

AN INTER-DISCIPLINARY RESEARCH PROGRAM FOR BUILDING WATER SENSITIVE CITIES

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ABSTRACT

Urban communities face future uncertainties in urban water services caused by a combination of climate variability, population growth, and climate change as well as ongoing challenges in the protection/enhancement of the water environment. Successful urban communities are complex socio-physical systems that are integrated and constantly evolving. Contemporary research in integrated urban water cycle management highlights that a Water Sensitive City will involve a major socio-technical overhaul of conventional urban water management approaches requiring an inter-disciplinary approach.

The ‘Centre for Water Sensitive Cities’ at Monash University was established with the mission to undertake inter-disciplinary research to provide socio-technical evidence for guiding the formulation of an overall policy blueprint for Water Sensitive Australian Cities. The Centre hosts a number of cross-faculty interdisciplinary research projects with a core vision to advance sustainable urban water practices through research excellence, engagement with practitioners, supporting the development of government policies, and the translation of research into practice.

This paper presents an overview of the concept of a water sensitive city, the program design of the Centre, and its underpinning philosophical approach to fostering inter-disciplinary research.

KEYWORDS

inter-disciplinary research; urban water management; transition; water sensitive cities

INTRODUCTION

Cities across the world are facing increasing challenges for managing urban water. The way we manage urban water influences almost every aspect of our urban environment and quality of life. Urban population growth and climate variability/climate change are placing increasing pressure on resource availability and already stressed ecosystems. At the same time, water services infrastructures are reaching the end of their lifespan in developed countries, while developing countries race to meet growing needs, often importing traditional models and standards from developed nations, arguably representing methods and institutions that are either out-dated or are unsuited to the conditions and socio-political contexts of these countries. Despite policy rhetoric, proven technology options and well performing demonstrations projects, modern cities have had limited success at implementing and managing these complex water supply, flood mitigation and waterway health protection practices in a cohesive and mainstream way. We consider institutional inertia associated with disciplinary silos as a significant causal factor for the continued investment in conventional approaches.

Historically, promoting cross-disciplinary efforts to address complex societal problems have focused on the integration of a number of environmental considerations but often without an inter-disciplinary framework to engender adaptation and learning within individual disciplines. Within the context of promoting inter-disciplinary research, there has in fact been a somewhat sceptical view from industry and amongst academic circles on the scientific merit of cross-disciplinary research, with the perception that depth has been traded for breadth. Yet, addressing grand societal challenges are well beyond the plight of single disciplinary insights and solutions. Society is nevertheless expecting the scientific community to lead the development of adaptive and robust solutions to these critical challenges. However, in practice, enabling an inter-disciplinary scientific approach, at a scale that is sufficient enough to critically inform policy processes, presents a significant challenge to the traditional norms and services of the scientific community.

The 'Centre for Water Sensitive Cities' at Monash University was established in February 2010 with the mission to undertake inter-disciplinary research to address the challenges of realising sustainable water management in cities of the future. This paper presents an overview of the concept of a water sensitive city, the program design of the Centre, and our underpinning philosophical approach to fostering inter-disciplinary research.

ENVISAGING THE WATER SENSITIVE CITY

Concepts such as integrated urban water management and adaptive water management offer alternative philosophical approaches to the conventional paradigm. The case for establishing water sensitive cities in Australia is well argued as reflected in Australian government policy and strategy statements, notably:-

- the Australian Government's Our Cities Our Future - A National Urban Policy for a productive, sustainable and liveable future highlighting that productivity, sustainability and liveability are part of an interrelated and dynamic system. It sets out the challenge for future cities to avoid and mitigate the impacts of urban development on critical environments by "incorporating quality green space, microclimate and water sensitive design into urban systems";
- the National Water Commission's report Urban Water in Australia: future directions states that the future urban water sector challenge is "to enhance its effective contribution to more liveable, sustainable and economically prosperous cities in circumstances where broader social, public health and environmental benefits and costs are clearly defined and assessed";
- the Victorian Government's Living Melbourne, Living Victoria sets out the "roadmap for urban water reform to support a more liveable, sustainable and productive city". In developing the case for reform, it highlighted that there is "an urgent need for a new phase of reform in the way water is valued, planned for and managed in Melbourne. Otherwise we are at serious risk of locking in a pattern of city design and development that will bring with it further costly augmentation of our water supply and increased environmental damage";

Articulating the vision for a water sensitive city is easy, but it is not yet clear how it can be achieved. Consequently, Australian towns and cities are trying to meet 21st century challenges by re-investing in 19th century strategies and infrastructures that assume nature is an unlimited resource and that society made up of passive consumers. These assumptions are now recognised as economically and environmentally wasteful and are not aligned with community values and expectations.

