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Prologue

I love a sunburnt country,
A land of sweeping plains,
Of ragged mountain ranges,
Of droughts and flooding rains.
Dorothea Mackellar, 'My Country' (1908)[1]

Dorothea Mackellar's poem 'My Country', first published in London in 1908 by its homesick author, recalls life in rural Australia. Born into a wealthy Sydney family in 1885, Mackellar's Australian-born parents owned a number of large rural properties.[2] The poem opens by suggesting that 'the love of field and coppice' and of 'ordered woods and gardens' runs in the veins of a British audience. Mackellar regrets Australia's 'ring-barked forests' but celebrates 'the wide brown land' and declares love for the 'sunburnt country'. 'Droughts and flooding rains' are the essence of the water management challenges across Australia, including its ever-growing cities. When Mackellar wrote 'My Country', 55 per cent of Australians lived in cities and towns, many of which were vulnerable to extremes of too little water, or too much. The five mainland state capitals

[1] Mackellar, *My Country and Other Poems*, 11–12.
[2] Beverley Kingston, 'Mackellar, Isobel Marion Dorothea (1885–1968)', *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, https://adb.anu.edu.au/biography/mackellar-isobel-marion-dorothea-7383/text12835, published first in hardcopy 1986, accessed 16 April 2021; *Sydney Mail* 21 October 1908. The poem first appeared in the *Spectator* under the title 'Core of My Heart', but when published in book form the title became 'My Country'.

alone were home to one in three Australians; currently the figure is two in three.

How has water shaped the largest Australian cities? What are the historical drivers that produced today's urban water systems, and how have these systems impacted on human and ecological welfare? This book aims to reveal not only why our urban water systems developed as they did but also the many ways in which they have shaped city growth and suburban development.

There is much to learn from the stories of how both Indigenous and non-Indigenous Australians have learned to live with climate variability over a range of timescales. Mackellar's poem makes no mention of Indigenous inhabitants or landscapes, but it is important to recognise that the places that are now Australia's five largest metropolitan capitals were deeply known, managed, and loved for tens of thousands of years before the present, and that the Aboriginal peoples of those places have – remarkably, given the violent disruption of colonisation – maintained connection with and knowledge of those places. In telling of Aboriginal relationships with water in these locations, our approach as non-Indigenous historians is to collate narratives respectfully from Indigenous and non-Indigenous accounts published in the public domain, whether in the form of oral testimony or written word. Where possible, we follow the guidance of Palyku legal scholar Ambelin Kwaymullina by seeking to privilege Indigenous voices and engage with works produced by Indigenous people in ethical partnerships with non-Indigenous people.[3] We recognise that while there is a diversity of Indigenous views, 'Aboriginal stories, however expressed or embodied, hold power, spirit and agency'. Moreover, 'Knowledge can never be separated from the diverse Countries that shaped the ancient epistemologies of Aboriginal people, and the many voices of Country speak through the embodiment of story into text, object, symbol or design.'[4] We pay our respects to the First Nations people and the land on which their ancestors lived for millennia. We hope this current work reflects, in some small part, their generations of custodianship and a perspective that will endure and guide future generations.

In 2015, the World Economic Forum declared water crises to be the biggest risk facing the planet.[5] Yet, in Australia, there has been

[3] Kwaymullina, 'Research, ethics and Indigenous peoples'.
[4] Kwaymullina, Kwaymullina and Butterly, 'Living texts', 5.
[5] World Economic Forum, *Global Risks Report 2015*, http://reports.weforum.org/global-risks-2015/, accessed 23 April 2021.

surprisingly little reflection on how the past has shaped our urban water systems, or how this knowledge might inform present solutions to water management problems. There is an extensive literature on the history of Australian urbanisation, including studies of individual cities and histories of particular suburbs or local government areas.[6] The issue of how governments overcame the challenge of providing water to urban residents is implicit in much of this literature. Yet, these works provide no coherent understanding of how water availability and scarcity have shaped urban structures and environments, neighbourhoods' social experiences, or individual living standards through different periods of population growth, economic and land use changes, flood, and drought. The historiography of water in Australia has largely focused on the rural sector and irrigation schemes.[7] Many book-length studies of urban water have been commissioned by the statutory authorities that built the dams, reservoirs, pipelines, and sewage treatment plants.[8] Very little has been written on how the majority of Australians, the capital city dwellers, have shaped and been shaped by one of the nation's most defining characteristics – its relationship to fresh water.

