced in major urban centres. This use will grow as new housing estates in metropolitan growth corridors adopt dual pipe systems to supply recycled water.

In 2019–20, recycled water use increased in all the major urban centres in comparison to the previous year, except Melbourne and South East Queensland (Figure 23). The total volume of recycled water sourced for the major urban centres increased by 14 per cent in comparison to the previous year. Recycled water use increased by 75, 40 and 36 per cent in Perth, Adelaide, and Canberra, respectively. In South East Queensland and Melbourne, on the other hand, water recycling declined by 13 and 5 per cent, respectively.

7 https://www.agriculture.gov.au/water/mdb/programs/basin-wide/water-for-fodder/sa-agreement

8 https://www.data.gov.au/data/dataset/water-for-fodder

9 https://www.melbournewater.com.au/water-data-and-education/water-facts-and-history/why-melbournes-water-tastes-great/water-0

Amongst all the major urban centres, Melbourne had the highest recycled water use of 48 GL (Figure 23). Melbourne Water produces this at two treatment plants and 16 per cent of the total wastewater treated was reused. Adelaide had the second highest recycled water use of 44 GL during 2019–20.

Due to a significant reduction in winter rainfall in the southwest of Western Australia since 1970's, the Shire of Augusta–Margaret River has developed safe and sustainable alternatives to support the community's water needs and the Western Australian Government is investing $19 million to double the capacity of the wastewater treatment plant to treat up to three million litres of wastewater per day. Treated wastewater will be used to irrigate a wide range of ovals, parks, and other recreational facilities in the Shire and about 87 hectares of Government-owned pine plantation.[10]

10 https://www.watercorporation.com.au/About-us/Latest-updates/October-2020/Every-drop-of-wastewater-recycled-at-Margaret-River-facility

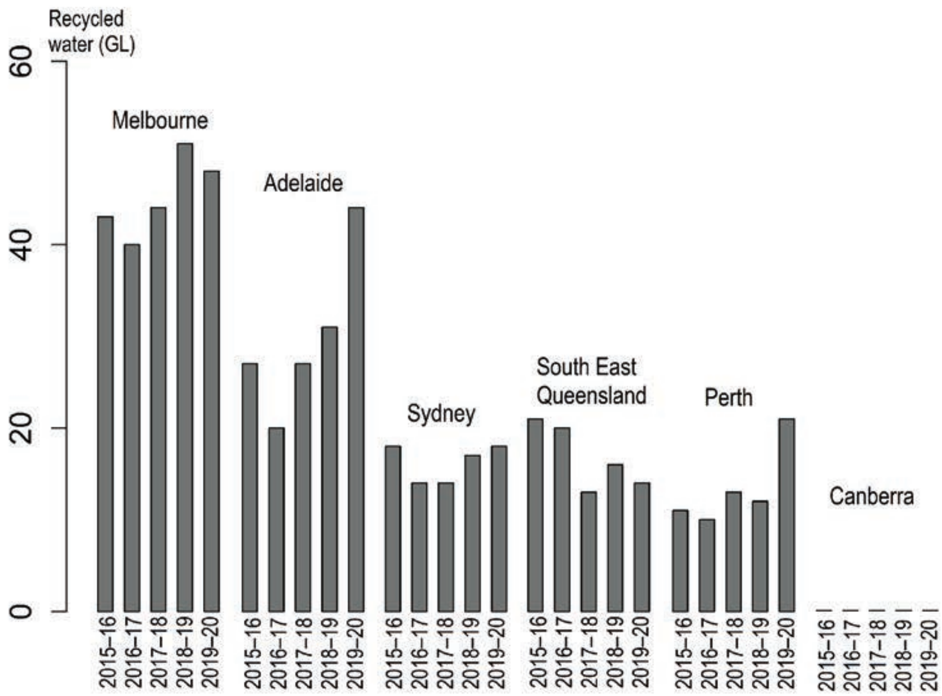


Figure 23. Recycled water used in major urban centres from 2015–16 to 2019–20

3 WATER TRADING AND USE

This chapter begins with an overview of water trading in Section 3.1 and then in Section 3.2 summarises the water extractions for agricultural, urban and industrial uses. Water stress in Australia is estimated in Section 3.3 using a United Nations' indicator. Water use by environmental water holders is discussed in Section 3.4 and Aboriginal cultural water needs are addressed in Section 3.5.

3.1 WATER TRADE

Water markets facilitate the buying and selling of water entitlements and allocations to allow water to move between various rural, agricultural and environmental uses. However, in Australia, water trading occurs mainly between agricultural users. Entitlement trades involve the permanent trade or leasing of water access entitlements, while allocation trades involve the buying and selling of specific volumes of water each year.

Water trade prices are determined by the value placed on water by buyers and sellers in response to many factors such as the purpose of water use, weather patterns, available allocations, storage volumes, jurisdictional legislative arrangements and commodity market conditions. Generally, dry climate conditions push up prices for both allocation and entitlement trade. In contrast, higher storage levels and carryover from the previous year are major drivers for low water trade prices.

