Sustainable Population Australia

DISCUSSION PAPER

Big thirsty Australia:

how population growth threatens our water security and sustainability

Jonathan Sobels, Peter Cook, Sandra Kanck and Jane O'Sullivan

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Sustainable Population Australia

Sustainable Population Australia (SPA) is an independent not-for-profit environmental advocacy organisation established in 1988. SPA seeks to protect the environment and quality of life by ending population growth in Australia and globally, while rejecting racism and involuntary population control. SPA works on many fronts to inform public awareness about population issues from ecological, social and economic viewpoints, and to advocate for how Australia and the world can achieve an ecologically sustainable population.

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Peter G. Cook, BA, MA, PhD, grew up in Toodyay in rural Western Australia. He has degrees in communication studies, and was awarded two Canadian Commonwealth Scholarships for post-graduate study at Simon Fraser University in Canada. Peter has worked variously as a beekeeper, university lecturer, public policy researcher, digital media project manager and senior executive in the non-profit sector. He has been involved over many years in environment-related issues including uranium mining, nuclear weapons, forests, energy and climate. He is coordinator of the SPA discussion paper series.

Hon. Sandra Kanck, DipTeach, was a member of South Australia's Legislative Council for 15 years. During that time she participated in a number of committee inquiries related to water particularly looking into Murray-Darling Basin issues, from southern Queensland through NSW to the Murray mouth, and the Upper South East Dryland Salinity project in South Australia. Before her parliamentary service she was employed by the Conservation Council of SA, and was formerly a primary school teacher in NSW. Since her retirement from parliament in early 2009 she has continuously held leadership positions in Sustainable Population Australia and is currently its national secretary. She has recently published a memoir of her childhood.

Jane O'Sullivan, BAgrSc, PhD, is a cross-disciplinary researcher spanning the nexus between agriculture and demography, embracing food security, ecological sustainability and economic development. She has led international research on tropical subsistence and semi-subsistence crops and farming systems, before shifting her focus to the threats posed by population growth to food security, economic development and ecological sustainability, and the effectiveness of measures available to limit population growth. She has participated in numerous collaborations with international colleagues in ecological economics, environmental philosophy, climate change responses and family planning promotion and implementation. She is a co-convenor of The Overpopulation Project https://overpopulation-project.com/

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Summary

Most Australians are oblivious of the momentous changes taking place in Australia's water security due to population growth and climate change. For 200 years, Australia's expanding population has driven demand for more water. As population continues to grow due to high immigration levels, concerns about water security are also mounting. Recent major droughts (1997-2009 and 2017-19) have put pressure on water supplies in both small towns and capital cities, prompting state governments to commission large-scale desalination plants.

Population growth slowed (but did not halt) during the Covid-19 pandemic, when migrants leaving Australia briefly exceeded those arriving. Then the government restarted immigration at unprecedented levels: six times the long-term average! Even if the government succeeds in reducing immigration to pre-Covid levels, Australia will grow from 27 million to 40 million people inside of 40 years, and continue growing indefinitely thereafter.

There has been surprisingly little discussion about whether there will be enough water to support this goal. Despite Australia being the driest continent with the least run-off and most variable rainfall, water planning simply assumes the population projections of the Treasury Department must be achieved. Treasury makes these projections of high immigration levels in order to boost GDP, without considering natural resources or quality of life. It is assumed technological fixes, particularly desalination, will save the day. Is this techno-hubris? Is it wishful thinking?

This Discussion Paper argues those assumptions of water abundance are dangerously flawed. It explains why expanded desalination, rather than being a solution, is a further symptom of the financial, environmental and social costs of population growth. The paper argues strongly for net migration to return to pre-2005 average levels, around 70,000 per year, to achieve a stabilised population size.

Population growth is putting pressure on urban water supplies.

Since the early 2000s, water demand in many Australian cities has exceeded what can be supplied reliably by conventional means, namely rainfall and groundwater. Rapid population growth in the last 20 years has rendered our capital cities vulnerable to shortages of fresh water during droughts. Each major capital city, except Hobart, Darwin and Canberra, has built at least one desalination plant because their water demands are growing while the water catchments are progressively drying.

City dwellers are not only users of water directly through the tap, but also indirectly via the 'virtual water' necessary to produce food, fibre, energy and manufactured goods. Virtual water footprints in Australia's cities are 8 to 10 times higher than direct per capita residential water consumption, with most of that virtual water being used outside the city boundaries in agricultural areas.

Although we still depend on rainfall (including groundwater) for around 85% of urban water supplies, growth in demand from a growing population will need to be met from other sources. We have no suitable sites for additional big dams within reach of our capital cities. Australia is flat, dam sites are rare, and mostly already built upon.

Most of Australia's rainfall is in the tropical north, while most Australians live in the temperate south. It is not economically feasible nor environmentally benign to build pipelines or canals or water tankers to take water from north to south for urban water supply, let alone for irrigation. Permanent subsidies would be required. Despite repeated debunking, proposals persist for megaprojects such as a pipeline from the Argyle Dam to Perth or the Bradfield Scheme to divert Queensland's coastal rivers inland, because of a simplistic faith that technology will permit unlimited population growth.

We are therefore entering a new era of growing reliance on 'manufactured' sources of water, such as desalination and water recycling. These are claimed to be 'climate-independent' but are energy-intensive. These technologies increase complexity, costs, risks and uncertainty, making Australian cities increasingly vulnerable to shocks, whether from accelerating climate change or fragile global supply chains.

Australia's scarce water resources will be further diminished by climate change.

Australia is the continent subject to the greatest variability in rainfall, the least amount of runoff, and the highest evaporation of any inhabited continent. For every 1% less rainfall, there is 3% less runoff. As droughts increase in frequency, it is prudent to use drought as the norm in planning. For a drought-prone large city, increasing population escalates stresses.

Human-induced climate change is expected to result in hotter, drier and more extreme conditions particularly in southern Australia. We can expect the length and severity of future droughts to worsen.

Other extreme weather events such as floods and bushfires will place increasing stress on water infrastructure. Floods can damage water treatment plants and distribution systems. Bushfires can damage catchment areas and reduce the water yield from the catchment. A study of the Thomson River catchment, Melbourne's largest water source, estimates around 13% reduction in catchment water yield by 2050 due to recurring fires. If bushfires are followed by heavy rains, burnt debris washes into water storages, affecting water treatment. These factors all increase threats to Australia's water supplies, which will require complex and costly responses.

Much of inland Australia depends on groundwater to sustain towns, livestock and mining. Groundwater basins are effectively being mined for irrigation and urban supplies, taking more water out than can recharge. One quarter of Australia's 288 groundwater management areas are over-allocated. Data on replenishment rates are often missing, ignored or inaccurate. Much of the water being pumped, for example, from the western Great Artesian Basin, is well over one million years old. A drying climate means less recharge of groundwater.

The sobering findings of paleoclimate research

Recent studies of Australia's climate over the past 2000 years suggest that, even prior to human-caused climate change, the continent had *already* experienced extended megadroughts more severe than any encountered during the twentieth century. There is evidence of megadroughts that lasted as long as four decades. What we have assumed as normal rainfall in the twentieth century is atypically high compared to the longer history. Australia's so-called Millennium Drought (1997 to 2009) is a minor blip by comparison.

The water infrastructure built in the twentieth century was based on an assumption that the future will be like the recent past. Our paleoclimate history, combined with the present drying trends, indicate a highly uncertain and erratic future for water supply. The prospect of droughts lasting decades, in an Australia with a larger (and still growing) population than currently exists, is a recipe for disaster.

Continuing population growth in our cities will increase demand for water.

From 19 million at the turn of the century, Australia's population reached 27 million in 2024. The official government projection is that Australia will reach a population of 40 million by 2063, based on a constant net overseas migration of 235,000 per year. In other words, that's another Sydney, plus another Melbourne, plus another Perth. Most of the projected growth would come from immigration and the children migrants will have.

Some Big Australia advocates want even higher growth to 50, 60 or 70 million people by 2075. Some even contemplate a 150 million target. It is surely incumbent upon these advocates, and Australian governments specifically, to explain how adequate water for human and environmental use will be provided in these scenarios, when water security is already precarious.

Over the past few decades, urban water demand has been stable or increasing slowly despite population increases. Lower per person water use has been achieved through water restrictions during prolonged drought, increased water prices, more efficient technologies, public education, and more apartment living. However, the low-hanging fruit for water saving have now been picked. Mainland urban water authorities anticipate further population growth will require adding anywhere from 850 gigalitres (GL) to over 1450 GL to annual water supply to capital cities over the next several decades. (A gigalitre is equal to one billion litres of water, which would fill a cube 100 metres in each direction, or 400 Olympic swimming pools.) For purposes of comparison, 1450 GL is around the total volume of water currently supplied each year for Sydney, Melbourne and Perth combined.

Water authorities and politicians are increasingly committed to desalination as the means to supply most of this additional water, with a minor role for recycled water. Some cities use the latter to irrigate parklands but adding it to drinking water has proved politically controversial.

Increasing reliance on desalination will put Australia on a precarious and unsustainable path.

Using desalination to support ongoing population growth is maladaptive in terms of cost, availability of suitable sites, additional energy demands, greater complexity, and vulnerability to threats such as sea level rise.

Desalination is presented as being 'sustainable' because it can be powered by renewable energy. However, it is the most energy intensive form of water supply. It requires large amounts of electrical energy to push the water through the desalting membranes, typically 3 kWh of electricity to produce one kL (1000 L) of potable water. It's not helping 'sustainability' if extra renewable capacity is being used to meet the *extra* energy demand from desalination, rather than displacing existing fossil fuel use in other sectors.

Water authorities and ministers are turning to desalination technology to prevent water being a *constraint* to population growth; in doing so it becomes an *enabler* of growth. It externalises wide-ranging negative impacts of that growth in other parts of the social-ecological system. These impacts are not considered as part of the water strategy, due to the siloed nature of planning and policy making. Cramming an additional 13 million people into Australia's largest cities cannot avoid impacting the surrounding biodiversity, particularly through further land clearing for greenfield development, greater demand for goods and services produced in the hinterlands, and more recreation and tourism pressures.

As we get increasingly locked into desalination to meet population growth, water bills rise, vulnerability to ever-more severe climate and geopolitical shocks increases – from sea level rise to global supply chain disruption – and quality of life decreases in our hotter, sprawling and more congested cities.

While desalination and recycling are valuable technologies to compensate for unavoidable impacts of climate change on water supplies, it is irrational to impose extra costs and vulnerabilities to cater for avoidable population growth, when no benefits of a larger population are evident to justify these (and many other) extra burdens.

Water planners should frame future population growth as a policy choice, not an inevitability.

Continuing growth of Australia's population is not sustainable. As documented by a series of government State of the Environment reports, Australia's natural systems are continuing to deteriorate, and population growth is among the greatest causes. Sustainability means avoiding further depletion of our natural ecosystems and the natural capital on which future Australians depend, in order to maintain an ecological balance indefinitely into the future. Further population growth will divert more water to human use and deprive already-damaged ecosystems of the water they need to survive and thrive. It will make us dependent on desalination with its high costs and vulnerabilities.

If we can, at least, stabilise the number of people, we might stem the deterioration. We could fund urgently needed maintenance of aging water infrastructure, put more water towards greening our cities and regenerate wetlands and other ecosystems. With improved water management, such as reducing leakage and evaporation losses, we might return more water to riverine environments without sacrificing our standard of living. The constant expansion of water infrastructure to accommodate population increase is a costly exercise in running to stand still, with huge environmental costs but little or no benefit for existing residents. A stable population would be by far the cheapest way to meet Australia's water requirements, with many other benefits for the environment and quality of life.

The fatalistic acceptance of official population projections has meant there is a population blind spot in Australia's water planning. Stabilising our population size must become part of the portfolio of options for managing our water security.

1. Introduction

It is January 17th 1908 – possibly Australia's hottest day on record, in a heat wave remembered for decades as the Month from Hell![1] A few months later, in September 1908 Dorothea Mackellar published the poem 'Core of My Heart', later to become known as 'My Country'. For the 4.2 million Australians of the time, 'droughts and flooding rains' were the defining elements of Australia's geography and with it, our identity. The poem dramatically contrasts the bucolic ideal of England's mild climate, plentiful water, green vistas and rich soils with their Australian antithesis.

> The love of field and coppice,
> Of green and shaded lanes.
> Of ordered woods and gardens
> Is running in your veins,
> Strong love of grey-blue distance
> Brown streams and soft dim skies
> I know but cannot share it,
> My love is otherwise.
>
> I love a sunburnt country,
> A land of sweeping plains,
> Of ragged mountain ranges,
> Of droughts and flooding rains.
> I love her far horizons,
> I love her jewel-sea,
> Her beauty and her terror -
> The wide brown land for me!

The resident population of Australia passed 27 million in January 2024.[2] The previous year saw record growth, adding around 650,000 people, mostly through immigration. The consequences of droughts and floods are exacerbated by our rapidly increasing numbers of people, their concentration in cities and especially on floodplains, the increasing volume of biophysical resources they consume, and our misguided assumption that water is abundant.

Population growth since European colonisation has been a major driver of water use and the development of water infrastructure. In their history *Cities in a sunburnt country: water and the making of urban Australia* (2022), Margaret Cook and co-authors document this journey and its challenges. Just prior to white settlement it is estimated the indigenous population was about 800,000 – having remained relatively stable for thousands of years. This number dropped tragically to 200,000 by 1850, following exposure to European diseases, frontier violence and

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1 https://www.waclimate.net/1908.html
2 ABS 2023 Population Clock, accessed 27/02/2023, at https://www.abs.gov.au/ausstats/abs%40.nsf/94713ad445ff1425ca25682000192af2/1647509ef7e25faaca2568a900154b63?OpenDocument

displacement.[3] From 1788 onwards, the growing European settler population chose coastal areas adjacent to freshwater rivers. The settlers began a process of 'reshaping of the Australian landscape to meet urban demand for water, fuel and construction materials by clearing vegetation, altering watercourses and draining and filling wetlands'.[4] This inevitably encroached on Aboriginal communities who had settled in these same fertile surrounds. As European settlers enforced new private property rights and spread new diseases, these communities were inexorably pushed out and in many cases their links to country were 'irretrievably destroyed'.[5]

From the 1850s onwards the new settlers started building dams and networks of pipes for urban water infrastructure. The twentieth century was the era of the 'hydraulic mission' approach to securing Australia's water supply: large-scale engineering solutions including the Goldfields Water Supply Scheme in Western Australia, the iconic nation-building Snowy Mountains project and the network of dams and channels built for irrigation of the Murray-Darling Basin.[6] These projects were seeking to extract water for human use with scant regard for the environmental consequences.

This technological system of 'big water' – the descriptor coined by cultural researcher Zoë Sofoulis – brought with it an urban form and cultural practices premised on abundant water.[7]

Beginning in the late 1980s, concerns mounted about over-diversion of water for irrigation causing environmental degradation in the Murray-Darling Basin (MDB), as well as population growth threatening the adequacy of urban water supplies. With the added impetus of the Millennium Drought, this led to a decade or more of reforms which culminated in the *National Water Initiative* (2004) and the *Water Act 2007*. For the first time, the environment was recognised as a key user of water ('environmental water') that must be accommodated in water planning. Various initiatives and principles were adopted to enable efficiency, integration, and transparency in water policy and planning, and to allow for environmental water.

> "No government yet seems to have been able to see the connection with rampant population growth and increasing water deficits."
> - Prof. Peter Cullen AO

The Commonwealth *Water Act 2007* created the Murray-Darling Basin Agreement and Plan. The agreement is a political accomplishment of cross-jurisdictional arrangements of international significance, administered by the Murray-Darling Basin Authority (MDBA). It is, however, bedevilled by inter-state conflict, poor compliance, weak market mechanisms, political interference in setting water recovery targets to restore riverine health, and continuing pressure by allowing vested interests to 'water down' scientific objectives without the data to support their arguments. The idea of a 'Working River' is yet to be defined in actual outcomes that will allow this major river system and its biodiversity to thrive in perpetuity alongside the agricultural and many other uses of fresh water – in other words, to be truly sustainable.

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3 Cook, M., Frost, L., Gaynor, A., Gregory, J., Morgan, R. A., Shanahan, M., & Spearritt, P. (2022). *Cities in a sunburnt country: water and the making of urban Australia*. Cambridge University Press, p. 56.

4 Ibid., p. 53.

5 Ibid., p. 233.

6 Wester defines the hydraulic mission as "the strong conviction that every drop of water flowing to the ocean is a waste and that the state should develop hydraulic infrastructure to capture as much water as possible for human uses. The carrier of this mission is the hydrocracy, that, based on a high-modernist worldview, sets out to control nature and "conquer the desert" by "developing" water resources for the sake of progress and development." See, Wester, P. (2009). Capturing the waters: the hydraulic mission in the Lerma–Chapala Basin, Mexico (1876–1976). *Water Hist* **1**, 9–29, p. 10. https://doi.org/10.1007/s12685-009-0002-7

7 Sofoulis, Z. (2005). Big water, everyday water: a sociotechnical perspective. *Continuum*, 19(4), 445-463. https://doi.org/10.1080/10304310500322685

Throughout these decades of reforms, the underlying assumption has remained that sufficient water can always be found for a perpetually increasing population. At the turn of the twenty-first century, in the face of droughts, continuing population growth and exhaustion of new sites for dams, doubts began to be raised about whether the abundant water ethos was sustainable.[8]

Among those drawing attention to the population factor was the late Professor Peter Cullen AO, one of Australia's great water and ecology scientists and a founding member of the Wentworth Group of Concerned Scientists. Cullen pointed to population pressures in a number of conference presentations:

- 'There is an increasing diversity of pressures on our natural resources, and an intensification of the pressures due to population growth'.[9]
- 'The contribution of population growth, climate change and the awareness of the need to leave some water in rivers to protect their health is leading to a squeeze on water resources and we are entering an age of relative water scarcity'.[10]
- 'No government yet seems to have been able to see the connection with rampant population growth and increasing water deficits'.[11]
- 'Along with climate change, population growth is recognised as a key factor that will put pressure on water resources'.[12]

Despite the long-standing recognition of the role of population growth in the demand for water, there has been no policy initiative to question or rein in the rate of that growth.

More recently, the Productivity Commission states in its *National Water Reform 2020* report: 'the key issues that water management will need to deal with over the next 10 to 20 years to ensure proper stewardship of Australia's water resources … will be dominated by the effects of climate change, coupled with the needs of a growing population.' [13]

Despite the long-standing recognition of the role of population growth in the demand for water, there has been no policy initiative to question or rein in the rate of that growth. The default position is to assume population growth can and should continue indefinitely. This discussion paper challenges that assumption.

1.1 Australia's population growth and water supply

It is a truism that Australia is the driest inhabited continent. Lower rainfall translates into much lower runoff into rivers and lakes, since a higher proportion evaporates. Table 1 starkly contrasts the water resources of the continents. Due to Australia's aridity, the population densities reached on other continents are not feasible here.

8 Aside from lack of sites, large dams are also extremely costly to build and environmentally destructive. See, Kandulu, J., Kingsford, R. and Wheeler, S.A. (2024, 29 October). Why building more big dams is a costly gamble for our future water security and the environment. *The Conversation*. https://theconversation.com/why-building-more-big-dams-is-a-costly-gamble-for-our-future-water-security-and-the-environment-239106

9 Cullen, P. (1995). The knowledge base for the water industry. Address to 15th AWWA Federal Convention, Sydney, 2-6 April.

10 Cullen, P. (1996). Science Brokering and Managing Uncertainty. Address to the CRC for Freshwater Ecology, Townsville; 25-29 Nov.

11 Cullen, P. (2006). Water as a constraint to growth in the 21st century. Natural Resources Conference, 17 May.

12 Cullen, P. (2007). Confronting water scarcity: Water Futures for South Australia. Schulz Oration, Flinders University Research Centre for Coastal and Catchment Environments, 16 Nov.

13 Productivity Commission 2021, *National Water Reform 2020*, Inquiry Report no. 96, Canberra, p. 32. https://www.pc.gov.au/inquiries/completed/water-reform-2020/report

Table 1. Rainfall-runoff characteristics of the continents

Continent	Area (km^2)	Average annual rainfall (mm)	Average annual runoff (mm)	Average annual runoff (km3)	Percentage runoff
Australia	7 700 000	465	57	440	12
Asia	45 000 000	600	290	13 000	48
Europe	9 800 000	640	250	2 500	39
North America	20 700 000	660	340	6 900	52
Africa	30 300 000	690	260	7 900	38
South America	17 800 000	1 630	930	16 700	56

Source: Kahn (2008) [14]

As the Productivity Commission found in its 2016 report, *Migrant intake into Australia:* 'with low and stable rates of natural population growth, decisions about the size of the permanent and temporary immigration intake amount to a de facto population policy'.[15] Rather than being set through public consultation, however, this policy is determined by the federal government behind closed doors, under intense lobbying from property developers and other beneficiaries of growth.

In practice, Treasury sets targets for net overseas migration, which it prefers to keep high to elevate GDP growth, with little concern for GDP per capita or the costs imposed on state and local governments for infrastructure, and even less for environmental constraints. While the migration levels announced annually in Budget Paper No. 3 are nominally projections, since budget modelling depends on them, they exert pressure on the government to deliver.

Around 2005, the Howard government decided to increase population growth via a 'baby bonus' as well as massive increases in immigration, ostensibly in response to mounting fears of population ageing.[16] The Rudd government further ramped up migrant intakes. From 2007 to 2019, the average annual Net Overseas Migration (NOM) for Australia was 226,000,[17] more than three times the twentieth century peacetime average of 62,000.[18] During 2007-2019 our population growth has hovered around 1.4 to 1.6% per annum, four times the average for developed countries and higher than most developing countries.[19] This surge of population growth was briefly interrupted by the Covid-19 pandemic, but from 2022 quickly surpassed pre-pandemic levels. Australia's population grew by an unprecedented 651,000 people in 2023, a growth rate of 2.5%. Immigration contributed 547,000 to this growth, and natural increase (births minus deaths) added 104,000.[20]

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14 Kahn, S. (2008). Managing climate risks in Australia: options for water policy and irrigation management. *Australian Journal of Experimental Agriculture, 2008*, **48**, 265–273. https://doi.org/10.1071/EA06090

15 Productivity Commission (2016). *Migrant intake into Australia.* Inquiry Report No. 77, Canberra, Finding 3.1. https://www.pc.gov.au/inquiries/completed/migrant-intake/report

16 On population ageing, see O'Sullivan, J. (2020) *Silver tsunami or silver lining? Why we should not fear an ageing population.* Discussion paper, Sustainable Population Australia. https://population.org.au/discussion-papers/ageing/

17 Australian Bureau of Statistics. (2020-21). *Overseas migration.* ABS. Released 16/12/2022. https://www.abs.gov.au/statistics/people/population/overseas-migration/latest-release

18 For historical NOM data, see: Phillips, J., Klapdor, M., & Simon-Davies, J. (2010). Migration to Australia since federation: a guide to the statistics. *Migration,* 27, 11. Archived at www.population.org.au

19 Australian Bureau of Statistics (2021). 50 years of estimated resident population. Released 16/12/2021. https://www.abs.gov.au/articles/50-years-estimated-resident-population

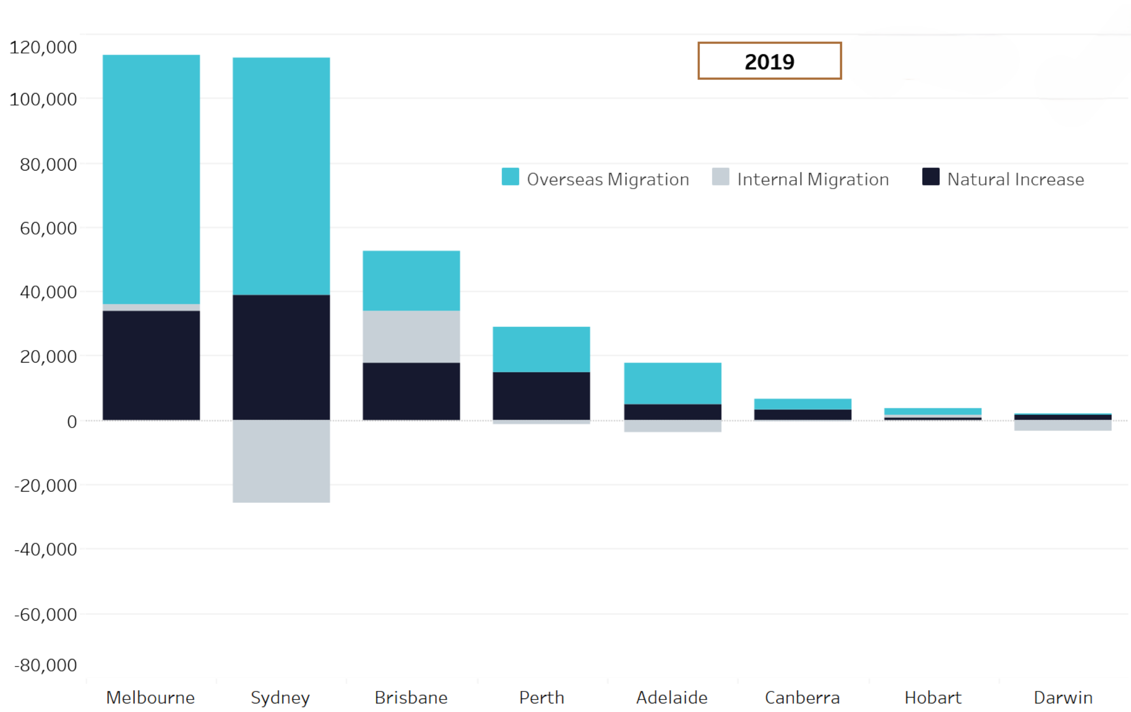
20 Centre for Population (2024, 13 June). *National, state and territory population*, December 2023. https://population.gov.au/data-and-forecasts/key-data-releases/national-state-and-territory-population-december-2023

The reliable supply of clean fresh water has allowed the development of Australian capital cities which now house almost 70% of all Australians. Some 87% of us live in towns or cities within 50 km of the coast. As population growth has continued at high rates this century, most migrants settle in these coastal capital cities (Figure 1).

