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Helping Australian cities transition to more sustainable water system services.

Six Australian cities were examined to provide stakeholders with the insights and guidance needed to provide strategic change toward their water sensitive city vision.

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EXECUTIVE SUMMARY

Governments and water sector organisations in Australia, and increasingly in other nations, are beginning to adopt policies and agendas to improve urban liveability, particularly regarding greening, cooling, improved amenity, equity, affordability, and safety. The concept of the water sensitive city is widely used to represent these aspirations in cities where water has a central city-shaping role. Monash University and the Cooperative Research Centre for Water Sensitive Cities has worked with six Australian cities (Perth, Adelaide, Bendigo, Sydney, Gold Coast and Townsville) as part of a comprehensive research collaboration. The research revealed key insights that can guide leadership responses to the challenges facing our growing cities. These cities have used transition tools, including the Water Sensitive Cities Index and the Transitions Dynamics Framework to benchmark current status and to develop a 50 year vison and transition plan.

Total water cycle or integrated water management has become a widespread policy aspiration in Australia, particularly where growth in demand is limited by the availability of traditional resources and predicted climate change impacts. Circular economy principles are gaining traction, and the water sector is starting to explore how water management can improve holistic recovery, generation and reuse of resources. On-ground investment in recycled water schemes is evident in most cities. These are all characteristic of an emergent water cycle city. However, significant progress towards WSC status is unlikely without substantial changes in governance settings, which mostly still reflect water sector policy reforms of the 1990s, favouring cost efficiency over broader liveability outcomes.

Our work with Australian cities and towns highlights that a water system transformation is underway, with profound implications for the liveability, sustainability, resilience and productivity of Australian cities and towns. Our research has helped to see this shift as part of a continuum of change and to understand the drivers involved and the responses required.

The challenges observed, such as governance, policy and cross sector collaboration, paint a picture of the barriers to cities achieving their water sensitive visions. These include the many policy settings that govern the urban water sector in Australia, which were established under past circumstances and are no longer appropriate to our needs today. In contrast, government and industry tend to focus innovation investment more on technologies and demonstration projects to improve urban outcomes. These investments are unlikely to drive the system changes and momentum needed to support the transition to a more water sensitive future state. Institutional innovations that fundamentally change the operating model of the water sector are needed, with a focus on its city shaping role and enabler of urban liveability and resilience.

Our research has identified critical socio-technical themes that need advancement to support ongoing water system transformation: climate-adapted communities, regenerative urban planning, Indigenous water justice, and leadership diversity. These themes build on the water sensitive city foundations laid in the last decade. They form a strategic agenda for the next horizon of knowledge generation and collaborative impact work at the Monash Sustainable Development Institute's Water unit.

ABSTRACT

Australia's water sector is transforming, with profound implications for the health and wellbeing of people and environment. Governments and water sector organisations are adopting policies and agendas to improve urban liveability regarding greening, cooling, improved amenity, equity, affordability, and safety – but achieving these goals in practice is challenging.

This paper reflects on how the water sector can continue its transformation to meet the challenges of our growing cities and navigate pathways toward greater community value from water system services. Our insights come from action research with six Australian cities that were guided through envisioning and transition planning processes, utilising the Water Sensitive Cities Index and transition tools developed by the Cooperative Research Centre for Water Sensitive Cities.

We found that achieving cities' future water aspirations will only be possible with substantial changes in governance settings that move away from the cost efficiency focus of the 1990s toward broader water sensitive outcomes. A narrow investment focus on technologies and demonstration projects is unlikely to drive the system changes and momentum needed to support transformation. Institutional innovations that change the water sector's operating model are needed, with a focus on its city-shaping role and enabler of urban liveability and resilience.

INTRODUCTION

The inevitability of climate change is making it urgent to plan for a future where floods, drought, heatwaves, bushfires and disease will be an increasing threat to our health and wellbeing. COVID-19 has highlighted our vulnerability and forced us to recognise that business-as-usual thinking and practices will not be enough to mitigate these threats. Governments and water sector organisations have begun to adopt policies and agendas with a focus on resilience to climate change impacts and protecting public health and wellbeing (e.g. Government of Western Australia 2019; The State of Victoria 2016). These include outcomes to improve urban liveability, particularly regarding greening, cooling, improved amenity, equity, affordability, and safety. Delivering these outcomes will require new approaches by water institutions to work collaboratively with other sectors and non-traditional stakeholders who can help the sector to transform water systems for people and planet.

