

Strategic Analysis Paper

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Australia's Water Security Part 1: Water Resources

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Key Points

- Despite occupying 5.6 per cent of the world's landmass, Australia receives little more than one per cent of the world's available freshwater resources.
- The bulk of Australia's population, agriculture and industry are located in the temperate and southern coastal stretches of Australia, while more than 50 per cent of its water run-off occurs in tropical and sub-tropical northern Australia.
- Approximately 85 to 95 per cent of rainfall in Australia is lost to evaporation or transpiration.
- Only five to 10 per cent of Australia's annual rainfall reaches streams, water storage or groundwater aquifers.
- Managing Australia's water more efficiently and increasing its capture and storage will be critical to ensure ongoing water access under climate change and population growth predictions.

Summary

Australia is recognised as the world's driest inhabited continent; with access to just over one per cent of global freshwater resources. In addition, the variability in water availability across the continent is considerable. Despite limited freshwater resources, most Australians have ready access to water and one of the highest per capita usage rates in the world. This, however, does not reflect the variability in water access across the country.

While rainfall in the tropical north is high for short periods of the year, the high demand areas in the south-east and south-west do not have access to that water. Groundwater, surface water and rainfall vary greatly from region to region and population growth and climate change are expected to make these disparities more pronounced. It is critical that the variability of Australia's water resources is acknowledged; generalisations about the

state of Australia's water security nationally must be avoided, to ensure policy measures are designed for local conditions.

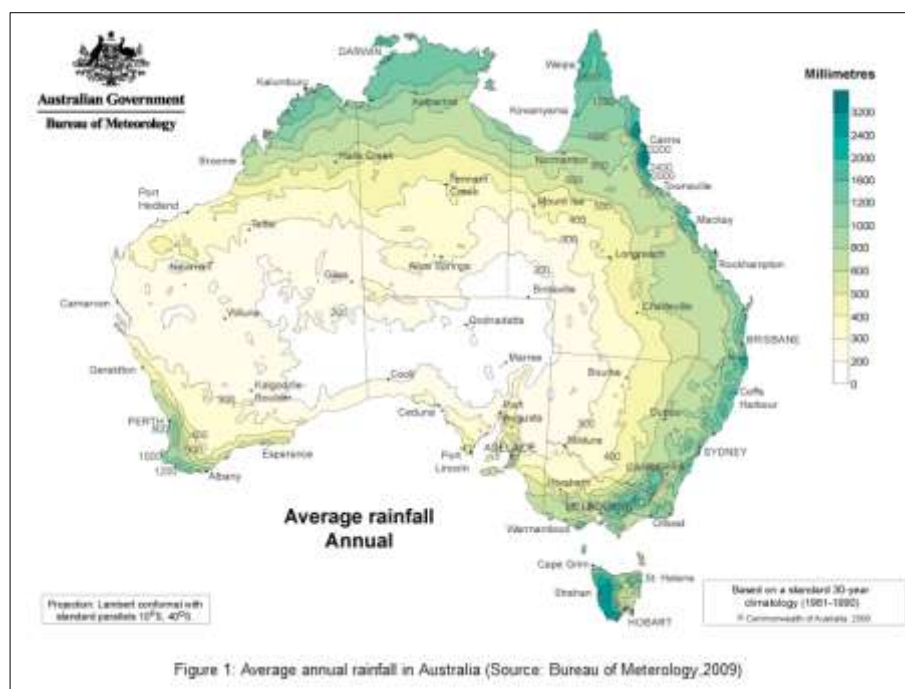
Analysis

Australia's Water Cycle: Quantity and Access

Despite occupying 5.6 per cent of the world's landmass, Australia receives little more than one per cent of the available freshwater resources. Access to freshwater varies considerably across the continent; widespread drought is frequent, as is the occurrence of flooding in some parts of the country. Taking into consideration population growth and climate change predictions, the efficient management of Australia's water, including increasing the capacity to capture and store it, is critical if we are to meet future water demands.