While the federal government can control total migrant intake, they have little control on where migrants settle. Whether a town or city has enough water to meet added demand is not considered. The practical realities of water constraints are now being encountered in Australia's cities and towns.

In Adelaide, SA Water is slowing the release of development approvals for new northern suburbs due to water supply constraints – at a time when population growth is putting councils under extraordinary pressure to accelerate house construction.[21] On South Australia's Eyre Peninsula, over-extraction of groundwater means the SA government is planning a desalination plant for Port Lincoln – causing controversy about siting of the new plant and its saline discharge.[22]

Figure 1. Components of Population Change, Greater Capital Cities, 2019 (pre-Covid)



Source: Australian Bureau of Statistics (ABS) [23]

The Sydney Water Corporation is coming under pressure to accelerate its water infrastructure rollout in Sydney's southwest greenfield suburbs, due to the pressures of population growth causing urgent needs for housing.[24] North of Sydney, the Central Coast Council is planning for a desalination plant to cope with population growth.[25] The relatively well-watered city of Cairns is facing a half-billion dollar investment for new water infrastructure to cope with devastating flood

21 McLaren, Rory (2024, 19 June). Housing industry warns of construction 'valley of death' as SA Water cuts approvals for new homes. ABC online. https://www.abc.net.au/news/2024-06-19/sa-water-approvals-for-new-homes-slow-to-trickle/103991586
22 Donnellan, Angelique (2024, 10 June). Port Lincoln's fight for water security might threaten one of the region's key industries. ABC online. https://www.abc.net.au/news/2024-06-10/port-lincoln-desalination-plant-aquaculture-water-security/103959976
23 *ABS Regional Population 2020–21* (Canberra: ABS, 2022) *Regional Population 2018–19 (2020)* at https://www.aph.gov.au/About_Parliament/Parliamentary_departments/Parliamentary_Library/pubs/BriefingBook47p/AustraliasPopulationRecentChanges
24 Koziol, M. (2024, 2 September). 'Get with the program': The issue holding back Sydney's new homes. Sydney Morning Herald. https://www.smh.com.au/politics/nsw/get-with-the-program-the-issue-holding-back-sydney-s-new-homes-20240901-p5k6y7.html
25 Central Coast Council: What is the Toukley desalination water treatment plant project? https://www.centralcoast.nsw.gov.au/desalination-treatment-plant (accessed October 2024)

damage to its water treatment plant and a more than three-fold population increase since 1976, with another 50% increase projected by 2050.[26]

In each location, it is the extremes of drought and flood that are important in the design of water supplies: there are few instances where averages are useful. For each location, questions arise as to how much water can be reliably supplied in any given year; what the costs will be for maintaining water quality and infrastructure; and then for pumping water ever further along distribution networks. Pumping is energy-intensive (each thousand litres weighs one tonne). Desalination is far more energy-intensive. Yet most of Australia's capital cities have resorted to desalination, initially as drought insurance during the Millennium Drought (circa 1997 – 2009) but increasingly necessary in 'normal' times. Recently State governments have announced new desalination plans for Sydney, Perth and Brisbane to cope with the growth.[27] Destruction of ecological and cultural assets displaced by water infrastructure is a further cost not measured in dollars, but ultimately adds a further challenge for sustainability.

Ironically, Australia's population growth rate increased in the first decades of this century even while concerns about water security have risen. The precautionary principle is turned upside down.

In giving the keynote address on 1st April 2009 to the National Water Summit in Sydney, Maude Barlow, Senior Adviser on Water to the President of the UN General Assembly, described Australia as 'a nation destroying its water heritage in order to remain an economic powerhouse and lulled by successive political leaders into thinking that this is just a temporary drought and that technology will save the day.'

> We have already gone beyond the natural limits of rain-fed water supply for many cities and towns, a supply that is shrinking due to a warming, drying climate.

This discussion paper argues that we have already gone beyond the natural limits of rain-fed water supply for many cities and towns, a supply that is shrinking due to a warming, drying climate. The 'low-hanging fruit' for additional water and efficiency improvements have been picked: we are entering a new era of reliance on the almost oxymoronic idea of 'climate-independent', 'manufactured' sources of water, such as desalination and water recycling, to meet the extra demands of a still-growing population. Water scarcity adds to the extra costs of living and constraints on lifestyles imposed on Australians by population growth, alongside housing unaffordability, congestion, pollution, waste management, and reduced access to public services. Reliance on increasingly complex and energy-intensive desalination to enable population growth will escalate environmental impacts and increase vulnerability to critical technology failures.

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26 Testa, Christopher (2023, 26 December). Cairns seeking urgent upgrade to water supply after flood washes away infrastructure. ABC online. https://www.abc.net.au/news/2023-12-26/cairns-request-for-funding-to-upgrade-water-supply/103264402 ;
Cairns Regional Council (2023). Cairns 2050: Growth strategy framework.
https://www.cairns.qld.gov.au/__data/assets/pdf_file/0011/572465/20230825-T2050-Growth-Strategy-Framework-WEB.pdf

27 NSW Minister for Water (2023, 21 October). Doubling down on desalination. Media Release. https://www.nsw.gov.au/media-releases/doubling-down-on-desalination ;
Water Corporation (2023, 4 December). $2.8 billion investment to secure Perth's next major water source. Media Release. https://www.watercorporation.com.au/About-us/Media-releases/2023/December-2023/Perth-next-major-water-source ;
Jurss-Lewis, T. (2023, 11 October). A new desalination plant will be built in Queensland by 2035. But what do we actually know about it? ABC News online. https://www.abc.net.au/news/2023-10-11/queensland-desalination-plant-built-2035-details-unknown/102956362

2. Sustainability and water security

Will there be enough water for Australia's continuing population growth to be *sustainable*? The answer will partly depend on how we understand sustainability. This chapter seeks to clarify what we mean by sustainability and its relationship to water security.

The term sustainable development was popularised by the Brundtland Commission's report *Our common future* (1987), which it defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. This definition highlighted intergenerational equity and balancing of the economic, social and environmental aspects of civilisation. In the 1990s, the Australian government adopted a definition of Ecologically Sustainable Development as 'development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends'.

Unfortunately, a recent assessment of Australia's track record concludes:

> The Australian government ... has had a National Strategy for Ecologically Sustainable Development (NSESD) since 1992, yet the country is less sustainable today than when the strategy was adopted because of declining environmental quality. This is despite the fact that the principles of ecologically sustainable development have now been enshrined in numerous pieces of legislation, policies, and plans at all levels of government for more than a generation of Australians.[28]

The idea of sustainable development has been criticised as a contradictory concept, trying to balance ecological sustainability with potentially infinite economic growth. Ecologically-minded economists, from John Stuart Mill to Herman Daly, have observed that betterment does not require growth.[29] Nevertheless, governments worldwide remain fixated on the oxymoron of 'sustainable growth'.

Sustainability can only be achieved at the level of the whole system. As Turner and Poldy point out, there are no sustainable parts of an unsustainable whole.[30] At the same time, sustainability of the whole system is only as good as its weakest link: there is no sustainable whole that contains unsustainable parts.

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28 Howes, M. (2023). National sustainability planning: Australian National Strategy for Ecologically Sustainable Development. In: Brinkmann, R. (Ed.) (2023). *The Palgrave handbook of global sustainability*. Springer Nature, pp. 1319-1330, p. 1319. https://research-repository.griffith.edu.au/bitstream/handle/10072/413341/Howes1125402-Accepted.pdf?sequence=2

29 Ruggerio, C. A. (2021). Sustainability and sustainable development: A review of principles and definitions. *Science of the Total Environment*, 786, 147481. https://doi.org/10.1016/j.scitotenv.2021.147481 ;
Washington, H. (2015). *Demystifying sustainability: Towards real solutions*. Routledge.

30 Turner, G. and Poldy, F. (2008). Resource consumption and resource depletion: future scenarios and pathways for change, in Newton, P. (Ed.) *Urban transitions*. CSIRO Publishing, Chapter 3, p. 35.

Water security is a crucial, non-negotiable dimension of human sustainability. A task force report for UN-Water, the United Nations agency on water matters, defines water security as:

> The capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.[31]

A report on water security prepared in 2023 for the federal government developed the following definition:

> [Water security is] [e]nsuring that needs for water in towns and cities – encompassing quantity, quality, affordability and access – can be met, over time and under changing supply and demand profiles. And, that this is achieved by investment coordination and operations that are economically efficient, financially and environmentally sustainable, culturally appropriate, and resilient to shocks.[32]

2.1 Weak versus strong sustainability

The contested character of sustainability arises in disagreements about what really needs to be sustained. From an economic rationalist perspective, 'sustainability' means the continued ability to deliver the services people demand, regardless of changes to the methods employed or the natural environment over time. This view is sometimes called 'weak sustainability', the idea that nothing that currently exists need be sustained, only the utility that people derive from those things. Hence, in theory, human-made capital can be almost fully substituted for natural capital as the latter is depleted and/or destroyed.[33]

However, weak sustainability lacks acknowledgement of any intrinsic value of the non-human world. Equally, it underestimates the services natural systems perform and our society's dependence on them, until they are irrevocably lost. It reflects the hubris of techno-optimism, despite a long history of technological 'solutions' to resource scarcity or environmental damage often creating as many new problems as they solve. From ancient Sumeria to today's Riverina, almost all use of irrigation to increase food production has resulted in raised groundwater and salt deposition in topsoils, requiring more, expensive engineering and irrigation management to mitigate. Otherwise, fields become too salty and useless for intensive crop production.

> Strong sustainability is precautionary, careful, knowledgeable, and concerned with the long-term future.

Strong sustainability aims to prevent further loss of natural habitats and ecosystem functions, even if they are of no apparent or economically measurable value to humans. In reality, this is an aspirational goal, as we know Sydney, Melbourne, south-east Queensland and Perth are expected to expand enormously, swallowing islands of habitat which were once protected. However, like losing rivets from an aeroplane, we don't know exactly how much further transformation of vulnerable ecosystems can safely be done without entering a vicious cycle where the loss of ecosystem functions leads to cascading impacts on other natural systems and their ability to

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31 UN-Water. (2013). *Water security & the global water agenda: A UN-water analytical brief.* United Nations University. https://collections.unu.edu/eserv/UNU:2651/Water-Security-and-the-Global-Water-Agenda.pdf

32 AITHER. (2023). *Town and city water security: definition and reporting framework.* A final report prepared for the Department of Climate Change, Energy, the Environment and Water, p. 12. https://www.dcceew.gov.au/sites/default/files/documents/town-and-city-water-security-definition-reporting-framework.pdf

33 *Demystifying sustainability,* pp. 38-40.

sustain us. The precautionary principle advises us to minimise further damage, and where possible, to restore damaged areas.

The Productivity Commission exemplifies 'weak sustainability' in its report on *National Water Reform 2020*:

> Water planning aims to set the balance between environmental and consumptive use at an environmentally sustainable level – that is, a level that maintains key environmental assets and ecosystem functions while accepting a degree of ecological risk.

The weak sustainability assumptions can be seen here in the reference to maintaining only 'key' environmental assets necessary for maintaining water services, and the idea that biodiversity and ecological functions can be 'risked' and potentially traded off for human benefit. This implies a sliding scale where ecosystems can be incrementally diminished to accommodate the imperatives of forever growth. Conveniently, it ignores the extent to which these same ecosystems are already badly degraded. Strong sustainability is precautionary, careful, knowledgeable, and concerned with the long-term future. Strong sustainability would seek an absolute moratorium on further environmental damage – meaning that additional people could only be accommodated if existing people reduce their ecological footprint.

2.2 More complex technology generates vulnerability

Anthropologist Joseph Tainter observed that past civilisations have invariably used technological innovations to mitigate resource scarcity, but this comes with a price tag of complexity. Tainter says,

> Through problem solving, we have changed from simple structure and organization, egalitarian relations, and minimal economic differentiation to complex structure and organization, hierarchical relations, and great economic specialization. Each increase in complexity has costs, which may be measured in labor, time, money, or energy.
>
> Growth in complexity, like any investment, ultimately reaches diminishing returns, where increments to complexity no longer yield proportionate returns. Higher increments of complexity produce smaller increments of benefit in problem solving. When this point is reached, a society or other institution begins to experience economic weakness and disaffection of the populace, which in some ancient societies caused dramatic collapses.[34]

Tainter has applied this perspective to water supply technologies used in Ancient Mayan civilisation, which underwent a devastating collapse over a period of 200 years from 750 AD onwards.[35] (Tainter's findings are further discussed in Chapter 7).

> Sustainability cannot be guaranteed by a naïve faith in technological progress.

Water security requires sustainability of water supply, as well as sustainability of the social-ecological system as a whole. Sustainability cannot be guaranteed by a naïve faith in technological progress. The cascading environmental challenges in today's world, from climate change and biodiversity loss to soil degradation and water pollution, are all products of technological solutions to circumvent barriers to growth. *In the end, the only real solution is to stop growing.*

34 Tainter, J. (2003). A framework for sustainability. *World Futures: The Journal of General Evolution,* 59(3-4), 213-223, p. 218. https://doi.org/10.1080/02604020310132

35 Tainter, J. A., Scarborough, V. L., & Allen, T. F. (2018). Concluding essay 1: Resource gain and complexity: water past and future. In *Water and society from ancient times to the present* (pp. 328-347). Routledge.

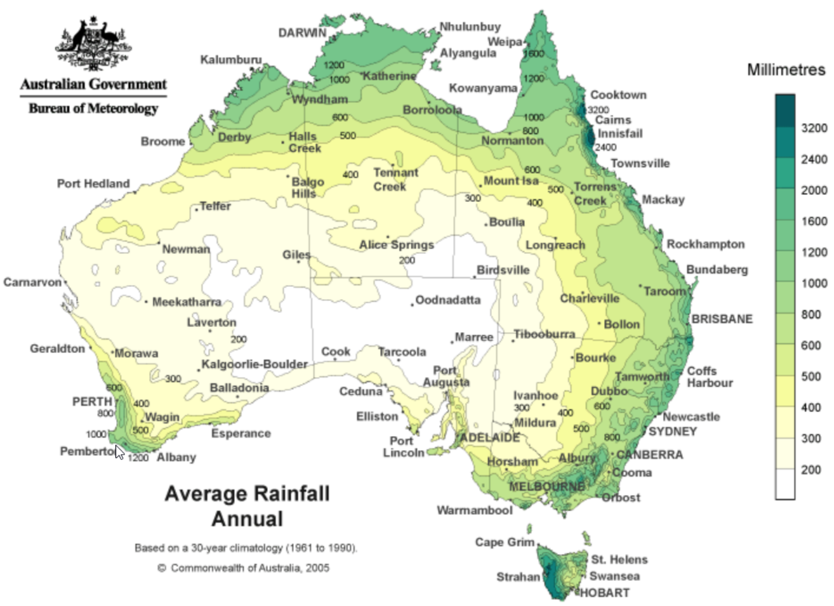
3. Australia's water resources and water use: where is the water and where does it go?

3.1 Water resources

Australia has a thin ribbon of territory with reasonably reliable rainfall along the northern tropical zone, eastern seaboard and south-west coast. The rest of the continent is arid or semi-arid.

Eighty per cent of the continent receives less than 600 millimetres (mm) annual rainfall while 50% receives less than 300 mm. In a few areas, such as north-eastern Queensland and western Tasmania, rainfall exceeds 3,000 mm/year but these areas are far from where most Australians live.[36] Australia's rainfall is distributed unevenly, in terms of both geography and seasonal cycles (Figure 2). The recent string of natural events in the form of drought, bushfires, and floods means even formerly reliable areas are becoming less so.

Figure 2. Average Rainfall in Australia, 1961 to 1990



Source: BOM [37]

36 BOM 2021. *Water in Australia 2019-20*. http://www.bom.gov.au/water/waterinaustralia/files/Water-in-Australia-2019-20.pdf
37 BOM. http://www.bom.gov.au/cgi-bin/climate/change/averagemaps.cgi

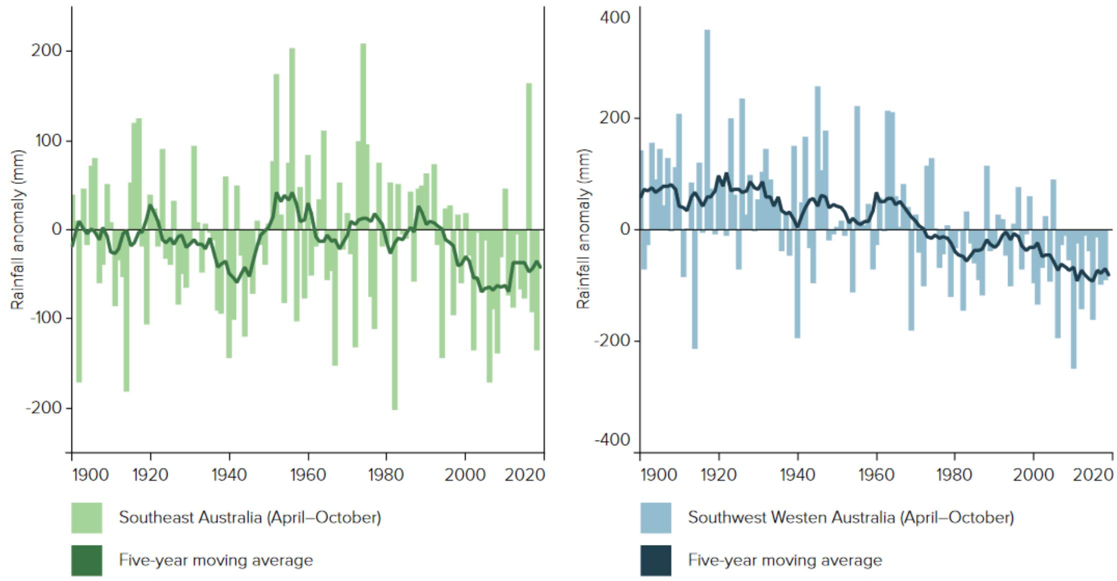
Our continent has the most variable rainfall and runoff of all inhabited continents. Its flat landscape is also the oldest, the most weathered and eroded, with the poorest soils and the most ephemeral rivers and streams. Our geomorphology has minimal surface water resources but extensive groundwater basins. We have the world's oldest river channel (Finke River). Ways of thinking about water inherited from Northern hemisphere cultures are largely inappropriate in Australia, as is dramatically illustrated by the Dorothea McKellar poem.

> Only a tiny fraction of the continent's rainfall finds its way into the rivers and dams on which most of the people and agriculture depend.

Low rainfall means even lower runoff as a higher proportion evaporates from the soil and plants.[38] Even in the wetter catchments, little of the rainfall ends up running into streams and river systems. On average, about 9% of Australia's rainfall becomes runoff and 2% soaks into aquifers as groundwater; the rest either evaporates or is used by vegetation.[39] Almost 50% of Australia's average annual run-off is in the far north, quickly discharging into the Gulf of Carpentaria and the Timor Sea. This leaves a tiny fraction of the continent's rainfall to find its way into the rivers and dams on which most of the people and agriculture depend.

In the last 30 years, average rainfalls have decreased across the temperate south-west and south-east of the continent (Figure 3).[40] This rainfall trend is clear: droughts are increasingly the norm, not the exception, as are savage bushfires.

Figure 3. South-eastern and south-western Australia annual rainfall and 11-year running mean



Source: Infrastructure Australia [41]

38 McMahon, T.A., Finlayson, B.L., Haines, A. and Srikantham, R. (1987) *Runoff variability: a global perspective*, in The influence of climate change and climatic variability on the hydrologic regime and water resources, Proceedings of the Vancouver Symposium, August 1987. IAHSPubl. no. 168.

39 Prosser, I. (2011) Current water availability and use, Ch. 1 in *Water: science and solutions for Australia*, ed. I. Prosser. CSIRO, Canberra, pp. 2, 3. Cited from Pigram, J.J., 2006, *Australia's water resources: from use to management*. CSIRO, Canberra.

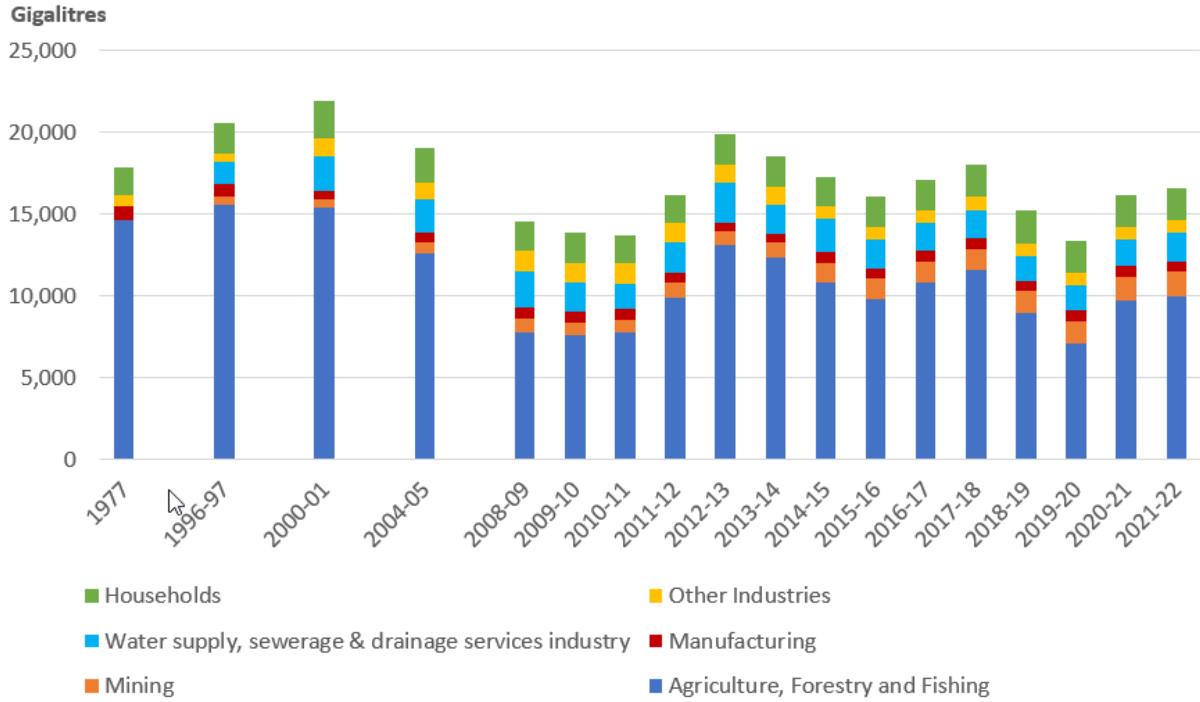
40 *Australia state of the environment 2021*. https://soe.dcceew.gov.au/climate/environment/rainfall-and-snow

41 Infrastructure Australia (2019), *An assessment of Australia's future infrastructure needs: the Australian infrastructure audit 2019*, Australian Government, Sydney, June, p. 608. https://www.infrastructureaustralia.gov.au/publications/australian-infrastructure-audit-2019

3.2 Human use of water in Australia

Human use of water in Australia varies from year to year, dictated by rainfall. Agriculture is by far the biggest user of water at between 60% and 70% of the total, and smaller irrigation water allocations in drought years largely account for changes in total water consumption. In 2020-21, which was a wetter year, agricultural use was 69% of total water use, followed by manufacturing and mining (19%) and domestic use (12%). A time series of Australia's water use since 1977 is shown in Figure 4.

