Blue-Green Systems

IWA PUBLISHING

364

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

Culturally inclusive water urban design: a critical history of hydrosocial infrastructures in Southern Sydney, Australia

Taylor Coyne[a], Maria de Lourdes Melo Zurita[a], David Reid[b] and Veljko Prodanovic[c,*]

[a] School of Humanities and Languages, UNSW Sydney, Kensington, NSW 2052, Australia

[b] Georges Riverkeeper, Hurstville, NSW, Australia

[c] School of Civil and Environmental Engineering, UNSW Sydney, Kensington, NSW 2052, Australia

*Corresponding author. E-mail: v.prodanovic@unsw.edu.au

Abstract

Historic relationships between communities and waterscapes are complex and often explained solely in technical terms. There is a key need to understand how human-centered developments have shifted the use of river spaces over time, and how these changes reflect on the values of rivers and surrounding cultures. In this paper, we develop a critical analysis of the historically changing relationship between urban communities and water infrastructures using the Georges River catchment in Sydney, Australia. Our focus was on bringing together past and current perspectives, engaging with the formation of diverse hydrosocial behaviors entangled with water infrastructures. Using post-settlement historical documents, maps, journals, and newspaper articles, we trace shifts in hydrosocial perspectives over time, mapping six distinct historic phases. In our study, we offer a shift from the main paradigms currently influencing the development of urban water infrastructures, moving away from the dominant technical propositions of systems designed purely for the management and treatment of stormwater. Drawing on our analysis, we propose a new urban water design concept: Culturally Inclusive Water Urban Design (CIWUD). This presents an advancement on current framework to include a consideration of people's connections and uses of urban waterscapes, as well as a shift towards democratic space design.

Key words: culturally responsive design, environmental history, hydrosocial cycle, waterscapes, water sensitive design, WSUD

Highlights

- Urban waterscape's history promotes understanding of diverse hydrosocial values.
- Six urban river historical phases highlights the shift towards democratic and inclusive design.
- Culturally Inclusive Water Urban Design links the social and the ecological values.
- Inclusive waterscapes design includes social, technical, cultural, ecological and political considerations.

INTRODUCTION

Like many cities around the world, the city of Sydney was chosen during colonial ventures in part because of its hydrological features – a deep harbour and access to freshwater (Cathcart 2009; Goodall & Cadzow 2009; Karskens 2009). However, soon into the British colonial occupation of the Sydney region, expeditions out of Sydney Cove and its surrounds led to an acknowledgment by

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

the colonists of the network of rivers that stretch out and around the Sydney Basin. One such river which came to shape Sydney's social, economic and cultural geographies is the Georges River. The communities that the River has supported over the years since British colonial occupation have gone through dramatic periods of change.

Today, Sydney faces multiple environmental challenges such as extreme storm events, drought, flooding and increased pollution. The fundamental challenges facing not only the Georges River but many urban waterways around the world, is to balance the needs of those who live, work and play in and around the river, with the needs of the river itself (DeFries *et al.* 2004; Lehn 2009). In a global context, examples of working towards such a balance can be found in a range of cities including Lagos, Nigeria (Adeloye & Rustrum 2011), Hyderabad, India (van Rooijen *et al.* 2005), Cape Town, South Africa (Gxokwe *et al.* 2020), and Beijing, China (Jiang *et al.* 2012). Within the tensions present in designing resilient urban waterscapes (Bava 2009), there is a deeper, resoundingly political approach to understanding the rivers. Goodall & Cadzow (2009, p. 22–23) speak of how the Georges River might be thought of as either a celebration of the survival of a 'native' ideal or thought of in a way that 'values the processes by which all non-human species interact and adapt to changing urban physical environments …'. It is with this latter approach that we approach this paper.

The detailed and nuanced environmental history work on Sydney's waterways (Cathcart 2009; Goodall & Cadzow 2009; Irish 2017; Tyrrell 2018; Karskens 2020) have highlighted the ways in which dynamic and brutal histories across and alongside rivers have unfolded, which have partly been the result of the violence and speed with which settler-colonialism has occurred (Moreton-Robinson 2015; Dorries *et al.* 2019). For example, exploring the environmental histories of Shoal Lake in Winnipeg, Canada, Perry (2016, p. 93) makes an astute observation on water, colonialism and history: 'the forgetting of where water comes from … [is] enabled by the social relations of colonialism'. The notion of 'where water comes from' can be interpreted in a material sense of water's journey to a place, but also in the geosophical and historiographical sense of water's placement being set within a way of knowing and valuing the environment. The 230-year-old relationship that settler-colonial Australia has had with waters in general, and rivers in particular, has imposed irreversible consequences on the enduring knowledge and practices of waterscapes. Given that the focus of the environmental history work of rivers in Australia, so far, has been on constructing biographies of Sydney's water bodies, the interplay between historical and material processes and the contemporary political structures which respond to these processes could be more emphatic in the telling of an environmental history of an urban river. Following how a river's history changes requires the tracing of the historical flows of power into and within a city (Harvey 1973; Swyngedouw 1997; Gandy 2004; Swyngedouw 2004; Swyngedouw 2006). As such, the speed and the form in which Sydney's waterscapes are being entangled with urban development processes, including infrastructure design needs to be understood historically.

While the development of environmental engineering technologies has increased somewhat gradually in Europe, Australia has experienced what might be thought of as a 'fast-tracked' program of colonial, fit-for-purpose engineering. Whilst some pioneering work by civil and environmental engineers mitigated technical water challenges (such as stormwater drainage, collection and reuse, and recently pollution treatment), an understanding of how engineering measures are situated against social, cultural and economic factors is only just emerging (Rosen 2012). The shifting status of water engineering within the Australian political psyche (Crase *et al.* 2009) can be set against a public wanting to see water management with a more 'considered' and 'sustainable' approach (Farrelly & Brown 2011; Wilfong & Pavao-Zuckerman 2020). This is manifested in the development of a new concept in Australia called Water Sensitive Urban Design (WSUD). The objective of WSUD approaches has been to improve urban environments through the capture, transport, treatment and re-use of urban waters (mainly stormwater), aiming to reduce the pollution and degradation of receiving waterbodies, such as creeks, rivers and bays. Similar concepts have been popularised in Europe ('nature-based infrastructure'), North America ('Low Impact Development (LID)'), and recently China ('Sponge City'), all

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

based on ecological principles for water management (Fletcher *et al.* 2015). The fundamental premise of WSUD, according to Wong & Eadie (2000, p. 5) is 'based on formulating structural plans for urban development that incorporate multiple stormwater management objectives'. The Wong & Eadie (2000) outline was, at the time, forward thinking; solutions were set amongst best management practices from a technology perspective with best planning practices from a design perspective (Whelans *et al.* 1994). The growing appreciation for a need to create co-ordinated techno-political structures that push for creating and managing stormwater infrastructures, with intrinsically linked planning and design processes, was at the core of WSUD (Wong & Eadie 2000). More broadly, WSUD technology fits into a global shift towards more 'considered' water management solutions, as well as a shift in the real and expected roles of local governments and utility companies (Oral *et al.* 2020). However, the primary focus of WSUD remains on designing infrastructures informed by engineering principles, hence even WSUD approach is still techno-centred and not culturally inclusive. Current literature on WSUD, while strongly examining stakeholders views of urban water practices (Ruiz *et al.* 2017), fails to acknowledge deeper cultural connections between people and natural space, and how this approach can be made more responsive to the place where it is being implemented.

Critical interpretations of cultural and affectual ways in which the Georges River's histories have been told is a salient approach towards addressing this gap. Situating dynamic representations of the River against current and dynamic ways of knowing, presents a path forward to consider the role of culturally inclusive water design infrastructure in a metropolitan city such as Sydney. The well-preserved post-settlement archival record for how water infrastructures emerged helps in mapping out broad trends in settler-colonial Australia's cultural relationship with water and rivers. As such, there is scope for contemporary water managers to better understand trends in how the multiplicity of values of urban rivers came to be the way they are. While Australia has a unique history about rivers, the approach investigated in this work offers a theoretical framework that can be used in other countries around the world, especially ones with well documented colonial history. Understanding the history of cultural beliefs and practices and the technological developments of rivers in juxtaposition presents a relevant framework for the ways in which Culturally Inclusive Water Urban Design (CIWUD) could be better integrated to urban planning. To further this point, this work suggests the development of a new urban water design concept (based on current WSUD approach) to promote democratic futures for waterscape. We explore the main principles and ideas of this concept throughout the paper.

