

# surface water



“For most of Australia, our main source of fresh water is surface water and this is found in large dams and weirs. Right now, these supplies are under great pressure. Future supply is predicted to decline ...”

*Do you know in the past 20 years we have doubled the amount of water we have pulled out of our rivers, our surface water, for irrigation, and trebled the amount we've pulled out of the ground for irrigation? So it's a bit like the old 6 o'clock swill when the pubs closed at 6 o'clock, and just as the minute hand was getting to the 12 everyone would order more rounds of drinks because they wanted to belt them down before the publican said 'Time gentlemen please'.*

Malcolm Turnbull, speech to the Sydney Institute, 28 August 2006

Australia is the lowest continent in the world with an average height of only 330 m above sea level. This flatness means that after rain falls its passage into rivers and streams is very slow, and all the while it is evaporating.

The majority of Australia's rainfall is returned to the atmosphere through evaporation, leaving only about 12% as surface runoff.<sup>1</sup> Our main sources of fresh water are surface water (from rivers and lakes) and groundwater. About 73% of the fresh water used across Australia (approximately 24 000 GL) is supplied by rivers. In 1996–97, this amounted to a total of 19 109 GL. Surface water is the major source of fresh water in all jurisdictions except Western Australia and the Northern Territory.<sup>2</sup>

In an average year, a lot of rain falls on Australia – in fact more than 3 million billion litres!<sup>3</sup> But much of it falls in places where it can't run into rivers and most of it evaporates. Some makes its way into vast natural underground storages called aquifers.

The surface-water story becomes even more complex when we consider the spatial distribution of this rainfall with respect to Australia's drainage divisions. There are 12 of these. The largest is Lake Eyre, an area of

approximately 1 152 000 km<sup>2</sup> covering much of South Australia, Western Australia and the central part of the Northern Territory. The smallest division (Bulloo-Bancannia) is an area of nearly 98 000 km<sup>2</sup> in far western NSW.

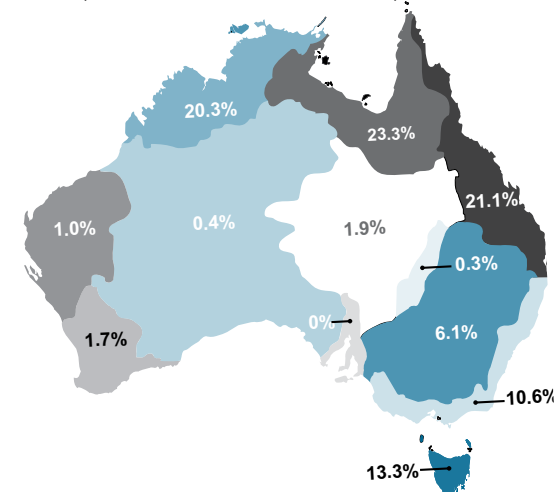


Figure 1. Australia's 12 drainage divisions

There is wide variation amongst the drainage divisions with regard to their physical characteristics, local climates and the volume of rain that falls on each one in an average year. The number written over each drainage division indicates the percentage of Australia's total rainfall that runs into that area.

Source: National Land and Water Resources Audit, *Australian water resources assessment 2000*, NLWRA, Canberra, 2001, p. 24.



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Five of the 11 mainland drainage divisions have runoff rates of less than 2%.<sup>4</sup> Surface water runoff exceeds 20% in only two monsoonal drainage systems adjacent to the Timor Sea and the Gulf of Carpentaria.

### LARGE-CAPACITY WATER STORAGEES

For the past 100 or so years, water management practices in this country have tried to address the consequences of our rainfall variability by capturing and storing surface water in almost 500 large dams.<sup>5</sup>

**A consequence of the construction of this large water-storage capacity is that many of Australia's major river systems are now regulated, i.e. the natural seasonal flow patterns have been reversed.**

These water storages have been strategically placed in high-yield catchments to minimise the cost of moving water to users. For instance, when full, the Hume Dam on the Murray River at Albury stores a volume of water six times that of Sydney Harbour.<sup>6</sup> Throughout the Murray-Darling Basin, which produces 41% of Australia's total farm output, 28 major dams and weirs have been built.