Wong and Brown (2011, 2009) proposed a framework for envisioning the attributes of Water Sensitive Cities in different bio-physical and socio-political contexts. They propose three guiding principles or ‘pillars’ that would need to be integrated into the urban environment through urban design and planning. These include:

- *Cities as Water Supply Catchments*: Cities would have access to a diversity of water sources in addition to the established convention of capturing rainfall-runoff from rural and forested catchments. These alternative water sources for cities could include a mix of groundwater, urban stormwater (catchment run-off), rainwater (roof run-off), recycled wastewater and desalinated water. These sources would be delivered through an integrated mix of centralised and decentralised infrastructure. Such a strategy of diverse water sources delivered at a mix of water infrastructure scales is to allow cities the flexibility to access a portfolio of sources at least environmental, social and economic costs. Each of the alternative water sources will have an individual reliability, environmental risk and cost profile. This pillar ensures that cities contain both centralised and decentralised water supply schemes, such as a simple domestic rainwater tank for non-potable use, through to city-scale indirect potable reuse schemes and a pipeline grid linking regional reservoirs. Further, when cities are as viewed as water supply catchments land-use management within cities would place a higher emphasis on pollution reduction and environmental protection.
- *Cities Providing Ecosystem Services*: Landscapes are the product of varying natural and human-induced forces, interacting within a regional and global ecosystem. Traditionally spaces in the public domain are essential features of public amenities; however in water sensitive cities these urban landscapes are also ecologically functional while providing for spatial amenity. In a Water Sensitive City, urban landscapes are designed and retrofitted to capture the essence of sustainable water management, micro-climate influences, facilitation of carbon sinks and potential use for urban food production. Water services would focus on providing low carbon urban ecosystem services (such as passive water quality treatment, localised stormwater harvesting and wastewater recycling, and city cooling) rather than continuing to draw ecosystem services from the natural environment. New ecological landscapes supported by access to local water resources buffer the impact of climate change (in particular increased frequency of extreme storm events) and increasing urban densities on natural aquatic environments.
- *Cities Comprising Water Sensitive Communities and Institutions*: The capacity of institutions themselves to advance sustainable urban water management is essential. Unless new technologies are embedded into the local institutional and social context, their development in isolation will not be enough to ensure their successful implementation in practice. The social and institutional capital inherent in the city is reflected in (i) the community living an ecologically sustainability lifestyle and cognisant of the ongoing balance and tension between consumption and conservation of the city’s natural capital; (ii) the industry and its professional capacity to innovate and adapt as reflective practitioners in city building; and (iii) government policies that foster innovation and facilitate the ongoing adaptive evolution of the water sensitive city.

Therefore a water sensitive city is a city:-

- that plans for diverse and flexible water sources - local stormwater harvesting and recycling as well as dams, desalination and water grids;
- that values water and promotes water conservation;
- where the planning system promotes water sensitive urban design for flood mitigation, environmental protection and low carbon urban water services;

- where waterways, trees and vegetation make the city more liveable and improve the environment;
- intertwined with productive landscapes irrigated by recycled water; and
- that has the social and institutional capacity for sustainable water management.

The approach of the Water Sensitive City should be underpinned by a flexible institutional regime and diverse infrastructure. While such socio-technical perspectives have been identified as the most promising for addressing the need for resiliency and advancing sustainable development (Meadowcroft, 2005), they have yet to be systematically applied to the urban water environment.

TRANSITIONING TO THE WATER SENSITIVE CITY

The lack of a socio-technical heuristic tool for assessing and informing the transition of cities towards more sustainable practices has been a critical barrier for conceptualising significant changes over time. In an attempt to address this crucial gap, an *urban water transitions framework* has been developed through an historical and futures analysis of the changing socio-technical arrangements supporting Australian cities urban water management practices over the last 200 years (Brown *et al.*, 2009). The framework recognises temporal, ideological and technological contexts of different management paradigms, and is sensitive to other influencing contextual variables such as histories, ecologies, geographies and socio-political dynamics. This mix of contextual features has been described as the ‘hydro-social contract’ and encompasses dominant values or implicit agreements between communities, governments and business on how water should be managed (Lundqvist *et al.*, 2001).