THEORETICAL FRAMEWORK

A need to shift away from thinking about rivers in a way that separates 'water' from 'society' underpins reimagined futures of the Georges River. As such, for our analysis we build upon recent scholarship that has adopted an ontology based on the notion of the hydrosocial cycle (Swyngedouw 1999; Swyngedouw 2009; Bakker 2012; Linton & Budds 2014; Boelens *et al.* 2016). Understanding that 'water's materiality, conceptual significance, and meaning is the direct result of the social relations that produce it' (Wilfong & Pavao-Zuckerman 2020, p. 1) is crucial to move away from entrenched hydroimperial ways of knowing water (D'Souza 2006; Pritchard 2012). Significant work by McLean *et al.* (2018) on how certain waters are known is, in the context of this paper, highly pertinent. In referring to 'shadow waters', McLean *et al.* (2018, p. 615) comment on how uneven historical and spatial processes and structures 'privilege certain waters while rendering other waters invisible and marginalised'. Situating hydrosocial knowledges within what might be thought of as the confines of the colonial legacy of water engineering practices necessitates contemplation from current actors involved on how they have come to know water. As a discursive mechanism, 'hydro-epistemology' (Baghel *et al.* 2017; Staddon & Everard 2017, p. 105) analyses

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

water management practices through the integration of historical, cultural, economic and political structures which are read against an uneven access and representation of water knowledges (Fricker 2007).

In response to the call to reflect on the emergence and presence of hydro-epistemologies, there is a clear need to situate the water that flows throughout the systems of cities within a broader socio-political context. Central to such analyses is the concept of 'waterscape'. According to Budds & Hinojosa (2012, p. 124), 'waterscapes' are how spatial and temporal power relationships emerge from the ways 'flows of water, power and capital' combine. If this is thought about in an urban context (Swyngedouw 1997), that a waterscape has a transformative capacity – materially and socially – it becomes fundamental to framing how the dynamic settings of cities develop through deeply entrenched, and in many cases, symbiotic (albeit often uneven) relationships with water (Cousins 2017).

The development towards culturally responsive waterscapes can be read against the global trend for cities to address issues of social and environmental injustices (Canigilia *et al.* 2017). Pressures on urban waterways have seen a proliferation in the breadth and severity of justice issues related to how waters are accessed and managed (Zwarteveen & Boelens 2014; Boelens *et al.* 2018; Sultana 2018). Water justice literature points to the need to design and manage urban water infrastructures with consideration to the diverse needs of people and environments (McLean 2007; Bohman *et al.* 2020). As such, we focus much of our analytical framing within the growing literature surrounding the issues of 'water sensitive cities'. Following the work of Brown *et al.* (2008) we adopted the 'urban water transitions framework' to contextualise the hydrosocial history of the Georges River through its various phases. Central to this framework is the acknowledgement that the social and ecological histories of a place greatly influence the ways that management paradigms transition through not only time, but also through ideas and technology (Brown *et al.* 2008, p. 2). For Sydney, this means reflecting on the shift from seeing large parts of the city, such as the southwest, as being connected to industry and agriculture, towards being more aligned with a global, 'liveable' urban metropolis. It also, crucially, means acknowledging the continuous and enduring knowledges of the First Nations peoples who have maintained these lands and waters for thousands of years (Attenbrow 2002; Pascoe 2014; Irish 2017; Moggridge *et al.* 2019; Foley & Read 2020).

METHODOLOGY

Case study – Sydney waterscapes

Metropolitan Sydney is highly urbanised, being the region of initial European colonisation of Australia over 230 years ago and continuing to be the most populous region in the country. Across metropolitan Sydney, waterways dissect the urban form. To the north, beginning in Broken Bay, the Hawkesbury River meanders through tall sandstone cliffs. Heading west, and then once reaching the foothills of the Blue Mountains, the Hawkesbury and the Grose River merge, turning south as the wide, slow Nepean River. Flanking the western edge of Sydney, and crossed in multiple points by road, rail and pedestrian bridges, the Nepean continues south through a mosaic of remnant Cumberland Woodplains. Scattered throughout, some water is collected in small dams and ponds on ageing farms, whilst the rapidly expanding residential areas add impermeable surfaces that increase flows of stormwater into the urban drainage network. The Parramatta River and the Cooks River slice across the urban landscape, originating in the drainage networks of dense industrial regions, and progress into Sydney Harbour and Botany Bay, respectively. Sydney's southern most major river systems in the metropolitan Sydney region, the Georges River, begins deep in the Illawarra escarpment, then weaves its way across the Woronora Plateau, eventually emptying into the southern rim of Botany Bay. In places, the Georges River waterscape is typified by rugged peninsulas that jut out into wide

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

stretches of the River, and in other places rocky cliffs create secluded pools of deep water. By and large, however, the River is characterised by the leafy headlands populated by suburban houses, many with private access to its waters.

These rivers are exemplars of the hydrosocial cycle (Swyngedouw 1996; Swyngedouw 2009). They are not 'natural features' of the landscape, rather their water flows are moderated by social, political, economic, and cultural relations which are then in turn, influenced by the materiality and physicality of water (Melo Zurita *et al.* 2016; Jones *et al.* 2019). The creation of various water infrastructures is key for the types of social-natural entanglements that exist in a particular place-shaping the uses and flows of water towards different social, political, and economic agendas. To construct a focused understanding of the broader aspects at play in the river's management, the study benefited from developing a case study around a particular place. For the Georges River, given the vastness and the social and environmental diversity of the region, a park in Lugarno, near where Salt Pan Creek meets the Georges River, was chosen. HV Evatt Memorial Park (the park) (−33.98106, 151.04331) is located on the western flank of the Peakhurst-Lugarno Peninsula (Figure 1) and was chosen for its proximity to the Georges River, and for the available historical resources. Additionally, in 2013 the park had been also retrofitted with a constructed wetland and biofiltration system, under a novel WSUD approach. This allowed for contemporary analysis of records involving WSUD infrastructure and allows for discussion on how current concepts can be adapted to become more culturally responsive and inclusive.

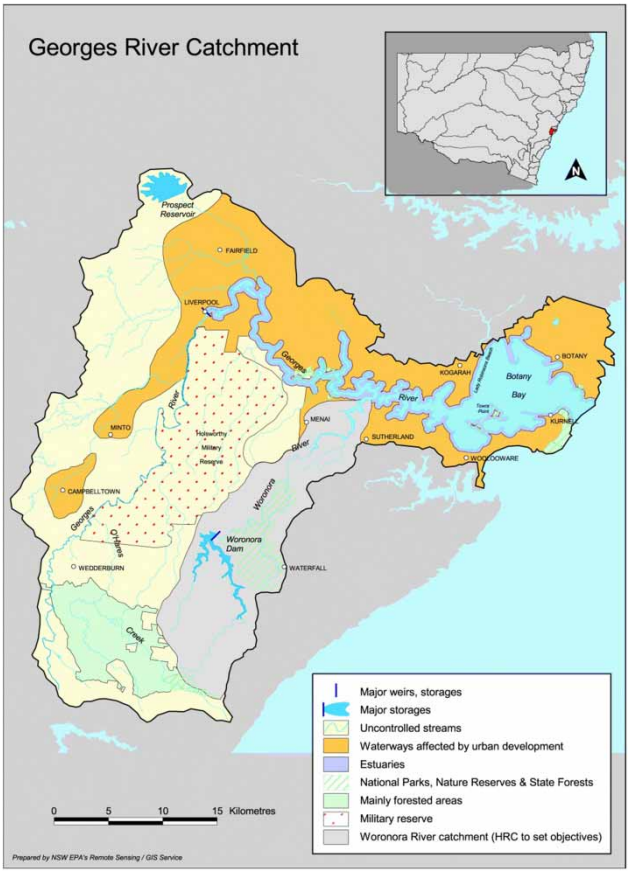


Figure 1 | Map showing location of Lugarno in relation to Sydney and the state of New South Wales (NSW Government EPA Remote Sensing/GIS Service).

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

Study approach – a biography of place through hydrosocial identities

In this study, we engaged with extensive archival analysis as our core research method. This involved collating and coding digitized newspaper clippings, journals, photographs, drawings, paintings, sketches and maps. This material was hierarchically catalogued and analysed for relevance and applicability to this study (L'Eplattenier 2009; Bell 2020). Using the urban water transitions framework, and mapping the 'histories, ecologies, geographies and socio-political dynamics' (Brown *et al.* 2008, p. 2) we developed a method to understand the River's histories, through a series of key framings, or phases. Embracing what Purdy (2011, p. 25) refers to as the 'integration, customization, and accessibility' of digital archives, the archival analysis drew heavily on the use of the Australian National Library tool 'Trove' to work across multiple sources, media, locations, and timeframes. Whilst some scholars, such as Nicholson (2013) find the use of digital archives problematic, we chose to engage with the digital archives because of the ability to efficiently generated connections between archival material, as well as draw on an increasing network of sources (Bode 2014, p. 4).