Rainfall

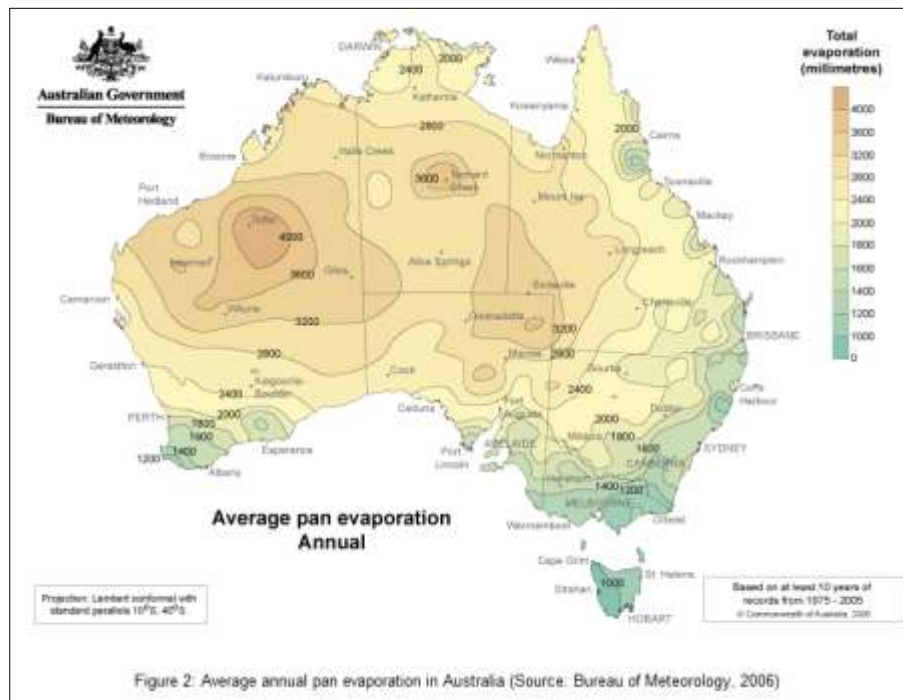
Rainfall and climate variability have a significant impact on water availability. It is crucial that climatic zones within Australia are recognised, as a 'one size fits all approach' to assessing water security will not provide an accurate picture of Australia's water environment. In the tropical north, rainfall can exceed 4,000mm per annum, often leading to seasonal flooding (Figure 1). Overall, however, 80 per cent of the country receives less than 600mm of rainfall¹.



According to the Bureau of Meteorology (BOM) approximately 85 to 95 per cent of rainfall in Australia is lost to evaporation or transpiration. Evaporation occurs when water returns to the atmosphere from a surface (land surface, upper soil layer, water body) as water vapour. Transpiration is the process where water absorbed by plants is lost through plant tissue as

¹ Sivakumar, B (2014), "Water resources and environment in Australia," *Stoch Environ Res Risk Asses*, vol. 28, pp. 1-2

water vapour. Both processes together are referred to as evapotranspiration. As Figure 2 highlights, the total evaporation rates in the majority of Australian regions is above 1800mm per annum. The south-west and south-east regions have the lowest rates of evaporation, correlating with the temperate climatic zones. As expected, the Central Desert Region and north-west have the highest rates of evaporation.



When assessing water availability in Australia, it is also important to take into account the irregularity of precipitation in many areas. Long periods of drought are interspersed with short periods of heavy rainfall and flooding. This leads to limited in-stream water availability after evaporation and transpiration. The national mean annual rainfall is approximately 564 mm. The Australian Bureau of Meteorology's [2012 Australian Water Resources Assessment](#) found that the annual rainfall for 2011-12 was 33 per cent above the long-term average for 1911-2012. Soil moisture increased substantially as a result and the water yield for much of the country was 57 per cent above the long-term average. Conversely, evapotranspiration rates were 30 per cent higher than the long-term average, while elevated rainfall levels across most of the country were equal to annual evapotranspiration and landscape water yields combined. The South-West region of Western Australia was the exception to this trend; here soil moisture volumes and annual rainfall levels continue to fall.

The bulk of Australia's population, agriculture and industry are located in the temperate and southern coastal stretches of Australia, but more than 50 per cent of total run-off occurs in tropical and sub-tropical northern Australia². The disparity between population concentration and rainfall has increased the need for long-term water management strategies that address significant shortages of water for cities and industries.

