A Research Agenda for Water Smart Tropical and Sub-Tropical Cities and Towns

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The Urban Water Security Research Alliance (UWSRA) is a $50 million partnership over five years between the Queensland Government, CSIRO's Water for a Healthy Country Flagship, Griffith University and The University of Queensland. The Alliance has been formed to address South East Queensland's emerging urban water issues with a focus on water security and recycling. The program will bring new research capacity to South East Queensland tailored to tackling existing and anticipated future issues to inform the implementation of the Water Strategy.

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FOREWORD

Water is fundamental to our quality of life, to economic growth and to the environment. With its booming economy and growing population, Australia's South East Queensland (SEQ) region faces increasing pressure on its water resources. These pressures are compounded by the impact of climate variability and accelerating climate change.

The Urban Water Security Research Alliance, through targeted, multidisciplinary research initiatives, has been formed to address the region's emerging urban water issues.

As the largest regionally focused urban water research program in Australia, the Alliance is focused on water security and recycling, but will align research where appropriate with other water research programs such as those of other SEQ water agencies, CSIRO's Water for a Healthy Country National Research Flagship, Water Quality Research Australia, eWater CRC and the Water Services Association of Australia (WSAA).

The Alliance is a partnership between the Queensland Government, CSIRO's Water for a Healthy Country National Research Flagship, The University of Queensland and Griffith University. It brings new research capacity to SEQ, tailored to tackling existing and anticipated future risks, assumptions and uncertainties facing water supply strategy. It is a $50 million partnership over five years.

Alliance research is examining fundamental issues necessary to deliver the region's water needs, including:

- ensuring the reliability and safety of recycled water systems.
- advising on infrastructure and technology for the recycling of wastewater and stormwater.
- building scientific knowledge into the management of health and safety risks in the water supply system.
- increasing community confidence in the future of water supply.

This report is part of a series summarising the output from the Urban Water Security Research Alliance. All reports and additional information about the Alliance can be found at http://www.urbanwateralliance.org.au/about.html.

Chris Davis
Chair, Urban Water Security Research Alliance

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EXECUTIVE SUMMARY

This report describes the process and outcomes relating to the development of a research agenda to advance the current understanding of the role and importance of water in achieving sustainable urban development, specifically in the context of tropical and sub-tropical climates and at the science-policy interface. As this issue of "water smart" cities was only identified as a strategic research priority late in the lifespan of the Alliance, the intention with this project was to deliver a research program as an Alliance "legacy" for implementation by another agency at a later stage. A dialogue-driven approach was used to design the research agenda to achieve a convergence between the requirements of key policy and decision-making stakeholders in the region. An iterative process was used, with option development and refinement occurring through increasingly focused stakeholder feedback, supported by an increasingly targeted review of scientific, industry and practice literature for advancing the science. During this process, a number of useful contributions to the water smart cities debate have been made, including:

- Understanding and integration of recent advances in conceptual models based on urban metabolism;
- Extraction and distillation of changes and actions necessary to transition to more water smart cities as identified by key Queensland government and research stakeholders;
- Effective resolution of "top-down" issues (changes and actions needed) and "bottom-up" knowledge areas into research focus areas - where science meets policy needs; and
- Classification of focus areas into a four-pillar research agenda.

Three focus areas have been identified for the future research agenda:

- enabling communities to practise water smart activities and behaviour through enhanced understanding, advocacy and capacity building;
- enabling institutional processes and models; and
- enabling information for individuals, communities and government, underpinned by a guiding conceptual framework and a solid, web-based information platform with accessible, relevant, updated and comparable data and data analysis tools.

1. INTRODUCTION

1.1. Water and Cities

Urbanisation and population growth are world-wide phenomena which are gathering momentum in the 21st century. Predictions from the United Nations indicate that, by 2030, not only will the world's population have increased by about 50% over current levels, but the proportion living in cities will have increased to about 60%. Even in Australia, with its relatively low population, it is anticipated that the major urban centres will grow substantially. For example, in South East Queensland (SEQ), one of Australia's fastest growing metropolitan regions, the population is expected to grow from 2.4 million to 4.4 million from 2006 to 2031 (Priestley *et al.*, 2011).

This growth will place increasing pressures on the need for human services in urban areas, in particular: water, food and energy. At the same time, it is likely that climate change and resource depletion will challenge the ability of cities to provide such resources in an affordable manner. Concern about these issues has led to the concept of Cities of the Future and the question of what will be required of these cities to make them not only habitable but also pleasant and healthy places to live. The concept of sustainability underlies many of these considerations and a considerable literature exists around defining this term in relation to cities (Priestley *et al.*, 2011).

While water is only one component of a liveable city, it is being increasingly recognised that it plays a central role in facilitating many of the sustainability characteristics required for the proposed Cities of the Future, such as:

- secure, safe and resilient water supply;
- safe and effective waste disposal;
- flood prevention and stormwater management;
- ecologically diverse and healthy waterways;
- green and attractive open spaces which encourage outdoor activity;
- summer cooling and reduction of the heat island effect;
- aesthetically pleasing environments and gardens;
- urban agriculture/food production; and
- energy generation (Priestley *et al.*, 2011).

The Australian water industry has now recognised that, if all of these services are to be delivered in a sustainable manner, then a new strategy will be required in which all urban infrastructure and services are planned and delivered through a partnership involving urban planners and developers, the water sector and other service providers such as energy companies. It is only through such collaboration that real synergies can be obtained and the most sustainable city designs identified and implemented. Consequently, the urban water industry requires a paradigm shift away from the manner in which water services have traditionally been provided.

Gabe *et al.* (2007) cite integrated urban water management (IUWM) as an example of a response by urban water managers to societal and statutory demands for multiple-bottom-line outcomes. They point out that IUWM 'recognises that actions to improve urban water systems can include a broader range of social, economic and other environmental outcomes beyond improving water quality and managing quantity'. Changes in water management practices can contribute significantly towards sustainable cities by, for example: improving human health; supporting urban biodiversity; reducing greenhouse gas emissions; increasing amenity; sustaining environmental values; counteracting the effects of urban heat islands; and augmenting city liveability in general (Priestley *et al.*, 2011).

The mainstreaming of sustainability principles has led to an emergence of innovative and integrative sustainable urban water management (SUWM) practices and an increasingly clearer vision of water sensitive cities (Priestley *et al.*, 2011). While significant progress has been made with implementing SUWM in some cities (Mitchell *et al.,* 2007; Brown *et al.*, 2009), the transition has been hampered by: continued investment in traditional water infrastructure (Wong and Brown, 2009); socio-institutional issues including institutional inertia (Brown and Farrelly, 2009); a lack of a benchmarking tools for informing the development of long-term policy for SUWM; and a lack of vision regarding the attributes of a sustainable water city (Brown *et al.*, 2009).

Further to the seminal work of Brown *et al.* (2009), which proposed an 'urban water transitional framework' for guiding the transition to more water sensitive cities, the Centre for Water Sensitive Cities is playing a leading role in building Australia's capacity to advance sustainable urban water practices through research, engagement and policy support (Centre for Water Sensitive Cities, 2010). The Centre has attempted to describe the attributes of a Water Sensitive City in relation to the attributes of a more "traditional" city in terms of system boundary, management approach, expertise, service delivery, role of the public and risk (Centre for Water Sensitive Cities, 2010).

The key point which emerged from this, and other, descriptions of Water Sensitive Cities given in the literature, is that not only can anyone not yet point to a clear example of such a city, but also the language used to describe it is still cast in generalised statements about the desirability of certain attributes, e.g. adaptive, multi-functional infrastructure, flexible institutional arrangements, engaged community and holistic thinking. Clearly, clarification of these issues is critical to progress towards more sustainable urban water systems and providing direction for how to get there (Priestley *et al.*, 2011).

1.2. Project Background

1.2.1. Need

With its rapidly expanding economy and growing population, compounded by climate variability, Australia's SEQ region faces increasing pressure on its water resources. On the other hand, flooding and drought have, in turn, impacted significantly on the people and economy of the region. Managing urban development in a water smart way is a necessity and requires a solid evidence base on which to underpin investment decisions and policy direction. The Urban Water Security Research Alliance (Alliance) was established in 2007, in the midst of a severe drought, to strengthen the research capacity in SEQ to tackle the issue of water security in the region. A broad-ranging research program has delivered outputs relating to reducing the demand for grid water, improving water quality and enhancing total water cycle management and planning.

The issue of Water Smart Cities was identified by key stakeholders as a strategic research priority late in the lifespan of the Alliance, with the intention being to deliver a research program as an Alliance "legacy" for implementation by another agency at a later stage. The topic is certainly not a new area of endeavour in either the wider research community or in practice. In Australia, in the continued striving towards more sustainable development, the water industry and research community have produced a range of frameworks, designs, demonstrations, case studies and guidelines using the concepts of IUWM and Water Sensitive Urban Design (WSUD) to promote sustainability in the water cycle. In practice, water sensitive urban design has been implemented at a range of building, precinct and neighbourhood scales. More recently, the importance of integrating water sensitive design within the wider urban planning context, at not only the local development scale but at the scale of cities, has been recognised (IWA, Cities of the Future, 2010).

1.2.2. Project Purpose

Within this research and practice landscape, the challenge for the Alliance was to develop a research agenda, with stakeholders, to advance the current understanding of the role and importance of water in achieving sustainable urban development, specifically in the context of tropical and sub-tropical cities and towns and to identify what is required to integrate and mainstream water thinking into urban planning processes.

1.2.3. Phase 1 Outcomes

An initial, limited scope project (Phase 1) was conducted during 2010/11 with the purpose of scanning the national and international environment (literature and industry activity) and bringing together the current state of literature discussion regarding water smart and sustainability principles and analytical frameworks. Phase 1 comprised a review of the scientific literature relating to the sustainability of urban water systems and a description of the construction and use of analytical frameworks and associated sets of indicators proposed to assess sustainability. It also considered Australian experience in implementing some of these methodologies, going on to capture principles and actions for constructing proposed Cities of the Future (Priestley *et al.*, 2011).

The Phase 1 report contends that, by obtaining a clear understanding of the physical and scientific factors impacting on the availability and efficient use of physical resources, common ground will be obtained from which all parties involved in urban planning (including those in the social and organisational realms) can move forward. The concept of 'urban metabolism' was put forward as one way of pursuing this goal. However, this report also concludes that quantifying an urban metabolism model will only provide answers directly related to resource use efficiency and that other tools will still be required to answer questions related to factors such as cost, resilience and risk. The report concludes with some recommendations for future work, which will not only explore the potential use of 'urban metabolism' models, but also assess their integration with other analytical tools relating to system resilience, risk and cost (Priestley *et al.*, 2011).