Initial scoping of *Trove* enabled an understanding of what types of material would be targeted. A process of keyword searching with Boolean operators was then undertaken, with word combinations being set against media, locations, and times. For example, 'Georges River Flood' would be searched alongside the categories 'Newspaper', 'New South Wales' and 'From 1803 to 1960'. These results from the search were then catalogued into our dataset, categorised according to the material's source, type of media, date of publication, the location of publication, key words, title, a summary of the material, its relevance ranking for the research from 1 to 10 in accordance with our framework, a link to the digital record, and a partial reproduction of the original material.

The archival material analysis was the primary source for the mapping of the various phases of the River's history. To formulate this analysis, we drew on content analysis through themes and dates. The results draw on 'manifest content' (Winter 1992; Lee & Peterson 1997) as well as 'latent content' (theme) analysis (Harrison 2004; Farrell 2012).

GEORGES RIVER: A HYDROSOCIAL HISTORY

We have developed six key temporal phases as a heuristic to reflect the various ideological and technological ways of knowing the River. They are: *Phase 0: Deep History River, Phase 1: Seclusion River. Phase 2: 'Development' River, Phase 3: Menacing River, Phase 4: Recreation River*, and *Phase 5: Democratic River.* It should be noted that these phases are not meant to refer directly to a chronological progression of the River, nor do they speak to a constant place. Instead, these phases offer a way of mapping the dynamic histories of the connected waterscape which shape the Georges River beyond the pipes. Just as each identified 'phase' might seem to conclude, there is no definitive 'end' to the perceptions of the River. Instead, contrasting permutations of perceptions of the River by 'users' and 'managers' exist concurrently with other phases identified thus far in this paper. Further, these phases can also be thought to reflect the various roles and responsibilities that local councils have in managing the region's stormwater infrastructures. Managing recreational and sporting facilities, local flood mitigation responses, and stormwater pollution for example, illustrate that the multiple ways of *knowing* the River have a relationship with the multiple ways of *managing* it.

Foundations – deep history of the river (phase 0)

The first phase, *Phase 0*, is so called deep history because it situates the entire foundation for understanding *all* histories of the area. This phase transcends progressions in time and instead resembles a cyclical way of mapping history (as promoted by work done by those such as Duara (2015)). The

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

'Deep History' of this phase stretches back thousands, tens of thousands, and millions of years and highlights the significance of the lands and waters in shaping how the River has physically changed over time, and the role that the River has had in shaping people, and how people have shaped the River (Shrycok & Smail 2011; Wilcock *et al.* 2013).

From the archival material found, there were several references to a unique feature within the Sydney environment – volcanic intrusions. The volcanic neck which sits under the Peakhurst-Lugarno Peninsula is described in detail as,

> '*The neck occupies a conspicuous depression within the Hawkesbury sandstone. In the deepest portion of the valley, the surface of the neck is from 75 to 160 feet below the ridge top, and about 100 feet above the level of the George's River*' (Department of Mines 1929–1930, p. 91).

HV Evatt Memorial Park is present on what is this volcanic neck. The early Triassic intrusion cuts up in through the area's sandstone formations and provides fertile soils for the growth of the vegetation that now surrounds the area. This volcanic soil would be crucial to the agricultural activities which would take place on the site in its later years.

Phase 0 here refers not simply to a foundational history of the site but also to an enduring and transtemporal way of understanding the waterscapes of the region. Accordingly, its inclusion acknowledges the diverse histories of the region's First Nations Peoples. As Goodall (2014) notes, the Georges River is Country to the Dharug and Bidjigal people on the northern side of the River; the Dharawal people to the south; and the Gundungara people to the west. The connection that First Nations Peoples of the region have had with the River and its surrounding landscape is evidenced through oral histories of the Georges River and its surrounding lands. Oral histories of water knowledges exist on Dreamings. Knowledges of where and when water would move throughout the region, as well as how to modify landscapes and use different technologies is part of the life of First Nations Peoples and it has been for thousands of years (Bandler 1995; Moggridge *et al.* 2019).

The living history of the region's First Nations Peoples is articulated through the Dreamings that emerge from generations of collective knowledge building. The various narratives that connect the features of the land and water in the region and the First Nations Peoples' connection to Country is profound and rich and must be acknowledged as a fundamental and continuing element of the River's history – in the past, present and in the future.

Phase 0, with its complexity and underlying nuance has much to offer from a management perspective. As seen in numerous instances across Australia, First Nations Peoples who live along rivers have a long and intricate system of custodianship often manifest through infrastructures such as weirs, and eel and fish traps (Humphries 2007; Gammage 2011; Pascoe 2014). The existence of such infrastructure that was sensitive, responsive and active towards the ecological environment prior to British invasion reflects the deep relationship between First Nations Peoples and water (Barber & Jackson 2015; Moggridge *et al.* 2019).

Colonial settlements – seclusion river (phase 1)

Where First Nations Peoples' connections to water and to the River have developed in a responsive and sensitive manner, the interaction of European settlers during this colonial period show a far less nuanced relationship, producing more pronounced and often violent changes. The introduction of livestock for example, as well as the development of irrigation canals and pipes, most certainly played a significant role in reshaping the waterscapes of Sydney.

In the centre of the map shown in Figure 2, is Botany Bay, the site of initial contact between the British and the First Nations Peoples. To the north of Botany Bay, the Cooks River is visible. The Georges River, at this stage unnamed by settlers, occupies the southern parts of Botany Bay.

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

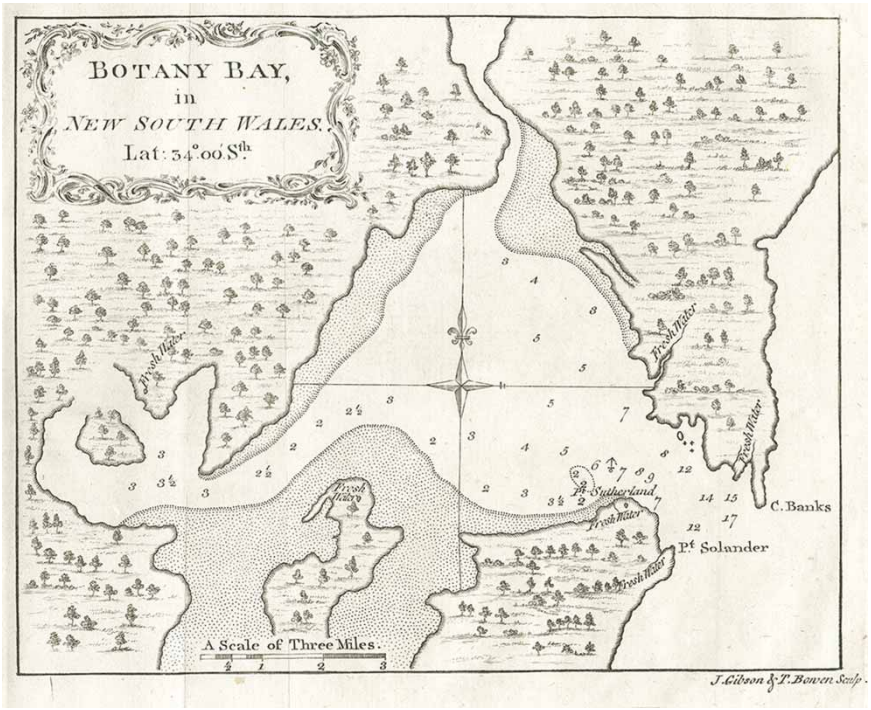
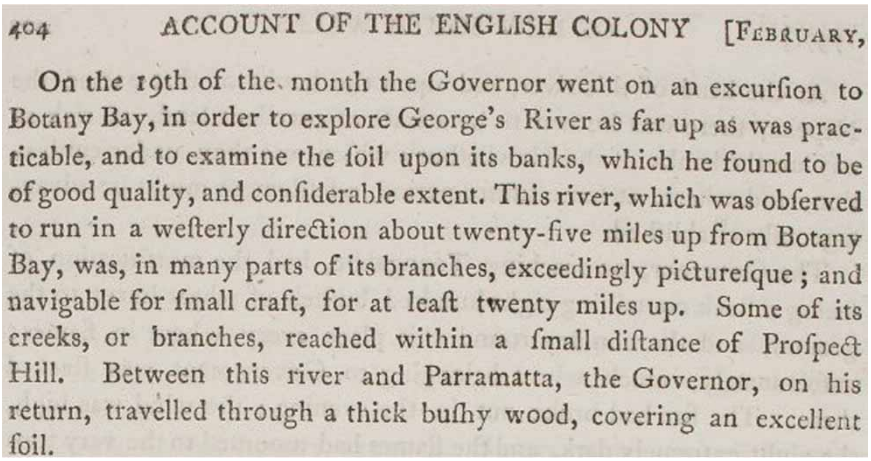


Figure 2 | Entrance of Endeavour River, in New South Wales (1773) State Library of Queensland.