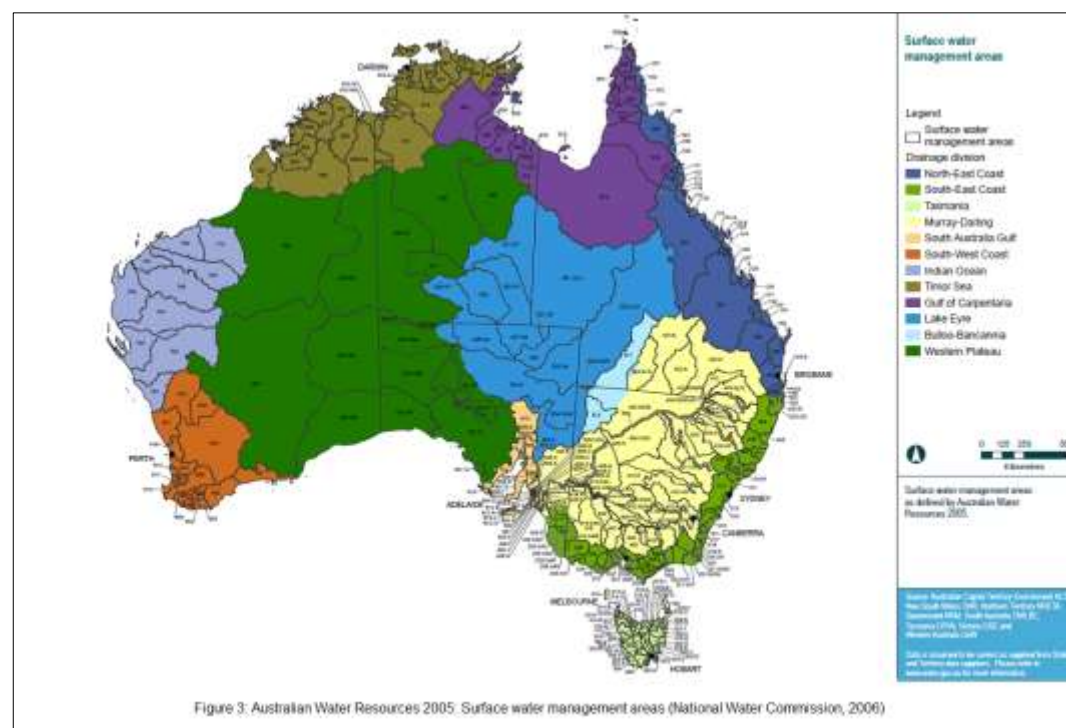
² White, Robert (2007), "Australia's Water Crisis" *Australasian Science*, Mar 2007, vol. 28(2), pp. 35-36

Surface Water

The dependence on surface water systems varies across Australia. According to the [2013 National Water Planning Report Card](#), 80 per cent of Victoria's water use and almost two-thirds of water consumption in Queensland are dependent on surface water flows. The River Murray is South Australia's major surface water resource, accounting for approximately 30 per cent of the state's available water resources. In the Australian Capital Territory the majority of available surface water is shared with New South Wales. In the Northern Territory, tropical climatic conditions and extreme rainfall variability, lead to highly sporadic surface water flows and dependence on groundwater in the dry season.

Western Australia's South-West region has witnessed a decline in rainfall of approximately 15 per cent since the 1970s, leading to a significant reduction in the availability of surface water. Tasmania, on the other hand, has less than one per cent of Australia's landmass and 12 per cent of its freshwater resources. This variability in surface water availability and consumption highlights the complexities of water management in Australia. Availability does not always correlate with demand (urban, industry and agriculture), which is, generally, highly focused in Australia's south-east.

Major surface water sources within Australia are divided, as outlined by the [National Water Commission](#), between 12 drainage divisions, 246 river basins and 340 surface water management areas (Figure 3). In July 2012 the national surface water storage volumes stood at approximately 93 per cent of capacity (38,196,600ML). By June 2013 those volumes had decreased to 75 per cent capacity, or 30,811,000ML ([Bureau of Meteorology 2013](#)). Of the volume of water used nationally (excluding environmental water use), 87 per cent was sourced from surface water, with the Murray-Darling Basin accounting for 83 per cent of the water used in National Water Account regions according to the BOM.



