The environmental history of Australian rivers: a neglected field of opportunity?

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Abstract. Historical ecology documents environmental change with scientific precepts, commonly by using statistical analyses of numerical data to test specific hypotheses. It is usually undertaken by ecologists. An alternative approach to understanding the natural world, undertaken instead by historians, geographers, sociologists, resource economists or literary critics, is environmental history. It attempts to explain in cultural terms why and how environmental change takes place. This essay outlines 10 case studies that show how rivers have affected perceptions and attitudes of the Australian community over the past 200+ years. They examine the influence at two contrasting scales, namely, the collective and the personal, by investigating the role that rivers had in the colonisation of Australia by the British in 1788, the establishment of capital cities, perceptions of and attitudes to the environment informed by explorers’ accounts of their journeys through inland Australia, the push for closer settlement by harnessing the country’s rivers for navigation and irrigation, anxiety about defence and national security, and the solastalgia occasioned by chronic environmental degradation. Historical ecology and environmental history are complementary intellectual approaches, and increased collaboration across the two disciplines should yield many benefits to historians, to ecologists, and to the conservation of Australian rivers more widely.

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Historical ecology and environmental history

Ecology is the scientific study of how organisms interact with each other and with their environment (Begon et al. 1996). If humans are considered in ecological investigations, it is almost always in terms of their negative effects on biodiversity, on the integrity of ecological processes, or, more latterly, on the provision of ecosystem services. In Australia, for example, aquatic ecologists have over many decades studied the impacts of river regulation, water extraction and vegetation clearance on the ecological structure and function of the rivers, floodplains and wetlands of the Murray–Darling Basin (e.g. Walker and Thoms 1993; Walker et al. 1993; Kingsford 2000; Kingsford et al. 2015). More recently, attention has been paid to how those impacts could be ameliorated and perhaps even reversed (e.g. Pittock and Finlayson 2011; Koehn and Lintermans 2012; Bunn 2017). Some research has addressed the likely pre-European extent and condition of aquatic systems, which is frequently taken as the baseline against which environmental change should be measured and rehabilitation or restoration success be gauged (e.g. Walker et al. 1993; Thoms et al. 1999; Reid et al. 2002; Humphries and Winemiller 2009). These types of ecological investigation are almost always characterised by the following two features: (1) they are based on the statistical analysis of numerical data; and (2) ideally, they test specific hypotheses, often generated in the light of generalised conceptual models (Peters 1991).

However, there is another way of investigating the natural world. This is commonly the realm of the historian or the geographer, sometimes the sociologist, resource economist, lexicographer or art critic, but only infrequently the ecologist. It focuses not on a quantitative understanding of the structure and function of ecosystems and of the quantitative impact that humans have had on the environment, but on its converse, namely, how the natural world has affected the perceptions, beliefs, attitudes, behaviour and culture of people. Although statistical evaluation may be undertaken (e.g. Floud 1979), this approach differs from the data-centric focus of quantitative ecology by being more concerned with the construction of narratives and with the interrogation of non-epistemic values (e.g. Worster 1986, 1988; Dovers 1994; Bonyhady 2000; Bowman 2001; Robertson et al. 2000; Robin and Smith 2008; Smout 2009; Robin 2012; Sutter 2013a). Two streams can be discerned in this alternative, but demonstrably complementary, approach to investigating the natural world.

The first stream is located in the geographic, historic or socio-economic realm and focuses either on bioregional histories, objective accounts of the histories of particular places (McGeachan 2014), or on oral histories, the reporting of structured conversations between an interviewer and residents (Fogerty 2005). Bioregional histories can tackle a wide range of questions, but commonly include questions as to why some parts of a country were explored early and became densely populated and others were not, why some were used for agriculture or pastoralism and others were set aside as ‘wastes’ or as reserves, and where and why cities were located and how their characteristics were informed by the landscapes that surrounded them
Australia provides a thrilling backdrop for the preparation of environmental histories (Bolton 1976; Robin and Smith 2008; Robin 2012). The first investigations were published in the late 1950s, with Russel Ward’s *The Australian Legend* (Ward 1958) and Griffith Taylor’s *Australia: a Study of Warm Environments and Their Effect on British Settlement* (Taylor 1959), quickly followed by the work of two historical geographers, T. M. Perry and R. L. Heathcote, in the early–mid-1960s (Perry 1963; Heathcote 1965). In turn, they were followed in the early–mid-1970s by the pivotal monographs from George Seddon on the Swan Coastal Plain of Western Australia (Seddon 1970), Keith Hancock on the Monaro district of southern New South Wales (Hancock 1972) and Michael Williams on the historical geography of South Australia (Williams 1974). Since then, many environmental histories have been prepared in Australia, most having a terrestrial or agricultural focus. Aquatic systems have not been served as well as have terrestrial systems, despite the manifest importance of rivers and other reliable sources of fresh water in a country as dry as Australia. The neglect of aquatic systems was identified as early as 1967, when George Farwell lamented in *Australian Landscapes* (p. 23) that ‘No one has ever yet written of Australia in terms of its rivers’. Perhaps the earliest environmental history of an Australian river is Louise Tiffany Daley’s *Men and a River: a History of the Richmond River District 1828–1895*, published in 1966 (Daley 1966). Ian Mudie’s *Rivers of Australia*, published the same year, also bears citing, although it is more a simple descriptive geography than an environmental history (Mudie 1966). The Murray River system has, not unexpectedly, loomed large, but, as with Mudie’s treatment, it is not always clear that the many books on it really are environmental histories, especially the earlier works. Nevertheless, some later examples, from the 1970s on, on the Murray River include Frith and Sawer (1974), Lawrence and Smith (1975) and Younger (1976). Dovers (1994) and Robin (2012) similarly found it difficult to identify workable limits for what to class as Australian environmental history, with the former observing that the selection could be ‘embarrassingly wide’ (Dovers 1994, p. 5).

Environmental histories (some including a substantial oral-history component) have been prepared for the Snowy River in south-eastern Australia (Wigmore 1968; Seddon 1994, 1999); the King River in Tasmania (Crawford 2000); the Lachlan River (Roberts and Sainty 1996, 2000), the Tuggerah Lakes (Scott 1999), the Parramatta River (Blaxell 2004), the Cooks River (Tyrrell 2018) and the Hawkesbury River (Rosen 1995; Boon 2017) in New South Wales; the Brisbane River (Cook 2018) and the Channel Country in Queensland, the latter with its Barcoo, Diamantina and Georgina Rivers (Robin et al. 2010); the rivers of the Lake Eyre Basin in central Australia (Kingsford 2017); the Swan River in Western Australia (Seddon 1970, 1972b, 2005; Graham-Taylor 2011); and, in Victoria, the Wannon River (Brown et al. 2002) and the Yarra River (Lacey 2004; Presland 2008), as well as the wetlands of Melbourne (Presland 2014). The rivers of the Murray–Darling Basin have, of course, loomed large too in recent works (e.g. Sinclair 2001; Breekwoldt et al. 2004; O’Gorman 2012). The legal, social and economic basis of water management has been examined for rivers in New South Wales (Lloyd 1988), Victoria (Powell 1989) and Queensland (Powell 1991). The Australia-wide overview of rivers and water management provided by Mary E. White also bears citing (White 2000). Robin and Smith (2008) and Robin (2012) concluded that a setting notably neglected in existing Australian environmental
Environmental history of Australian rivers

Table 1. Summary of the 10 case studies used to demonstrate how rivers have influenced the perceptions and attitudes of non-Aboriginal Australians and the types of evidence used to gauge that influence

<table>
<thead>
<tr>
<th>Case study</th>
<th>Evidence for role of rivers in influencing perceptions and attitudes</th>
</tr>
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<tbody>
<tr>
<td>(1) Rivers and the British colonisation of Australia: the role of water supply in the selection of Port Jackson in 1788</td>
<td>Matter of historical fact</td>
</tr>
<tr>
<td>(2) Rivers and the establishment of other capital cities: the role of water supply and riverside location</td>
<td>Matter of historical fact</td>
</tr>
<tr>
<td>(3) Rivers and national identity: inland Australia and the accounts of early explorers</td>
<td>Subject of repeated scholarly investigation</td>
</tr>
<tr>
<td>(4) Rivers and State-subsidised irrigation</td>
<td>Significant role in the psychological life of Australians</td>
</tr>
<tr>
<td>(5) <em>The Tyranny of Distance</em>: the role of inland rivers in transport</td>
<td>Matter of historical fact</td>
</tr>
<tr>
<td>(6) Rivers and national defence</td>
<td>Matter of historical fact</td>
</tr>
<tr>
<td>(7) Rivers and national pride: images of rivers on Australian banknotes</td>
<td>Significant role in the psychological life of Australians</td>
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<tr>
<td>(8) Rivers and personal fear: bunyips and other mythical aquatic creatures</td>
<td>Subject of retrospectives or exhibitions at galleries or libraries</td>
</tr>
<tr>
<td>(9) Rivers and personal inspiration: portrayals of Australian rivers by artists</td>
<td>Significant role in the psychological life of Australians</td>
</tr>
<tr>
<td>(10) Rivers and personal bereavement: solastalgia and despair at the loss of Australian rivers</td>
<td>Subject of repeated scholarly investigation</td>
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However, before the 10 case studies are brought into play, the following two sets of background material have to be addressed: (1) what are the fundamental characteristics of the climate and rivers of Australia that might make rivers socially important; and (2) what evidence is required to demonstrate that rivers have had a significant role in structuring the perceptions and attitudes of the Australian community, that is, their social significance?

The background setting

*A primer on the climate and rivers of Australia*

It is almost a truism that Australia is the driest habitable continent on Earth. The percentage of Australia that is arid or semi-arid has consistently been calculated to be in the range of 70–80% (Heathcote 1987). By comparison, only 0.1% of Europe is arid and 2.3% is semi-arid; in Africa, the figures are 20 and 17% respectively (Williams 1998). On a continent-wide basis, Australia’s average rainfall is only 465 mm year⁻¹; Europe’s is 640 mm, North America’s is 660 mm, Africa’s is 690 mm and South America’s is 1630 mm (Pigram 2006). Put another way, only 11% of Australia receives an average annual rainfall of >1000 mm; in Africa the percentage is 28% and in South America it is 76% (Davidson 1969). A consequence of the low average rainfall and high potential evaporation is that mainland Australia has the smallest annual river run-off of any habitable continent on the planet. The average specific discharge of Australian rivers is 1.6 mm, whereas that of European, North American and South American rivers is 9.7, 10.7 and 21.0 mm respectively (Smith 1998). Illustrative of the dryness of the country is that the total run-off from the rivers in Asia is ~30 times that of all the rivers in Australia combined (Pigram 2006).
Not only is Australia a dry country, but the rainfall it does receive is, generally speaking, highly erratic. As a general principle this had been acknowledged since the earliest years of the British colony in Sydney (Gergis 2018), and had been demonstrated quantitatively from approximately the middle of the 20th century (e.g. Taylor 1959; Leeper 1960; Weatherley 1967). However, it was substantiated most fully with the international study by McMahon et al. (1992), which showed that rainfall in Australia was less predictable than that in most other regions of the world with similar annual average rainfall values. Only in the extreme south-west of Western Australia, southern Victoria and western Tasmania is there <15% variability in average annual rainfall; almost all the rest of the continent shows >20% variability, and the most extreme is the western areas of Western Australia centred on the Tropic of Capricorn, which shows >40% (Pigrun 2006). This variability in rainfall translates into enormous variability in river flow. McMahon et al. (1992) showed that the inter-annual coefficient of variation for runoff ($C_{\text{vr}}$) in Australia was 0.70; for Europe it was only 0.29. The global average was 0.43. Moreover, the drier the catchment, the less predictable the rainfall and run-off. As large portions of the continent of Australia are extremely dry, their rainfall is also extremely unreliable.

However, there is an important qualification that has to be applied to these continent-wide generalisations. As Taylor (1928, p. 17) pointed out nearly a century ago,

three it is obvious that one cannot strictly speak of the climate of Australia, for it has many climates, ranging from a tropical climate akin to that of the Sudan to a cool temperate like that of Scotland.

Thus, any overview of the ‘climate and rivers of Australia’ has to recognise that a great diversity of climatic zones and river hydrologies occur across the country. This diversity has important implications for environmental history, as observed by Robin and Smith (2008, p. 137) when they commented that:

One of the challenges faced by ‘national’ histories is to tell a story about the whole continent, which [in the case of Australia] is large (comparable in size to the contiguous United States) and ecologically varied and complex.

Fig. 1 shows the distribution of the major aquatic systems in Australia. Four points are noteworthy. First, a very large
proportion of the inland, especially in the western central part of the continent, lacks any notable rivers or lakes at all. This is where the very large, contiguous deserts are found, including the Great Sandy Desert, the Gibson Desert, the Great Victoria Desert and the Tanami Desert. Haigh (1964, fig. 7) described the entire Western Plateau Division of central and western Australia simply as having 'no rivers'.

Second, the rivers that are present in the inland are often ephemeral or, if permanent, of small and highly variable discharge (Weatherley 1967; Williams 1988; Lake 1995).

Third, many of the inland rivers are arheic or endorheic, meaning that they either fizzle out in the desert expanses or discharge not into the ocean but into shallow, intermittently filled inland lakes (Fig. 2). Endorheic streams are so dominant in Australia that less than one-half of the area of mainland Australia drains to the sea (Dury 1968). Indeed, only 9 of the 12 drainage divisions of Australia deliver run-off to the ocean, and the other three discharge by arheic or endorheic drainage patterns into the dry interior of the continent (Lake 1995).

Fourth, because of the arid climate, the inland lakes that do exist are almost always dry and salty (Williams 1988, 1998; Pigram 2006). Weatherley (1967, p. 9) observed that 'The only extensive natural lakeland in Australia that has all the indications of endurance is the Tasmanian Central Plateau'. Although the lakes of the interior of the mainland are usually dry, they can fill unexpectedly following rain across the extensive catchments of the rivers that feed into them. The Lake Eyre catchment, for example, covers $1.2 \times 10^6$ km$^2$ and the endorheic waterways in it discharge water into Lake Eyre only episodically, mostly in years experiencing a strong La Niña (Bonython and Mason 1953; Kotwicki and Isdale 1991).

What evidence is needed to demonstrate the social significance of rivers in Australia?

There is widespread agreement that rivers, and the related matter of ensuring a reliable water supply, have exercised a paramount influence on Australian society. The following twelve statements made over the past half-century by a wide range of commentators illustrate the consensus:

1. They [water resources] are indeed the life blood of the country, and if Australia is to support a population which can effectively occupy it, it is essential that every controllable drop of water be utilized to the best advantage [Nimmo 1949, cited in Haigh 1964, p. 35].
2. Water is Australia’s greatest problem [Bevan 1953, p. 205].
3. All in all, this austere country seems to be a pretty good one. Why then, is it not swarming with animals and people? The trouble, of course, is water or, rather, the lack of it [Marshall and Drysdale 1962, p. 9].
4. Australia has always had a water problem, and the significance of this to our national growth will become more apparent with the passage of time [Raggatt 1964, p. 3].
5. Australia is not only the driest continent, but high annual and seasonal rainfall variability, and frequent droughts, have serious effects on dry land agricultural and pastoral output, and hence our overall economy [Haigh 1964, p. 21].
6. Water is Australia’s most critical limiting resource, its availability affecting every avenue of primary and secondary industry [McCutchan 1964, p. 382].
7. There is no doubt that the Australian character has been profoundly affected through living in a predominately semi-arid environment [Campbell 1964, p. 453].
(8) Water conservation is of vital importance in this driest of all continents [Tisdall 1964, p. 458].

(9) The conservation of water, and its use for irrigation, domestic and stock needs have long been considered vital problems in Australia where a dearth of water hinders economic activity over vast areas… [Rutherford 1968, p. 137].

(10) Over the past twenty years or so irrigation has become a disputatious issue, separating metropolitan and country residents while deriving good measures of political and moral support, and fiery antagonism, from every quarter [Powell 1988, p. 322, italic text in original].

(11) In any country, the history of ‘water management’ in its most comprehensive characterisation is bound to generate a large research portfolio. In Australia, the theme is extraordinarily pervasive, but it has received only intermittent attention… The neglected water key unlocks so many doors on the Australian experience [Powell 2000, pp. 48, 50].

(12) …it is perhaps easier [given these physical characteristics] to understand why the pervasive view of Australia is one of water scarcity, or at least recurrent anxiety over water adequacy [Pigram 2006, p. 21].

The questions that then arise include the following: (1) what made these different commentators repeatedly come to the conclusion that water (and, thus, rivers) play a pivotal role in Australian society; and (2) what types of evidence can be used to test the claim that the country’s rivers have significantly influenced the perceptions and attitudes of the Australian community and have, thus, exerted an important social significance?

Heathcote (1972a) argued that a national ‘contemporary vision’ could be expressed in various ways, including by literary evidence, such as letters from settlers, newspaper articles, official reports, policy statements or legislation, and by graphic evidence, such as contemporary paintings or photographs (Heathcote 1972a, pp. 77, 78). One example of the way such a ‘contemporary vision’ has been expressed nationally is provided by the Snowy Mountains Hydro-electric Scheme. The title of the book published to commemorate the scheme’s 50-year anniversary, i.e. A Vision for Australia: the Snowy Mountains Scheme 1949–1999 (Raymond 1999), implies that the dams and related infrastructure were not merely instrumental devices constructed to provide water and electricity. They also provided a collective vision and, for many Australians, the undertaking was a source of national pride, a symbol of Australian maturity and of the country finally having ‘arrived on the world stage’ (e.g. Johnston 1953). However, not all Australians shared that singular, positive ‘vision’. Dr W. R. Browne, for example, called the Snowy Mountains Hydro-electric Authority (presently Snowy Hydro Limited) a ‘monster’ and its works in the alpine and subalpine environments of south-eastern Australia ‘outrageous’ and a ‘desecration’ when he presented the 1952 David Memorial Lecture at the University of Sydney (Hancock 1972, pp. 164, 168, 169). Here, then, is the first hurdle faced by anyone attempting to discuss the way anything in Australia has informed a supposedly national ‘vision’: is there such a thing as a singular national perception or attitude?

The criteria identified by Heathcote (1972a) are undoubtedly useful guides to how a national ‘vision’ could be identified post facto, but they can be expanded. Some of the other indicators or lines of evidence that are potentially useful apply to the national scale and arguably arise from collective beliefs. Others, by contrast, are deeply personal. Some readers may find the distinction between the collective and the personal a contrivance, but it is a division that previous investigators found to have considerable merit. In their analysis of the value of oral histories to environmental rehabilitation, Roberts and Sainty (1997), for example, distinguished between two different types of information: (1) anecdotal information, which they saw as individual and mostly reflecting personal experience; and (2) collective group knowledge, which reflected traditional experience passed down through generations. Powell (2000, pp. 48, 57), similarly, drew a distinction between ‘collective’ and ‘individualistic conceits’ in his overview of Australians’ attitudes to water.

The first line of evidence that I think is potentially useful in demonstrating the social significance of rivers concerns matters of historical fact; namely, can rivers be demonstrated to have played an important role in some aspect of Australian history? This criterion provides the rationale for Case studies 1 and 2, on the role that rivers played as sources of potable water in the establishment of Australia’s major cities, and for Case study 5, on the importance of a substantial network of inland rivers (or the lack of it) for efficient transport in the 19th century (Table 1).

The second is whether Australian rivers appear repeatedly in matters of national expenditure and investment. The Snowy Mountains Hydro-electric Scheme, and dam construction more generally, fall into this category, as does the related matter of State-subsidised irrigation. Case study 4 details how State-subsidised irrigation schemes have long featured in the minds of decision-makers obsessed with how to populate the interior of Australia, defend the country against invasion, generate export income and private wealth, and turn the rivers to ‘productive’ use. The economics of such irrigation schemes and the allocation of scarce water resources to support them have long been controversial in Australia (e.g. Aird 1956; Taylor 1959; Campbell 1964; Haigh 1964; Davidson 1969, 1976; Munro 1970; see also Powell 1988, Seddon 1999, Connell 2007, Musgrave 2008 and Webster 2017 for more recent assessments) and if the abundance of contemporary literature on the topic, including a recent royal commission in South Australia (Walker 2019), is any guide, this divisiveness shows no sign of abating (e.g. Crase 2010; Crase et al. 2011; Grafton and Horne 2014; Williams 2017; Grafton and Wheeler 2018).