Monash University, through the Cooperative Research Centre for Water Sensitive Cities (CRCWSC), has been undertaking research and working in Australia and the Asia-Pacific to assist cities with this transformation. Our research partnerships have revealed key insights into transition barriers and enablers and led to the development of knowledge and tools to understand, influence and transform systems for sustainable development in Australia and our region. The University, through the Monash Sustainable Development Institute, is now collaborating with partners to build knowledge and capacity that can help drive practical change to enhance the wellbeing of people and planet.

In this article, we reflect on how the water sector can meet the challenges of our growing cities and navigate pathways for providing greater value to communities from water system services. Our insights are drawn from action research with six Australian cities that were guided through envisioning and transition planning processes.

URBAN WATER MANAGEMENT IN TRANSITION

Established models of water servicing typically involve separate systems of management for water supply, wastewater and stormwater, commonly through large-scale, centralised infrastructure provided by corporate entities. These conventional water systems have given us critical benefits such as clean water, safe sanitation and effective drainage, and this mode of servicing is still an important part of Australia's water future. However, our major urban centres are reaching environmental limits in their regions to provide the resources and ecosystem services to support further growth, and climate change is further challenging the capacity of water services. This is bringing into question current water servicing practices.

The Urban Water Transitions Framework (Figure 1; Brown et al. 2009) can be used to help cities understand their present water management orientation and define their short and long-term aspirations. The framework identifies six distinct developmental states that cities may move through on their path toward increased water sensitivity. For Australian cities, movement along this continuum over 120 years or more has generally been a process of adapting progressively to changing drivers such as public health, rapid population growth, financial efficiency and environmental sustainability (Hammer et al. 2020).

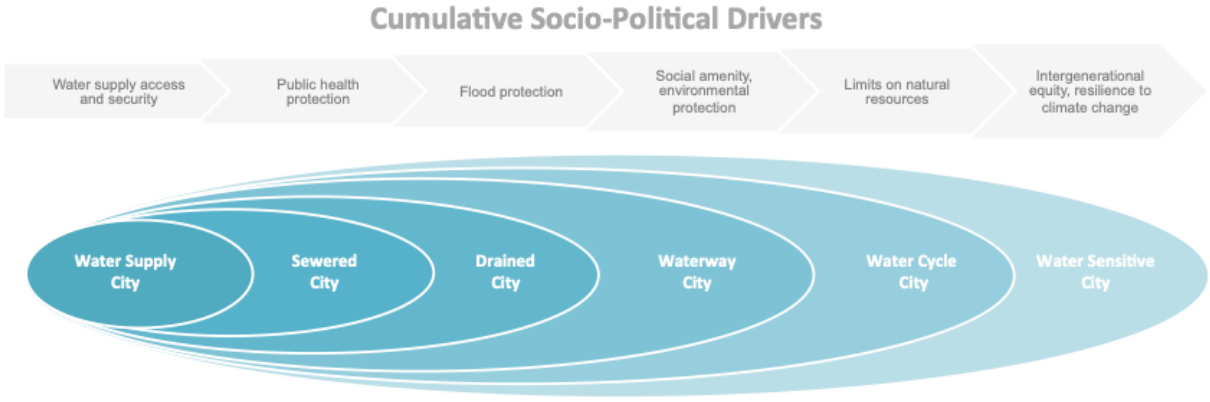

Figure 1. Urban water transitions framework (adapted from Brown et al. 2009)

RESEARCH METHODOLOGY

Through the CRCWSC, Monash University worked with six Australian cities – Perth, Adelaide, Bendigo, Sydney, Townsville and the Gold Coast – to examine changes in their water servicing over time and explore their water sensitive city aspirations (Hammer et al. 2020). For each case study city, the research involved a desktop review of local policies and plans (e.g. water, environment, planning, health, community, sustainability, liveability, resilience), stakeholder interviews and a series of participatory workshops. The workshops were supported by application of the CRCWSC's transition tools to inform detailed analysis□specifically the WSC Index (Rogers et al. 2020) and the Transition Dynamics Framework (Brown et al. 2017, Wong et al. 2020). These tools were developed through CRCWSC research to provide city stakeholders with insights and guidance to inform strategic actions for driving rapid change toward their water sensitive city vision.