Cities in a Sunburnt Country is the first comparative study of the provision, use, and social impact of water and water infrastructure in Australia's five largest cities – the nation's only cities to have exceeded a population of 1 million. Large-scale water supply and sewerage infrastructure has underpinned the growth of large cities, with intended and unintended consequences. Beginning with the First Australians, the book sketches Indigenous understandings and approaches to water and Country, before turning to the early colonial development of small-scale water sources and then the domestication of water with large-scale water supply and sewerage infrastructure. The book concludes in the twenty-first century, when prolonged drought and the spectre of anthropogenic climate change raised questions as to the sustainability of long-standing assumptions and strategies for urban water management.

[6] See for example Frost and O'Hanlon, 'Urban history and the future of Australian cities'; O'Hanlon, *City Life*; Davison, *City Dreamers*.

[7] See for example Cathcart, *The Water Dreamers*; O'Gorman, *Flood Country*; Anderson, *Endurance*; Jones, *Slow Catastrophes*.

[8] See for example Aird, *The Water Supply*; Dingle and Rasmussen, *Vital Connections*; Powell, *Watering the Western Third*; Lloyd, *Either Drought or Plenty*. Troy (ed.) *Troubled Waters* brings together historians, geographers, ecologists, and lawyers to examine the Millennium Drought-induced urban water crisis.

As Australia's cities continue to grow in the face of changing climates, water has been thrust to the forefront of national conversations about sustainability and urban futures. Fresh water resources within easy reach have already been harnessed, often to their maximum capacity, attaching a mounting sense of urgency to these discussions. An understanding of why complex water cultures and infrastructures exist in their current forms can enable a more historically informed and equitable approach to urban water provision and management. While new approaches and technologies will be required to face future challenges, and there is something deeply attractive about models of well-designed water-sensitive cities, plans to dramatically alter urban water systems must not only work with the present urban fabric but also rely on public support. Examining the development of urban water supply can help citizens to reflect upon what they value about present systems and inspire confidence to change without losing what counts most. Policymakers, too, can consider how past changes have occurred, in order to inform their own approaches to developing just, equitable, and sustainable strategies for managing and accommodating water in Australian cities.

At a time when water systems of large cities worldwide are under pressure from environmental change and population growth, historical knowledge of the provision, use, and cultures of water is critical. Comparatively rapid changes to water supplies, river flows, the frequency of floods and droughts, and rising sea levels mean the need for cities to respond effectively to the challenge of water supply and sanitation is stronger than ever. Every metropolis produces its own set of water management problems that must be addressed in the context of particular knowledges, cultures, technologies, and levels of economic development for the city to continue to function. Some decisions, once made, cannot easily be undone – and may have ongoing consequences for later generations. The challenge to produce effective water management strategies that foster more sustainable, resilient, productive, liveable, and equitable cities is an example of a 'wicked' problem that defies simple solution.

This book was written by seven researchers with a shared mission of seeking to contribute to the creation of more resilient and sustainable water systems through an enhanced understanding of water history. Its genesis lies in an invitation to join the Cooperative Research Centre (CRC) for Water Sensitive Cities, formed in 2012 to bring together researchers from disciplines and sub-disciplines across social and biophysical sciences and humanities. This interdisciplinary forum allowed us to share ideas and approaches, with dialogue formalised through works of

synthesis, including a summary CRC report,[9] as well as a special issue of *Journal of Urban History* ('Water and the making of Californian and Australian cities').[10] In 2015, we secured funding from the Australian Research Council to produce the first longitudinal, multi-city comparative historical study of how and why water has been provided to Australian cities, and how it has transformed them. One of the principal aims of the new project was to integrate cultural, economic, and environmental histories. We felt that this was an essential precondition to two of the other project aims: producing new knowledge that might help to improve the effectiveness, equity, and sustainability of Australian urban water policy; and producing water stories that engage the public through history and help us imagine alternatives. In addition to this book, the project also produced a virtual exhibition at the Rachel Carson Center[11] and a special issue of *Australian Historical Studies* ('Ripple effects: Urban water in Australian History').[12]