The third is whether a river-related topic has been the subject of scholarly investigation by researchers such as geographers, economists or historians, art critics or lexicographers. Oral and bioregional histories are captured by this criterion, as indicated by the many books published on the Murray–Darling River system since the turn of the 20th century, but so are a wide range of other subjects. The types of language used by explorers to describe their expeditions informs Case study 3, on the role played by rivers discovered during the colonial exploration of Australia in formulating perceptions and attitudes to the Australian environment. Case study 9 addresses the way artists have portrayed Australian riverine landscapes, a topic that several art critics and some environmental historians have examined previously in other studies. There is also a surprising large published literature on the bunyip, a mythical aquatic
monster of inland waterways, and this criterion supports its inclusion as Case study 8.

The fourth concerns matters of State-endorsed iconography, such as occurs on coats of arms and as flora and fauna emblems. This provides the rationale for Case study 7, which examines the changing appearance of river-related scenes on banknotes issued by the commonwealth government.

The fifth is whether river-related matters have been the subject of retrospectives or exhibitions at major art galleries or libraries. If so, this would indicate that there was sufficient interest among the wider population to warrant investment by the curatorial organisation. Case study 8 falls into this category. So does Case study 9, because the works of art surveyed are housed in State or national art galleries and many remain on permanent exhibition to the public. Indeed, some paintings of Australian rivers are powerful ‘draw cards’ that various galleries have used to their advantage.

So does Case study 8, because the works of art surveyed are housed in State or national art galleries and many remain on permanent exhibition to the public. Indeed, some paintings of Australian rivers are powerful ‘draw cards’ that various galleries have used to their advantage.

The historian Geoffrey Blainey speculated that had Cook and Banks come to south-eastern Australia slightly earlier, say at the end of a dry summer and the accompanying descriptions of the climate and country been prepared accordingly, the British may never have decided to send convicts to Botany Bay at all (Blainey 1980, p. 12). Nevertheless, the decision was made and the First Fleet came to Botany Bay in January 1788, carrying nearly 1400 officials, marines and convicts (Gillen 1989).

When Arthur Phillip arrived in Botany Bay in the summer of 1788, the ‘fine meadows’ described by Cook were nowhere to be seen and the supply of fresh water was meagre. Phillip stayed in Botany Bay only 2 days, and quickly concluded that the location was completely unsuitable as a place to establish a self-sustaining convict settlement in a remote part of the world. Phillip explained in correspondence to Lord Sydney on 15 May 1788, in the first official report of the voyage and establishment of the colony, the results of the initial reconnoitre of Botany Bay (Auchmuty 1970, pp. 22, 23), as follows:

Several runs of water were found in different parts of the bay, but there did not appear to be any situation to which there was not some very strong objection. In the northern part of it is a small creek, which runs a considerable way into the country, but it has water only for a boat, the sides of it are frequently overflowed, and the low lands near it are a perfect swamp. The western branch of the bay is continued to a great extent, but the officers sent to examine it could not find there any supply of fresh water, except in very small drains.

Dismayed by the shallow and unsafe harbour, the paucity of locations where people and stores could be unloaded safely, the lack of free-draining land and, most especially, the lack of a good supply of fresh water at Botany Bay that could accommodate the large number of people in his charge, Phillip ventured north with three of the fleet’s small boats to explore Port Jackson, the nextembayment to the north. After a 3-day inspection, he chose a cove in Port Jackson deep enough to allow the largest ships to anchor and to discharge their cargo. The surrounding land was hilly and well wooded, two attributes considered important as swampy or flat land (as were common around Botany Bay) were thought to give rise to miasmas and cause sickness. As Phillip explained clearly in the correspondence of 15 May 1788, the site selected for the establishment of the colony in Port Jackson was the one with the best water supply:

The different coves of this harbour were examined with all possible expedition, and the preference was given to one which had the finest spring of [fresh] water, and in which ships can anchor so close to the shore, that at a very small expence quays may be constructed at which the largest vessels may unload. [Watson 1914, S1. V1, p. 18]

Case study 1. Rivers and the British colonisation of Australia: the role of water supply in the selection of Port Jackson in 1788

It has long been known that the decision of the British to establish a colony on the eastern coast of Australia at the end of the 18th century was strongly influenced by what seemed, at the time, to be the prevailing climate, alas an understanding led astray by ‘incomplete and erroneous science’ (Gilbert 1981, p. 9). When James Cook and Joseph Banks visited the south-eastern coast of Australia in April–May 1770 in HMS Endeavour, the region was experiencing a wet autumn and this led them to conclude that they were travelling along a fertile, well watered coastline, with abundant water and extensive fine, grassy meadows. Moreover, Cook and Banks thought they were present during the dry season and that conditions would be even better during other times of the year. Their encouraging reports on the characteristics of the soils and vegetation and the availability of fresh water around Botany Bay, where they stayed a mere 7 days in early May 1770, were highly influential in the decision by the cabinet of Prime Minister Pitt to send convicts there some 18 years later. In A Land Half Won, the historian Geoffrey Blainey speculated that had Cook and Banks come to south-eastern Australia slightly earlier, say at the end of a dry summer and the accompanying descriptions of the climate and country been prepared accordingly, the British may never have decided to send convicts to Botany Bay at all (Blainey 1980, p. 12). Nevertheless, the decision was made and the First Fleet came to Botany Bay in January 1788, carrying nearly 1400 officials, marines and convicts (Gillen 1989).
David Collins, the colony’s deputy judge advocate and lieutenant governor, also commented on the primary need for the selected site to have a good supply of fresh water: ‘The spot chosen for this purpose was at the head of the Cove, near the run of fresh water, which stole silently through a very thick wood…’ (An Account of the English Colony in New South Wales Vol. 1, p. 5, cited in Gibson 1984, p. 43). In the correspondence to Lord Sydney of 15 May 1788 justifying the choice of Port Jackson, Phillip further elaborated on the primacy of water supply: ‘…it was absolutely necessary to be certain of a sufficient quantity of fresh water, in a situation that was healthy…’ (Watson 1914, S1. V1, p. 19). It is, thus, clearly the case that having a good source of fresh water, namely, a reliable and sizeable stream close at hand, was crucial in Phillip’s rejection of the recommended site at Botany Bay and the selection of an alternative, next to the Tank Stream flowing into Sydney Cove, in Port Jackson. The primacy of this consideration has been noted often in the past by other researchers, including Stephensen (1966, p. 11), Martin (1989, p. 48) and Pigram (2006, p. 42).

The problem of finding a reliable supply of water has dogged the city of Sydney ever since its establishment by Governor Phillip over 200 years ago (Lloyd 1988). It resurfaced only a few years after the colony was founded when, in November 1791, Phillip recorded that the Tank Stream had been dry for some months. The creek did not flow again until 1794; the colony was experiencing its first El Niño (Grove 2005; Gergis et al. 2010; Gergis 2018). In 1850, the surveyor-general of New South Wales, Thomas Mitchell, again identified the limitations of Sydney’s existing water supply (Lloyd 1988, p. 127), as follows:

I cannot but see that the weakest point in the character of this great city [i.e. Sydney] – for a great city it is likely to be – is the present insufficient supply of water. I should therefore desire a more certain source.

The problem was not easily or quickly solved, and a royal commission was established in 1867 to find a way to deliver Sydney a reliable supply of good-quality potable water, followed by another in 1902, and together these two inquiries led to the current supply from the Upper Nepean River system (Lloyd 1988). This scheme solved the problem for a while, but the challenge of Sydney’s water supply keeps resurfacing. Water restrictions were put in place in Sydney from May 1940 to the end of 1942, an event that not only led to the construction of the Warragamba Dam but prompted the novelist-historian Marjorie Barnard to describe its effect on city life in her apocalyptic short story The Dry Spell (Barnard 1940). Water restrictions again came into force in 2005 and were not relieved until 2009.

Case study 2. Rivers and the establishment of other capital cities: the role of water supply and riverside location

A similar set of requirements to those experienced in Port Jackson informed the establishment of capital cities in the various colonies elsewhere in Australia. The capital city of every Australian State is located on a coastal river: Sydney (1788) on Port Jackson, a drowned river valley where the Parramatta River discharges into the Pacific Ocean; Hobart (1825) on the Derwent River (another drowned river valley); Perth (aka the Swan River Colony, 1829) on the Swan River; Adelaide (1836) on the Torrens River; Melbourne (1850) on the Yarra River; and Brisbane (1859) on the Brisbane River. Darwin may appear a territorial exception, but it was established as the capital of the Northern Territory much later than the capital cities of the other colonies, in 1911, and then only after repeated failures to establish a permanent settlement in northern Australia at Fort Dundas on Melville Island, and at Raffles Bay and at Port Essington on the Coburg Peninsular (McKenna 2016).

Stratham (1989) argued that the original choice of location in all cases was based on a mostly rational process of decision making, informed principally by the following four strategic factors: (1) suitability as a penal establishment; (2) as a site for defence against incursions by other countries, particularly France; (3) as a site from which trade could be undertaken; and (4) as a direct consequence of private investment or speculation. The high-level, strategic considerations having been met to an acceptable degree, the next decision was the selection of a specific site in the general locality. The six practical criteria used to inform this decision, as collated by Stratham (1989), are shown in Table 2. For every Australian capital city, the availability of fresh water was the paramount criterion. Indeed, Stratham (1989, p. 12) concluded that ‘The first striking feature of the various city site decisions is the narrowness of criteria used. There were basically only six determinants, of which the most important was fresh water’.

Table 2. Criteria judged as important in the choice of specific location to establish capital cities in Australian States or Territories
+ the criterion is of high importance; –, the criterion is of low importance. Derived from Stratham (1989, table 4)

<table>
<thead>
<tr>
<th>Capital</th>
<th>Ready availability of fresh water</th>
<th>Good agricultural soils</th>
<th>High ground to provide defence</th>
<th>Availability of building materials</th>
<th>Location on river between port and upstream agricultural land</th>
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Case study 2. Rivers and the establishment of other capital cities: the role of water supply and riverside location
The lesson to be drawn from this suite of decisions is that, in the words of Pigram (2006, pp. 41, 42), ‘The pattern of settlement [of Australia] reflects the demand and search for reliable supplies of water’. The primacy of that single consideration continues to hold sway nearly two centuries later. The capital cities of Australia continue to draw their water from storages built by damming rivers (e.g. Sydney, Brisbane and Melbourne) or from rivers directly (e.g. Adelaide), with the exception that Perth and Darwin both draw appreciable amounts of groundwater and, most recently, potable supplies in many capital cities have been bolstered by the building of large desalination plants.

Case study 3. Rivers and national identity: inland Australia and the accounts of early explorers

Rivers feature prominently in the discourse of inland exploration, arguably for four inter-related reasons. First, it was the presence of potable water that largely determined whether the exploration of inland Australia in the 19th century was only moderately taxing or was unmitigated purgatory (McLaren 1996; Cannon 1999; Macinnes 2007).

Second, most of the early explorations were undertaken with an eye to identifying the course of the inland rivers and to determine whether they fed into an inland sea that many supposed lie in the middle of the continent (Scott 1929; Cathcart 2009). Although now derided, at the time that proposition was not unreasonable. In the early–mid-1800s, Surveyor-General Thomas Mitchell, for example, concluded that the continent-long arc of the Great Dividing Range must concentrate all the westward flowing rivers into a massive inland sea. By the early 1800s, Matthew Flinders had circumnavigated the continent and his charts had become widely available, and these indicated that Australia was one contiguous landmass (excepting of course Tasmania). Rivers, therefore, could not discharge cryptically into a massive north–south strait that separated the eastern and western portions of the continent. The failure to find a substantial delta or estuary anywhere on the southern coast indicated that the inland rivers could not discharge into the Southern Ocean either. Collectively, these observations generated what, at the time, was a reasonable theory, one that could be tested by inland exploration and was considerably more advanced than what could otherwise be construed merely as a semi-blind quest to simply ‘know something more of the country’. Conversely, however, the colonists had by this time experienced dozens of Australian summers. That in the south of the continent this season often consisted of hot dry winds coming from the west or north-west suggested to many contemporary observers that the inland was reasonable, one that could be tested by inland exploration. Some explorations ended successfully (e.g. Sturt’s first two expeditions to the Darling River); however, in many other cases, the initial hubris was quickly followed by nemesis (e.g. Mitchell’s first journey, and the expedition of Lieutenant George Grey to the Kimberley region of north-western Western Australia).

This section of the essay surveys the eye-witness accounts of six 19th-century explorers of inland Australia (the Victorian Exploring Expedition, led by Robert O’Hara Burke and assisted by William John Wills; Ernest Giles; Charles Sturt; Thomas Mitchell; and Edward John Eyre). It shows the pivotal role that fresh water and permanent rivers (or the lack of them) played in the explorers’ experience as related in their written accounts, and the influence that water availability has had ever since on Australian perceptions of and attitudes to the inland of the continent.

Burke and Wills

Commenting on the hydrological discoveries made by the Victorian Exploring Expedition (a.k.a. ‘Burke and Wills’) in 1860 and the various relief efforts mounted to rescue it, Lawrence (2012, p. 207) noted that:

Throughout the journals and letters written by Burke, Wills, Becker, Beckler, Howitt, Welch and Aitken, the word ‘water’ is repeated page after page, along with the search for water and the relief of finding it.

Ernest Giles

The experiences of Ernest Giles, one of the best-known and certainly one of the most widely travelled early European explorers, provide another example of the centrality of water to the exploration of inland Australia (Giles 1889). Giles made three expeditions into arid inland Australia, in 1872, 1873 and 1875, the last one involving a trip overland to Perth and back to South Australia. In the first expedition, he left Port Augusta in South Australia, travelled north to Chambers Pillar in central Australia, and then headed north-west. Finding the way blocked by the dry salt pans of Lake Amadeus, he returned to the Finke River and to Charlotte Waters before finally retreating to Adelaide. Thus, the journey was blocked by one intermittent water body, the dry and saline Lake Amadeus, but salvation was reached by following the bed of a river, the Finke, down to one of various sections of each chapter have, inter alia, titles such as ‘Reach the Finke’, ‘The Finke’, ‘Sounds of running water’, ‘Name of the river’, ‘Name a new creek’, ‘Name a new creek’ [again], ‘A flooded channel’, ‘Cross a western tributary’, ‘Progress stopped by a torrent and impassable gorge’, ‘Fall back on a tributary’, ‘River flooded’, ‘Rudall’s Creek’, ‘Scarcity of water’, ‘A barren spot’, ‘Water seen from it’, ‘Follow a creek channel’, ‘Other creeks join it’. The journal goes on in this way for page after page, almost every entry having an aquatic overtone. Most telling perhaps, Giles noted that ‘To the traveller in such a wilderness, when he once turns his back upon a water, the ever-recurring question presents itself, of when and where shall I obtain more’ (cited in Fitzpatrick 1958, p. 3).
Giles’ narrative is very nearly matched in its obsession with water by the journals of Charles Sturt (Two Expeditions into the Interior of Southern Australia, Sturt 1833; and Narrative of an Expedition into Central Australia, Sturt 1849), Thomas Mitchell (Three Expeditions into the Interior of Eastern Australia, Mitchell 1838), and Edward Eyre (Journals of Expeditions of Discovery into Central Australia, Eyre 1845). The central role played by rivers and the search for water in each expedition is discussed next.

**Charles Sturt’s first two expeditions to the Darling River**

Charles Sturt arrived in Australia aboard the Mariner in 1827, as captain of the guard in charge of a shipment of convicts. Seeing little future in that line of work, soon after arriving in Sydney, he convinced the governor, Sir Ralph Darling, to allow him to lead an expedition into the interior of New South Wales with the intention of tracing the course of the Macquarie River, which had been discovered by George Evans 14 years earlier. Following from Evan’s journeys of 1813–1815, the surveyor-general of New South Wales, John Oxley, had crossed at least a dozen rivers in his (unsuccessful) attempts to trace the path of the Macquarie, and as a result the courses and ultimate destination of the various inland waterways remained a mystery (Scott 1929; Crowley 1980; Cannon 1999).

Sturt departed in late 1828, in the middle of a 3-year drought, accompanied by the experienced explorer Hamilton Hume. They followed the course of the Macquarie River from the recently established township of Wellington in central New South Wales until they entered the Macquarie Marshes, where they (like Oxley before them) became lost among seemingly endless beds of reeds. In desperation they turned west, into the interior and, eventually, came across the Darling River (which Sturt named after the governor), in February 1829. Initially delighted at finding such a ‘noble river’, Sturt wrote that ‘Our difficulties seemed to be at an end, for here was a river that promised to reward all our exertions, and which appeared every moment to increase in importance in our imagination’ (Two Expeditions into the Interior of Southern Australia, Vol. I, p. 82–86, cited in Crowley 1980, p. 381). However, Sturt’s joy quickly turned to horror as he found the water too salty to drink: ‘...nor shall I ever forget the cry of amazement that followed their doing so [descending the steep bank of the river], or the looks of terror and disappointment with which they called out to inform me that the water was so salt as to be unfit to drink!’ (cited in Scott 1929, p. 131).

Nevertheless, episodic discoveries of potable water provided occasional delight; on Hume’s finding a small pond of fresh water to the side of the main waterway, Sturt concluded that ‘It was too late to move, but we had, at least, the prospect of a comfortable breakfast in the morning’ (cited in Scott 1929, p. 132). The party followed the Darling River some distance to the south-west until, oppressed by the heat, flies and lack of fresh water, they turned around near today’s East Toorale, near the confluence with the Warrego River, and returned to Wellington after a 4-month journey, having failed to locate good grazing land, but with the consolation of having discovered the Darling River and of identifying the main flow paths of other rivers in the north-west of New South Wales. However, the problem remained that it was not known where the Darling ended; did it discharge into a massive inland sea, end in another morass of reeds, or flow all the way to the ocean somewhere unknown on the coast to the south-west? This question was to be addressed in a follow-up expedition.

Sturt’s second expedition left Gundagai in late November 1829 (i.e. again in the summer), at first travelling overland but this time equipped with a whale boat on a bullock dray for subsequent river travel. The aim was to clarify the course and terminus of the Darling; however, in case its waters again proved undrinkable, Sturt chose to follow the course of the Murrumbidgee, under the (correct) assumption that it and the Darling shared the same overall catchment and that travel would be easier by water than overland (Scott 1929). On reaching the section of the Murrumbidgee River near today’s township of Jugiong, Sturt praised the surrounding land, writing that ‘The scenery around us was wild, romantic and beautiful; as beautiful as a rich and glowing sunset in the most delightful climate under the heavens could make it’ (Two Expeditions into the Interior of Southern Australia, Vol. II, p. 22, cited in Gibson 1984, p. 108).

The expedition proceeded, using the whale boat, into the Murray River, which Sturt named after Sir George Murray, secretary of state for the colonies (the same river as discovered by Hume and Howell in 1824, named by them the Hume River), downstream to the confluence with the Darling, then further down the Murray to today’s Morgan and, eventually, into Lake Alexandrina on the coast of South Australia. To return, the party retraced its steps from Lake Alexandrina by rowing 1600 km up the Murray River, against the current, and then up the Murrumbidgee River, which was then in flood and, thus, again counter to the strong downstream current. The expedition returned successfully to Sydney in May 1830, to public acclaim. Crowley (1980, p. 393) termed this ‘...the most important inland exploration in Australian history’, given that it suggested that all the rivers in western New South Wales discharged into one river, the Murray, which flowed into the Southern Ocean at Lake Alexandrina, not into an inland sea or into an internal morass of reeds and swamps.

This second journey of discovery bears on the central topic of this essay in three important ways. First, Sturt’s imagination was central to the success of the expedition, with Scott (1929, p. xviii) stating that ‘It was a remarkable feat of imagination on Sturt’s part to conclude that these streams reached one great channel by which they flowed to the sea’. Second, what kept the exploration team motivated during their prolonged journey was the rivers, with Sturt concluding that ‘Amid the desolation around us, the river kept alive our hopes. If it traversed deserts, it might reach fertile lands, and it was to the issue of the journey that we had to look for success’ (Vol. II, p. 58, cited in Gibson 1984, p. 105). Third, the discovery of the Murray River had significant political consequences, leading to the establishment of the colony of South Australia in 1836 (Scott 1929). Sturt became assistant commissioner of crown lands in the colony, from which he later launched an excursion north, into central Australia (described later).

**Thomas Mitchell’s three expeditions to the Darling River**

Oxley’s replacement as surveyor-general of New South Wales, Thomas Mitchell, was appalled that Charles Sturt, ‘an amateur’
in Mitchell’s view, had been permitted by the governor to undertake a second expedition to trace the path of the Darling River. This sort of work was supposed to be the job of the surveyor-general or his appointed staff. Since Evan’s and Oxley’s journeys — 15 years earlier, a large number of rivers had been discovered by various inland expeditions, including the Macquarie, Lachlan, Murrumbidgee, Bogang, Castlereagh, Namoi, Gwydir, Barwon, Abercrombie, Dumaresque, Logan, Mitta, Ovens and Goulburn Rivers; however, it was still unclear where they variously discharged (Scott 1929). Mitchell was at first a passionate supporter of the notion that the inland rivers must discharge into an inland sea, and this belief led him to mistrust Sturt’s description of the course of the Darling. Mitchell led three expeditions into inland Australia to test these ideas, and, always an ambitious and arguably vainglorious person, to claim glory and to promote his personal profile within the colony and abroad.