In Victoria alone, dam capacity increased from 1 million ML in the 1920s to nearly 12 million ML today, representing a twelve-fold increase over 80 years.<sup>7</sup>

It's worth noting that the extraordinary period of economic and population growth that took place after WW II occurred during decades in which

rainfall was generally higher than the long-term average. (This was in contrast to the decades from 1900 to 1940, which were relatively dry.) Today's water allocations, and our current expectations of water availability, are based upon the post-WW II rainfall patterns.

It's possible that we're now entering another prolonged dry period as we experience the effects of climate change. It's imperative that we take account of predictions of reduced rainfall and position ourselves accordingly.

Our water storage capacity is put to the test during prolonged dry periods. As we are probably all aware by now, the current declared drought has resulted in a significant decline in surface water runoff across most of mainland Australia during the past six to 10 years. As water levels have dropped in the major water storages supplying our cities, water restrictions have been introduced, and progressively increased.

**At the end of December 2006, water restrictions applied in 28 out of 32 cities across Australia with a population of greater than 50 000 people. A total of 15 602 000 people were on Stage 3 or Stage 4 restrictions. This represents 71% of the Australian population.**

Rainfall predictions suggest the current declared drought will break. There may yet be enough rainfall to refill these dams. However, rainfall predictions do not take account of the climate change that now seems to be underway. If lower average rainfall as a result of climate change comes about as predicted, the rate at which these

dams fill will be slower. There are two important unknowns here. How many years will pass before these dams fill again (indeed, if they ever completely do)? And what happens if another period of drought occurs in the short term?

### SMALL FARM DAMS

In addition to these major water storages, there are millions of small dams across Australia (many on 'hobby farms') which together hold an estimated 9% of all stored surface water.<sup>8</sup> For example, in the Gellibrand Catchment, west of Melbourne, it is estimated there are some 56 000 small dams.<sup>9</sup>

Small farm dams have two major impacts upon the hydrology of a catchment area. They trap an appreciable amount of water that would otherwise enter major waterways and, because of their relative shallowness, evaporation rates are usually high. With evaporation, water which could be used on land goes back as vapour into the atmosphere. When evaporation is high, more water is lost from the land surface.

Evaporation is measured by leaving a calibrated tray or pan exposed and measuring how much the water level falls over, for example, a week. This loss is the 'pan evaporation' rate and this rate varies from place to place. Evaporation rates across Australia are shown in Figure 4 on page 30. The evaporation rate from small farm dams is often almost the same as the pan evaporation rate because the relative shallowness of small farm dams means that the surface water warms up more quickly than water in major storages. In the Mallee region of Victoria, a 20 m<sup>2</sup> dam can

lose 500 000 L to evaporation in a single year. A 50 m<sup>2</sup> dam can lose 3 million L over the same period.<sup>10</sup>

In the past, farmers were encouraged to build small dams to 'drought-proof' their properties. However, because small dams actually reduce the amount of surface water reaching rivers and streams, many municipalities now require landowners to apply for a planning permit before establishing a dam. In the future, in some catchments farm dams may have to be decommissioned so that downstream users can obtain water.<sup>11</sup>

### OUR WATER DEMAND INCREASES

Despite the fact that our large storages are now under extreme pressure, our use of surface water has increased across all sectors: in agriculture, in industry and in cities and towns.

**Between 1983 and 1984 and 1995 and 1996, surface-water use increased from 12 008 GL to 19 109 GL – an increase of 59%. Water extracted for irrigation in this period increased by 76%, while urban and industrial use increased by 55%.<sup>12</sup>**

In NSW, Victoria and South Australia, surface-water extraction is either close to, or exceeds, extraction limits. In other words, more licences have been issued or allocated than there is water to supply based on the calculation of surface water runoff in average rainfall years.<sup>13</sup>

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**Figure 2. The status of surface-water use across Australia in 2000**

Water in rivers is managed on the basis of surface-water management areas. Approximately a quarter (26%) of Australia's surface-water management areas are either close to, or exceed, the sustainable flow regime. Most of the rivers in the NSW portion of the Murray-Darling Basin, the rivers in the west of Victoria and on the eastern side of St Vincent Gulf in South Australia are over-allocated; the total volume of water that has been approved for removal exceeds the average annual flow of these rivers.