The Murray Darling Basin

The Murray-Darling Basin (MDB) is the largest river system in Australia. The Basin occupies a seventh of Australia's landmass and accounts for almost half the country's agricultural production. Australia has 12 major drainage basins; however, most of its water use and extractions come from the MDB³. In total, approximately one-third of Australia's food supply and forty per cent of Australian farms are dependent on the MDB. Sixty-five per cent of Australia's irrigated land area also lies within the Basin, creating a large concentrated area of water dependency. In economic terms, the gross value of agricultural production in the Basin in 2011/12 was approximately \$18.6 billion.

Until the introduction of the 2007 Water Act, the Murray-Darling Basin was managed jointly by five states and territories. Competition over water access and differing interests led to critical over-allocations of available water and accelerated environmental degradation. Thousands of canals, channels, dams and weirs were developed to ensure that users (particularly within agriculture) had a reliable water source. The Murray Darling Basin Authority was established under the federal *Water Act 2007*, to address conflict between states over water and support the integrated management of the Basin's water resources in a sustainable and equitable manner. Despite the size of the Basin, water flows are quite low. High rainfall variability from year to year creates challenges in managing water supplies and ensuring sustainable and equitable access for all users, whether for social or economic purposes.

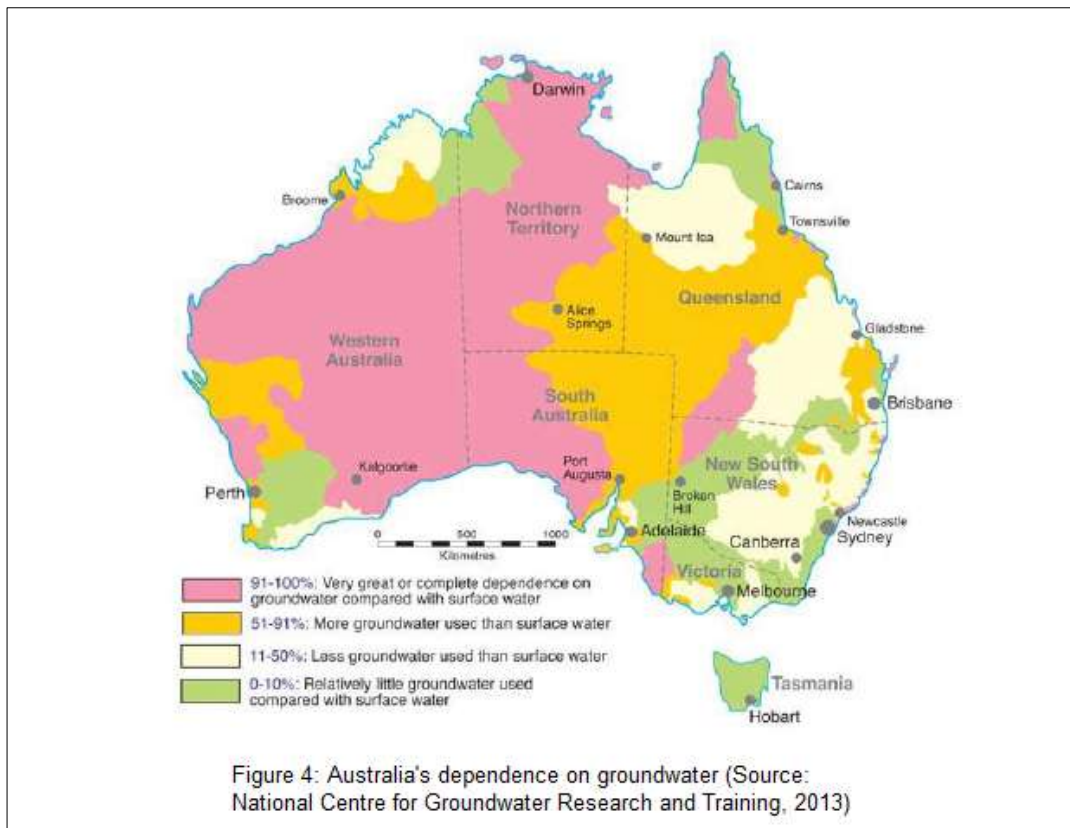
Groundwater

Only five to 10 per cent of Australia's annual rainfall reaches streams, water storage or groundwater aquifers. It is difficult to estimate the availability of groundwater in Australia as reliable data is limited to a few regions. In Western Australia, the Northern Territory and Tasmania nationally-significant groundwater systems are yet to be assessed. Further challenges arise because of the limited knowledge available regarding the connectivity between ground and surface water systems and their dependent ecosystems.