The first expedition (1831–32) proceeded from the Hunter River north of Sydney, to the Peel River near Tamworth, down the Namoi River in two collapsible canvas boats brought from Sydney, and into the Gwydir River, discovered earlier by Alan Cunningham in 1827. In January 1832, near today’s Mungindi, Mitchell gave up all hope of finding his expected great northern river. The journey was described as a ‘purgatorial experience’ (Gibson 1984, p. 116).

The second expedition, leaving Sydney in early 1835, aimed again to test Sturt’s description of the course of the Darling and to confirm his speculation that the river could lead to ‘fertile expanses’ in the interior (Gibson 1984, p. 117). It proceeded overland via today’s townships of Orange, Nyngan and Bourke to the Darling River, which was reached in late May (not that these townships then existed: Orange, for example, was established in 1846 and Bourke in 1869). Portable boats were then deployed, as on the first expedition, but the Darling was too low and so blocked with fallen trees that they proved useless. Approximately 500 km down the Darling, Mitchell realised that the expedition was fatigued beyond endurance and at risk of losing too many men to conflict with successive tribes of Aborigines, especially after a serious conflict with a tribe on the Darling in the vicinity of today’s Menindee. He gave up, acknowledging that Sturt’s earlier journey had in all likelihood correctly described the course of the Darling.

Even so, Mitchell harboured a niggling suspicion about the true course of the inland rivers and this doubt led to his third venture. It departed from Sydney in 1836 and proceeded via Bathurst, Orange and Forbes to the Lachlan River, which was followed downstream until the confluence with the Murrumbidgee at Balranald, and onto the confluence with the Darling at Wentworth. As with Sturt’s first exploration of 1828, Mitchell had the misfortune of travelling in the middle of a severe drought. The conditions prompted him to describe the Darling as a ‘hopeless river’ (Cannon 1999, p. 146) and the land around it as ‘melancholy waste’ (Three Expeditions into the Interior of Eastern Australia, Vol. II, p. 234, cited in Gibson 1984, p. 119), where his men went to bed at the end of each day ‘...burning with thirst and dreaming of water’ (Volume II, p. 51, cited in Gibson 1984, p. 119). After locating the confluence of the Darling and Murray Rivers, Mitchell sensed his job was done and he was in the position to finally ‘...bid adieu forever to the dreary banks of the Darling’ (Volume II, p. 126, cited in Gibson 1984, p. 119). The journey had shown that Sturt’s interpretation was, after all, correct.

The Murray, in contrast to the Darling, Mitchell found worthy of admiration, concluding that ‘The country southward of the Murray is not so deficient in this respect [aridity and low flow], for there the mountains are higher, the rocks more varied, and the soil consequently, better,... The Murray, perhaps the largest river in all Australia, arises amongst those mountains, and receives in its course various other rivers of considerable magnitude. These flow over extensive plains in directions nearly parallel to the main stream, and thus irrigate and fertilize a great extent of rich country’ (Three Expeditions into the Interior of Eastern Australia Vol. II, p. 326–329, cited in Crowley 1980, p. 515).

It was on the return journey that Mitchell travelled through the western, south-western and central-northern parts of today’s Victoria and was so delighted at the country traversed that he described the region as Australia felix, ‘...the most felicitous land for settlement he had ever seen’ (Cannon 1999, p. 149). The Murray River and its floodplain were particularly impressive, with Mitchell stating that ‘The grassy plains which extend northwards from these thinly wooded hills to the banks of the Murray, are chequered by the channels of many streams falling from them, and by the more permanent and extensive waters of deep lagoons, which are numerous on the face of these plains ... by preserving in these abundant reservoirs the surplus waters of the large river, and indeed finer country for cattle stations than this, can scarcely be imagined’ (Three Expeditions into the Interior of Eastern Australia, Vol. II, p. 326–329, cited in Crowley 1980, p. 516). As with other journeys to inland Australia described next, it was rivers that held centre place in the reports of the expedition leaders. But in the case of Australia felix, this was because the rivers were abundant and flowed reliably, with the result that the country around them was fertile and well watered; in other words, highly suited to European-style pastoralism or agriculture. It was a distinct change from the arid and semi-arid landscapes that Mitchell had travelled through during earlier expeditions.

Charles Sturt’s 1844 exploration of inland Australia

Sturt’s next expedition, described in Narrative of an Expedition into Central Australia (Sturt 1849), left Adelaide in 1844, in the second year of the drought that then gripped southern Australia, and followed the Murray River upstream until it met the Darling River. The expedition was predicated on the belief that good agricultural land must lie to the north of Adelaide, an idea that had been hatched in Sturt’s imagination by the west–north-west flight of native birds observed during earlier expeditions (Scott 1929, p. xx). Finding that the Darling took a north-easterly course, away from the direction he wished to follow, Sturt turned to the north into the savage environment of the Stony Desert in central South Australia, just east of Lake Eyre.

It was in the Stony Desert that Sturt’s team experienced ‘...unprecedented horrors of deprivation near the still centre of an infernally desolate world’ (Gibson 1984, p. 123). They were forced to spend half a year at a waterhole in which ‘The stillness of death reigned around us, no living creature was to be heard; nothing visible inhabited the dreary desert but the ant, even the
fly shunned it…” (Narrative of an Expedition, Vol. 1, p. 277, 278, cited in Gibson 1984, p. 124). At this juncture, Sturt gave up any hope of finding the long sought-after inland sea or abundant fertile plains in central Australia. He left for the return trip to Adelaide, concluding that ‘A veil hung over Central Australia that could neither be pierced or raised’ (Vol. II, p. 2, cited in Gibson 1984, p. 126, 127). At least Sturt returned from purgatory to tell the tale; many later explorers, including Ludwig Leichhardt, Alfred Gibson, and Burke and Wills, did not.

**Edward John Eyre’s expeditions into South Australia and across the Nullabor Plain**

Edward John Eyre undertook a series of expeditions in southern Australia in the 1830s and 1840s. Flush with funds after a bonanza selling sheep and cattle in the booming Melbourne market in 1837, Eyre intended to be the first person to find a way overland from Sydney to Adelaide, via the mallee region of north-western Victoria and the lower Murray River. The expedition team included 1000 sheep and 600 cattle from Limestone Plains, near today’s Canberra. Making the mistake of leaving in late December 1837, in the height of summer, the expedition came to grief first near the Grampians in western Victoria when they found that the lakes, which they expected to be filled with water, were dry. The Wimmera River, next of the expected water spots, was almost empty, but a local Aboriginal tribe pointed them to a large freshwater lake nearby (Lake Hindmarsh) with abundant waterfowl. A reconnoitre to the north proved fruitless and, again running out of water, the expedition and all its stock were forced to retrace their steps to the Loddon River and to proceed to Adelaide along the well-known Murray–Darling route.

Eyre’s second expedition, in May 1839, left from Adelaide and proceeded to the top of Spencer Gulf, with the Flinders Ranges to the east and the salt pans of Lake Torrens to the north and west. Neither route looked promising, so the party returned to Adelaide. An attempt to demonstrate access to coastal western South Australia was made again in August 1839, when Eyre caught a ship from Adelaide to Port Lincoln on the western side of Spencer Gulf, then rode on horseback along the coast to Streaky Bay, where he turned east towards the GawlerRanges. During this 1000-km ride, Eyre reported that ‘We never crossed a single creek, river, or chain of ponds, nor did we meet with permanent water anywhere, with the exception of three solitary springs on the coast’ (Cannon 1999, p. 192). Early in 1840, Eyre tried for a third time to find a way out of Adelaide to the north or the west. On this occasion, he left in a northerly direction, with forty sheep and eight men, aiming to walk to central Australia via the Flinders Ranges. But the party soon found its way blocked by immense salt lakes and creeks as saline as sea water. He gave up any hope of finding a way north from Adelaide. (This was finally achieved in 1862, by John McDougall Stuart, the first European to cross Australia south to north and to return, but only on his third attempt at the traverse, previous trips having been undertaken in 1860 and 1861.)

Eyre’s next and most notable expedition took place in early 1841, when he led a small group across the Nullabor Plain, from Port Lincoln to Albany in Western Australia. The reasons that prompted the journey are not at all clear, because he had been forewarned that the trip was in probability suicidal (Cannon 1999). With a small team of four other men, including his long-time colleague and fellow explorer John Baxter and three Aborigines, Eyre this time travelled light, with only one dray loaded with water and food, six sheep and ten horses. Conditions deteriorated as they proceeded west: on 11 March 1841, Eyre wrote that they and their animals had not had a drink of water for 4 days. Relief was found at Eucla, when they followed an Aboriginal path leading to a series of small wells. But there were still nearly 1000 km to travel, and the four men had only 0.5 L of water each left for each day. The rest of the trip was desperate. The horses had to be physically restrained from drinking sea water. On 17 May, Eyre came across the only running water the party had seen since their departure, a faint trickle running down a rock where limestone country gave way to granite country. The expedition could have ended when Eyre spied a ship near Thistle Cove, namely, the French whaler Mississippi, which allowed them to be re-provisioned. But rather than take the ship home, Eyre and his single remaining companion, the Aboriginal guide Wylie, continued overland to Albany, on King George Sound, where the journey was concluded. Eyre could report no new grazing lands or any surface streams, but was welcomed as a hero when he returned to Adelaide in July 1841.

**A summary: the influence of inland exploration, and accounts of the persistent lack of fresh water, on Australian perceptions and attitudes**

Early explorers’ accounts had a powerful influence on Australian perceptions and attitudes at the time, and that influence persists into the current day. I have used the examples of only half a dozen prominent 19th century expeditioners, but the case could be mounted just as strongly if the experiences of, say, George Grey, the Forrest brothers, William Gosse, Peter Warburton, David Carnegie or William Tietkens or, in more modern times, C. T. Madigan or Len Beadell, were used instead. The various accounts indicate that the supply of potable water for humans and for stock was a recurring problem across almost all expeditions into inland Australia. There are many reasons for this.

It was only with the first inland expedition of John Oxley in 1817 that explorers routinely included a keg of drinking water among their provisions; prior expeditions had, in almost all cases, relied on the routine finding of potable water along the way to satisfy their daily needs (McLaren 1996). This may have worked passably well for the well watered, temperate eastern coast, but was potentially fatal when journeys extended into the drier inland and especially into arid central Australia. It was not until Sturt’s inaugural expedition of 1828 that individual members each carried as a matter of course a small supply of water for day-to-day use. However, even then, all expeditions relied heavily on finding substantial supplies of potable water to bolster the limited amount they or their packhorses could carry. There is a simple reason for this, namely, the daily water requirements of a substantial expedition, especially if it was one of the military-styled ones favoured by, for example, Thomas Mitchell, with many pack horses, accompanying bullocks to pull the drays, and a flock of sheep to supply fresh meat, could exceed 5000 L day⁻¹ (McLaren 1996). Sturt’s 1844 expedition, for example, included 16 men, 4 riding horses, 8 draught horses, 32 bullocks and 200 sheep. It was not always possible to obtain the huge volume of high-quality fresh water...
needed to support such a massive party. In turn, this requirement for large amounts of fresh water at all stages of the expedition could create conflict with Aboriginal residents over access to water, as occurred during, for example, the journeys of Giles, the Forrest brothers and Stuart.

As Macinnis (2007) pointed out, the problem faced by 19th century expeditioners in inland Australia could start with the absolute absence of water (e.g. Eyre). If water were present, it could be salty (dominated by sodium chloride) or soda (dominated by sodium carbonate), both of which, if sufficiently concentrated, make the water impossible to drink (e.g. Sturt). Unrecorded in the summaries above, but still a limitation in other expeditions (e.g. those of Allan Cunningham and Oxley), was that surface water could be present but foul with putrefying matter. Last of all, rivers could be lethal; the presence of crocodiles was a concern of many expeditions to northern Australia. And, of course, there was always the risk of proceeding far into the country with ever-diminishing water supplies and having to turn around when they were exhausted, only to find that the sources that existed on the way out had dried up on the return journey, cutting off all means of retreat (McLaren 1996).

For over 150 years, writers have commented on the pivotal role played by water availability in the exploration and settlement of inland Australia. Writing in 1856, the explorer A. C. Gregory concluded that prior explorations by Oxley, Sturt, Mitchell, Eyre and others (including his own expedition to the Great Sandy Desert in 1855–1856) provided sufficient information to conclude that the ‘...remainder of the unexplored interior is a desert, or at least unfit for habitation by civilised man’ (cited in Perry 1966, p. 145). In 1859, the renowned economist and part-time meteorologist W. S. Jevons concluded that Australia could, for practical purposes, be divided into two sections: (1) an eastern section bounded to the west by the Glenelg River in western Victoria, running north along the Darling River, and ending near the Fitzroy River on the north-western coast of the continent, which contained ‘all the rivers’; and (2) a western section, comprising the rest of the continent, which ‘...may be truthfully described as riverless’ and is ‘...probably quite uninhabitable’ (cited in Perry 1966, p. 147, italic text in original). Ranken (1874, p. 124), likewise, concluded that one-half of Australia was simply not amenable to exploration; the country west of 135°E (approximately the longitude of Coober Pedy), he concluded, was impenetrable on account of the fact that ‘...no river whatever drains it to the south’.

Griffith Taylor (1919, p. 182), a staunch environmental determinist, concurred, noting that ‘The great problem in South Australian exploration was entirely due to physiographic conditions [i.e. aridity]’. Along a similar vein, Hancock (1930, p. 33) concluded that ‘The most precious possessions of Australia are her rivers, whose even flow [in the wetter south-eastern parts of the country] is protected by the forests which stand around their mountain sources and the trees which line their banks’. Fitzpatrick (1958) was, similarly, in no doubt as the central position of rivers and water supply in the European exploration of inland Australia, writing that ‘Anxiety about the water supply was the major preoccupation of the explorers’ (p. 3) and ‘The difficulty of finding water and the exertion entailed by the endless search for it made exploring in so vast a country as Australia a slow business’ (p. 4). The first page of Cumpton’s (1964) The Inland Sea and the Great River: the Story of Australian Exploration, likewise, noted that ‘An inland sea and a great internal river were continuously present as persistent and elusive mirages throughout the whole history of Australian exploration, and they provide the main themes for the story of that exploration’. Serle (1973, p. 7), similarly, noted that ‘The geographical problem [of the inland rivers] was central in the Australian imagination for nearly half our history and aroused passionate popular interest’. These overviews have led to a recurring image of central Australia as a dry, riverless expanse commonly known as ‘The dead heart’. How this terminology came about, and its enduring legacy, are described next.

Origins and continuing influence of ‘The dead heart’

By 1900, the central topics of discussion among geographers and climatologists in Australia were whether the interior of the country could indeed be described as a river-less desert, whether drought alternated regularly with wet years and, if so, whether the pattern could be predicted with sufficient accuracy to make the interior suitable for pastoralism or cropping and, if not, whether steps could be taken to ameliorate dry conditions by the flooding of inland Australia or by extensive irrigation schemes (Perry 1966). To answer the first question, Professor J. W. Gregory proposed that only Sturt’s Stony Desert, the Great Victoria Desert and the Gibson Desert really deserved the descriptor ‘desert’. It was also Gregory who coined the term ‘The dead heart’, first in a newspaper article in the Melbourne newspaper The Age in February 1902, and expounded in greater detail in his 1906 book The Dead Heart of Australia (Gregory 1906; Perry 1966). The term reflected a persistent attitude towards central Australia, expressed for example in the title of C. T. Madigan’s book, Crossing the Dead Heart, an account of the first terrestrial crossing of the Simpson Desert, in 1939 (Madigan 1974). It is a terminology predicated on the lack of permanently flowing rivers. The negative, but perhaps realist, language was reinforced with Griffith Taylor’s appellation in the early 20th century of large parts of the centre of Australia as ‘useless’, ‘almost useless’ or ‘uninhabitable[,] no present value for stock’ (Taylor 1959, frontispiece; Powell 1988, pp. 144, 145).

The influence of the concept of a waterless ‘dead heart’ has proved long-lived and, despite the term having been replaced somewhat by the more tourist-friendly description ‘The red centre’, it still finds widespread use. The popular rock band Midnight Oil, for example, released a song titled ‘The dead heart’ in 1986, and a film starring Bryan Brown, Ernie Dingo and Aaron Pedersen of 1996 had the same name. Even peer-reviewed academic studies continue to invoke the original terminology (e.g. Larsen et al. 2009). Another expression is found in the example of free independent travel through inland Australia by a growing population of ‘grey nomads’ (Cridland 2008), peripatetic retirees who often tackle the Australian outback, sometimes with the specific interest of following the routes of 19th-century or mid-20th century explorers (e.g. Bayly 2009; Phoenix 2015). In their trips, a degree of privation is often an acceptable, perhaps even eagerly anticipated, element of the experience. As McGrath (1991, p. 123) observed, the tourists ‘...imagine they are explorers. The myth is lived out in a sort of
historical re-enactment, which people find empowering; they see themselves as ‘making history’.

Case study 4. Rivers and State-subsidised irrigation

In 1966, the historian Geoffrey Blainey argued in The Tyranny of Distance that the absence of large, permanent rivers meant that there was only poor access to the interior of Australia and that this was a contributing factor to its slow development by Europeans: ‘The lack of long inland waterways in Australia is often ignored, but it explains much of Australia’s early history. The absence of long inland waterways partly explains why Australia was so slow in growing enough to feed itself…’ (Blainey 1966, p. 119). The absence of a large network of inland rivers was also posited to explain why the British were initially more interested in annexing strategic embayments or rivers along the coast (e.g. at Launceston on the Tamar River and at Hobart on the Derwent River in Tasmania, as well as the first British settlement in Western Australia, at Albany, all as precautions against incursions by the French) than in seizing the entire country. In Blainey’s analysis (vigorously rejected, but perhaps not fully refuted, in 2005 by John Hirst in Sense and Nonsense in Australian History, Hirst 2005), the problem was that Australia has no equivalent to the Mississippi–Missouri River system of the United States of America that could guide and foster inland development.

What role then did inland rivers play in the social and economic development of Australia and in the perceptions and attitudes of the Australian community? Large-scale irrigation schemes, originally non-intensive but increasingly intensive in operation, are one of the most obvious manifestations of that influence (Rutherford 1963, 1968; Davidson 1969). This case study addresses this specific subject, but because the story is so complicated and involves so many players I have broken it down into several inter-related subheadings, organised as far as possible in chronological order. The subject matter is central to the essay for a wide range of reasons, including the following: (1) harnessing rivers in support of inland irrigation has been an obsession of Australian decision-makers and persons of influence for well over 140 years; (2) this historical fixation informs contemporary irrigation schemes, all of which have a foundation similar to that which provided the rationale for earlier attempts at irrigation of the dry inland; (3) almost all of the decisions to support irrigation lacked, and continue to lack, transparency and have frequently failed independent measures of economic sustainability; and (4) the consequences for the Australian environment of regulating so many of the country’s rivers and of extracting so much water from them to support large-scale irrigation ventures continues to resonate strongly, especially in terms of chronic environmental degradation across the Murray–Darling Basin.

The fourth consideration is likely to be of particular interest to many of the readers of this 70th anniversary issue and of the journal more generally, so it’s worth providing a brief overview of the environmental consequences of over a century of river regulation and large-scale irrigation in Australia. They include the creation of chronically flow-stressed rivers (e.g. Walker and Thoms 1993; Pittock and Finlayson 2011), of rising water tables and land degradation induced by secondary salinisation (e.g. Smith 1998; Bailey et al. 2006), and the landscape-scale loss of floodplain wetlands and of riparian vegetation (e.g. Walker et al. 1993; Kingsford 2000; Kingsford and Thomas 2004; Kingsford et al. 2015). As the resource economist Alistair Watson (2001, p. 93) concluded, these environmental problems were all ‘…the result of past ill-conceived enthusiasm for irrigation’. Lemly et al. (2000) made a similar point, noting that, globally, intensive irrigation is incompatible with wildlife conservation. Most Australian studies into the adverse effects of irrigation and excessive water extraction have taken place in the Murray–Darling Basin, but similar situations hold for other Australian rivers, among which the best described is the Snowy River (e.g. Erskine et al. 1999; Seddon 1999). Moreover, it is irrigation that is, by far, the greatest user of fresh water in Australia, consuming at least three-quarters of all water used in the country (Smith 1998; Argent 2016).