Figure 4. Total water use by sector, Australia 1977 – 2022



Source: See footnote. [42]

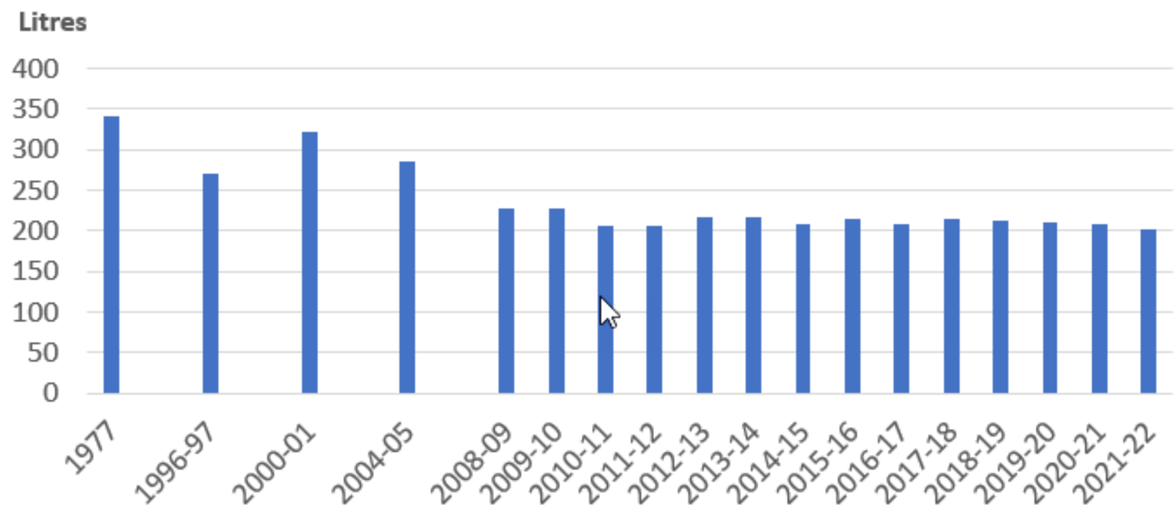
Since 1977 Australia's population has doubled, but aggregate water use has slightly reduced, largely due to increased regulation of irrigation in the Murray-Darling Basin. Despite population growth, total water use by the household sector has remained fairly stable, accommodated by increasing efficiency of water use within households and less watering of gardens (Figure 5).

This increasing household sector efficiency has been driven by several factors: temporary water restrictions introduced during drought, educational and involvement campaigns to encourage less water use, increases in the price of water, new water efficiency labelling on appliances, changes in building codes and changes in the housing stock to smaller blocks, higher densities and reduced garden size.[43]

42 ABS Water Accounts; Klaassen, B. (1981). Estimated annual water use in Australia. *Water. The official journal of the Australian Water and Wastewater Association,* vol. 8 no. 1, pp. 25-26. For full details of sources, see Appendix A of this paper.

43 Horne, J. (2020). Water demand reduction to help meet SDG 6: learning from major Australian cities. *International Journal of Water Resources Development,* 36(6), 888-908.

Figure 5. Daily per capita water use in the household sector, Australia 1977 – 2022



Source: See footnote. [44]

However, Figure 5 shows that per-person household sector efficiency has barely improved since 2010-11; it is getting harder to find new efficiencies to offset population growth. As commented in the Greater Melbourne Urban Water & System Strategy:

Average household water use efficiency has barely improved since 2010-11; it is getting harder to find new efficiencies to offset population growth.

Following the significant and sustained reductions in water use during the Millennium Drought, future water restrictions are not expected to deliver the same extent of water savings. … When water is already used efficiently, it becomes more difficult to find ways of using even less. Similarly, over the longer term, the ongoing urban densification of Greater Melbourne will lead to less external water use as gardens diminish in size, further reducing the effectiveness of water restrictions.[45]

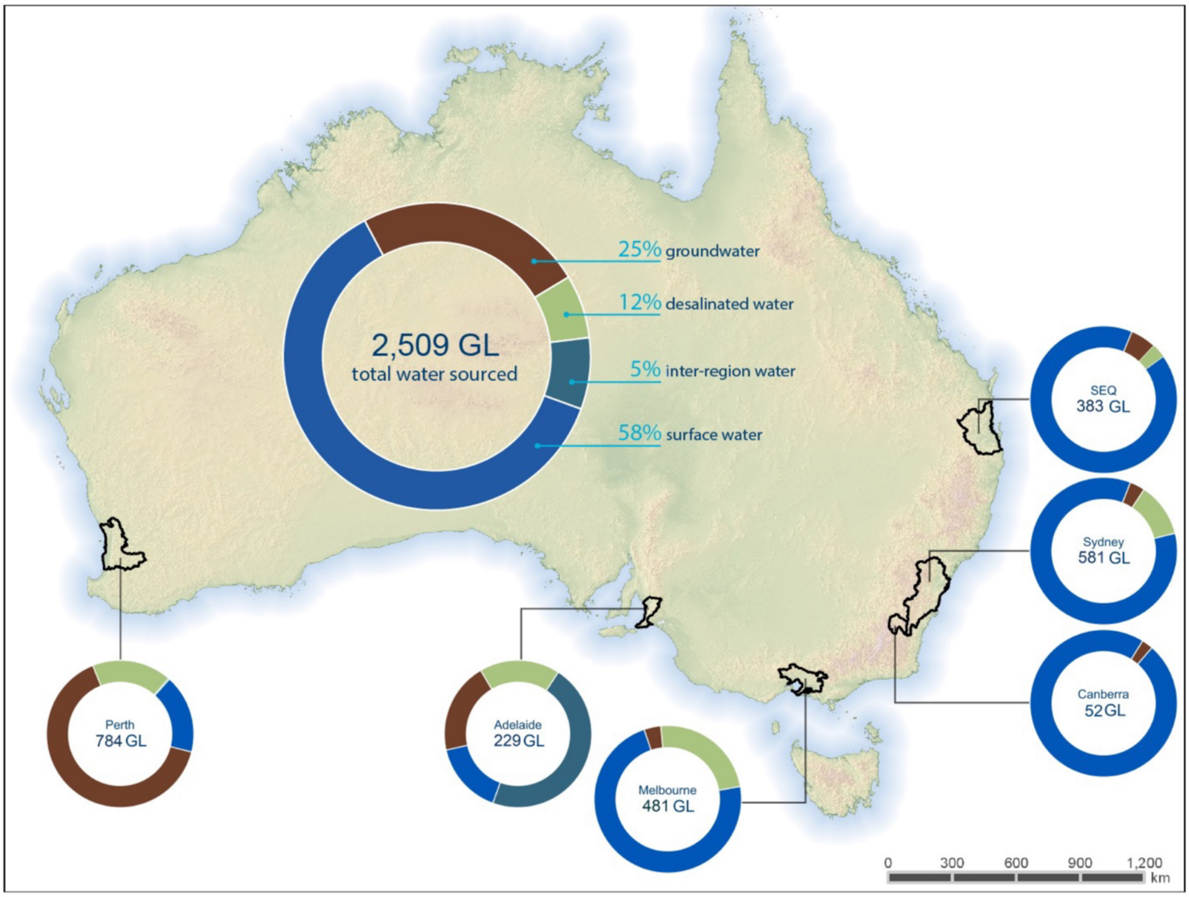
3.3 Water Sources

The sources of the water in Australia's largest cities in 2020-21 are shown in Figure 6. Around 58% was surface water, from creeks, rivers and dams. Groundwater was the next largest source, at 25%. Desalinated water made up 12% of total water supply compared to 15% in the previous year.

44 ABS Water Accounts; Klaassen, B. (1981). Estimated annual water use in Australia. *Water. The official journal of the Australian Water and Wastewater Association,* vol. 8 no. 1, pp. 25-26. For full details of sources, see Appendix A of this paper.

45 Melbourne Water (2023) *Greater Melbourne urban water and system strategy: water for life,* p. 104. https://www.melbournewater.com.au/about/what-we-do/publications/greater-melbourne-urban-water-and-system-strategy-water-life

Figure 6: Water taken by source in 2020-21.



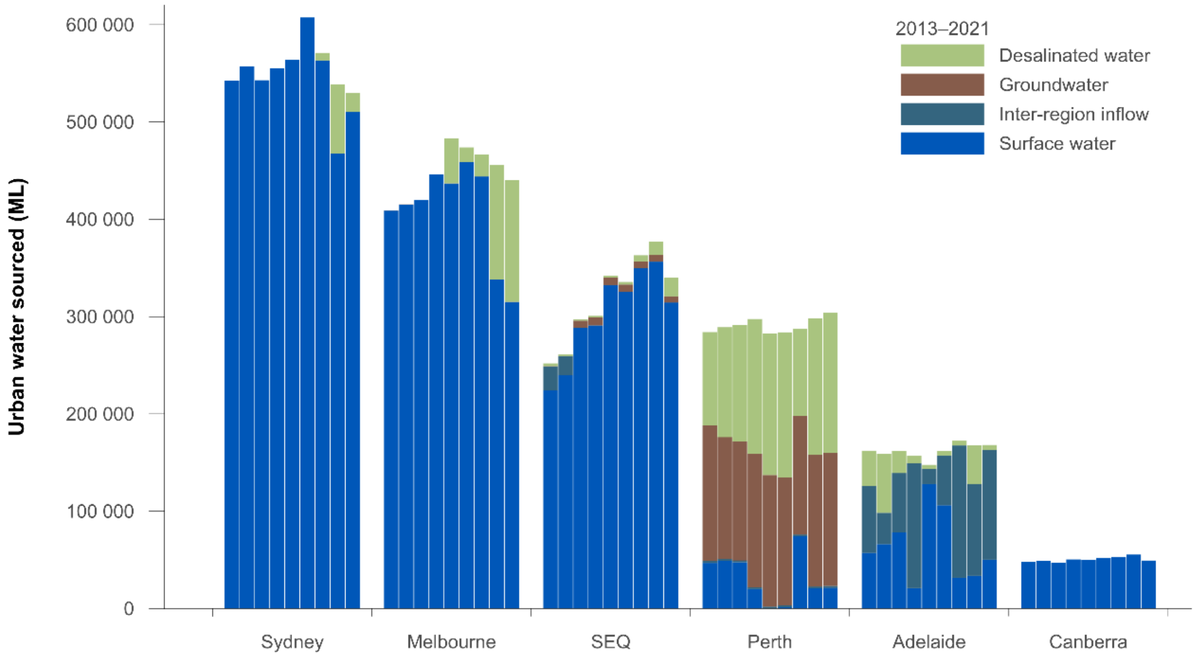
Source: BOM [46]

The time series bar chart in Figure 7 shows the increasing uptake of desalination for most capital cities. The chart also shows Perth's dependence on groundwater is far larger than other capital cities. This water is used for industry and horticulture, irrigation of recreational green spaces and for watering of domestic lawns and gardens.[47] The WA Government estimates that:

> Collectively, garden bore users take 22 per cent of all the groundwater used across the Perth and Mandurah areas. In 2021, we estimate there are about 180,000 households using garden bores, collectively taking about 90 billion litres a year (90 gigalitres).[48]

46 Bureau of Meteorology (2021) National Water Account 2021. http://www.bom.gov.au/water/nwa/2021/urban/index.shtml
47 https://www.wa.gov.au/service/natural-resources/water-resources/rebalancing-our-groundwater
48 https://begroundwaterwise.wa.gov.au/our-precious-groundwater/

Figure 7. Urban system water sources and volumes in six major cities for years 2013—2021



Source: BOM [49]

> "Today, one quarter of Australia's 288 groundwater management areas are over-allocated."

Pumping from groundwater basins under coastal capital cities must be controlled, as too much removal draws sea water into the aquifer, raising the salinity of groundwater to a level that harms plants and soils. Hence, the volume of water available for drawdown is much less than the total volume. Regulating extraction is made more difficult by the many unmetered private bores.

Groundwater resources in many parts of Australia are coming under increasing stress. The limestone aquifer supplying the city of Mt Gambier and the lucrative Coonawarra horticultural region is among those becoming critically depleted.[50] According to a recent study:

> today, one quarter of Australia's 288 groundwater management areas are over-allocated. Australia is not ready to manage a doubling of groundwater demand within the next few decades ... due to the joint impacts of climate change, impending El Nino conditions, population growth, an increase in mining, and a shift in Australia's energy mix.[51]

The recharge of groundwater from rainfall is also under threat. A recent CSIRO study of data from caves in south-western Australia concludes that a combination of increased water extraction and decreased rainfall due to climate change has decreased groundwater recharge, and that this

49 Bureau of Meteorology (BOM) (2021). National Water Account 2021. http://www.bom.gov.au/water/nwa/2021/urban/index.shtml . Bars shown for each city are for the years 2013-2021.

50 Thompson, F. (2024, 20 October). Protecting the Green Triangle: experts warn of 'irreversible' groundwater decline. *Guardian Australia*. https://www.theguardian.com/australia-news/2024/oct/20/protecting-green-triangle-experts-warn-irreversible-groundwater-decline-victoria-south-australia

51 Cook P.G., Richardson S., Baker P., Barron O., Carrara E., Douglas B., Evans R., Hamilton S., McKelvey P., Moggridge B., Nelson R., Pandey S., Papworth S., Robinson D., Searle J., Thiele Z., Trott S., Vertessy R. (2024). *National Groundwater Research Priorities*. National Centre for Groundwater Research and Training, Australia, pp. 5, 6. https://doi.org/10.25957/ayqy-gw06

decline 'is unprecedented for the last eight centuries.' For many aquifers, recharge is no longer reliably occurring, highlighting 'the immediate threat of climate change to water security in a region heavily dependent on groundwater.'[52]

3.4 Water recycling

The new era of water scarcity has led to increasing interest in recycling of water for agricultural, industrial and potable uses. The amounts of recycled use are not included in the above charts because they include only the first instance when water is extracted from the environment, to avoid double counting. Most recycled water in Australia is for non-potable uses, although in Perth sewage plants produce around 22 GL per year of recycled water (Table 2) which is pumped into the Gnangara Mound aquifer to replace diminished recharge from rainfall. This water is then mixed with the potable supply.[53]

Table 2. Total volume of recycled water supplied (ML)

Major urban area	2017-18	2018-19	2019-20	2020-21	2021-22
Adelaide	26,564	30,533	23,803	26,627	33,122
Canberra	77	60	75	27	24
Darwin	451	488	0	0	0
Melbourne[ab]	38,147	45,535	42,877	41,716	45,242
Perth	12,100	9,817	20,681	22,579	21,759
South East Queensland[a]	13,056	15,445	14,874	15,468	13,554
Sydney	42,833	44,020	46,919	37,669	37,693

Notes:

a Melbourne and South East Queensland figures are the aggregate figures for the bulk utility and the existing retailers in that reporting year.

b Melbourne values for 2021-22 are not comparable with earlier years due to the merging of City West Water and Western Water to form Greater Western Water on 1 July 2021. Values displayed in this table pre-2021-22 do not include the service areas previously managed by Western Water.

Source: Bureau of Meteorology (BOM) [54]

52 Priestley, S.C., Treble, P.C., Griffiths, A.D. et al. (2023). Caves demonstrate decrease in rainfall recharge of southwest Australian groundwater is unprecedented for the last 800 years. *Commun Earth Environ* **4**, 206, pp. 9-10. https://doi.org/10.1038/s43247-023-00858-7

53 Radcliffe, J.C. (2022) Current status of recycled water for agricultural irrigation in Australia, potential opportunities and areas of emerging concern, *Science of the Total Environment,* **807**, https://doi.org/10.1016/j.scitotenv.2021.151676;
For further discussion and examples of water recycling in Australia, see James, C. A., Kavanagh, M., Manton, C., & Soar, J. (2023). Revisiting recycled water for the next drought; a case study of South East Queensland, Australia. *Utilities Policy*, 84, 101626. https://doi.org/10.1016/j.jup.2023.101626

54 BOM (2023). National performance report 2021-2022: urban water utilities, Part A,, p. 22 at http://www.bom.gov.au/water/npr/docs/2021-22/Urban_National_Performace_Report_2021-22.pdf

3.5 Virtual water consumption

City dwellers are not only users of water directly through the tap, but also indirectly via the 'virtual water' necessary to produce food and fibre, to cool power stations, in mining, and for other industrial processes. Virtual water footprints in Australia's cities are 8 to 10 times higher than direct per capita residential water consumption, with most of that virtual water being used outside the city boundaries in agricultural areas.[55] Eastern seaboard cities are hugely dependent on food produced in the Murray-Darling Basin (MDB) in particular. Doubling the population of those cities at the same time as climate change is expected to reduce water available for irrigation and will mean increasing dependence on imported horticultural products, since the MDB will be unlikely to meet this demand. Foreign suppliers will in turn be suffering similar pressures from climate change and increasing local populations. Rising prices for these foods will exacerbate today's trend where low-income households can't afford healthy food. Rising prices will also increase political pressure to divert more of the remaining MDB flow to horticulture, at the expense of riverine ecosystems.

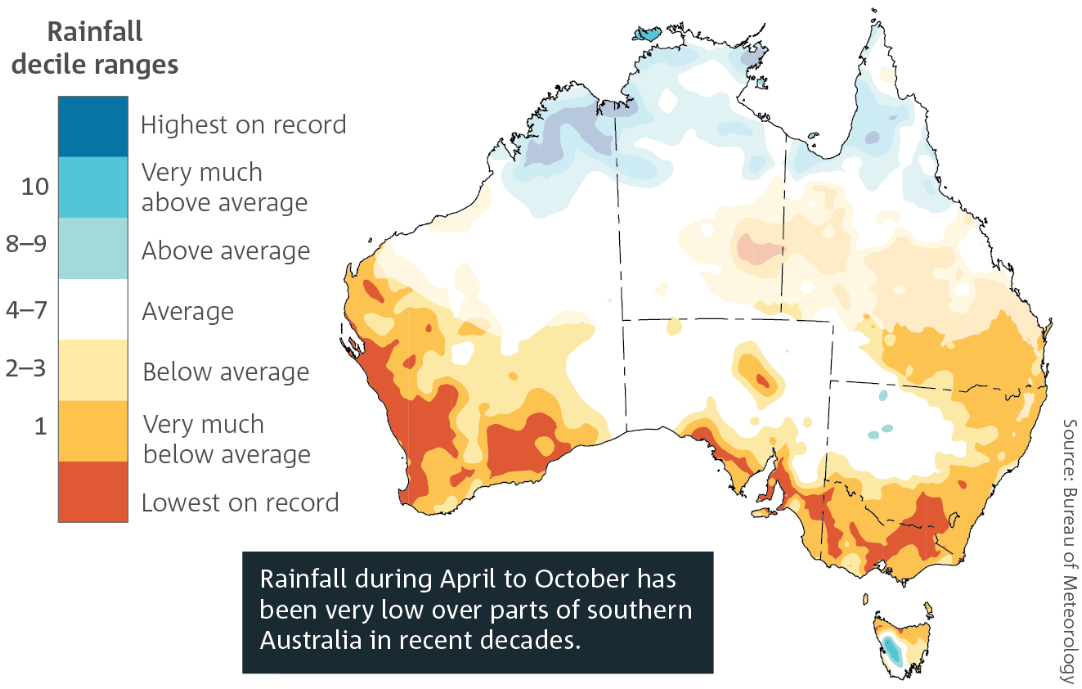
55 Islam, K. N., Kenway, S. J., Renouf, M. A., Wiedmann, T., & Lam, K. L. (2021). A multi-regional input-output analysis of direct and virtual urban water flows to reduce city water footprints in Australia. *Sustainable Cities and Society,* 75, 103236. https://doi.org/10.1016/j.scs.2021.103236

4. Climate change makes water supply more vulnerable

4.1 Recent trends

Climate change has immense implications for Australia's water supply. In recent decades Australia's climate has become hotter and drier (see Figures 8 and 9). In much of southern Australia, average winter rainfall over the past 20 years has been in the lowest tenth of observations since 1900, leading to declining streamflows. Inflows to Perth dams are now a quarter of those during most of the twentieth century. Murray River inflows over the past twenty years are half those of the preceding century, with more frequent drier years. Victoria's surface water availability has declined in all basins over the same period.[56] Australia's driest year on record was in 2019 (Figure 10).

Figure 8. April to October rainfall, 1994 to 2023, compared with long-term averages from 1900 to 1993.



Source: CSIRO and BOM [57]

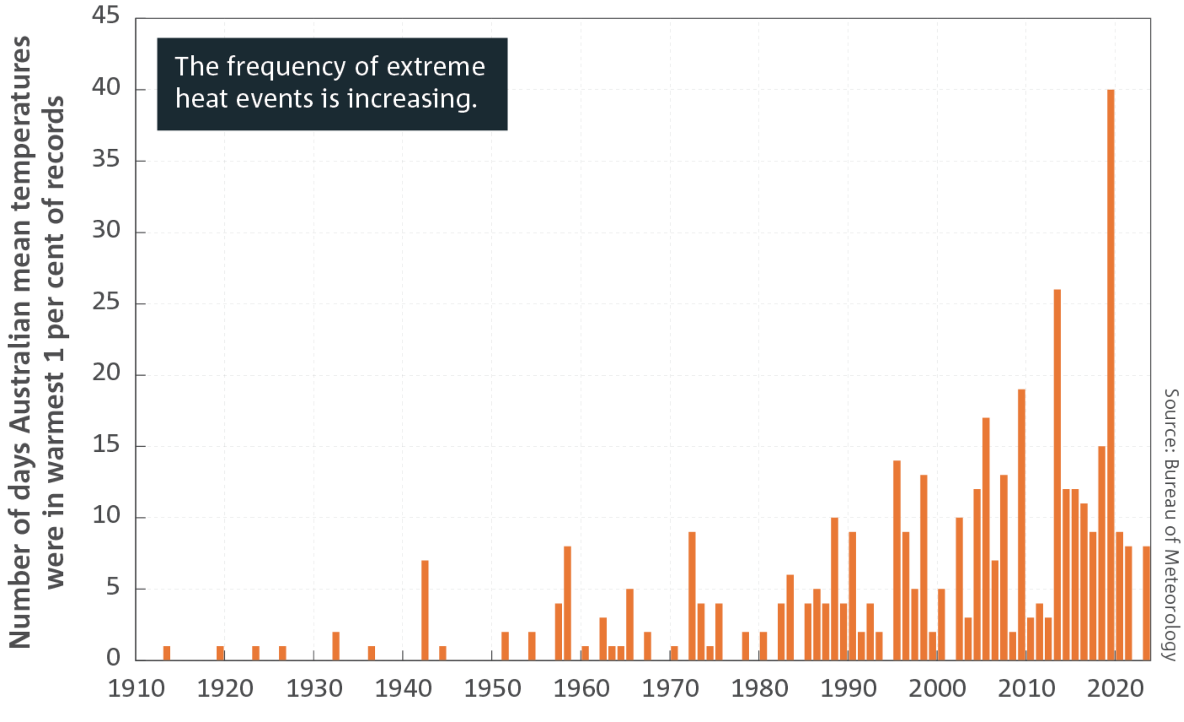
56 Productivity Commission (2021). Op. cit., pp. 36-37.
57 CSIRO and BOM (2024). *State of the climate 2024*. http://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml. The decile map shows where rainfall is above average, average, or below average for this period compared to all years from 1900 (when reliable rainfall records began) to 1993. Areas across northern and central Australia that receive less than 40% of their annual rainfall from April to October are faded.

At the same time, the frequency and intensity of severe rainfall events is increasing, leading to extreme flood events. Rainfall and streamflow in northern Australia have increased.[58]

According to the CSIRO and Bureau of Meteorology (BOM) *State of the Climate 2024* report,

> There has been a shift towards drier conditions across the south-west and south-east of Australia, with more frequent periods of below-average rainfall, especially for the cool season months from April to October. Cool season rainfall in southern Australia has been above the 1961–1990 average in only 6 of the 30 years from 1994–2023, a 30-year period which includes the Millennium Drought (1997–2009). This is due to a combination of natural variability on decadal timescales and changes in large-scale circulation largely driven by an increase in greenhouse gas emissions. Cool season rainfall is particularly important for southern Australia, as it is the main growing season for many crops. It is when peak streamflow occurs in most catchments in the region, ... and is also when groundwater recharge is most likely to occur.
>
> The drying trend in southern Australia is most evident in the south-west and south-east of the country. The recent drying across these regions is the most sustained large-scale change in observed rainfall since widespread observations became available in the late 1880s.[59]

Figure 9. The frequency of extreme heat events is increasing, 1910 to 2023



Source: CSIRO and BOM [60]

58 Ibid.
59 CSIRO and BOM (2024). *State of the climate 2024.* http://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml
60 CSIRO and BOM (2024). *State of the climate 2024.* http://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml The graph shows number of days each year where the Australian area-averaged daily mean temperature for each month is extreme (extremely warm days). Extreme days are defined as those where daily mean temperatures are the warmest 1% of days for each month, calculated for the period 1910–2023.