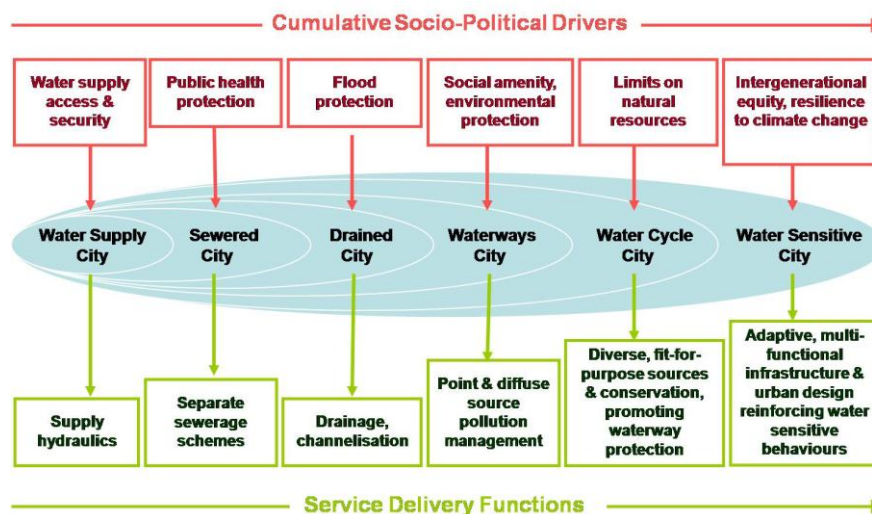


Figure 1 Urban Water Management Transitions Framework (Brown *et al.*, 2009a)

The transitions framework (Figure 1) presents a typology of six types of dominant water management regimes (water supply, sewered, drained, waterways, water cycle and water sensitive) that represent a nested continuum of socio-political drivers and service delivery responses. This typology is based on the attributes of past and present hydro-social contracts in Australian cities and proposes potential future hydro-social contracts by anticipating social and institutional factors underpinning the principles of integration and resilience espoused in proposed future management paradigms such as sustainable water management. The idea being that as cities progress towards the Water Sensitive City they accommodate additional and sometimes competing objectives of previous management regimes and therefore water management becomes necessarily more complex, but also more resilient to major system

‘disturbances’ (such as floods, droughts, heat waves and waterway health degradation) and improves its adaptive capacity to create opportunities from these disturbances for innovation and development or even the pursuit of new trajectories (Folke, 2006).

The application of the transitions framework to cities around the world suggests that many cities are located on the left half of the continuum (Duffy, 2009), with frontrunners located somewhere between the ‘Waterways’ and ‘Water Cycle’ city. Reflecting on the commentary thus far, it could be argued that there appears to be a deep barrier to making the transition from the ‘Drained City’, to the more complex, adaptive and context specific practices represented on the right side of the continuum. Typical characteristics of the nested Water Supply-Sewered-Drained City represents a state of large technical, single source water supply systems, energy intensive reticulation and wastewater treatment systems and drainage systems designed to rapidly convey stormwater to receiving aquatic ecosystems. The structure of the hydro-social contract is significantly challenged with the advent of the Waterways City, with the stakeholders in this contract expanding and responding to environmental protection and more social amenity needs and therefore increasing the disciplinary breadth of knowledge required. With the Water Cycle City the stakeholders and the distribution of functions and responsibilities need to be fundamentally re-structured with a complete inter-disciplinary and multi-sectoral approach required for a Water Sensitive City.

CENTRE FOR WATER SENSITIVE CITIES

At Monash University, we have extended our focus on inter-disciplinary environment and sustainability education into a serious and significant inter-disciplinary research focus in ‘urban water resources’. Over the years, there have been a number of disciplinary groups (from engineering, arts, science, and economics faculties) that have excelled in their individual research in various aspects of urban water resource management. These have now been formally consolidated through the establishment of the Centre for Water Sensitive Cities in February 2010. The vision of the Centre is *to advance sustainable urban water practices through research excellence, engagement with practitioners, supporting the development of government policies, and the translation of research into practice*. This inter-disciplinary, multi-faculty research centre is built on the premise that inter-disciplinary endeavours and responses to complex environmental problems can be most effectively delivered through research and education activities that is linked to practice in industry and government (rather than exclusively through the typical approach of an undergraduate education program).