Due to the dry conditions experienced in the first half of 2019–20, there was a large increase in allocation prices in the Murray-Darling Basin (MDB), in some cases to record levels. For example, in lower Murray regions of the southern MDB allocation prices peaked at over $900/ML. Entitlement prices for major high reliability entitlement classes in the southern MDB also reached record levels, with increases of 22–80 per cent compared to the previous year. In early 2020, there was rainfall relief across most of eastern Australia, which led to large decreases in allocation prices in the southern MDB. Allocation prices also declined across the northern MDB in the latter half of 2019–20 but to a lesser extent due to continued low water availability following years of severe rainfall deficiencies.

The total volume of surface water allocation trade across Australia in 2019–20 was 6275 GL, a 14 per cent increase from the previous year. The volume of surface water traded in the southern MDB was over 5500 GL and about 190 GL in the northern MDB. The volume of groundwater allocation traded in the Murray–Darling Basin was 291 GL, up by 11 per cent from the previous year, and 28 GL in the rest of Australia (up from 13 GL in 2018–19).

The volume of entitlement trade in Australia increased by 13 per cent in 2019–20 compared to the previous year. The volume of entitlements traded was 1961 GL in 2019–20, with an increase in entitlement trade in the MDB and an increase in allocation trade in the rest of Australia. A detailed assessment of water trade is given in the Australian Water Markets Report (Bureau of Meteorology, 2021).

3.2 WATER FOR CONSUMPTIVE USE

3.2.1 Total water taken

The total volume of water taken for consumptive use is defined here as all licensed water abstractions from rivers, storages, high-yielding aquifers and desalination plants that are not used for environmental or cultural purposes. Using this definition, the total volume of water taken across Australia during 2019–20 is estimated as 14 270 GL, six per cent lower than the previous year. Water taken for agricultural use (9550 GL) accounted for 67 per cent of the total, followed by water taken for urban use (3125 GL) at 22 per cent (Figure 24). Water taken for agricultural use declined by 11 per cent in comparison to the previous year due to the continued dry conditions and low surface water availability across southeastern Australia.

Water taken for industrial purposes (1595 GL) accounted for 11 per cent of the total water use. This estimate is based on the three-year average of water consumed by the mining, manufacturing, electricity and gas supply, and other industrial categories given in the *Water Account, Australia*.[11]

Surface water made up 75 per cent of the total water sourced and the groundwater portion was 20 per cent (Figure 24). The portion sourced from groundwater increased from the previous year, due to low surface water availability for agriculture. The contribution from desalination was four per cent in 2019–20 compared to one per cent in the previous year. The dry conditions during the year, particularly during the final six months of 2019, meant urban utilities opted to reduce pressure on their surface water resources and increase their reliance on desalinated water supply to meet urban demand.

Water taken for agriculture, urban and industrial uses from 2013–14 to 2019–20 are shown in Figure 25. Total water taken was the highest in 2013–14 and the lowest in 2019–20, following the trends of agricultural water. The water taken for urban users varied between 3050 GL (2018–19) and 3900 GL (2013–14). The proportion of total water taken by agricultural, urban and industrial uses varied between years. The proportion of water taken for agricultural purposes was the highest in 2014–15 (73 per cent) and the lowest in 2019–20 (68 per cent). The urban and industrial proportions were the highest in 2019–20 and 2015–16 (21 per cent and 11 per cent respectively) and were the lowest in 2014–15 (18 per cent and 9 per cent, respectively).

11 https://www.abs.gov.au/statistics/environment/environmental-management/water-account-australia/latest-release