4.2 Outlook and impacts

The Productivity Commission's *National Water Reform 2020* report provides a summary of scientific expectations for the future water outlook:

> Projections of the future climate point to hotter, drier and more extreme conditions – particularly in southern Australia. The impacts of climate change are being driven by increased concentrations of greenhouse gas emissions in the atmosphere, and will likely result in increased average temperatures, higher-intensity rainfall and other extreme weather events. Recent modelling by CSIRO scientists points to declines in water availability across Australia. Reduced water availability is very likely in southern Australia due to declines in cool-season rainfall, increases in evapotranspiration and reductions in run-off. In parts of Australia, large declines are expected, with medium projections showing a 50 per cent drop in runoff in southern Western Australia and 19 per cent fall in Victoria. Rainfall in northern Australia is slightly more likely to decrease than increase, however, a wide range of outcomes is possible.[61]

CSIRO hydrologist Francis Chiew summarises recent research:

> The majority of global climate models project that there will be less cool season rainfall in Australia under climate change, particularly in western Australia and southeast Australia. As most of the runoff in far southern Australia occurs in winter and spring, streamflow and water resources there will reduce significantly under climate change. The median projection from hydrological modelling informed by CMIP6 global climate models (used in IPCC AR6 assessment) is a 13% reduction in mean annual streamflow in southeast Australia and 18% reduction in far southeast Australia under 2°C global average warming (Figure 6c). The reduction in streamflow is caused by the reduction in rainfall and by the higher potential evaporation.
>
> However, there is a large uncertainty or range in the future streamflow projection, mainly due to the uncertainty in the future rainfall projection. … The inter-annual and multi-year variability in streamflow will remain high, and we will continue to have long periods of low streamflow as well as long periods of high streamflow, occurring against a background of long-term declining streamflow trend. Multi-year hydrological droughts will therefore become more frequent and severe, and the reliability of water supply will significantly reduce, and further exacerbated by the projected increase in inter-annual rainfall and streamflow variability.[62]

In a recent study by Ukkola and co-workers, the researchers ran multiple simulations of future drought changes in Australia using hydrological projections and global climate models. The authors' discussion of their findings is worth quoting at some length:

> We show future increases in the time spent under drought for all three drought types, with largest increases projected in winter and spring. The future changes are particularly robust in the highly populated and agricultural regions of Australia, suggesting potential impacts on agricultural activities, ecosystems and urban water supply. …
>
> … projected changes are most robust and indicate more time under drought in the eastern parts of the [Murray-Darling] basin which encompass the alpine regions where much of the

61 Ibid, p. 38.

62 Chiew, F.H.S. (2024). Climate change and water resources, *Australasian Journal of Water Resources*, 28:1, 6-17, p. 14. https://doi.org/10.1080/13241583.2024.2341920

basin's streamflow is generated. As such, increased drought occurrence in these important runoff generation areas may have significant impacts on irrigation water supply even if the changes are spatially limited. In the southern parts of the basin runoff generation is highest in the cooler months, potentially making the more robust changes in winter and spring particularly impactful. The Murray-Darling basin also hosts important ecological regions, including wetland and river habitats, that rely on sufficient environmental flows to thrive. Projected increases in drought occurrence would also threaten the availability of these flows, particularly if prolonged drought periods become more frequent. Parts of the basin have experienced disproportionate declines in runoff relative to precipitation in response to past droughts; the stronger future increases in runoff droughts relative to precipitation droughts suggest an ongoing risk to water availability in the basin.

> Australia's major population centres are also located along the southeast and southwest coasts where widespread increases in hydrological drought are projected, with potential implications on municipal water security. The alpine regions that generate much of Murray-Darling Basin's streamflow are also important for supplying water resources to large population centres including Australia's two largest cities Sydney and Melbourne. While seasonal droughts generally have small impacts on municipal water supply, particularly in these large cities with several years of dam storage, increased drought occurrence may increase water scarcity over time, particularly as Australia's urban population continues to increase.[63]

The combination of droughts, floods and bushfires have interacting and escalating effects on soils, vegetation and water quality. In turn, they place increasing stress on water infrastructure. For example, the catchment for Melbourne's largest water source, the Thomson Reservoir, is covered largely by mountain ash forest. Recent modelling anticipated more frequent bushfires and found that 'If 10% of the Ash is burnt every 10 years, the percentage reduction in total water yield varies from 12.2 to 13.9% in 2050 for all seven scenarios considered in the analysis…' [64] The authors state: 'Frequent bushfire events will modify the vegetation characteristics in Victorian forests and adversely impact water supply reliability for Melbourne.'[65]

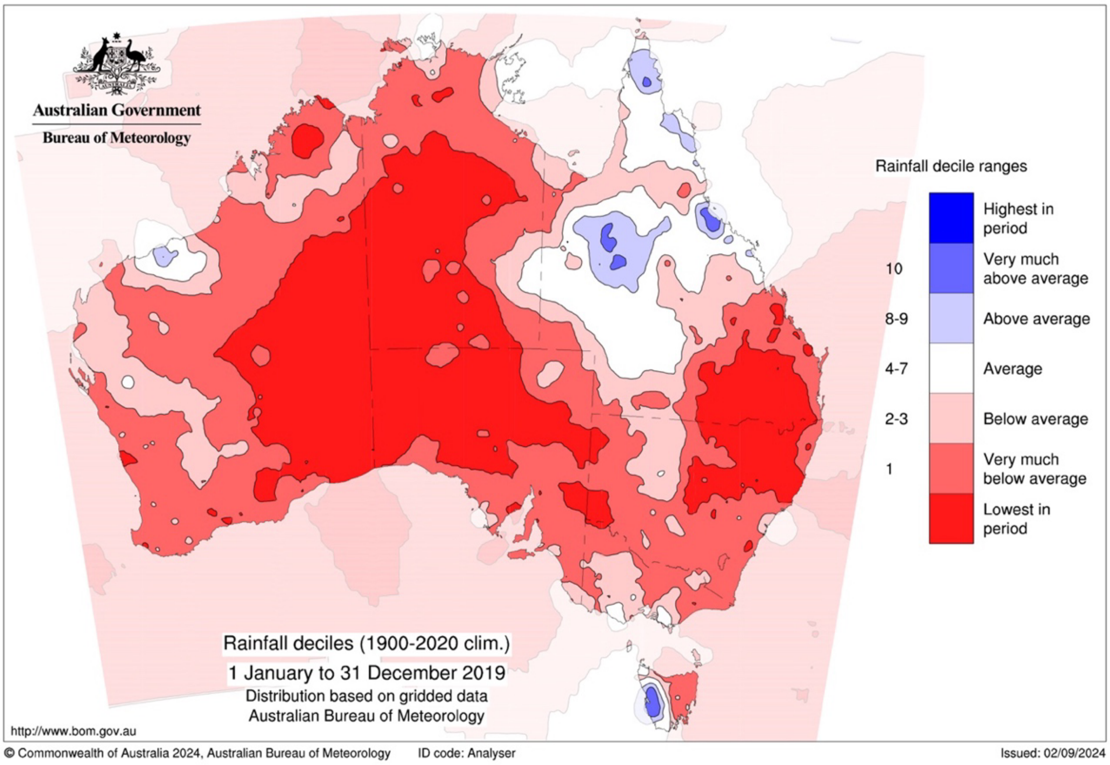
Every 1% less rainfall causes approximately 3% less runoff.

'The Long Paddock' web site of the Queensland Government describes how climate models see the state's aridity and streamflow developing over the next 25 years.[66] By 2030 the Burdekin, Fitzroy and Burnett River basins are expected to have 10% reduced streamflow. By 2050 streamflow might drop by 20%, enough to shift from wet to semi-arid climates. Similar trends are likely to occur in South East Queensland, reducing dam yields even while the population is expected to increase more than 40% in the next 20 years.[67]

63 Ukkola, A. M., Thomas, S., Vogel, E., Bende-Michl, U., Siems, S., Matic, V., & Sharples, W. (2024). Future changes in seasonal drought in Australia. EarthArXiv Preprint, version 2024-07-22, lines 25, 535-560. https://doi.org/10.31223/X56110
64 Khastagir, A., Hossain, I. & Rahmat, S.N. (2023). Effect of frequent bushfire on water supply reliability in Thomson Catchment, Victoria, Australia. *Theor Appl Climatol* **152,** 967–979, p. 967. https://doi.org/10.1007/s00704-023-04443-y
65 Ibid., p. 969.
66 The Long Paddock: Climate risk information for rural Queensland - A Queensland Government initiative providing seasonal climate and pasture condition information to the grazing community. https://www.longpaddock.qld.gov.au/
67 Population estimate from: Australian Government, Department of Infrastructure (2022). *South East Queensland Population, Housing, Jobs, Connectivity And Liveability,* p. 249, at https://www.infrastructure.gov.au/sites/default/files/documents/bcarr-seq-report.pdf

More generally, dams are far less able to supply water in our warming, drying climate. Every 1% less rainfall causes approximately 3% less runoff.[68] Of particular note from Figure 8 is the dire trend of reducing rainfall in the dam catchments for the major population centres where most Australians reside. Building more dams in the face of long-term reduction in rainfall averages is not only ultimately futile, but viable sites for new dams are very few in Australia. Our geomorphology is largely flat and suitable sites are already taken, especially near population centres.

Figure 10. Rainfall anomalies for 2019, the driest year on record.



Source: BOM [69]

Regional towns, as well as major cities, are facing challenges from increasing extreme weather events. The 2019-20 bushfires and the 2020-22 floods in the eastern states provide vivid examples. Many regional towns have experienced acute water shortages, requiring severe restrictions on water use, as well as costly and energy-intensive supply alternatives such as groundwater, water carting or building interconnecting pipe networks to access more distant water sources. Further drawdown of groundwater intensifies competition among water users, especially if groundwater is not being replenished because of drought.

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68 Smith, I. and Power, S. (2014). Past and future changes to inflows into Perth (Western Australia) dams. *Journal of Hydrology: Regional Studies,* volume 2, pp. 84-96, p. 93. https://doi.org/10.1016/j.ejrh.2014.08.005.
See also: Ho, M. (2020, 27 May). A systems approach to understanding climate change impacts on water. Victorian Water Climate Initiative webinar, at https://www.water.vic.gov.au/our-programs/climate-change-and-victorias-water-sector/hydrology-and-climate-science-research/climate-science-webinars/transcript-system-approach-understanding-climate-change-impacts-water-webinar

69 Bureau of Meteorology (BOM). 124 years of Australian rainfall. http://www.bom.gov.au/climate/history/rainfall/ . Accessed 22 August 2024.

Floods can damage water treatment plants and distribution systems. Fires damage catchment areas and, if followed by heavy rains, burnt matter and debris is transported into water storages, posing challenges for water treatment.[70]

The warming trend (Figure 9) not only reduces useful rainfall but the health of people and ecosystems. Historically, heatwaves have caused more deaths in Australia than any other natural hazard aside from disease epidemics, and deaths are expected to increase with further climate change.[71] This increased heating is amplified in cities due to the urban heat island effect, whereby heat-absorbing hard surfaces, lack of vegetation, the blanketing effect of smog, and heat produced from vehicles, generators and air conditioning, can raise temperatures compared to rural surrounds. Loss of vegetation in cities such as Sydney has been found to also increase atmospheric dryness and local drought.[72]

Population growth increases these effects through densification of housing and traffic, expanded infrastructure, urban sprawl and reduction of green space (including household gardens and public open space). Measures to counteract this effect, such as increasing the urban tree canopy,[73] can further increase the demand for water, as the Productivity Commission observed:

> A shift towards more urban greening will increase the demand for water. Preliminary estimates suggest that achieving a 20% increase in urban tree canopy in Adelaide could potentially require an additional 10% to 30% of Adelaide's current water demand…[74]

The quality of freshwater is expected to decline as a result of more intense rainfall events increasing erosion and sediment loads. This applies both to water entering water supply reservoirs and stormwater entering natural environments from urban areas. According to the Productivity Commission:[75]

- in South East Queensland, CSIRO modelling indicates more intense rainfall and flood events and a deterioration in raw water quality by 2030, despite a 7 per cent decrease in average annual rainfall (relative to the 1971–2000 average)
- more intense storms in Melbourne, combined with more impermeable surfaces as density increases, will lead to greater stormwater runoff and increases in wet weather overflows from wastewater treatment plants. As a result of increases in nutrients and pollutants entering downstream environments, poorer water quality is expected unless action is taken to manage impacts

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70 Hickey, A., & Senevirathna, L. (2023). Performance of regional water purification plants during extreme weather events: three case studies from New South Wales, Australia. *Environmental Science and Pollution Research*, 1-13, pp. 1, 2 and 7 of online version. https://doi.org/10.1007/s11356-023-28101-y

71 Coates, L., van Leeuwen, J., Browning, S., Gissing, A., Bratchell, J., & Avci, A. (2022). Heatwave fatalities in Australia, 2001–2018: an analysis of coronial records. *International Journal of Disaster Risk Reduction,* 67, 102671. https://doi.org/10.1016/j.ijdrr.2021.102671

72 Wright, I.A. (2024, 12 August). Urban growth is leading to more intense droughts for most of the world's cities – and Sydney is a case study for areas at risk. *The Conversation*. https://theconversation.com/urban-growth-is-leading-to-more-intense-droughts-for-most-of-the-worlds-cities-and-sydney-is-a-case-study-for-areas-at-risk-236315

73 Chaston, T. B., Broome, R. A., Cooper, N., Duck, G., Geromboux, C., Guo, Y., ... & Hanigan, I. C. (2022). Mortality burden of heatwaves in Sydney, Australia is exacerbated by the urban heat island and climate change: can tree cover help mitigate the health impacts?*Atmosphere,* 13(5), 714. https://doi.org/10.3390/atmos13050714 ;
According to the South Australia *State of the Environment 2023* report, 'Urban heat mapping in western Adelaide undertaken during a hot weather event in 2017 showed that irrigated grass can reduce surface temperature by up to 20ºC compared with dry grass, and irrigated shade trees can cool the ground by more than 2-3ºC during the day and 4-5ºC at night.' https://soe.epa.sa.gov.au/environmental-themes/liveability/water-supply-liveability

74 Productivity Commission (2024). *National Water Reform 2024,* Inquiry Report no. 105, Canberra, pp. 100, 101. https://www.pc.gov.au/inquiries/completed/water-reform-2024/report

75 Productivity Commission (2020). *Integrated Urban Water Management — Why a good idea seems hard to implement,* Commission Research Paper, Canberra, p. 20.

4.3 The sobering findings of paleoclimate research

Recent research into Australia's climate over the past 2000 years adds new insights and warnings about Australia's water supply outlook. In one study, using summer sea-salt in Antarctic ice cores as a rainfall proxy, Vance and colleagues identify 8 mega-droughts (more than 5 years' duration) in eastern Australia correlated with the climate mode known as the Inter-Pacific Decadal Oscillation (IPO). Six of these droughts were prior to AD 1320; the longest was 39 years between CE 1174-1212 and occurred towards the end of a century of predominantly drought conditions, according to the IPO index.[76]

> The predominance of moister conditions during the mid-twentieth century was atypical.

In a follow-up study of IPO variability over the past two millennia, Vance and colleagues find that contrary to previous understanding, the negative, wetter phase of the IPO has been shorter (average 7 years) and the drier neutral-positive state longer (average 61 years). The predominance of moister conditions during the mid-twentieth century was atypical. Coincidentally, this period (the decades following WW II) was when much of Australia's water infrastructure was planned and built. If neutral-positive IPO conditions continue to dominate in the twenty-first century as they have over the past 2000 years, then mean annual rainfall in eastern Australia would be 2–4% lower than the 20th Century average. This translates into a 3–4 times greater (6–16%) decrease in annual runoff and reservoir flows, due to non-linearity in the relationship between rainfall and runoff. The authors say this poses a 'major threat to water security in eastern Australia'.[77]

A study by Cook and colleagues found, based on tree ring and coral data, that there was a 'persistent, multidecadal drought event' (more than 20 years' duration) in eastern Australia in the early 1500s.[78] O'Donnell and colleagues report on a 668-year tree-ring reconstruction of winter rainfall for inland southwestern Australia. They conclude that:

> Drought periods of greater magnitude and duration than those in the instrumental record occurred prior to 1900 CE, including two 'mega-droughts' of > 30 years duration in the eighteenth and nineteenth centuries. By contrast, the wettest decadal periods of the last seven centuries occurred after 1900 CE, making the twentieth century the wettest of the last seven centuries. We conclude that the instrumental rainfall record (since ~ 1900 CE) does not capture the full scale of natural hydro-climatic variability for inland southwest Australia and that *the risk of prolonged droughts in the region is likely much higher than currently estimated*.[79] (emphasis added)

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76 Vance, T. R., Roberts, J. L., Plummer, C. T., Kiem, A. S., & Van Ommen, T. D. (2015). Interdecadal Pacific variability and eastern Australian megadroughts over the last millennium. *Geophysical Research Letters,* 42(1), 129-137, p. 134. https://doi.org/10.1002/2014GL062447

77 Vance, T.R., Kiem, A.S., Jong, L.M. et al. (2022). Pacific decadal variability over the last 2000 years and implications for climatic risk. *Commun Earth Environ* 3, 33, p. 5. https://doi.org/10.1038/s43247-022-00359-z

78 Cook, B. I., Palmer, J. G., Cook, E. R., Turney, C. S., Allen, K., Fenwick, P., ... & Baker, P. J. (2016). The paleoclimate context and future trajectory of extreme summer hydroclimate in eastern Australia. *Journal of Geophysical Research: Atmospheres, 121*(21), 12820-12838, p. 12829. https://doi.org/10.1002/2016JD024892

79 O'Donnell, A. J., McCaw, W. L., Cook, E. R., & Grierson, P. F. (2021). Megadroughts and pluvials in southwest Australia: 1350–2017 CE. *Climate Dynamics,* 57(7), 1817-1831, p. 1817. https://doi.org/10.1007/s00382-021-05782-0

A study by Barr and colleagues of sediment cores from two crater lakes in south-eastern Australia provide evidence for a multi-decadal drought starting about 650 CE, and a period of variable climate from 850 to 1400 CE. The authors conclude:

> Knowledge of climatic variability in Australia beyond the last 200 years is limited. In the south-east of the continent, prolonged rainfall anomalies, such as the 'Big Dry' [Millennium Drought], have had significant impacts on the region during this period. However, the results of this study indicate that the 'Big Dry' was, in the context of the last 1500 years, a relatively minor event.

"The 'Big Dry' Millennium Drought was, in the context of the last 1500 years, a relatively minor event."

> … the findings presented here demonstrate the potential for the region to suffer more extreme droughts, and substantially greater climatic variability, than that which has been experienced during the period of European settlement. *Similar occurrences in the contemporary setting would have severe environmental, social and economic consequences*.[80] (emphasis added)

In a recent study, Falster and co-workers reinforce this conclusion:

> Model simulations of droughts over the last millennium suggest that future droughts across Australia could be much longer than what was experienced in the 20th century, even without any human influence. With the addition of anthropogenic climate change, which favours drought conditions across much of southern Australia due to reduced cool-season rainfall, it is likely that future droughts in Australia will exceed recent historical experience.[81]

The above studies suggest that even prior to current anthropogenic climate change, Australia's long-term climate history *has already* seen extended megadroughts, more severe than encountered in the twentieth century. The water infrastructure built over this time has been based on an assumption that the future will be like the recent past. Our paleoclimate history, combined with present drying trends, indicate a highly uncertain and erratic future for Australia's water supply, with more prolonged drought. The prospect of droughts lasting decades, in an Australia with a still larger (and still growing) population than currently exists, is a recipe for disaster.

4.4 Inadequate responses

Water is a non-negotiable resource for existence. Its limitations in our Australian context are stark: vicious droughts and bushfires followed by record-breaking rainfall and floods. Each cycle of weather is now supercharged by the energy drawn from a warming atmosphere and ocean. Once-rare events are now common: 2023 saw three one-in-one-thousand-year flooding events occur within a year. It would be foolhardy to think the Millennium drought, claimed as a one-in-one-thousand-year event, will not hit us for another thousand years. Yet, instead of prudently protecting our buffers by limiting demand growth, we recklessly rush to expand.

80 Barr, C., Tibby, J., Gell, P., Tyler, J., Zawadzki, A., & Jacobsen, G. E. (2014). Climate variability in south-eastern Australia over the last 1500 years inferred from the high-resolution diatom records of two crater lakes. *Quaternary Science Reviews*, 95, 115-131, p. 129. https://doi.org/10.1016/j.quascirev.2014.05.001

81 Falster, G. M., Wright, N. M., Abram, N. J., Ukkola, A. M., & Henley, B. J. (2024). Potential for historically unprecedented Australian droughts from natural variability and climate change. *Hydrology and Earth System Sciences*, 28(6), 1383-1401, p. 1383. https://doi.org/10.5194/hess-28-1383-2024

Urban water authorities are beginning to take the gravity of the climate situation more seriously. Climate change scenarios are included in future demand and supply modelling. The 2022 Greater Sydney Water Strategy refers to the results of paleoclimate research in describing its reduced supply scenario.[82] Water authorities are developing climate projections at finer spatial resolution, although translating these into practical water planning is proving complex and resource-intensive.[83]

In contrast, management of irrigation withdrawals seems too deeply mired in politics to honestly and effectively respond to climate change. The South Australian Murray-Darling Royal Commission into basin management found *inter alia* that the Murray Darling Basin Authority ignored CSIRO climate change estimates. The Commission's Key Findings included the following statements:[84]

> 6.3 In 2009, the CSIRO advised the MDBA that for its modelling for the period of implementation of the first Basin Plan, the MDBA should consider the recent climate of the past 10–20 years, and its climate change projections. This advice was ignored by the MDBA. This amounts to negligence, and maladministration.
>
> 6.4 In the Guide [to the Proposed Basin Plan], the determination of the ESLT [environmentally sustainable level of take] range was influenced by factoring in a run-off drop of 3%, despite the mean CSIRO projection being 11%. The Commissioner agrees with the view of the CSIRO at the time that limited inclusion of climate change projections was not scientifically defensible.
>
> 6.5 In the ESLT Report, climate change was not considered or factored into the modelling at all. This decision was unlawful, as it meant the Basin Plan was not based on the best available scientific knowledge, and was done with total disregard for the principle of ESD [environmentally sustainable development].

There is little prospect that environmental flows will be maintained in the face of climate change, when they are currently insufficient. In the MDB, they are currently about two thirds of the bare minimum required for healthy river and riverine environments to thrive.[85] Buy-backs of water licenses have faced enormous political resistance from irrigation lobbyists and the previous Coalition Governments. In February 2024 the Minister for the Environment and Water Tanya Plibersek overturned the Coalition government's ban on water licence buy-backs, re-instituting voluntary licence buy-backs by Government. However, it is doubtful whether buy-backs will be sufficient to reduce water withdrawals to sustainable levels.

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82 NSW Dept of Planning and Environment. (2022). *Greater Sydney water strategy: water for a thriving, sustainable and resilient Sydney,* Table 1. https://water.dpie.nsw.gov.au/plans-and-programs/greater-sydney-water-strategy/about

83 Productivity Commission (2024). *National Water Reform 2024,* pp. 105, 106.

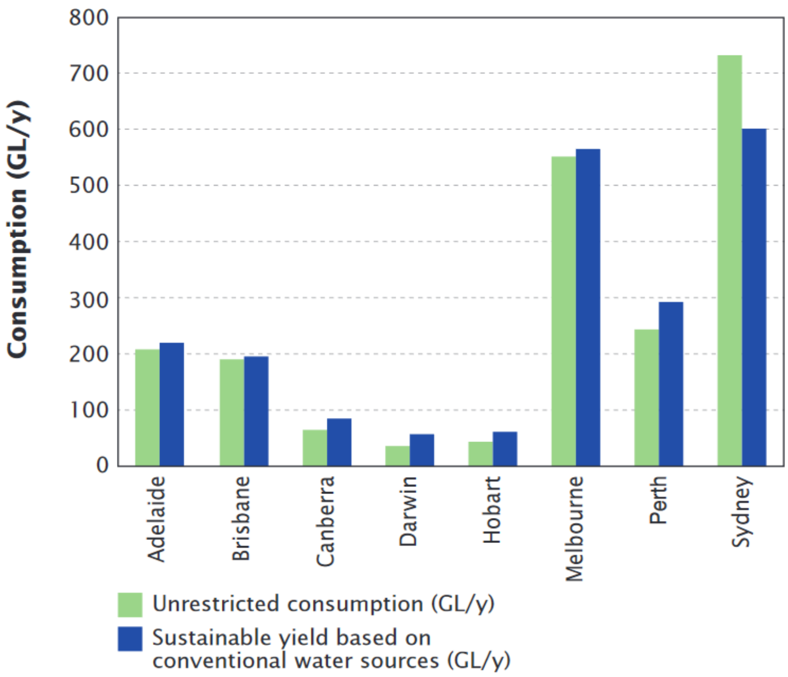
84 Murray-Darling Basin Royal Commission Report, 19 January 2019, p. 55. https://cdn.environment.sa.gov.au/environment/docs/murray-darling-basin-royal-commission-report.pdf

85 Ibid, pp. 167-168: '… the MDBA determined that the level of Basin-wide diversions that represented an ESLT fell within a range. From the starting point of Basin-wide diversions as 13 677 GL, this is expressed as a water recovery amount for the environment, which correspondingly relates to a reduction in diversions for consumptive use. Accordingly, at the lower end of the determined range, the MDBA assessed that a water recovery amount of 3856 GL, representing a diversion limit of 9821 GL, would achieve the environmental watering requirements of the Basin with a "high level of uncertainty". At the higher end of the range, the MDBA assessed that a water recovery amount of 6983 GL, or a diversion limit of 6694 GL, would achieve the environmental watering requirements of the Basin with a "low level of uncertainty".'