The mission of the Centre is to undertake inter-disciplinary research to provide social and technical evidence for guiding the formulation of an overall policy blueprint for Water Sensitive Australian Cities. Areas of research include:

- Resilience to droughts and climate change – diversity of water sources and enabling infrastructure
- Water conservation and behavioural change
- Climate adaptation – resilience to floods and sea level rise
- Climate adaptation – micro-climate, urban heat island, health impacts
- Planning neighbourhoods and precincts that are more water sensitive
- Liveable & affordable urban renewal/greenfield developments
- Utilising water sensitive planning principles in designing industrial and commercial precincts
- Nexus between local water recycling/stormwater harvesting and low carbon energy production

- Delivering Ecological Landscapes – healthy streams, flora and fauna bio-diversity, productive landscapes, carbon sink, micro-climate etc
- Building connected and sustainable communities
- Governance and socio-political arrangements for a water sensitive city

Establishing an Inter-disciplinary Scientific Approach at the University Level

The Centre brings together established researchers from across the physical, natural and social sciences. This ensures the necessary depth needed from their respective disciplinary, departmental and faculty perspectives into the Centre; this is what we see as critical for future research in this space of environmental and sustainability research. While there are some significant transaction costs and barriers to doing this type of research, Monash University is investing in the institutional infrastructure and incentive systems to assist and encourage established researchers to work in an inter-disciplinary context should they be interested. The underpinning philosophical design of the Centre is based on integrating the fundamental research activities of individual disciplines at two levels: (i) the development and refinement of research perspectives in formulating core research questions; and (ii) integration of the research insights while engaging with industry and government agencies. The Centre plays an important integrating role amongst researchers from differing faculties and disciplines through undertaking a number of open initiatives and facilitating processes. Examples include envisioning alternative future scenarios for sustainable cities, work-shopping novel research questions and the development of new conceptual frameworks across the social, natural and physical sciences. We have found that the process of formulating core inter-disciplinary research questions fosters and ensures the researchers' understanding of the broader context and contribution of their work towards addressing the complex and global water sustainability challenge. Further, the development of inter-disciplinary demonstration projects, in collaboration with industry and government partners, challenges researchers to understand and accommodate the research insights and recommendations of other disciplinary perspectives. This leads to highly integrated outcomes which may not be immediately apparent from the outset nor from any single disciplinary perspective.

The Research Program Design

The program design of the Centre provides the linkages between fundamental research and industry outreach as shown in Figure 2.

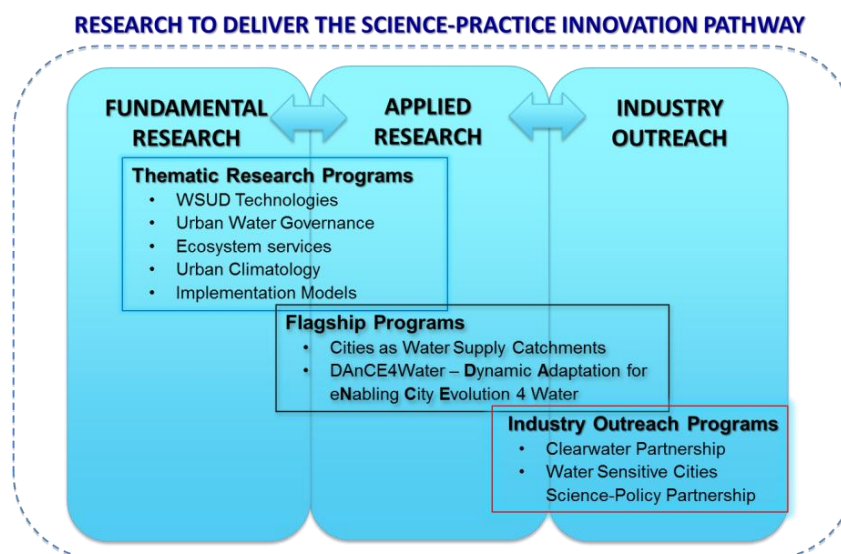


Figure 2 Research Design to Deliver the Science Practice Innovation Pathway of the Monash Centre for Water Sensitive Cities

Three groups of research programs span across these three domains i.e. thematic research programs encompassing fundamental and applied research activities; industry outreach programs linking applied research to practice and flagship programs that provide the forum for interdisciplinary research and industry engagement.

Thematic Research Programs: Mono-disciplinary research is critical and must be supported and maintained within an inter-disciplinary centre. The Centre supports the endeavours of academic and research staff in pursuing research excellence in their respective disciplines while providing the necessary platform for their inter-disciplinary integration. The thematic research programs coordinate an array of projects around a number of research ‘themes’ including (a) WSUD Treatment Technologies, (b) Urban Water Governance, (c) Ecosystem Dynamics, (d) Urban Climatology and (e) Implementation Models Programs.