In Victoria, most of the rivers north of the Great Dividing Range which flow to the Murray River are fully allocated. The volumes of water being removed from the rivers in the Queensland portion of the Murray-Darling Basin and the rivers north of the Basin, from Charleville to Townsville as well as those to the northeast of Adelaide, are allocated at up to at least 70% of sustainable yields.

With such high allocations and extended periods of very dry conditions, natural flows can drop so low that the rivers and streams struggle to sustain aquatic ecosystems.

**The shading on the map indicates the extent of allocation.**

- Over developed, greater than 100%
- Fully developed, 100%
- High, 70–100%
- Medium, 32–70%
- Low, less than 32%

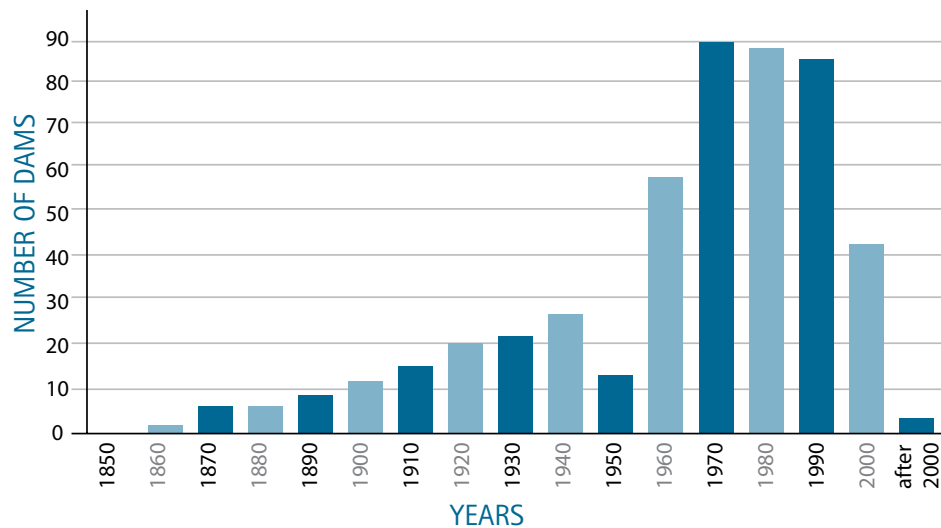
Note: While figure 2 provides a useful snapshot of surface-water use, some caution is needed. It would appear that allocations for Queensland are grossly underestimated. The rivers around Brisbane, in the Condamine area, are all either fully allocated or over-allocated.

Source: Australian Academy of Technological Sciences and Engineering, *Water recycling in Australia, special report*, ATSE, Melbourne, 2004, ch. 1, p. 3.