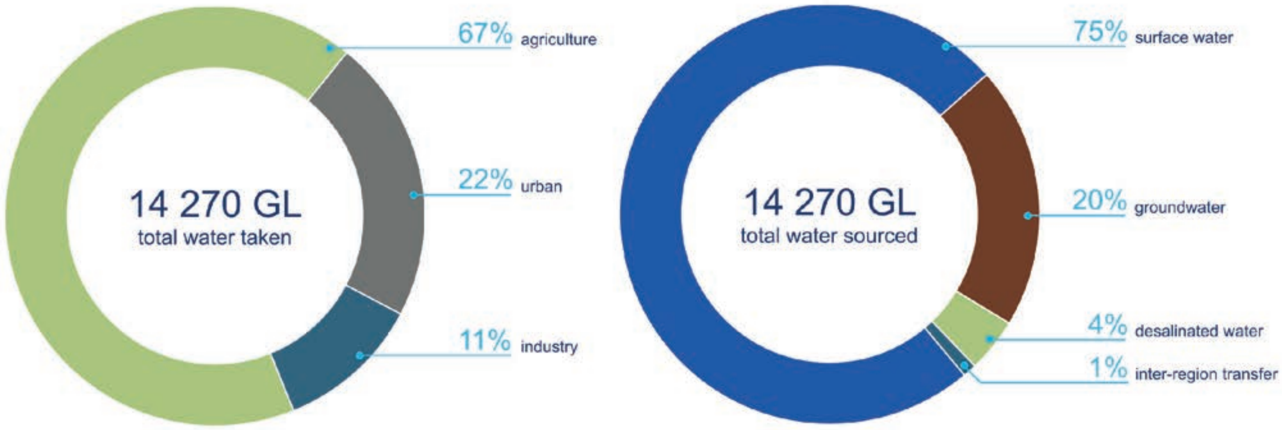


Figure 24. Water taken by category and source in 2019–20

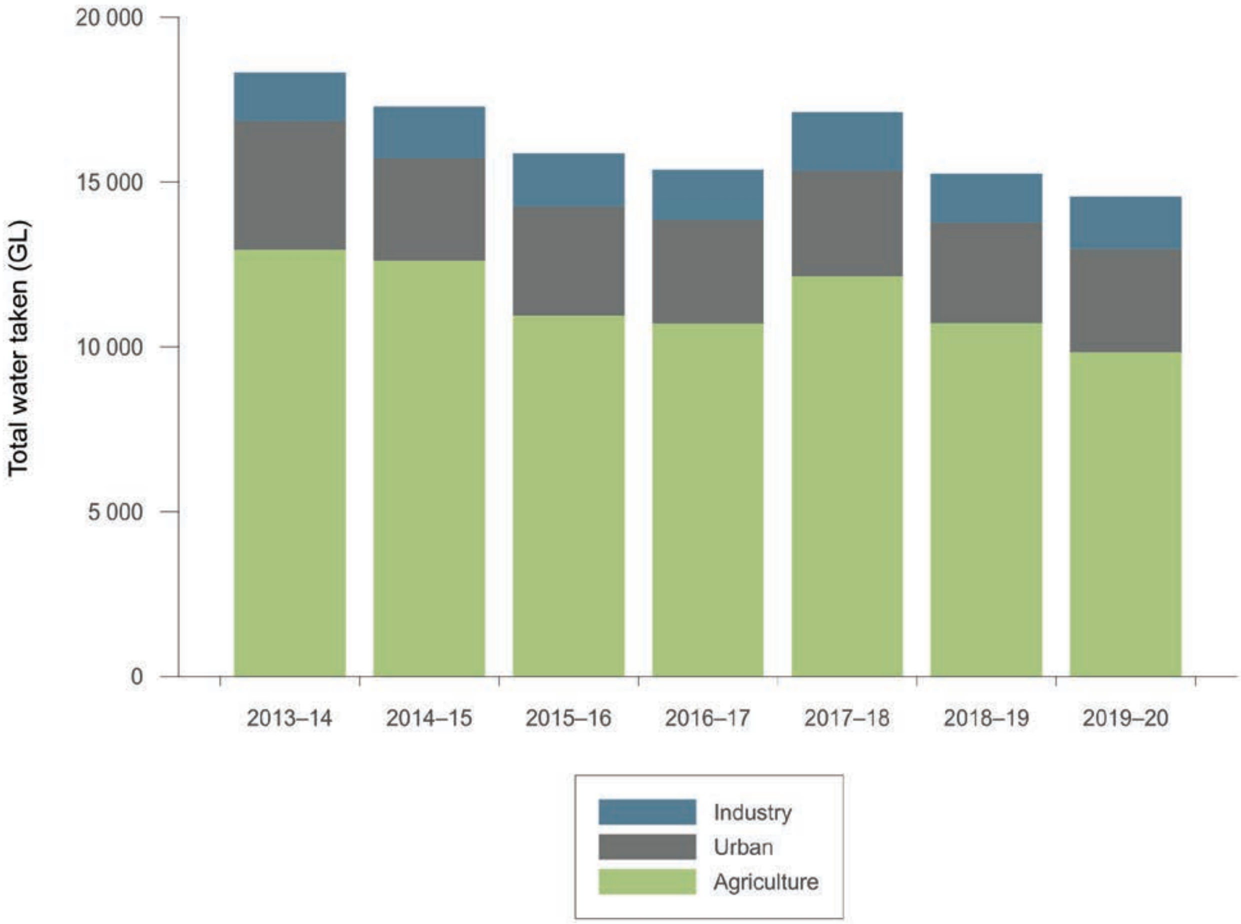


Figure 25. Historical water taken for agriculture, urban and industrial users

3.2.2 Water taken for agriculture

The total water taken for agriculture in Australia in 2019–20 was 9550 GL, of which 7050 GL (74 per cent) was sourced from surface water and 2500 GL (26 per cent) from groundwater. The annual total decreased by eleven per cent from the previous year; surface water diversion decreased by 15 per cent and groundwater extractions increased by five per cent.

Agricultural water-use in Victoria and New South Wales accounted for half of Australia's agricultural water use. The Northern Territory used the least water for agriculture (less than one per cent), followed by Tasmania (5 per cent), and South Australia (9 per cent).