As a 'wicked' problem, the achievement of sustainable water systems requires bridging disciplinary divides to deliver knowledge that can inform appropriate resource use and policy action. This necessity is increasingly recognised in the broadening field of urban water management, which has extended beyond engineers and sanitarians to include economists and more recently the insights of the humanities and social sciences, as well as Indigenous peoples. Our team also brings together diverse expertise and perspectives. As individual scholars, we have published in environmental history, economic history, urban history, planning history, and public administration. Some of us have published in more than one of those fields. As historians from different sub-disciplines working in conversation across our various areas of expertise, we are able to ask new questions, identify the complex causes of past problems,

[9] Frost, Gaynor, Gregory, Morgan, O'Hanlon, Spearritt, and Young, *Water, History and the Australian City: Urbanism, Suburbanism and Watering a Dry Continent, 1788–2015* (Melbourne: Cooperative Research Centre for Water Sensitive Cities, 2015), https://watersensitivecities.org.au/wp-content/uploads/2016/12/A2.1_2_2016_R5-19-12-2016-V2.pdf, accessed 20 June 2021.

[10] See Frost, 'Water technology and the urban environment'; Dobbie, Morgan and Frost, 'Overcoming abundance'; Gaynor, 'Lawnscaping Perth'; Gregory, 'A spirit of Bolshevism'; O'Hanlon and Spearritt, 'From water engineers to financial engineering'.

[11] Drought, Mud, Filth, and Flood: Water Crises in Australian Cities, 1880s–2010s (Rachel Carson Center, Virtual exhibitions 2019, no. 3). www.environmentandsociety.org/exhibitions/drought-mud-filth-and-flood, accessed 1 June 2021.

[12] O'Gorman and Morgan, 'Fluid terrains'; Frost and Shanahan, 'Domesticating water; Gaynor and Martin, 'Every fountain tells a story'; Cook and Spearritt, 'Water forever'.

unearth a wide range of relevant stories, and suggest diverse lessons for the future. Accordingly, rather than an anthology of chapters from individual authors – reflecting author sub-disciplinary perspectives – each chapter has been co-written. Each is the product of constructive dialogue and co-creation between researchers who have developed and drawn on both disciplinary expertise and interdisciplinary orientation.

Australia is the driest inhabited continent, with a desert centre and few large river systems. Located on coastal fringes and separated by long distances, the five cities are marked by climatic diversity. Adelaide and Perth's Mediterranean climates are comparable to those of the Mediterranean region itself, and other regions where a similar climate prevails, such as southern California, south-central Chile, and South Africa's Western Cape. Such climates are confined to relatively narrow coastal fringes, as mountain ranges block the movement of oceanic weather fronts, creating rain shadow effects. In nearby mountains and hills where rainfall is higher, river systems and valleys in nearby mountains provide sites for urban water storages to supply cities on the coastal plains.

Perth's long-term average (since 1876) annual rainfall of 838 mm is much higher than that of Adelaide, which averages 533 mm.[13] Perth, however, has experienced a drying trend from the last quarter of the twentieth century. Average rainfall has been declining since 1971, and the figure from 1994 to 2015 was 13 per cent below the historic average. Very little rain falls in Perth in summer, the sandy soil does not retain water, and evaporation rates are high. In Adelaide, the average evaporation rate exceeds rainfall every month except in late autumn and winter. That city's water supply is critically dependant on the River Murray and the River Murray basin – a semi-arid region that has the lowest run-off of any large river system in the world.[14] The flow of water through the river system exhibits a wider range of variability than almost any other of all the world's major river systems.

Melbourne's climate is more temperate and oceanic, with changeable weather conditions resulting from the influence of hot inland winds and air masses and the cool Southern Ocean. Rainfall averages 521 mm per annum, distributed more evenly over the year than in Perth and Adelaide.

[13] Australian Government, Bureau of Meteorology, 'Climate statistics for Australian sites www.bom.gov.au/climate/averages/tables/ca_site_file_names.shtml, accessed on 7 June 2021.
[14] River Murray Commission, *Harnessing Australia's Greatest River*, 34–35.