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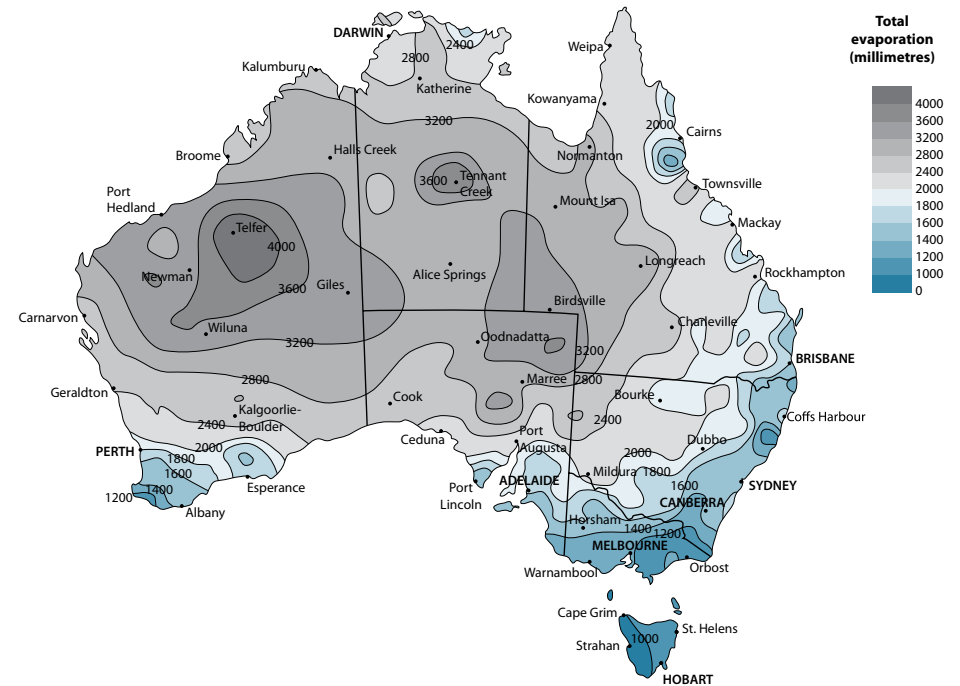
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**Figure 3. Number of large dams built in Australia since 1850**

The building of large-capacity dams really started after Federation, and by 1990 large dams had been built in all states and territories with a total combined storage capacity of 78 919 400 ML.

Source: W Boughton (ed.), *A century of water resources development in Australia, 1900-1999*, the Institute of Engineers, ACT, 1999, p. 21.



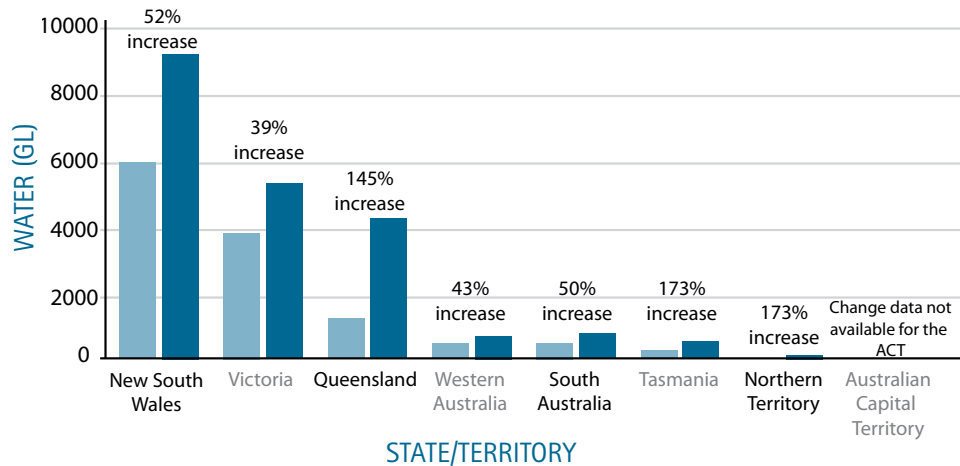
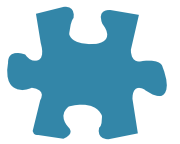
**Figure 4. Evaporation rates around Australia**

Evaporation is an essential component of the global water cycle. Without evaporation, clouds could not form and there would be no rain. There is wide variation in evaporation rates between different parts of Australia. In the map shown, the grey areas have the highest evaporation rates, while in the blue areas evaporation is lowest.

Source: Bureau of Meteorology, *Evaporation map*, BOM, Melbourne, <[www.bom.gov.au/watl/evaporation/](http://www.bom.gov.au/watl/evaporation/)>.

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**Figure 5. Change in mean annual surface-water use (in GL) between 1983 and 1984, and 1996 and 1997**

Use of surface water has been increasing across Australia for most of the past 20 years. Use in recent years has only been lower because of the drought conditions.

Source: National Land and Water Resources Audit, *Australian water resources assessment 2000*, NLWRA, Canberra, 2001, p. 61.