A total of 274 leaders and strategic thinkers from across water, planning, environment, development, and other related sectors participated in the workshops from across 117 organisations. These spanned water utilities, local governments, state government policy departments and regulatory agencies (particularly water, environment, health, planning), water industry and urban design consultants, land development companies, water technology providers, research institutions and community not-for-profits. Participants were typically organisational leaders, recognised champions of water sensitive approaches, respected contributors to water industry networks and/or experts in particular areas of relevance. They were identified by local stakeholders and invited to be involved as individuals with their diverse perspectives, rather than as formal representatives of their organisation. In Bendigo, 31 community members were also involved in the process.

The six case study cities have each developed water sensitive city transition strategies using the CRCWSC's participatory processes and transition tools that facilitate benchmarking, envisioning, transition planning and action prioritisation. These cities are taking action to implement these strategies through various formal and informal opportunities in their contexts (Gunn et al. 2017, Rogers et al. 2017, Rogers et al. 2018, Hammer et al. 2018a, Hammer et al. 2018b, Hammer et al. 2018c).

We now present a synthesis of insights from the research across these six cities. Specific data and analytical detail for each individual city are found in the above references.

A STORY OF WATER IN AUSTRALIAN CITIES IN TRANSITION

Early years

Prior to European settlement, Aboriginal and Torres Strait Islander Communities existed and thrived on the resources of their land and water environments. Local waterways and water features often defined their ways of life. Aboriginal and Torres Strait Islander Peoples have a strong connection with water, which is a result of both their creation stories and their long-established relationship with the land. Because their stories are passed down from generation to generation, their connection to water and understanding of their local water cycle remained strong. The arrival of European colonisers disrupted this relationship between people and nature.

The frontier towns of the colonies grew rapidly in the late 19th century, built on wealth generated from mining and agriculture. As towns transformed into cities, new institutions were created to construct and operate water supply systems and later, sewerage systems. In the larger capital cities, stand-alone public water utilities became the norm and emerged as large and influential institutions. This period is represented by the water supply city and sewered city phases in Figure 1.

Post-war investment and population boom

In the first half of the 20th century, the First World War, Great Depression, and Second World War held back growth and investment in Australia's cities and water systems. However, the population boom post-World War II drove significant investment in water infrastructure, and public water utilities such as the Melbourne and Metropolitan Board of Works and Sydney Water Board grew large and powerful. During this period, suburban growth doubled the footprint of cities like Melbourne and pushed development into lands further from the city centre, requiring more coordinated planning and investment in effective drainage networks. This is represented by the Drained City phase in Figure 1. By the late 1970's over 80% of Australians were living in urban areas.

Pollution of waterways and coasts from urban stormwater, particularly in unsewered developments or from poor treatment of sewage, generated increasing community concern in the 1960s and 70s. Protests and campaigns for greater environmental protection led to increased regulation of industry, investment in 'backlog' sewerage programs and improvements in wastewater treatment. Australia's first environment protection agency was created in 1971. Waterways and coastal environments became important elements of the open space and amenity of Australian cities, attracting increasing co-investment by state and local governments in land acquisition and development of recreational trail networks and other community facilities. This was the beginning of the waterways city phase in Figure 1.

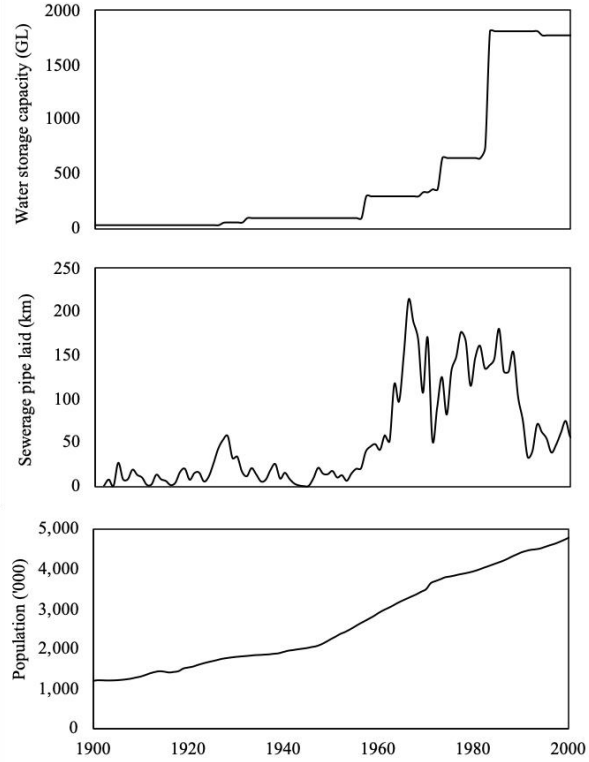

Figure 2. Services struggled to keep up with post-War growth, prompting significant investment in water supply, sewerage and drainage infrastructure. Left: Investments in water storage capacity and sewerage pipes as Victoria's population grew (Source: Melbourne Water, South East Water, City West Water and Yarra Valley Water). Right: Unserviced properties, Moorabbin, Victoria, 1955 (Source: Kingston Historical Society, cited in Frost et al. 2016).