Understanding how to navigate these lands and waters, materialised through images such as this map and they mark the beginning of *Phase 1*: *Seclusion River*.

The choice of 'seclusion' to identify this phase of the River's history reflects the sentiment that existed amongst settlers. Early accounts of expeditions up the River, such as Gov. Arthur Phillip's writings (Figure 3), speak to a way of knowing the River as clean, vast, picturesque and secluded. But there is also another layer to this choice of terminology – that is of the agency of the River itself. During these transformative years, detailed in Karskens (2009) book *The Colony*, the distance provided by the undulating terrain of Sydney, enabled the River to remain largely secluded from the often-violent changes that were taking place in Port Jackson (e.g. the degradation of the Tank Stream).


404 ACCOUNT OF THE ENGLISH COLONY [FEBRUARY,

On the 19th of the month the Governor went on an excurſion to Botany Bay, in order to explore George's River as far up as was practicable, and to examine the ſoil upon its banks, which he found to be of good quality, and conſiderable extent. This river, which was obſerved to run in a weſterly direction about twenty-five miles up from Botany Bay, was, in many parts of its branches, exceedingly pictureſque; and navigable for ſmall craft, for at leaſt twenty miles up. Some of its creeks, or branches, reached within a ſmall diſtance of Proſpect Hill. Between this river and Parramatta, the Governor, on his return, travelled through a thick buſhy wood, covering an excellent ſoil.

Figure 3 | A description of the expedition by Gov. Arthur Phillip along the Georges River (1804) Mitchell Library, State Library of New South Wales.

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

That the River would offer some form of respite for those seeking to leave the nearby chaos of the rapidly growing Sydney town speaks to the types of settlement which occurred along the River. Many of Sydney's most marginalised and disadvantaged communities emerged from the settlements which were often near to creeks and swamps, such as in Waterloo. While it could be argued that working-class people were drawn to the proliferation of continuous fresh water that helped sustain the industries of the area (Frith 2004), perhaps a more nuanced analysis would draw on the 19th century power structures that emerged from a colony grappling to control the free settlers, new migrants and First Nation Peoples who defied orders to not settle and dwell around flood-prone rivers (Karskens 2016). Being instructed to avoid rivers, creeks and other metropolitan waterways significantly reflects the bureaucratic colonial mindset of thinking about water.

For many freed convicts and early settlers however, the River worked within a way of thinking about nature that fit with Western ideologies of Romanticism, but within an Antipodean setting (Cousins 1998–1999). These notions of nature as the 'sublime', the 'vast' and the 'wild' would come to shape how the Georges River became thought of within the settler-colonial psyche. Small riverside huts (Figure 4) that would come to typify early settlement in Sydney's fringes (Karskens 2014) reflect the hydrosocial imaginaries of the time.

An exemplar of this vision of the River comes from the Latin phrase *Australia Felix* (meaning 'Fortunate Australia'), which was coined by early colonial explorer Thomas Mitchell (1838). In a Georges River context the term can be seen to shape the desire to make a name for one's self. This phase saw settlers move into various locations along the River, and First Nations Peoples being forced to live alongside those who went searching for a place of their own – on someone else's land.

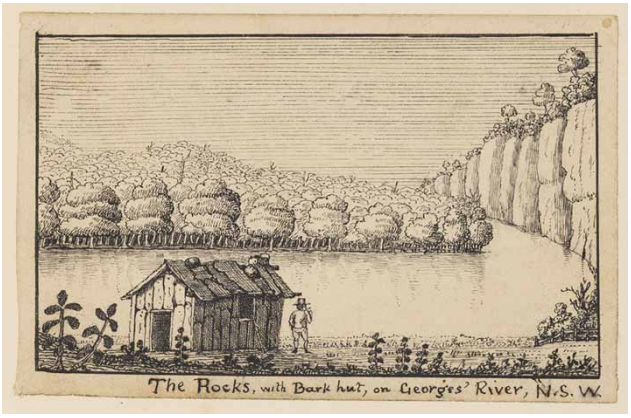


Figure 4 | An etching of a Bark Hut along the Georges River (1840–1865) Mitchell Library, State Library of New South Wales.

The hydraulic city – development river (phase 2)

If *Seclusion River* is typified by a desire to 'get away' from urbanization, *Phase 2* is typified by the notion of wanting to bring urbanization to the River, through the ideals of development. The move towards developing the lands and waters around the River emerged at the beginning of the 20th century with the notions of the secluded river fading away to a river which was connected, modern and a center of production – towards the '*Development' River*.

Settlements such as Liverpool, Canterbury, Campbelltown and Bankstown were expanding. Farming was thriving, especially the growing of fruit and vegetables. Lugarno offered much to the growing city of Sydney; where HV Evatt Memorial Park now sits, a farm once flourished. Dating back to 1831, the orchard evolved over the years and remained a market garden ('Webbs Garden') up until 1963. Highlighted in an article in 1951 (Figure 5), Webbs Garden can be seen to be a significant part of

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

GROWS VEGETABLES IN OLD VOLCANO CRATER NEAR CITY

(By a Staff Reporter)

WHAT is believed to once have been an old volcano crater is the site of a vegetable market garden owned by Mr. E. Webb, Lugarno Parade, Lugarno.

Figure 5 | Newspaper article discussing how the volcanic soils have helped a market garden thrive. The Farmer and Settler, 2 Nov 1951, p. 10.

the River's story because it connects two key phases of the River – that of the ancient volcanic deep history and the development of the region as a hub of productivity.

Webbs Garden, and the other food production areas of the region were largely enabled by a shift in thinking about how to manage water. The change is consistent with what Allan (2005) describes as a 'hydraulic mission', an underlying principle that humans are dominant over nature which is manifest through particular 'hydraulic feats'. This concept highlights the widespread belief that water can, and should, be controlled and used as a resource by society to better the economic systems (Molle *et al.* 2009). In Sydney, for example, the construction of the Upper Nepean region dams (Cataract, Cordeaux, Avon, Nepean, Waragamba) in the early-to-mid-20th century emerged during what can be seen as a more widespread utilitarian phase for almost all of Sydney's waterways, including the Georges River. Underpinning this pervasive push for modernity, was the idea that Sydney – the urban and the suburban city – would be a connected and industrious metropolis. Catchment maps such as Figure 6 highlight the drive to manage and develop Sydney (and its infrastructure) in a structured and entirely 'Modern' way.

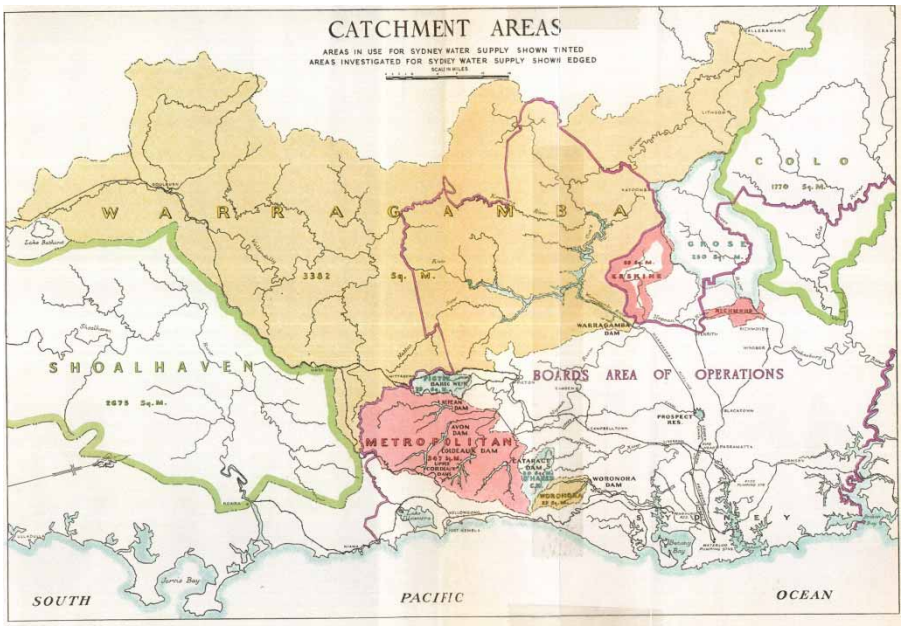


Figure 6 | Map of Greater Sydney's catchments (1961) Metropolitan Water, Sewage and Drainage Board, Sydney.