**Table 1. Distribution of water storage capacity across Australia, as at 1989**

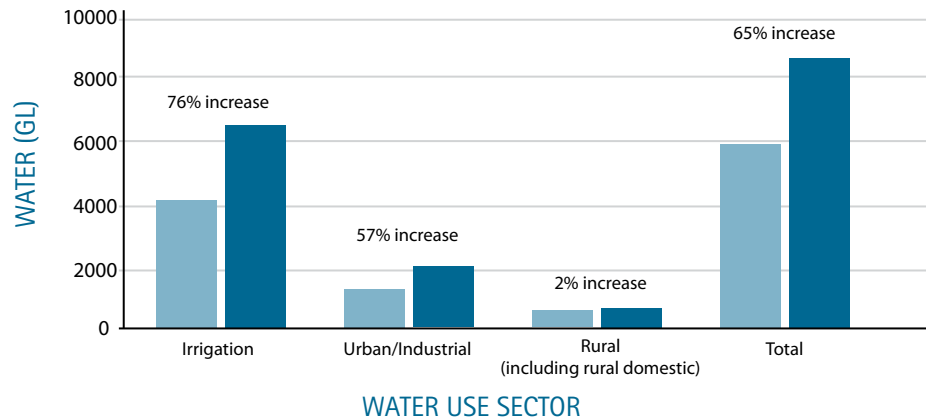
STATE/TERRITORY	TOTAL CAPACITY (GL)
New South Wales	25 389 300
Tasmania	24 167 000
Victoria	12 225 000
Queensland	9 459 200
Western Australia	7 011 300
Northern Territory	275 200
South Australia	266 800
Australian Capital Territory	124 600
<b>TOTAL</b>	<b>78 919 400</b>

Source: W Boughton (ed.), *A century of water resources development in Australia, 1900–1999*, The Institute of Engineers, ACT, 1999, p. 22. (These are the most recent figures available.)



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**Figure 6. Change in mean annual water use (in GL) in Australia between 1983 and 1984, and 1996 and 1997**

During much of the past two decades, total use of water in Australia has been increasing steadily. In the mid-term this demand will have to factor in the likelihood of less annual rainfall.

Source: National Land and Water Resources Audit, *Australian water resources assessment 2000*, NLWRA, Canberra, 2001, p. 57.

### ▶ REFERENCES

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2. *ibid.*, p. 55.
3. B Foran & F Poldy, *Future dilemmas – options to 2050 for Australia’s population, technology, resources and environment*, CSIRO Resources Futures Working Paper 02/01, CSIRO Sustainable Ecosystems, CSIRO, Canberra, 2002.
4. DI Smith, *Water in Australia: resources and management*, Oxford University Press, Melbourne, 1998.
5. W Boughton (ed.), *A century of water resources development in Australia, 1900–1999*, Institute of Engineers, ACT, 1999, pp.1–170.
6. Murray-Darling Basin Commission, *River Murray water – design and operation of the Hume Dam*, MDBC, Canberra, 2007, <[www.mdbc.gov.au/river\\_murray\\_system/hume\\_reservoir](http://www.mdbc.gov.au/river_murray_system/hume_reservoir)>.
7. W Boughton (ed.), *A century of water resources development in Australia, 1900–1999*, Institute of Engineers, ACT, 1999, app. 3, p. 78.
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9. Department of Sustainability and Environment, *Sustainable water strategy, central region – action to 2055*, DSE, Melbourne, 2006, p.15.
10. Grampians and Mallee Water, *Farm dams – piping it*, fact sheet, 2006, <[www.gwmwater.org.au](http://www.gwmwater.org.au)>.
11. K Savadamuthu, *Impact of farm dams on stream flow in the upper Marne catchment*, Department of Water Resources South Australia, report 02/01/003, DWR, Adelaide, 2002.
12. National Land and Water Resources Audit, *op.cit.*, p. 57.
13. National Land and Water Resources Audit, *Australia’s natural resources: 1997–2002 and beyond*, NLWRA, Canberra, 2000, p. 37.

### Some other useful sources

- D Smith, *Water in Australia*, Oxford University Press, Australia, 1998, ch.1.
- P Newell, *The olive grove*, Penguin Books Australia, Ringwood, Victoria, 2000.