Water taken for agriculture decreased in all States and Territories except Queensland, Western Australia and South Australia. The use of surface water predominated and only in South Australia and the Northern Territory were groundwater extractions larger than surface water diversions (Figure 26).

Although agricultural water-use in Victoria during 2019–20 was larger than that for each of the other States and Territories, it was 23 per cent less than for the previous year. Surface water diversions and groundwater extractions for Victoria decreased by 21 per cent and 41 per cent, respectively (Figure 26). The year started with low opening allocations for High Reliability water shares for the various water systems in Victoria and these never attained full allocation during the year. This was mainly due to the low water availability arising from extremely dry conditions. For the two largest water systems, the Goulburn and Victorian Murray, the maximum allocations only reached 80 per cent and 66 per cent, respectively; the end of year allocations in the Victorian Murray were the lowest in more than 10 years.

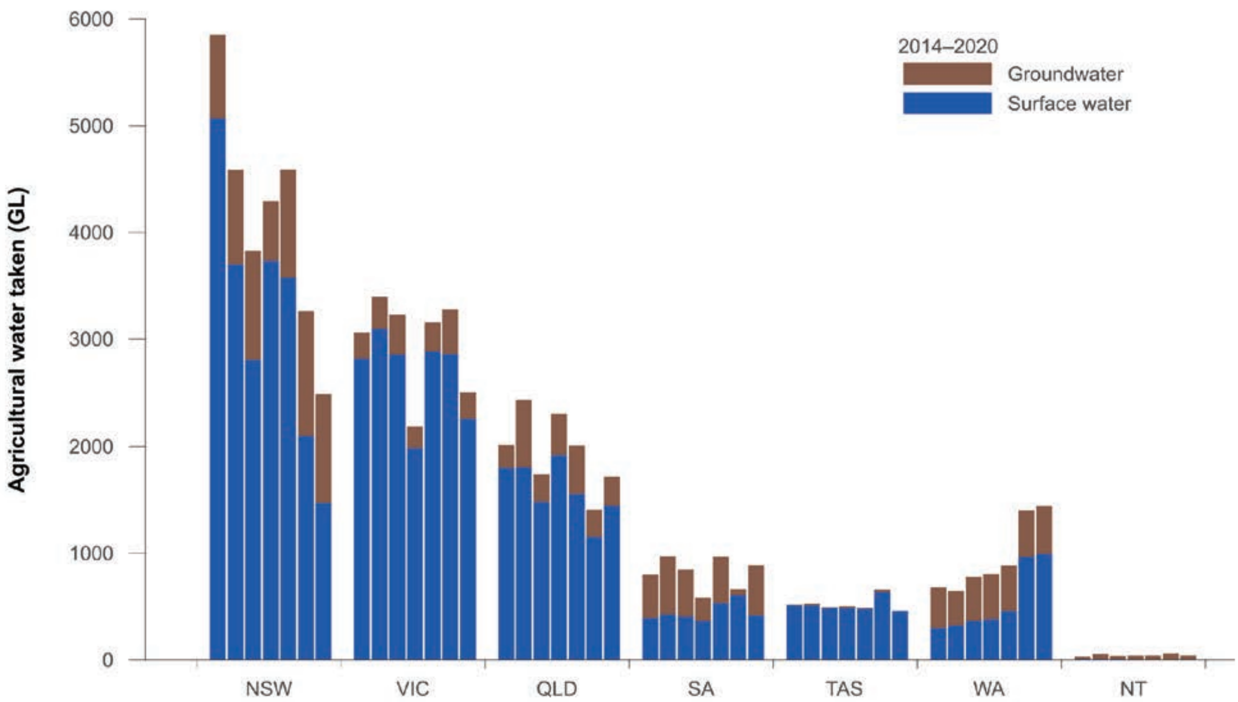


Figure 26. Volume of agricultural water taken from surface water and groundwater in each State and Territory, 2013–14 to 2019–20

In New South Wales, the total water taken for agriculture in 2019–20 was 2490 GL, 24 per cent lower than in the previous year. Surface water diversions decreased by 30 per cent and groundwater extractions by 12 per cent. The first half of 2019–20 was dry, storage levels were low and rainfall deficiencies continued in the north resulting in low surface water allocations for license holders. Due to the ongoing dry conditions and water storages approaching critical levels, tight temporary water restrictions were in place in the northern New South Wales catchments. These restrictions and high water-trade prices led farmers to reduce the area of annual crops at the beginning of the irrigation season.

In contrast to New South Wales and Victoria, agricultural water-use in Queensland increased by 22 per cent; from 1406 GL in 2018–19 to 1715 GL in 2019–20. Surface water diversions and groundwater extractions increased by 25 per cent and eight per cent, respectively, in comparison to those of the previous year due to the dry weather conditions. High carry-over volumes from the previous year in various large storages, such as the Burdekin, Bundaberg, Mareeba–Dimbulah and Proserpine, contributed positively to water availability for agriculture in Queensland.