Policy and economic reform

Australia, along with most western nations, embraced neo-liberal economic policy reforms through the 1980's and 90's. The water sector underwent significant change, with a focus on cost efficiency and commercialisation of services.

Many internal services of water utilities were outsourced or sold to the private sector. Pricing for services was set to recover costs and reflect usage. Policy, planning and regulatory functions were separated from service delivery organisations, which were increasingly corporatized and commercialized.

These reforms were implemented when Australian cities were experiencing relatively low rates of growth and the water sector had accumulated significant debt from infrastructure investments during the post-War growth period. System capacity commonly exceeded demand and attention shifted from capital investment to operational efficiency. These new drivers of change reflected a policy perspective that utilities were no longer about city building for growth and should focus on core services to customers.

Climate change and resource limits

From 1997 to 2010, many parts of Australia experienced the longest drought in the nation's history. This became known as the 'Millennium Drought' and it resulted in years of restrictions on water use. Augmentations that had been thought decades away were rapidly reconsidered based on new planning assumptions. Out of the crisis, decisions were made to construct desalination plants in Perth, Sydney, Melbourne, Adelaide and South-East Queensland.

Ultimately, the drought ended before most of these desalination plants were commissioned, fuelling a community and political backlash in some cities against what

was widely perceived as unnecessary, expensive and energy intensive water infrastructure. The policy response and almost exclusive investment in desalination raised questions about the management and apparent 'waste' of alternative water resources such as recycled water and stormwater. Only in Perth, which continued to face a drying climate, has desalination become a significant and broadly welcomed part of the water supply system.

The 'browning' of our cities and towns during the Millennium Drought coincided with a sustained period of population growth, particularly in Sydney, Melbourne and South-East Queensland. This helped to heighten awareness of the importance of water for enhancing the liveability of cities, for example through maintaining green spaces for recreation and protection from climate extremes. The widespread perception of mismanagement following the investments in desalination contributed to changes in Government in the eastern States, along with a questioning of the policy and institutional settings in the water sector. A new policy direction emerged, shifting focus from economic efficiency to liveability and challenging the institutional status quo, particularly in the eastern capitals of Brisbane, Sydney and Melbourne.

Ensuring ongoing resilience and livability

Australia's major urban centres are now reaching their environmental limits, whereby the demands our city lives place on the environment will soon outstrip nature's ability to provide. This is constraining the environment's capacity to provide the resources and ecosystem services needed for further growth. Climate change is further reducing the capacity of the environment to meet even existing needs. Nowhere in Australia is this clearer than in Perth, where 70% of the city's drinking water was once sourced from surface water catchments, which today provides only around 10%. The other 90% now comes from desalination and groundwater.

Conventional water systems, designed to meet singular objectives under a set of relatively narrow assumptions, are becoming increasingly vulnerable to changing climate, economic and social conditions. Australian cities are now recognising the need for more flexible, adaptive water systems in order to be resilient to future uncertainties.

Pressure from communities for cities to support healthy lifestyles is also increasing. Governments and water sector organisations are adopting policies and agendas for urban liveability through measures that increase greening, cooling, improved amenity, equity, affordability, and safety. Delivering these liveability outcomes will require new approaches by water institutions to work collaboratively with other sectors and non-traditional stakeholders who can help the sector diversify its service offering and shift from a city-servicing, efficiency focused operating model to a city-shaping, liveability focused, operating model.

EMERGING VISION FOR AUSTRALIAN WATER SENSITIVE CITIES

Water sensitive city visions were developed through the research's participatory workshops with the six case study cities, which ranged in scale, biophysical and social contexts, and institutional arrangements. They also differed in people's relationships with water, with historical responses to certain drivers shaping how water is currently viewed and managed. Despite these contextual differences, cities articulated common themes regarding future water sensitive aspirations for their city in 50 years (Figure 3). See Hammer et al. 2020 for details on the specific aspirations expressed within each of these vision themes.