5. Urban water projections and desalination dependence

By the turn of the century Australia's urban water demand had reached the maximum that could be supplied reliably by conventional means, namely rainfall and groundwater. In assessing water resources available to capital cities in 2002, Figure 11 demonstrates how closely urban water consumption matched water from dams and groundwater. (In Figure 11, 'unrestricted consumption' refers to consumption at times when no water restrictions apply.) In the five largest population centres, *consumption had grown to the limit of sustainable yield of the water supply*. The estimates of 'sustainable yield' used in this chart are based on twentieth century averages and do not allow for ongoing drying of the climate.

Figure 11. Rain-dependent water supply versus consumption in capital cities in 2002



Source: Burn (2011) [86]

86 Burn, S. (2011) Future Urban Water Supplies, Ch 7 in *Water: science and solutions for Australia*. Prosser I. (ed), CSIRO: Canberra, p .91.

In 2000, none of Australia's capital cities utilised desalinated water. By 2021, on average 12% of capital city supplies were from desalination. This marks a fundamental transformation of the urban water outlook, which is only just the beginning according to water planning authorities. Despite significant changes in household behaviour to reduce water use, the gap is widening between rainfed supply and urban demand.

All of Australia's water authorities recognise population growth as the key driver of water demand and climate change as a cause of diminishing water supply. The operation of these two factors together leads to potential water insecurity. While climate change is clearly understood as a 'threat', the same language is not applied to population growth, which is politely termed an 'uncertainty'.

In most places, more dams are out of the question due to declining streamflow and lack of suitable sites. The alternatives are referred to as 'manufactured water', including desalination and recycled water. Both typically involve the use of 'reverse osmosis' in which water is pushed through porous membranes whose holes are so tiny that the salts in seawater can't get through, let alone organic matter and bacteria in sewage, which are much bigger particles than dissolved salts. The result is highly purified water. But a great deal of energy is used to push the water through at high pressure. A typical figure is 3 kWh per kL (1000 L) of water.

Recycled water, while having considerable potential and being cheaper than desalination (but still much more costly than conventional supply), is being treated cautiously due to questions of public acceptability of 'drinking sewage'. That said, some water planning authorities are keen to promote use of 'fit for purpose' recycled water for non-drinking purposes, as well as potable recycled water even if only as a last resort in extended drought situations.

5.1 Desalination to date

Perth was the first city to embrace desalination in 2006, responding to the twin pressures of high population growth and climate change that has radically reduced streamflow in dam catchments. Desalination was adopted with bipartisan support, after consideration of alternatives. For instance, building a 3,000 km pipeline to Perth from Lake Argyle on the Ord River in the state's far north was found to be orders of magnitude more expensive than desalination.[87] With Perth's history of profligate water use for domestic gardens, it was also politically expedient to opt for desalination rather than risk a public backlash against sprinkler bans.[88] Perth has two desalination plants which can provide up to 150 GL per year, almost half the city's needs. A third plant at the Alkimos Water Precinct is planned to go online in 2028, initially with 50 GL capacity and potential to expand by another 50 GL.[89] Estimated cost of the first phase is $2.8 billion.[90]

Perth has also been at the forefront of adding recycled water to the drinking water supply via aquifer storage. As mentioned in chapter 3, the city is also heavily reliant on groundwater which is under threat from seawater incursion and reduced recharge rates due to drought and climate change. Facing a dire outlook for conventional water supply, Perth has gone all-in on desalination, water recycling and public education campaigns to encourage water conservation.

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87 Department of Premier and Cabinet (WA) (2006) *Options for Bringing Water to Perth from the Kimberley: An Independent Review*. Accessed at https://www.water.wa.gov.au/__data/assets/pdf_file/0007/4966/64772.pdf

88 Isler, P. L., Merson, J., & Roser, D. (2010). 'Drought Proofing' Australian Cities: Implications for Climate Change Adaptation and Sustainability. *International Journal of Humanities and Social Sciences*, 4(10), 2029-2037. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=e59bf95920018762a086de2a31923e61948b098d

89 https://www.watercorporation.com.au/Outages-and-works/Ongoing-Works/Alkimos-Seawater-Desalination-Plant

90 WA Government. (2023, 3 December). Media release. https://www.wa.gov.au/government/media-statements/Cook-Labor-Government/%242.8-billion-investment-to-secure-Perth%27s-next-major-water-source-20231204

Melbourne, Adelaide, Sydney and Brisbane followed suit with desalination plants. The desalination decisions for eastern seaboard cities were more controversial. They followed a typical pattern for decision-making about 'big water' infrastructure in Australia, being precipitated by an imminent crisis of water supply due to drought, and in the face of heated political debate.[91]

Table 3. Capital city reverse osmosis plants

State	Plant name	Initial investment	Capacity (GL/yr)	Completion date	Comment
WA	Perth Seawater Desalination Plant (Kwinana)	$387M	45	2006	In operation 100%
WA	Southern Seawater Desalination Plant (Binningup)	$1,400M	100	2012	In operation 100%
QLD	Gold Coast Desalination Plant (Tugan)	$1,200M	49	2009	Operates in hot standby mode at 5%, with capacity to reach 100% in 72 hours.
SA	Adelaide Desalination Plant (Port Stanvac)	$1,830M	100	2012	In operation at 10%. Operated at 100% for the first 2 years and again in the first half of 2020.
VIC	Victorian Desalination Plant (Wonthaggi)	$3,500M	150	2012	In operation at 80% for the 3 years up to 2021.
NSW	Sydney Desalination Plant (Kurnell)	$1,890M	90	2010	Operates when dam storage levels fall below 60% and is turned off when dam levels reach 90%. Operated from 2010 to mid-2012 and from 2019 to August 2020.

Source: CSIRO [92]

At the time there was criticism, from varying perspectives, of the high cost and undue haste in decision-making. The Productivity Commission questioned the timing and efficiency of the investments from an economic viewpoint.[93] A range of lower cost options were proposed by various community groups and independent experts, including more demand- and supply-sensitive water pricing, recycled water, greater water conservation measures, and decentralised supply options such as household water tanks.[94] However, with ongoing population growth, these alternative measures could only defer an inevitable resort to desalination.

91 For Sydney, see Lawhon Isler, P. (2011). Security and sustainability in urban water management: an interdisciplinary analysis of decision making in relation to Sydney's water system during the millennium drought of 2000-2010. Doctoral dissertation, UNSW Sydney. https://unsworks.unsw.edu.au/bitstreams/788f9ebd-2f1e-4284-8893-8bba25767942/download

92 Barron O, Hodgson G, Jalilov S, Martinez J, Hayward J, Ela W, Li X, Palmer N, Ravisankar V, Thomson J, Politzi M, Shek A, Ma I and Tucker A (2021). *Review of low-cost desalination opportunities for agriculture in Australia*. A report to the National Water Grid Authority. CSIRO Land and Water, Australia. https://www.nationalwatergrid.gov.au/projects/review-low-cost-desalination-opportunities-australian-agriculture

93 Productivity Commission 2011, *Australia's Urban Water Sector*, Report No. 55, Final Inquiry Report, Canberra, p. xxiii. https://www.pc.gov.au/inquiries/completed/urban-water/report/urban-water-overview.pdf

94 See for example, Wright, I.A. and Reynolds J. (2019, 12 February). Cities turn to desalination for water security, but at what cost? *The Conversation*. https://theconversation.com/cities-turn-to-desalination-for-water-security-but-at-what-cost-110972 ; Wright, I.A. and Reynolds J. (2019, 13 February). When water is scarce, we can't afford to neglect the alternatives to desalination. *The Conversation*. https://theconversation.com/when-water-is-scarce-we-cant-afford-to-neglect-the-alternatives-to-desalination-111249

5.2 Hooked on desalination

A quarter of a century after being fully reliant on rain-fed water sources, water authorities and their political masters now see desalination as the primary way to drought-proof Australia's cities and, in some cases, rural towns. We are seeing the advent of what Green and Bell call the 'neo-hydraulic paradigm' which replaces the old hydraulic paradigm (dam building) of the twentieth century:

> This is to emphasize the role of private finance and the shift from large, classical hydraulic structures of dams and pipelines, to an emphasis on new technologies to treat water of any quality to drinking standard. … The emphasis on the certainty of supply and reliance on capital-intensive engineering-led solutions can be characterized as the neo-hydraulic paradigm. … Neo-hydraulic approaches to water management require minimal intervention in urban life and politics, providing a relatively simple technological solution to the problem of water scarcity, compared to the deeper reforms required to achieve integrated, sustainable urban water management. … [They] are therefore likely to find consistency and stability in desalination as a certain source of water in the midst of the uncertainty of drought, even if it comes at great expense and is under-utilized in operation.[95]

The commitment to desalination was supported by a series of federally funded research studies between 2010 and 2016 conducted under the auspices of the National Centre of Excellence in Desalination. These studies modelled the relative costs of desalination compared to building of dams to meet the needs of a growing population over the next hundred years. Studies were conducted for Melbourne, Adelaide and Brisbane (South East Queensland).[96] In each case, the analyses found that, 'over a longer time horizon, desalination provides a more viable, cost effective and secure bulk water supply alternative when compared to building large rain-dependent dams' (or in the case of Adelaide, relative to expanding dams and pipelines connecting to the Murray-Darling Basin).

However, the option of maintaining a stable population size was never considered. Had it been, it would have been by far the most cost-effective option.

These studies anticipated considerable population growth: at the end of the hundred-year simulation period, there would be 14.2 million people in Melbourne, 13.6 million in South East Queensland and 4.2 million in Adelaide. These correspond to annual growth rates of 1.25%, 1.5% and 1.2% respectively. Despite almost tripling current populations, these growth rates are lower than experienced over the past two decades. If current growth rates persist, these studies would vastly underestimate future water demand.

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95 Green, A., & Bell, S. (2019). Neo-hydraulic water management: An international comparison of idle desalination plants. *Urban Water Journal,* 16(2), 125-135, p. 128. https://doi.org/10.1080/1573062X.2019.1637003

96 Scarborough, H., Sahin, O., Porter, M., & Stewart, R. (2015). Long-term water supply planning in an Australian coastal city: Dams or desalination? *Desalination,* 358, 61-68. https://doi.org/10.1016/j.desal.2014.12.013 ;
Porter, M. G., Askarov, Z., & Hilborn, S. (2015). *Securing unlimited water supply in Adelaide over the next century: balancing desalinated and Murray-Darling Basin water*. Economics Series. SWP_2015. https://www.deakin.edu.au/__data/assets/pdf_file/0009/408753/2015_3.pdf;
Porter, M. G., Downie, D., Scarborough, H., Sahin, O., & Stewart, R. A. (2015). Drought and Desalination: Melbourne water supply and development choices in the twenty-first century. *Desalination and Water Treatment,* 55(9), 2278-2295. https://doi.org/10.1080/19443994.2014.959743 ;
Sahin, O., Stewart, R. A., & Helfer, F. (2015). Bridging the water supply–demand gap in Australia: coupling water demand efficiency with rain-independent desalination supply. *Water resources management,* 29, 253-272. https://doi.org/10.1007/s11269-014-0794-9

Exemplifying the techno-optimist mindset, the feasibility of such growth from a broader sustainability perspective was not mentioned, let alone questioned. On the contrary, these studies advocated desalination as a *means* to such growth:

> The theme of the simulations underlying this paper is that the conjunction of evolving water markets and reverse osmosis technology has *set the stage for water constraints being relaxed in countries with coastal access and strong water institutions and networks*. Agricultural and industrial sectors are now capable of responsibly using far more water for economic production and settlements of population. The result is, for water in all its forms to become a far more positive force for growth rather than the barrier to economic development that so many assume. …
>
> … these results show that *water demands and security needs can be met as the population and economy expand*. Rainfall volatility and drought are surmountable challenges, with relatively affordable desalination enabling more settlements across Australia depending on distances from coastlines. [97] (emphases added)

The studies also served as a response to the criticisms by the Productivity Commission, by providing a rationale for the expected higher costs of desalination:

> The Productivity Commission Inquiry (2011) suggested that investments in desalination in Australia have achieved water supply security but at an excessive cost. However, this judgement depends on assumptions about the treatment of uncertainty and the willingness of the community to pay for water security.[98]

Thus, high water charges are rendered acceptable by removing people's water security. Not mentioned are what the community is 'willing' to sacrifice in order to pay, nor whether they 'willingly' embrace the population growth that deprives them of cheap and abundant water.

These studies, backed by tens of millions of dollars in government funding, yet deeply flawed in their analytic approach, helped foster acceptance of desalination as not only a necessary response to drought, but as a way to overcome the growth limits imposed by Australia's inherent water scarcity. As water historian Peter Spearritt comments, the research program 'took a remarkably uncritical approach to assessing the pros and cons of desalination plants.'[99]

The 2017-19 drought led to renewed concerns about water security. Sydney's Warragamba dam levels dropped by 40% in just two years. As a result, water authorities began to plan for increased desalination capacity.

An interesting alternative water strategy for Sydney was prepared by a group of independent water engineers in 2020. Its key insight was that:

> a combination of supply and demand management is more efficient than relying entirely on supply solutions when considering whole of society benefits. These demand management solutions include behaviour change, water efficient appliances and rainwater harvesting. An example of these benefits is the 5 year deferral of the multi-billion dollar desalination augmentation provided by the BASIX [water efficient building standards] policy. The inclusion of rainwater harvesting as a stormwater management solution has

97 Porter et al. (2015) Drought and desalination, pp. 7, 17.
98 Sahin et al. (2015) Bridging the water supply–demand gap, p. 18.
99 Spearritt, P. (2024). Potable water. In Freestone, R., Randolph, B., & Steele, W. (2024). *Australian urban policy: prospects and pathways*. ANU Press, pp. 111-124, p. 113.

both infrastructure and demand management benefits and is an efficient decentralised infrastructure asset that improves the performance of the whole system.[100]

The strategy advocated a more decentralised approach which recognised the extra costs of moving water over greater distances. It also advocated pricing reforms to encourage take-up of rainwater tanks. The authors claimed their preferred strategy would delay by four years the need for three supply augmentations over the next two decades (either the Fitzroy Falls to Avon tunnel or desalination plants). However, since they assume Sydney's population will keep growing, the expense of new supply options are merely deferred, not avoided.

A summary of the long-term population and water demand projections by water authorities in the five mainland capital cities, is shown in Table 4.

It is evident from the scenarios in Table 4 that mainland urban water authorities anticipate further population growth will require adding anywhere from 850 GL to over 1450 GL to annual water supply to capital cities over the next several decades. The difference between the lower and higher demand projections are largely due to differences in population projections.[101] For purposes of comparison, 1450 GL is around the total volume of water currently supplied each year for Sydney, Melbourne and Perth combined.

Where lower population projections are analysed, it can be seen they greatly diminish the additional supply needs. Even these low population growth scenarios envision considerable growth – for Melbourne, three million more by 2070 compared to its 2021 population of 5.1 million. Stabilising Melbourne's (and other capital cities') population near existing levels would further minimise the need for water supply augmentation.

The momentous nature of the proposed transformation is laid out in Melbourne Water's discussion of 'manufactured water':

> We are transitioning to a manufactured water supply due to the natural resource constraints on availability from our existing surface water supplies, and the expected continued reduction in observed surface water availability associated with climate change (that is, reduction in rainfall). ... This transition to manufactured water could see 80 per cent of Greater Melbourne's water supply coming from manufactured water sources such as recycled water and desalination by 2070 as compared to 35 per cent now.[102]

To achieve this by 2070, Melbourne Water envisages between 540 and 780 GL of desalination and up to 200 GL of 'integrated water management' which includes recycled water and greater use of urban stormwater (p. 97). However, Water Services Association of Australia's 2020 cost study of water supply options found that 'the cost effectiveness of stormwater schemes is generally low due to the water treatment requirements relative to the volume of water produced.' [103]

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100 Urban Water Cycle Solutions Pty Ltd and Kingspan Water & Energy Pty Ltd. (2020). Alternative water strategy for Sydney, p. 4. https://kingspanwatertanks.com.au/wp-content/uploads/2022/03/143171_Alternative-Water-Strategy-for-Sydney-Kingspan-Urban-Water-Cycle-Solutions.pdf

101 It is noteworthy that some water authorities are reluctant to publish the specific population projections upon which their scenarios depend. For example Seqwater does not provide its population projections, nor does Sydney Water provide the numbers for its 'low' scenario.

102 Melbourne Water (2023) *Greater Melbourne urban water and system strategy: water for life*, pp. 85, 94. https://www.melbournewater.com.au/about/what-we-do/publications/greater-melbourne-urban-water-and-system-strategy-water-life

103 Water Services Association of Australia (2020, August). *All options on the table: urban water supply options for Australia*. https://www.wsaa.asn.au/publication/all-options-table-urban-water-supply-options-australia , p. 44.

Table 4: Mainland capital cities water demand and supply projections – summary [104]

City	Population 2021	Current (~2021) water demand	Projected future population (for given year)	Projected water demand (for given year)	Additional supply to cover population increase
Sydney	5.4 m	535 GL	8.4 m by 2060 (medium growth scenario) (population and demand data not released for low growth scenario)	800 GL (medium) -	250 GL (medium) 120 GL (low)
Melbourne	5.1 m	425 GL	12.3 m by 2070 (high scenario)* 10.2 m by 2070 (medium) 8.2 m by 2070 (low) * Scenarios include Greater Melbourne adjacent serviced areas. Strictly within Greater Melbourne boundary, high scenario envisages 11 million.	850 GL 690 GL 570 GL	Ranging from 280 GL to 600 GL depending on population and climate projections.
Brisbane (SEQ)	3.8 m	300 GL	Population figures not published by Seqwater, but said to be based on Qld Government Statistician 2018 projections. We assume high scenario > 6 million.	630 GL (high) 500 GL (medium) 480 GL (low)	Ranging from 150 GL (low) to 300 GL (high), both under 'gradual' climate change scenario.
Perth (inc. Peel)	2.1 m	465 GL (estimate not actual)	3.5 m by 2050	765 GL	300 GL
Adelaide	1.4 m	153 GL	2.27 m by 2050 (medium) (28% increase)	Not available. Studies currently under way	Full 100 GL of existing desal capacity will be required in driest years

104 **Sydney:** NSW Dept of Planning and Environment. (2022). *Greater Sydney water strategy: water for a thriving, sustainable and resilient Sydney*. https://water.dpie.nsw.gov.au/plans-and-programs/greater-sydney-water-strategy/about (Figures 11 and 13, and p. 114)
Melbourne: Melbourne Water (2023) *Greater Melbourne urban water and system strategy: water for life*. https://www.melbournewater.com.au/about/what-we-do/publications/greater-melbourne-urban-water-and-system-strategy-water-life (Figures 9, 15 and 30)
Brisbane: Seqwater (2023). *South East Queensland water security program 2023*. https://www.seqwater.com.au/water-security (Figures 4, 6 and 7)
Perth: Department of Water and Environmental Regulation, personal communication, 10 June 2024.
Adelaide: Government of South Australia, Department for environment and water. (2023). *Annual water security update 2023*. https://www.environment.sa.gov.au/topics/water/water-security/water-security-statement
Note: Some values were taken from charts where the raw numerical data were not published.

This 2070 scenario depends on an assumption that Melbourne's population will double over the next 50 years – with huge implications for urban form, infrastructure, quality of life, and peri-urban landscapes and habitats. Yet the population does not *have* to double. The only reason it is envisaged to double is that government has decided – without any consultation with the wider community – that it must keep growing.

5.3 Rural and regional towns remain vulnerable

Until recently, most inland towns have had relatively stable populations if not declining numbers. They had not faced the imminent threat of water scarcity until the Millennium Drought. Now increasing numbers of coastal and inland town water supplies are under increasing pressure from population growth, drying hinterlands and diminishing groundwater. This gives the lie to those who think that population increase can simply be decentralised to the regions.

Some regional towns have reached limits in easily extractable water supplies (see Figure 12), and some also face a surge in population growth. Tina Perinotto reported in 2019 that in arranging water supply for 90 towns in regional NSW during the 2017-20 drought, the State Government had spent over $200 million on weirs to divert river flow, pipelines to transport water from alternative dams, bores to tap groundwater if available, local desalination plants to treat alternative water sources of poor quality, and on trucking in water.[105] However, the cost of supplying more water escalates as more distant and less pure sources are accessed. It costs nothing to avoid adding to the existing population.

> Coastal and inland town water supplies are under increasing pressure from population growth, drying hinterlands and diminishing groundwater.

Government planning for extreme water shortages is still a knee-jerk reaction even with clear evidence of rainfall decline. Despite the same deficiency being reported in 2011, in 2020 governments were still forced to undertake emergency water supply infrastructure over broad regions of southern and eastern inland Australia.[106]

Desalination is increasingly being used or investigated for supplying rural areas. South Australia already has nine smaller desalination plants in regional and remote towns to purify brackish groundwater, with three more planned. Planning has been completed for a 5.3 GL desalination plant for Port Lincoln on Eyre Peninsula, where 75% of current water supply is sourced from the increasingly salty groundwater in the Uley South Basin and the rest from a Murray River-fed pipeline. The feasibility of desalination for the Upper Spencer Gulf region is also being studied to serve mining and 'green' steel industries.[107]

In Western Australia there is talk of desalination plants for both the Albany region and in Esperance as their groundwater supplies are increasingly stressed by climate change and population growth.[108,109]

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105 Perinotto, T. (2019). NSW considering evacuating up to 90 towns if they run out of water. *The Fifth Estate*. https://thefifthestate.com.au/articles/day-zero-might-mean-tough-choices-for-90-towns-looking-at-new-locations/; Perinotto, T. (2019, 19 December). How the NSW gov is mobilising a water effort for 90 drought-stricken towns in NSW. *The Fifth Estate*. https://thefifthestate.com.au/articles/mobilising-the-water-effort-for-90-drought-stricken-towns/

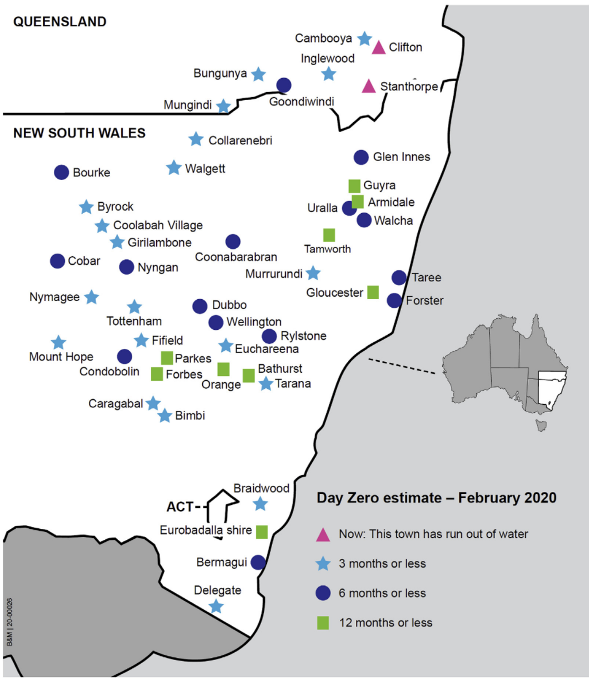
106 Prosser (2010). Op. cit.

107 Government of South Australia, Department for Environment and Water. (2023). *Annual water security update 2023*, p. 4. https://www.environment.sa.gov.au/topics/water/water-security/water-security-statement

108 Lucas, J. and da Silva, I. (2023, 30 May). Plans for desalination plant revived as part of Goldfields-Esperance water security strategy. https://www.abc.net.au/news/2023-05-30/water-security-for-goldfields-on-agenda/102404798

109 McGurk, S. (2023, 13 March). Lower Great Southern's next major water source ramps up. Media Release by the Minister for Training, Water and Youth.