The first section of this case study addresses the historical precursors that led to the collective sentiment that rivers had to be ‘developed’ and their waters turned to ‘productive use’ in order to bolster national development. Subsequent parts examine how those sentiments were acted upon, commencing with an analysis of some of the grand schemes for large-scale irrigation proposed in the mid–late 19th and early–mid 20th centuries and then addressing the development and economics of irrigation schemes along the Murray River, in South Australia and New South Wales, at the end of the 19th century. The case study concludes with an analysis of the contemporary situation in 21st century Australia, with special attention given to the 2012 Murray–Darling Basin Plan.

Popularist calls for river regulation and national development

One of the first popularist books about the Murray River was Edwin Brady’s (1911) River Rovers, a travelogue describing how Brady and a colleague boated down the Murray. In it, Brady argued for the urgent harnessing of Australian rivers for nation-building and national security (Brady’s 1911, p. 46), as follows:

The Murray squatter is, on the whole, an uncivil creature, with, necessarily, noble exceptions. These sheep sheiks of the West have for so long undisputed monopoly over holdings as large as European principalities that they fail to read the writing on the wall, which proclaims the beginning of a new order of things. The vast estates of the Riverina will have to be cut up for closer settlement, and the land monopolist must go. This splendid territory, embracing millions of acres of irrigable land, on which a dense population might live and thrive, cannot remain forever in the possession of a few dozen wool kings and foreign investors. It must, sooner or later, be occupied by Australians – or Japanese. Sheep cannot hold it.

Similar in tone was C. Brunsdon Fletcher’s (1926) The Murray Valley: a Three Thousand Mile Run, which focussed on the country surrounding the mid- and lower reaches of the Murray River, explored during a lengthy road trip over the Christmas holidays. Fletcher pointed out the ‘redemption’ that could be achieved if only the river were turned to irrigation and the ‘right type of people’ were encouraged to migrate to its banks and populate a ‘…land that seemed almost uninhabited’ (Fletcher 1926, p. 17). But he also drew attention to the difficulty...
of expanding a struggling irrigation industry and deplored the condition of the soldier settlers, families placed on small and mostly economically unviable plots of land in country Australia following the end of World War 1. Fletcher exhorted as one solution that each week every family in Victoria should eat an extra pound of dried fruit produced in the irrigation settlements. The clearing of trees along the river and deep into the hinterland was commented on, but from the perception that there was now insufficient firewood to fuel steam pumps and to heat houses. No fundamental concern was expressed that the river and its floodplain might be in the process of being ruined by irrigation and the excessive abstraction of water from the rivers. Fletcher concluded that the rivers of south-eastern Australia needed to be brought under control and be put into productive use, stating that ‘Yet the Murrumbidgee calls aloud for the harness that is slowly being put on the back of the Murray…’; ‘…a Murray valley in harness would double the amount [of production] in a very short time, if the ten million people to which it is entitled were settled therein and the river was doing its duty by navigation as well as by irrigation’. Only then could a large-enough population be brought into the area to preclude invasion and ‘…make a real and enduring line of defence for Australia’ (Fletcher 1926, pp. 44, 108, 124).

Again, similar is Ernestine Hill’s (1937) Water into Gold. Its chapters go under buccaneering titles such as ‘Yeoman of the river’, ‘Apostles of irrigation’, ‘Utopia on the Murray’ and ‘Reining in the river’. Hill followed up this book in 1940 with the more nuanced The Great Australian Loneliness, a journal of her travels around Australia but which, nevertheless, on the last page concluded that:

I have used the word desert often enough in these pages, but mainly in the dictionary sense of desertion. There is water everywhere, could it but be conserved. The desert soils are rich. Already miracles of irrigation are redeeming the waste [Hill 1940, p. 340].

The language in these early monographs is, first, a descendant of the perceptions and attitudes introduced in the accounts of the 19th century explorers discussed in Case study 3 and, second, a response to collective national anxieties about moral improvement, national development and closer settlement, subjects interrogated in greater detail later in this case study.

In some of the books in the middle parts of the 20th century, there was the faintest twinge of discomfort in the way the country’s inland rivers were being modified. In his 1946 book From Kosciusko to the Sea: a Journey along the Murray River, P. J. Hurley lamented the extensive clearing of river red gum forests around the saw-milling town of Echuca on the New South Wales–Victoria border. He argued that ‘…unless steps for their preservation are taken … we may have a Murray without its trees; a picture no more enticing than a man without his clothes’ (Hurley 1946, p. 52). Nonetheless, a utilitarian view of the natural world permeated the monograph, as it did in Fletcher (1926). Especially telling in Hurley’s book is the inclusion of a photograph of a mass of dead river red gums in a ponded wetland, with the caption that they were ‘Trees which have been ‘drowned in their country’s service’” (Hurley 1946, p. 47).

Such ‘rhetoric of river regulation and development’ (Bonyhady and Griffiths 2002, p. 174) appeared often in popular nationalistic writings of the mid-20th century, including L. Pirani’s (1945) Old Man River of Australia: a Saga of the River Murray; J. M. Holmes’ (1948) The Murray Valley: a Geographical Reconnaissance of the Murray Valley and New Design for its Regional Organisation; and Archer Russell’s (1953) Murray Walkabout: on the Murray River and its Valley, which all tell similar stories of the benefits of irrigation and the need to develop and control, to harness, the inland rivers to foster closer settlement and as an aid to national security. Professor Keith Hancock, then at the University of Adelaide, epitomised the prevailing attitude: ‘There is plenty of water [in Victoria], but much of it runs gaily away in fast streams or else sullenly stagnates in swamps…’ (Hancock 1930, p. 130). The rhetoric was matched at the political level too: at the 1920 Premiers’ Conference, Prime Minister Billy Hughes concluded that ‘I say deliberately that the possibilities of the Murray are not less than those of the Nile. I see no reason whatever, in the valley of the Murray, there should not ultimately be as great a population as there is in the valley of the Nile’ (Powell 1993, p. 55).

Grand schemes for inland irrigation in the 19th and 20th centuries

In some cases, the vague notions put forward to advance national development and to facilitate closer settlement generated concrete proposals. An early one is the prospectus of the Grand Victorian North-Western Canal Co. of 1871, which outlined plans for 130 ‘irrigation stations’ connected by a massive canal system, the longest being 300 km in length, filled with water from the Murray River and by groundwater pumped up by steam engines, running from Echuca, through the Wimmera and Mallee bioregions, to Lake Tyrrell, via Lakes Albacutya and Hindmarsh (Powell 1997). Fig. 3 shows the type of semi-arid land that was to be emancipated in this way, by irrigation and by the navigational opportunities created by a grand network of canals. The array of inland waterways and irrigated farms was also expected to ameliorate the inhospitable climate of north-western Victoria, an idea that similarly informed multiple proposals for central and northern Australia, including ones to flood Lake Eyre with seawater from Spencer Gulf in 1883 and the Bradford Scheme of 1938.

At least three schemes have been put forward to flood Lake Eyre with water, one using seawater brought up from Spencer Gulf under the Port Augusta–Lake Eyre Canal Scheme, another involving the diversion of coastal rivers in Queensland into Lake Eyre under the Great Boomerang Scheme, and the third by the extraction of groundwater from the Great Artesian Basin (Ghassemi and White 2007). The belief providing the foundation for the Port Augusta–Lake Eyre Canal Scheme was that a massive body of water, even sea water, if created in central Australia, would alter the climate on a near-continental scale, leading to better rainfall and the blossoming of the desert wastes across thousands of square kilometres. In turn, these rejuvenated lands could be used for grazing sheep or even for growing crops. The Port Augusta–Lake Eyre Canal Scheme was inspired by a contemporary French proposal to flood the Sahara Desert with water from the Mediterranean Sea and was debated in the Legislative Council of South Australia in 1883. After evidence was presented that the proposed diversion channels were, from an engineering perspective, preposterous and the infrastructure
cost was likely to be economically crippling to the colony, the proposal was rejected. Professor Gregory, earlier noted as the author of the term ‘The dead heart’, so derided the plan that he concluded the sheep the scheme was supposed to support would have to ‘grow golden fleeces’ for the undertaking to pay for itself (Madigan 1974, p. 162). The idea was briefly revisited in 1905 by the now Sir Richard Baker, the same man who had moved the original motion in 1883 (Ghassemi and White 2007). For a second time, it was rejected. Overarching the hydrological and climatic objections to both schemes was the simple fact that were large bodies of sea water to have the effect of generating rain and moderating the climate on a regional scale, the land around the Dead Sea and the Red Sea, indeed the land surrounding Spencer Gulf in South Australia, would be Edenic green pastures rather than some of the most arid landscapes on Earth (Ghassemi and White 2007).

Bizarrely, the idea that Lake Eyre should be flooded with sea water is periodically resurrected. The first time was its re-emergence in 1905, as noted above. Fifty-odd years later, an article in the Sydney Morning Herald of 21 May 1954 challenged decision-makers to commence the flooding of Lake Eyre, invoking the even-then discredited rationale that ‘We need to fill the lake to increase or stabilise the rainfall. The inland is dry paradoxically because it is dry’ (see https://trove.nla.gov.au/newspaper/article/18433482, accessed 7 September 2018). Another half a century later, an article in the Farm Weekly newspaper in 2009 was titled ‘Will a full Lake Eyre bring rain to southern Aus [sic]?’. It initiated a flurry of correspondence arguing for Lake Eyre to be inundated along the lines proposed in 1883 (Heard 2009). Even more preposterous resurrections of the scheme are, of course, available on the internet (e.g. Hannigan 2017). These are mentioned here not because they have any merit but because they reflect an ongoing element of the Australian imagination that would like to see such an inland sea created de novo, so as to redeem the dry-inland wastes.

Pro-development arguments along these lines were not constrained to south-eastern Australia. Abbott (1948) made similar claims about the need to more densely settle with white people the coastal rivers in northern Australia. So did Sir Harold Raggatt (1966) in the inaugural issue of the journal of the Economic Society of Australia, Economic Papers. Perhaps the most courageous proposal was the scheme promoted by Dr J. J. C. Bradfield (engineer of the Sydney Harbour Bridge) to dam the rivers of coastal northern Queensland and to turn their flows into the interior, so that they would form a massive inland sea and support a gigantic irrigation system in central Australia (Powell 1988, 1991; Griffiths and Sherratt 2006). The Bradfield Scheme was proposed to the Queensland government in 1938 and was popularised in the then-influential magazine Walkabout. The pitch went through several iterations (Griffiths and Sherratt 2006; Ghassemi and White 2007), but the principle idea was, first, to dam the headwaters of the Tully, Herbert and Burdekin Rivers in coastal Queensland, and to divert their flows via tunnels or aqueducts across the Great Divide into the Flinders and Thompson Rivers of inland Queensland, and from there into Coopers Creek. That there were few, and in most cases no, flow records available for the affected rivers seemed not to be too serious an impediment (Ghassemi and White 2007). In later phases, for example, in the ‘expanded Bradfield Scheme’ of 1941, the Diamantina and Georgina Rivers would also be dammed, so as to create a 60 × 160-km

![Fig. 3. Lake Albacutya, north-western Victoria, an ephemeral water body central to the plans of the Grand Victorian North-Western Canal Co. in 1871. Photograph taken by the author, May 2018.](image-url)
lake at Innamincka, as well as the damming of streams that flow into the gorges in the MacDonnell–Musgrave Ranges in central Australia, to intercept and store flood waters of the Finke River. There was even the option in the expanded scheme of supplying Adelaide with drinking water, by a pump and weir on Cooper Creek, over a distance of ~800 km to the south-west, to the South Australian border.

The various constructions were believed to serve the following four purposes: (1) flood waters flowing ‘wastefully’ to the ocean in northern Queensland would be diverted inland and put to productive use; (2) the water thus saved and stored would support a massive inland irrigation industry, permitting closer settlement; (3) the creation of so many expanses of surface water would ameliorate the climate of inland Australia, improving the rainfall and lowering the temperature on a regional scale; and (4) at least 370 MW, and possibly up to 740 MW, of hydroelectric paper would be generated, which could be used to electrify the railways of Queensland (Ghassemi and White 2007). Not all were convinced, even among pro-irrigation water-supply engineers, with Haigh (1964, p. 21), for example, dismissing these ‘spectacular schemes for inland diversions by then, more accurate estimates of water availability and of the land that could be put to irrigation were available (Ghassemi and White 2007). Stage 1 of this rejuvenated scheme was estimated to cost A$1440 million (in 2002 prices) and would provide sufficient water to irrigate 11 300 ha, yielding a cost of ~A$130 000 ha\(^{-1}\) of irrigated land. Despite the rapid abandonment of the original proposal, elements of the Bradfield Scheme are, like the proposal to flood Lake Eyre, resurrected at distressingly frequent intervals. In 1946, for example, the Reid Scheme was proposed for Cape York in far-northern Queensland (Ghassemi and White 2007). It involved the turning around of the headwaters of the Mitchell and Gilbert Rivers that otherwise discharge into the Gulf of Carpentaria and diverting their flow to the Diamantina River. Despite no costings having been made, the scheme was defended by its proponents on the grounds that it would ‘…cost less than one year of war [World War 2 having just ended] and would constitute a great asset for the nation’ (Ghassemi and White 2007, p. 137).

More recently, in 2007, the then premier of Queensland, Peter Beattie, announced a scoping study into piping water from the Burdekin Dam to Brisbane to deal with water limitations in the capital city, an idea that was soon dismissed when it was pointed out that the pumping costs alone would make the water more expensive than if it were to be generated by a desalination plant (Wahlquist 2008). Also, in 2007, it was announced that an enlarged Bradfield Scheme would be considered by the Queensland government, in which not only the Tully, Herbert and Burdekin rivers would be turned inland but also the Mann River, a tributary of the Clarence River, in northern New South Wales (Wahlquist 2008). The central notion of the scheme was revived once more in 2012, when the iconoclastic north-Queensland politician Bob Katter argued with no sense of obvious irony that turning around the northern coastal rivers for use in an inland irrigation scheme would be an admirable development since ‘…as well as ameliorating some of the cruelty of northern Australia, would also be of incalculable value in preserving Australia’s ecology’ (Katter 2012, p. 95).

Not only the surface waters in rivers were to be tapped in the service of national development and closer settlement in inland Australia, but groundwater was also of interest (Haigh 1964; McCutchan 1964). The at-the-time recently discovered and, presumably, unlimited sources of groundwater trapped in underground aquifers of the Great Artesian Basin were to be developed as a source of water for irrigation and for stock. In Queensland, for example, the first bore to successfully intercept artesian water was drilled near Cunnamulla, in 1886, financed by The Squatting Investment Co. In New South Wales, an experimental farm using groundwater was established at Pera Bore, west of Bourke, in an area that was recognised to be marginal, even then, for sheep farming and so remote that stock would have to be moved more than 1000 km to Adelaide and over 800 km to Sydney for market (Smith 1998). The Pera Bore experimental farm was established in 1895. It was abandoned in 1920. Failure was blamed on the area having attracted ‘the wrong kind of settler’ rather than it having been inherently unsuitable to agriculture and the water that issued from the bore being ‘a fountain of corroding soda’ (Muir 2014, p. 41). The failure of the Pera Bore experiment prompted the New South Wales government, and the State Department of Agriculture in particular, to look to inland rivers as a better source of irrigation water. The great dam-building era of the 20th century, described well by Broughton (2006), was about to begin.

The lesson from these introduction parts of Case study 4 is that the desire to see Australia’s rivers harnessed and put to ‘productive use’ is a recurring element of Australians’ attitude to their rivers and has been active, perhaps even a dominant mind set, for well over 140 years. Independent, rational investigation into specific proposals usually sees each scheme quickly dismissed on a suite of engineering, economic and social (rarely environmental) grounds, but they are brought back to life at alarmingly frequent intervals, seemingly in ignorance of the manifold array of evidence that led to their rejection in the first place. Powell (1997, p. 118) noted that such schemes would be judged incomprehensible today in the light of contemporary attitudes. Two decades later, that judgement is perhaps even more relevant. Who today, for example, could countenance the flooding of the magnificent gorges of the West MacDonnell Ranges (Fig. 4), as proposed in the various iterations of the Bradfield Scheme? The next part of Case study 4 examines how such schemes came to be seen as rational and worthy undertakings. It provides the basis for understanding why their descendents are routinely promoted in the second decade of the 21st century.

The non-epistemic basis of the desire to develop inland Australia and harness its rivers

A variety of justifications for large-scale irrigation have been erected over the past half-century (e.g. Haigh 1964; Hudson 1964; Tisdall 1964; Hoare 1999). One of the most insightful modern assessments is the analysis by Muir (2014), who discerned the involvement of the following five principle...
factors: (1) the desire for moral improvement of the community; (2) national anxiety about invasion and the loss of British foundations to the Australian population; (3) the deep desire for closer settlement as a redress to concerns about national security; (4) the psychological necessity to control the fickle Australian climate and its rivers; and (5) the prior experience of drought and the failure of pastoralism in the late 19th century that led to notions of a more ‘efficient’ use of the country’s natural resources.

The first factor, moral improvement, rested on the belief that ‘Only agriculture could provide the stable foundation for a civilised society in a country rich with land. Moral goodness was to be found in hard work, in cultivating the soil, in shaping and improving nature’ (Muir 2014, p. 49). In fact, one civil engineer in the mid-20th century commented that ‘water has no intrinsic value – that it derives value only by virtue of use’ (Linsley 1964, p. 429). The moral connotations of the word ‘virtue’ are noteworthy and coincide with the ‘redemption’ of the inland wastes and a river needing to be seen to be ‘doing its duty’, both terminologies having been noted earlier in this essay in similar contexts.

The second factor, i.e. fear, grew from the double-barrelled worry that a land mass as large as Australia’s was, in the late 19th and early 20th centuries, supporting so few people that the miniscule white population could not defend itself against an attack from Asia (Walker 1999) and, even if it were not to come to that, that British Australians would experience ‘…not physical conquest by another race, but rather the internal decomposition and degradation of their own civilisation’ (Hancock 1930, p. 80). The national anxiety about invasion is reflected in several novels published in the early middle of the 20th century that deal with invasions of Australia from ambitious and more populous countries to the north. Examples include George Mitchell’s (1937) The Awakening and Earl Cox’s (1939) Fool’s Harvest. So great was the concern that the country was underpopulated that a maternity allowance was introduced in 1912 to boost the white population; so desperate was the perceived need for a larger white population in Australia in the early 20th century that even Italians were encouraged to migrate. In the words of one American reporter at the time, the country had ‘…abandoned hope of an entirely Anglo-Saxon Australia in order to make sure of a Caucasian Australia’ (Muir 2014, p. 118). The distinction is important, as at the time ‘They [British Australians] even doubted whether some European nations, such as the Italians, were ‘civilised in the ordinary Australian sense’’, and that migrants from southern Europe were widely regarded as a ‘semi-coloured race’ (Hancock 1930, pp. 78, 151).

The third factor, closely related to the second, is the desire for closer settlement. This yearning has been a recurring element underwriting all attempts at intensive group irrigation in southeastern Australia (Rutherford 1968). Dams, river regulation and irrigation would stabilise, modernise and enlarge the existing meagre, scattered and impoverished rural settlements (Muir 2014). Closer settlement would lead to improvements in ‘local facilities, amenities and secondary activities’ (Haigh 1964, p. 23). These advances would be concurrent with improved direct and indirect employment opportunities in sparsely populated rural areas, because it was perceived that ‘Australia’s requirement is for more people, for whom we require more jobs. Irrigation development is one of the few types of development works which not only provide work during the construction phase, but also create much greater employment on completion of the works’ (Haigh 1964, p. 25). State-subsidised irrigation
was, therefore, a powerful means to achieve closer settlement, especially if the irrigation schemes involved ‘intensive’ projects concentrated in defined ‘group irrigation areas’ (Rutherford 1963). These would support close-knit mosaics of small family farms, often specialising in horticulture, created by the State resumption of dryland farms and their subdivision into smaller plots better geared to the utilisation of reticulated irrigation water, with each farm being provided with a copious water right (again, State-provided).

These three factors, although having their origins in the late 19th and early 20th centuries, exerted an influence well into the 1950s and 1960s. Post-war leaders were well aware of the perception that Australia had very nearly been invaded by Japan during World War 2 (although the factual basis for whether an invasion was ever planned is dubious; see Stanley 2008). They understood that a country with a population of a mere 7 million people could not mount a credible defence during future conflicts with a densely populated Asia. They were also painfully aware also of the legacy of the Great Depression and of the sacrifices made by Australian men and women during World War 1. A concerted effort to increase the (white) population and to strengthen the country’s industrial and agricultural capacity followed. As noted in the quote in the Introduction from Haigh (1964, p. 35), a national concern in the post-war years was that it was necessary to develop the country’s water resources, so as to ‘support a population which can effectively occupy it’. A half century earlier, Brady (1911, p. 46) had made the same point, as follows: ‘It [the Murray River basin] must, sooner or later, be occupied by Australians – or Japanese. Sheep cannot hold it’.