Analysis of various newspaper articles from the early 20th century indicate that for many people involved in the management of urban waterways, public concern over sanitation and safety were driving factors to 'cleaning up' the urban drains, canals and pipes. The development of the Ashfield

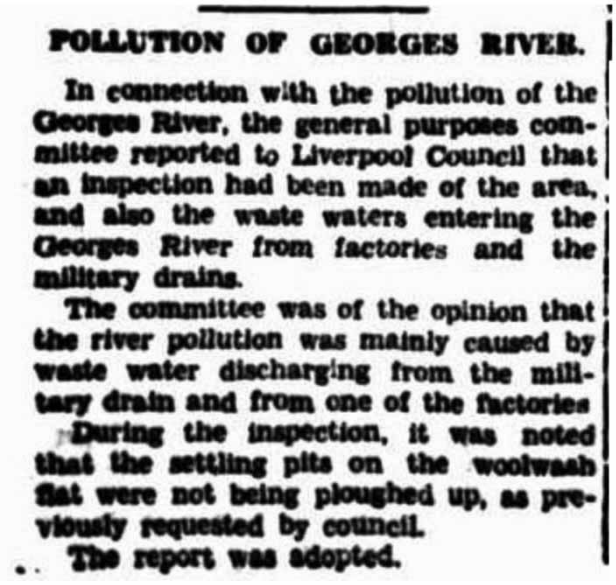
Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

Stormwater Sewer (mentioned in *The Australian Star* (25 February 1891, p. 7)) was seen by government officials as a way to remove 'all danger of flooding' through the draining of the 'low-lying lands', as well as increasing the heights and widths of the drain walls themselves. The connecting of the Iron Cove in the north to the Georges River in the south was framed to those concerned about the cost of such an expenditure as something that would 'increase in the value of property and the greater conservation of the health of the residents'.

The development of techno-centric engineering projects was the focus of much of the 20th century decision-making processes in Sydney. The Ashfield project illustrates the hydraulic mission manifest – a connection between a 'hydro-imperial ontology' of sorts (Pritchard 2012), which relies on, and co-constructs particular socio-political conditions. The development of urban stormwater systems across metropolitan Sydney saw rivers like the Georges not as a body of water which is to be revered or respected, but rather under a utilitarian gaze, to serve dominant societal interests. And yet there was another way of thinking about the River which would come to dominate the thinking for much of the mid-20th century: The River as a menace.

Rising waters – menacing river (phase 3)

The *Menacing River (Phase 3)* emerges from the numerous recorded catastrophes which occurred in and around the River over the last two centuries. That Sydney's rivers were in need of 'cleaning up' was only one of many concerns that communities had over these waterways (Figure 7).



POLLUTION OF GEORGES RIVER.

In connection with the pollution of the Georges River, the general purposes committee reported to Liverpool Council that an inspection had been made of the area, and also the waste waters entering the Georges River from factories and the military drains.

The committee was of the opinion that the river pollution was mainly caused by waste water discharging from the military drain and from one of the factories.

During the inspection, it was noted that the settling pits on the woolwash flat were not being ploughed up, as previously requested by council.

The report was adopted.

Figure 7 | Pollution from Military drains and factories is recognised as a contributing factor to the increasing pollution of the Georges River, The Biz, 2 Oct 1941, p. 2.

The *Menacing River* highlights the growing fear that rivers were becoming heavily polluted, unsafe and an unpleasant part of the urban setting. An enduring aspect of Sydney's waterways from early colonial accounts until today has been that rivers flood. Grace Karskens (2016) paper 'Floods and Flood-mindedness in Early Colonial Australia' discusses the role of flooding in shaping socioecological understandings of rivers. For the Georges River, flood events like the one occurring in 1950 (Figure 8) solidified concerns over the safety of living near the River.

Causing widespread damage and cutting off communities, flooding, when placed alongside other events such as drownings and shark attacks, strengthened the concern that interactions with the River should be restricted. Framing rivers as a chaotic and unpredictable threat alludes to a way of

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

150 HOMES MENACED BY RISING RIVER

Police Stand By At Milperra

Police and 100 volunteers were standing by at Milperra, 13 miles south of Sydney, late last night to evacuate more than 400 people in 150 homes menaced by flood waters from the George's River.

Fourteen houses were isolated when the river burst its banks at 11 p.m. and another 15 are in serious danger.

Other highlights of the deluge and floods yesterday were:

● A 74-year-old pensioner was drowned near Mudgee when his horse and sulky were swept away in the Cudgegong River.

● A young unidentified boy was seen being swept away in a storm-water channel at Parramatta. It is feared he was drowned.

GEORGE'S RIVER BREAKS BANKS

Torrential rains caused floods in Sydney last night. Here, Mr. and Mrs. Geoffrey Parker leave their home in Newbridge Street, Milperra, with neighbours, after the George's River had broken its banks and flooded land around their home. By 2.30 this morning eight families had left their homes. (Story this page.)

Figure 8 | Across the Georges River catchment, but mostly between Cabramatta and Liverpool and Millpera, there was widespread damage to property as the river broke its banks and stormwater drainage systems overflowed. The Sydney Morning Herald, 16 June 1950, p. 1.

constructing waterscape imaginaries which Karskens (2016, p. 324) notes has historically been imbued with notions of 'terror and ordeal'.

Stakeholder river – recreation river (phase 4)

A fundamental shift by policy makers away from urban waterways as a threat, to viewing them as an asset occurred in the latter decades of the 20th century in Sydney (Morison *et al.* 2010). Living near waterways in places like Sydney was now seen as a fundamental component of the liveability of the city (Birtles *et al.* 2013).

The push for Sydney's metropolitan region to be part of the urban sustainability and global 'liveable' city agenda was to get communities to be proud of their environment and to take joy in sharing their natural features. This phase, *Phase 4: Recreation River* is defined by *transformation*. Seeking to take back ownership of the River and its surrounds, *Recreation River,* as Goodal *et al.* (2005, p. 1) note, was about local park committees 'protecting and extending what they understood to be "natural"'. Transformations of parks in this phase show a push for greater recreational facilities in and around the River, like Webbs Garden becoming HV Evatt Memorial Park in 1965.

Recreational activities centered around the River such as swimming, speedboating, kayaking, and fishing illustrate a shift in the thinking of the River from something to be feared to something to be enjoyed. Although various signs and warnings near the River, suggest that the River should be respected for its power, might and ferocity; perceptions of the River shifted towards a vision of users enjoying it. Fun, relaxation, entertainment, and physical exercise became central themes, facilitated by the River. This shift still largely sees the River as a material body of water, but with elements of positivity attributed to it, rather than fear or contempt.

In instances where recreation is the central focus of what the River 'provides' to those who engage with it, there are two crucial factors to consider. The first is that of the feelings of emotional connection towards the River, and the second is a recognition that infrastructures that exist in or around the River should be constructed in a way that are inclusive of both the cultural identity and the ecological conditions of the place. These conditions, importantly, do not exist exclusively, but rather are in a concurrent process of creation and re-creation. Emotional connections work towards caring for the River's ecological health, which in turn creates positive associations further entrenching connection. A recognition that the River has a role in shaping these connections has, during this historical framing been lacking.

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

What emerged during this phase of the River's story was an increasing number of organisations and institutions which had a role to play in its managing. Across the entirety of the River and at any one intersect, there could be inputs from private residents, local councils, the utility corporation *Sydney Water*, the NSW National Parks and Wildlife Service, the Roads and Maritime Authority, and the Environmental Protection Agency. A decision-making process between all such stakeholders is a complex and intricate thing; situating community needs and values within any type of ecological management has, historically, been a somewhat difficult and at times neglected process (Andrachuk & Armitage 2015; Fletcher *et al.* 2015; Sutton-Grier *et al.* 2015).

To this point, in 2013 a novel WSUD approach was applied to HV Evatt Memorial Park, Webb's Dam and surrounding environment, retrofitting these spaces into a constructed wetland and water biofiltration system (Figure 9). This was a step towards engaging with local community needs and values by caring for river and ecosystem health through pollution prevention and reduction, while providing service to humans in the form of a recreational amenity. While, at the time, this was considered an innovative and novel approach, a fundamentally techno-centric approach was used for its development, as evident from local signage (Figure 9). From an historical perspective, highlighted in various phases of this study, while this project reflects environmental, flood-minded and water saving

Figure 9 | Local signage of the implementation of WSUD approach in Evatt Park.

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

approaches to water management, it is unclear whether cultural factors are considered in its design. This has resulted in limiting community interactions with the space by creating an over-engineered, community-exclusive environment.