In South Australia, the total of surface water diversions for 2019–20 was 418 GL, 31 per cent less than the previous year. However, groundwater extractions increased dramatically, from 51 GL in 2018–19 to 470 GL in 2019–20. There are no major rural water storages in South Australia and agriculture depends mainly on groundwater, and seasonal rainfall and streamflow. Given that dry conditions prevailed over most of the year, irrigated agriculture depended heavily on groundwater extractions to address the rainfall deficiencies during 2019–20.

Water taken for agriculture in Western Australia was 1441 GL during 2019–20 which is three per cent higher than the previous year and the highest in the previous six years. Surface water diversions and groundwater extractions accounted for 69 and 31 per cent, respectively, of the total water sourced. Surface water diversions were 997 GL, which was three per cent higher than the previous year and groundwater extractions were 444 GL, two per cent higher than the previous year. Due to the dry climatic conditions and expansion of agricultural areas, surface water diversions from Lake Argyle in the Ord River basin increased significantly in 2018–19 in comparison to the previous year. The total water taken in 2019–20 was similar to that of 2018–19 (309 GL).

Tasmania and the Northern Territory were the two lowest users of water for agriculture in 2019–20. Agricultural water use in Tasmania was 461 GL, 30 per cent less than the previous year; almost 99 per cent of the water taken was sourced from surface water. In the Northern Territory, 43 GL was taken for agricultural purposes, 98 per cent of which was sourced from groundwater.

Total annual water taken for agriculture was the highest in 2019–20 compared to the previous six years in Western Australia and the lowest in New South Wales and Tasmania. Both surface water diversions and groundwater extractions were the highest compared to the previous six years in Western Australia but in Tasmania both surface water diversions and groundwater extractions were the lowest compared to the same period. The surface water diversions in the Northern Territory remained similar to those for the previous three years. Surface water diversions were the lowest compared to the previous six years in New South Wales whereas groundwater extractions were the second highest. In South Australia groundwater extractions were more than 9 times higher compared to the previous year.

Low surface water allocations, due to the dry conditions during the year, resulted in low water take in the southeastern States except Queensland. In Victoria both surface water diversions and groundwater extractions were the lowest in the previous three years. Generally, when surface water availability is low or restricted, the overall demand for groundwater to supplement allocations increases. During 2019–20, despite low surface water availability groundwater use did not increase in New South Wales and Victoria in comparison to the previous year, because of decreased annual cropping and relatively mild climatic conditions during the latter half of the year.

The variation in surface water diversions was low in both Tasmania and Western Australia from 2013–14 to 2017–18. After 2018–19, surface water diversions increased in Western Australia in comparison to the previous five years due to dry conditions and the expansion in agricultural areas. In Tasmania surface water diversions increased in 2018–19 in comparison to the previous years due to the expansion of agricultural areas but due to the dry conditions in 2019–20 surface water diversions dropped to levels similar to that of 2017–18.

3.2.3 Water sourced by urban utilities

In 2019–20, total water taken by urban utilities was 3125 GL. Surface water contributed 78 per cent of this, 8 per cent lower the previous year. Groundwater and desalinated water contributed 9 per cent and 13 per cent, respectively. Total urban water sourced in 2018–19 was around 3050 GL; this was due to similar dry conditions in most urban regions.

Looking at just the major urban centres across the continent, the average annual volume of residential water supplied per property was 213 kL in 2019–20, 1 per cent lower than the previous year. This was due to decreased water consumption in most centres. Average residential water-use per property decreased in 2019–20 in comparison to the previous year in all major urban centres except Perth and South East Queensland.[12] Sydney reported the largest decrease (5 per cent) followed by Adelaide, Darwin and Melbourne (2 per cent). In Sydney the average annual volume of residential water supplied per property was the lowest in the previous five years as a result of reduced consumption due to declining water availability in the urban water storages.

Average residential use in Melbourne decreased from 151 kL per property in 2018–19 to 148 kL per property in 2019–20 and was the lowest in the previous five years. In Adelaide it decreased from 202 kL per property in 2018–19 to 198 kL per property in 2019–20 and in Darwin it declined from 380 kL per property to 373 kL per property.

Darwin had the highest average urban water use per property (373 kL), followed by Perth (227 kL). Average residential water supplied was the lowest in Melbourne (148 kL) reflecting ongoing water saving measures. Average residential use per property in Melbourne (151 kL), Adelaide (202 kL) and Darwin (373 kL) all showed a decline of about 2 per cent from in 2018–19; Melbourne had the lowest use per property in the previous five years.

The average annual residential water use is influenced by several factors, including climate, temperature, rainfall, water restrictions, water availability, housing density and water prices. The increase in average annual residential water use in Perth and South East Queensland during 2019–20 may be due to an increase in the demand for outdoor watering arising from above-average temperatures and lower rainfall. In Sydney, water use declined due to the water restrictions in place and a decline in water availability in urban storages during the first half of 2019–20.