The fourth factor is the psychological necessity to control the fickle Australian climate and its rivers (Muir 2014). The development of rivers would, henceforth, be ‘rational’ (Broughton 2006). Scientifically informed and technically based water management, it was believed, would even-out droughts and floods. The country would be drought proofed and the notoriously fickle Australian climate would be made impotent in the face of rational development. Water wasted by ‘running uncontrolled into the sea’ would be harnessed (McCutchan 1964, p. 361). The conviction that science and technology could be used to harness the country’s rivers reached such a peak in the early 1960s that it was seriously proposed that nuclear explosions could be used to create huge reservoirs to harness water in it to earn the most meagre of livings. Thus it was that inquiries tabled in the Victorian Parliament in 1880, 1881, 1882, 1884, 1885 and 1886 into crop failures and the abandonment of dryland farms in the face of repeated drought triggered the first major plans to develop irrigation in northern Victoria. Similarly, drought, the collapse of pastoralism and the resultant economic depression of the 1880s stimulated a serious interest in irrigation in South Australia (Williams 1974).

The rise and fall of pastoralism; and the beginnings of large-scale irrigation in the late 19th century

The glorifying of river regulation and large-scale irrigation in the late 19th and early 20th centuries were preceded by the promotion of a different form of land use in inland Australia. Pastoralism, rather than dryland agriculture or irrigation, was held at first by many decision-makers to be the mechanism by which the inland could be put to use and populated, and at least some of the national anxieties surrounding closer settlement and economic security could be salved. Pastoralist squatters started to occupy land in the Monaro district of southern New South Wales by 1823, along the Hunter River north of Sydney by 1824, along the Murrumbidgee River in 1829, and on either side of the New South Wales Murray and lower Darling Rivers in 1844–1846. By 1830, it was judged that there were 12,000–15,000 sheep along the Murrumbidgee River (Roberts 1968). Squatters originally avoided country up the Darling River as not ‘worth occupying’, but, by 1850, they seemed to have changed their minds and squatters were by then found as far up the river as today’s township of Menindee (Roberts 1968, p. 172). Although squatters occupied the land with no legal basis whatsoever, rivers often formed the practical boundaries of their claims, as well as providing the necessary watering points. Pastoralists started to enter the Western District of New South Wales in 1860, and the numbers of sheep increased exponentially over the period 1860–1882 (Muir 2014). By then, there were nearly 10 million sheep in western New South Wales, and in Victoria the mallee region in the north-west of Victoria was being opened to settlers on easy terms by the Victorian colonial government (Andrews 1966).

... This growth was rudely interrupted in 1877, when Queensland entered a period of severe drought. By 1880, the drought had spread south, through all of New South Wales, and finally to the point where even the normally wet Gippsland region of south-eastern Victoria was desiccated. The dry conditions lasted until at least 1886, when there was brief intermission, only to be followed by the onset of another drought in 1888. In northern Victoria, the situation was made even worse by, in 1878, the beginnings of an explosion in rabbit numbers (Andrews 1966). Pastoralists, or rather their unfortunate workers, were reduced to scraping wool from the bodies of dead animals and washing it in any nearby river that continued to have water in it to earn the most meagre of livings.

The economic difficulties, the destruction of soils and vegetation, and the terrible treatment of stock prompted the New South Wales government in 1884 to establish the Lynne Royal Commission into Conservation of Water (1884–1886). In December 1884, the Royal Commission on Water Supply (1884–1887) was established by the Victorian government, chaired by Alfred Deakin (Smith 1998). A separate royal commission was established in South Australia along the same lines as those in New South Wales and Victoria, also in response to the calamities induced by the drought (Webster 2017). The New South...
Wales commissioners ‘… were shocked to find that witness after witness had no interest in conserving water’ (Muir 2014, p. 28). It was cheaper to let stock die by the millions than to raise fodder to keep the animals alive. Even if the government had provided graziers with water, they would not use it. It was a simple management decision. It was more economic to overstock the land during ‘good times’ and to walk away during ‘bad times’ than to alleviate the suffering of animals or to make capital improvements, even if government subsidised (Muir 2014).

The findings of the Lynne Royal Commission had little effect on pastoralists in New South Wales. However, they did create unease among non-pastoralists, who were once again concerned about economic stability, unsustainable debt, environmental damage (mainly soil degradation) and the undischarged responsibility of graziers to the welfare of their stock. With the passing of the drought of the 1880s, stock numbers recovered and, by the early 1890s, there were 13.5 million head of stock in western New South Wales. The dense stocking of sheep and the recent appearance of rabbits, probably exacerbated by repression of traditional Aboriginal burning practices, resulted in environmental devastation on a scale never seen before in Australia. After a few good years, drought returned in 1895. Pastoralism collapsed under the renewed environmental realities. By 1902, there were fewer than 4 million sheep in western New South Wales and, as Muir (2014) pointed out, the land was mostly ruined.

The catastrophic failure of pastoralism in south-eastern Australia on environmental, social, economic and ethical grounds prompted renewed interest in water conservation and the possibility that agriculture, this time supported by extensive irrigation, might prove the saviour of the nation. It is important to remember too that the term ‘water conservation’ held a meaning at the end of the 19th century, and even in the middle of the 20th century, quite different than it does today. Writing on ‘The national outlook’ for the symposium on water-resource use and management held by the Australian Academy of Science in Canberra in 1963, Sir Harold Raggatt, secretary of the Department of National Development, stated that there were two categories of water conservation: (1) ‘actions undertaken to meet a demand for a reliable water supply’ and (2) actions that ‘create a demand for water rather than meet an existing need [!]’ (Raggatt 1964, p. 4). Nowadays, of course, ‘water conservation’ is taken to mean a reduction in the amount of water used by society, a reduction in demand rather than the meeting of current demand or the creation of new demand.

The 1884 Victorian Royal Commission led to the Irrigation Act 1886, which vested all surface-water resources in the Crown and established the foundation for large-scale irrigation in the colony, and later, State of Victoria (Tisdall 1964; Smith 1998; Powell 1997; Musgrave 2008). The Victorian legislation rejected the North American model of ‘prior appropriation’, a frontier system of natural-resource management often enforced violently by shotgun or less violently by litigation in the courts. Langford-Smith (1968) provided an example of how violent the arguments could be over access to river water in regional south-eastern Australia. In the early 1850s, squatters built dams across the upper parts of Billabong Creek (a tributary of the Murrumbidgee River) to make their water supply more reliable. This was ‘much to the annoyance of those downstream who were thereby deprived of the all too infrequent flow. Feeling on the matter reached such a pitch that raiding parties were frequently organised to destroy the dams, resulting on occasion in physical violence’ (Langford-Smith 1968, p. 115).

The Victorian legislation of 1886 allowed for the following three types of irrigation scheme: (1) national works, financed by the colonial (later State) government; (2) trust works, financed by loans from government and with water provided to private users on terms decided by the various trusts; and (3) private irrigation schemes, not eligible for government loans but still requiring to be authorised. The primary author of the 1886 legislation, Alfred Deakin, anticipated that irrigation would increase the value of farmland in the irrigated areas, prevent their degeneration to mere sheep holdings held by squatters or wealthy selectors, and encourage owners to subdivide their land and to plant orchards and vineyards, which could provide a good standard of living on holdings as small as 40 acres, or ~16 ha (Musgrave 2008). A similar process followed the Lynne Royal Commission in New South Wales, which, in 1885, recommended the expansion of irrigation along the Murray and Murrumbidgee Rivers (including the diversion of waters from the Snowy River in the east, over the Great Divide), and led to the New South Wales Water Rights Act 1896.

In response to the change in Victorian legislation, two Canadian brothers, George and William Benjamin Chaffey, established a private irrigation scheme at Mildura in north-western Victoria. They had prior success in irrigation development in California and were keen to repeat that triumph in Australia. In 1887 the brothers had purchased a defunct pastoral lease and established the Mildura Irrigation Colony. Around the same time, they also began work on a 250 000-acre (~100 000 ha) irrigation scheme at Renmark in South Australia, at the invitation of the South Australian premier, whose government was reluctant to make even the smallest expenditure of government funds towards irrigation and therefore welcomed this private investment (Williams 1974). William Chaffey managed the Mildura scheme and the Renmark scheme was managed by his younger brother, Charles. By 1890, the Victorian scheme was so successful that the population of Mildura had swollen to 3000. But by 1895, it had collapsed and the Chaffey brothers were bankrupt in New South Wales. A broadly similar series of events took place with the South Australian venture; the Renmark scheme was much less successful than anticipated (only 2600 acres (~1100 ha) were under irrigation in 1896 and merely 3700 acres (~1500 ha) in 1905, in contrast to the 2 000 000 acres (~800 000 ha) anticipated by some supporters), and as a result of the Chaffey brothers having become bankrupt in South Australian in 1892 the colonial government was forced to offer grants of £3000 in 1897 and £16 000 in 1899 to ‘put the scheme on a sound footing’ (Williams 1974, p. 240).

The two pioneering schemes had failed for a range of reasons, including inadequate and distant markets, widely leaking irrigation channels, poor or inappropriate soils, and the fact that much of the land was purchased by speculators and remained vacant rather than being put to irrigation (Williams 1974; Musgrave 2008). A contributing factor was also the fact that many irrigators considered the new water supply to be useful only in dry seasons and so used (and paid for) water only when it was needed, regardless of the capital cost of providing...
the infrastructure and the relentless interest costs. This, of course, is fatal for a venture that relies on communal use of a resource. Thus, attempts by the trusts to extract even the interest cost of their investments were unsuccessful. Notwithstanding the negative experience at Mildura, by the early 1890s there were over 20 irrigation and waterworks trusts operating in Victoria. By 1889, there were nearly 90 (Tisdall 1964). By the late 1890s, all were bankrupt and, in 1899, the Relief Act was passed, which wrote off three-quarters of the existing liabilities of the trusts (Tisdall 1964). All but one of the trusts was abolished in the subsequent Water Act of 1905.

Another royal commission, namely, the Mildura Royal Commission, led by A. L. Tucker, was established to investigate the failure (Powell 1989; Delacorn 2011). It found that the Chaffey brothers were too ambitious in ‘…their own ability to found a monumental irrigation colony’ (Smith 1998, p. 153). It also found that ‘…many farmers were only enthusiastic about irrigation because they believed it would increase land values and enable them to sell out at higher prices and move onto new land’ (Musgrave 2008, p. 32). This was to be a recurring pattern in the regulation of inland rivers and the diversion of their waters for irrigation, as shown later.

An important consequence of the various royal commissions and subsequent reform legislation in Victoria and New South Wales was the banning of private monopolies in the supply of bulk irrigation water and, in their place, the creation of State-based water monopolies, such as the State Rivers and Water Supply Commission in Victoria (established in 1906) and the Water Conservation and Irrigation Board in New South Wales (established in 1896). Critical to developments in Victoria was that Elwood Mead, from the US Department of Agriculture, was appointed as the first chairman of the new Commission and who introduced many of the new ideas about irrigation then developing in California (Teisch 2011). Mead ‘savaged’ the prior approach to large-scale, low-intensity irrigation and, with his Minister for Water Supply, initiated ‘pockets of small-scale irrigated farming into the State’s broad-acre checkerboard’ (Powell 2000, p. 56). A similar process unfolded in New South Wales, where the 1906 Public Works Enquiry set about establishing an intensive irrigation scheme along the Murrumbidgee River; this investigation marked ‘an important switch of official policy away from limited government intervention … to much more sweeping State socialism for intensive irrigation’ (Rutherford 1968, p. 172, italic text in original). Williams (1974) described parallel events in South Australia, where a second phase of irrigation development commenced in 1905, this time characterised by direct government intervention and the planned expenditure of government funds.

Note that the irrigation scheme developed along the Murrumbidgee was soon, like so many other irrigation ventures, subject to a royal commission (in 1916) into its establishment and operation (Rutherford 1968). The year 1916 also saw a royal commission held into failure of irrigation farms established along the Goulburn and Campaspe Rivers in Victoria. Given the number of royal commissions and other inquiries undertaken into irrigation and the Murray River throughout the 19th and 20th centuries (including the Davis Royal Commission of 1902: Davis et al. 1902), and the most recent South Australian Royal Commission (Walker 2019), it seems that river regulation and irrigation schemes and royal commissions are close bedfellows in Australia.

For the entirety of the 20th century, irrigation works (i.e. the main storages, supply channels and drains) were paid for entirely out of State funds ‘and neither capital nor interest is paid by the irrigators’ (Tisdall 1964, p. 462). Tisdall (1964, p. 462) went on to say that:

Probably few recent irrigation projects in the world have been a paying proposition, in that direct income from water sales and charges is sufficient to pay for operation and maintenance and also to allow for ruling rates of interest and repayment of capital expenditure.

Instead:

The rationale for subsidising the large-scale irrigation schemes seems to have been that Governments are satisfied that irrigation is desirable from a national point of view, that increasing populations must be fed, and that money must be found to finance development… [Tisdall 1964, p. 463].

Moreover, the conventional wisdom was that ‘…frontier families were entitled to expect infrastructural investment from governments to compensate for the niggardly environment they were enjoined to ‘pioneer’ (Powell 2000, p. 52). Put another way, large-scale irrigation in Australia has to be State-subsidised to ‘succeed’. Rutherford (1968, p. 142) acknowledged this essential requirement, when he noted that large-scale irrigation schemes in south-eastern Australia involved ‘…politically-contrived [sic] systems of ‘cheap’ water supplies in which the direct beneficiaries are charged rates barely sufficient to cover district running costs, and capital costs are a charge on the State’. In the case of the Snowy Mountains Hydro-electric Scheme, the economic returns from irrigation alone were insufficient to justify the investment required and ‘…ultimately its financial feasibility was based on direct revenue from the sale of power’ (Hudson 1964, p. 43).

The 20th century: recognition of the dubious economic foundations of State-subsidised irrigated agriculture in Australia

By the early decades of the 20th century, it was widely recognised by historians that State subsidies to agriculture had become ‘…the Heaven-sent instrument of cockpit-farmers, and marginal wheat-growers, and fruit-growers on irrigated lands, who seek an untidy agrarian socialism for themselves’ (Hancock 1930, p. 236). Campbell (1964) noted the problem too, he commented that it was particularly objectionable for irrigation schemes to proceed ‘on the implicit assumption that the Government, as if by some natural law, should automatically pay the full costs of certain irrigation facilities, which are therefore left out of the calculations [of investment analyses]’ (Campbell 1964, pp. 454, 455). Several commentators used the term ‘State socialism’ to describe agricultural policies then implemented by various State governments to promote irrigation in Australia (e.g. Eggleston 1932; Rutherford 1968).

Warning bells continued to ring throughout the 1950s and 1960s as to the wisdom of State subsidy of irrigation schemes (e.g. Taylor 1959; Campbell 1964; Davidson 1969), but the critics were often dismissed as naysayers and out of touch with the prevailing climate of environmental possibilism (e.g. Haigh 1964; Tisdall 1964). In response to these criticisms, one
detractor of large-scale irrigation investment, K. O. Campbell, from the School of Agriculture in the University of Sydney, replied that the defences mounted in support of ongoing sizable investment into State-subsidised irrigation in Australia sounded more like they had come from ‘ancient Egypt in the twentieth century B.C. rather than in the Australian Academy of Science in 1963’ (Hills 1964, p. 476).

The fundamental basis of these concerns is that there are few parts of Australia that meet successfully the manifold requirements for successful irrigation (Taylor 1959). Taylor was particularly scathing of schemes for large-scale irrigation of the arid zone: ‘...he [i.e. the author Taylor] does hope that we shall hear less concerning irrigation as a cure for arid Australia!’ (Taylor 1959, p. 269, italic text and exclamation mark in original). The resource economist B. R. Davidson (1966, 1969), similarly, had great misgivings about the success of irrigation in inland Australia and the agricultural development of northern Australia. In his chapter on the history of the Australian rural landscape, Davidson (1976, p. 73) stated unequivocally that ‘Many Australians are proud of this, mainly man-made, landscape [i.e. massive dams in the mountains, diversion weirs and distribution channels supporting large-scale irrigation] but few realise it is the most uneconomic form of farming in Australia’. The problem was, in part, laid at the feet of the very State-based organisations that had been established in the early 20th century to manage more rationally and economically the country’s water resources, as is demonstrated by the following statement:

Following a well recognised behaviour pattern … such Government agencies tend to become vigorous pressure groups in favour of further extension of the particular facilities for which they are responsible, and continue to do so irrespective of the march of time [Campbell 1964, p. 454].

The fact is that Australia is, by and large, physiographically and climatically poorly suited to large-scale, intensive irrigation (Taylor 1959; Davidson 1969, 1976; Seddon 1999). A result is that irrigators bear the cost only of basic operating costs, never the full cost of supplying and maintaining the massive infrastructure required for large-scale irrigation. A corollary is that large-scale irrigation in Australia can survive only because of the massive subsidies paid by State and commonwealth governments (Powell 1988; Crase 2010; Williams 2017; Grafton and Wheeler 2018). This fact has been apparent for decades and, although the weak economic basis of large-scale irrigation is frequently noted by resource economists, it was and continues to be rarely acknowledged in wider public debate about the way Australian rivers should be used and managed. For example, Taylor (1959, p. 277) pointed out that the 1927 auditor’s general report showed that the New South Wales government lost over A£3.3 million from 1915 to 1927 in subsidising irrigation, in one scheme having spent A£8684 to establish each new irrigator. This amount is equivalent to A$703,000 per irrigator in 2018 values (calculated as per https://www.rba.gov.au/calculator/annualPreDecimal.html, accessed 6 August 2019). Williams (1974, p. 256) likewise noted that losses incurred by the South Australian government in subsidising soldier settler irrigation schemes since 1918 were estimated to exceed A£3 million by 1925. At current (2018) values, this is equivalent to more than A$245 million over that 7-year period.

Similarly negative analyses were provided by Hancock (1930, p. 161), who examined the economic return from irrigation schemes in inland New South Wales. He reported the 1929 assessment of these schemes by the visiting British Economic Mission, that they were ‘dubious enterprises’ imposing a very heavy and unsustainable burden on State coffers, a judgement reinforced by the observation that, up until 1927, A£9 million (equivalent to A$728 million in 2018) had been poured into the Murrumbidgee Irrigation Area scheme alone by the New South Wales government, yet within the preceding 10-year period the accumulated deficit of the venture was A£2.7 million (equivalent to A$219 million in 2018). The conclusion was inevitable, in that ‘They [the States’ auditors-general] have repeatedly warned the Australian Governments that they are not getting their money’s worth’ (Hancock 1930, p. 161). It was not only New South Wales that laboured under uneconomic irrigation schemes; in Queensland, the Inkerman scheme had proven (in 1935) to be ‘...the most expensive settlement scheme in Queensland’s history, having cost A£8492 (equivalent to A$827,000 in 2018) to place each settler on the land’ (Taylor 1959, p. 281).

Subsequent irrigation schemes have hardly fared any better than those in the late 19th century and early 20th century. The Burdekin Scheme in northern Queensland, discussed earlier in terms of the even more grandiose Bradfield Scheme proposal, ‘...was completed in 1957, and the project has never been denied criticism’ (Powell 1988, p. 328). Tobacco growing was ‘quite unsuccessful’ and its replacement, mixed vegetable production, also ‘proved doubtful’. At least half the costs of maintaining the channels had to be met by the State, and taxation on the produce of the areas did not even cover a small portion of the interest charged on the infrastructure. The situation was so bad in the middle of the 1960s that Campbell (1964, p. 453) was led to conclude that ‘we must seriously question whether the opening up of new irrigation areas is the most effective way of utilising the available capital and manpower resources of the country in the interests of achieving increased rural output’.