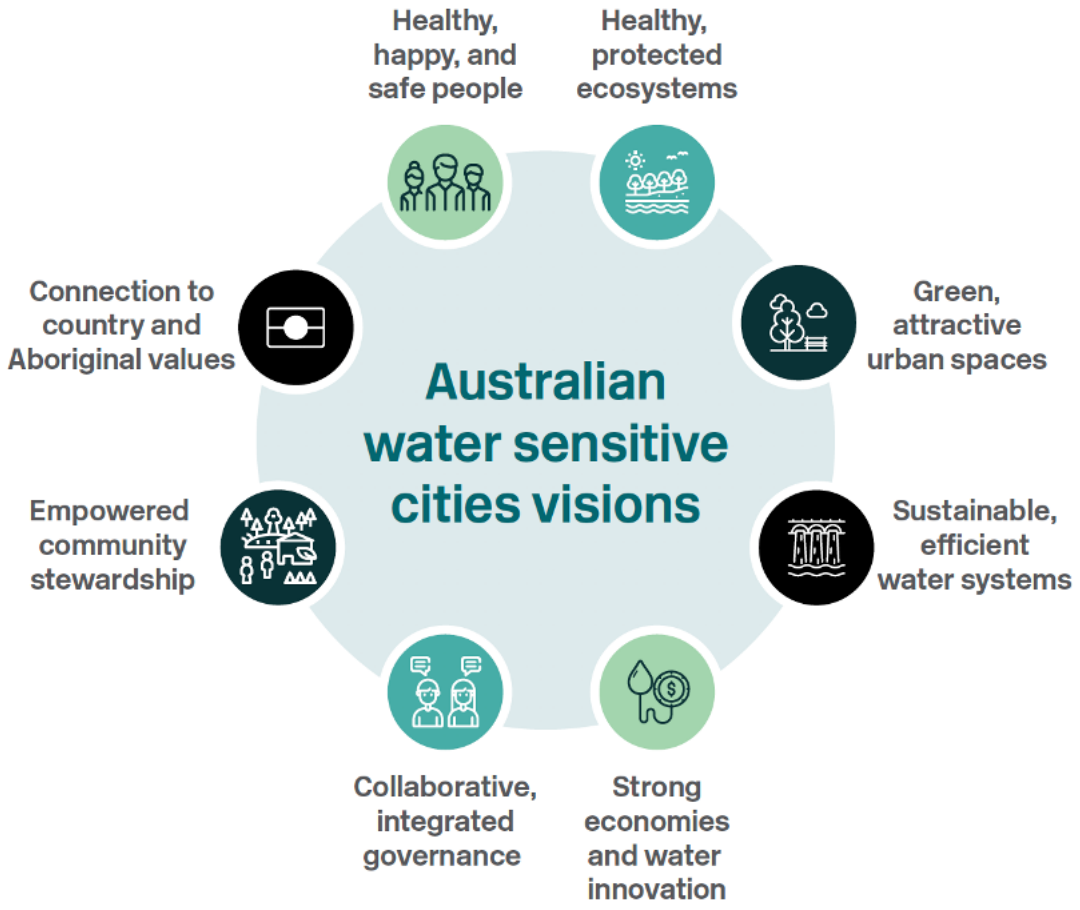

Figure 3. Vision for Australian water sensitive cities (Hammer et al. 2020)

HOW WATER SENSITIVE ARE CURRENT AUSTRALIAN CITIES?

Planning a city's transition to its WSC vision requires a detailed understanding of its current performance in relation to its aspirations. The CRCWSC's Water Sensitive Cities Index (WSC Index) (Rogers et al. 2020) is a benchmarking tool designed for this purpose. It articulates seven WSC goals, which organise 34 indicators representing the major attributes of a WSC. These indicators are also mapped to the idealised city-states represented in the Urban Water Transitions Framework (Figure 1) to provide a benchmarked city-state. Figure 4 presents the average benchmarking results for the six case study cities.