Overall, inter annual change in average residential water use is very low in major urban centres. The inflows into Perth's water storages have declined significantly in the previous few decades and the city now relies heavily on energy intensive sources like groundwater and desalination. Perth remains the second highest per capita water-using capital city in Australia.

12 http://www.bom.gov.au/water/npr/docs/2019-20/National_Performance_Report_2019-20_urban_water_utilities.pdf

3.2.4 Sources of water for major urban centres

Major urban water supplies 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 these sources, cities have adopted a variety of approaches including extending their water supply catchment areas to more remote areas, investing in non-traditional sources such as desalination and recycling, as well as exploring options for stormwater use and rainwater harvesting.

In 2019–20, surface water sourced from local reservoirs was the main source of urban water supply in all major urban centres in Australia except Adelaide and Perth. In Adelaide inter-regional supply was the dominant source whereas in Perth desalination and groundwater were the main sources. Surface water diversions were larger in South East Queensland, Adelaide and Canberra in 2019–20 compared with the previous year (Figure 27).

For comparison purposes, 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 elsewhere. In Figure 27, recycled water volumes are shown on top of the total water sourced.

In Sydney, 539 GL was sourced for urban water use, a 6 per cent decrease from the previous year[13] and was the largest decrease of all major urban centres. This decrease was mainly due to low water consumption in response to water restrictions that were in place during the year. Level 1 water restrictions, which limit how and when water can be used outdoors, were introduced from 1 June 2019. Water restrictions were upgraded to Level 2 in December 2019 to further reduce pressure on surface water resources. When Level 2 restrictions were in place during December 2019–February 2020, the desalination plant operated at full capacity. These restrictions were lowered to Level 1 on 1 March 2020 following the high rainfall in February. The contribution from surface water was 87 per cent and the remaining 13 per cent was from desalination. About 3 per cent of the total sourced was recycled.

Total water sourced for urban use in Melbourne in 2019– was 456 GL, a 2 per cent decrease from the previous year. This was the third consecutive decrease in annual urban supply. Surface water contributed 74 per cent of total supply and 26 per cent was from desalination. The contribution from groundwater was minimal. The contribution of desalinated water to urban supply was the highest it has ever been. The Melbourne Water Corporation opted to increase its reliance on desalinated water in 2019–20 following the very dry conditions in the previous year. Melbourne Water produces recycled water at the Western Treatment Plant and the Eastern Treatment Plant, providing Class A (uncontrolled public access) and Class C (controlled public access) recycled water to customers. About 11 per cent of the total water sourced for Melbourne was recycled.

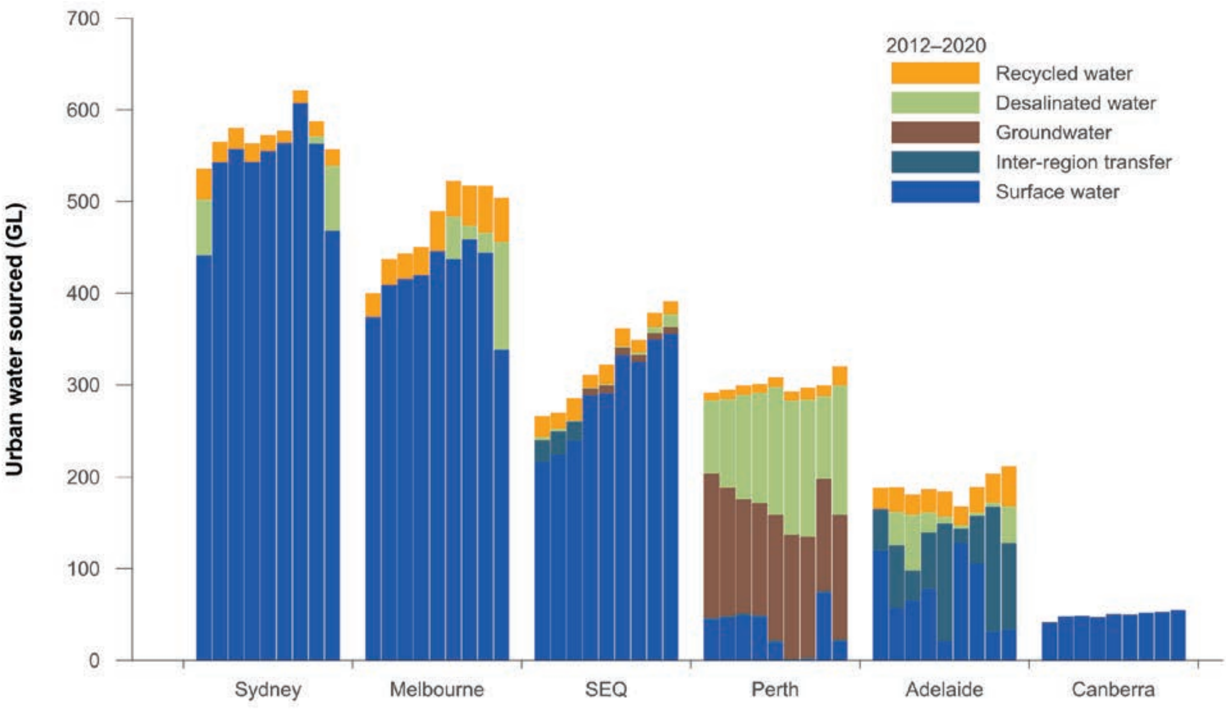
In South East Queensland, the total water sourced was 377 GL in 2019–20, 4 per cent higher than the previous year. This was the second highest increase of all the major urban centres. About 94 per cent of the total was sourced from surface water. The contributions from groundwater and desalination were about 2 per cent and 4 per cent respectively and the contribution from inter-regional supply was minimal. The contribution from desalination was the highest since 2010–11. About 4 per cent of the total water sourced was recycled.