The warnings were not heeded, and the Ord River Scheme in northern Western Australia continued and intensified what was by now becoming a very familiar story to the critics of State-subsidised irrigation. Phase 1 was completed in 1972 with the creation of the main storage reservoir, Lake Argyle. Almost from the beginning it was labelled a ‘white elephant’ (Wahlquist 2008, p. 24). Review after review has demonstrated its failure. Davidson and Graham-Taylor (1982, p. 3), writing for a hard-right, neoliberal think tank, commenced their assessment with the lines ‘In retrospect, the most interesting aspect of the Ord River Irrigation Project is that anyone should at any time have thought that it would be economically viable’. Powell (1988, pp. 330–332) ascribed the ‘blunders on the Ord’ to ‘...the slack reasoning of the 1960s, but to some extent, they were also reminiscent of the kinds of bragging boosterism and “empty north” paranoia which characterised the inter-war period’ and warned that ‘...there is surely nothing more to be gained from breast-beating over the fiasco perpetrated in the far north-west’. Smith (1998, pp. 170–172) concluded that the Ord River Scheme was a ‘...pork-barrelling failure’ in which ‘water charges … have never met the operating costs, let alone made any contribution to capital expenditure or asset replacement’.
Head (1999), reviewing the combined Stage 1 and 2 components of the scheme, pointed out the repeated *ad hoc* nature of decision making and the adverse effects on Aboriginal communities. Arthur (2002) showed how language had been used in an attempt to sell and, when it proved unviable, redeem the failed system. Pigram (2006, p. 54) noted that ‘...the waters of Lake Argyle remain largely unused except as a tourist attraction and a fishing resource.’ Writing only 4 years ago, Dent and Ward (2015, p. 1) concluded that ‘...the Ord River irrigation scheme has a history of repeated and consistent failure, despite massive public subsidies that, in current dollar terms, total well over $1 billion. This is not atypical of irrigation ventures in the north...’. Most recently, the left-leaning Australia Institute reported that over A$2 billion had been spent on the Ord River Scheme, three-quarters of which were public funds. The ‘investment’ yielded a meagre return of 17¢ per $1; the subsidies expended in expanding the area under irrigation since 2009 alone were A$227 500 ha⁻¹ (Grudnoff and Campbell 2017).

Cullen and Lake (1995, p. 115) described the massive irrigation projects such as the Bradfield Scheme and the Ord River Scheme as ‘Grand, symbolic and ignorant gestures to development have caused a futile loss of natural resources, the loss of large amounts of public money, and considerable misery for many of the supposed beneficiaries. The main beneficiaries were the professionals who designed and built the monuments, and the politicians who supported them’. Indeed, it is the case that periodic announcements are made regarding the success and imminent expansion of the Ord River Scheme were frequently linked to political needs, especially when it was touted during times of State and Federal elections (Powell 1988). As I show later, the same state of affairs continues to apply to smaller irrigation schemes elsewhere in Australia.

The Bradfield, Burdekin and Ord River schemes are not the only recent examples of substantial irrigation ventures in northern Australia to have been initiated and failed. Wahlquist (2008) pointed out that the Fitzroy Camballin Scheme in Western Australia, the Tipperary and Humpty Doo schemes in the Northern Territory, and Lakelands in Queensland are others. Had the Spencer Gulf–Lake Eyre and the Bradfield schemes proceeded, they would have undoubtedly added to the tally.

*Have we learnt anything from history? River regulation and large-scale irrigation in 21st century Australia*

Musgrave (2008) argued that the 1960s saw a decline in support for closer settlement as Australians realised that the country had a comparative advantage in broad-acre farming and not in uneconomic, large-scale, State-subsidised irrigation schemes. The construction of major dams in Australia peaked in the 1970s and declined rapidly after 1990 (Broughton 2006). Consistent with this timeframe, all the examples examined in the previous sections took place in the 19th and 20th centuries. Has the situation improved in the 21st century, and have policy-makers learnt the obvious lessons from the history of prior State subsidisation of large-scale irrigation?

There is little evidence that such a turnaround has taken place. Indeed, writing on the history of water management in the Murray–Darling Basin, Musgrave (2008, p. 29) concluded that ‘...after more than 200 years, [water] policy has not yet fully come to grips with the implications of these two matters [the great variability of rainfall and stream flow in Australia, and the inadequacy of common law riparian doctrine as a basis for rights of access to river water], particularly the first’. He went on to conclude that although irrigation in Australia has always had its Cassandras, it was not until the late 20th century that the economic, social equity and environmental arguments against irrigation blunted ‘...the enthusiasm of the wider community for the romance of making the desert bloom, and the belief that the development it represented was in the overall national interest’ (Musgrave 2008, p. 38).

Nevertheless, irrigation continues to receive rigorous support from many quarters. Writing in response to a critical assessment by George Seddon of the Snowy Mountains Hydro-electric Scheme, the ongoing State-subsidy of irrigation and the terrible environmental impacts of river regulation on the Snowy River (Seddon 1999), Hoare argued that State investment into intensive irrigation schemes had ‘paid off handsomely’ by the ‘drought-proofing’ of regional Australia, successful closer settlement, the advancement of decentralisation and of regional development, and through the generation of ‘thousands of jobs’ (Hoare 1999, p. 322). Criticism of such irrigation by academics, Hoare claimed, was merely an action ‘heroic to militant greenies’ (Hoare 1999, p. 322). This bizarre assertion finds a peculiar precedent noted by Rutherford (1968) in his overview of the history of government-sponsored irrigation in Australia where, on page 187, he concluded that ‘Some protagonists of irrigation tend, on occasions, to verge on hysteria when faced with objections to irrigation as one of the various alternative forms of public investment’.

The text that follows showcases six examples that demonstrate that little has changed and, arguably, that little has been learnt by decision-makers when it comes to beliefs and attitudes about rivers and irrigation in contemporary Australia.

*Example 1*

A recent book on water resources and their management in Australia, namely, *Water: Science and Solutions for Australia*, contained a chapter on irrigation that concluded ‘There are strong economic prospects for irrigation’ in Australia (Kirby 2011, p. 108). Underpinning this conclusion is the idea that irrigation can continue to expand, irrespective of growingly unacceptable environmental and social costs and, presumably, not requiring ongoing public subsidies.

*Example 2*

Massive dam-building schemes continue to be proposed as serious options to remove ‘surplus water’ from the environment and to put it to productive use. Ghassemi and White (2007) analysed the various proposals for diverting water from the coastal rivers to inland New South Wales so their flow could support massive irrigation schemes in the inland. Schemes proposed before 1982 include 17 diversion plans for the Clarence River alone, 10 for the Macleay River, and one each for the Manning and Tuross Rivers. Schemes proposed after 1982 include the Newton Boyd Scheme, the scheme proposed by the Water Research Foundation of Australia, and the White Scheme, all involving the Clarence River near Grafton, northern New South Wales. All were eventually rejected by the New South Wales government.
Even so, the idea of massive inter-basin transfers refuses to die in the public imagination, among speculators, and even among some members of the scientific and engineering community. Two examples follow. In the first, the Australian Water Exploration Co. (2014, p. 28) proposed that ‘The potential thus exists [in northern New South Wales] for diverting some surplus coastal water inland for flood mitigation, irrigation and hydropower generation’. For Victoria, this group argued for new dams on the Aberfeldy, Kiewa, Mitchell, Murray and Wonnangatta Rivers. Enormous plans were outlined for northern Australia, with proposals to convert the Fitzroy River Basin into ‘...a replica of the Ord River Project’ to generate a further 100 000 ha under irrigation, and for a further 1 000 000 ha of irrigation to be developed in the Northern Territory (Australian Water Exploration Company 2014, p. 80). The boosterist claims made in these sorts of proposals are little different from the chimera that accompanied the Chaffey brothers’ irrigation project at Renmark at the end of the 19th century, when supporters of the scheme claimed that an astonishing 2 000 000 acres (~800 000 ha) of land would become available for irrigation alongside the Murray River (Williams 1974, p. 236). And why any person or organisation would want to emulate the failed Ord River Scheme is truly a mystery to this writer. In the second example, Peirson and Laut (2016) examined the future of dams in Australia. They also concluded that diverting flood flows from the coastal rivers east of the Great Divide into the Murray–Darling Basin could alleviate the excessive extraction of water in the Basin. Surely, is this not an example of the creation of even more environmental problems for the already heavily abused coastal rivers (e.g. Boon 2017), so as to help resolve the chronic problem of over-extraction in the rivers of the Murray–Darling Basin?

Example 3

Environmental possibilism remains the belief underpinning the glowing prospectus for northern Australia outlined in the commonwealth government’s recent (2015) White Paper, Our North, Our Future: White Paper on Developing Northern Australia. (Commonwealth of Australia 2015). This document painted a shimmering future for the north of the continent, much of it based on the ‘harnessing’ of the region’s wild rivers to overcome the difficult, highly seasonal climate of the wet–dry tropics of northern Australia. Prompted by the White Paper, the CSIRO then announced the outcomes of a 2.5-year-long study of the potential of northern waters for irrigation and hydro-power generation’. For Victoria, this group argued for new dams on the Aberfeldy, Kiewa, Mitchell, Murray and Wonnangatta Rivers. Enormous plans were outlined for northern Australia, with proposals to convert the Fitzroy River Basin into ‘...a replica of the Ord River Project’ to generate a further 100 000 ha under irrigation, and for a further 1 000 000 ha of irrigation to be developed in the Northern Territory (Australian Water Exploration Company 2014, p. 80). The boosterist claims made in these sorts of proposals are little different from the chimera that accompanied the Chaffey brothers’ irrigation project at Renmark at the end of the 19th century, when supporters of the scheme claimed that an astonishing 2 000 000 acres (~800 000 ha) of land would become available for irrigation alongside the Murray River (Williams 1974, p. 236). And why any person or organisation would want to emulate the failed Ord River Scheme is truly a mystery to this writer. In the second example, Peirson and Laut (2016) examined the future of dams in Australia. They also concluded that diverting flood flows from the coastal rivers east of the Great Divide into the Murray–Darling Basin could alleviate the excessive extraction of water in the Basin. Surely, is this not an example of the creation of even more environmental problems for the already heavily abused coastal rivers (e.g. Boon 2017), so as to help resolve the chronic problem of over-extraction in the rivers of the Murray–Darling Basin?

Example 4

Not only are grand new schemes proposed, but existing irrigation schemes and their related infrastructure or facilities continue to be expanded and subsidised by the State. This occurs at a range of scales, varying from small-scale, regional programs to entire river basins covering one-seventh of the continent. An example from South Australia illustrates the variety of small-scale subsidies on offer and the way they seem to have been repeatedly used as political footballs and electoral bargaining chips, namely, the A$156 million scheme to provide northern Adelaide with irrigation water, announced in 2018, with the claim that it would generate an astonishing 3700 full-time jobs (Joyce 2018). A second example is from Queensland, where, in late 2018, A$234 million was pledged by Prime Minister Scott Morrison to expand irrigation schemes in northern Queensland (A$180 million for the Hughenden Irrigation Scheme and up to A$54 million for the Helles Gate Dam Stage 1), an expenditure described by Koziol (2018) as ‘...a $234 million handout to Bob Katter’s electorate in return for the independent MPs support on the floor of the House of Representatives’.

The next two examples showcase how irrigation is subsidised also at a far broader scale, the first (Example 5) being at the State scale and the second (Example 6) at the scale of the entire Murray–Darling Basin.

Example 5

A striking example of State subsidy to irrigation masquerading as ‘industry rejuvenation’ is the A$2 billion Northern Victorian Irrigation Renewal Project (NVIRP), a State-owned entity charged with upgrading irrigation infrastructure in north-central Victoria. The NVIRP was a major component of the State-wide policy of water management outlined in the Our Water Our Future framework of 2007; other substantial elements including the construction of a desalination plant at Wonthaggi, support for urban water recycling through upgrades to sewage-treatment plants, and the construction of a pipeline from the Goulburn River, north of the Great Divide, to Sugarloaf Reservoir in Melbourne to provide water to the metropolis during drought (Crace and O’Keefe 2009). The rationale underpinning the NVIRP was that 225 GL of water would be ‘saved’ by renovating and updating (at public expense, mostly from residents in Melbourne) irrigation infrastructure in north-central Victoria, with the ‘saved’ water being available to support even more irrigation, 75 GL made available for environmental purposes to help rehabilitate flow-stressed rivers and wetlands, and 75 GL ‘generated’ to supplement Melbourne’s potable water supply if required, by the construction of the North–South pipeline to Melbourne. Following a scathing assessment by the Victorian Ombudsman (2011), the original NVIRP project was merged with Goulburn–Murray Water and re-named the ‘Connections Program’. The exercise was sold to the public as the ‘Foodbowl Modernization Project’, a title described by one highly regarded resource economist as taking ‘first prize’ in political spin (Crace 2010, p. 16). The underpinning economics
were described as ‘dodgy’ and the business case built to support the massive expenditure as setting ‘...a new benchmark in mediocrity’ (Crase 2010, pp. 10, 17); the calculation of water savings was grossly overestimated according to Watson (2005) and Crase and O’Keefe (2009).

Example 6

A final example of the way the public continues to subsidise large-scale irrigation (and receives a pitiful return in exchange) is illustrated by the tortured history of the 2012 Murray–Darling Basin Plan. The earlier history of water use and management in the Murray–Darling Basin has been covered elsewhere (e.g. Connell 2007; Musgrave 2008; Webster 2017; Walker 2019).

The A$13 billion Murray–Darling Basin Plan was supposed to ensure the sustainability of irrigated agriculture in the Murray–Darling Basin and to return environmental water to flow-stressed rivers, wetlands and floodplains (Kneebone and Wilson 2017). From the beginning, it has been surrounded by controversy, originally from irrigators who wanted to retain full (even expanded) access to river water, regardless of the fact that extractions were demonstrably unsustainable and were having disastrous environmental consequences. The irrigation lobby showed immense influence (and political finesse) in overturning almost all the elements of the Basin Plan that involved environmental rehabilitation (Crase et al. 2011). In 2010, irrigators in the central New South Wales irrigation township of Griffith, for example, burnt copies of the Guide to the Proposed Basin Plan (see below) in the street to show their contempt for the very idea of reducing the volume of water currently available (even if not used) for irrigation and an increase in the volume of water to be used for environmental improvement. Signs were erected to show disdain at the very notion (Fig. 5). Conservationists were at the start mostly supportive of the Basin Plan, but grew increasingly disillusioned at the colossal expenditure and the lack of obvious environmental benefits (see Case study 10. Rivers and personal bereavement, below).

The Murray–Darling Basin Plan was adopted by the Commonwealth Minister for Water in 2012, with bipartisan political support from parliament. Even allowing for the century-long history of negotiation about the waters of the Murray River, involving several royal commissions into the Murray River in the early 20th century (e.g. the 1902 Interstate Royal Commission on the River Murray, the 1910 Victorian Royal Commission on the Murray Waters), the River Murray Waters Agreement of 1914–1915 and the establishment of the River Murray Commission (Connell 2007), the Basin Plan had convoluted origins. The basis of the Basin Plan was laid out in the National Plan for Water Security prepared by the Howard coalition government in early 2007 (McCormick 2007; see also Crase and O’Keefe 2009; Kneebone and Wilson 2017). Under the National Plan, the commonwealth would contribute ~A$10 billion over a 10-year period to redress the environmental degradation caused by the excessive extraction of water from the rivers of the Murray–Darling Basin, much of which was to be spent on improving the efficiency of large-scale irrigation through so-called ‘modernisation projects’ (cf. the NVIRP example discussed above). A taskforce was also to be developed to examine the expansion of irrigation in northern Australia. The National Plan was described by Crase and O’Keefe (2009, p. 48) as ‘...arguably more an act of political desperation than it was a response to concerns about deficiencies in water-resource management’.

Fig. 5. Sign on a take-away food shop in the irrigation-based township of Finley, New South Wales. Photograph taken by the author, June 2012.
In late 2007, the Howard coalition government was defeated at the Federal election. The incoming Gillard Labor government released its position on water-resource management in the Murray–Darling Basin, *Water for the Future*, early the next year. It also aimed at modernising large-scale irrigated agriculture, but by the dual processes of upgrading irrigation infrastructure and of ‘buying back’ water-access rights. The final cost increased to A$12.9 billion (*Crase* 2017; *Grafton and Wheeler* 2018). Funds committed to meet these aims came to A$4.3 billion, including support of the NVIRP project outlined above, a further A$183 million to modernise irrigation in the Sunraysia region, A$31.55 billion for similar activities in New South Wales, A$510 million in Queensland and A$610 million to South Australia (*Crase and O’Keefe* 2009).

The Murray–Darling Basin Plan, although formally adopted by the commonwealth government in November 2012, was foreshadowed by the quite unexpected release in late 2010 of a *Guide to the Proposed* [Murray–Darling] *Basin Plan* by the Murray–Darling Basin Commission (*Crase* 2012). It was this Guide that prompted the outrage by irrigators noted above, largely because it anticipated the sustainable diversion limit being set at somewhere between 3000 and 4000 GL. These volumes were a very major decrease from the 7600 GL that the Murray–Darling Basin Commission had been advised were required to have a reasonable likelihood of achieving good environmental outcomes and were the result of ‘considerable manoeuvring’ (*Crase* 2012, p. 190). When it was released in 2012, the *Basin Plan* aimed to recover 3200 GL (later, an even lower 2750 GL) of water for the environment, again a volume far smaller than the 3856 GL (high uncertainty) and 6983 GL (low uncertainty) thought required for environmental rehabilitation (*Wentworth Group of Concerned Scientists* 2017). *Williams* (2017, p. 80) commented that the science to support the reduction in diversion limits was ‘a mystery’ that lacked quantitative evaluation, although it does seem to be based on long-term average annual water yields (*Grafton and Wheeler* 2018). However, disturbing evidence presented at the 2018–2019 South Australian Royal Commission into the Murray–Darling Basin by a water planner involved in setting the diversion limits showed that the first, admittedly preliminary, estimates were ~4000–4500 GL; these were judged as too high and the planner was told that the target had to be recast ‘to be a number beginning with 2’ [i.e. a number less than 3000 GL] (*Hannam* 2018, p. 2).

Even more perversely, the revised 2750 GL reduction in surface-water extractions outlined in the *Basin Plan* was further offset by an increase in the baseline diversion limit by 2720 GL above its earlier value, in what *Williams* (2017, p. 81) called ‘an exercise in smoke and mirrors’. Meanwhile, the permissible groundwater extractions increased from 1786 to 3334 GL year\(^{-1}\), an increase of 1548 GL annually. Furthermore, under the so-called ‘sustainable diversion limit adjustment mechanism’ of 2018, the previously agreed 2750 GL reduction was reduced even further, on the assumption that ‘complementary works and measures’ could replace the environmental benefit that accrued from increased environmental flows. It was invoked to prevent Victoria and New South Wales from abandoning the *Basin Plan* completely. In essence, the target for water recovery had, thus, been cut even further and is now just 2145 GL (Angus Webb, pers. comm., 2 November 2018). Regardless of all this manoeuvring, it was clear from the beginning that the volume of water ‘saved’ or clawed back that could be used for environmental flows was completely inadequate. *Young et al.* (2011, p. 10) concluded that ‘Given the current evidence base the level of take represented by the 2800 GL/yr reduction scenario is not consistent with the hydrologic and ecological targets provided in the review’.

Since 2002, the commonwealth government has spent more than A$15 billion on water ‘reform’ and ‘irrigation renewal’, mostly on infrastructure subsidies (A$5.8 billion) and on water buy-backs (A$3.1 billion; *Grafton and Wheeler* 2018). Regarding the money expended to purchase water entitlements from irrigators, *Williams* (2017, p. 79) described the process as follows: ‘The conversion of a water licence to a tradeable private property right meant transferring a huge amount of wealth from the public sector to the private sector’. Property rights to water in Australia are now worth over A$47 billion (*Williams* 2017), and their purchase by State and commonwealth governments has had the result that ‘…many of the gains from water recovery have accrued as private benefits to irrigators’ (*Grafton and Wheeler* 2018, p. 3.1).

The cost per megalitre of water ‘recovered’ for the environment under the various irrigation renewal and buy-back projects has been as outrageous as A$22143 (for the Healthy HeadWaters Water Use Efficiency program in Queensland) and commonly exceeds A$5000 ML\(^{-1}\) (see table 3 in *Grafton and Wheeler* 2018). The cost of water recovered from the Sunraysia Modernisation Project in Victoria was more than A$14 000 ML\(^{-1}\), as was that from the Irrigated Farm Modernization Border Rivers-Gwydir Pilot Project in New South Wales. The best return was generated in the Nimmie-Caria project in New South Wales, at A$1354 ML\(^{-1}\). By way of comparison, irrigators expressed concern when prices exceeded A$200 ML\(^{-1}\) at the beginning of the irrigation season in 2015 (*Long* 2015). The average price for water allocation trades in the southern Murray–Darling Basin was less than A$600 ML\(^{-1}\) in every year from 2008–2012 inclusive, and in 2010–2012 was less than A$100 ML\(^{-1}\) throughout the entire irrigation season (*Grafton and Horne* 2014, fig. 2). The highest amounts paid were in the Millenium Drought of 2007–2008, when prices varied from approximately A$700–1100 ML\(^{-1}\). It is no wonder that one assessment of the past two decades of water management in the Murray–Darling Basin by ‘irrigation renewal’ and water buy-back schemes called it a ‘A river of funding, a trickle of achievement’ (*Lee and Ancev* 2009).