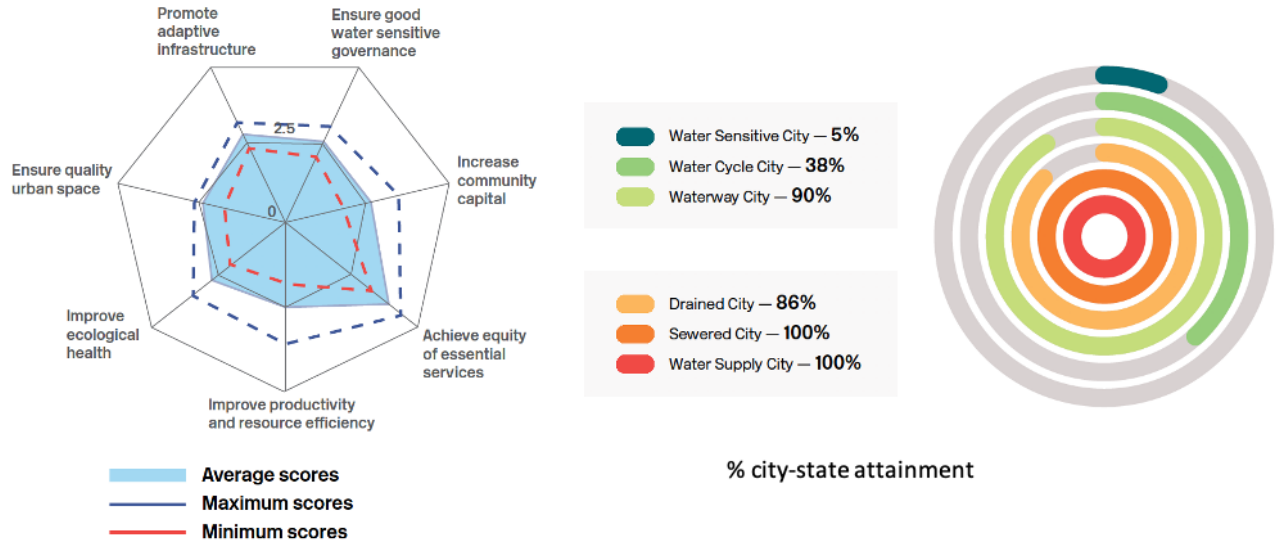

Figure 4: Average benchmark results for the six Australian case study cities. Left: Average, minimum and maximum goal scores. Right: Percentage attainment of each city–state. (Hammer et al. 2020)

The benchmarking results reveal that Australian cities and towns are typically somewhere between a drained city and a water cycle city, with some observable features across all six of the city-states. On average, the six case study cities have fully achieved the water supply and sewered city status, and are close to fully achieving drained and waterway city status. All of these cities are in a water cycle city transition phase with some elements of the water sensitive city beginning to emerge (5%).

Across Australia, water utilities have successfully provided safe and secure water supply and sewerage services through robust infrastructure systems, reliable delivery networks, and affordable services. This is evident in the average score of 100% achieved for both water supply and sewered cities. When it comes to drainage, servicing is typically more fragmented, since responsibility often lies across local councils and water authorities. This creates differences in levels of service across councils. There are also many instances of flash flooding within highly urbanised environments and issues with continued development in flood risk areas.

An average benchmark of 90% was achieved by the case study cities for the waterways city. This high score can be attributed to the focus on waterway and environmental health over the past several decades, and standards that have been put in place to protect these natural water assets. Community activism across Australia in the 1960's and 70's led to governments and water utilities investing heavily in connecting properties to sewerage networks and improving treatment plant performance. New environment protection agencies were established to regulate industry and monitor water quality. Waterways form a significant part of the open space network in these Australian cities and there has been considerable investment by governments in environmental improvements and creating access and connectivity.

In working towards a water cycle city, the average score for the case study cities was 38%. Total water cycle or integrated water management has recently become a clear policy aspiration for Australian cities, particularly where growth in demand is limited by availability of traditional resources and predicted climate change impacts. The concept of a circular economy is gaining traction, and the water sector is at the early stages of exploring how water management can improve holistic recovery, generation and reuse of other resources. On-ground investment in recycled water schemes is evident in most cities, though it is almost entirely for non-potable purposes such as open space irrigation. Perth is the only case study city that has a major operating trial of indirect potable reuse through recycled water injection into a groundwater system that supplies drinking water to parts of the city. Stormwater harvesting is most advanced in Adelaide where aquifer storage is widely feasible.

BARRIERS TO PROGRESS – WATER SECTOR CHALLENGES

So far, the transition for Australian cities to water cycle city status has progressed without significant changes to existing water sector business models. The main drivers of planning and investment in water management largely still reflects water sector policy reforms of the 1990's, which favour resource and cost efficiency over broader outcomes. Achievement of full WSC status is unlikely without substantial changes in governance settings to create conditions that are supportive of the shift in culture, mindsets, capability and practices necessary for the sustainability, liveability and resilience of our rapidly growing cities.