As part of Phase 1, a series of research design criteria were initially established after high-level workshops with key local and national policy and industry stakeholders to guide and scope the development of the research agenda (Phase 1). The discussions determined that the research agenda for water smart tropical and sub-tropical cities and towns should:

- be framed in the broader context of planning for Cities of the Future with the perspective being the role of water and its interaction with other agents and flows within the urban development process;
- be based on an integrated socio-economic and ecological system approach – the biophysical system is relatively well understood but not in relation to the socio-economic system;
- recognise multiple geographic scales with clear definition of system boundaries for each scale – for example, WSUD is technologically well-developed for the local household or neighbourhood scale, but solutions at the scale of the city, region or catchment and accounting for interactions between scales, are not advanced;
- have clearly defined destination objectives;
- accommodate differentiation and multi-purpose uses through classification of types of contexts and using a fit-for-purpose approach. Opportunities differ across a city and between different cities and towns, with a range of local biophysical and socio-economic contexts at play. Different qualities of water are appropriate for different uses and for achieving different outcomes (i.e. differentiate between water for supply and water for aesthetics);
- incorporate the concepts of resilience and risks by ensuring that systems are not only based on best-case scenarios but also recognise the range of potential stressors;
- guide the formulation of associated outcomes-oriented metrics for applying principles in practice, assessing the sustainability of options and for monitoring progress on a comparable basis; and
- be pragmatic by focusing on the factors with the biggest impact and considering information availability.

1.2.4. Phase 2 Purpose

The purpose of Phase 2, the primary focus of this current report, was: to further develop the research agenda ideas emanating from the Phase 1 report, supplemented by a more targeted literature review and a review of the Queensland (particularly SEQ) policy and practice environment; and further engage with key government and research stakeholders to obtain agreement on SEQ specific research priorities to form the basis for designing a longer term research program.

This report describes the process and outcomes relating to the development of a research agenda to advance the current understanding of the role and importance of water in achieving sustainable urban development, specifically in the context of tropical and sub-tropical climates and at the science-policy interface.

2. APPROACH

2.1. Focus Area Determination Process

As an integral part of a systems-based approach developed to manage research and development (R&D) in the road infrastructure sector, Rust (2009) outlines a process to determine R&D needs (Figure 1). A set of key Focus Areas for R&D are derived through a "top-down" process, where dominant issues are identified by "lead user" stakeholders, and a "bottom-up" accumulation of innovative project ideas from practitioners and researchers, also informed by existing knowledge, international technology trends and foresight studies (Figure 1).

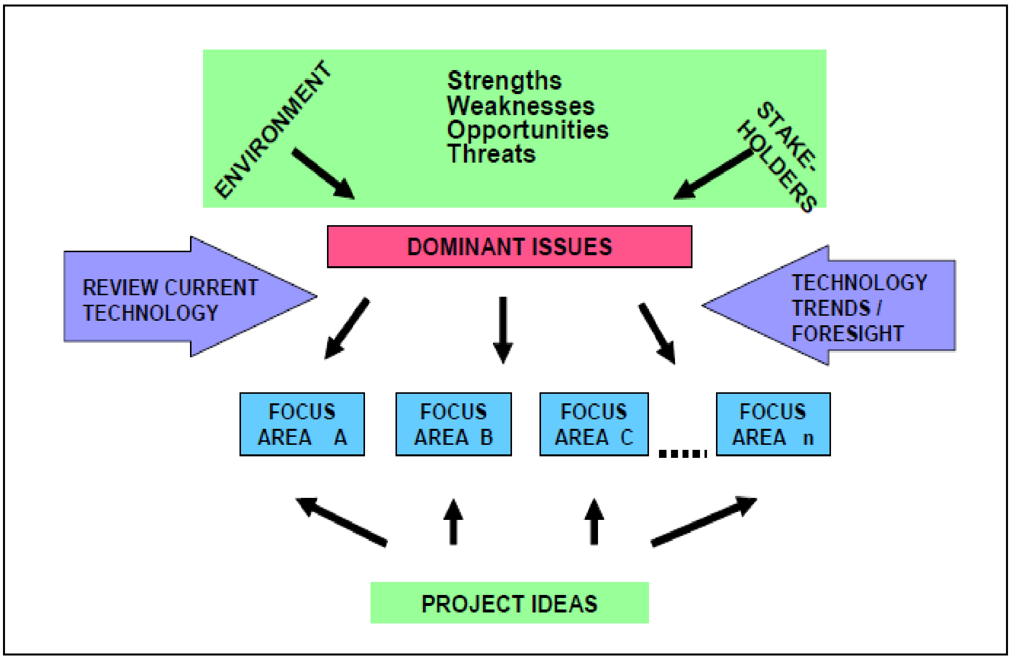


Figure 1: The needs determination process.
(Source: Rust, 2009, pg 235)

Once these Focus Areas addressing dominant issues have been obtained through the needs determination process, they form the focal point for designing a sustainable research program which is relevant to issues facing industry and users (high impact) but is grounded on a solid science foundation (science excellence). For the present purpose, the research agenda is equivalent to a set of Focus Areas obtained through a similar process based on the needs determination process described above. As a next step, a research program would need to be designed around these identified Focus Areas, detailing the science base and applied technologies necessary to address the needs and issues captured as Focus Areas.

Technology trees are one method which can be used to guide the development of such a research program. The concept of technology trees has been used in the technology management arena for a range of purposes (Rust, 2009; Heiss, 2001). Examples include: to generate a common understanding amongst researchers, stakeholders and funders about the process and expected outcomes of R&D; and to motivate the importance of certain base science activities to achieve desired high impact outcomes, i.e. to demonstrate more directly, the link between science and policy/practice (Verhaeghe and Kfir, 2002). Technology trees are also helpful in designing research programs with a "balanced portfolio" of basic and applied science in cases where both science excellence and high impact science outcomes are required (Rust, 2009). With the Focus Areas as determined in the needs determination process at the top and infrastructure and basic science at the roots, technology trees link user needs and base science through a series of key products or solutions, technology platforms and applied technology towards the top end of the tree (in the more applied space), down to base technologies and basic science at the base of the tree (Figure 2).

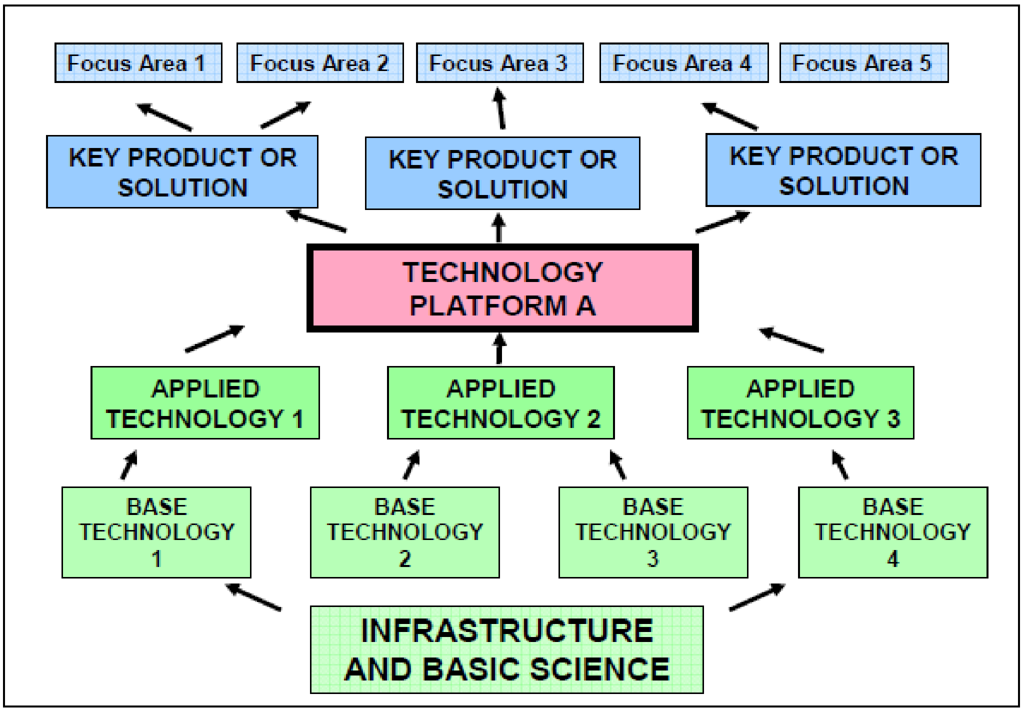


Figure 2: **Simplified schematic of a technology tree.**
(Source: Rust, 2009, pg 238)

Technology trees would be most useful for the next phase when the detailed research program is designed. At this current research agenda formulation stage, the technology tree concept is used to help resolve a wide range of inputs from researchers and stakeholders which are not always neatly defined at the conceptual level of Focus Areas, but can be situated at a range of levels in the tree. Researchers and findings from the literature review tend to identify opportunities lower down in the tree while policy-makers and practitioners tend to identify issues higher up in the tree. The technology tree concept is useful at this stage to map this range of inputs at whichever level in the tree they fit and then to resolve them into a coherent set of Focus Areas at one level in the tree.

2.2. Research Agenda Formulation Process

Based on the focus area determination process described above, a dialogue-driven approach was used to design a research agenda which achieves a convergence between the requirements of key policy and decision-making stakeholders and the findings of the literature review which identified opportunities for advancing the science. An iterative process was employed with option development and refinement occurring through increasingly focused stakeholder feedback, supported by an increasingly targeted review of scientific and industry and practice literature (Figure 3).

The literature/industry/practice review stream of work, incorporating outcomes of a researcher workshop, a targeted literature review and a policy and practice review, culminated in a set of "knowledge areas" or areas of opportunity for expanding the science base which loosely equate to Rust's (2009) "bottom-up" "project ideas" formulation process (Figure 4).

The stakeholder engagement stream of work, through Stakeholder Workshop 1, identified a set of "changes and actions" necessary to transition to more water smart cities and towns (Figure 4), equivalent to Rust's (2009) "top-down" "dominant issues". Stakeholder Workshop 2, comprising both government and research stakeholders, considered and discussed the relationship between the identified "knowledge areas" and "changes and actions", informing the formulation of a set of "focus areas" to form the basis of a research agenda (Figure 4).