Given all these manifest failings, it is not surprising that recently there has been a chorus of calls to completely rethink the foundations to and the implementation of the *Basin Plan* (e.g. *Wentworth Group of Concerned Scientists* 2017; *Grafton et al.* 2018), with one publicly released position, The Murray–Darling Declaration (*Bjomlund et al.* 2018), demanding that the commonwealth government ‘Stop any further expenditures on infrastructure related to water-use efficiency’. These concerns were reinforced most recently by the scathing findings of the 2018–2019 South Australian Royal Commission into the Murray–Darling Basin, which were released in January 2019 (*Walker* 2019). The academic and legal critiques have been matched by numerous investigations by the mass media, which
have revealed repeated mismanagement and unremitting ideological bias and, in some cases, have made serious allegations of illegal behaviour and possible corruption (e.g. Besser 2017; Dingle 2018; Sinclair 2019).

Conclusions to Case study 4

Case study 4 shows how State-sponsored, large-scale irrigation schemes have long featured in the minds of decision-makers wishing to more densely populate the interior of Australia, defend the country against invasion, generate export income and private wealth, and turn the inland rivers to ‘productive’ use. The economics of such irrigation schemes, and the allocation of scarce water resources to support them, have been controversial for well over 140 years. The multiple lines of evidence presented in this case study reinforce the statements made in John Pigram’s book *Australia’s Water Resources: from Use to Management*, where he pointed out that ‘No commodity [i.e. water] has played a more significant role in the nation’s development, and no belief appears to be more widely shared than the need for the country to grasp every opportunity to conserve more water’ (Pigram 2006, p. 41). It also indicates that little has changed – indeed, the situation has arguably become even muddier and more contentious – in the three decades since Powell (1988, p. 322) commented that ‘Over the past twenty years or so irrigation has become a disputatious issue, separating metropolitan and country residents while deriving good measures of political and moral support, and fiesty antagonism, from every quarter’ (italic text in original). Finally, it also supports the more recent contention by Musgrave (2008, p. 30), namely that ‘Water was a major cause of unhappiness, disruption, and administrative action from the beginning of settlement in south-eastern Australia’.

Case study 5. The Tyranny of Distance: the role of inland rivers in transport

It is timely to return to Geoffrey Blainey’s proposal that closer settlement of inland Australia was hampered by the lack of large, reliable inland rivers that could provide efficient transport routes. Despite Blainey’s argument that the lack of a substantial inland river system hampered the colonisation of the country, until the spread of railways in the mid–late 19th century, rivers provided the only means of getting products cheaply from distant agricultural lands to markets on the coast. It was riverboats that carried wool and wheat from inland Australia to the capital city, providing cheap transport of goods to and from distant markets. Railways and roads have now almost utterly displaced them as significant transport routes and the array of small boats that once plied the country’s waterways (e.g. Purcell 1995, 2011) are long gone.

Case study 6. Rivers and national defence

Rivers have long been focal points for military activity, either as features to defend or as obstacles to be crossed (e.g. Finch 1846). As discussed in the first two case studies, the easy navigational access provided by coastal rivers was a crucial consideration in the location of almost all the capital cities of Australia. Unfortunately, such a location also provided opportunities for the settlements to be attacked from the sea, creating an anxiety about the need to defend coastal cities against maritime attack. The river most thoroughly analysed with respect to its perception as a vital military asset of strategic significance during World War 2 is probably the Hawkesbury River, north of Sydney. In response to the threat of attack by the Japanese in 1942, the Hawkesbury and its militarily critical railway bridge linking Sydney with Newcastle and Brisbane to the north were very strongly defended, as outlined by Boon (2017). Rosen (2017) described how jetties and wharves on coastal rivers all along the eastern seaboard were to be demolished or inactivated in anticipation of Japanese attack during World War 2, so as to deny them to the enemy, and how boats were to be beached above the high-water mark and their engines removed, or corralled into remote areas upstream and then destroyed. Wharves on the Hawkesbury, Richmond, Clarence and Macleay Rivers in New South Wales were to be destroyed in a ‘scorched earth’ policy. In the Clarence River, for example, 13 wharves were
classified as critical to be destroyed once a threat became imminent and another 15 as requiring demolition if the surrounding area came under attack and invasion was feared. It is unclear whether rivers, especially coastal rivers, still hold a meaningful strategic value. However, it is possible that with the defence of the ‘sea–air gap’ now being the dominant military strategy in Australia, coastal rivers, particularly in northern Australia, retain much of their earlier military significance (Babbage 1990).

Case study 7. Rivers and national pride: images of rivers on Australian banknotes

Banknotes are one way a nation reveals the official image it wishes to extend to the outside world, the picture it wants to paint of itself. The first banknote issued by the commonwealth, a 10-shilling note in 1913, featured the Goulburn Weir on the reverse side. At the time, national identity was tightly bound with notions of developing the nation’s resources and creating an improved society for Australians (White 1981). Frawley (1994, p. 66) noted that water-management projects were ‘great symbols of national development’ during the early and mid-parts of the 20th century, an era that stressed the ‘wise use’ of resources. As the first major diversion weir built in Victoria, the Goulburn Weir symbolised the era perfectly. That it also housed one of the first hydro-electric power-station turbines in the southern hemisphere also helped its profile. The image of the weir (and its control over water) remained on the 1915–1918 issue and appeared again on the half-sovereign notes of 1923 and 1926–1933 (Reserve Bank of Australia 2018).

The Hawkesbury River featured on the reverse side of the A£5 note of 1913–1918 and again on the 1924–1927 and 1927–1932 issues. The lower Hawkesbury River was the location of the railway bridge which, in 1889, allowed for a continuous (if of broken gauge) railway line between Adelaide and Brisbane, an event significant in building momentum for the federation of the various colonies into a single commonwealth, an event that took place in 1901 (Boon 2017).

River scenes also featured on the reverse side of the A£100 note of 1914–1918; the falls on the Upper Yarra on the left, and Leura Falls in the Blue Mountains on the right. Other images on the reverse of early pre-decimal notes included scenes reflecting the pride and wealth of the new commonwealth, such as underground gold mining, merino sheep, timber cutters in Tasmania, wagons with bags of grain and manufacturing scenes.

A shift in the iconography is noticeable from the mid-1950s, and individuals judged to be nationally important started to appear on banknotes issued from 1954 to 1966, including Matthew Flinders, Charles Sturt, John Franklin, Arthur Phillip and James Cook. Decimal currency was introduced in 1966 and the new, more colourful, notes continued with the portrayal of eminent persons, including John Macarthur, William Farrer, Caroline Chisholm, Francis Greenway, Henry Lawson, Howard Florey, Douglas Mawson and John Tibbett, often with people shown on both sides. The most recent polymer notes, with the first series being introduced in 1995–1996 and the second in 2015–2018, continue this tradition. It is curious that the Snowy Mountains Hydro-electric Scheme has not featured on an Australian banknote, given the very great engineering achievement it was and the position it was granted as a significant nation-building exercise. The Ord River Scheme also failed to appear, despite the boosterism that surrounded it. Given the scheme’s obvious failure, perhaps this was not such a bad thing. To conclude, if banknotes are any guide to national iconography and of a nation’s collective psyche, rivers were seen as important in the early–mid-20th century, but are no longer.

It is now time to turn away from the national or collective scale to examine three case studies that indicate the way rivers have affected Australians at the personal level, namely, (1) fear of dangerous mythical aquatic creatures, particularly the bunyip, (2) rivers as a source of inspiration for artists, and (3) personal bereavement at environmental degradation.

Case study 8. Rivers and personal fear: bunyips and other mythical aquatic creatures

Many parts of the world have their mythical, usually feared, creatures, of which the Scottish Loch Ness monster is perhaps the best known. The great mythical aquatic creature of Australia is the *bunyip*, a reputedly human- and stock-eating monster that lives in rivers and wetlands and that has depictions across a staggering breadth of literature. The word seems to have Aboriginal origins, having come from the Wegaia language of western Victoria. It appears to have been first used in The Geelong Advertiser of July 1845. However, at least 23 other Aboriginal terms have been recorded for mysterious river-dwelling beasts, including *bunjil* from the Grampians region of western Victoria, *katenpai* from the Murrumbidgee River, *mochel-mochel* from the Darling Downs, *orundoo* from the Murray River, *wan-gul* from north-western Western Australia, and *whowie* from the Riverland region of south-western New South Wales (Flett 1999). In almost all cases, these creatures were dreaded by Aboriginal people (Smith 1996; Holden 2001; Clarke 2018). Europeans are also said to fear them, and reports have been made of people being snatched from riverbanks or pulled out of boats by the mysterious creatures, as well as of stock being pulled into the water and devoured (Holden 2001). Recently, one resident of a northern Queensland town warned that ‘Now, you don’t go out there especially on dark and don’t swim in it [the local water hole], because you can get dragged down never to be seen again’ (ABC News 2013).

Various types of *bunyip* are reckoned to exist, some having fur, others scales, or feathers, or a leathery skin. Some have long necks, others long tails. Some have feet allowing them to walk on land, others have plesiosaur-like paddles (Wignell and Graham 1981; Healy and Cropper 1994; Smith 1996; Flett 1999; Holden 2001; Clarke 2018). Some are reported to have dreamy eyes, others a terrifying visage. The Hawkesbury Monster, for example, has been described by those lucky enough to catch a glimpse of it to be a large, dark-coloured, water-dwelling beast, 7–24 m long, with two sets of flippers and a long neck (Stubbs 1983). The diversity is perhaps not surprising, given that *bunyips* have been sighted from at least 53 locations around mainland Australia and Tasmania (Flett 1999). Although most sightings occurred in the mid–late 19th century, the animals continue to be spotted well into recent times. In August 1979, a bushwalker saw a ‘horrible reptilian creature’ 13–15 m long, just upstream of the Hawkesbury River bridge in coastal New South Wales; a ‘baby’ was spotted upstream later that year (Boon 2017). Reports of the creatures’ existence continue into the 21st
century, with a recent example being one reported to lurk in the ‘Bunyip Hole’ at Mulgildie in the upper North Burnett region of Queensland (ABC News 2013). Victoria even has a Bunyip River and Bunyip State Park, the latter having a formal management plan (Parks Victoria 1998). Bunyip conservation was not included as one of the management objectives. One reviewer of the original submission of this essay made the perceptive inference that this seemed a foolish oversight, because the rarity of sightings would imply bunyips urgently needed conservation.

If the abundance of written reports and widespread community interest are good indicators, bunyips are a firm fixture in the psychology of many Australians. Aboriginal stone carvings often feature the organism in its various forms. Norman Lindsay’s (1918) classic children’s book The Magic Pudding outlined the exploits of Bunyip Bluegum and his friends Bill Barnacle and Sam Sawnoff. The celebrated artist Lionel Lindsay drew them too, in a cover design for Steve Brown’s 1905 book Bunyip (Holden 2001). They have appeared in plays, including the three-act melodrama The Australian Bunyips (1857) and the 1858 burlesque The Bunyip. Bunyips featured often in cartoons, and were included in a 1934 book for young readers prepared by the New South Wales Department of Education (Holden 2001). They featured on a series of stamps issued by Australia Post in 1994. In 2001, the National Library of Australia held an exhibition on bunyips (Bunyips: a National Australia Travelling Exhibition), and in mid-2018 they were the subject of an exhibition at the National Gallery of Victoria (Bunyips and Dragons: Australian Children’s Book Illustrations). The word has also entered the Australian lexicon with the phrase ‘bunyip aristocracy’, a term introduced in 1853 as a disreputable description of a plan by W. C. Wentworth (a prominent lawyer, politician and landowner) for an Australian system of hereditary peerage to entrench the squattocracy (Wilkes 1978). Ever since, to be accused of being a member of the ‘bunyip aristocracy’ has carried a deep stigma among Australians (e.g. see Wright 2014).

Case study 9. Rivers and personal inspiration: portrayals of Australian rivers by artists

Rivers have long been a source of inspiration to artists. Arguably the greatest landscape artist in the Western tradition, J. M. W. Turner (1775–1851), was deeply inspired by the Thames River and painted it frequently (Ackroyd 2007). So was the French artist Claude Monet (1840–1926), who was often drawn to the Thames from his home in France between 1870 and 1901 (House 2010). In New York State, in north-eastern USA, an influential group of artists known as the Hudson River School flourished in the mid-19th century. They were inspired by the Hudson River valley and the surrounding mountainous landscapes (Kornhauser 1999).

A strong relationship also exists between rivers and artists in Australia. Some artists are inspired by a particular river, and some rivers inspire a series or a group of influential artists. Perhaps Arthur Boyd and the Shoalhaven River in southern New South Wales provides the best example of the first type of relationship (McGrath 1982). In the case of the second, the Hawkesbury River, north of Sydney, has provided inspiration for an array of well known artists for over 200 years, ranging from William Westall, Joseph Lycett, Conrad Martens, Julian Ashton, Charles Condor, Livingston Hopkins, George Collingridge, Arthur Streeton (perhaps most famously The Purple Noon’s Transparent Might) and Sydney Long (Boon 2017). In some cases, for example, George Collingridge and Margaret Preston, artists moved to the Hawkesbury River from Sydney to be nearer the river (Anonymous 2007; Boon 2017).

This section of the essay aims not to discuss the development of Australian landscape painting. That topic has been addressed frequently enough (e.g. Lynne 1977; Smith 1979; Sayers 1998; McCaughey 2014), although curiously often without much explicit reference to rivers or aquatic elements of the landscape. Moreover, there seem to be few biographical histories that include sections explicitly dedicated to how artists have portrayed rivers in specific regions of Australia, with Brown et al. (2002) for the Wannon River in western Victoria, Gaynor and McLean (2008) for the Swan River in Western Australia, and Boon (2017) for the Hawkesbury River in New South Wales being obvious exceptions, and perhaps Bun (1980) for the Yarra River near Melbourne, Victoria and Haynes (2006) for art work associated with Tasmania, including its rivers. Nor does this section address the thorny issue of how, or indeed, whether, artistic portrayals can be used to infer prior environmental condition (e.g. Heathcote 1972a, 1972b, 1976, 1983; McLoughlin 1999; Gaynor and McLean 2008; Adam 2017). Instead, it focuses on three artists who have repeatedly painted Australian rivers, as examples that demonstrate how rivers have provided inspiration, sometimes emotional relief, to a number of landscape artists in this country.

H. J. Johnstone (1835–1907)

Henry James Johnstone was born in Birmingham (UK) in 1835 and arrived in Australia in 1853 (McCulloch 1984; Kerr 2011). Johnstone was a prolific painter of Australian rivers, and some work featuring them include The Yarra Track to Woods Point (1870); Sundown, Stringy Bark Creek (1874); The Billabong (1876); Cox’s Creek, Bridgewater, South Australia 1878 (1878); Twilight, River Goulburn, Victoria (1878); Valley of the Sturt, Craigeburn, South Australia (1878); Morning on the Murray near Blanchetown (1882); Near Gundagai NSW 1885 (1885); Bush Creek (1897); In the Valley of the Goulbourn [sic], Victoria (1885); On the Yarra, Victoria (no date); Lagoon on the Goulburn River Near Seymour, Vic. (no date); Evening Mist, Sunset on the Lagoon at Seymour (no date); On the Foggerby River Near Marysville (no date); The Dipping Place, Dandenong Creek (no date); and On the Tambo (no date). The most famous of Johnstone’s works, Evening Shadows, Backwater of the Murray, South Australia, is shown in Fig. 6. It is a prime example of Australian picturesque landscape style, combining photographic realism with what some commentators have described as obvious symbolism: the fading light, the stillness of the Australian bush, hints of a gathering storm, the few remaining Aboriginal people on the billabong. However, perhaps it is also the case that the palpable stillness in this work is a consequence of it having been undertaken when Johnstone was no longer a resident of Australia, but was living overseas and working from black-and-white photographs generated when
he was the owner of the photographic studio in Melbourne. In this, he would not be alone, as many prominent artists in 19th century Australia worked from photographs (e.g. S. T. Gill, Conrad Martens and W. C. Piguenit, maybe also Louis Buvelot; see Lendon 1980). The original photographs, requiring lengthy exposure of their insensitive emulsions, would necessarily generate images devoid of movement, and this is reflected in the tranquillity of the scene. Johnstone’s reputation deteriorated quickly after his death in 1907, but this painting is significant for many reasons. It was not only the first work of art to be acquired by the Art Gallery of South Australia, but it is one of the most popular paintings in the gallery and among its most reproduced (Art Gallery of South Australia 2005).

**W. C. Piguenit (1836–1914)**

William Charles Piguenit, son of a convict transported in 1830, was born in Hobart in 1836. He has a valid claim to be the first Australian-borne professional painter and is one of the country’s most acknowledged and skilled landscape artists (Gleeson 1976; McCulloch 1984). Conservative in taste, Piguenit eschewed Impressionism and, instead, sought the most dramatic scenes to work on; he took little or no interest in domesticated landscapes or in portraiture. The art critic James Gleeson (1976, p. 15) thought that the self-taught Piguenit was a ‘careful and accurate observer of nature’ and, although deficient as a colourist, was very skilled in using subtle tonal variations to portray natural landscapes; he liked to paint ‘...Nature in its loneliest, sternest, most remote and forbidding aspects’. Bernard Smith (1979, p. 115) was less complimentary, referring to Piguenit as a mere academic romantic. Writing nearly three decades later, Roslynn Haynes was far more sympathetic, concluding that ‘Somewhat surprisingly, Piguenit’s popularity has not been superseded by wilderness photography. In his own time his landscapes aroused the curiosity and admiration of viewers who had not themselves visited these areas; today they retain their appeal precisely because they evoke something different from the photograph, however artistically composed: a sense of awe and mystery, of imagination for Nature over and beyond admiration for the artist’s technique’ (Haynes 2006, p. 162).

Rivers featured strongly in Piguenit’s works and he was widely acknowledged for his skill in this subject matter. He regularly painted the Grose, Hawkesbury and Nepean Rivers, east of Sydney, and the Lane Cove River in northern Sydney, the latter near where he lived from 1880 (e.g. Valley of the Grose 1876; Hawkesbury River with figures in a boat: on the Nepean 1881; In Lane Cove 1883; Lane Cover from Above the Bridge 1893; An Australian Mangrove, Ebb Tide 1885; A winter evening, Lane Cove 1888; An Australian fjord 1889; The Upper Nepean 1889). Piguenit’s two masterpieces are generally considered to be Mount Kosciusko, and the Valley of the Upper Murray (1883) and Flood in the Darling 1890 (1895). Fig. 7 shows the latter work. It was painted in response to the floods in the western regions of New South Wales of 1890, an event that Piguenit observed first-hand while at Bourke. In the painting he portrays not the devastated building and stockyards occasioned by the massive inundation, but the quiet calm after the flood, in a ‘...symphonic celebration of sky, land and water with ibises the only living creatures populating the tranquil scene’ (Art Gallery of New South Wales, artist profile: W.C. Piguenit, see https://www.artgallery.nsw.gov.au/collection/artists/piguenit-wc/, accessed 10 August 2018). Elwyn Lynne (1977, p. 36) was similarly appreciative, and argued that no other Australian painter had before achieved...
such an ‘effect of opalescent wetness’; Piguenit had ‘caught the iridescent [sic] transience of the flood’, the horizon low ‘with its suggestion of infinity.’”

Arthur Boyd (1920–1999)

Arthur Merric Bloomfield Boyd is one of the great post-World War 2 artists of Australia, along with Charles Blackman, John Brack, Russell Drysdale, Sydney Nolan, John Percival and Albert Tucker (McCaughey 2014). Boyd lived in London from 1959, but after seeing the Shoalhaven River, southern New South Wales, in the summer of 1971–1972, its characteristic light and the ‘wild and primitive nature, alien, primordial and untamed’ landscape (McGrath 1982, p. 18) prompted him to return to Australia and to settle at Bundanon and then Riversdale, on the river in 1973. Fig. 8 shows one of Boyd’s paintings from the Shoalhaven series, Cattle on hillside, Shoalhaven. Sandra McGrath (1982) collated the artist’s works from the Shoalhaven period, and she postulated that the paintings done there ‘...give us a new depth of understanding of landscape, a new set of forms and vistas to look upon’ (McGrath 1982, p. 16). But the effect was not only outwards, towards the viewer. McCaughey (2014, p. 219) concluded that the river and its surrounding bush ‘became an antidote to his despair’. And this provides a convenient segue into a related subject, namely, rivers and personal bereavement and spiritual regeneration.