The more northerly east coast capitals, Sydney and Brisbane, have temperate and sub-tropical climates with much higher average rainfall than the three southerly cities (1175 mm per annum in Sydney, 1149 mm in Brisbane), although both are also vulnerable to periodic, extended drought and significant variation in average rainfall across the urban area. Sydney has a temperate climate of warm, sometimes hot summers and mild winters, with temperature variations moderated by proximity to the Pacific. Brisbane's climate is sub-tropical, with hot, humid summers, in which thunderstorms are common, and dry, moderately warm winters.

The east coast capitals are subject to the effects of the El Niño-Southern Oscillation (ENSO), alternating periods of seven to ten years of dry and wetter conditions. At longer, unpredictable intervals of twenty to thirty years, they may also be impacted by Pacific Decadal Oscillation patterns of warming and cooling of the ocean surface, which act as 'throttle and brake' for shorter ENSO cycles of drought and flooding rains.[15] Perth's rainfall is also affected by variability in sea surface temperatures associated with the Indian Ocean Dipole.

Melbourne, Brisbane, Perth, the north-western suburbs of Sydney, and parts of Adelaide are built on floodplains. Melbourne's Yarra River drains a catchment of over 5000 square kilometres south of the Great Dividing Range, a complex of mountains and uplands extending from western Victoria to northern Queensland that separates coastal areas and inland grasslands. The city of Melbourne is located on flat, naturally swampy ground. Major floods occurred in Melbourne in 1839, 1863, 1891, and 1934. At around 13,500 square kilometres, the Brisbane River catchment, also in the Great Dividing Range, is larger than the Yarra catchment and subject to heavier rainfall. Brisbane's inundation in 1893 was the result of three flood events within one fortnight, the 1974 flood was caused by rainfall from decaying tropical cyclones, and the catastrophic flood of 2011 was associated with strong La Niña rain events.[16] Perth's Swan River and its tributaries are part of a very large river system, the Avon River, which has a catchment area of almost 120,000 square kilometres. Perth's most extensive flooding was in 1862, 1872, and 1926; the city experienced eleven floods with an average recurrence interval of ten years between 1910 and 1983.[17]

[15] Karskens, 'Floods and floodmindedness', 325.
[16] Van den Honert and McAneney, 'The 2011 Brisbane floods', 1151.
[17] Middelmann et al., 'Riverine flood hazard', 102–06.

For all its size, Australia has a small population relative to comparable continents such as North America. At the point of British invasion and subsequent colonisation in 1788, the Indigenous population was an estimated 800,000, spread out in settings ranging from desert to sub-tropical coastal rainforest.[18] None of the Indigenous camps and settlements had large populations in particular localities, other than the much more closely settled Torres Strait Islands. However, all of the sites of the five settler cities were home to thriving Indigenous groups. These groups sustained themselves over millennia with the water available in their regions. They achieved this through detailed, intergenerational knowledge of Country and its patterns of water movement through and under the land, as well as respect for water as a living entity: water was and is held central to everyday material and spiritual life. The importance of water, and its power over life and death, is woven into legends that capture both the moral dimensions of water and its capacity to shape landscape over millennia. The changing seasonal abundance of water guided the location of campsites and seasonal patterns of movement between them: mobility was a key element of the groups' relationships with water. Indigenous water cultures vary, yet they share a common approach to water, based on understanding and respect. By contrast, settler approaches have usually been based on control, though recent consideration of water-sensitive urban design reflects a turn towards knowledge and adaptation.

European colonisers always sought out settlement prospects with ready fresh water, not just for drinking but also market gardening, given the necessity to be self-sufficient in fresh food as reliance on the irregular supply of dried foodstuffs from Britain was untenable. All early settlements had ocean or river access, with farming lands near to watercourses. Early industries included whaling and timber, with wool becoming the dominant export from the 1830s. Most long-distance movement of goods and people was by ship, whether around the continent itself or to and from Britain. Two of the five mainland capital cities, Sydney and Brisbane, were convict settlements; Perth received convicts from 1850 to 1868; Melbourne and Adelaide were free settler colonies. The prosperity of the wool industry, and the discovery of gold in Victoria and New South Wales in the 1850s, further integrated Melbourne and Sydney into a burgeoning world economy. By the end of the nineteenth century, both

[18] Hunter and Carmody, 'Estimating the Aboriginal population'.