Groundwater is a critical source in states where dry climatic conditions or high rainfall variability have affected the availability of surface water. Western Australia relies on groundwater for at least 50 per cent of its water consumption. In Perth, the prioritisation of climate independent water sources has led to plans for Australia's first full-scale [groundwater replenishment scheme](#). The aim is to boost drinking water supplies, as falling annual rainfall rates are predicted to continue.

Australia has a number of key groundwater sources, including: the alluvial aquifers of the Murray-Darling Basin; the Perth Basin; the Canning Basin in north-Western Australia; the Daly Basin in the Northern Territory; the Otway Basin of south-east South Australia and south-west Victoria; and the Great Artesian Basin, which covers a fifth of Australia, including 70 per cent of Queensland.

³ Kingsford, R (2009), "Managing Australia's Scarce Water Resources for the Environment," *Pacific Conservation Biology*, Vol. 15, pp.4-6



According to official statistics, national groundwater use is approximately 5,000GL per annum. Actual groundwater use, however, may be double this figure according to a recent [publication](#) from the National Centre for Groundwater Research and Training (NCGRT). Limited monitoring infrastructure and inconsistent national reporting make it difficult to obtain accurate statistics. The largest user of groundwater is the agricultural sector, accounting for approximately 60 per cent of all withdrawals.

As Figure 4 highlights, groundwater dependence varies considerably from state to state. The majority of Western Australia, the Northern Territory and South Australia are dependent on groundwater as a key water resource. South Australia is the driest state in Australia. Low rainfall has led to an increased dependence on groundwater, which is now critical for the state's south-east agricultural areas. The Northern Territory sources approximately 90 per cent of its water from aquifers according to the NCGRT and New South Wales and Victoria have experienced a significant increase in groundwater dependence over the last two decades.

Under climate change predictions, further dependence on groundwater and increased abstractions by multiple users can be expected. This creates a level of urgency in the task of increasing investment in monitoring and reporting mechanisms for groundwater across Australia. Ensuring that groundwater use is sustainable and abstractions are managed within recharge limits will become increasingly critical in maintaining a positive groundwater balance and long-term groundwater supplies.

The Water Balance

In 2012 the Bureau of Meteorology (BOM) used the Australian Water Resources Assessment Modelling System (AWRAMS)⁴ to estimate landscape water flows and storage across Australia. The assessment is part of the [Water Information Research and Development Alliance](#). The AWRAMS includes regular assessment of the landscape water balance (including vegetation and soil water balances); a river component assessing river and floodplain balances; and a groundwater component estimating groundwater flows. The assessment of water balances across Australia is critical to ensure that management and policy decisions are based on the most accurate water data available.

Australia's Current Water Environment

Taking Australia's water variability into account is useful in assessing water resources from a regional (or basin) perspective. In doing so a more concise analysis can be applied to Australia's water security without risk of generalising or simplifying complex water systems. Water availability and annual rainfall rates are significant in some regions, leading Australia to present with high per capita water availability in global comparisons. This does not, however, translate to Australia being water abundant. Only 5 to 10 per cent of Australia's water resources are accessible for consumption. High rainfall variability rates, both between regions and over time, create further challenges in storing and accessing water.

Managing Australia's water more efficiently and increasing the capture and storage of water will be critical to ensure ongoing water access under climate change and population growth predictions. Increased investment in monitoring and reporting mechanisms for groundwater sources must also be prioritised to ensure that policy decisions are based on the most accurate data available.

This first part of Future Directions International's Australian water assessment has provided an overview of water availability in Australia, the major sources of water and the spatial and time challenges limiting access to water resources. The second part will discuss the major users of water in Australia, analyse usage trends and predicted demand increases; it will also consider where water use efficiencies can be addressed.

Any opinions or views expressed in this paper are those of the individual author, unless stated to be those of Future Directions International.

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⁴ The AWRAMS is a nationally consistent landscape water balance model, recently developed through a CSIRO and Bureau of Meteorology partnership [http://www.csiro.au/Organisation-Structure/Flagships/Water-for-a-Healthy-Country-Flagship/WIRADA_WFHC_ResearchProfile/Water-Resources-Assessment-and-Water-Use-Accounting.aspx] [accessed August 2014].