However, transformative change is complex and existing inertia can be difficult to overcome. Water sector organisations responsible for protecting public health through the provision of water supply and sewerage services have an appropriately conservative culture, but it can impede innovation. The huge existing asset base of centralised and long life infrastructure reinforces this lock-in and hinders adaptation to new service models and technologies. In discussing these challenges, the stakeholders involved in this research identified that the many barriers to transformation largely related to governance. Of specific focus was the degree of fit between current institutional arrangements and the conditions needed to support innovation, including long-term cross-sectoral planning, new servicing approaches including decentralised and nature-based solutions, and collaborative partnerships with communities (Hammer et al. 2020).

Cities can deliberately work to overcome these challenges by strengthening key enablers of collaboration, innovation and widespread implementation of new practices. Our previous transitions research (Brown et al. 2017) identified six types of enabling factors that are critical for transforming water management practices to create water sensitive cities (Figure 5). These factors underpin the CRCWSC's Transition Dynamics Framework (TDF; Wong et al. 2020), a tool to guide the identification of strategic priorities for transition action. The TDF was applied to each case study city to assess the city's current enabling conditions and develop strategies for progressing its transition to more water sensitive practice.

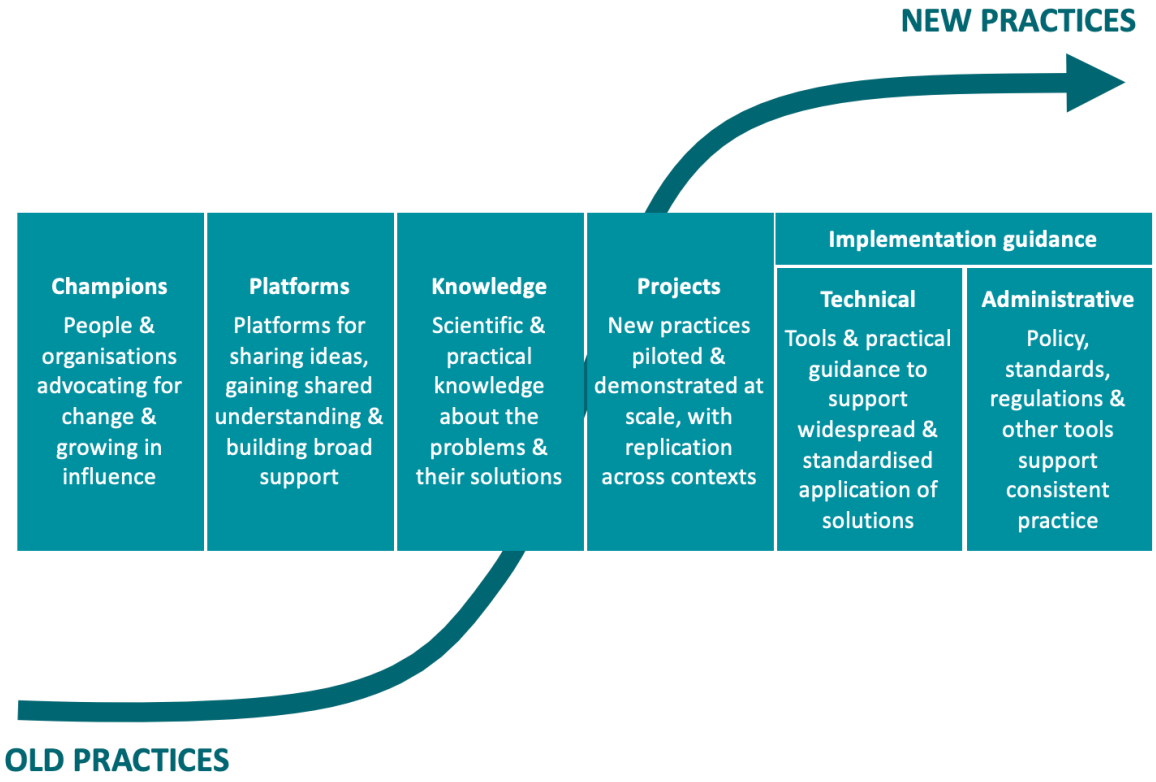

Figure 5. Types of enabling factors to transform practices (adapted from Brown et al. 2017 and Wong et al. 2020)

The transition strategies developed with the case study cities show how each is planning to address their priorities through action tailored for their local context (Gunn et al. 2017, Rogers et al. 2017, Rogers et al. 2018, Hammer et al. 2018a, Hammer et al. 2018b, Hammer et al. 2018c). Common transition priorities across the cities include (see Hammer et al. 2020 for more details):