TABLE 1.1. *Population of the five cities (thousands), 1851–2021*

Census date	Sydney	Brisbane	Perth	Melbourne	Adelaide
1851	54	3	8	29	18
1901	496	119	61	478	141
1947	1484	402	273	1226	382
1976	3144	1058	846	2764	940
2020	5367	2561	2125	5159	1377

Sources: McCarty, 'Australian capital cities in the nineteenth century', 119; Commonwealth of Australia, *Census*.

had close to half a million inhabitants, making them the 46th and 47th most populous cities in the world.[19] This extraordinary urban growth, in a country with a population at that time of a little less than 4 million, represents a pattern that continues to the present day (see Table 1.1).

The British crown claimed all of the Australian continent, including land and water, regarding the continent as '*terra nullius*' (nobody's land). This fiction was only overturned with the Mabo judgement in 1992, which acknowledged Native Title. British governors, as royal representatives, were installed in every colony (and continue to perform constitutional and ceremonial functions). In 1900, the British parliament gave permission for the Australian colonies to federate as the 'Commonwealth of Australia', with the colonies becoming states the following year. 'Crown land' still underpins land ownership in Australia, while the Crown owns the continent's subterranean resources, whether water or mineral. State governments oversee land sales, levying stamp duty on all land transfers. The primary landowners in every Australian state remain the state governments, which retain the right to appropriate private property for 'public goods', from freeways to dams, pipelines, and reservoirs.

Land grants and land sales were overseen by colonial governors and later Departments of Lands. Properties were subdivided for residential, commercial, and industrial purposes, while river and water reserves provided respite from the relentless march of privately owned land, enabling Aboriginal people to make semi-permanent homes. The most sought-after residential sites tended to look out over waterways, whether rivers, harbours, or later beaches; the wealthy preferred elevated sites, especially in flood-prone cities. Industries, especially those which needed plentiful water or ready waste disposal, also sought river sites; consequently,

[19] Chandler, *Four Thousand Years of Urban Growth*, 492.

tanneries, boat builders, brewers, flour mills, and paint manufactures were established along waterways. Later, the need for water supply prompted construction of coal-based gas plants and later electricity power stations near waterways.

Maps of the five cities in 2021, created by environmental designer Daniel Jan Martin and drawn to the same scale, show their oceanic settings, along with rivers, bays, and harbours. The current urban footprint is indicated in white shading, while protected areas are indicated by cross-hatched shading. These areas include national parks and nature reserves, preserved by state governments in perpetuity. Sydney is the only city of the five where protected areas serve as a key barrier to future urban growth. Melbourne has an almost unlimited hinterland for future urban development. Adelaide has partially regulated its urban sprawl, limiting development in the hill catchment areas to the east while allowing an ever-increasing north–south footprint. New suburban development in Perth and Brisbane heads to the north and south along the coast as well as moving inland along major transport corridors, following freeway systems.

Sydney (Map 1.1) developed on a semi-circular site, abutting the Pacific Ocean. It has substantial bays and river systems to its north (Broken Bay and the Hawkesbury River), west (the Nepean River), and south (Botany Bay and the Georges River). All three rivers flood after heavy rain, whereas the much deeper harbour, without riverine choke points, is not subject to flooding.

The initial British invasion force, predominantly composed of naval personnel and convicts, made their first settlement at Port Jackson (now Sydney Harbour), close to what is today Sydney's Central Business District, which offered a ready supply of fresh water. The Eora nation, traditional owners comprising a number of clans with their own territories, were decimated by introduced disease and frontier violence. The survivors' lifeways were devastated as successive governors, having claimed the continent for the Crown, handed out land grants to colonists for residential development and farms.

Much of the early settlement took place to the west and north-west of the town centre, with the valleys of the Parramatta, Nepean, and Hawkesbury Rivers all sought after for farming land. In the latter decades of the nineteenth century, suburban development followed train and tram routes. Reservoirs and water towers were built at high points around the growing metropolis. The water supply was augmented by five dams built in bushland to the south of the city between 1907 and 1941, with that