Figure 12. Towns in New South Wales and South East Queensland with insecure water supplies as at 15 February 2020



Source: Radcliffe and Page (2020) [110]

5.4 Desalination, adaptation and sustainability

To date, desalination has been a response to low rainfall and a drying climate, while increases in demand from population growth have been lessened in most major cities through behavioural change and efficiency improvements (see Figure 4). However, water supply authorities now recognise that additional major efficiency gains will become harder to achieve. The low-hanging fruit have been picked.

At this juncture, without desalination, Australia would have been forced to confront a real physical limit to how much further its population could grow. Does this mean desalination is the technological saviour that will enable Australia's population to grow indefinitely? The flexibility of desalination, sourcing seemingly limitless water from the ocean, with production adjusted according to need, and allowing additional units to be added to the water network over time, is a politician's dream.

While the ocean may seem limitless, desalination itself operates in the real world of constraints: limited investment capital for infrastructure, limited potential site locations, limited energy. These constraints will impose economic and political costs and difficulties like taxation and NIMBYism. In addition, the growth in population that desalination could enable will have significant flow-on effects to the whole social-ecological system.

Desalination is presented as an adaptation to both climate change and population growth. In the context of climate change, the Intergovernmental Panel on Climate Change (IPCC) views adaptation as 'The process of adjustment to actual or expected climate and its effects … to

110 Radcliffe, J.C. and Page, D. (2020). Water reuse and recycling in Australia —history, current situation and future perspectives, *Water Cycle* 1, pp 19-40. https://doi.org/10.1016/j.watcyc.2020.05.005

moderate or avoid harm or exploit beneficial opportunities.'[111] However, some adjustments to climate threats can be maladaptive. Tubi and Williams argue that adaptation and maladaptation are not binary opposites.[112] Measures may be adaptive in the short term but maladaptive in the long term. Alternatively, actions might mitigate direct threat of harm (e.g. scarcity of water for urban populations) but displace or externalize maladaptive effects onto other systems like energy supply or coastal brine shock. Lock-in to a particular strategy can reduce the capacity to respond to unforeseen challenges. For example, dependence on desalinated water makes a community vulnerable to water system failure in the case of prolonged power outages or supply chain disruptions. For these reasons, conclude Tubi and Williams, 'desalination inevitably involves trade-offs between adaptive and maladaptive effects'.[113]

For Australia, the maladaptive implications of desalination are considerable. In particular they include energy intensity, cost, siting and environmental impacts, sea level rise and risks of critical failure.

Energy intensity. Desalination is the most energy intensive form of water supply. It requires large amounts of electrical energy to push the water through the desalting membranes. Energy is also required for pumping within the water pipe network, for example the pipeline from the Wonthaggi desalination plant to Melbourne's storage dams is 100 km. Dams are often in high country above cities allowing gravity to supply water pressure, while desalinated water is generally produced at sea level and must be pumped up to header tanks. As Tubi and Williams conclude:

> In effect, desalination technologies translate a water supply problem into an energy supply problem. As such, the (mal)adaptive effects of desalination are also determined by the energy sector and its capacity to meet the associated increase to base-load demand. In particular, the development of desalination could expose the water sector to energy price fluctuations and other energy-related stresses.[114]

"Desalination technologies translate a water supply problem into an energy supply problem."

Unless the energy supplied is zero carbon, there is a climate impact. It should be zero carbon throughout the value chain and in both the construction and operating phases – which is clearly not currently the case.[115] Most of Australia's water authorities are claiming to use renewable energy for desalination, although when their wind and solar plants aren't generating enough, the desalination plant will draw on the grid. Western Australia is installing 300 MW of wind energy which it claims will cover the powering of its three desalination plants. In effect, this is additional renewable energy capacity that is not displacing coal or gas generators, only meeting additional energy demand.

Renewables are not a magic pudding for infinite energy. Every extra megawatt comes with environmental impacts of its own, and the sites for the most efficient energy harvesting and storage will be rapidly exhausted. The quantities of minerals such as copper, lithium and rare earth metals required to scale up renewable technology raise issues of scarcity of available ores, geopolitical constraints and environmental impacts of mining. The energy required in mining,

111 Intergovernmental Panel on Climate Change (2014). *Climate change 2014: AR5 synthesis report.* R.K. Pachauri, L.A. Meyer (Eds.), Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Core Writing Team, IPCC, Geneva, Switzerland. https://www.ipcc.ch/report/ar5/syr/, p. 5.

112 Tubi, A., & Williams, J. (2021). Beyond binary outcomes in climate adaptation: The illustrative case of desalination. *Wiley Interdisciplinary Reviews: Climate Change,* 12(2), e695, p. 3. https://doi.org/10.1016/j.desal.2018.12.008

113 Ibid, pp. 4, 7.

114 Ibid, p. 7.

115 Heihsel, M., Lenzen, M., Malik, A., & Geschke, A. (2019). The carbon footprint of desalination: an input-output analysis of seawater reverse osmosis desalination in Australia for 2005–2015. *Desalination*, 454, 71-81. https://doi.org/10.1016/j.desal.2018.12.008

manufacture, installation and maintenance of energy infrastructure is not insignificant. Feasible methods for decommissioning and recycling solar panels and wind turbines are by no means settled.[116] Anything we can do to minimise our aggregate water *and* energy demand is going to make the transition more feasible and ecologically sustainable. As a multiplier of both water and energy demand, the scale of the future human population is a crucial factor for ensuring a world powered by renewables can deliver enough water and energy per person.

Cost. The capital and operating costs of desalination are considerable. In December 2023 the Queensland government cited a ballpark cost of $4 – 8 billion dollars to construct its next 50 GL desalination unit.[117] The planned third Perth unit is officially costed at $2.8 billion. Electrical energy costs are generally said to average around 41% of the operating costs for seawater reverse-osmosis desalination plants.[118]

The historical experience in Australia has been that, in the decade since the millennium drought, four of the six desalination plants were idle or operating at minimum capacity.[119] There are still large maintenance costs even when plants are not producing water. For Melbourne's Wonthaggi plant these were $654 million annually.[120] Investments in these plants could be interpreted as inefficient or poorly timed uses of capital where demand is not enough to warrant the cost of increased supply.[121] Water authorities seem resigned to the likelihood that desalination units may operate at less than full capacity for much of the time, increasing the capital cost per litre. This is perceived as the price of using desalination as an 'insurance policy' against drought and climate change, given they can no longer maintain the high buffer levels of dam storages that were possible in the twentieth century when population was lower.

> Infrastructure Australia projects that household water and sewage bills would increase in real terms by two and a half times by 2040 and six-fold by 2067.

All of this translates into increased water prices for consumers. Per litre of water, desalination is between 2.5 and 5 times the cost of rain-fed dam water (Figures 13 and 14). Paying more for a fundamental requirement of life means less for discretionary items that maintain quality of life. As recommended by the Productivity Commission,[122] National Water Initiative reforms require full cost recovery for water infrastructure built since 2007 to be implemented via increased prices to the consumer, although the degree this has been done varies between states. A 2017 study for Infrastructure Australia projected that, based on population growth and increasing water infrastructure requirements, household water and sewage bills would increase (in real terms adjusted for inflation) by two and a half times by 2040 and six-fold by 2067.[123]

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116 Bell, J. and Martin, S. (2024, 18 July). What happens to wind farms in Victoria when turbines reach the end of their lives? ABC news online. https://www.abc.net.au/news/2024-07-18/can-old-wind-farm-turbines-be-recycled/104062334;
King, R. (2021, 6 June). Rooftop solar produces clean energy but most panels end up in landfill despite being recyclable. ABC news online. https://www.abc.net.au/news/2021-06-06/what-happens-to-solar-panels-after-their-useful-life-is-over/100193244

117 Dennien, M. (2023, 10 October). Qld's premier would drink recycled water. But residents won't get it. Brisbane Times. https://www.brisbanetimes.com.au/politics/queensland/new-desalination-plant-no-recycled-water-in-south-east-qld-plan-20231010-p5eb30.html

118 Voutchkov, N. (2022). Desalinated Water. In: Qadir, M., Smakhtin, V., Koo-Oshima, S., Guenther, E. (eds) *Unconventional water resources,* pp. 233-254, Figure 11.5. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-90146-2_11

119 Tubi, A., & Williams, J. (2021). Beyond binary outcomes in climate adaptation: The illustrative case of desalination. *Wiley Interdisciplinary Reviews: Climate Change,* 12(2), e695, p. 11. https://doi.org/10.1016/j.desal.2018.12.008

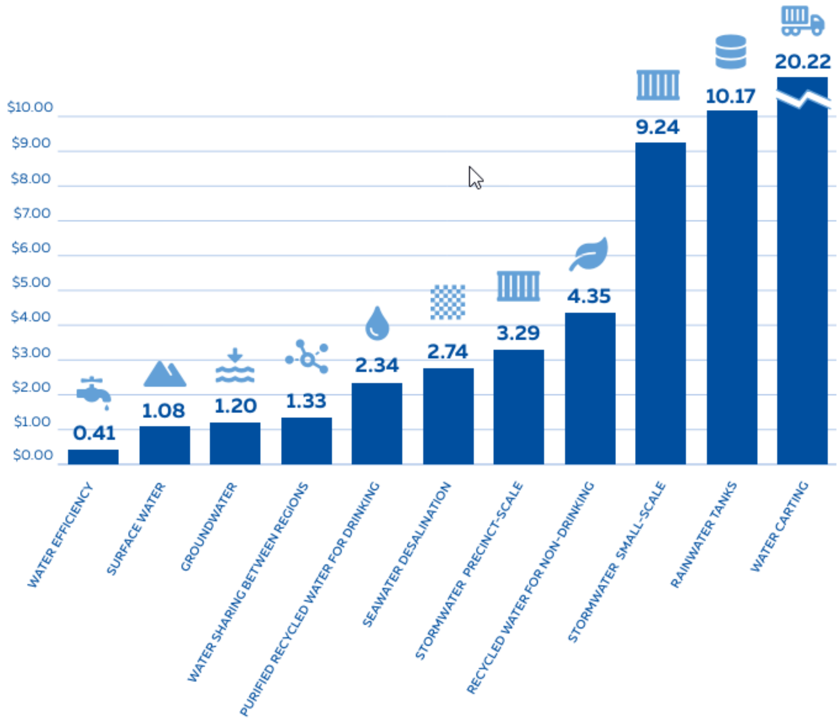
120 Wittwer, G. (2013). Urban water management in response to prolonged droughts and urban growth. *Economic Papers: A journal of applied economics and policy,* 32(1), 41-50. https://doi.org/10.1111/1759-3441.12023

121 Tubi, A., & Williams, J. (2021). Beyond binary outcomes, p. 11.

122 Productivity Commission 2024, *National water reform 2024,* Inquiry Report no. 105, Canberra, pp. 165-166. https://www.pc.gov.au/inquiries/completed/water-reform-2024/report

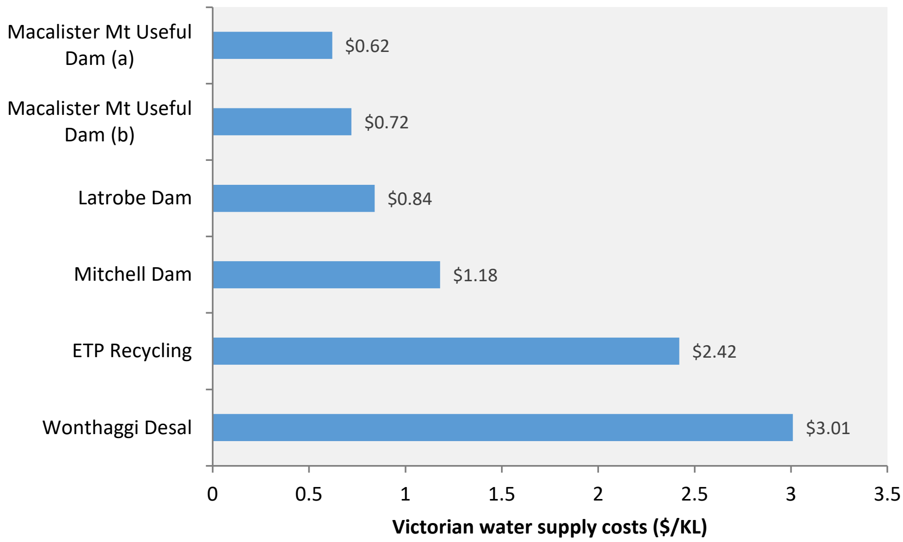
123 AITHER. (2017). *Urban water sector: future cost and affordability analysis.* https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/aither_future_cost_and_affordabilty_analysis.pdf. This

Figure 13. Typical costs of water supply options – $/kL, 2019–20



Source: Water Services Association of Australia [124]

Figure 14. Cost of water from specific additions to Melbourne's water supply (2008 dollars)



Source: Moran, A. (2008) [125]

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factor of increase may well be an under-estimate, since the report does not appear to factor in the higher cost of desalination and recycled options compared to traditional supply infrastructure.

124 Water Services Association of Australia (2020, August). *All options on the table: urban water supply options for Australia.* https://www.wsaa.asn.au/publication/all-options-table-urban-water-supply-options-australia Figure 1, p. 3. From the report: 'For this study, we have measured levelised costs so that estimates are directly comparable. The levelised costs in this report have been developed by considering the total direct life cycle cost to deliver the proposed yield. This means the levelised costs for a surface water option includes the capital costs to construct the dam or weir, any additional water treatment infrastructure, and any additional network infrastructure to deliver water to the community, as well the cost to operate the water supply option over its asset life.' (p. 15).

125 Moran, A. (2008). Water supply options for Melbourne. Occasional Paper. Institute of Public Affairs. August. https://ipa.org.au/wp-content/uploads/archive/1222147673_document_moran_watersupply-melbourne.pdf . Reprinted as Chart 14 in: van Onselen, L., O'Sullivan, J. and Cook, P.G. (2019). *Population growth and infrastructure in Australia: the catch-up illusion. Discussion Paper, Sustainable Population Australia.* https://population.org.au/wp-content/files/SPA_DiscussionPaper_Infrastructure_Nov2019_FullReport_1.pdf

It may be argued that future technological change will increase the efficiency and reduce the costs of desalination. There have been improvements in desalination efficiencies in the past decade and there will no doubt be continuing improvements over time. One industry spruiker opined:

> Near and long-term desalination technology advances are projected to yield significant decreases in the costs of production of desalinated water by 2030. Innovative technologies, such as nanoparticle enhanced membranes, biomimetic membranes, and forward osmosis, as well as beneficial extraction of valuable minerals from the brine generated by desalination plants, are aimed at reducing energy consumption by 20–35%, reducing capital costs by 20–30%, improving process reliability and flexibility, and greatly reducing the volume of brine discharge. Soon, the brine derived commercial products, such as valuable metals and salts, are expected to create an adequate revenue to partially, and over time, fully subsidize the production of desalinated water, making desalination the lowest-cost unconventional water-supply resource worldwide.[126]

However, if or when such new technologies will be commercially viable is anyone's guess. In particular, economically retrieving valuable metals from brine is still in the realm of pipe-dream, as they occur at concentrations orders of magnitude lower than required for profitable extraction with known technologies.[127] For the foreseeable future, it is likely that large desalination plants will remain costly, capital intensive and energy hungry. Increasing dependence on desalination will mean higher water prices.

Siting and environmental impacts. Ocean desalination units require land near the sea and reasonably close to population centres to avoid excessive pumping costs. Sites also have to be suitable from an environmental viewpoint and be publicly acceptable in terms of nearby residential areas and favourite beaches. In particular, the brine discharged by desalination plants is around twice as salty as seawater and toxic to marine plants and animals, unless quickly disbursed by currents.[128] If not quickly mixed, the brine sinks, forming a hypersaline layer on the seabed. Outflows fitted with high-pressure diffusers can increase mixing, reducing impacts of hypersalinity, but have their own impacts on the invertebrate species by creating turbulence.[129] Unfortunately, many large cities are sited on sheltered waters of bays and inlets where currents and waves are gentle and water does not readily mix with the wider ocean. Such bays are vital habitats and breeding grounds for ocean fisheries. The location of the proposed Port Lincoln desalination plant is receiving pushback from the fishing industry, citing concerns about the plant's intake of spat from which mussels grow.

Consequently, suitable desalination sites are often far from the centres of population or industry they are intended to serve. The water has to be pumped to dams, tanks or aquifers for further distribution, adding a substantial extra energy expense.

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126 Voutchkov, Desalinated Water, p. 252.

127 Sharkh, B.A., Al-Amoudi, A.A., Farooque, M. et al. Seawater desalination concentrate—a new frontier for sustainable mining of valuable minerals. *npj Clean Water* 5, 9 (2022). https://doi.org/10.1038/s41545-022-00153-6 ;
Ihsanullah, I., Mustafa, J., Zafar, A.M., Obaid, M., Atieh, M.A. Noreddine Ghaffour, Waste to wealth: A critical analysis of resource recovery from desalination brine. *Desalination* 543 (2022) https://doi.org/10.1016/j.desal.2022.116093

128 Kaempf, J. (2024) More desalination is coming to Australia's driest states – but super-salty outflows could trash ecosystems and fisheries. The Conversation, 13 May 2024. https://theconversation.com/more-desalination-is-coming-to-australias-driest-states-but-super-salty-outflows-could-trash-ecosystems-and-fisheries-229629 The article cites studies that discuss the effects of brine and hydrodynamics at outfall sites. New technologies are also canvassed.

129 Clark G F, Knott N A, Miller B M, Kelaher B P, Coleman M A, Ushiama S and Johnston E L (2018) First large-scale ecological impact study of desalination outfall reveals trade-offs in effects of hypersalinity and hydrodynamics. *Water Res.* 145: 757–68. https://doi.org/10.1016/j.watres.2018.08.071

To allow for Western Sydney suburban expansion, Sydney Water is planning an extension of desalination water infrastructure to accommodate an additional 1.5 million people. However, Professor Stuart Khan, head of Civil Engineering at Sydney University, has pointed out: 'we can't pump water from [a desal plant on] the coast to western Sydney: it would have to go under roads, under an entire city. That is simply not a realistic option.'[130] He notes that water engineering currently moves water from dams west of the city, to the east. Whole new infrastructure would be required to supply large volumes of water from the coastal east to the Western Sydney suburbs. He further notes that:

> Since the area in between the east coast and western Sydney is a highly developed urban environment, it is not possible to run an above-ground pipe (there is no obvious available corridor). There are thousands of roads and buildings that would need to be crossed. Similarly, a new trenched/buried pipeline is not practical through a large urban area, due to the level of disruption that would be encountered in its construction. The only viable solution would be an underground tunnel, constructed by a tunnel-boring machine, such as the type now used to construct freeway tunnels and railway tunnels. While this would be possible, it would add billions of dollars to the capital costs of the water supply, making it difficult for a government to fund.[131]

Sea level rise. An important siting issue is the potential impact of climate-induced sea level rise. Estimates of extreme sea levels due to storm surge, waves and tides are used to estimate risk and insurance for coastal areas. Due to climate change, both average sea level and intensity of storms are projected to rise, both of which increase extreme sea levels. A 2023 study projects that Australia's southern coastline could face worst case extreme sea levels of around 3.5 to 4.5 metres above the normal high-tide level by 2100, around 1.5 metres higher than now. Frequency of such extreme events is also expected to increase, becoming yearly events.[132]

However, understanding of the rate and extent of future sea level rise is rapidly evolving, with more recent work raising the estimates and highlighting 'deep uncertainties'.[133] A 2023 review of research by an international association of cryosphere (ice sheets) scientists finds that:

> A compelling number of new studies, taking into account ice dynamics, paleo-climate records from Earth's past, and recent observations of ice sheet behaviour, all point to a threshold for both Greenland and parts of Antarctica well below 2°C, committing the planet to between 12–20 meters sea-level rise if 2°C becomes the new constant Earth temperature.[134]

Professor James Hansen, a pioneering climate scientist, predicts global temperature rise will reach 2°C by the 2040s. Similarly, a study by NASA scientists states: 'Earth likely will reach 2°C of global warming by the 2040s without significant policy changes.'[135]

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130 Chung, L. (2023, 4 September). Sydney's running out of water, and we haven't been paying attention. *Sydney Morning Herald.* https://www.smh.com.au/environment/climate-change/sydney-s-running-out-of-water-and-we-haven-t-been-paying-attention-20230830-p5e0jn.html

131 Professor Stuart Khan, personal email communication, 25 May 2024.

132 Jevrejeva, S., Williams, J., Vousdoukas, M. I., & Jackson, L. P. (2023). Future sea level rise dominates changes in worst case extreme sea levels along the global coastline by 2100. *Environmental Research Letters,* 18(2), 024037, p. 6. ESL Projections cited above are based on visual inspection of Figures 1(a) and 1(b). https://doi.org/10.1088/1748-9326/acb504

133 Drollette Jr, D. (2024, 15 July). Figuring out the most realistic projections for sea-level rise: Interview with glaciologist Rob DeConto. Bulletin of the Atomic Scientists. https://thebulletin.org/premium/2024-07/figuring-out-the-most-realistic-projections-for-sea-level-rise-interview-with-glaciologist-rob-deconto/

134 ICCI, 2023. *State of the cryosphere 2023 – two degrees is too high.* International Cryosphere Climate Initiative (ICCI), Stockholm, Sweden. 62 pp., p. 2. https://iccinet.org/statecryo23/

135 Park, T., Hashimoto, H., Wang, W., Thrasher, B., Michaelis, A. R., Lee, T., ... & Nemani, R. R. (2023). What does global land climate look like at 2° C warming?. *Earth's Future,* 11(5), e2022EF003330, p. 1. https://doi.org/10.1029/2022EF003330

Hansen further warns that:

> the world is approaching a point of no return in which the overturning ocean circulation may shut down as early as mid-century and sea level rise of many meters will occur on a time scale of 50-150 years.[136]

There are uncertainties involved, particularly about the rate of sea level rise; however, the higher the peak temperature, and the longer we stay there, the greater the risk.[137] Desalination infrastructure as currently situated or envisaged would be vulnerable within their life spans and would need to be moved or protected to avoid possible worst case sea level outcomes – a difficult task given the uncertainties, on decadal and centennial time scales, with the impact of failure being catastrophic for water supply.

Risks of critical failure. In addition to the risks from sea level rise, high dependence on desalination introduces an unprecedented critical failure point into our water supply. These plants are compact targets vulnerable to malevolent actors (e.g. hacking or terrorism), or accident. What happens if – for whatever reason – one or more desalination plants fail in a drought? Where is the risk analysis? What is Plan 'B"?

5.5 Desalination for agriculture

In a 2021 report, the CSIRO evaluated the potential for desalination to support agriculture, concluding that engineering possibilities existed, but costs are challenging.[138] While the average cost of water to Australian irrigators is under 44 cents per kilolitre, desalinated water is likely to cost one to several dollars, depending on characteristics of the location and feedwater. At inland locations, where brine must be evaporated in lined ponds rather than discharged to the sea, and aquifer water might be pumped from considerable depth, the costs escalate. In theory, desalination could significantly expand the water available for irrigation: the report estimated the availability of Australia's brackish and saline groundwater resource at over 5,000 GL/yr, compared with current water use for irrigation around 8,000 GL. However, only high-value crops, such as greenhouse-grown horticulture, are likely to afford the cost.

One successful example is that of Sundrop Farms near Port Augusta in South Australia.[139] The farm uses concentrated solar power to distil seawater, generate electricity via a steam generator, and heat glasshouses for large-scale hydroponic tomato production. While this technology could be expanded elsewhere, few locations share such a favourable combination of attributes. It is noteworthy that the project settled on concentrated solar and distillation, rather than photovoltaics and reverse osmosis, as a cheaper, more robust option to meet their needs.