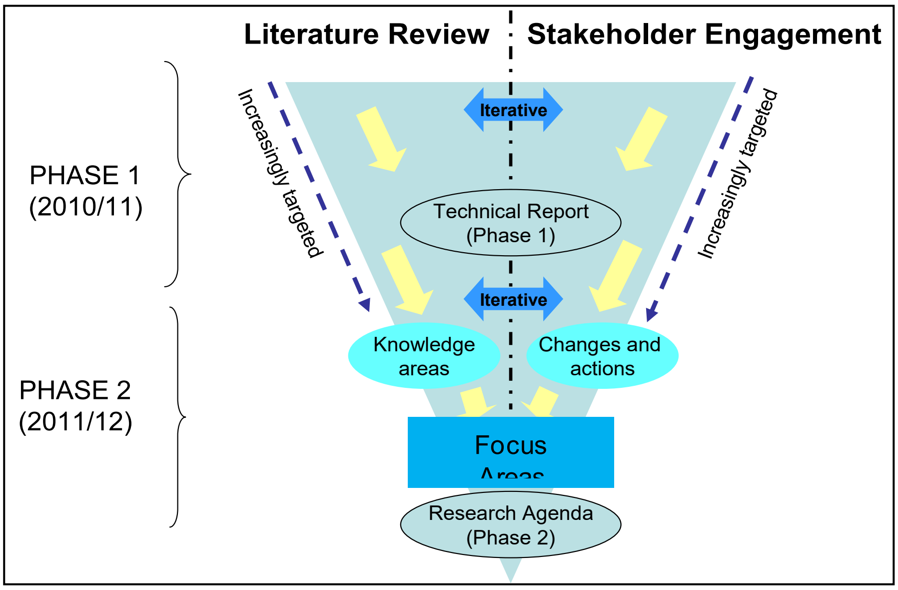


Figure 3: **A dialogue-driven approach to designing the research agenda.**

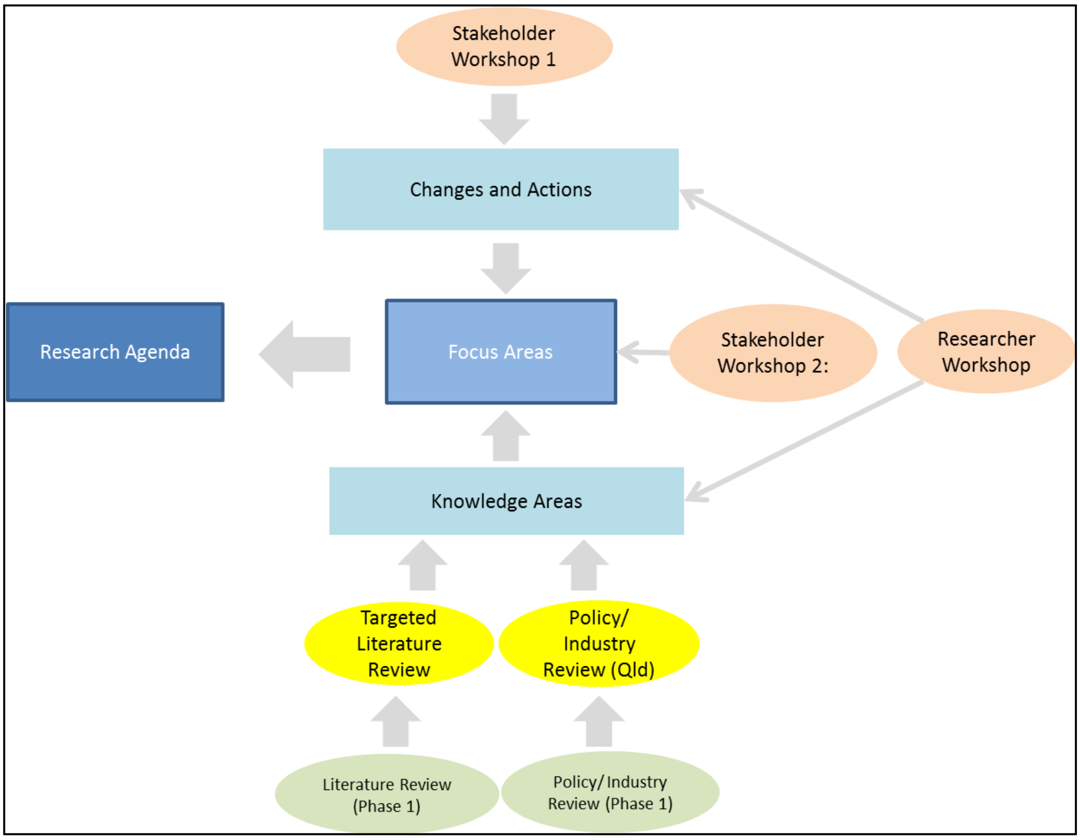


Figure 4: **Research agenda formulation process.**

From here on, this report is structured by firstly a consideration of the results of the literature review stream of work leading to the articulation of a set of knowledge areas. The report secondly elucidates the changes and actions identified during the first stakeholder engagement workshop. The report then presents a set of focus areas which emerge out of a process of resolution of the "top-down"-identified changes and actions and the "bottom-up"-identified knowledge areas. A discussion of the next step of developing the focus areas further into a full-scale research program and some possible ways forward, concludes the report.

3. KNOWLEDGE AREAS IDENTIFIED

3.1. Literature Review

3.1.1. Phase 1 Literature Review Findings

The initial review of scientific and industry and practice literature concluded that significant opportunities for further research to enhance urban sustainability, from a water perspective, lie in the area of resource efficiency, in particular through the integration of: energy, water and nutrient flows; resource efficiency and the human (socio-economic) dimensions of urban development; and resource efficiency, resilience and risk (Priestley, 2011). A comparative assessment of a number of alternate approaches to understanding resource efficiency in urban contexts has indicated that the urban metabolism approach, first articulated by Wolman (1965), is a solid basis from which to begin (Priestley *et al.*, 2011). This is because it has been demonstrated to, amongst others:

- build on a solid foundation of material and energy balances which underpin the resource flows throughout the city rather than simply "accounting" for them as inflows and outflows;
- incorporate social and physical sciences (eg, bridging some of the typically divided science elements);
- quantify the performance of cities (eg, hydrological performance);
- drive accuracy and structure into water (and other urban) accounting systems;
- allow for the captures of flows beyond the urban boundary;
- allow for capture of virtual water flows and nutrients;
- be extendable, with a number of attempts having been made, in theory and practice, to extend the urban metabolism to account for broader human and ecological processes;
- be divisible, possible to apply only selected parts of the urban metabolism model to understand particular aspects. Techniques such as mass and energy flow analysis are a simplified subset of urban metabolism and provide a basic example of what the approach can offer; and
- can be applied using pragmatic methods to acquire data including downscaling techniques, in recognition of the complexity and data-hungriness in applying the urban metabolism concept.

Recommendations for the application of an urban metabolism approach based on the Phase 1 literature review included: developing simplified urban metabolism models to focus on "big gains" factors and drivers; investigating the integration of urban metabolism models dealing primarily with resource use efficiency with other tools used for the assessment of system resilience, risk and cost; and developing and evaluating approaches to the clear communication of the outputs of urban metabolism models to urban planners, politicians and the general public in relation to resource efficiency indicators and their changes over time (Priestley *et al.*, 2011).

3.1.2. Targeted Literature Review

The targeted literature review around the research gap of conceptual framework revealed a number of alternative approaches and theoretical advances to urban metabolism (discussed in Phase 1, see Technical Report 43 (Priestley *et al.*, 2011)), which may be useful bases for the formulation of an appropriate conceptual framework to guide the water smart cities and towns research agenda in SEQ and other tropical and sub-tropical areas. It is eminently clear from much of the prominent literature that the conceptual framework needs to view urban areas as integrated, complex, adaptive, social-ecological systems with emergent properties (Newman, 1999; Alberti, 2003; Alberti, 2005; PIMSEIC, 2010; Resilience Alliance, 2007 and 2010; Minx *et al.*, 2011).

Until recently, the human and ecological processes occurring in urban areas have generally been studied as separate phenomena. This approach precludes gaining an understanding of how human-dominated ecosystems emerge from interactions between socio-economic and ecological processes, both locally and over larger spatial scales. An extended metabolism model has been proposed and applied in assessing the sustainability of a number of cities (Newman, 1999; Figure 5). The inclusion of liveability factors, in addition to resource efficiency factors, is advocated to enable the identification of how a simultaneous increase in liveability benefits alongside a reduction of resource inputs and waste outputs, as the goal of sustainability in cities, might be achieved (Newman, 1999).

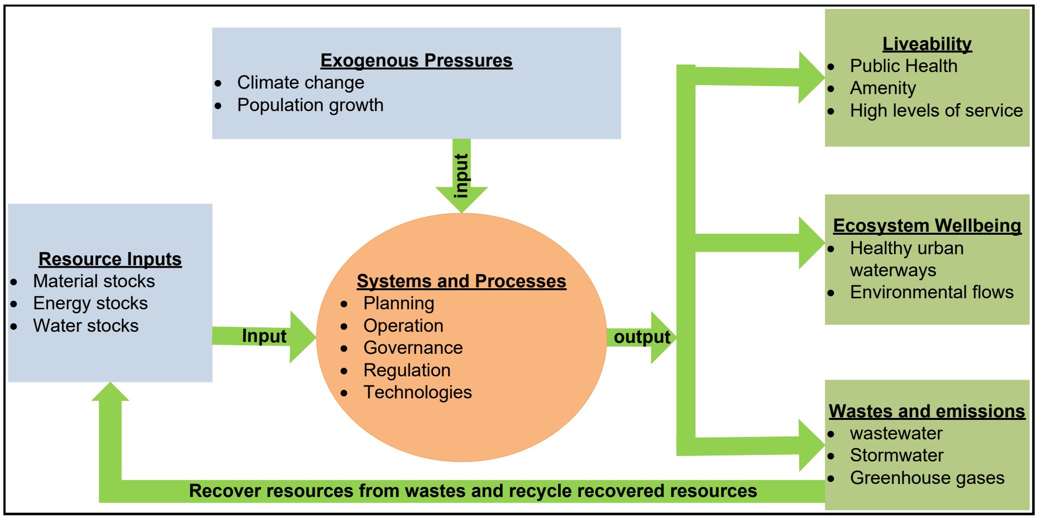


Figure 5: Newman's Extended Urban Metabolism model.

The extended metabolism model has been used as a basis for deriving a set of principles to guide IUWM (Burn *et al.*, 2011). The Resilience Alliance (2007; 2010) has developed a resilience assessment framework for assessing the resilience in social-ecological systems based on the four interconnected themes of metabolic flows, social dynamics, governance networks, and the built environment (Figure 6).