Recognizing tomorrow's river, today – democratic river (phase 5)

By and large, notions of the lower River as secluded and menacing have faded from social perceptions (although for the upper River, which is surrounded by National Parks, these may still be present). The River meets the criteria of the *Recreation River*, and there are certainly legacies of the *Development River phase;* the idea of restraining and manipulating the River – that humans are dominant *over* the River – is proving hard to shake, especially with instances where physical infrastructures are seen as doing this job – as in the case of pipes, weirs, jetties, bridges, etc. We suggest that the River now reflects an amalgam of the aforementioned phases.

The River – as conduit for material waters as well as social waters – is now potentially entering a new phase. Underpinning what we see as *Phase 5: The Democratic River* is 'the reconceptualization of rivers as democratic entities' (Smith 2017, p. 99). This phase speaks to the need to create equitable spaces for shared knowledge and values of the River to be expressed and practiced, pushing for greater democratic process in decision-making concerning the River and its future. By focusing on who benefits from the creation and continued use of water infrastructures, community participation and co-production of democratic infrastructures come to the front. Interrogating the historical production of the Georges River promotes a move away from thinking about water infrastructures as techno-managerial propositions, and instead to reflect on place-based identity, broader socio-cultural ideals, and democratic practices of participation.

Through this approach, we propose a new concept, Culturally Inclusive Water Urban Design (CIWUD). It is directed at responding to the growing recognition that the Georges River (like many other Rivers around the world), as a more-than-human agent, should, through specific judicial structures, be an active participant in the processes that affect it. We agree with the position of Barad (2012) and Haraway (1991) that there is a need to shift our understandings of what constitutes a political agent as not only humans, but also to non-humans – including more-than-human bodies such as rivers, lakes, mountains and forests.

INTERPRETING CURRENT AND FUTURE HYDROSOCIAL REIMAGININGS – THE CONCEPT OF CIWUD

The complex interactions with the River present a way of understanding its 'function' in multiple – and concurrent – ways. If each of the abovementioned phases are considered against the roles of management that are enacted on, in, for and with the River and the human and more-than-human communities that it supports, there is scope for further enriching the meaning of the River. We see potential for WSUD to respond to the call for being culturally responsive by linking the various ways of knowing and valuing the River, through new concept of CIWUD.

The shifts in how stormwater infrastructures are designed, conceptualised and managed can be considered as transitioning alongside the perceptions of the River. As stated previously, the phases of the Georges River mentioned in this article do not exist exclusively at any one point in time, but rather present a way of knowing the River across times. The connections between fundamental CIWUD concepts and the proposed phases are: A respect for nature – Phase 0 and Phase 5; Flood protection – Phase 3; Water quality protection – Phase 1 and Phase 4; Water Supply – Phase 2; Water recycling – Phase 5; Water management and accessibility – Phase 4 and Phase 5; Social amenity – Phase 1, Phase 4 and Phase 5. The ability to cross between each of these phases reflects the potential for

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

CIWUD to be more than a technical solution, a way to respond to the values and perceptions of rivers of communities within a particular place.

Foundationally, focussing on the 'who' of water urban design (Ward *et al.* 2019) will enhance the social and cultural components of projects that aim to create water sensitive solutions to urban issues, such as localised urban flooding and waterway pollution. This requires an appreciation for how the democratic processes of public participation inform policies in discursively relational hybrid assemblages (Latour 1993; Haraway 1997; Chilvers & Kearnes 2015, p. 33). The ways in which technology can achieve particular agendas (e.g., enhancing urban amenity and/or resilience to a changing climate) requires not only acknowledging, but responding to these processes head on.

Across Sydney, as for other highly urbanised regions around the world, there has been increased interest and investment in revitalisation of waterways. Such a push highlights a consideration of water and landscapes as being part of a complex socioecological system – as waterscape (Hundley 1987; Strang 2004; Loftus 2007; Budds & Hinojosa 2012). In engaging with waterscapes as a framing, there is a recognition that the River has a crucial role to play as an active agent in the past, present and future of the space where it exists. Waterscapes also enable a particular ontological positioning which supports and promotes understandings of Country with First Nations Peoples. As suggested by Jackson & Barber (2016, p. 385), understandings of 'the waterscape' in an Australian setting represent 'key features of Indigenous peoples' dynamic relationships to water and to link water and social power relations in these watersheds over time'. Ensuring there exist mechanisms to continue, foster, strengthen and realise these relationships is a central and fundamental part of creating democratic urban waterscapes.

Emergent notions of rivers as persons have been progressively gaining traction in many parts of the world. Examples range from the rights of Nature in Ecuador and Bolivia, as well as legal personhood being given to particular mountains, forests and rivers in India (the Ganges), the USA (Tamaqua), and New Zealand (Whanganui) (Tanasescu 2017). These processes reflect a trend towards including the rights of nature to be considered more seriously. The discursive trends surrounding the giving of rights to nature speak to a wider recognition that democratic processes can, and we argue should, involve consideration and input from representatives speaking on behalf of nature (Stone 1970). In the case of the Georges River, the presence of pollutants that have been flowing into the River for the last two centuries should be taken seriously as an example of slow violence (Nixon 2011). While technocratic approaches have limitations, CIWUD has the potential to ameliorate negative impacts of urbanisation whilst also fostering a consideration of the intrinsic rights of the River.

Here, the importance of understanding perceptions and values becomes deeply apparent. A form of CIWUD that fails to respond to the social, cultural and political features such as trends in incoming migration or shifts in land use from agricultural, to industrial to residential, will surely be destined to fail. The aim to understand how water infrastructures can better reflect community values whilst providing sustainable future across a number of set indicators (Sørup *et al.* 2019) aligns with the push to create resilient (Marlow *et al.* 2013) and just (Wessells & Lejano 2017) urban waterways for present and future generations.

CONCLUSION: VOICING DEMOCRACY IN HYDROSOCIAL FUTURES

Drawing on archival material, in this paper we have constructed a narrative which maps historical perceptions and values of water and water infrastructure in the Georges River region. Highlighting the fundamental shifts that have occurred over time, the archival material that has been analysed in this paper has helped us realise this.

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

In this paper, we argue for a greater democratisation of the River reflecting an opinion that the agency of the River itself needs to be considered. That the River should be acknowledged as an active stakeholder in its management and governance could have far-reaching implications, particularly around strengthening capacity building programs and promoting a greater sense of belonging. Engaging with those who might represent the 'voice' of the River in a judicial sense could see even greater awareness of the intricacies in the River's story, particularly those of First Nations. To this point, this work suggest that this can be achieved through novel design approach (based on current WSUD approach) called Culturally Inclusive Water Urban Design – CIWUD, which would incorporate social, technical, cultural, ecological, and political features for more democratic development of river and urban waterscape. While some strong foundations for such approach have been laid in this work, future research on this topic should seek to understand the diversity of perspectives within the wider River region, through examining multiple field sites. We conclude by acknowledging that technology based on WSUD and, following CIWUD principles can have a positive impact on creating vibrant and democratic waterscapes that reflect different social values. Acknowledging the Deep History of a place, and its continuous connections to the present in this sense will be vital to creating not only water sensitive, but also socially responsive and culturally inclusive urban design features.

Future research should also be focused on understanding social and political structures which exists around how democracy is already perceived with regard to the River's future governance. Developing place specific CIWUD projects that work towards promoting the embedded histories within a place will go far to ensure that urban water technology remains adaptable and socially relevant.

ACKNOWLEDGEMENTS

We acknowledge the financial and data collection support from the Georges Riverkeeper organisation through a student project partnership with the University of New South Wales (UNSW), Sydney.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

REFERENCES

Adeloye, A. J. & Rustrum, R. 2011 Lagos (Nigeria) flooding and influence of urban planning. *Proceedings of the Institution of Civil Engineers: Urban Design and Planning* **164**, 175–187.

Allan, J. A. 2005 Water in the environment/socio-economic development discourse: sustainability, changing management paradigms and policy responses in a global system. *Government and Opposition* **40**, 181–199.

Andrachuk, M. & Armitage, D. 2015 Understanding social-ecological change and transformation through community perceptions of system identity. *Ecology and Society* **20** (4), 26. http://dx.doi.org/10.5751/ES-07759-200426.

Attenbrow, V. 2002 *Sydney's Aboriginal Past: Investigating the Archaeological and Historical Records*. UNSW Press, Sydney.

Baghel, R., Stepan, L. & Hill, J. K. W. 2017 *Water, Knowledge and the Environment in Asia: Epistemologies, Practices and Locales*. Routledge, Oxon.

Bakker, K. 2012 Water: political, biopolitical, material. *Social Studies of Science* **42**, 616–623.

Bandler, H. 1995 Water resources exploitation in Australian prehistory environment. *Environmentalist* **15**, 97–107.

Barad, K. 2012 On touching – the inhuman that therefore I Am. *differences* **23**, 206–223.