- A shift in leadership from top-down to distributed, bottom-up and adaptive models, with leadership at all levels and from a range of perspectives and expertise.
- Stronger collaboration to maximise opportunities, improve efficiency, and deliver broad city outcomes through water management.
- A culture of innovation and experimentation to support new solutions across technical, design and social domains, underpinned by acceptance of a certain level of managed risk and learning from innovations that do not succeed.
- Increased organisational and professional capacity to implement integrated, water sensitive solutions, including understanding of cross-sectoral and cross-disciplinary linkages and research partnerships to support the development of new solutions.
- Open and transparent data and platforms supporting the sharing of knowledge across boundaries, including organisations, councils, cities and countries.

A STRATEGIC TRANSITION AGENDA

The work with the six case study cities shows that Australia's water sector is in transformation, which has profound implications for the health of people and the environment in our cities and towns. Considerations for liveability, resilience, adaptability, equity, and social inclusion are now entering urban water policy conversations in Australia. Communities are beginning to be seen as partners, rather than simply

consumers, in water management. Cultural considerations, including Aboriginal connections to and knowledge of water, are also beginning to be explored and valued.

Our research has helped these cities to see these shifts as part of a continuum of change and to understand the drivers involved and the responses required. While there is still significant work to be done across Australia to achieve water sensitive cities, there are many opportunities to be leveraged to continue cities' water sensitive transitions.

Tools such as the Urban Water Transitions Framework, the WSC Index and the Transition Dynamics Framework provide value for cities, enabling them to understand their current context, learn from other cities in similar situations, and inform a broader transition agenda to drive solutions towards WSC outcomes. More than 60 cities in Australia and internationally have now used the WSC Index to understand their current state and consider their aspirations for the future. Accredited providers have been trained to use these tools in North and South America, South Africa, New Zealand and Australia. Monash University is working on assembling these and other tools, and the city data they facilitate the collection of in a global web-based water system transformation platform. We hope this will enable cities around the world, no matter their context and water management status, to readily use these tools, and collaborate with and learn from each other. What we have learned from Australian cities can help water sector leaders and practitioners around the world to create more liveable, sustainable and resilient cities for their communities.

The challenges observed in our analysis, such as governance, policy and cross-sector collaboration, paint a picture of the needs of cities to achieve their visions for greater 'water sensitivity'. In contrast, government and industry have tended to focus innovation investment more on technologies and short-term solutions, such as demonstration projects, to improve urban outcomes. These investments alone will not create the system changes and momentum needed to drive the transition to a more water sensitive future state. Institutional innovations that fundamentally change the operating model of the water sector are needed, with a focus on its city-shaping role and enabler of urban liveability and resilience. Addressing the transition priorities identified through our research will require a new wave of knowledge generation and innovation, building on the WSC foundations laid through the CRCWSC's duration. There are several socio-technical themes that we argue will be catalytic in supporting ongoing transformations toward this new operating model and the shared vision of Australian water sensitive cities and towns.

Climate-adapted communities: Supporting communities to cope, adapt and thrive amidst the growing impacts of climate change, including flood, drought and heat. Empowerment of communities and partnerships between citizens, governments and industries are key.

Regenerative urban planning: Driving technological and institutional innovation for implementing circular economy, nature-based and cross-sectoral solutions. Ensuring urban development and city servicing has a net positive social, environmental and economic impact is key.

Indigenous water justice: Strengthening Indigenous sovereignty, water rights and peoples as part of water governance frameworks. Embracing Indigenous ways of knowing, doing and being in our approach to water planning and decision making is key.

Leadership and diversity: Increasing leadership diversity across organisational levels is critical for different perspectives, values and knowledges to inform planning and decision making toward our broad water visions for the future. Creating the conditions for leadership to reflect diversity in, for example, gender, age, ethnicity and discipline is key.

These themes, and the creation of a global water system transformation platform, have become the strategic agenda for the next horizon of knowledge generation and impact work for MSDI Water at the Monash Sustainable Development Institute (MSDI). Water Sensitive Cities Australia, now based at MSDI, will continue the work of supporting cities and towns to mainstream water sensitive cities approaches. Continued collaboration between government, industry, community and research will be essential for Australia to develop the new knowledge and practical tools that are needed to accelerate ongoing water system transformations to sustain people and planet.

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