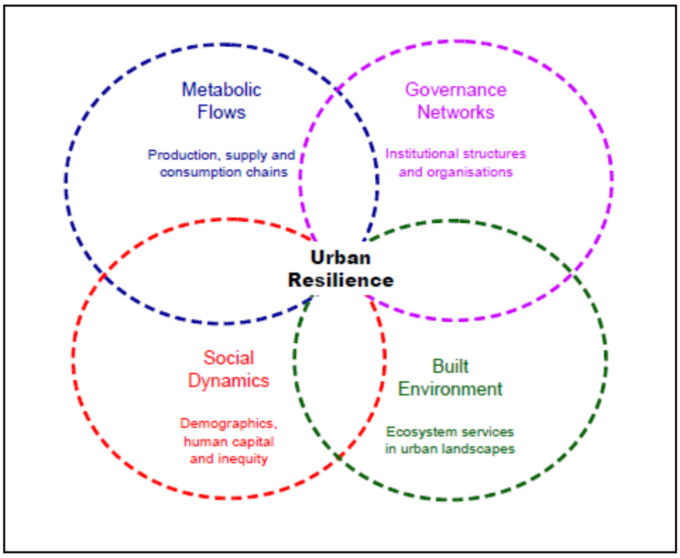


Figure 6: Resilience Assessment Framework (Resilience Alliance).

In an attempt to more fully capture the interactions and feedbacks in human-dominated ecosystems, Alberti *et al.* (2003), have elegantly postulated and applied (Alberti, 2005) an integrated model of human and ecological processes to understand the forces driving urban development patterns, resulting patterns of natural and developed land, impacts on social and biophysical processes, resulting environmental and social changes and effects and feedback on human and biophysical drivers (Figure 7). The model has been applied in an empirical study in the Puget Sound Region to determine the impacts of urban patterns of ecosystem dynamics. It was found that not only the amount of impervious area but also patterns of urban development and roads are strongly correlated with ecological condition (Alberti, 2005). In applying the model, valuable consolidation of the measures of the effects of urban patterns on ecosystem function were made. In addition to impacts on nutrient and material cycles (which is the direct domain of urban metabolism), effects on biodiversity, primary productivity and disturbance regimes are also measured (Alberti, 2005). These measures are the means of effective feedback to the urban development process to evaluate the effect of human development patterns on the urban ecology.

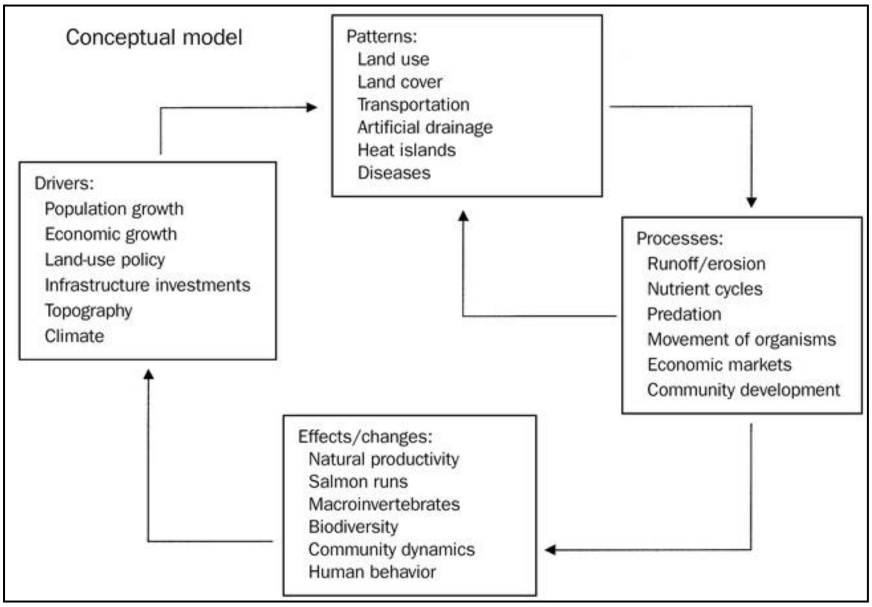


Figure 7: Integrated model of humans and ecological processes.
(Source: Alberti et al., 2003)

The Prime Minister's Science, Engineering and Innovation Council (PMSEIC, 2010) has recognized that energy, water, carbon and other natural cycles, such as nutrient cycles, are significant interconnectors between the natural environment and human society. Accordingly, an integrative, resilience-based approach has been advocated as an appropriate framework for addressing the combined and intersecting energy, water and carbon challenges of Australian cities and towns (Figure 8). Resilient urban development pathways are considered as those where living standards continue to increase but with a simultaneous reduction in GHG emissions and water demand and maintenance of environmental quality, all in the presence of global uncertainties and shocks (PMSEIC, 2010).

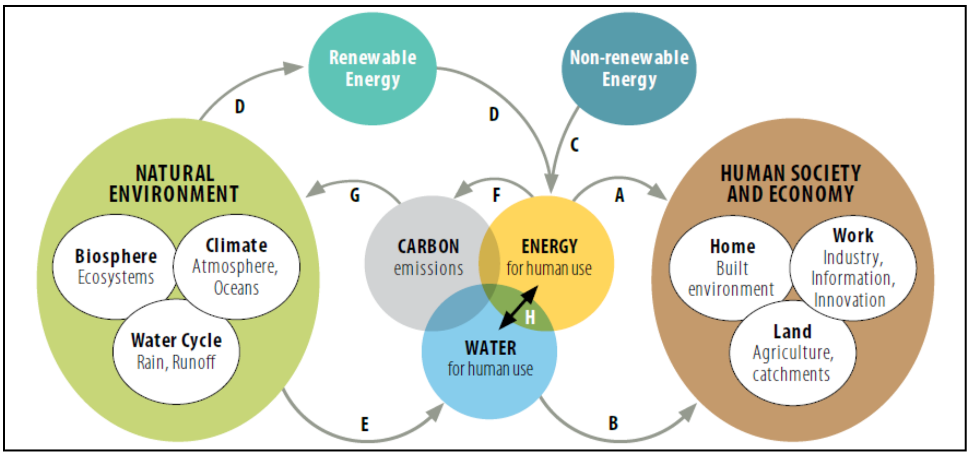


Figure 8: Energy, water, carbon interconnectors between the natural environment and human society.
(Source: PMSEIC, 2010)

In a recent report to the European Environmental Agency, Minx *et al.* (2011) present an extended concept of urban metabolism as part of developing a pragmatic approach to assessing urban metabolism in Europe (Figure 9). Three major extensions are recommended in going beyond a purely metabolic assessment were shown to be:

1) linking the urban metabolism to environmental pressures and aspects of environmental quality at multiple spatial scales from local to global (with implications for concepts of carrying capacity and resilience);
2) linking urban metabolism to urban drivers, patterns (physical structure of the city) and lifestyles to enable an assessment of causes; and
3) linking urban metabolism to aspects of quality of life to understand consequences.

Important contributions relating to the application of the model and the derivation of indicators in accordance with the model have been made. These include:

1) the necessity of being pragmatic in relation to data availability;
2) the importance of analysis at a disaggregated spatial scale;
3) ways in which downscaling techniques can be used to disaggregate higher level input-output stocks and flow data to smaller scale spatial units; and
4) the necessity of incorporating links and relationships from and to the specific geographic area of interest and between different scales so as to be able to explore questions related to the localisation and globalisation of resource flows (Alberti, 2003; Minx *et al.*, 2011).

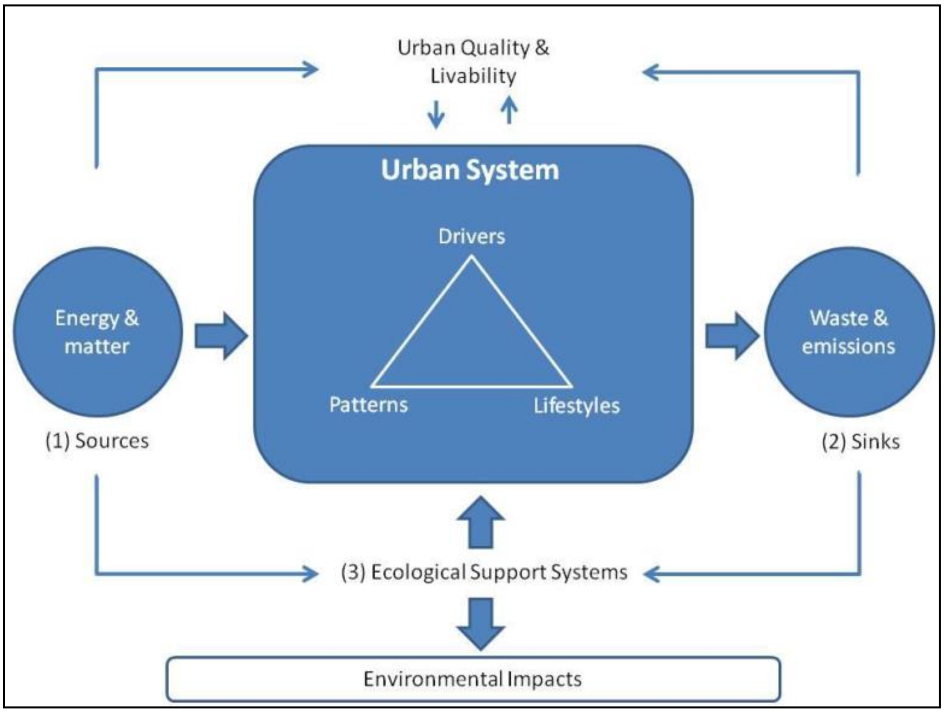


Figure 9: Extended and pragmatic concept for urban metabolism.
(Source: Climatecon – European Environment Agency, 2011)

3.2. Industry Practice and Policy Review

3.2.1. National Policy and Practice

A number of major initiatives have recently been launched in Australia and internationally to help progress the management of aspects of urban water sustainability. Launched by the International Water Association, the Cities of the Future program focuses on water security and the design of cities to minimise the use of scarce natural resources and increase the coverage of water and sanitation in lower and middle income countries (http://www.iwahq.org/3p, accessed 17/5/2012).

In striving towards more sustainable development, the water industry and research community in Australia have produced a range of frameworks, designs, demonstrations, case studies, principles and guidelines using the concepts of Integrated Urban Water Management (IUWM) (Mitchell, 2006; Maheepala *et al.*, 2010) and Water Sensitive Urban Design (WSUD) (Wong and Brown, 2009). In practice, WSUD has been implemented at a range of building, precinct and neighbourhood scales. More recently, the importance of integrating water sensitive design within the wider urban planning context, at not only the local development scale but at the scale of cities, has been recognised (Binney *et al.*, 2010; Burn *et al.*, 2011).

The recently-announced Cooperative Research Centre for Water Sensitive Cities (CRC WSC) will address four key themes (Society, Future Technologies, Water Sensitive Urbanism, and Adoption Pathways) identified as critical to encourage community acceptance of, and participation in, the development of water sensitive cities (CRC WSC Bid Document). The CRC is hosted in the Centre for Water Sensitive Cities at Monash University, Melbourne. The current activities of the Centre relate to enabling the wider uptake of WSUD with a strong focus on the sustainable integration of stormwater into the planning of cities, and the development and use of cities as water supply catchments (http://www.watersensitivecities.org.au/about-us/cwsc/background-and-aims, accessed 17/5/2012).