Proposals for megaprojects to overcome Australia's inherent water scarcity have long been part of the Australian imagination. One of the latest is a proposal by Heihsel and co-workers to replenish the Murray-Darling Basin using 5,500 GL per year of desalinated seawater from 29 coastal plants.[140] This volume is about half the extraction currently allowed under the Murray-Darling Basin Plan. It would involve thousands of kilometres of pipelines with an average diameter of 2.1 metres to transport the water to existing storages over or through the Great

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136 Hansen, J., Sato M. and Kharecha P. (2024). Global warming acceleration: hope vs hopium, p. 4. http://www.columbia.edu/~jeh1/mailings/2024/Hopium.MarchEmail.2024.03.29.pdf

137 Pam Pearson, Director, International Cryosphere Climate Initiative, personal communication, 8 August 2024.

138 Barron O, Hodgson G, Jalilov S, Martinez J, Hayward J, Ela W, Li X, Palmer N, Ravisankar V, Thomson J, Politzi M, Shek A, Ma I and Tucker A (2021). *Review of low-cost desalination opportunities for agriculture in Australia. A report to the National Water Grid Authority.* CSIRO Land and Water, Australia. https://publications.csiro.au/publications/publication/PIcsiro:EP211403

139 Sundrop Farms, https://www.sundropfarms.com/

140 Heihsel, M., Ali, S. M. H., Kirchherr, J., & Lenzen, M. (2019). Renewable-powered desalination as an optimisation pathway for renewable energy systems: the case of Australia's Murray–Darling Basin. *Environmental Research Letters,* 14(12), 124054. https://iopscience.iop.org/article/10.1088/1748-9326/ab57ab

Dividing Range (some 300 m altitude at a minimum) into the MDB. The proposal envisions a 100% renewable national electricity grid of 135 GW capacity, in which desalination and water pumping mainly utilise surplus renewable electricity at times when generation exceeds demand. The study focuses on the electricity grid, without analysing the cost and feasibility of the desalination plants. Some simple maths quickly raise doubts about such a proposal. Each of the 29 plants would need to produce nearly 200 GL per year (consuming some 600 GWh of power), while running only at times when the renewable energy grid has surplus power, after having topped up batteries and pumped hydro dams. The researchers bank on an oversize factor of 1.5, meaning delivering 200 GL would need a 300 GL plant, averaging two-thirds capacity. If truly using only surplus power, in an era when car battery charging will be timed to smooth demand, a more realistic factor might be four or five, requiring truly enormous plants sitting idle most of the time. The total infrastructure cost would be in the hundreds of billions, delivering water at many times the current cost to irrigators, requiring substantial government subsidies.

This proposal is on par with the mountain-moving hydraulic fantasies of the twentieth century such as the Bradfield scheme,[141] towing icebergs from Antarctica,[142] or pumping water from Lake Argyle in the Kimberley to provide fresh water for Australia's southern cities.[143] While technically feasible on paper, it is hard to see how it could ever be feasible in practical terms.

Beyond feasibility, the environmental footprint would be immense. It is an eco-modernist vision of ongoing growth based on technological innovation, with little regard for its ecological and aesthetic impacts. But it is a logical conclusion of hubris: that desalination is an ideal technology to support unending population and economic growth.

5.6 Ecological impacts of desalination-enabled growth

Water authorities present desalination as a necessary technology to meet future requirements and as being 'sustainable' because it can, in principle, be powered by renewable energy. However, the infrastructure, including renewable energy infrastructure, also has its own environmental footprint and opportunity costs. As Turner and Foran's maxim stated, '*there are no sustainable parts of an unsustainable whole*.'[144] When problems and their solutions are narrowly defined in engineering or economic terms, the bigger picture is often neglected until too late when unintended consequences emerge.

Since the desalination strategy aims to prevent water being a *constraint* to population growth, it instead becomes an *enabler* of growth. It externalises wide-ranging negative impacts of that growth into other parts of the social-ecological system. These impacts are not considered as part of the water strategy, due to the siloed nature of planning and policy making. To give an obvious example, it is hard to imagine how cramming an additional 13 million people into Australia's largest cities can avoid impacting the surrounding biodiversity, particularly through further land clearing for greenfield development. There will be increasing habitat impacts due to more usage of regional and coastal areas for recreation and tourism. The government's State of the

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141 CSIRO (2021). *An assessment of contemporary variations of the Bradfield Scheme - summary report*. Canberra: CSIRO; csiro:EP2021-3535. https://doi.org/10.25919/6180-3k09; https://www.abc.net.au/news/2019-04-30/fact-check-bradfield-scheme/11057224

142 Spandonide, B. (2012). *Iceberg water transportation from Antarctica to Australia* (Doctoral dissertation, University of Tasmania). https://figshare.utas.edu.au/articles/thesis/Iceberg_water_transportation_from_Antarctica_to_Australia/23206868 ; Asianometry (2022, 7 January). Towing icebergs to Australia for freshwater. https://www.youtube.com/watch?v=tqhUP7gfFNk ; ABC (2006, 23 November). Ask an expert: Water crisis. https://www.abc.net.au/science/articles/2006/11/23/2241914.htm

143 Department of Premier and Cabinet (WA) (2006) *Options for Bringing Water to Perth from the Kimberley: An Independent Review*. Accessed at: https://www.water.wa.gov.au/__data/assets/pdf_file/0007/4966/64772.pdf

144 Turner, G. and Poldy, F. (2008). Resource consumption and resource depletion: future scenarios and pathways for change, in Newton, P. (2008). *Urban transitions*. CSIRO Publishing, Chapter 3, p. 35.

Environment reports have repeatedly identified population growth as a key threat to biodiversity.[145]

Melbourne Water's *Water for Life* strategy claims that a benefit of desalination and manufactured water is that it:

> returns more water to waterways by not drawing on already stressed river systems or preventing Traditional Owner access to water. We know that surface water options are dependent on rainfall so their contribution may be less reliable into the future, particularly in times of drought. Manufactured water contributes to both climate resilience and ensuring the greatest efficiency and flexibility in options to deliver long-term water security for the broader community across our region including for Traditional Owners and also for waterway health.[146]

To thus suggest that manufactured water will be used instead of, rather than additional to, diversions of streamflow, is disingenuous. Given the continuing high population growth envisaged in the Melbourne strategy, it is hard to imagine how more desalination would mitigate the damage such growth would do to local ecosystems, streamflows and Traditional Owners' opportunity to use or influence the use of these resources.

> To suggest that manufactured water will be used instead of, rather than additional to, diversions of streamflow, is disingenuous.

Desalination *to support ongoing population growth*, as underway in Australia, is maladaptive in several ways. There may be a *limited* role for desalination as a buffer against climate change. However, as a buttress for perpetual population growth, desalination merely defers dealing with fundamentally unsustainable trends and allows negative impacts to further escalate before we accept the inevitable fact that population growth must end.

A better alternative is available to us: we can choose to stabilise our population. Australia could feasibly stabilise its population under 30 million without onerous restrictions on immigration. With less requirement for constant expansion, more attention and resources could be put into other elements of integrated design and retrofitting for water sensitive cities, including community involvement and co-design.

A stable population would be by far the lowest cost way to meet Australia's water requirements, with many spin-off benefits for the environment and quality of life.

145 *Australia state of the environment report 2021*. https://soe.dcceew.gov.au/

146 *Greater Melbourne urban water and system strategy: water for life*. (2023), p. 90. https://waterforlifestrategy.com.au/

6. Population stabilisation: putting the option on the table

Population growth means infrastructure provision is always struggling to keep pace. In contrast to 'capital deepening', where new infrastructure improves provision of services or amenity per person, 'capital widening' is when things are built just to keep pace with growth, with little or no benefit for existing residents, but nonetheless increasing costs for all. The provision of water infrastructure in Australia is increasingly capital widening.

Infrastructure authorities in both NSW and Victoria have demonstrated that water infrastructure makes a considerable contribution to the public cost of population growth. Infill development is considered cheaper when models assume existing infrastructure has the capacity to serve more households.[147] For Sydney, estimates ranged from around $6,000 per additional dwelling in inner-urban infill to more than $20,000 for greenfield developments.[148] However, when existing capacity is exceeded, retrofitting densely built-up areas with new water and sewage mains is extremely costly and disruptive to traffic and water services.

None of this cost of urban growth improves the quality of life for residents: when given the choice, most people prefer to live in low- to medium-density housing with access to green space, but not too far from an urban centre. Population growth constrains their choices and thereby reduces quality of life. Infrastructure, housing and services hardly ever keep pace with population growth. Residents absorb the pain through greater congestion, less green space, increased housing costs, sometimes shoddy build quality and higher charges for services (including water). If water bills go up, low-income households trade off food or power consumption against water use, with potential impacts on hygiene and health. Water costs might be relatively small beside the impacts of population growth on housing affordability and standards of healthcare and education in overcrowded facilities, but they add to the overall impact on quality of life.

In addition to the billions of dollars being spent on desalination plants in particular, Infrastructure Australia highlights the additional costs of maintenance and replacement of ageing water infrastructure:

> Compounding the challenges of climate change and population growth, the water and wastewater infrastructure networks in our cities were largely designed and built many decades ago for very different cities of a much smaller scale. This infrastructure has served Australia well, but with so much of Australia's water and sewerage network built over the

147 Infrastructure Victoria (2019). Infrastructure Provision in Different Development Settings. https://www.infrastructurevictoria.com.au/resources/infrastructure-provision-in-different-development-settings

148 NSW Productivity Commission (2023). Building more homes where infrastructure costs less Comparing the marginal costs of servicing growth in different areas of Sydney. https://www.productivity.nsw.gov.au/sites/default/files/2023-08/202308_NSW-Productivity-Commission_Building-more-homes-where-infrastructure-costs-less_accessible-v2.pdf

> first three-quarters of the twentieth century, utilities are expected to require an increasing level of investment to replace ageing assets. [149]

All these cost estimates and requirements for new infrastructure are based on projections of substantial population growth. What is lacking is any insight that reducing population growth (e.g. by adjusting immigration levels) is a 'policy lever' that can be used to reduce requirements for new water infrastructure.

In 2010, when the Rudd government rapidly elevated population growth, the Water Services Association of Australia (WSAA) published a detailed study of future impact of population growth on the need for water resources. At present (2024), Australia is tracking significantly higher than the highest population projection adopted for that study. It projected a population of 27.2 million in 2026 and 35.5 million in 2056. We passed 27.2 million in the first half of 2024. Treasury's 2021 Intergenerational report, which assumes a steady annual net migration level of 235,000 (much lower than current net migration), is projecting 38.8 million by 2060-61, still higher than the WSAA projection.

On the basis of their high population projection, WSAA projected a 42% increase (631 GL) in total urban water consumption from 2009 to 2056. WSAA did not present a costed plan or feasibility assessment for meeting this additional demand but merely assumed that all such potential gaps could be overcome:

> A long term planning horizon exists for water utilities to continue to proactively respond to the key drivers of consumption and climate change. The urban water industry needs to consider and plan for all population growth scenarios to ensure future water security. High quality water resource plans, reviewed on a regular basis involving all stakeholders is likely to be the only approach that will ensure reliable and sustainable supplies of urban water going forward, *regardless of the magnitude of population growth that Australia experiences*. The backbone of these water resource plans will always be water efficiency measures supported by the development of new water sources including recycled water, desalination, rural to urban water trading[150], groundwater, stormwater, rainwater tanks and dams. (emphasis added)

The report further concludes that 'The industry is *well positioned to accommodate higher population growth* through the development of a *diverse portfolio* of water supply sources and sophisticated water efficiency strategies' (emphases added). This implies that water planners can adapt to virtually any level of population growth, using energy-intensive technologies, and that the cost, no matter how high, will presumably be met by consumers or the taxpayer.

Similar confidence that any growth can be met is expressed in a review of Australia's water security in 2018 by James Horne:

> Despite the significant emerging risks to water security from population growth, economic development, and climate change, the overall risks in the future can be effectively managed.
>
> Increased water demand from population growth (which is concentrated in large cities) can be managed in coming decades by further increasing water use efficiency in corporations

149 Infrastructure Australia (2019). An assessment of Australia's future infrastructure needs: the Australian infrastructure audit 2019, Australian Government, Sydney, p. 609.

150 Whilst not addressed in depth in this report the operation of a water market should allow such transfers to occur in particular for Adelaide and to a lesser extent, Melbourne. In a drought, Adelaide may depend upon the River Murray for 70% of its water supply. The city has been asked to consider using more of its desalination capacity in summer to leave more water in the River Murray for irrigators and the Lower Murray environment. Melbourne has already tapped Lake Eildon via the Sugarloaf pipeline, thus reducing the total available water for irrigators from Eildon.

> and households, and use of climate-resilient supply sources such as new desalination plants, or increasing water reuse where economic. …
>
> Population growth in key urban centres, coupled with a drying climate, means that without some other change the current … surplus will disappear. So efforts to reduce household use per capita and industrial use will need to continue.[151]

More examples of the simultaneous acknowledgement and dismissal of the importance of population growth can readily be found. Gill, for example, concludes that:

> Water is not a severe constraint on Australia's urban population growth. … Australia's water resources can continue to support the inevitable (sic) population growth.[152]

In an assessment of what they call Australia's 'water-food-environment-energy nexus', Patrick and colleagues conclude that:

> The coastal perimeter of the continent houses all the capital and major cities of Australia where increasing population growth increases demands on water resources. The political economy of Australia is such that it is able to overcome water scarcity issues through economic means which for the urban sector in the future will be met primarily through desalination.[153]

Once again, the option of 'not increasing population' is not canvassed – neither are the growing costs, risks and environmental impacts of the desalination solution.

Sometimes this 'population blind spot' yields perverse conclusions, as in this editorial from the Australasian Journal of Water Resources. Under the heading of 'Population considerations for the long-term', water researcher Katherine Daniell comments:

> Like horizontal spread of urbanisation, vertical spread of urbanisation can also create a range of problems, including access to sunlight, challenges to the use of particular energy and water designs, and accessibility challenges in less than ideal vertical and higher density urban development. All of these challenges of changing population structures and the impacts of urbanisation on the rural environment and vice-versa are universal water challenges, not just for Australia …[154]

The terms population size or growth are here literally unsayable, and side-stepped by the obfuscatory phrase 'population structure'. The author instead jumps to speculating on urban agriculture (without mentioning its additional water demand) rather than questioning the desirability of continuing with destruction of habitat and good agricultural land by urban sprawl.[155]

In 2020 Water Services Association of Australia published a report entitled *All options on the table: urban water supply options for Australia*.[156] This study of the 'diverse portfolio' approach to water management provided detailed cost assessments of various options, namely water efficiency, recycled water, desalination, rural to urban water trading, groundwater, stormwater,

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151 Horne, J. (2018), op. cit., pp. 44, 46.

152 Gill, R. (2011). *Droughts and flooding rains: water provision for a growing Australia*. CIS policy monograph 115. Centre for Independent Studies, p. 15. https://www.cis.org.au/wp-content/uploads/2015/07/pm115.pdf

153 Patrick, M. J., Elsawah, S., Burgher, I., & Jakeman, A. J. (2016). Australian water security: A water–food–environment–energy nexus perspective. In *Handbook on water security*. Edward Elgar Publishing, p. 353.

154 Daniell, K. A. (2020). Water management beyond the fortressed COVID-19 world: considerations for the long-term. *Australasian Journal of Water Resources, 24*(2), 85-90, p. 87. https://doi.org/10.1080/13241583.2020.1844496

155 See, for example, Sobels, J. (2012, 3 January). Paving our market gardens: Choosing suburbs over food, *The Conversation*. https://theconversation.com/paving-our-market-gardens-choosing-suburbs-over-food-4419

156 Water Services Association of Australia (2020, August). *All options on the table: urban water supply options for Australia*. https://www.wsaa.asn.au/publication/all-options-table-urban-water-supply-options-australia

rainwater tanks and dams. Clearly, since ending population growth was excluded, *all* options were never on the table.

Similarly, the Productivity Commission's *National Water Reform 2020* report concludes:

> In working to balance declining surface water availability with increasing water demand, water service providers may have a number of supply augmentation options: alternative surface water sources, groundwater, stormwater harvesting, purified recycled water for drinking, non-potable recycled water, desalination or transferring water between sectors or regions. Conversely, they can look to increase water distribution efficiency or manage water demand to avoid (or delay) the need for major augmentations. This requires a commitment to 'all options on the table'.[157]

The phrase 'all options on the table' has become commonplace in water planning discourse in Australia. In part, this phrase points to the need for more options beyond the traditional dependence on large dams. It is also code for the need to seriously consider the potentially controversial option of using purified recycled sewage water in the potable water supply and not just for horticulture or golf courses.

The Productivity Commission's report on *National Water Reform 2024* leans strongly into the 'all options on the table' message:

> Australia has a significant water investment challenge ahead of it.
>
> The first is to achieve water security in the face of a changing climate. This requires a diversity of solutions, including supply and demand measures and infrastructure and non-infrastructure alternatives.
>
> The second is to maintain and upgrade ageing, conventional water storage and wastewater infrastructure (such as dams and sewers). As this infrastructure reaches the end of its design life, maintenance costs tend to increase and operational efficiency declines. According to WSAA [Water Services Association of Australia], capital expenditure is expected to double to over $10 billion annually by 2027.
>
> *To deal with these challenges efficiently and at least cost, all options need to be available and evaluated on their merits, even those that are politically difficult.*[158] (emphasis added)

Recommending the formal inclusion of the National Urban Water Planning Principles into a re-vamped and updated National Water Initiative, the Commission advises:

> The development of water strategies based on the urban planning principles are important risk management tools that provide an opportunity to identify cost effective options for meeting water security objectives. *All potential supply and demand options must be considered.*[159] (emphasis added)

The Commission goes even further, to warn against 'policy bans':

> Governments often rule out options for water security for political reasons, without due consideration of the actual costs and benefits – so called 'policy bans'. Options such as purified recycled water (PRW) for drinking and other potable uses, stormwater harvesting

157 Productivity Commission *Water Reform 2020,* p. 166.
158 Productivity Commission (2024). *National Water Reform 2024*, Inquiry Report no. 105, Canberra, p. 115. https://www.pc.gov.au/inquiries/completed/water-reform-2024/report
159 Ibid, p. 114.

and rural-urban water trade are all contemporary examples of viable supply augmentation options that have been subject to policy bans in Australian jurisdictions …

Policy bans potentially result in outcomes that are not lowest cost or efficient. They are almost never justified on economic grounds.[160] (emphasis added)

Despite repeated insistence by WSAA and the Productivity Commission, it should be clear that not all options *are* on the table. By far the most economically and environmentally effective way of ensuring water security is to reduce and eventually halt population growth. Yet this is the one option that is censored or taboo in the water policy discourse – it is *not* on the table. Water is political; population and immigration doubly so. But as the Commission says, just because a topic may be 'politically difficult' should not prevent it being evaluated on its merits. Indeed, given that polls repeatedly show Australians overwhelmingly do not want further population growth, the population option may prove easier than some others.

> By far the most economically and environmentally effective way of ensuring water security is to reduce and eventually halt population growth. Yet this is the one option that is *not* on the table.

The nub of the population blind spot in the water planning and policy community is that population growth is seen as an *exogenous* variable, beyond the reach of the water planning process. However, by failing to contrast the outcomes of less and more population growth, water planners are failing to give policy-makers vital information informing population policy.

It is not that water planners don't understand that less population growth would lessen the challenges and costs, but they believe it is not their job to say so. As technical specialists, they apparently perceive their job is to cater for whatever demand growth is forecast. Our urban planners behave in exactly the same manner.

Exploring the roots of this population taboo is beyond the scope of this paper.[161] But the taboo must be overcome: it is past time for political leaders to seek and receive fearless advice about *all* the options, including demand management through reducing population growth. Population growth should be considered an *endogenous* variable. It is neither economically reasonable nor socially or environmentally responsible to simply keep adding more, very expensive technology to fix a situation created and controlled by the Australian Government's population policies, when a much more cost-effective approach would be to aim for a stable population size.

Since the abolition of the National Water Commission by the Abbott government in 2014, the Productivity Commission has taken on a role in assessing progress of the National Water Initiative.[162] Despite frequent mention in its assessment reports of the role of population in driving water demand, the Commission has failed to identify population growth as an endogenous variable, one amenable to policy adjustment. Instead the Commission focuses on water pricing as the primary way to allocate increasingly scarce water resources to an ever-increasing population. Its economic rationalist strategy is to penalise users into ever-increasing water austerity, rather than the wellbeing-preserving alternative of ending population growth.

160 Ibid, p. 118.
161 For further discussion, see Lowe, I., O'Sullivan, J. and Cook, P. (2022). *Population and climate change*. Discussion Paper. Sustainable Population Australia, pp. 4-6 and endnote 63. www.population.org.au/discussionpapers/climate; See also Cook, P.G. (2023, 16 May). Big Australia needn't be a taboo subject. *Independent Australia*. https://independentaustralia.net/politics/politics-display/big-australia,17516
162 https://en.wikipedia.org/wiki/National_Water_Commission

The Commission's omission is unfortunate given that, in its 2016 *Migrant intake into Australia* report, it argued the federal government should consider the impacts of immigration-fed population growth on future generations and on Australia's 'absorptive capacity'. The Commission further called for regular public assessment of economic, social and environmental impacts of such growth, along with broad public engagement in the process for setting population policy. Without information from sectors such as water, about the relative costs and impacts of alternative population scenarios, population policy is ill-founded.[163]

In a similar spirit, the National Water Initiative should be amended (for example in the section on urban water) to require the Commonwealth and states to recognise low or zero population growth as a low cost option for urban water demand management and water security.[164]

> A policy to stabilise population does not impinge on Australians' freedom to have children nor on international obligations to accommodate refugees.

Whether Australia continues growing at 2023's near-record rate of 2.5% (doubling the population every 28 years) or slows to the rate of natural increase (around 0.4%) tapering to no further growth within a decade or two, or chooses some course in between, is governed by the federal government's immigration settings. A policy to stabilise population does not impinge on Australians' freedom to have children nor on international obligations to accommodate refugees (who are a tiny fraction of Australia's total immigration). Population policy should consider the whole range of ecological, economic and social factors, to arrive at settings that are appropriate for an ancient continent that is flat, weathered, hot, drying, and increasingly erratic in its rainfall and weather patterns. Water security is one very important consideration.

While much about the future is uncertain, one thing we know is that Australia's population can't grow indefinitely. At some point, it must stop growing. It can stop growing in one of two ways: by becoming such an unattractive place to live, compared with the poorest and most crowded places in the world, that few migrants choose to come, or by the government setting a lower level of immigration using the same levers available to it now. What is to be gained by deferring those actions, if doing so escalates all the challenges we face – not least the challenge of water security?

163 Productivity Commission 2016, *Migrant intake into Australia,* Inquiry Report No. 77, Canberra, Finding 3.1 and Recommendation 3.1, p. 37.
164 Intergovernmental agreement on a National Water Initiative (2004), p. 19. https://www.dcceew.gov.au/water/policy/policy/nwi

7. Towards a new paradigm for water security and sustainability

As we get increasingly locked into desalination to meet population growth, the financial costs rise, vulnerability to ever-more severe climate and geopolitical shocks increases, and quality of life decreases in our hotter, sprawling and more congested cities. Meanwhile, desalination can do little to water our drying hinterlands. At the core of the techno-optimist mindset is a conviction that technology can treat symptoms rather than causes while continuing business as usual. It is ultimately an unsustainable situation.

7.1 High gain and low gain water sources

Anthropologist Joseph Tainter argues that societies' use of resources (especially water) evolves over time, from 'high gain' (the juiciest low-hanging fruit) to 'low gain' sources (requiring more effort for less benefit): 'In high gain systems resources tend to be concentrated and abundant. ... The high gain resource subsidises human activity without much human effort. Because the resource seems abundant, there is little incentive to conserve. ... [In low gain systems] resources are often scarce or dispersed'.[165] Increasing quantities of other scarce resources (energy, materials, labour, knowledge) are needed to utilise incrementally lower grade water resources, diminishing the net benefit to society. The progression from high-gain to low-gain resources, often responding to population growth, drives increasing complexity of social organisation and supply lines. This increases a society's vulnerability to disruptive events, such as megadroughts, and the risk of cascading effects if one or more elements in the system fail.

Tainter's historical perspective highlights the ambiguity of technology. Technology has positive and negative impacts, over different time scales. Technological innovation can initially solve a problem that has arisen due to population growth, but as the population continues to grow, the environment changes (e.g. depletion of a particular resource), and the old solution is no longer adequate or causes more harm than benefit. This is called the vicious circle principle.[166] The only way out of the vicious circle is to end the growth that keeps demanding ever-greater resources from lower-gain sources.

In Australia's case, the transition from high gain to lower gain water resources is evident, as we outgrow the capacity of dams and groundwater and resort to the so-called 'diverse portfolio' of

165 Tainter, J. A., Scarborough, V. L., & Allen, T. F. (2018). Concluding essay 1: Resource gain and complexity: Water past and future. In *Water and society from ancient times to the present* (pp. 328-347). Routledge, p. 341.
166 Dilworth, C. (2010). *Too smart for our own good: the ecological predicament of humankind.* Cambridge University Press.

options, culminating in desalination. Despite seawater being abundant, desalination's more complex infrastructure and higher energy requirements make it a low-gain resource. Price becomes a rationing tool as resources are increasingly hard-won, magnifying social inequalities of resource access. Behavioural constraints, from taking shorter showers to foregoing gardens altogether, add to the social penalty.