Flagship Programs: Flagship programs are highly integrated, drawing together many different areas of research. The main Flagship Program currently led by the Centre is the *Cities as Water Supply Catchments* Program. The vision of this research program is to harness the potential of stormwater to overcome water shortages, reduce urban temperatures, and improve waterways health and the landscape of Australian cities. This program with its eight separate but interlinked research projects (P1 to P8 – see Figure 3) and its integrated demonstration and communications strategies, addresses key issues which have so far restricted the on-site capture and use of stormwater to ease long term water shortages in urban environments in Australia. In addition to proving that stormwater harvesting is safe, practical and cost effective, solutions developed by this program will enhance the livability of cities by delivering improvements in urban micro-climates, waterways health, and urban landscaping. These benefits are not available as part of any other water supply management strategy,

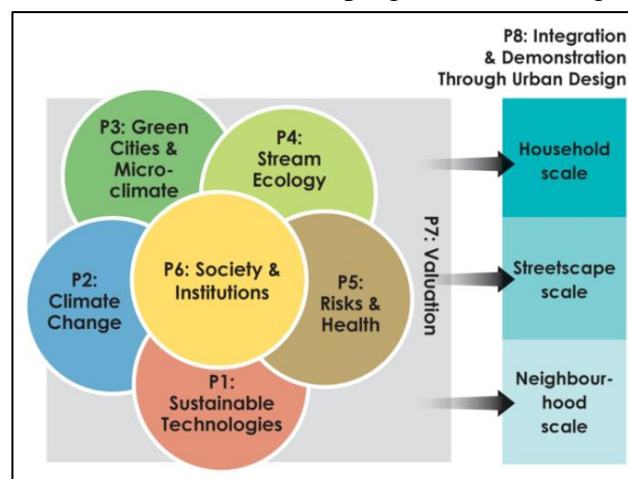


Figure 3. Projects of the Cities as Water Supply Catchments Research Program.

Industry Outreach Programs: The research adoption pathways of the Centre focus on capacity building through the creation of a community of practice in water sensitive planning and design, and the establishment of science-policy partnerships with all levels of governments. The establishment of a community of practice provides the forum for knowledge brokering, industry training, networking of multi-sector champions and industry and community feedback and defining of key water sensitive cities research questions. Scientifically-rigorous evidence-based policy development is considered fundamental to the institutional capital of water sensitive cities with policies underpinning the environment for innovation in future urban communities.

REFLECTIONS & INTER-DISCIPLINARY CHALLENGES AHEAD

Unlike multi-disciplinary activities, the inter-disciplinary research focus is still emerging, with researchers from a variety of disciplinary backgrounds attempting to define the research agenda for needed to underpin the paradigm shift required. This inter-disciplinary challenge is exacerbated by the limited incentives for academics to participate in inter-disciplinary research, particularly given the need to publish rapidly and bring in high profile research

grants. So, efficiency is critical to top researchers and inter-disciplinary research has many transaction costs with time often the most significant. Reflecting on the challenges of fostering inter-disciplinary research have highlighted the following two key issues:-

- the lack of scholarly incentives to work in an inter-disciplinary context. There are limited top tier journals for inter-disciplinary publications and research council grants in Australia still prioritise mono-disciplinary research projects, and
- the extra time and personal commitment needed of researchers to overcome different disciplinary norms and language. Academic staff typically do not have the skills and experience with working in an inter-disciplinary context and can get frustrated or be at risk of being highly judgmental of other disciplinary approaches.

To assist with addressing these issues, we have found the following to be important:

- create a common space and non-faculty institutional focal point such as a university level centre or institute that has physical meeting spaces, a non-faculty aligned leader and research director/integrator;
- non-faculty aligned administrative support that coordinates contracts and meetings with multi stakeholder partnerships and proportional funding allocation to individual faculties participating in interdisciplinary programs;
- a commitment to pro-active industry engagement as a focus for fostering dissemination and adoption of research insights; and
- the common coordination of a large PhD student pool of the respective researchers across faculties and disciplines to maintain a level of rigour and depth in their respective disciplines while grounding their perspective across multiple disciplines.

CONCLUSIONS

The Centre for Water Sensitive Cities at Monash University was established in February 2010 with the mission to undertake inter-disciplinary research to provide social and technical evidence for guiding the formulation of an overall policy blueprint for Water Sensitive Australian Cities. The Centre hosts a number of cross-faculty interdisciplinary research projects with a core vision to advance sustainable urban water practices through research excellence, engagement with practitioners, supporting the development of government policies, and the translation of research into practice.

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