3.2.2. Queensland Policy and Practice Opportunities

A scan of the Queensland policy and planning environment has identified regional plans, and the associated state of the region reporting and monitoring, as the most appropriate planning instrument to consider influencing in moving towards water smart communities. Under the Sustainable Planning Act (2009), Regional Plans are a statutory state planning instrument, requiring designated regions to provide: an integrated planning policy for a designated region through the identification of desired regional outcomes and the policies and actions for achieving them; the desired future spatial structure of the region including land use and infrastructure; and key regional environmental, economic and cultural resources to be preserved, maintained or developed (Queensland Government, 2009a). Regional Plans are currently in various stages of development throughout Queensland and are all quite different in terms of content detail and also associated regulatory controls. This has implications for the degree to which innovative water smart solutions can be tried and tested in practice and an opportunity exists to investigate the role of regional planning statutory strictures in limiting or promoting the implementation of water smart solutions across Queensland.

The stated purpose of the most recent SEQ Regional Plan 2009-2031 is to manage regional growth and change in the most sustainable way to protect and enhance quality of life in the region (Queensland Government, 2009b). As part of the SEQ State of the Region Report, prepared every five years, sustainability indicators based on the desired regional outcomes are captured to monitor changes in economic, environmental and social factors and to report on the progress of the region towards sustainability (Queensland Government, 2008). The sections relating to the desired regional outcomes (DRO) for water management (DRO 11) and integrated sustainability (DRO 1) (Figure 10) provide a good opportunity for enhancement and addition through further indicator development.

In Phase 1 (Priestley *et al.*, 2011), a set of scale–related integrated water indicators (to amongst others, inform State of the Region reporting) was advocated as important in assisting to achieve "water smartness" in tropical and sub-tropical cities and towns. It is proposed that relational and intensity-based indicators are developed to highlight links between water-water aspects, water-energy links, water-economic growth relationships and water-social interactions. A set of mass balance-based indicators (Kenway *et al.,* 2011) and a set of 24 indicators to assess sustainability of the urban water cycle, water footprints-based – City Blueprint (Van Leeuwen *et al*., 2012), offer a good starting point.

2013 Sustainability Indicators	2013 - Datasets	2008 – Sustainability Indicators
DRO 1 - SUSTAINABILITY		
• Genuine progress indicator	• Quality of life • Population growth	• Genuine progress indicator • Population growth • Quality of life • Rural population (DRO5)
• Ecological footprint	• Ecological footprint	• Ecological footprint
• Greenhouse gas emissions	• Co2 emissions from car and electricity use per capita	• Greenhouse gas emissions (DRO2) • Climate change trends (DRO2)
		• Ecosystem service provision
DRO 11 – WATER MANAGEMENT		
• Water for urban usage	• Water usage	• Water usage • Groundwater availability
• Water conservation	• Consumption data to map against Target 200	•
• Water quality	• EHMP grades	• Residential potable water use
• Groundwater levels and quality	• Ground water availability • Percentage of groundwater units that have groundwater quality (nutrients and EC measurements) within identified acceptable annual ranges	
• Waterways and catchments	• Percentage increase in vegetation cover in water supply catchments • EHMP grades	
• Rural water use	• Rural water use efficiency	• Rural water use efficiency

Figure 10: Extract from the SEQ State of the Region Report (Desired Regional Outcomes (DRO) 11 Water Management and DRO 1 Sustainability).

3.3. Resulting Knowledge Areas

A set of knowledge areas emerged from the targeted literature and industry policy and practice reviews as well as from the Researcher Workshop (May 2012) (Figure 11).

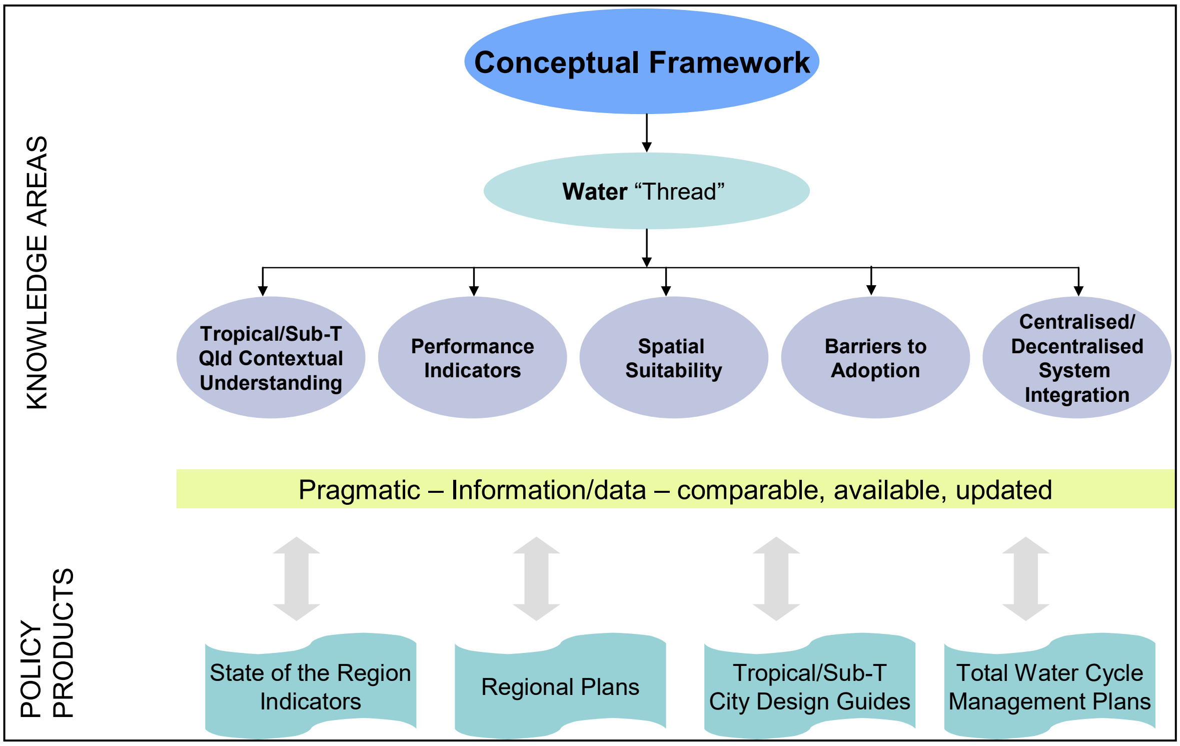


Figure 11: Knowledge areas for "water smartness" in tropical and sub-tropical cities and towns.

An overarching knowledge area is the high level, guiding and integrating conceptual framework, which all other knowledge areas should related to. This emerging conceptual framework is discussed in more detail in Section 3.3.1 below. The conceptual framework will be articulated and adapted from the theoretical advances already made in relation to the urban metabolism model. The water "thread", or nodes and feedback loops where water factors influence or are influenced by other socio-ecological factors, will be mapped within the broader, high level conceptual framework to prioritise areas of focus for water smart transitions, including their linkages within the broader system.

To be informed by the overarching conceptual framework, the following knowledge areas identified were: contextual understanding; performance indicators; spatial suitability; barriers to adoption; and centralised-decentralised system integration. These are described generally in Table 1. These knowledge areas will all be further designed within the broader guiding framework as part of the next stage Research Program development. It will be a high priority to develop and regularly update an information base to provide other knowledge areas with access to comparable, updated supporting data and analysis tools. To ensure relevance and impact of research outcomes, each knowledge area will be clearly mapped to specific policies and/or products where relevant such as the State of the Region Report, Regional Plans, Design Guides and Total Water Cycle Management Plans (Figure 11).

Table 1: Description of knowledge areas.

Knowledge Areas	Explanation
Conceptual framework	Describes the high level system components, interactions and flows to guide an empirical inquiry.
Queensland context	Physical and socio-economic conditions across Queensland which offer a different set of conditions with which to work when designing water smart solutions – internal differentiation as well as differences from say more temperate climates.
Performance indicators	Quantifiable metrics to describe the state of particular elements of the system in order to comparably monitor changes over time and between areas.
Spatial suitability	Maps of the relative potential for water smart solutions compiled by combining a range of suitability - influencing factors, normally using GIS technology.
Barriers to adoption	Typically institutional, policy, regulatory or cost factors which inhibit the uptake of non-traditional innovative solutions.
Centralised/decentralised system integration	Technical, regulatory, cost, acceptance and maintenance aspects of integrating decentralised systems as part of the centralised system, overcoming issues of redundancy.
Information base	Comparable and regularly updated data and information is required to inform all other knowledge areas. Need to know what is available, what proxy data can be used and where primary data gathering need to occur.

3.3.1. The Emerging Conceptual Framework

A workshop was held in late May 2011, with influential and relevant academics operating in the Queensland context, to advance the discussion, amongst others, on the usefulness of an emerging conceptual framework based on the alternative approaches and theoretical advances to urban metabolism advanced in the literature and industry practice and policy reviews as described above. Some of the key discussion points to emerge in terms of taking forward the development of an applicable guiding conceptual framework included:

- clarifying the scope of the framework for tropical and sub-tropical Queensland (this is explored in more detail in Section 3.5 below);
- defining and developing a common understanding and language about "Water Smart" and describing the key themes and elements to be incorporated into the conceptual framework, goals and objectives; and
- defining the boundary for the framework – the spatial scale and how to account for flows and effects in and out of the region of interest, eg, emissions relevant at a scale broader than cities; offsets often happen outside of region of interest.

3.3.2. Understanding the Queensland Context

Understanding the particular tropical/sub-tropical context of Queensland, and SEQ in particular, emerged as one of the key knowledge areas. Participants at the Researcher Workshop (May 2012) and the second Stakeholder Workshop (June 2012) broadly determined a set of biophysical and socio-economic contextual differences or unique characteristics of Queensland when compared with other Australian or international cities and regions.

Much of the current thinking and research into making cities more water smart originates from work undertaken in cities in Europe and south-east Australia, where not only are the climates more temperate, but very different hydrogeological conditions exist. In tropical and sub-tropical Queensland, water smart solutions which attempt to reduce heat island effects and use aquifer storage are not relevant. In addition, implementing water smart transitions in any context is highly dependent on prevailing political, institutional, legislative and behavioural factors. Major biophysical and socio-economic differences identified are summarised below .

3.3.3. Biophysical Environment

The climate in Queensland is significantly different to most other Australian States. Rainfall, temperatures and evaporation rates are higher. Climatic variability is very high (as is Sydney) reflecting Queensland's sub-tropical location. This variability has strong implication for infrastructure design, particularly storage sizes for capturing and holding runoff. It influences the viability of various water harvesting options – such as rainwater tanks and/or groundwater aquifer recharge. Elevated temperatures also mean major differences for water quality management, for example in relation to management of algal or microbiological growth in storages or distribution systems.