Case study 10. Rivers and personal bereavement: solastalgia and despair at the loss of Australian rivers

‘Solastalgia’ is the term coined by the Australian philosopher Glenn Albrecht to describe the existential distress felt by people experiencing environmental change in places they love, often in the places where they live (Albrecht et al. 2007; Albrecht 2012). It is not the same as nostalgia. Nostalgia, contrary to the way the term is most often used, is an emotion related to a physical absence from their home (nostos = return home; algia = pain). It is synonymous with ‘homesickness’. Solastalgia is quite different. It relates to changes that occur over time to a given place. It is an emotion that reflects the despair many Australians feel about the changing world around them (Albrecht 2012).

There is a substantial body of work to show that many Australians suffer a feeling of solastalgia when they reflect on how the rivers they grew up alongside or are otherwise important to them have changed, almost always for the worse. Oral histories are one avenue where these feelings are most openly made public. The contribution by John Myers to the oral history of the Wannon River in western Victoria, for example, includes the statement that ‘The Wannon River is in a state of degradation. It has been virtually destroyed. There are no holes in the river any more. It floods in the winter and there is nothing in it in the summer... Before the drain went in there was great fishing along the Wannon. Nowadays you can’t get any fish – there’s no continuity in the water supply’ (Brown et al. 2002, p. 45). Similar sentiments were expressed for the Lachlan River in central New South Wales in the books by Roberts and Sainty (1996, 2000). Regarding the catchment-wide loss of the once abundant submerged aquatic macrophyte, ribbon weed, Vallisneria australis, one local reported that ‘Well, it is only since we got this carp situation that it took the ribbon weed out of the river, and the river is not filtering. It has got muddy’ (Roberts and Sainty 1996, p. 15). In my monograph on the Hawkesbury River, I reported on the sense of loss that old-time anglers felt about the way the mulloway, Argyrosomus japonicus, population in this coastal river had collapsed beyond repair and that they, and younger anglers, would no longer experience the joy of catching these magnificent fish on a regular basis (Boon 2017, p. 198).
Particularly relevant to the readers of this essay is the likelihood that non-epistemic values might also affect a sizeable number of the ecologists who study Australia’s rivers. Reports are now emerging of the enormous emotional impact dealing with chronic environmental degradation has on ecologists and conservation biologists (e.g. Yong 2017). Hobbs (2013), for example, noted that ecologists and conservation biologists may be ‘grieving for the past’. Environmental historians are also susceptible to solastalgia when reporting on changes to the natural environment. Sutter (2013b, p. 147), for example, confessed that ‘...the other aspect of my angst is a feeling of environmental urgency that the intellectual lessons of hybridity [i.e. the loss of ecosystems not grossly degraded by humans] have yet to exercise. Put simply, I cannot shake narratives of environmental decline’.

Perhaps because they fear it will reflect poorly on their professional standing, ecologists rarely articulate their personal concerns in public and it is only in small, private gatherings with long-standing colleagues that I find they are willing to express their deepest worries. Routinely working in systems such as Gol Gol Billabong, a Murray River wetland ravished by acid sulfate soils, nutrient enrichment and a century-long inappropriate flow regime (Fig. 9), or Pyramid Creek, a Victorian stream channelised, straightened, deepened and regulated to provide irrigation water, utterly devoid of native riparian vegetation (Fig. 10), is a dispiriting experience. The recent series of massive fish kills along the lower Darling River, prompted by a combination of drought and excessive water extraction for irrigation, provides another example of an event that concerns and distresses the country’s aquatic ecologists (Australian Academy of Science 2019; Vertessy et al. 2019).

It would seem that aquatic ecologists find themselves ‘alone in a world of wounds’, as Aldo Leopold famously observed in his 1953 essay The Round River (Leopold 1970, p. 197). Peter Sale identified the dilemma that many ecologists confront in Our Dying Plant: an Ecologist’s View of the Crisis we Face, with the concluding remarks that ‘We are well into what may become one of the largest mass extinction events the world has seen... This is not a world that I want to see, or one that I want to help create’ (Sale 2011, p. 233). Ecologists can attempt to recharge their spiritual and emotional batteries by visiting unspoiled rivers that keep them spell-bound and enthused (Fig. 11), but such opportunities come only rarely and can offer...
only fleeting remission. Many are acutely aware that the science of ecology has been variously described as ‘subversive’ (e.g. Sears 1964; Shepard and McKinley 1969; Hardin 1985), as ‘grim’ (Griffiths 1996, p. 259) or as ‘dire’ (Hay 1988, p. 50). It is a science that can be ‘a harbinger of gloom – sometimes doom’ (Hay 1988, p. 50), and aquatic ecologists are often the couriers of those sad and inconvenient and, to politicians especially, mostly unwanted messages.

Fig. 9. Example of a highly degraded (flow-deprived and acid-sulfate affected) floodplain wetland, Gol Gol Billabong, on the Murray River, south-western New South Wales. Photograph taken by the author, October 2008.

Fig. 10. Example of a highly degraded and regulated stream, Pyramid Creek, north-central Victoria. Photograph taken by the author, May 2014.
Conclusions

The Introduction to this essay noted the comment by George Farwell in the mid-1960s that the history of Australia had yet to be written in terms of its rivers. It is apposite to quote the full text in the essay’s Conclusions:

No one has ever yet written of Australia in terms of its rivers. This is surprising when you consider how great has always been our need for water, how frequently the tracks of the early explorers were decided by the inland river systems, how profoundly the cycles of drought and flood have affected settlement, even in modern times. This is not a mere question of dams, pipelines, and irrigation. It strikes more deeply into the nation’s soul, embedding itself in folk-tales, legend, and poetry...

[Farwell 1967, p. 23, emphasis added].

In the Introduction I also noted that few, if any, academics have commented on the fact that rivers have been short-changed in the development of Australian environmental history. When preparing the 10 case studies that inform this essay, I was struck by the persistent lack of reference to terms such as ‘river’ or ‘water’ in the indices of the monographs and edited books on Australian history or even in bioregional environmental histories. Terms such as ‘art’, ‘convict’, ‘democracy’, ‘education’, ‘exploration’, ‘feminism’, ‘imperialism’, ‘labour’, ‘patriotism’, ‘railway’, ‘religion’, ‘road’, ‘science’, ‘squatters’, ‘transport’, ‘wheat’ and ‘wool’ loomed large in the former, but few indeed were the treatments that even included the words ‘river’ or ‘water’ in the index. Some texts made a specific reference to rivers in their title or were structured to emphasise the role of rivers in Australian history (e.g. Scott 1929; Cumpston 1964; Powell 1991; McLaren 1996; Cathcart 2009), but most did neither.

The environmental historian George Seddon (1972c, p. 5) observed that it was common among Australian researchers to suppose that ‘...the environment is a trivial backdrop, as have so many of our professional historians’. Geoffrey Bolton (1976, p. 123) came to the same conclusion when he wrote that ‘Historians in the past have tended to follow a long way after the artists and creative writers in meditating upon the relationship between man and the environment in this country [i.e. Australia]’. In some circles, these accusations still hold as valid; the historian John Hirst, for example, made the astonishing claim in Sense and Nonsense in Australian History (Hirst 2005, p. 63) that, with regard to the impact of the Australian environment on European settlers:

The one subject which demands that the whole human occupation of the continent be considered is a history of the land itself. But whatever the influences of people on the land, the land has not had a determining influence on the nature of human society which has existed upon it.

Even a cursory reading of any of the early Australian environmental or geographic histories (e.g. Taylor 1959; Perry 1963; Heathcote 1965; Seddon 1970; Hancock 1972; Williams 1974) would show just how wrong this judgement is. Perhaps a partial explanation for Hirst’s claim is that, as Robin (2012, p. 186) commented, ‘...historians dealt with nation, and ecologists with nature’, but even this would seem to be insufficient to explain the proposition.

These concluding observations reinforce the validity of Farwell’s conjecture of half a century ago, namely that we are yet to determine just to what degree Australian rivers have affected the perceptions and attitudes of the Australian people.
The way this topic is handled in the future is likely to be multifarious and multifaceted, given that rivers mean different things to different people and different things at different times. This essay is merely an introductory demonstration of some of the ways in which rivers have been perceived by Australians, the attitudes we have formed to them, and the actions that, for better or worse, have resulted. It is necessarily diffuse. Works that follow will surely have a sharper focus, as an environmental history of Australia in terms of its rivers slowly unfolds and engages with other studies in the discipline of historical ecology. However, the following two things are certain: (1) environmental history is one of the most dynamic and interesting of all the threads in the discipline of history (Igler 2013; Sutter 2013a); and (2) Australia provides exceptionally fertile ground for these types of investigation (Bolton 1976; Robin and Smith 2008; Robin 2012).

Many academic commentators have called for increased collaboration across disciplines, and, in particular, among the environmental sciences (e.g. ecology), history, geography, and art and literary criticism. Keith Hancock returned to the idea several times in his pioneering book on the environmental history of the Monaro district, stating variously that ‘Historians and ecologists ought to keep in close contact with each other’ (Hancock 1972, p. 10) and ‘To explore and explain these swings of population [in emus, small and large marsupials, parrots etc] is a task that an ecologist and an historian might profitably tackle in partnership, provided they had a few years to spare’ (p. 65). So as to explain the environmental impact of different intensities of grazing on rangelands is a research task that he thought would ‘…require an historian who is able and willing to work in very close contact with natural scientists on the one side, and with economists on the other’ (Hancock 1972, p. 200). Similar cross-disciplinary sentiments have been expressed by non-ecologists such as Serle (1973), Powell (1988), Haynes (1998) and Griffiths (2002). From the perspective of the ecological sciences, Bowman (2001, p. 549) concluded that ‘Ecologists must learn to harness the power of environmental history narratives to bolster land management practices designed to conserve biological heritage’. In a subsequent paper, he argued that ‘…the emerging fields of environmental history (from the humanities) and historical ecology (from the sciences) are proving to be invaluable intellectual arenas whereby the great challenges of land management can be tackled’ (Bowman 2002, p. i).

Deeper collaboration between ecological science and Australian history would have benefits to both disciplines. Notwithstanding the apparent separation of the two intellectual traditions, they can and should learn from each other’s successes and failures. The ongoing degradation of Australian rivers, for example, can be understood only through the lens of why we, as a society, allowed (and continue to allow) it to occur and seem unwilling (or unable) to halt the decline. The answer to that question lies not so much in quantitative, hypothesis-testing ecology as in the realm of non-epistemic values, of beliefs and of cultures (e.g. see Boon and Pralahad 2017). Ehrenfeld (2000), for example, argued that an increase in scientific knowledge alone would not result in more effective conservation of the natural environment. That can come about only by better understanding the place of science in the broader social life of the community and in the history, beliefs and attitudes of that culture. Environmental histories can contribute substantially to that understanding.

Deeper recognition of historical processes and of the shifting interface between ecology, natural history, environmental history, bioregional history and landscape aesthetics is likely to be of particular value to conservation biology and, more broadly, to the modern conservation movement, which is riddled with unacknowledged and problematic non-epistemic and historical contradictions (Hay 1988; Griffiths 1996). Albeit an ethically risky process, environmental histories might also be useful in allocating culpability (e.g. Dovers 1994, cf. Lines 1991 and Cary and Brown 1992). At the very least, being aware of the environmental history of a given area will generate a deeper understanding of its historical context and help explain why the extant biota is as it is currently (e.g. for the Gippsland Lakes, see Dow 2008; Boon et al. 2016, 2019; for irrigation districts in the Riverland of South Australia and north-western New South Wales, see Williams 1974; Rutherford 1963, 1968). We might then be in a better position to answer a question that Professor Hancock raised in 1972, this time in the concluding chapter of his treatise on the Monaro district, namely ‘Here we are now. How did we get here? Where do we go from here?’ (Hancock 1972, p. 183).

Conversely, historians could benefit from an injection of empirical environmental data to test (and sometimes, correct) the historical perspective provided by oral histories. Finlayson and Brizga (1995), Tibby et al. (2007) and Boon (2014) are examples of studies where local perceptions and oral histories have been shown to be inconsistent and unreliable, and where geomorphological, palaeoecological and ecological evidence provides more coherent and robust frameworks for understanding historical change. As Roberts and Sainty (2000, p. 119, 120) observed, ‘…oral history has been a poor – even unwanted – relation to conventional history’ and in contrast to its acceptance by some members of the history discipline, ‘…there has been no place for oral history within the discipline of science’. A closer working relationship between those undertaking oral histories and quantitative ecologists may help heal this wound, to the benefit of both groups.

Ecologists’ understanding of the complexity of interactions among organisms and between organisms and their environment could also alleviate some of the more naïve positions regarding an implied ‘balance of nature’ and the finer details of biogeography and the structure and dynamics of Australian plant and animal communities (Bowman 2012). Gammage (2011), for example, berated several eminent ecologists for an alleged lack of historical sophistication; equally, several ecologists and, in particular, botanists, have roundly criticised Gammage’s The Biggest Estate on Earth: How Aborigines Made Australia for its artless treatment of biodiversity and ecological processes (especially fire ecology) and for its bioregional naivety (e.g. Bowman 2012; Fensham 2012; Adam 2017; see also David 2013 and Hiscock 2014 for critical perspectives from non-ecologists). Perhaps what this discourse illustrates more than anything is the perceptiveness of George Caley, the Sydney-based plant collector for Joseph Banks in the first decade of the 19th century, when he lamented in a letter to his London patron in 1808 that ‘…the misfortune is, they who study geography are very indifferent botanists, and vice-a-versa. For my part I should
never have employed myself in a geographical pursuit’ (cit in McLaren 1996, p. 26).

Thus far, I have spoken in generalities about the relationship between historical ecology and environmental history, and of the practitioners involved in each discipline. Although this approach was intended to not limit the scope or approaches whereby future collaboration could occur, an essayist has an obligation to provide more specific guidance. There are many areas in which ‘an ecologist and an historian might profitably tackle in partnership’; but to me two subjects stand out where that collaboration would yield immediate fruit.

The first is the landscape-scale drainage of water-logged country, not only wetlands, to facilitate dryland agriculture. There is some information on the drainage of the floodplains of coastal rivers in Queensland (Griggs 2018) and for the Koo-Wee-Rup Swamp in southern coastal Victoria (East 1935; Roberts 1985) but perhaps the best-studied system is the South East region of South Australia (Williams 1964, 1974; Department of Primary Industries and Regions SA 2017). Drainage activities in this part of South Australia include several individual schemes dating back for over 150 years, including the Millicent–Tantanoola System (1864–1883), the Andersons Scheme (1950–1972) and, most recently, the Upper South East Scheme (1990–2011). Early reports, almost always set in a congratulatory tone, commended the drainage of the extensive mosaic of wetlands so that agriculture could expand into the prior ‘swamp country’ (e.g. Brady 1918; Callaghan 1948). Williams (1964, p. 96) sounded a note of warning about the ‘negligible benefits’ that had accrued after the ‘expenditure of much money’ in attempting to ‘reclaim’ these extensive wetlands for agriculture. In his monograph on the historical geography of South Australia, Williams later concluded that the story of the drainage of the swamps of the South East region was ‘one long tale of melancholy and failure’ (Williams 1974, p. 199). More recent assessments have been even more critical (e.g. Taffs 2001). Given the huge areas of land that have been drained across Australia to render them fit for agriculture (e.g. see Davis and Froend 1999 for south-western Western Australia), this topic would surely be a productive one to investigate more broadly from the prism of environmental history.

The second is the environmental history of mining and its relationship with surface waters, particularly rivers. The environmental impacts of mining in Australia are reasonably well established (e.g. Woodside and O’Neill 1995; Lloyd et al. 2002; Mudd 2013; Lawrence and Davies 2014) and include the horrific legacies of hydraulic sluicing (Rutherford 2000), eductor dredging (Hall 1988; Parliament of Victoria 1994), the movement of sand slugs down rivers, and the deposition of sediments on floodplains of what historically was called ‘sludge’ as a result of gold mining and mineral processing (Rutherford 2000; Lawrence and Davies 2014; Davies et al. 2018). Even so, mining history is arguably one of the ‘neglected aspects of Australian environmental history’ (Robin 2012, p. 185) and there are few treatments of this topic, except for national overviews such as Clark (1904), Blainey (1978) and Lee (2016) and a history of the Mount Lyell copper mine specifically (Blainey 1954). None of them make a great mention of rivers. I am aware of only one detailed treatment of an Australian river in terms of the role it played in mining, namely Patsy Crawford’s (2000) King: the Story of a River. In total, 95–97 Tg of tailings went directly into the King and Queen Rivers in south-western Tasmania as a result of mining operations and mineral processing. They were sufficient to fill in almost all of the King River downstream of the mine to a depth of 5 m, and to form a 250-ha delta where the river debouches into Macquarie Harbour.

The absence of Australian studies examining the environmental history of mining in terms of the roles played by rivers is surprising from three perspectives. First, mining has featured prominently in the economic and social history of Australia for well over 160 years; the discovery of gold across New South Wales and Victoria in the 1850–1860s is perhaps the most well known example (Blainey 1978; Mountford and Tuffnell 2018), but there were also significant finds of copper in South Australia in the 1840s, tin across eastern Australia in the 1870s, the silver–lead rush at Broken Hill (western New South Wales) in the 1880s, gold rushes in Western Australia in the 1890s, iron finds in South Australia in the 1900s, iron again in the Pilbara region of Western Australia in the 1960s, and of uranium at various times and at a wide range of locations since World War 2, and finally the boom in coal and natural gas exports, starting in the 2000s (Mudd 2013; Lee 2016). Second, mineral and fuel exports continue to dominate Australian export earnings; in 2016–2017, iron ore exports were worth A$63 billion and accounted for 17% of total exports of goods and services (Thirwell 2017). Third, there is barely a patch of Australia that has not been affected by mining to some degree or other. This is most obvious for Victoria, as an inspection of Flett’s (1970) survey of gold discoveries in that State makes clear. Even in the most remote sites, the impact of mining on rivers was immense (e.g. Davies et al. 2018) and, conversely, rivers were often turned to the service of mining. Referring to the Omeo district in north-eastern Victoria and the use there of hydraulic sluicing to recover alluvial gold, Christie (1993, p. 10), for example, concluded that ‘The key to understanding the operations of the Oriental Claims is [the] role played by water in the sluicing process.’

As a corrective to the picture of deepened collaboration between historical ecology and environmental history being boundlessly positive, it is worth examining some of the potential complications and drawbacks. Dovers (1994) observed that although historians may deal with natural resources and the Australian environment to some degree (e.g. their analysis of the spread of European settlement), their focus tends to be on relationships between people and their institutions rather than between people and their environment. This point was repeated by Robin (2012, p. 186) in her overview of the historiography of Australian environmental history in the international compilation A Companion to Global Environmental History. Nash (2013, p. 133) made a similar observation regarding environmental history as practised in the USA, with the added comment that although many historical subjects have extensive historiographies, most of which are ‘overwhelmingly nonenvironmental’, in every case ‘environmental history has shifted our perspectives on these topics’.

An explicit inclusion of the environment into historical discourse will require an expansion of historians’ horizons. This is not without its risks. Adam (2017), for example, pointed out some of the dangers of tying historical observations to land and water management, particularly with respect to flawed
interpretation of colonial-era paintings and, if the assessment were undertaken solely by historians, of an inadequate understanding of ecological processes such as fire history and of an unwarranted extrapolation of place-specific conclusions to much larger spatial scales, sometimes to the entire continent. Bowman (2012) voiced similar concerns. Even so, Adam (2017) saw many advantages of developing better working relations between ecologists and historians, and concluded that it should lead not only to ‘significant advances at the cross disciplinary interface, but also to new research directions in individual disciplines’ (Adam 2017, p. 360), Grace Karskens’ (2009) book The Colony: a History of Early Sydney shows what can be achieved when historians and ecologists collaborate and acknowledge the strengths and limitations of each other’s disciplines.

I am hopeful that this essay will act as a catalyst for such a productive cross-fertilisation of ideas and as a stimulant for ecologists, environmental scientists, historians and geographers, among others, such as resource economists, to work together to understand and help resolve the very great problem we face with the conservation and management of Australia’s aquatic systems. My critique addressed a mere handful of the broad spectrum of ways in which the country’s rivers have influenced Australians over the past two centuries, and there are ample opportunities for later studies to build on (or refute) the ideas that have been presented here.

Conflicts of interest

P. I. Boon was an Associate Editor for Marine and Freshwater Research while preparing this essay. Despite this relationship, he did not at any stage have editorial-level access to the manuscript while it was in peer review. Marine and Freshwater Research encourages its editors to publish in the journal and they are kept totally separate from the decision-making processes for their manuscripts. The author has no further conflicts of interest to declare.

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