Barber, M. & Jackson, S. 2015 'Knowledge making': issues in modelling local and indigenous ecological knowledge. *Human Ecology* **43**, 119–130.

Bava, H. 2009 Urban Water Landscapes of Resilience. In *The International Symposium on Water Landscapes at the University of New South Wales*. The University of New South Wales, Sydney, Australia. Karlsruhe KIT Scientific Publishing, 123–130.

Bell, M. 2020 From tree to network: reordering an archival catalogue. *Records Management Journal* **30**, 379–394.

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

Birtles, P. J., Hore, J., Dean, M., Dahlenburg, J., Hamilton, R., Moore, J. & Bailey, M. 2013 Creating a Liveable City – the role of ecosystem services. In *State of Australian Cities*, Sydney, Australia.

Bode, K. 2014 *Mining A 'Trove': Modelling A Transnational Literary Culture*. Digital Humanities, Lausanne, Switzerland.

Boelens, R., Hoogesteger, J., Swyngedouw, E., Vos, J. & Wester, P. 2016 Hydrosocial territories: a political ecology perspective. *Water International* **41**, 1–14.

Boelens, R., Perreault, T. & Vos, J. 2018 *Water Justice*. Cambridge University Press, Cambridge.

Bohman, A., Glaas, E. & Karlson, M. 2020 Integrating sustainable stormwater management in urban planning: ways forward towards institutional change and collaborative action. *Water* **12**, 203.

Brown, R., Keath, N. & Wong, T. 2008 Transitioning to Water Sensitive Cities: Historical, Current and Future Transition States. In: *11th International Conference on Urban Drainage* (Ashley, R. ed). IWA Publishing, Edinburgh, Scotland.

Budds, J. & Hinojosa, L. 2012 Restructuring and rescaling water governance in mining contexts: the Co-Production of waterscapes in Peru. *Water Alternatives* **5**, 119–137.

Canigilia, B., Vallee, M. & Frank, B. 2017 *Resilience, Environmental Justice & the City*. Routledge, Oxon.

Cathcart, M. 2009 *The Water Dreamers: The Remarkable History of our dry Continent*. The Text Publishing Company, Melbourne.

Chilvers, J. & Kearnes, M. 2015 *Remaking Participation: Science, Environment and Emergent Publics*. Routledge, New York.

Cousins, A. D. 1998–1999 Barron field and the translation of romanticism to colonial Australia. *Southerly* **58**, 157–174.

Cousins, J. J. 2017 Structuring hydrosocial relations in urban water governance. *Annals of the American Association of Geographers* **107**, 1144–1161.

Crase, L. R., O'keefe, S. M. & Dollery, B. E. 2009 The fluctuating political appeal of water engineering in Australia. *Water Alternatives* **2**, 441–447.

Defries, R. S., Foley, J. A. & Asner, G. P. 2004 Land-use choices: balancing human needs and ecosystem function. *Frontiers in Ecology and the Environment* **2**, 249–257.

Department of Mines, P. P. 1929–1930 *Annual Report of the Department of Mines for the Year 1929*.

Dorries, H., Hugill, D. & Tomiak, J. 2019 Racial capitalism and the production of settler colonial cities. *Geoforum*. https://doi.org/10.1016/j.geoforum.2019.07.016.

D'Souza, R. 2006 Water in British India: the making of a 'colonial hydrology'. *History Compass* **4**, 621–628.

Duara, P. 2015 *The Crisis of Global Modernity, Asian Traditions and A Sustainable Future*. University of Cambridge Press, Cambridge.

Farrell, M. 2012 *Born-Digital Objects in the Deeds of Gift of Collecting Repositories: A Latent Content Analysis*. Masters, University of North Carolina, Chapel Hill, USA.

Farrelly, M. & Brown, R. 2011 Rethinking urban water management: experimentation as a way forward? *Global Environmental Change* **21**, 721–731.

Fletcher, T. D., Shuster, W., Hunt, W. F., Ashley, R., Butler, D., Arthur, S., Trowsdale, S., Barraud, S., Semadeni-Davies, A., Bertrand-Krajewski, J. L., Mikkelsen, P. S., Rivard, G., Uhl, M., Dagenais, D. & Viklander, M. 2015 SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage. *Urban Water Journal* **12**, 525–542.

Foley, D. & Read, P. 2020 *What the Colonists Never Knew: A History of Aboriginal Sydney*. National Museum of Australia Press, Canberra.

Fricker, M. 2007 *Epistemic Injustice: Power and the Ethics of Knowing*. Oxford University Press, Oxford.

Frith, S. 2004 From Tanning to Planning: An Industrial History of Green Squrare. In: *Histories of Green Square* (Karskens, G. & Rogowsky, M. eds). University of NSW Publishing, Sydney.

Gammage, B. 2011 *The Biggest Estate on Earth*. Allen & Unwin, Crows Nest.

Gandy, M. 2004 Rethinking urban metabolism: water, space and the modern city. *City* **8**, 263–279.

Goodal, H., Cadzow, A., Bryne, D. & Wearing, S. 2005 *Making the City Green: the Creation of Public Greenspace in Suburban Sydney, 1940–1992*. https://apo.org.au/node/60343. Analysis and Policy Observatory. [Accessed 9 October 2019].

Goodall, G. 2014 *Aboriginal People on Sydney's Georges River From 1820*. www.dictionaryofsydney.org/entry/aboriginal_people_on_sydneys_georges_river_from_1820#ref-uuid=e20b21ae-6508-f22f-c189-c60a0880d0b8. [Accessed 9 October 2019 2019].

Goodall, G. & Cadzow, A. 2009 *Rivers and Resilience: Aboriginal People on Sydney's Georges River*. University of New South Wales Press, Sydney.

Gxokwe, S., Xu, Y. & Kanyerere, T. 2020 Scenarios analysis using water-sensitive urban design principles: a case study of the cape flats aquifer in South Africa. *Hydrogeology Journal* **28**, 2009–2023.

Haraway, D. 1991 *Simians, Cyborgs, and Women: the Reinvention of Nature*. Routledge, New York.

Haraway, D. 1997 *ModestWitness@Second_Millennium.FemaleMan©_Meets_OncoMouse™: Feminism and Technoscience*. Routledge, New York.

Harrison, T. 2004 *The Internet Archive and Content Analysis*. British Academy of Management: Management Futures. St Andrews University, Scotland, UK.

Harvey, D. 1973 *Social Justice and the City*. Blackwell Publishers, Cambridge, MA.

Humphries, P. 2007 Historical indigenous use of aquatic resources in Australia's Murray-Darling basin, and its implications for river management. *Ecological Management & Restoration* **8**, 106–113.

Hundley, N. 1987 California's original waterscape: harmony & manipulation. *California History* **66**, 2–11.