In SEQ, the natural geology has negligible natural aquifers. This means that storage of water underground is far more problematic. Almost all of SEQ drains into Moreton Bay, which has international environmental significance. Consequently, SEQ has no ocean outfalls, which is a difference to Sydney and Perth. A flow-on effect is that SEQ has relatively high levels of wastewater treatment prior to discharge. Further north, the World Heritage status of the Great Barrier Reef imposes even stronger environmental and water and wastewater management responsibilities. The warmer ocean ecological processes are also distinct.

3.3.3.1 Human (Socio-Economic) Environment

The resources boom and high population growth increased demands on the Queensland environment. Queensland's relatively recent development (compared with NSW and Victoria), and strong resources base has inclined policy towards pro-development and relatively conservative decision-making, with a power-base strongly within SEQ. SEQ also has highly-developed, decentralised development patterns, which is similar to Western Australia. Household mobility is also relatively high, however this may stabilise with time.

Local government has particular strength in Queensland, and there is some political dispensation to strengthen this. This is in contrast to other States which are perceived as still pushing for centralisation of government to the State. Queensland has fewer, larger and financially stronger local government than elsewhere in Australia. An outcome is that the relationships between State, Local and Federal Government, and business, are different in Queensland. For example, local government (eg, Gold Coast Water) have typically managed urban water. Elsewhere in Australia, State Government manages urban water, typically via a state-owned corporation such as Water Corporation (in Western Australia) or SA Water (in South Australia). This structure contributes to stronger decentralisation of water and wastewater infrastructure compared to other states. Similar State-based differences are evident with regard to energy supply.

A substantial difference in the planning environment relates to compensation for Injurious Affection, for example when changes to planning schemes are proposed, or when planning scheme policies affect development rights (‘down zoning’). This is unique to Queensland and influences local government decision-making. A flow-on effect is interference with the ability of local government to act in the greater community interest or in ecologically sustainable ways. The argument supporting injurious affection claims for planning scheme changes is that such provisions ensure the protection of development rights and property values and that a move to an ‘ecological’ or ‘liveable’ community need not be at the expense of landowners.

In SEQ, there is also a much greater proportion of freehold land compared to other States with have much higher proportions of State or Crown Land. For example, Sydney has about 44% State Land, while SEQ has only 17%. An implication is that it is more difficult to “control” land use, so implementing water smart solutions may be more difficult, or may need to be implemented differently.

Considerable differences are also evident within Queensland. Solutions in the tropical areas and the Great Barrier Reef catchment are highly distinct to drier inland cities and sub-tropical SEQ. Consequently, the differences between Queensland and other Australian States, discussed above, should not be read as universally applicable, rather, the factors identified should be taken into account when considering the outcomes of research, management or policy developed in different areas.

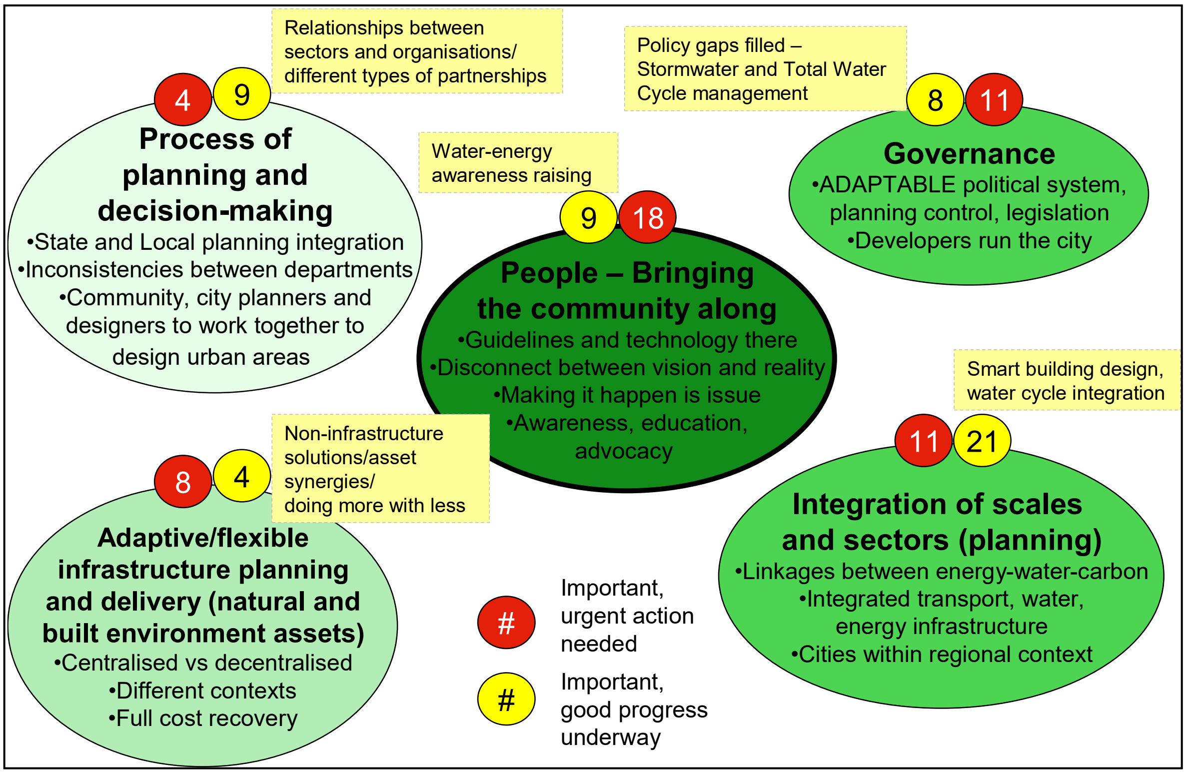
4. CHANGES AND ACTIONS IDENTIFIED

4.1. Stakeholder Identified Changes and Actions

A Stakeholder Workshop, held in January 2012, specifically explored the needs and opportunities for advancing the change to "water smartness" in cities and towns in tropical and sub-tropical Queensland Four questions were explored:

- How do our cities and towns need to change?
- Where should we be focussing our attention?
- What can we do better to get change happening?
- How effective and difficult are these actions to achieve and how important are they?

A range of areas for change were identified and prioritised in terms of importance and degree of action required or in progress (Figure 12). Individual areas for change and action identified by government stakeholders were grouped into five broader categories and the priority score totalled for each: people; governance; integration; adaptive planning and delivery and process of planning and delivery. In Figure 12, areas for change which are important, and where it was felt significant action was still needed to resolve are indicated by the number of red dots. Area of importance where it is felt most progress is already being made in terms of achieving change are indicated by the number of yellow dots.



Note: Red dots - important but not making headway
Yellow dots – important and making headway

Figure 12: Areas for change to "water smartness" in tropical and sub-tropical cities and towns identified and prioritised.

Areas for change which are important, and where it was felt significant action was still needed to resolve are listed below in decreasing order of importance:

- People - bringing the community along so as to bridge the apparent disconnect between vision and reality, bringing about the practical application of readily available knowledge already present in existing guidelines and policy:
  - Disconnect between the vision and reality - have the guidelines, how to make it happen
  - Awareness, education, advocacy
    - Research to make clear to residents the best ways to be energy and water smart
    - Empowering residents with knowledge
    - Using multiple outcomes/benefits of open spaces to activate community and raise profile of environmental values
  - Greater awareness of water-energy issues
  - Community expectations around liveability and lifestyle. The way we live may need to change to enable smarter use of energy and water
    - It's about the people/residents behaviours and change/ interventions vs actions.
- Governance - changes to more adaptable and flexible political, planning control and legislative systems:
  - Planning control (limitations) in development outside scope of utilities
  - Political system
  - Legislation
  - Adaptability in planning, legislative and political system needed (links to above 3 points)
  - Developers run the city(ies)
  - Policy gaps to be plugged (Stormwater, TWCMP)
- Integration of scales and sectors (planning) - more specifically the linkages between energy-water-carbon, transport, water and energy infrastructure and cities within their regional context:
  - Smarter building design for climate
  - Integrating efficient buildings with each other and with surroundings
  - Turn cities into producers of water, energy etc
  - Linkages between energy –water –carbon and planning for transport, water, energy infrastructure
  - Increased connectivity between transport and green assets
  - Great consideration of regions in city planning – ecological footprints
  - Fragmented water cycle elements
  - Should be integrated
  - More effective partnering
- Adaptive/flexible infrastructure planning and delivery, including natural and built environment assets - focused on issues of centralised vs decentralised infrastructure, different contexts, full cost recovery:
  - Adaptive infrastructure planning
  - Flexible/adaptive infrastructure planning that allows for innovation
  - Centralised infrastructure locks in investment – approaches
  - Can decentralised approaches be better considered?
  - Adaptability and flexibility of principles and processes to suit different contexts (regions, rainfall zones etc)
  - How is full cost recovery determined
  - Revalue infrastructure
  - Non-infrastructure solutions/Asset synergies
  - Doing more with less
  - Multi-value

- Processes of planning and decision-making - including improved levels of State and Local planning integration, reducing inconsistencies between departments and greater levels of community, city planners and designers work together to design urban areas:
  - Better State and Local Government planning integration
  - Council ambition for land and water clashed with State
  - State policy behind local?
  - Inconsistencies within Government departments
  - Community and city planners and designers to work collectively at the concept stage to design urban areas and cities
  - Relationships between sectors and organisations/ different types of partnerships.

The area of importance where it is felt most progress is already being made in terms of achieving change relates to the integration of scales and sectors in planning, where there is significant action in smart building design and total water cycle integration. Other areas of progress include awareness-raising of the links between water and energy, multiple uses of infrastructure assets and educating communities of ways to be more water and energy smart (Figure 12).

Effectiveness of proposed actions and difficulty to achieve them were indicated by plotting actions on a graph with level of difficulty (hard to easy) indicated on the y-axis and level of effectiveness (ineffective to effective) indicated on the x-axis. Importance was indicated by allocating red dots to actions of priority. Most action identified fall into the "effective" half of the map, with most falling into the "effective but difficult to achieve" quadrant. Most actions for change identified, relate to "People – bringing the community along" (Figure 13).