13 http://www.bom.gov.au/water/nwa/2020/

The volume of water sourced for urban use in Perth in 2019–20 was 298 GL, 4 per cent higher than the previous year. The city had to rely mostly on desalinated water and groundwater for urban supply due to low storage inflows following a dry winter in 2019. The contribution from groundwater was 45 per cent and desalination was 47 per cent in 2019–20 compared with 43 per cent and 31 per cent in the previous year. The contribution of surface water dropped by 75 per cent from the previous year due to dry conditions in the catchment areas. The lower surface water contribution meant more desalinated water was required to meet urban demand. The region's two desalination plants were run at near capacity, similar to the 3-year period between 2014–15 and 2017–18. About 7 per cent of the total urban water sourced was recycled in 2019–20 in comparison to 4 per cent in the previous year. Excess groundwater and desalinated water produced during low-demand periods was discharged into the surface water storages, to buffer peak period demands.

Water sourced for urban use in Adelaide decreased by 3 per cent from 2018–19 to 2019–20, the second largest proportional decrease of all the major urban centres. Twenty per cent of total urban supply was sourced from surface water and 56 per cent through interregional transfers (from the River Murray) compared with 18 per cent from surface water and 79 per cent through interregional transfers in 2018–19. This decrease in interregional transfers was mainly due to the release of 40 GL upstream in the River Murray to help farmers who were affected by water scarcity under the Water for Fodder program. The State and Federal Governments reached an agreement to produce desalinated water from the Adelaide Desalination plant for urban use and release an equivalent quantity from the River Murray to the farmers. Desalinated water made up of about a quarter of urban supply, the highest contribution since 2013–14. About 26 per cent of the total water sourced was recycled, 39 per cent higher than previous year and the highest since 2010–11.

In Canberra, 55 GL of water was sourced for urban use, 5 per cent higher than the previous year. This was the highest increase of all major urban centres. Surface water diversions from storages made up nearly 100 per cent of supply. Less than 1 per cent of urban water sourced was recycled.



Source: National Water Account 2020

Note: Total water sourced is equal to the sum of surface water, groundwater, desalinated water, and inter-region transfers. Recycled water is not included.

Figure 27. Volumes and sources of urban water used annually in Australia's major urban centres, 2011–12 to 2019–20

3.2.5 Water use by 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 and electricity production.

The latest data available for industries are for 2018–19.[14] The total water consumed in Australia for industrial purposes is estimated as the average of the water estimates from 2016–17 to 2018–19 for the mining, manufacturing and electricity generation (ABS 2019; ABS 2020a; ABS 2020b). The total water consumed in Australia for industrial purposes is estimated as 1595 GL, 5 per cent higher than the estimate for the previous year. Electricity generation mostly uses surface water, with many large power plants having a high-security entitlement, whereas mining water is sourced from surface water, groundwater and/or desalinated water.

3.3 WATER STRESS

Water is essential for human activity and ecosystem healthy functioning. Global freshwater supplies are increasingly under pressure as water requirements increase 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 establish whether freshwater is constrained in meeting the basic needs of humans and economic development, several indicators have been developed over the previous 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 of the UN to compare estimates of the sustainability of water use across the world.[15] 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 indicators for Australia for 2016–17 to 2019–20 are shown in Table 2. The estimate for 2019–20 is similar to that of the previous year but is well below the water stress threshold 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 generally high availability and low use in northern Australia, compared to the high use in southern Australia.

Table 2. Water stress indicator values for Australia, 2016–17 to 2019–20

Year	2016–17	2017–18	2018–19	2019–20
SDG 6.4.2 indicator	5.1%	7.7%	8.6%	8.0%

14 https://www.abs.gov.au/

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

3.4 WATER FOR ENVIRONMENTAL USE

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 use disrupts the natural flow cycle and can affect the health and condition of rivers and their ecosystems. Environmental water 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.