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

Irish, P. 2017 *Hidden in Plain View: The Aboriginal People of Coastal Sydney*. NewSouth Publishing, Sydney.
Jackson, S. & Barber, M. 2016 Historical and contemporary waterscapes of North Australia: indigenous attitudes to dams and water diversions. *Water History* **8**, 385–404.
Jiang, W., Wang, W., Chen, Y., Liu, J., Tang, H., Hou, P. & Yang, Y. 2012 Quantifying driving forces of urban wetlands change in Beijing city. *Journal of Geographical Sciences* **22**, 301–314.
Jones, O., Barnes, L. G. & Lyons, A. 2019 Voicing waters: (co-)creative reflections on sound, water, conversations and hydrocitizenship. In: *Sounding the World: More-Than-Representational Accounts of Sound and Music* (Doherty, K., Duffy, M. & Harada, T. eds). Edward Elgar, Cheltenham.
Karskens, G. 2009 *The Colony*. Allen & Unwin, Crows Nest.
Karskens, G. 2014 The settler evolution: space, place and memory in early colonial Australia. *Journal of the Association for the Study of Australian Literature* **13**, 21 pp.
Karskens, G. 2016 Floods and flood-mindedness in Early Colonial Australia. *Environmental History* **21**, 315–342.
Karskens, G. 2020 *People of the River: Lost Worlds of Early Australia*. Allen & Unwin, Crows Nest.
Latour, B. 1993 *We Have Never Been Moden*. Pearson Education, Harlow.
Lee, F. & Peterson, C. 1997 Context analysis of archival data. *Journal of Consulting and Clinical Psychology* **65**, 959–969.
Lehn, H. 2009 Technologies for sustainable urban water management – dissolving the antagonism between urban comfort and hygienic pollution of urban environs. In: *International Symposium on Water Landscapes*, October 2009. The University of New South Wales, Sydney, Australia. Karlsruhe: KIT Scientific Publishing.
L' Eplattenier, B. E. 2009 An argument for archival research methods: thinking beyond methodology. *College English* **72**, 67–79.
Linton, J. & Budds, J. 2014 The hydrosocial cycle: defining and mobilizing a relational-dialectical approach to water. *Geoforum* **57**, 170–180.
Loftus, A. 2007 Working the socio-natural relations of the urban waterscape in South Africa. *International Journal of Urban and Regional Research.* **31**, 41–59.
Marlow, D. R., Moglia, M., Cook, S. & Beale, D. J. 2013 Towards sustainable urban water management: a critical reassessment. *Water Research* **47**, 7150–7161.
Mclean, J. 2007 Water injustices and potential remedies in indigenous rural contexts: a water justice analysis. *The Environmentalist* **27**, 25–38.
Mclean, J., Lonsdale, A., Hammersley, L., O'Gorman, E. & Miller, F. 2018 Shadow waters: making Australian water cultures visible. *Transactions of the Institute of British Geographers* **43**, 615–629.
Melo Zurita, M. L., Thomsen, D. C., Smith, T. F., Lyth, A., Preston, B. L. & Baum, S. 2016 Reframing water: contesting H2O within the European Union. *Geoforum* **65**, 170–178.
Mitchell, T. L. 1838 *Three Expeditions Into the Interior of Eastern Australia*. Cambridge University Press, New York.
Moggridge, B. J., Betterridge, L. & Thompson, R. M. 2019 Integrating aboriginal cultural values into water planning: a case study from New South Wales, Australia. *Australasian Journal of Environmental Management* **26**, 273–286.
Molle, F., Mollinga, P. P. & Wester, P. 2009 Hydraulic bureaucracies and the hydraulic mission: flows of Water, Flows of Power. *Water Alternatives* **2**, 328–349.
Moreton-Robinson, A. 2015 *The White Possessive: Property, Powe, and Indigenous Sovereignty*. University of Minnesota Press, Minneapolis.
Morison, P. J., Brown, R. R. & Cocklin, C. 2010 Transitioning to a waterways city: municipal context, capacity and commitment. *Water Science and Technology* **62**, 162–171.
Nicholson, B. 2013 The digital turn. *Media History* **19**, 59–73.
Nixon, R. 2011 *Slow Violence and the Environmentalisms of the Poor*. Harvard University Press, Cambridge, MA.
Oral, H. V., Carvalho, P., Gajewska, M., Ursino, N., Masi, F., Hullebusch, E. D. V., Kazak, J. K., Exposito, A., Cipolletta, G., Andersen, T. R., Finger, D. C., Simperler, L., Regelsberger, M., Rous, V., Radinja, M., Buttiglieri, G., Krzeminski, P., Rizzo, A., Dehghanian, K., Nikolova, M. & Zimmermann, M. 2020 A review of nature-based solutions for urban water management in European circular cities: a critical assessment based on case studies and literature. *Blue-Green Systems* **2**, 112–136.
Pascoe, B. 2014 *Dark Emu*. Magabala Books, Broome.
Perry, A. 2016 *Aqueduct: Colonialism, Resources, and the Histories We Remember*. ARP Books, Winnipeg.
Pritchard, S. B. 2012 From hydroimperialism to hydrocapitalism: 'French' hydraulics in France, North Africa, and beyond. *Social Studies of Science* **42**, 591–615.
Purdy, J. P. 2011 Three gifts of digital archives. *Journal of Literacy and Technology* **12**, 25–49.
Rosen, M. A. 2012 Engineering sustainability: a technical approach to sustainability. *Sustainability* **4**, 2270–2292.
Ruiz, A. G., Dobbie, M. & Brown, R. 2017 Insights and future directions of transdisciplinary practice in the urban water sector. *Journal of Environmental Studies and Sciences* **7**, 251–263.
Shrycok, A. & Smail, D. L. 2011 Introduction. In: *Deep History: The Architecture of Past and Present* (Shryock, A. & Smail, D. L. eds). University of California Press, Berkley, Los Angeles, London.
Smith, J. L. 2017 I, river? New materialism, riparian non-human agency and the scale of democratic reform. *Asia Pacific Viewpoint* **58**, 99–111.
Sørup, H. J. D., Fryd, O., Liu, L., Arnbjerg-Nielsen, K. & Jensen, M. B. 2019 An SDG-based framework for assessing urban stormwater management systems. *Blue-Green Systems* **1**, 102–118.

Blue-Green Systems Vol 2 No 1
doi: 10.2166/bgs.2020.017

Staddon, C. & Everard, M. 2017 Competing epistemologies of community-based groundwater recharge in semi-arid north Rajasthan: Progress and lessons for groundwater-dependent areas. In: *Water, Knowledge and the Environment in Asia: Epistemologies, Practices and Locales* (Baghel, R., Stepan, L. & Hill, J. K. W. eds). Routledge, Oxon.

Stone, C. D. 1970 Should trees have standing? – towards legal rights for natural objects. *Southern California Law Review* **45**, 450–501.

Strang, V. 2004 *The Meaning of Water*. Berg Publishers, Oxford.

Sultana, F. 2018 Water justice: why it matters and how to achieve it. *Water International* **43**, 483–493.

Sutton-Grier, A. E., Wowk, K. & Bamford, H. 2015 Future of our coasts: the potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies and ecosystems. *Environmental Science & Policy* **51**, 137–148.

Swyngedouw, E. 1996 The city as a hybrid: on nature, society and cyborg urbanization. *Capitalism Nature Socialism* **7**, 65–80.

Swyngedouw, E. 1997 Power, nature, and the city. The conquest of water and the political ecology of urbanization in Guayaquil, Ecuador: 1880–1990. *Environment and Planning A* **29**, 311–332.

Swyngedouw, E. 1999 Modernity and hybridity: nature, regeneracionismo, and the production of the Spanish waterscape, 1890–1930. *Annals of the Association of American Geographers* **89**, 443–465.

Swyngedouw, E. 2004 *Social Power and the Urbanization of Water: Flows of Power*. Oxford University Press, Oxford.

Swyngedouw, E. 2006 Metabolic Urbanization: the making of cyborg cities. In: *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism* (Heynen, N., Kaika, M. & Swyngedouw, E. eds). Routledge, Oxon.

Swyngedouw, E. 2009 The political economy and political ecology of the hydro-social cycle. *Journal of Contemporary Water Research & Education* **142**, 56–60.

Tanasescu, M. 2017 *When A River is A Person: From Ecuador to New Zealand, Nature Gets its day in Court*. The Conversation. https://theconversation.com/when-a-river-is-a-person-from-ecuador-to-new-zealand-nature-gets-its-day-in-court-79278. [Accessed 2019].

Tyrrell, I. R. 2018 *River Dreams: the People and Landscape of the Cooks River*. NewSouth Publishing, Sydney.

Van Rooijen, D. J., Turral, H. & Biggs, T. W. 2005 Sponge city: water balance of mega-city water use and wastewater use in Hyderabad, India. *Irrigation and Drainage* **54**, S81–S91.

Ward, S., Staddon, C., de Vito, L., Zuniga-Teran, A., Gerlak, A. K., Schoeman, Y., Hart, A. & Booth, G. 2019 Embedding social inclusiveness and appropriateness in engineering assessment of green infrastructure to enhance urban resilience. *Urban Water Journal* **16**, 56–67.

Wessells, A. T. & Lejano, R. P. 2017 Urban waterways and waterfront spaces: social construction of a common good. *Journal of the Southwest* **59**, 106–132.

Whelans, C., Maunsell, H. G. & Thompson, P. 1994 *Planning and Management Guidelines for Water Sensitive Urban (Residential) Design*. Department of Planning and Urban Development of Western Australia, Perth, Western Australia.

Wilcock, D., Brierley, G. & Howitt, R. 2013 Ethnogeomorphology. *Progress in Physical Geography* **37**, 573–600.

Wilfong, M. & Pavao-Zuckerman, M. 2020 Rethinking stormwater: analysis using the hydrosocial cycle. *Water* **12**, 1273–1289.

Winter, D. G. 1992 Content analysis of archival materials, personal documents, and everyday verbal productions. In: *Motivation and Personality: Handbook of Thematic Content Analysis* (Smith, C. P., Atkinson, J. W., Mcclelland, D. C. & Veroff, J. eds). Cambridge University Press, Cambridge, MA.

Wong, T. F. & Eadie, M. L. 2000 Water sensitive urban design: A paradigm shift in urban design. In *10th World Water Congress: Water, the World's Most Important Resource*, Melbourne, Australia. International Water Resources Association.

Zwarteveen, M. Z. & Boelens, R. 2014 Defining, researching and struggling for water justice: some conceptual building blocks for research and action. *Water International* **39**, 143–158.

First received 27 November 2020; accepted in revised form 3 December 2020. Available online 10 December 2020