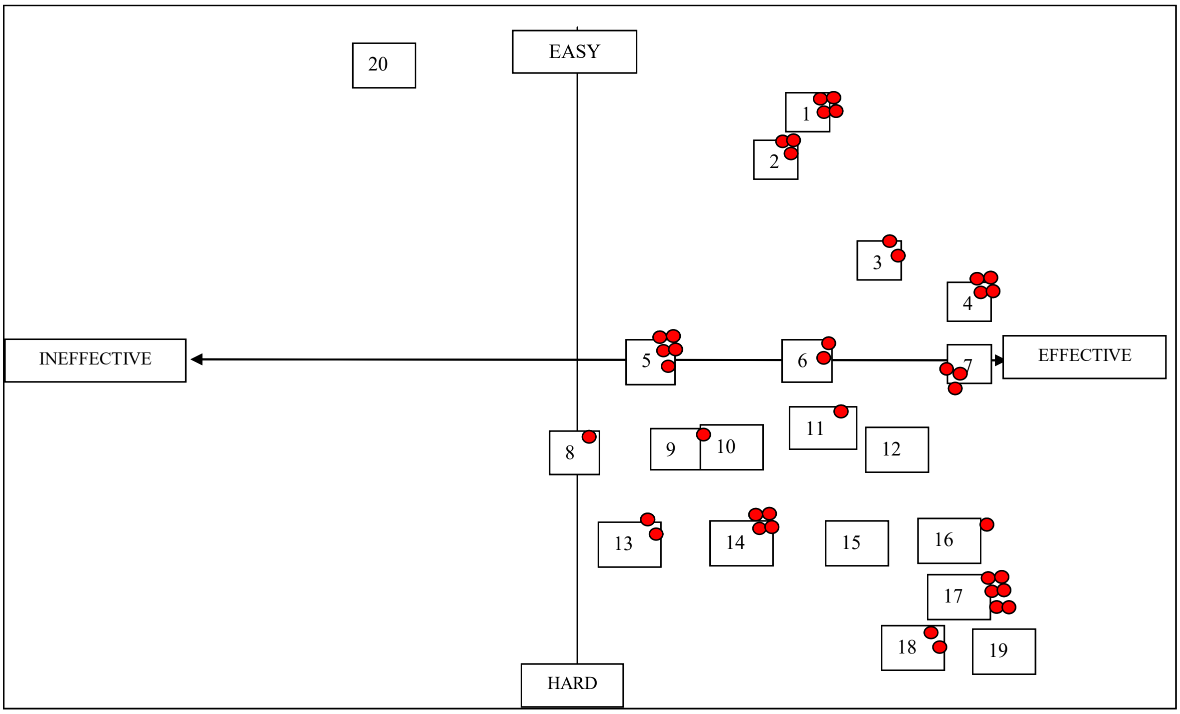


Figure 13: Actions for change, their effectiveness and difficulty to achieve and priorities.

The set of "easier to achieve but effective" actions identified relate primarily to high-level community engagement, education, advocacy and awareness-raising to effect behavioural change. Effective actions, identified as more difficult to achieve, relate to the provision of evidence-based, targeted information to create a deeper level of awareness and understanding of issues to not only effect a change in behaviour, but to enable community participation in infrastructure planning and visioning, ie, participatory decision-making where information such as costs and benefits are made clear and transparent so that informed decision-making can take place on the basis of a shared understanding of the implications of decisions (Figure 13).

Specific actions identified are as follows (numbering relates to position on graph, Figure 13):

Effective/Easy to achieve actions

- Provide information contextualised for particular households/personal impacts (1).
- Design engagement processes at a scale people can relate to (2).
- Influence behaviour by giving away slightly different things eg food plants, chooks (3).
- Women instigating family conversations. Use champions/elders to influence communities (4).

Effective/Moderately easy to achieve actions (on the borderline between easy and difficult quadrants)

- For WSUD, clear link between costs and services, eg, headworks, technical method and data (5).
- Investigate smaller scale solutions that can provide services to delay/offset investment in centralised systems (6).
- Prepare a State Planning policy for WSUD (7).

Effective/Difficult to achieve actions

- Involve communities in urban future visioning (BCC's view is that this was highly effective – depends on how effectiveness is viewed) (8).
- Engage people about infrastructure – raise visibility of what and how (9).
- Access adults through smart phones, QR reader, link to energy, water cycle, catchment tours (10).
- Local implementation – as long as State is not "in the way" (11).
- Explain change in audience-tailored ways (12).
- Feedback on success/failure (open, internal, public media, no systems of political backing – education for community) (13).
- Clear State and local responsibilities and holding accountable (14).
- Social marketing to influence behaviour change (15).
- Understand why people behave as they do and target accordingly (16).
- Identify and value costs and benefits of implementing new urban developments (17).
- Financial robustness, return on investment, consistent costing approaches, shareholder value, future carbon $ etc (18).
- State to set WSUD direction (only) (19).

Ineffective/Easy to do actions

One action identified in this quadrant as partially ineffective but very easy:

- Negative future imagery of natural asset degradation (20).

4.2. Researcher Response

A workshop was held at the end of May 2012, involving a number of influential and relevant academics operating in the Queensland context, to elicit a research response to the changes and actions raised by key stakeholders. It was concluded that most of the changes and actions identified by stakeholders are all fairly standard practice and that the research effort should be focussed on: (1) effectiveness of the interventions; (2) what the optimum package of interventions is; and (3) the particular socio-political and biophysical context of Queensland/Tropical-Sub-Tropical cities/regions.

Even in areas which stakeholders identified as being important but where there was good progress already underway, the researchers' workshop felt it is still important to maintain effort and action. A good example is the progress being made by the Healthy Waterways Partnership. More specific responses provided by the researchers are as follows:

- How important are crises in driving change? Or more positively, big events such as international games? Peak oil is probably still a bit far off the radar to drive change now.
- Benchmarking as a driver of change – introducing element of competition?
- How can a political appetite for integration be generated? Affordability, cost of living is part of it.
- Issue of expectation of "free water" still out there (DERM's regular survey data), water pricing, links to decoupling.
- Concept of "food miles"? Too simple and uni-dimensional?
- Allocation of capital approach (within the decoupling context)? Eg. Starwater good, utilities want the ongoing business but not the assets, "body corporate"/ community/users own the assets and manage the resources, risks and burden passed on to the users, decentralised systems, rain tank management a good example.
- Relating to easy-effective action identified by stakeholders – success in achieving water savings targets, conflict between maintaining behaviour of savings and utilities wanting increased consumption.
- Grid/Off-grid integration; need to overcome issue of redundancy - if one system fails the other stands in; regulatory, cost and behavioural issues – links to Stakeholder Action 5 ("For WSUD, clear link between costs and services eg, headworks, technical method and data").
- Options for management of decentralised systems – eg, Ecovillages – community run - using SCADA type monitoring, alerts, some form of external checks/monitoring – but that does increase cost – community scale/run/off-grid systems only expensive because are working within the constraints of the existing grid system – need new ways of integrating both.
- Good monitoring technologies – SMART systems needed.
- Concept of multi-purpose community level solutions eg, wastewater biogass – Perigian Springs good example but it is peri-urban – are things different in more urban context?
- "Bringing Community Along" is being investigated as part of Program A of the CRC for Water Sensitive Cities – how you communicate and what needs to be communicated.
- Centre for Sub-tropical Design is important partner – Brisbane connection missing.
- Peri-urban research gaps eg, farm dams hold back 40% of water – already identified as 3rd priority for NRM research but as yet unfunded.
- SMART regions rather than cities?

5. A WATER SMART RESEARCH AGENDA

5.1. Focus Areas

The second workshop with key stakeholders, also including researchers, convened to respond to both the stakeholder inputs relating to changes and actions and the knowledge areas identified from the literature review, policy and practice review and contextual understanding identified a set of focus areas to form the basis of the proposed research agenda for water smart tropical and sub-tropical cities and towns.

The focus areas can be grouped (Figure 14) into three broad categories:

- Enabling **communities** to practice water smart activities and behaviour through enhanced understanding, advocacy and capacity building.
- Enabling **institutional** processes and models.
- Enabling **information** for individuals, communities and government.

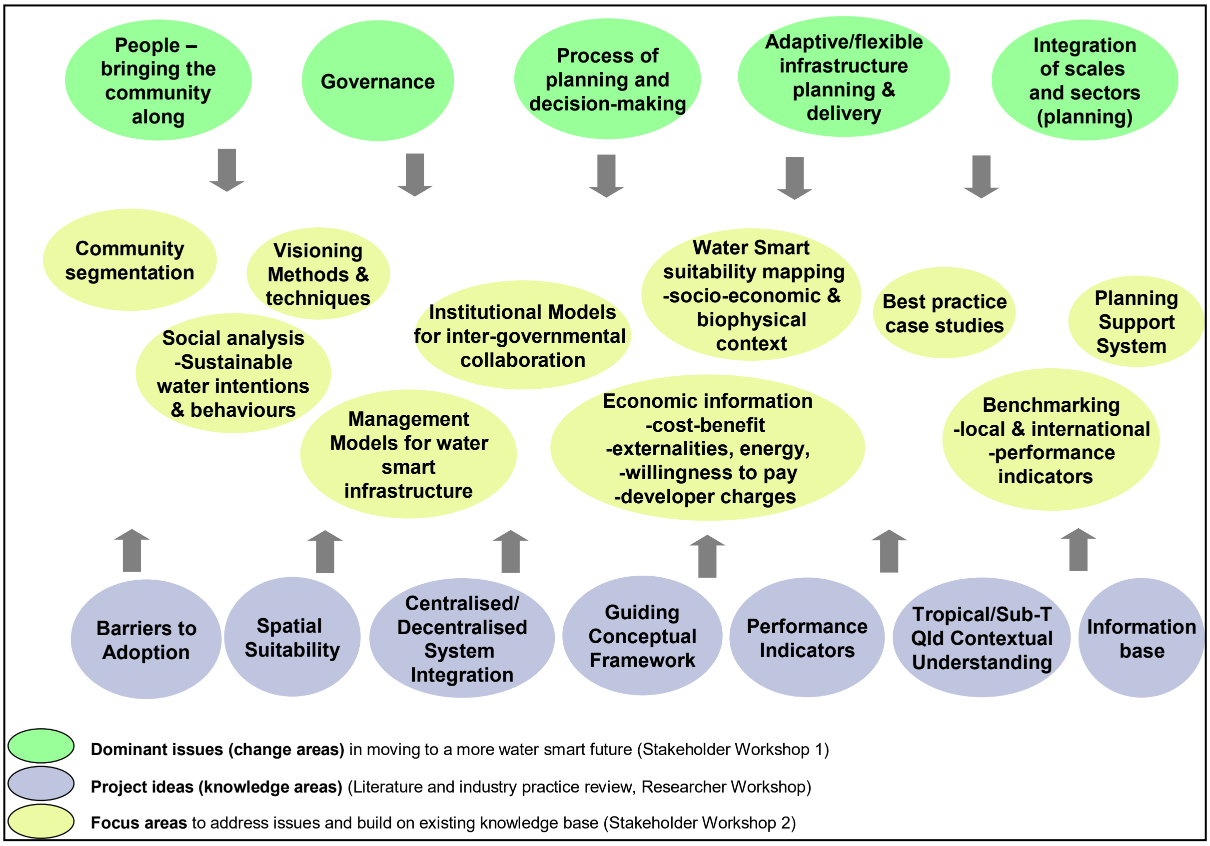


Figure 14: Focus Areas for a water smart tropical and sub-tropical cities and towns research program.