In 2019–20, the majority of environmental water was delivered in the Murray–Darling Basin in a coordinated manner to deliver multiple benefits from water released. The total environmental flow delivered to rivers, lakes and wetlands in 2019–20 from all environmental water holders and managers in the southern Murray–Darling Basin was just over 3179 GL, while the total for the northern Basin was 120 GL. In the previous year, environmental water volumes delivered were 1725 GL and 293 GL in the southern and northern Basin, respectively. Detailed information regarding environmental water delivery is available in the National Water Account.[16]

Very little information on environmental water use outside the Murray–Darling Basin is available to the Bureau. In Victoria, outside the Murray–Darling Basin, about 187 GL of environmental water was released in the Central (10 GL), Gippsland (153 GL) and Western regions (25 GL) of the State during 2019–20.[17]

3.5 WATER FOR ABORIGINAL CULTURAL USE

Cultural flows are water entitlements that are legally owned and managed by First Nations to improve the spiritual, cultural, environmental, social and economic conditions of the Aboriginal Nations (Murray and Lower Darling Rivers Indigenous Nations, 2007). Water for environment can also provide some cultural benefits by improving the conditions of culturally important locations in the river. More recently, in many parts of Australia, methods for the explicit provision and accounting of water for use by Aboriginal people are being developed. 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. Case studies (such as the one below) do, however, illustrate that significant progress being made across Australia in provision of water for Aboriginal cultural use. Information regarding cultural water delivery in the National Water Accounting regions is available in National Water Account.[18]

One of the environmental water releases in the Yarra River during 2019–20 that provided cultural benefits to Aboriginal people was the watering of the Banyule Billabong (Victorian Environmental Water Holder, 2020). Banyule Billabong is an important billabong on the Yarra floodplain which has a deep cultural connection for the Wurundjeri Woi-wurrung people.[19] In September 2019, Melbourne Water, in partnership with the Victorian Environmental Water Holder, Parks Victoria, Wurundjeri Woi-Wurrung Corporation and the local community delivered environmental water to Banyule Billabong (Victorian Environmental Water Holder, 2020). The watering led to the regeneration of native plants in the wetland and provided cultural benefits to the Wurundjeri Woi-wurrung people.[20]

16 http://www.bom.gov.au/water/nwa/2020/

17 https://www.vewh.vic.gov.au/__data/assets/pdf_file/0007/539125/VEWH-reflections-booklet_2020.-LR-20.01.21.pdf

18 http://www.bom.gov.au/water/nwa/2020/

19 https://www.banyule.vic.gov.au/News-items/Banyule-Billabong-is-getting-a-helping-hand

20 https://www.vewh.vic.gov.au/__data/assets/pdf_file/0007/539125/VEWH-reflections-booklet_2020.-LR-20.01.21.pdf

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.
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.
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.
groundwater	Subsurface water in soils and geological formations that are fully saturated.
groundwater level	The level of groundwater in an aquifer, typically measured in a groundwater bore. In the case of an unconfined aquifer, the groundwater level is equal to the watertable level.
held environmental water	Water available under (a) a water access right, (b) a water delivery right or (c) an irrigation right, for the purposes of achieving environmental outcomes (including water that is specified in a water access right to be for environmental use).

Indian Ocean Dipole	A major contributor to rainfall variability over Australia. When the dipole is in a positive phase, sea surface temperatures (SSTs) around Indonesia are cooler than average while those in the western Indian Ocean are warmer than average. The positive phase increases easterly winds across the Indian Ocean while convection in areas near Australia reduces. This results in suppressed rainfall over the Australian region. During a negative phase, warmer than average SSTs near Indonesia and cooler than average SSTs in the western Indian Ocean, result in more westerly winds across the Indian Ocean, greater convection near Australia and enhanced rainfall in the Australian region. See the Bureau's Weather and Climate page on Indian Ocean for more information http://www.bom.gov.au/climate/iod/
Millennium Drought	The prolonged period of dry conditions experienced in much of southern Australia from late 1996 to mid-2010.
planned environmental water	Planned environmental water is committed in a water plan for achieving environmental outcomes.
rainfall	The total liquid product of precipitation or condensation from the atmosphere, as received and measured in a rain gauge.
recycled water	Treated sewage effluent, including water extracted by sewer mining and subsequently treated; it does not include treated urban stormwater.
river region	Produced as part of the Australian Hydrological Geospatial Fabric (Geofabric). These regions align with, and are nested within, the revised drainage divisions.
residential water	The total amount of metered and estimated non-metered, potable and non-potable water supplied to residential properties.
salinity	The concentration of soluble salts in a solution, soil or other medium.
storage	A pond, lake or basin, whether natural or artificial, for the storage, regulation and control of water.
storage system	A water storage or group of water storages from which releases and diversions are the main source of water for users within the boundaries of a particular region, normally aligning with a river catchment.
storage volume	The volume of water stored at a particular time and date, including only the volume of water that can be accessed under normal circumstances without the installation of additional infrastructure.
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 take	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 taken illegally, it is taken 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 includes bundled and unbundled water rights and bulk water access entitlements.

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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