Instead of admitting there are no technological solutions that can sustain indefinite growth, we increasingly seek to cast the net wider, embracing interdisciplinary approaches in the hope of bringing together previously separated pieces of the puzzle. We see this in the discourse around sustainable urban water design and management practices, variously known as the water sensitive city, integrated urban water management, or the 'nexus' planning approaches that seek to optimise linkages between water, food, land use, environment and energy. They seek to move away from sectoral silos towards multi-sectoral and multi-scale approaches to planning, as well as greater community participation and co-design of solutions.[167] All of these initiatives infer greater government intervention to facilitate, educate, coordinate and regulate – meaning added layers of complexity. This doesn't make them bad ideas, but when little is achieved beyond wider consultation and theorising on whole-systems thinking, it becomes a form of self-delusion to think that solutions are simply waiting to be uncovered, rather than admitting we have a wicked problem.

7.2 A new water ethos is required

A Policy Brief from the ANU Crawford School, entitled *Water reform for all: a national response to a water emergency*, provides an incisive critique of the traditional 'frontier mentality' for development of water resources in Australia, which was instrumental in dispossession of Aboriginal people:

> The fundamental assumptions of this perspective are that: (1) water scarcity can be 'solved' by building more infrastructure; and (2) water that is not extracted has little or no value.
>
> Recognising the intrinsic value of water beyond its so-called 'productive' use must be central to our collective response to Australia's water emergency.[168]

Tingey-Holyoak and co-authors suggest more focus is needed on the spiritual and cultural dimensions of water:

> Water underpins the wellbeing of the planet and the humans that live on it and has a critical role in spirituality. How well we manage the water cycle is a direct indicator of how well our societies are physically, mentally, and spiritually functioning and is a significant basis on which our human ecology will evolve.[169]

We heartily endorse these fine sentiments, but feel impelled to add that these aspirations have little hope of being realised in an Australia of perpetual population growth. Australia's water ethos needs to fully embrace the intrinsic value of our natural environments and the aesthetic

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167 Cremades, R., Sanchez-Plaza, A., Hewitt, R. J., Mitter, H., Baggio, J. A., Olazabal, M., ... & Tudose, N. C. (2021). Guiding cities under increased droughts: The limits to sustainable urban futures. *Ecological Economics,* 189, 107140. https://doi.org/10.1016/j.ecolecon.2021.107140

168 Crawford School Policy Brief (May 2020). *Water reform for all: a national response to a water emergency*. Canberra, ACT, Australia, p. 4. https://openresearch-repository.anu.edu.au/handle/1885/204069

169 Tingey-Holyoak, J., Fenemor, A. & Syme, G. (2022). Enhancing the value of water: the need to start from somewhere else, *Australasian Journal of Water Resources,* 26:1, 1-6, p. 1. https://doi.org/10.1080/13241583.2022.2088138

and spiritual contributions of natural assets beyond being merely 'resources' as industrial inputs. This has implications for how we use water and the size of population that can be supported.

The ability, up to now, of large-scale engineering to deliver water in abundance, whenever we need it, has cultivated a false sense of security, now challenged by increasing risk of drought. Urban dwellers lack appreciation of potable water, according to cultural researcher Zoë Sofoulis, because it is assumed to come from an engineering black box – it's just there.[170] The expression 'on tap' epitomises this attitude: nothing is more reliably and effortlessly accessed than water. The centralised systems of water collection and distribution have assumed 'principles of extraction and abundant supply rather than conservation and sustainability'.[171]

Sofoulis describes the change in attitude from an earlier institutional role of government to provide an essential component of public health improvement (i.e. reliable supply of clean water and effective sanitation), to a more instrumentalist and neoliberal attitude of 'user pays': water as a marketable product and people as customers rather than members of a community.

> We need a radical shift in thinking to regard water as a commons, not just a commodity.

Desalination is a new engineering black box that fits perfectly into the water-as-commodity paradigm, seeking to extend the promise of abundant supply (for those who can afford it) even as population continues to increase. Despite its high cost, desalination all too readily meets politicians' need for political convenience, public demands for abundant water, and large multinational desalination corporations' search for new business. Yet this short-term convenience is not conducive to long-run social-ecological sustainability.

The water-as-commodity paradigm does not sit easily alongside an environmental ethos that seeks a sustainable balance between human communities and their surrounding ecosystems and landscapes. The quest for 'climate independent' sources of water, dependent instead on costly and vulnerable technology, further alienates people from nature. As Morgan concludes in a comparison of desalination projects in Perth and San Diego:

> Yet claims to independence from climate and water falsely imply the possibility of neatly separating city from hinterland and humans from nature—an impossible project, particularly in the Anthropocene. Whether in urban Australia or the American West, the story of water is a story not of independence, but of interdependence, between peoples and places, ecologies and economies, technologies and hydrologies. Suggesting otherwise not only ignores the past, but also limits the ways these places might inhabit the future.[172]

We need a radical shift in thinking to achieve equitable and sustainable use of water as a scarce essential resource – regarding water as a commons, not just a commodity. Although pricing can play a role, the market alone cannot guarantee timely or effective responses to the risks inherent in continuing population growth alongside a heating, drying climate.

Governments must govern for the long-term interests of the whole community and the ecosystems within which it is embedded. Community involvement is required in making key strategic decisions about water security and the sustainability of the whole social-ecological

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170 Sofoulis, Z. (2012). Below the double bottom line: the challenge of socially sustainable urban water strategies. In Daniell, K. (ed.) (2012). *Water and climate: policy implementation challenges; Proceedings of the 2nd practical responses to climate change conference,* 1-3 May 2012, Engineers Australia, Canberra. https://www.westernsydney.edu.au/__data/assets/pdf_file/0019/364060/PRCC_Sofoulis.pdf

171 Ibid, p. 4.

172 Morgan, R. (2020). The allure of climate and water independence: Desalination projects in Perth and San Diego. *Journal of Urban History*, 46(1), 113-128, p. 10. https://doi.org/10.1177/0096144217692990 . Morgan's use of the term 'interdependence' perhaps does not fully indicate that this is ultimately a relationship of societal dependence on larger natural systems.

system. A recent review of definitions of water security arrived at the following integrative definition:

> urban water security could be defined as sustainably meeting the *agreed* water needs of a community...[173] (emphasis added)

The emphasis on 'agreed' highlights the need for real community involvement as opposed to a tick-the-box consultation process. Communities should have avenues for input into both the questions and decisions about *all* options for water supply and demand, including and especially population growth. So far, policies driving rapid population growth have been pursued by all Australia's major political parties, knowingly against the preferences of most Australians.

During the Millennium Drought and since, we have seen that Australians are receptive to altruistic behaviour, to conserve water for the common good. Sofoulis reports water managers were surprised to learn that 'communities could be more than targets of behavioural change programs, and could actually be effective partners in co-managing urban water demand'.[174]

A new water ethos should harness this public goodwill and foster an ethic of water frugality which cautions against the risks of relying on expanded but maladaptive desalination. In his recent assessment of Australia's urban water future, water historian Peter Spearritt concludes that:

> If we cannot dampen demand for potable water and make more use of recycled water, not least greywater for gardens, we face a future in which, given the capital cost and the environmental damage caused by new dams, we will end up with more and more desalination plants cluttering our urban coastlines, consuming vast amounts of power.[175]

Although offering valuable insights, Spearritt, like so many before him, is a victim of the population blind spot. Even with recycling, water tanks and efficiency gains, it would become increasingly difficult to meet the water demand of the large population increases sought by Australia's 'masters of growth' in Treasury, government and business. Spearritt laments those who 'uncritically champion developers and the industry that builds houses and apartments, warehouses, casinos, and shopping malls',[176] but he neglects to make the connection that this 'development,' and the water demand it generates, is a result of population growth.

7.3 Limit growth before it (further) limits us

Our social institutions, our communities, and especially our governments must become far better stewards of our biophysical world and acknowledge our place within it, rather than apart from it. In contrast, the push for growth and urban densification enabled by 'manufactured water' will increasingly distance urban dwellers from their drying hinterlands.

We have a choice about whether this growth continues. The future is not set in stone. What needs to be added is an open conversation about population growth as a policy option. We must recognise how that growth has driven water demand and increasingly constrains how much water we each may use and what it costs us, financially, environmentally, aesthetically and spiritually. At some point, the sooner the better, growth must end if we are to have a fair chance at becoming an ecologically sustainable society.

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173 Allan, J. V., Kenway, S. J., & Head, B. W. (2018). Urban water security-what does it mean? *Urban Water Journal*, 15(9), 899-910. https://doi.org/10.1080/1573062X.2019.1574843

174 Ibid, p. 5.

175 Spearritt, P. (2024). Potable water. In Freestone, R., Randolph, B., & Steele, W. (2024). *Australian urban policy: prospects and pathways*. ANU Press, pp. 111-124, p. 121.

176 Ibid, p. 122.

8. Conclusion

The grandfather of modern economics, John Stuart Mill, observed 175 years ago:

> If the earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, for the mere purpose of enabling it to support a larger, but not a happier or a better population, I sincerely hope, for the sake of posterity, that they will be content to be stationary, long before necessity compels them to it.

Since then, world population has increased roughly six-fold, and Mill's dystopia has largely come to pass. We have exceeded prudent natural limits as our growing population overwhelms our life-giving environments. In terms of greenhouse gases, biodiversity loss and soil degradation, we have been permitted to hurtle well beyond safe limits due to the built-in delay between the changes we have made and their impacts on our lives.[177] It is as if we are enjoying the sense of weightlessness in a plane run out of fuel and falling from the sky, while refusing to look out the window at the ground rushing toward us. Water supply is a more immediate need, and water scarcity could be the factor that finally compels us to change course.

So far, however, the proponents of 'Big Australia' – including most politicians – remain wedded to an ideology of perpetual population and economic growth that denies ecological limits, and a naïve faith that technological change can always come to the rescue to save us from ecological crises.

> Whatever technologies and management mechanisms are deployed, water security will become increasingly precarious as Australia's population increases.

It should be clear that, whatever technologies and management mechanisms are deployed, water security will become increasingly precarious as Australia's population increases. Weasel words like 'increasing challenges from population growth and climate change' should not be used to imply that such challenges are always surmountable, when they are clearly not. A perpetually growing population is simply incompatible with water security.

Trade-offs between environmental flows, urban use, industry and agriculture will increasingly threaten the viability of annual irrigated cropping – a major income-earner for Australia, but by necessity the lowest priority when water is scarce. Growth of towns within the Murray-Darling Basin will inevitably divert water from agriculture. Elsewhere, energy intensive 'solutions' such as desalination expose future communities to increased vulnerability through their dependence on costly, complex, high-input systems to deliver water. These are not solutions as much as

177 Ripple, W.J., et al. (2024) The 2024 state of the climate report: perilous times on planet Earth. *BioScience,* biae087, https://doi.org/10.1093/biosci/biae087

symptoms of failure. We have failed to heed the warning signs from the natural environment to end population growth before its costs outweigh its benefits.

Official projections anticipate adding another 13 million people to Australia's population over the next forty years, exceeding 40 million by 2063.[178] For some Big Australia advocates, that is just a staging point on the way to much larger numbers, aiming for 50, 60 or 70 million by 2075.[179] Some are even aiming for a higher target of around 150 million by some unspecified date.[180] It is surely incumbent upon these advocates, and Australian governments specifically, to explain how adequate quantities of water will be supplied for human and environmental use under these scenarios. Their failure to do so is irresponsible.

With water, as with other limited resources, we can choose to grow toward calamity or shrink toward abundance.

For twenty years Australia's accelerated population growth has caused a substantial loss in the quality of life for a majority of Australians. The concurrent environmental deterioration has been documented in six State of the Environment reports since 1996. Politicians have embellished and perpetuated the narratives about skills shortages and an ageing population requiring high immigration levels. The government asserts that rapidly rising population is compatible with 'net zero' emissions, when clearly it is not.[181]

These are ill-founded excuses for an ideology of perpetual growth to benefit a few powerful sectoral interests.[182] High immigration has been pursued despite repeated polling showing the majority of Australians do not want further population growth.

Our water management regime should frame future population growth as a policy choice, not an inevitability. The fatalistic acceptance of official population projections has meant there is a population blind spot in Australia's water planning. Moderating and indeed ending population growth must become part of the 'diverse portfolio' of options for water demand and risk management.

By ignoring our biophysical and geographical reality in their ongoing commitment to rapid population growth, Australian governments are making a Faustian bargain, sacrificing long-term economic and environmental wellbeing of all Australians for short-term interests of an elite few. Ultimately, further population growth will not be feasible. The question is, how much worse must the situation get before our political leaders concede that the Ponzi scheme of immigration-fuelled population growth has run its course? With water, as with other limited resources, we can choose to grow toward calamity or shrink toward abundance.

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178 Centre for Population (2023). 2023 *Population Statement*. Australian Government, Canberra, p. 1. https://population.gov.au/publications/statements/2023-population-statement

179 Rudd, K. (2021). The case for courage. Monash University Publishing;
Perrett, B. (2022, 9 April). Australia's national security demands a vastly larger population. *The Canberra Times*. https://www.canberratimes.com.au/story/7689476/national-security-demands-we-aim-for-a-vastly-larger-population/;
Behm, A. (2015, 10 December). A larger Australia: situation, size and strategy. Lowy Institute. https://www.lowyinstitute.org/the-interpreter/larger-australia-situation-size-strategy

180 Greber, J. (2023, 27 July). Why Australia needs millions more people – and is getting there fast. *The Australian Financial Review Magazine*.

181 Lowe, I., O'Sullivan, J. and Cook, P. (2022). *Population and climate change*. Discussion Paper. Sustainable Population Australia. www.population.org.au/discussionpapers/climate

182 O'Sullivan, J. (2020) *Silver tsunami or silver lining? Why we should not fear an ageing population*. Discussion paper, Sustainable Population Australia, Chapter 5. https://population.org.au/discussion-papers/ageing/

Appendix

Appendix A

Water Use by Sector, Australia 1977 – 2022

		1977 (a)	1996-97 (b)	2000-01 (c)	2004-05 (d)	2008-09 (e)	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15 (g)	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Total Agriculture, Forestry and Fishing	GL	14,650	15,530	15,401	12,628	7,756	7,575	7,720	9,853	13,071	12,291	10,767	9,819	10,832	11,600	8,976	7,109	9,712	9,981
Total Mining	GL	0	575	452	609	864	737	834	936	876	955	1,254	1,247	1,273	1,252	1,286	1,346	1,457	1,504
Total Manufacturing	GL	827	728	549	589	667	686	675	570	545	564	644	620	623	648	640	641	655	626
Water supply, sewage and drainage industry	GL	0	1,357	2,142	2,045	2,227	1,826	1,492	1,881	2,460	1,718	2,054	1,784	1,757	1,730	1,513	1,513	1,597	1,746
Other Industries	GL	636	523	1,102	1,059	1,235	1,181	1,291	1,192	1,066	1,143	722	717	754	802	801	774	783	801
Households	GL	1,717	1,829	2,278	2,108	1,818	1,844	1,699	1,726	1,845	1,872	1,830	1,895	1,867	1,948	1,962	1,962	1,954	1,924
TOTAL WATER USE (less Electricity, Gas, Water and Waste Services) (h)	GL	17,830	20,542	21,924	19,038	14,568	13,849	13,712	16,160	19,862	18,542	17,271	16,083	17,106	17,980	15,178	13,344	16,158	16,582
Estimated population as of 30 June (i)	millions	13.8	18.5	19.4	20.3	21.9	22.2	22.5	22.9	23.3	23.6	24.0	24.2	24.6	25.0	25.3	25.6	25.7	26.0
Per capita daily use in the household sector	Litres	341	271	322	284	228	228	207	206	217	217	209	215	208	214	212	210	208	203
Per capita daily total water use	Litres	3,540	3,040	3,098	2,568	1,825	1,711	1,668	1,931	2,336	2,149	1,973	1,822	1,906	1,974	1,642	1,426	1,724	1,747
Household self-extracted (f)	GL											135	142	140	145	145	145	145	145

NOTES TO THE TABLE

(a) Derived from Klaassen, B. (1981). Estimated annual water use in Australia. *Water. The official journal of the Australian Water and Wastewater Association*, vol. 8 no. 1, pp. 25-26. The paper is a summary of: *The first national survey of water use in Australia* / Department of National Development and Energy, Australian Water Resources Council. (1981). Canberra: Australian Government Publishing Service. The 1977 data are based on a different survey methodology and are not strictly comparable with later ABS data. Klaassen provides a figure for total 'urban/industrial' use, of which the paper says '54 per cent ... is for domestic uses, 26 per cent is for industrial uses, 14 per cent is for commercial uses and the remaining 6 per cent for other uses including losses' (pp. 25-26). For the purposes of the present table, the 54 per cent for 'domestic' is allocated to Households, and the 26 per cent for 'industrial' is allocated to Manufacturing. The 'commercial' and 'other uses' items are allocated to Other Industries. The items given by Klaassen for 'irrigation' and 'other rural' are allocated to Agriculture, Forestry and Fishing. The 'other rural' category includes a small unspecified amount for domestic use in remote areas, provided privately or from groundwater. Klaassen does not provide a figure for mining, although possibly a small proportion is included in the urban/industrial category (but much mining is in remote areas). For the purposes of a rough estimate, ABS data shows mining water use doubled between 1996-97 and 2014-15 (18 years).
If we assume a roughly similar doubling from 1977 to 1997, then mining use in 1977 could be estimated at around 300,000 ML.

(b) ABS, 4610.0 *Water Account for Australia 1993–94 to 1996–97*, release date 03/05/2000. Table 1.4, p. 10.

(c) ABS, *Water Accounts 2004-05*, release date 28/11/2006. Chapter 2, Water supply and use, Table 2.18, p. 33.

(d) ABS, *Water Accounts 2004-05*, release date 28/11/2006. Chapter 2, Water supply and use, Table 2.9, p. 15

(e) Data for years 2008-09 to 2013-14 are from ABS, 4610.0 *Water Account, Australia, 2013-14*, release date 26/11/2015.

(f) Prior to 2014-15 household self-extracted is already rolled into the household totals. Data for years 2014-15 to 2016-17 are from ABS, 4610.0 *Water Account, Australia, 2021-22*, release date 19/10/2023. In this consolidation, ABS omitted household self-extracted data (domestic tanks and garden bores) collected for 2014-15 to 2016-17. These data have been re-added to household totals in the current table, sourced from the original ABS Water Account releases for those years. ABS has not published household self-extracted data since 2016-17. An estimate of 145,000 ML has been added for each of the years subsequent to 2016-17. This is likely an underestimate, as tank use has been growing for reasons such as general water-saving awareness in the population and the fact that new houses in most areas have compulsory tanks installed.

(g) Figures in red font are estimates due to there being confidential data for water reuse for Agriculture, Forestry and Fishing; Manufacturing; and Other Industries in those years. These data were not published (np) but are included only in the aggregated water reuse figures for those years -- thus preventing a sectoral breakdown. Estimates for this missing reuse data were made by applying the average proportional (%) breakdown of reuse in the same sectors for 2017-18 to 2021-22, for which the full data was available. This % breakdown was then applied to the aggregated np reuse data in each of the missing years, to arrive at sectoral estimates.

(h) Water use for each sector is the sum of distributed, reuse and self-extracted water use. Electricity, Gas, Water and Waste Services are not included, except for the Water supply, sewerage and drainage services industry. This component consists of water consumed by the water supply industry including losses in distribution and flushing of pipes. ABS notes that water *use* is a gross measure, rather than netting out the volumes of water in return flows, wastewater supply or water supplied to other users.

(i) Sources of population estimates are as follows. For 1977: Klassen op. cit. For 1996-97 to 2014-15: ABS, *Australian historical population statistics 2019*, release date 18 April 2019. For 2015-16 to 2021-22: ABS, 4610.0 *Water Account, Australia, 2021-22*, release date 19/10/2023

Population and climate change

Ian Lowe, Jane O'Sullivan and Peter Cook

Climate change is one of the greatest self-inflicted threats that human civilisation has ever faced. An unprecedented global effort is under way to change course to avert catastrophic outcomes – but doubts remain whether enough is being done, and quickly enough. In the flurry of activity and proposals, the role of human population size and growth is virtually ignored or actively rejected. This paper fills this gap with an in-depth review of the evidence. It explores questions such as:

- How is population a key driver of climate change?
- How has population growth contributed to Australia's greenhouse gas emissions?
- What are the implications of population growth for climate change mitigation and adaptation in poorer countries, compared to the more affluent countries?
- How does the greenhouse gas impact of having fewer children compare with other climate-friendly actions such as eating less meat or avoiding air travel?
- How can population policy be used as part of the actions to avoid catastrophic climate change?
- How will climate change affect the health, safety and growth of populations?
- Why has population been so often ignored in the policy prescriptions for combatting climate change?

This paper includes unique insights by lead author Ian Lowe, who has been deeply involved in climate policy and research in Australia from its very beginning in the 1980s.

How many Australians? The need for Earth-centric ethics

Paul Collins

Australia is a big country. Surely, we should allow the world's 'tired, poor, huddled masses' to settle here? And yet, despite its physical size, Australia is limited in biophysical and geophysical terms. All our State of Environment reports have found the demands of the current population have been degrading natural systems irreversibly. We are not living sustainably with the numbers we have at current standards of living.

And yet, the world is clamouring at our doors. Millions want to come and share the riches we enjoy. Do we have a moral duty to let them come and allow them a better life? Or should we protect the ecosystems in our care, not least the habitat of our iconic koala that is currently threatened by urban expansion and deforestation?

Immigration has made up the bulk of Australian population growth for the past quarter century. This critical discussion paper on the ethics of immigration addresses the competing demands of human beings seeking a better life, with the rights of our natural systems to prevail against the demands of human activities.

In this paper, Dr Paul Collins calls for a totally new moral principle to guide and govern our ethical behaviour as a species.

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Other titles in this series of discussion papers commissioned by Sustainable Population Australia:

Population growth and infrastructure in Australia: the catch-up illusion

Leith van Onselen, Jane O'Sullivan and Peter Cook

Sydney and Melbourne now have worse traffic congestion than New York and Toronto. This congestion is but one symptom of an infrastructure shortfall caused by Australia's rapid population growth, with both births and immigration elevated since the beginning of this century. If these trends continue towards a 'Big Australia', Australian living standards will continue to decline as people are forced into smaller, more expensive and lower-quality housing, endure worsening traffic congestion, pay more to access basic infrastructure and services, and have less access to public services and green space. Our political leaders are claiming that these problems can be managed by decentralisation, better planning and more investment.

This paper finds that these proposed solutions will not work under conditions of high population growth. Instead, the increasing cost and complexity of adding new infrastructure in our already sprawling cities can only guarantee declining living standards and growing deficits.

Silver tsunami or silver lining? Why we should not fear an ageing population

Jane O'Sullivan

With people living longer than ever and the baby-boomer generation reaching retirement age, some people worry that we will run short of workers and taxpayers. Media reports and political discourse about our ageing population often adopt a tone of panic.

But is this panic justified? This discussion paper untangles the facts from the myths, so that Australians can look afresh at the population ageing issue.

This paper addresses key questions, including:

- Will an ageing population blow government budgets?
- Will ageing cause a shortage of workers?
- Is high immigration and more population growth the answer?

A thorough analysis of the evidence finds that each of these concerns is unfounded. Far from being an economic calamity, our demographic maturity offers many advantages for improving social and environmental outcomes.

Sustainable Population Australia

DISCUSSION PAPER

Big thirsty Australia:
how population growth threatens our water security and sustainability

By Jonathan Sobels, Peter Cook, Sandra Kanck and Jane O'Sullivan

Most Australians are oblivious of the momentous changes taking place in Australia's water security due to population growth and climate change. For 200 years, Australia's expanding population has driven demand for more water. As population continues to grow due to high immigration levels, concerns about water security are also mounting. Recent major droughts (1997-2009 and 2017-19) have put pressure on water supplies in both small towns and capital cities, prompting state governments to commission large-scale desalination plants.

Population growth slowed (but did not halt) during the Covid-19 pandemic, when migrants leaving Australia briefly exceeded those arriving. Then the government restarted immigration at unprecedented levels: six times the long-term average! Even if the government succeeds in reducing immigration to pre-Covid levels, Australia will grow from 27 million to 40 million people inside of 40 years, and continue growing indefinitely thereafter.

There has been surprisingly little discussion about whether there will be enough water to support this goal. Despite Australia being the driest continent with the least run-off and most variable rainfall, water planning simply assumes the population projections of the Treasury Department must be achieved. Treasury makes these projections of high immigration levels in order to boost GDP, without considering natural resources or quality of life. It is assumed technological fixes, particularly desalination, will save the day. Is this techno-hubris? Is it wishful thinking?

This Discussion Paper argues those assumptions of water abundance are dangerously flawed. It explains why expanded desalination, rather than being a solution, is a further symptom of the financial, environmental and social costs of population growth. The paper argues strongly for net migration to return to pre-2005 average levels, around 70,000 per year, to achieve a stabilised population size.

For details of other discussion papers in this series, see overleaf.