5.2. Enabling Communities

This research focus area involves a focus on understanding community segmentation and dynamics and the variation between and within communities that will lead to different approaches to introducing, motivating and implementing water smart actions. A focus on innovative visioning techniques and processes is also required to enable communities to set their own water smart agenda. At the individual level, the required focus is on social analysis and gaining an understanding of aspects such as the relationship between sustainable water intentions and behaviours in different water supply contexts. In summary, the enabling community focus area includes:

- Community segmentation;
- Visioning methods and techniques; and
- Social analysis for transitioning to more sustainable water intentions and behaviours.

5.3. Enabling Institutions

A focus on enabling institutional models for enhanced inter-governmental collaboration is proposed. In addition, models for better managing water smart infrastructure are also required, such as decentralised systems involving aspects of governance of risk and who owns, is responsible for, and pays for the infrastructure. In summary, the enabling institutions focus area includes:

- Institutional models for intergovernmental collaboration; and
- Management models for water smart infrastructure.

5.4. Enabling Information

To support water smart decision-making and practice, enabling information appropriate to individuals, communities and government is a critical focus area. Water Smart suitability mapping which provides a spatial representation of opportunities and threats on the basis of socio-economic and biophysical contextual factors analysis emerged as a focus area.

Economic information comparing water smart options with traditional options, with water security as an overriding objective, consistently emerged as a priority focus area. This included cost and benefit, externality costs, energy implications, cost to whom, as well as willingness to pay information and information relating to developer charges.

Comparative local and international benchmarking and the role of performance indicators emerged as an important focus area as well as best practice case study information to provide evidence of what works and doesn't work particularly in relation to barriers to adoption. In summary, the enabling information focus area includes:

- Water Smart suitability mapping of socio-economic and biophysical contexts;
- Best practice case studies;
- Economic information including cost-benefit analysis, externalities, willingness to pay and developer charges; and
- Benchmarking – local and international performance indicators.

Necessary to the provision of enabling information is an overarching conceptual framework and a solid, underpinning information platform with accessible, relevant, updated and comparable data and data analysis tools.

5.4.1. Overarching Conceptual Framework

Development of a guiding and integrating conceptual framework emerged as an important overarching knowledge area. The reason it has not been captured as a specific focus area is that it is not a market-facing focus area at the level of the other focus areas but is rather a deeper foundational science area, underpinning the solutions developed to inform the needs-based focus areas. The conceptual framework would emerge in the next phase of designing a research program, as it is a research area which would be lower down in the technology tree. There would be a range of more foundational research areas identified, required to inform the more solution-based focus areas, higher in the tree, still to be determined.

5.4.2. Underpinning Information Platform

At the level of key products or solution in the technology tree (Figure 2), is the opportunity of developing an information platform which could take the form of a Planning Support System (PSS). In accordance with the directive to situate the research agenda at the science-policy interface and in response to the strong stakeholder requirement for evidence-based, targeted, clear and transparent information to enable participatory decision-making, the proposed research agenda is strongly predicated on the well-established concept and knowledge base relating to the development and practical implementation of PSS. PSS are geo-information-based instruments, providing an integrated environment of multiple technologies with a common interface, incorporating a suite of theories, data, information, knowledge, methods and tools to support the planning tasks of problem diagnosis, data collection, spatial and trend analysis, geodata modeling, spatial scenario building, visualization and display, plan formulation, prediction and forecasting, plan evaluation, monitoring, enhanced participation and collaborative decision-making (Geertman, 2006). They function as “information frameworks” that integrate the full range of information technologies useful for supporting the specific planning context for which they are designed (Klosterman, 1997; Geertman and Stillwell, 2003). It is envisaged that the various components of the research agenda (Figure 1) could be incorporated into a science-policy, water-urban planning “boundary object” (Guston, 2001): Planning Support System for Water Smart Tropical and Sub-Tropical Cities and Towns, an integrated, flexible, user-friendly, accessible, repository or “intelligent digital toolbox” (Klosterman, 1997), of data, information, tools and models from which users (planners and communities) can select to support the particular planning task at hand.

6. RESEARCH AGENDA TO RESEARCH PROGRAM

The way ahead for moving from this research agenda to a full research program could follow a number of pathways. With the winding up of the Alliance in December 2012, the most logical way forward is to transfer the learning and conclusions to other relevant and ongoing research initiatives to take forward.

Two potentially relevant initiatives were identified and the results of this process introduced and discussed at appropriate forums:

- International Water Association's Cities of the Future initiative – workshop at the World Water Congress, Busan, Korea, September 2012; and
- CRC for Water Sensitive Cities.

6.1. The Need for Benchmarking City Performance

As a component of this Alliance Water Smart Cities project, an international workshop was convened as part of the International Water Association's Cities of the Future initiative. at the World Water Congress, Busan, to discuss the need for benchmarking city performance. The Alliance had the opportunity to preface the workshop discussion by referring to some of the findings relating to this research agenda. In particular the identified focus area of enabling information - benchmarking by means of local and international performance indicators with a strong guiding conceptual framework based on recent advances on the urban metabolism model, was highlighted.

The workshop focussed on addressing the question as to whether the effort of benchmarking the performance of cities for "water smartness / water sensitivity" was needed and worthwhile. We measure performance at product scale, building scale, but do not yet implement this to the same degree at the city scale. Product scale and building scale measurement have delivered significant improvements. The workshop asked is it time we did it at a city scale?

Being water-smart suggests that water management in the city contributes in a number of ways including:

- Efficiency in water and related energy and materials use;
- Risk management (eg supply continuity, floods and water quality);
- Resilience (ie, able to recover from shocks);
- Liveability; and
- Human well-being and ecosystem health are improving.

There was strong consensus from the workshop that there is a need for a rating system for cities. The major benefits are that: (i) it creates motivation to perform and learn (ii) it promotes discussion and decision-making (iii) creates brand (iv) helps integrate planning efforts and innovation and (v) improves transparency. However there are many factors to consider in their development to avoid pitfalls such as: (a) poor consideration can drive systems in the wrong direction and lead to perverse outcomes (b) some systems can be self-serving and (c) some indicators can be misinforming.

A major challenge is having criteria that reflect meaning in different situations. Cities have different goals and different institutional, finance, social, governance barriers, and in many cases this can lead to a desire for indicators specific to individual cities. However, balance is needed between locally-specific indicators (for flexibility and to accommodate differences), and generically-applicable indicators (to enable benchmarking). Clarity is needed if the aim of the system to be used for communication or investment.

Any rating system would need to be well-designed. It would critical to link to local constraints and outcomes driven by the community. Clear principles are needed with links to community objectives and need to be agreed by all cities and verifiable by an independent body. Clarity is needed around the value propositions that the outcomes are trying to achieve. Example principles could be (a) preserve human health and biodiversity, (b) consider waste as a resource, (c) work towards a zero footprint.

Clear Identification of the boundary that is being benchmarked is important including consideration of virtual water and energy flows. Focussing on local and direct impacts and costs alone is inadequate. Independent verification would add enormously to a benchmarking effort. It was recognised that success can depend on the credibility of the rating agency.

While a number of organisations are developing rating systems at city scale (eg Green Cities index), building scale (eg Leadership in Energy and Environmental Design (LEED) and other scales. No single widely-used rating system yet exists to evaluate the overall water performance of a city. Product scale and building scale measurement have delivered significant improvements. However, we do not yet implement this to the same degree at the city scale. No single widely-used rating system yet exists to evaluate the overall water performance of a city. The workshop conclusion was that it is time that this was also undertaken at city scale.

6.2. CRC for Water Sensitive Cities

The CRC for Water Sensitive Cities was launched in September 2012 with four research programs: Society, Water Sensitive Urbanism, Future Technologies and Adoption Pathways. CRC research leaders participating in the Society and Urbanism Programs, based in Queensland, have been involved in the stakeholders and researcher workshops held as part of the process of formulating the research agenda. A special discussion took place with Queensland-based leaders of the Adoption Pathways program and a number of opportunities identified for incorporation of some of the findings into the future direction of this program.

Coordination with the program currently under development by the new CRC Water Sensitive Cities was identified as a very important element of any research moving forward in SEQ and/or sub-tropical Queensland. The need was identified for continued communication with the Urban Planning (Darryl Low Choy), Communication (Kelly Fielding) and Institutional/Governance (Brian Head) programs in particular to ensure that there is no duplication in what is proposed in the Alliance legacy program and the project plans of the CRC. Stakeholder outputs confirmed the importance the research proposed for Program A, which is exactly addressing the stakeholder identified actions relating to "Bringing the Community along".

7. CONCLUSION

It is clear from both the directed literature review and stakeholder needs identification process, that there are indeed research opportunities at the Science-Policy interface to advance the current understanding of the role and importance of water in achieving sustainable urban development, specifically in the context of tropical and sub-tropical climates and at the science-policy interface. An iterative process including a targeted literature review, a review of the Queensland, and particularly SEQ, policy and practice environment and engagement with key government and research stakeholders has resulted in agreement on SEQ specific research priorities to form the basis for designing a longer term research program. During this process, a number of useful contributions to the water smart cities debate have been made, including:

- Understanding and integration of recent advances in conceptual models based on urban metabolism;
- Extraction and distillation of changes and actions necessary to transition to more water smart cities as identified by key Queensland government and research stakeholders;
- Effective resolution of “top-down” issues (changes and actions needed) and “bottom-up” knowledge areas into research focus areas - where science meets policy needs; and
- Classification of focus areas into a four-pillar research agenda.

This project has culminated in a set of research focus areas which form the pillars of the research agenda:

- enabling communities to practice water smart activities and behaviour through enhanced understanding, advocacy and capacity building;
- enabling institutional processes and models; and
- enabling information for individuals, communities and government, underpinned by a guiding conceptual framework and a solid information platform with accessible, relevant, updated and comparable data and data analysis tools

It is intended that this set of focus areas will form the basis for designing a full research program. These focus areas are market facing and high in the technology tree. In designing a research program, these needs-based, focus areas need to be linked right through to base science through a series of key products or solutions, technology platforms and applied technology towards the top end of the tree in the more applied space, down to base technologies, and basic science at the base of the tree. The guiding conceptual framework which would necessarily underpin any research conducted to inform the focus areas, is an example of a research area lower down in the tree.

The opportunity this process of dialogue represents in terms of generating the genuinely trans-disciplinary, multi-scale basis for better integrating water within the urban development process, is significant and exciting. The state of Queensland, with its rapidly expanding urban population and economic growth, and tropical and sub-tropical climate, provides a unique context for making a step change in progressing towards the next generation of urban sustainability.

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